1. Introduction

The goal of the CLARIN Federated Content Search (CLARIN-FCS) - Core specification is to introduce an [interface specification](https://www.iso.org/obp/ui/#iso:std:oas-is:tsi:2020:08:en) that decouples the search engine functionality from its exploitation, i.e., user-interfaces, third-party applications, and to allow services to access heterogeneous search engines in a uniform way.

### 1.1. Terminology

The key words **MUST**, **MUST NOT**, **REQUIRED**, **SHALL**, **SHALL NOT**, **SHOULD**, **SHOULD NOT**, **RECOMMENDED**, **MAY**, and **OPTIONAL** in this document are to be interpreted as in [RFC2119](https://tools.ietf.org/html/rfc2119).

### 1.2. Glossary

**Aggregator**

A module or service to dispatch queries to repositories and collect results.

**Annotation Layer**

An annotation layer is the sum of possible annotations for a language resource, such as part of speech or orthographic transcription. Usually it is related to a given annotation task or topic. For the scope of the specification it is used as synonym for annotation tier.

**CLARIN-FCS, FCS**

CLARIN federated content search, an interface specification to allow searching within resource content of repositories.

**Client**

A software component, which implements the interface specification to query Endpoints, i.e., an aggregator or a user-interface.

**CQL**

Contextual Query Language, previously known as Common Query Language, is a domain specific language for representing queries to information retrieval systems such as search engines, bibliographic catalogs and museum collection information.

**Data View**

A Data View is a mechanism to support different representations of search results, e.g., a "hits with highlights" view, an image or a geolocation.

**Data View Payload, Payload**

The actual content encoded within a Data View, i.e., a CMDI metadata record or a KML encoded geolocation.

**Endpoint**

A software component, which implements the CLARIN-FCS interface specification and translates between CLARIN-FCS and a search engine.

**FCS-QL**

Federated Content Search Query Language is the query language used in the advanced CLARIN-FCS profile. It is derived from Corpus Workbench’s [CQP-TUTORIAL](https://corpus-workbench.org/docs/cqp-tutorial/).

**Hit**

A piece of data returned by a Search Engine that matches the search criterion. What is considered a Hit highly depends on Search Engine.

**Interface Specification**

Common harmonized interface and suite of protocols that repositories need to implement.

**Layer**

See Annotation Layer

**PID**

A Persistent identifier is a long-lasting reference to a digital object.

**Repository**

A software component at a CLARIN center that stores resources (= data) and information about these resources (= metadata).

**Repository Registry**

A separate service that allows registering Repositories and their Endpoints and provides information about these to other components, e.g., an Aggregator. The [CLARIN Center Registry](https://www.clarin.eu/clarin-center-registry/) is an implementation of such a repository registry.

**Resource**

A searchable and addressable entity at an Endpoint, such as a text corpus or a multi-modal corpus.

**Resource Fragment**

A smaller unit in a Resource, e.g., a sentence in a text corpus or a time interval in an audio transcription.

**Result Set**

An (ordered) set of hits that match a search criterion produced by a search engine as the result of processing a query.

**Search Engine**

A software component within a repository that allows for searching within the repository contents.

**SRU**

Search and Retrieve via URL is a protocol for Internet search queries. Originally introduced by Library of Congress LOC-SRU12, later standardization process moved to OASIS OASIS-SRU12, OASIS-SRU20.
The following typographic conventions for XML fragments will be used throughout this specification:

- `<prefix:Element>`: An XML element with the Generic Identifier `Element` that is bound to an XML namespace denoted by the prefix `prefix`.
- `@attr`: An XML attribute with the name `attr`
- `string`: The literal `string` must be used either as element content or attribute value.

Endpoints and Clients **MUST** adhere to the XML-Namespace specification. The CLARIN-FCS interface specification generally does not dictate whether XML elements should be serialized in their prefixed or non-prefixed syntax, but Endpoints **MUST** ensure that the correct XML namespace is used for elements and that XML namespaces are declared correctly. Clients **MUST** be agnostic regarding syntax for serializing the XML elements, i.e. if the prefixed or un-prefixed variant was used, and **SHOULD** operate solely on expanded names, i.e. pairs of namespace name and local name.

The following XML namespace names and prefixes are used throughout this specification. The column "Recommended Syntax" indicates which syntax variant **SHOULD** be used by the Endpoint to serialize the XML response.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Namespace Name</th>
<th>Comment</th>
<th>Recommended Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>fcs</td>
<td><a href="http://clarin.eu/fcs/resource">http://clarin.eu/fcs/resource</a></td>
<td>CLARIN-FCS Resources</td>
<td>prefixed</td>
</tr>
<tr>
<td>ed</td>
<td><a href="http://clarin.eu/fcs/endpoint-description">http://clarin.eu/fcs/endpoint-description</a></td>
<td>CLARIN-FCS Endpoint Description</td>
<td>prefixed</td>
</tr>
<tr>
<td>hits</td>
<td><a href="http://clarin.eu/fcs/dataview/hits">http://clarin.eu/fcs/dataview/hits</a></td>
<td>CLARIN-FCS Generic Hits Data View</td>
<td>prefixed</td>
</tr>
</tbody>
</table>
2. CLARIN-FCS Interface Specification

The CLARIN-FCS Interface Specification defines a set of capabilities, an extensible result format and a set of required operations. CLARIN-FCS is built on the SRU/CQL standard and additional functionality required for CLARIN-FCS is added through SRU/CQL's extension mechanisms.

Specifically, the CLARIN-FCS Interface Specification consists of two parts, a set of formats, and a transport protocol. The Endpoint component is a software component that acts as a bridge between a Client and a Search Engine and passes the requests sent by the Client to the Search Engine. The Search Engine is a custom software component that allows the search of language resources in a Repository. The Endpoint implements the Transport Protocol and acts as a mediator between the CLARIN-FCS specific formats and the idiosyncrasies of Search Engines of the individual Repositories. The following figure illustrates the overall architecture:

In general, the work flow in CLARIN-FCS is as follows: a Client submits a query to an Endpoint; the Endpoint translates the query from CQL or FCS-QL to the query dialect used by the Search Engine and submits the translated query to the Search Engine; the Search Engine processes the query and generates a result set, i.e. it compiles a set of hits that match the search criterion; the Endpoint then translates the results from the Search Engine-specific result set format to the CLARIN-FCS result format and sends them to the Client.

2.1. Discovery

The Discovery step allows a Client to gather information about an Endpoint, in particular which capabilities are supported or which resources are available for searching.

2.1.1. Capabilities

A Capability defines a certain feature set that is part of CLARIN-FCS, e.g. what kind of queries are supported. Each Endpoint implements some (or all) of these Capabilities. The Endpoint will announce the capabilities it provides to allow a Client to auto-tune itself (see section Endpoint Description). Each Capability is identified by a Capability Identifier, which uses the URI syntax. The following Capabilities are defined in CLARIN-FCS:

<table>
<thead>
<tr>
<th>Name</th>
<th>Capability Identifier</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Search</td>
<td><a href="http://clarin.eu/fcs/capability/basic-search">http://clarin.eu/fcs/capability/basic-search</a></td>
<td>Simple full-text searching</td>
</tr>
<tr>
<td>Advanced Search</td>
<td><a href="http://clarin.eu/fcs/capability/advanced-search">http://clarin.eu/fcs/capability/advanced-search</a></td>
<td>Searching in structured and/or annotated data</td>
</tr>
</tbody>
</table>

Endpoints MUST implement the Basic Search Capability. Endpoints MUST NOT invent custom Capability Identifiers and MUST only use the values defined above.

2.1.2. Endpoint Description

Endpoints need to provide information about their capabilities to support auto-configuration of Clients. The Endpoint Description mechanism provides the necessary facility to provide this information to the Clients. Endpoints MUST encode their capabilities using an XML format and embed this information into the SRU/CQL protocol as described in section Operation "explain". The XML fragment generated by the Endpoint for the Endpoint Description MUST be valid according to the XML schema "Endpoint-Description.xsd" (download).

The XML fragment for Endpoint Description is encoded as an `<edi:EndpointDescription>` element, that contains the following attributes and children:

- one `@version` attribute (REQUIRED) on the `<edi:EndpointDescription>` element. The value of the `@version` attribute MUST be 2.
- one `<edi:Capabilities>` element (REQUIRED) that contains one or more `<edi:Capability>` elements

The content of the `<edi:Capability>` element is a Capability Identifier, that indicates the capabilities, that are supported by the Endpoint. For valid values for the Capability Identifier, see section Capabilities. This list MUST NOT include duplicate values.
A list of Data Views that are supported by this Endpoint. This list is composed of one or more `<ed:SupportedDataView>` elements. The content of a `<ed:SupportedDataView>` element MUST be the MIME type of a supported Data View, e.g. application/x-clarin-fcs-hits+xml. Each `<ed:SupportedDataView>` element MUST carry an `@id` attribute. The value of the `@id` attribute is later used in the `<ed:Resource>` element to indicate which Data View is supported by a resource (see below). Endpoints SHOULD use the recommended short identifier for the Data View. The `@delivery-policy` indicates the Endpoint's delivery policy, for that Data View. Valid values are send-by-default for the send-by-default and need-to-request for the need-to-request delivery policy. This list MUST NOT include duplicate entries, i.e. no MIME type must appear more than once. The value of the `@id` attribute is a whitespace-separated list of id values, that correspond to the value of the appropriate `@ref` attribute; the value of the `@ref` attribute is later used in the `<ed:Resource>` element to indicate which Data View is supported by a resource (see below). The `@result-id` attribute is used in the Advanced Data View (see section "Advanced Data View"). Each `<ed:SupportedDataView>` element MAY carry an optional `@Qualifier` attribute. It is used as a qualifier in a FCS-QL search term in to address this specific layer.

A list of Resources that are available, i.e. searchable, at the Endpoint. The `<ed:Resources>` element contains one or more `<ed:Resource>` elements (see below). The Endpoint MUST declare at least one (top-level) resource.

The `<ed:Resource>` element contains a basic description of a resource that is available at the Endpoint. A resource is a searchable entity, e.g. a single corpus. The `<ed:Resource>` has a mandatory `@id` attribute that contains persistent identifier of the resource. This value MUST be the same as the MdSel/Link of the CMDI record describing the resource. The `<ed:Resource>` element contains the following children:

- one or more `<ed:Title>` elements (REQUIRED)
  A human readable title for the resource. A REQUIRED `@xml:lang` attribute indicates the language of the title. An English version of the title is REQUIRED. The list of titles MUST NOT contain duplicate entries for the same language.

- zero or more `<ed:Description>` elements (OPTIONAL)
  An optional human-readable description of the resource. It SHOULD be at most one sentence. A REQUIRED `@xml:lang` attribute indicates the language of the description. If supplied, an English version of the description is REQUIRED. The list of descriptions MUST NOT contain duplicate entries for the same language.

- zero or one `<ed:LandingPageURI>` element (OPTIONAL)
  A link to a website for the resource, e.g. a landing page for a resource, i.e. a web-site that describes a corpus.

- one `<ed:Languages>` element (REQUIRED)
  The (relevant) languages available within the resource. The `<ed:Languages>` element contains one or more `<ed:Language>` elements. The content of a `<ed:Language>` element MUST be a ISO 639-3 three letter language code. This element should be repeated for all languages present (or known) available within the resolvable with this list `@id` attribute.

- one `<ed:AvailableDataViews>` element (REQUIRED)
  The Data Views that are available for the resource. The `<ed:AvailableDataViews>` element MUST carry a `@ref` attribute, that contains a whitespace-separated list of id values, that correspond to value of the appropriate `@id` attribute for the `<ed:SupportedDataView>` elements that are referenced.

In case of sub-resources, each Resource SHOULD support all Data Views that are supported by the parent resource. However, every resource MUST declare all available Data Views independently, i.e. there is no implicit inheritance semantic.

- one `<ed:AvailableLayers>` element (REQUIRED if Endpoint supports Advanced Search capability)
  The `<ed:AvailableLayers>` element MUST carry a `@ref` attribute, that contains a whitespace-separated list of id values, that correspond to value of the appropriate `@id` attribute for the `<ed:SupportedLayer>` elements that are referenced.

In case of sub-resources, each Resource SHOULD support all Layers that are supported by the parent resource. However, every resource MUST declare all available Layers independently, i.e. there is no implicit inheritance semantic.

- zero or one `<ed:Languages>` elements (OPTIONAL)
  If a resource has searchable sub-resources, the Endpoint MUST supply additional finer grained resource elements, which are wrapped in a `<ed:Resources>` element. A sub-resource is a searchable entity within a resource, e.g. a sub-corpus.

Example 4:

```
<ed:EndpointDescription xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="2">
  <ed:Capabilities>
    <ed:SupportedDataViews>
      <ed:SupportedDataView id="hits" delivery-policy="send-by-default" application/x-clarin-fcs-hits+xml>
      </ed:SupportedDataView>
    </ed:SupportedDataViews>
  </ed:Capabilities>
  <ed:SupportedDataViews>
    <ed:SupportedDataView id="xml:lang="en">Goethe corpus</ed:SupportedDataView>
    <ed:SupportedDataView id="xml:lang="de">Goethe Korpus des IDS Mannheim</ed:SupportedDataView>
    <ed:SupportedDataView id="xml:lang="fr">Le Goethe corpus du IDS de Mannheim</ed:SupportedDataView>
  </ed:SupportedDataViews>
</ed:EndpointDescription>
```

Example 4 shows a simple Endpoint Description for an Endpoint that only supports the Basic Search Capability and only provides the Generic Hits Data View, which is indicated by a `<ed:SupportedDataView>` element. This element carries an `@id` attribute with a value of `hits`, the recommended value for the short identifier, and indicates a delivery policy of send-by-default by the `@delivery-policy` attribute. It only provides one top-level resource identified by the persistent identifier `http://hdl.handle.net/4711/0815`. The resource has a title as well as a description in German and English. A landing page is located at `http://repos.example.org/corpus1.html`. The predominant language in the resource contents is German. Only the Generic Hits Data View is supported for this resource, because the `<ed:AvailableDataViews>` element only references the `<ed:SupportedDataView>` element with the `@id` with a value of `hits`.

The more complex Example 5 show an Endpoint Description for an Endpoint that, similar to Example 4, supports the Basic Search capability. In addition to the Generic Hits Data View, it also supports the CMDI Data View. The delivery polices are send-by-default for the Generic Hits Data View and need-to-request for the CMDI Data View. The Endpoint has two top-level resources (identified by the persistent identifiers http://hdl.handle.net/4711/0815 and http://hdl.handle.net/4711/0816. The second top-level resource has two independently searchable sub-resources, identified by the persistent identifiers http://hdl.handle.net/4711/0816-1 and http://hdl.handle.net/4711/0816-2. All resources are described using several properties, like title, description, etc. The first top-level resource provides only the Generic Hits Data View, while the other top-level resource including its children provides the Generic Hits and the CMDI Data Views.

Example 6:
Example 6 shows an Endpoint Description for an Endpoint that supports the Advanced Search capability. The ed:SupportedDataViews also shows support for Advanced Data View in this case. The ed:SupportedLayers contains the list of ed:SupportedLayer elements. These elements must carry an @id attribute that is referred to by an ed:Resource element to indicate which Data View is supported and a @delivery-policy attribute. The #result-id attribute is used in ADV. If needed the optional @qualifier attribute is used in a FCS-QL search term to address this specific layer, e.g. pos or pos2. The attribute @alt-value-info should contain a short description about the layer. If further information is needed use the @alt-value-info-uri attribute with an well-formed URI to point to a web site. This information could be shown by the Aggregator together with any search results. The attribute @type has a default value of {value which should only be changed to empty when needed.

2.2. Searching

In the Searching step the Client performs the actual search request to a previously discovered Endpoint.

2.2.1. Basic Search

The Basic Search capability provides simple full-text search. Queries in Basic Search MUST be performed in the Contextual Query Language (OASIS-CQL). The Endpoint MUST support term-only queries. The Endpoint SHOULD support terms combined with boolean operator queries (AND or OR), including sub-queries. An Endpoint MAY also support NOT or PROX operator queries. If an Endpoint does not support a query, i.e. the used operators are not supported by the Endpoint, then it MUST return an appropriate error message using the appropriate SRU diagnostic (LOC-DIAG).

The Endpoint MUST perform the query on an annotation layer that makes the most sense for the user, i.e. the textual content for a text corpus resource or the orthographic transcription of a spoken language corpus. Endpoints SHOULD perform the query case-sensitive.

Examples of valid CQL queries for Basic Search are:

```
cat
"cat"
cat AND dog
"grumpy cat" AND dog
"grumpy cat" OR "lazy dog"
cat AND (mouse OR "lazy dog")
```

NOTE: In CQL, a term can be a single token or a phrase, i.e. tokens separated by spaces. If a single term contains spaces, it needs to be quoted. 

NOTE: Endpoints MUST be able to parse all of CQL. If they don't support a certain CQL feature, they MUST generate an appropriate error message (see section SRU/CQL). Especially, if an Endpoint only supports Basic Search, it MUST NOT silently accept queries that include CQL features besides term-only and terms combined with boolean operator queries, i.e. queries involving context sets, etc.

2.2.2. Advanced Search

The Advanced Search capability allows searching in annotated data, that is represented in annotation layers. An annotation layer contains annotations of a specific type, e.g. lemma or part-of-speech layer. Queries can be performed across annotation layer.

The Endpoint MAY support using a custom layer. For every custom layer that is supported, the Endpoint MUST provide an appropriate error message using the appropriate SRU diagnostic (LOC-DIAG). The value String denotes that symbols are arbitrary Unicode Strings, i.e. no fixed inventory of symbols is defined. An Endpoint SHOULD provide an appropriate error, if a Client used an invalid value.

2.2.2.1. Layers

Each Layer is assumed to be segmented, e.g. to allow for searching for a single lemma. However, CLARIN-FCS does not endorse a specific segmentation, i.e. the segmentation of Layers is in the domain of the Endpoint and opaque to CLARIN-FCS. CLARIN-FCS does not endorse nor assume a formal linguistic relation or formal linguistic hierarchy between two items on two different layers.

<table>
<thead>
<tr>
<th>Layer Type Identifier</th>
<th>Annotation Layer Description</th>
<th>Syntax</th>
<th>Examples (without quotes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>text</td>
<td>Textual representation of resource, also the layer that is used in Basic Search</td>
<td>String</td>
<td>&quot;Dog&quot;, &quot;cat&quot; &quot;walking&quot;, &quot;better&quot;</td>
</tr>
<tr>
<td>lemma</td>
<td>Lemmatisation</td>
<td>String</td>
<td>&quot;good&quot;, &quot;walk&quot;, &quot;dog&quot;</td>
</tr>
<tr>
<td>pos</td>
<td>Part-of-Speech annotations</td>
<td>Universal POS tags</td>
<td>&quot;NOUN&quot;, &quot;VERB&quot;, &quot;ADJ&quot;</td>
</tr>
<tr>
<td>orth</td>
<td>Orthographic transcription of (mostly) spoken resources</td>
<td>String</td>
<td>&quot;dug&quot;, &quot;cat&quot;, &quot;walking&quot;</td>
</tr>
<tr>
<td>norm</td>
<td>Orthographic normalization of (mostly) spoken resources</td>
<td>String</td>
<td>&quot;dog&quot;, &quot;cat&quot;, &quot;walking&quot;, &quot;best&quot;</td>
</tr>
<tr>
<td>phonetic</td>
<td>Phonetic transcription</td>
<td>SAMPA</td>
<td>&quot;[dː]&quot;, &quot;[vː] [:dː &quot;ha-&quot;b@n]&quot;</td>
</tr>
</tbody>
</table>

The column Layer Type Identifier denotes the identifier for a layer. It is used in FCS-QL queries and the XML serialization for the Advanced Data View. All valid identifiers are defined in the table above, all other identifiers are reserved and MUST NOT be used. Clients and Endpoints MAY create custom Layer Type Identifiers, e.g. for testing proposed. If they do so, the custom Layer Type identifiers MUST start with the string x-, e.g. x-customLayer. The column Syntax describes the inventory of symbols that a Client MUST use with a corresponding annotation layer; the value String denotes that symbols are arbitrary Unicode Strings, i.e. no fixed inventory of symbols is defined. An Endpoint SHOULD provide an appropriate error, if a Client used an invalid value.

2.2.2.2. FCS-QL

Queries in Advanced Search MUST be performed using FCS-QL (FCS-QL). The Endpoint MUST support parsing all of FCS-QL. If an Endpoint does not support a query, i.e. the used operators or layers are not supported by the Endpoint, it MUST return an appropriate error message using the appropriate SRU diagnostic (LOC-DIAG). Though if the parameter x-fcs-rewrites-allowed is set to true the Endpoint MAY rewrite the query with changed recall as a result.
2.2.3. Result Format

Resource and a Data View representing some annotation layers directly around the hit is more likely to belong within a Resource Fragment.

Endpoints SHOULD preprend the local prefix x- to any identifier used outside of the reserved set, e.g., x-customLayer for a local identifier customLayer.

2.2.3.1. Resource and ResourceFragment

To encode search results, CLARIN-FCS supports two building blocks:

**Resources**

A Resource is a searchable and addressable entity at the Endpoint, such as a text corpus or a multi-modal corpus. A resource SHOULD be a self-contained unit, i.e. not a single sentence in a text corpus or a time interval in an audio transcription, but rather a complete document from a text corpus or a complete audio transcription.

**Resource Fragments**

A Resource Fragment is a smaller unit in a Resource, i.e. a sentence in a text corpus or a time interval in an audio transcription.

The Endpoint MUST perform the query on the annotation layers that makes the most sense for the user, e.g. if no specific PartofSpeech? layer is given with several layers available from the Discovery phase it should use the most generic one. Endpoints SHOULD perform the query with case sensitivity as specified in the query which by default is case sensitive.

Examples of valid FCS-QL queries for Advanced Search are:

```
"walking"
[token = "walking"]
"Dog" /c
[word = "Dog" /c]
[pos != "NOUN"]
[pos != "NOUN"]
[lemma = "walk"]
[blue|grüne "pos = "NOUN"]
"dogs" {}
"cats" within s
[z:pos = "ADJ"]
[z:pos = "ADJ" & q:pos = "ADJ"]
```

The qualifiers z:pos and q:pos SHOULD match an available qualifier attribute value in a pos- SupportedLayer in a discovered EndpointDescription.

**NOTE:** Endpoints supporting Advanced Search MUST be able to parse all of FCS-QL. If they don't support a certain FCS-QL feature, they MUST generate an appropriate error message (see section SRU/CQL). If an Endpoint only supports Basic Search, it MUST silently accept queries that include FCS-QL features.

**NOTE:** FCS-QL layer identifiers are reserved. The Endpoint MUST prepend the local prefix x- to any identifier used outside of the reserved set, e.g., x-customLayer for a local identifier customLayer.

2.2.3.1. Resource and ResourceFragment

To encode search results, CLARIN-FCS supports two building blocks:

**Resources**

A Resource is a searchable and addressable entity at the Endpoint, such as a text corpus or a multi-modal corpus. A resource SHOULD be a self-contained unit, i.e. not a single sentence in a text corpus or a time interval in an audio transcription, but rather a complete document from a text corpus or a complete audio transcription.

**Resource Fragments**

A Resource Fragment is a smaller unit in a Resource, i.e. a sentence in a text corpus or a time interval in an audio transcription.

The Search Engine will produce a result set containing several hits as the outcome of processing a query. The Endpoint MUST serialize these hits in the CLARIN-FCS result format. Endpoints are REQUIRED to adhere to the principle, that one hit MUST be serialized as one CLARIN-FCS result record and MUST NOT combine several hits in one CLARIN-FCS result record. E.g., if a query matches five different sentences within one text (= the resource), the Endpoint must serialize them as five SRU records each with one Hit each referencing the same containing Resource (see section Operation "searchRetrieve").

CLARIN-FCS uses a customized format for returning results. Resource and Resource Fragments serve as containers for hit results, which are presented in one or more Data View. The following section describes the Resource Format and Data View format and section Operation "searchRetrieve" will describe how hits are embedded within SRU responses.

```
<CLARIN-FCS>
  <fcs:Resource>
    <fcs:ResourceFragment>
      <fcs:Resource>
        <!-- data view payload omitted -->
      </fcs:Resource>
    </fcs:ResourceFragment>
  </fcs:Resource>
</CLARIN-FCS>
```

Example 1:

```
<CLARIN-FCS>
  <fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/00-15">
    <fcs:ResourceFragment>
      <fcs:Resource>
        <!-- data view payload omitted -->
      </fcs:Resource>
    </fcs:ResourceFragment>
  </fcs:Resource>
</CLARIN-FCS>
```
View. Endpoints

The Endpoint Description
Recommended Short Identifier
implemented by an Endpoint for a specific Data View is part of the default considered
Endpoint details field of the diagnostic
dataviews such a Data View, a Client
Endpoint to not generate and serialize Data Views that are “expensive” in terms of computational power or bandwidth for every response. To request
request. In the case of
Data Views are classified into a
Payload Disposition
MIME type
Payload Delivery
Recommended Short Identifier
XML Schema

Example 1 shows a simple hit, which is encoded in one Data View of type Generic Hits embedded within a Resource. The type of the Data View is identified by the MIME type application/x-clarin-fcs-hits+xml. The Resource is referenceable by the persistent identifier
http://hdl.handle.net/4711/08-15.

Example 2 shows a hit encoded as a Resource Fragment embedded within a Resource. The actual hit is again encoded as one Data View of type Generic Hits. The hit is not directly referenceable, but the Resource, in which the hit occurred, is referenceable by the persistent identifier
http://hdl.handle.net/4711/08-15. In contrast to Example 1, the Endpoint decided to provide a “semantically richer” encoding and embedded the hit using a Resource Fragment within the Resource to indicate that the hit is a part of a larger resource, e.g. a sentence in a text document.

Example 3 is similar to Example 2, i.e. it shows a hit is encoded as one Generic Hits Data View in a Resource Fragment, which is embedded in a Resource. In contrast to Example 2, another Data View of type CMDI is embedded directly within the Resource. The Endpoint can use this type of Data View to directly provide CMDI metadata about the Resource to Clients. All entities of the Hit can be referenced by a persistent identifier and a URI. The complete Resource is referenceable by either the persistent identifier
http://hdl.handle.net/4711/08-15 or the URI
http://repos.example.org/file/text_08_15.html and the CMDI metadata record in the CMDI Data View is referenceable either by the persistent identifier
http://hdl.handle.net/4711/08-15-1 or the URI
http://repos.example.org/file/08_15.cmdi. The actual hit in the Resource Fragment is also directly referenceable by either the persistent identifier
http://hdl.handle.net/4711/00-15-2 or the URI
http://repos.example.org/file/08_15.html#sentence2.

The more complex Example 3 is similar to Example 2, i.e. it shows a hit is encoded as one Generic Hits Data View in a Resource Fragment, which is embedded in a Resource. In contrast to Example 2, another Data View of type CMDI is embedded directly within the Resource. The Endpoint can use this type of Data View to directly provide CMDI metadata about the Resource to Clients. All entities of the Hit can be referenced by a persistent identifier and a URI. The complete Resource is referenceable by either the persistent identifier
http://hdl.handle.net/4711/08-15 or the URI
http://repos.example.org/file/text_08_15.html and the CMDI metadata record in the CMDI Data View is referenceable either by the persistent identifier
http://hdl.handle.net/4711/08-15-1 or the URI
http://repos.example.org/file/08_15.cmdi. The actual hit in the Resource Fragment is also directly referenceable by either the persistent identifier
http://hdl.handle.net/4711/00-15-2 or the URI
http://repos.example.org/file/08_15.html#sentence2.

2.2.3.2. Data View

A Data View serves as a container for encoding the actual search results (the data fragments relevant to search) within CLARIN-FCS. Data Views are designed to allow for different representations of results, i.e. they are deliberately kept open to allow further extensions with more supported Data View formats. This specification only defines a most basic Data View for representing search results, called Generic Hits (see below). More Data Views are defined in the supplementary specification CLARIN-FCS-DataViews.

The content of a Data View is called Payload. Each Payload is typed and the type of the Payload is recorded in the @type attribute of the <fcs:DataView> element. The Payload type is identified by a MIME type (RFC6838, RFC3023). If no existing MIME type can be used, implementers
should define a proper private mime type.

The Payload of a Data View can either be deposited inline or by reference. In the case of inline, it must be serialized as an XML fragment below the <fcs:DataView> element. This is the preferred method for payloads that can easily be serialized in XML. Deposition by reference is meant for content that cannot easily be deposited inline, i.e. binary content (like images). In this case, the Data View must include a @ref or @pid attribute that links location for Clients to download the payload. This location should be openly accessible, i.e. data can be downloaded freely without any need to perform a login.

Data Views are classified into a send-by-default and a need-to-request delivery policy. In case of the send-by-default delivery policy, the Endpoint
must send the Data View automatically, i.e. Endpoints must unconditionally include the Data View when they serialize a response to a search request. In the case of need-to-request, the Client must explicitly request the Endpoint to include this Data View in the response. This enables the Endpoint to not generate and serialize Data Views that are “expensive” in terms of computational power or bandwidth for every response. To request such a Data View, a Client must submit a comma separated list of Data View identifiers (see section Endpoint Description) in the x-fcs-dataviews extra request parameter with the searchRetrieve request. If a Client requests a Data View that is not valid for the search context, the Endpoint must generate a non-fatal diagnostic
http://clarin.eu/fcs/diagnostic/4 ("Requested Data View not valid for this resource"). The details field of the diagnostic must contain the MIME type of the Data View that was not valid. If more than one requested Data View is invalid, the Endpoint must generate a separate non-fatal diagnostic
http://clarin.eu/fcs/diagnostic/4 for each of the requested Data Views.

The description of every Data View contains a recommendation as to how the Endpoint should handle the payload delivery, i.e. if a Data View is by default considered send-by-default or need-to-request. Endpoint may choose to implement different policy. The relevant information which policy is implemented by an Endpoint for a specific Data View is part of the Endpoint Description (see section Endpoint Description). For each Data View, a Recommended Short Identifier is defined, that Endpoint should use for an identifier of the Data View in the list of supported Data Views in the Endpoint Description

The Generic Hits Data View is mandatory, thus all Endpoints must implement it and provide search results represented in the Generic Hits Data View. Endpoints must implement the Generic Hits Data View with the send-by-default delivery policy.

NOTE: The examples in the following sections show only the payload with the enclosing <fcs:DataView> element of a Data View. Of course, the Data View must be embedded either in a <fcs:Resource> or a <fcs:ResourceFragment> element. The @pid and @ref attributes have been omitted for all inline payload types.

<table>
<thead>
<tr>
<th>Generic Hits (HITS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>MIME type</td>
</tr>
<tr>
<td>Payload Disposition</td>
</tr>
<tr>
<td>Payload Delivery</td>
</tr>
<tr>
<td>Recommended Short Identifier</td>
</tr>
<tr>
<td>XML Schema</td>
</tr>
</tbody>
</table>
The Generic Hits Data View serves as the most basic agreement in CLARIN-FCS for serialization of search results and MUST be implemented by all Endpoints. In many cases, this Data View can only serve as an (lossy) approximation, because resources at Endpoints are very heterogeneous. For instance, the Generic Hits Data View is probably not the best representation for a hit result in a corpus of spoken language, but an architecture like CLARIN-FCS requires one common representation to be implemented by all Endpoints, therefore this Data View was defined. The Generic Hits Data View supports multiple markers for supplying highlighting for an individual hit, e.g. if a query contains a (boolean) conjunction, the Endpoint can use multiple markers to provide individual highlights for the matching terms. An Endpoint MUST NOT use this Data View to aggregate several hits within one resource. Each hit SHOULD be presented within the context of a complete sentence. If that is not possible due to the nature of the type of the resource, the Endpoint MUST provide an equivalent reasonable unit of context (e.g. within a phrase of an orthographic transcription of an utterance). The <hits:Hit> element within the <hits:Result> element is not enforced by the XML schema, but Endpoints are RECOMMENDED to use it. The XML fragment of the Generic Hits payload MUST be valid according to the XML schema "DataView-Hits.xsd" (download).

- Example (single hit marker):

```xml
<Item potential @pid and &ref attributes omitted -->
<DataView type="application/x-clarin-fcs-hits+xml">
  <Result xmlns:hits="http://clarin.eu/fcs/dataview/hits"> The quick brown fox jumps over the lazy dog. </Result>
</DataView>
```

- Example (multiple hit markers):

```xml
<Item potential @pid and &ref attributes omitted -->
<DataView type="application/x-clarin-fcs-hits+xml">
  <Result xmlns:hits="http://clarin.eu/fcs/dataview/hits"> The quick brown fox jumps over the lazy fox </Result>
</DataView>
```

**Advanced (ADV)**

<table>
<thead>
<tr>
<th>Description</th>
<th>The representation of the hit for Advanced Search</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIME type</td>
<td>application/x-clarin-fcs-adv+xml</td>
</tr>
<tr>
<td>Payload Disposition</td>
<td>inline</td>
</tr>
<tr>
<td>Payload Delivery</td>
<td>send-by-default (REQUIRED)</td>
</tr>
<tr>
<td>Recommended Short Identifier</td>
<td>adv (RECOMMENDED)</td>
</tr>
<tr>
<td>XML Schema</td>
<td>DataView-Advanced.xsd (download)</td>
</tr>
</tbody>
</table>

The Advanced (ADV) Data View serves as the natural serialization of search results for Advanced Search queries. The ADV Data View supports structured information in one or more annotation layers. The annotations are streams (ranges) over the signal in a stand-off like format with start and end offsets. The list of `<Segment>` elements building a stream can be of type `item` for character-based streams or `timestamp` for audio streams (granularity up to 0.001s). The Endpoint is responsible for choosing the proper offsets for the segments. The segments MUST be possible to align over all annotation layers. For character streams the recommendation is Unicode Normalization Form KC. Segments MAY also have an endpoint specific reference indicated by an URI that could be shown in the Aggregator, e.g. to open an audio player or other viewer with contents from the Search Engine. The list of `<Layer>` elements contains `<Span>` elements making references to the segments. A `<Span>` inherits the start and end offsets from its segments and contains the actual annotation as its content. It MAY also carry information about the original annotation value in an `@alt-value` attribute. The document order of the `<Layer>` elements define the view order in the Aggregator. Each Layer has a `<Layer type identifier>` and a `<Layer identifier>`. The Endpoint SHOULD at least return all layers that were referenced in the Advanced Search query. It MAY return more layers. The attribute `@highlight` is used to mark Spans as hits. Multiple hit markers are supported and the Aggregator MAY display them visually distinct. It is up to the Endpoint to decide what should be marked as a hit, but the recommendation is to mark everything referenced in the Advanced Search query.

Example: a sentence interpreted as a character stream

<table>
<thead>
<tr>
<th>Data t</th>
<th>d a</th>
<th>s</th>
<th>d e</th>
<th>e n</th>
<th>i g e</th>
<th>e c</th>
<th>h t e</th>
<th>h o o p</th>
<th>v o o r</th>
<th>o n s</th>
<th>m e n s</th>
<th>e n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

Example: several annotation layers for the sentence

```xml
<Advanced>
  <Segments unite="items"/>
  <Segment id="s1" start="1" end="1" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=0:173?"/>
  <Segment id="s2" start="3" end="4" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=173:304?"/>
  <Segment id="s3" start="6" end="7" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=173:304?"/>
  <Segment id="s4" start="9" end="10" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=304:480?"/>
  <Segment id="s5" start="12" end="16" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=480:1119?"/>
  <Segment id="s6" start="18" end="22" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=1339:1901?"/>
  <Segment id="s7" start="24" end="27" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=1901:2427?"/>
  <Segment id="s8" start="29" end="32" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=3084:3493?"/>
  <Segment id="s9" start="34" end="36" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=3493:3754?"/>
  <Segment id="s10" start="38" end="43" ref="http://hdl.handle.net/4711/123456789?urlappend=%3Fplay=3754:4274?"/>
</Segments>
```
3. CLARIN-FCS to SRU/CQL binding

2.2.4. Versioning and Extensions

2.2.4.1. Backwards Compatibility

Clients MUST be compatible to CLARIN-FCS 1.0, thus MUST implement SRU 1.2. If a Client uses CLARIN-FCS 1.0 to talk to an Endpoint, it MUST NOT use features beyond the Basic Search capability. Clients MUST implement a heuristic to automatically determine which CLARIN-FCS protocol version, i.e. which version of the SRU protocol, can be used to talk an Endpoint.

Clients MUST be able to process the legacy XML namespaces:

- http://www.loc.gov/z39/50/ for SRU response documents, and

which SRU 1.2 Endpoints use for serializing responses as well as the OASIS XML namespaces. CLARIN-FCS deviates from the OASIS specification OASIS-SRU-Overview and OASIS-SRU-12 to ensure backwards comparability with SRU 1.2 services as they were defined by the LOC-SRU12.

Pseudo algorithm for version detection heuristic:

- Send explain request without version and operation parameter
- Check SRU response for content of the element <sru:explainResponse>/<sru:version>

2.2.4.2. Endpoint Custom Extensions

Endpoints can add custom extensions, i.e. custom data, to the Result Format. This extension mechanism can for example be used to provide hints for an (XSLT/XQuery) application that works directly on CLARIN-FCS, e.g. to allow it to generate back and forward links to navigate in a result set.


A Client MUST ignore any custom extensions it does not understand and skip over these XML fragments when parsing the Endpoint's response.

The non-normative appendix contains an example, how an extension could be implemented.

3. CLARIN-FCS to SRU/CQL binding

3.1. SRU/CQL

CLARIN-FCS Core 2.0 uses SRU 2.0 (Search/Retrieve via URL) as underlaying communication protocol. SRU specifies a general communication protocol that provides basic search and retrieval services over a network. CLARIN-FCS Core 2.0 is a return of a new version of the CLARIN-FCS Core 2.0 that provides improved search and retrieval functionality.
3.2. Operation explain

The explain operation of the SRU protocol serves to announce server capabilities and to allow clients to configure themselves automatically. This operation is used similarly.

The Endpoint MUST respond to a explain request by a proper explain response. As per SRU-Explain, the response MUST contain one <sr:record> element that contains an SRU Explain record. The <sr:recordSchema> element MUST contain the literal http://explain.z3950.org/dtd/2.0/., i.e. the official identifier for Explain records.

According to the Capabilities supported by the Endpoint the Explain record MUST contain the following elements:

**Basic-Search Capability**

- `<zr:configInfo>` as defined in SRU-Explain (REQUIRED)
- `<zr:databaseInfo>` as defined in SRU-Explain (REQUIRED)
- `<zr:schemaInfo>` as defined in SRU-Explain (REQUIRED). This element MUST contain an element `<zr:schema>` with an @identifier attribute with a value of http://clarin.eu/fcs/resource and a @name attribute with a value of fcs.
- `<zr:explainInfo>` is OPTIONAL

Other capabilities may define how the `<zr:indexInfo>` element is to be used, therefore it is NOT RECOMMENDED for Endpoints to use it in custom extensions.

To support auto-configuration in CLARIN-FCS, the Endpoint MUST provide support Endpoint Description. The Endpoint Description is included in explain response utilizing SRUs extension mechanism, i.e. by embedding an XML fragment into the `<sr:extraResponseData>` element. The Endpoint MUST include the Endpoint Description only if the Client performs an explain request with the extra request parameter x-fcs-endpoint-description with a value of true. If the Client performs an explain request without supplying this extra request parameter the Endpoint MUST NOT include the Endpoint Description. The format of this XML fragment is defined in Endpoint Description.

The following example shows a SRU 1.2 request and response to an explain request with added extra request parameter x-fcs-endpoint-description:

- **HTTP GET request:** Client → Endpoint:
  
  http://repos.example.org/fcs-endpoint?operation=explain&version=1.2&amp;x-fcs-endpoint-description=true

- **HTTP Response:** Endpoint → Client:

  ```xml
  <sr:explainResponse xmlns:sru="http://www.loc.gov/z3950/srw/">
    <sr:record>
      <sr:recordSchema>http://explain.z3950.org/dtd/2.0/</sr:recordSchema>
      <sr:recordPackaging>xml</sr:recordPackaging>
      <sr:recordData>
        <zr:configInfo>
          <!-- <zr:configInfo> is OPTIONAL -->
          <zr:serverInfo>
            <!-- <zr:serverInfo> is REQUIRED -->
            <zr:protocol>SRU</zr:protocol> version="1.2" transport="http" />
            <zr:host>repos.example.org</zr:host>
            <zr:port>80</zr:port>
            <zr:database>fcs-endpoint</zr:database>
          </zr:serverInfo>
          <!-- <zr:databaseInfo> is REQUIRED -->
          <zr:databaseInfo>
            <!-- <zr:title lang="de">Goethe Corpus</zr:title>  
            <zr:title lang="en" primary="true">Goethe Corpus</zr:title>  
            <zr:description lang="de">Der Goethe Korpus of IDS Mannheim</zr:description>  
            <zr:description lang="en" primary="true">The Goethe corpus of IDS Mannheim</zr:description>  
          </zr:databaseInfo>
          <!-- <zr:schemaInfo> is REQUIRED -->
          <zr:schemaInfo>
            <!-- <zr:schema identifier="http://clarin.eu/fcs/resource" name="fcs" lang="en" primary="true">CLARIN Federated Content Search</zr:schema>  
            <zr:title lang="en" primary="true">CLARIN Federated Content Search</zr:title>  
            <zr:description lang="en" primary="true">CLARIN Federated Content Search</zr:description>  
            <zr:identifier name="fcs" />
            <zr:resourceName>CLARIN Federated Content Search</zr:resourceName>
          </zr:schemaInfo>
        </zr:explainInfo>
      </sr:recordData>
    </sr:record>
  </sr:explainResponse>
  ```
And a SRU 2.0 example request and response to an explain request also with the extra request parameter `x-fcs-endpoint-description`:

- **HTTP GET request:** Client → Endpoint:

  http://repos.example.org/fcs-endpoint2?operation=explain&amp;x-fcs-endpoint-description=true

- **HTTP Response:** Endpoint → Client:

```xml
<sruResponse:explainResponse>
  <sruResponse:version>2.0</sruResponse:version>
  <sruResponse:record>
    <sruResponse:recordSchema>http://explain.z3950.org/dtd/2.0/</sruResponse:recordSchema>
    <sruResponse:recordXMLEscaping>xml</sruResponse:recordXMLEscaping>
    <sruResponse:recordData>
      <zr:configInfo>
        <zr:setting identifier="http://clarin.eu/fcs/resource" name="fcs">
          <zr:title lang="se">Språkbankens korpusar</zr:title>
          <zr:title lang="en" primary="true">The Språkbanken corpora</zr:title>
          <zr:description lang="se">Sök i Språkbankens korpusar.</zr:description>
          <zr:description lang="en" primary="true">Search in the Språkbanken corpora.</zr:description>
          <zr:author lang="en">Språkbanken (The Swedish Language Bank)</zr:author>
          <zr:author lang="se">Språkbanken</zr:author>
        </zr:setting>
        <zr:setting identifier="http://clarin.eu/fcs/resource" name="fcs">
          <zr:title lang="en" primary="true">CLARIN Content Search</zr:title>
          <zr:author lang="en">Clarins innehållssökning</zr:author>
        </zr:setting>
        <zr:indexInfo>
          <zr:identifier identifier="http://clarin.eu/fcs/resource" name="fcs">
          </zr:identifier>
          <zr:title lang="se">Clarins innehållssökning</zr:title>
          <zr:title lang="en" primary="true">CLARIN Content Search</zr:title>
        </zr:indexInfo>
        <zr:schemaInfo>
          <zr:schema identifier="http://clarin.eu/fcs/resource" name="fcs">
          </zr:identifier>
          <zr:title lang="en" primary="true">CLARIN Content Search</zr:title>
        </zr:schemaInfo>
      </zr:configInfo>
      <zr:configInfo>
        <zr:default type="numberOfRecords">250</zr:default>
        <zr:setting type="maximumRecords">1000</zr:setting>
      </zr:configInfo>
    </zr:configInfo>
  </sruResponse:recordData>
</sruResponse:record>
</sruResponse:explainResponse>
```
3.4. Operation scan

The scan operation of the SRU protocol is currently neither used in the Basic Search nor Advanced Search capability of CLARIN-FCS. Future capabilities may use this operation, therefore it is NOT RECOMMENDED for Endpoints to define custom extensions that use this operation.

3.4. Operation searchRetrieve

The searchRetrieve operation of the SRU protocol is used for searching in the Resources that are provided by the Endpoint. The SRU protocol defines the serialization of request and response formats in OASIS-SRU-20 for SRU version 2.0 and OASIS-SRU-12 for SRU version 1.2. An Endpoint MUST respond in the correct format, i.e. when Endpoint also supports SRU 1.2 and the request is issued in SRU version 1.2, the response must be encoded accordingly. For SRU 2.0 we introduce the queryType parameter to tell which query language to use. For Contextual Query Language the value is cql and for FCS-QL the value is fcs.

In SRU, search result hits are encoded down to a record level, i.e. the <sru:record> element, and SRU allows records to be serialized in various formats, so called record schemas. Endpoints MUST support the CLARIN-FCS record schema (see section Result Format) and MUST use the value http://clarin.eu/fcs/resource for the responseItem Type ("record schema identifier"). Endpoints MUST represent exactly one hit within the Resource as one SRU record, i.e. <sru:record> element.

The following example shows a request and response to a searchRetrieve request with a term-only query for "cat":

- **HTTP GET request:** Client → Endpoint:

  ```
  http://repos.example.org/fcs-endpoint?operation=searchRetrieve&version=1.2&query=cat
  ```

- **HTTP Response:** Endpoint → Client:

  ```xml
  <sru:searchRetrieveResponse xmlns:sru="http://www.loc.gov/zing/srw/"
  xmlns:fcs="http://clarin.eu/fcs/resource"
  xmlns:xquery="http://www.w3.org/2001/xquery"
  xmlns:xml="http://www.w3.org/2000/xml"
  xmlns:ed="http://www.loc.gov/zing/cql/xcql/"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:xlink="http://www.w3.org/1999/xlink">
  <sru:version>1.2</sru:version>
  <sru:numberOfRecords>6</sru:numberOfRecords>
  <sru:recordSchema>
    <sru:recordSchemaDefinition>
      <sru:complexType>
        <sru:record/>  
      </sru:complexType>
    </sru:recordSchemaDefinition>
  </sru:recordSchema>
  <sru:recordPackaging>xml</sru:recordPackaging>
  <sru:recordData>
      <fcs:recordData>
        <fcs:tile id="tile0" xml:lang="en">
          <fcs:tilePosition>1</fcs:tilePosition>
          <fcs:tileContent>"The quick brown <sru:Hit/> jumps over the lazy dog."</fcs:tileContent>
        </fcs:tile>
        <fcs:tile id="tile1" xml:lang="en">
          <fcs:tilePosition>2</fcs:tilePosition>
          <fcs:tileContent>"The SUC corpus is available at Språkbanken."</fcs:tileContent>
        </fcs:tile>
        <!-- more <fcs:tile> omitted for brevity -->
      </fcs:recordData>
    </fcs:Resource>
  </sru:recordData>
  </sru:searchRetrieveResponse>
  ```

```
Moving to SRU 2.0 have the introduced `queryType` parameter. The same query as seen with SRU 1.2 above would then become:

- **HTTP GET request:** Client → Endpoint:

  ```
  http://localhost:8080/korp-endpoint/sru?operation=searchRetrieve&queryType=cql&query=%22anv%C3%A4ndning%22
  ```

- **HTTP Response:** Endpoint → Client:

  ```
  <?xml version='1.0' encoding='utf-8'?>
  <sr:searchRetrieveResponse>
    <sr:ResultCountPrecision info:srw/vocabulary/resultCountPrecision/1/exact>1</sr:ResultCountPrecision>
    <sr:Hits>
      <sr:Hit>
        <sr:RecordData>
          <fcs:ResourceFragment>
            <adv:Advanced unit="item">
              <adv:Segments>
                <adv:Segment id="s1" start="1" end="15"/>
                <adv:Segment id="s2" start="16" end="19"/>
                <adv:Segment id="s3" start="20" end="25"/>
                <adv:Segment id="s4" start="26" end="32"/>
                <adv:Segment id="s5" start="33" end="35"/>
                <adv:Segment id="s6" start="36" end="46"/>
                <adv:Segment id="s7" start="47" end="57"/>
                <adv:Segment id="s8" start="58" end="60"/>
                <adv:Segment id="s9" start="61" end="65"/>
                <adv:Segment id="sa" start="66" end="67"/>
              </adv:Segments>
              <adv:Layers>
                <adv:Layer id="http://spraakbanken.gu.se/ns/fcs/layer/lemma">
                  <adv:Span ref="s1"/>
                  <adv:Span ref="s2"> ha
                </adv:Layer>
              </adv:Layers>
            </adv:Advanced>
          </fcs:ResourceFragment>
        </sr:RecordData>
      </sr:Hit>
    </sr:Hits>
  </sr:searchRetrieveResponse>
  ```

Using FCS-QL using `queryType` with value `fcs` we get a request and response to the `searchRetrieve` request with `queryType fcs` and query `[word = "användning"]:`

- **HTTP GET request:** Client → Endpoint:

  ```
  http://localhost:8080/korp-endpoint/sru?operation=searchRetrieve&queryType=fcs&query=[word=%22anv%C3%A4ndning%22]
  ```

- **HTTP Response:** Endpoint → Client:

  ```
  <?xml version='1.0' encoding='utf-8'?>
  <sr:searchRetrieveResponse>
    <sr:ResultCountPrecision info:srw/vocabulary/resultCountPrecision/1/exact>251</sr:ResultCountPrecision>
    <sr:Hits>
      <sr:Hit>
        <sr:RecordData>
          <fcs:ResourceFragment>
            <adv:Advanced unit="item">
              <adv:Segments>
                <adv:Segment id="s1" start="1" end="15"/>
                <adv:Segment id="s2" start="16" end="19"/>
                <adv:Segment id="s3" start="20" end="25"/>
                <adv:Segment id="s4" start="26" end="32"/>
                <adv:Segment id="s5" start="33" end="35"/>
                <adv:Segment id="s6" start="36" end="46"/>
                <adv:Segment id="s7" start="47" end="57"/>
                <adv:Segment id="s8" start="58" end="60"/>
                <adv:Segment id="s9" start="61" end="65"/>
                <adv:Segment id="sa" start="66" end="67"/>
              </adv:Segments>
              <adv:Layers>
                <adv:Layer id="http://spraakbanken.gu.se/ns/fcs/layer/lemma">
                  <adv:Span ref="s1"/>
                  <adv:Span ref="s2"> ha
                </adv:Layer>
              </adv:Layers>
            </adv:Advanced>
          </fcs:ResourceFragment>
        </sr:RecordData>
      </sr:Hit>
    </sr:Hits>
  </sr:searchRetrieveResponse>
  ```
For example, to request the CMDI Data View from an Endpoint that has an Endpoint Description, as described in section values for the diagnostic and perform no search, or it appropriate XML fragment to the following request:

```
To restrict the search to the Resources with the persistent identifier
```

The Client can extract all valid persistent identifiers from the following request:

```
http://hdl.handle.net/4711/0816-2
```

In general, as you can see from both the SRU 1.2 and SRU 2.0 examples above, the Endpoint is REQUIRED to accept an unrestricted search and SHOULD perform the search operation on all Resources that are available at the Endpoint. If that is for some reason not feasible, e.g. performing an unrestricted search would allocate too many resources, the Endpoint MAY independently restrict the search to a scope that it can handle. If it does so, it MUST issue a non-fatal diagnostic http://clarin.eu/fcs/diagnostic/2 ("Resource set too large. Query context automatically adjusted."). The details field of diagnostics MUST contain the persistent identifier of the resources to which the query scope was limited to. If the Endpoint limits the query scope to more than one resource, it MUST generate a separate non-fatal diagnostic http://clarin.eu/fcs/diagnostic/2 for each of the resources.

The Client can extract all valid persistent identifiers from the #pid attribute of the <ed:SupportedDataView> element, obtained by the explain request (see section Operation "explain" and section Endpoint Description). The list of persistent identifiers can get extensive, but a Client can use the HTTP POST method instead of HTTP GET method for submitting the request.

For example, to restrict the search to the Resource with the persistent identifier http://hdl.handle.net/4711/0815 the Client must issue the following request:

```
http://repos.example.org/fcs-endpoint?operation=searchRetrieve&version=1.2&query=x-fcs-datatype=av
```

To restrict the search to the Resources with the persistent identifier http://hdl.handle.net/4711/0815 and http://hdl.handle.net/4711/0816-2 the Client must issue the following request:

```
http://repos.example.org/fcs-endpoint?operation=searchRetrieve&version=1.2&query=x-fcs-datatype=av
```

If an invalid persistent identifier is passed by the Client, the Endpoint MUST issue a diagnostic http://clarin.eu/fcs/diagnostic/1, i.e. add the appropriate XML fragment to the <sr:diagnostic> element of the response. The Endpoint MAY treat this condition as fatal, i.e. just issue the diagnostic and perform no search, or it MAY treat it as non-fatal and perform the search.

If a Client wants to request one or more Data Views, that are handled by Endpoint with the need-to-request delivery policy, it MUST pass a comma-separated list of Data View identifiers in the x-fcs-dataviews extra request parameter of the 'searchRetrieve' request. A Client can extract valid values for the Data View identifiers from the @id attribute of the <ed:SupportedDataView> elements in the Endpoint Description of the Endpoint (see section explain and section Endpoint Description).

For example, to request the CMDI Data View from an Endpoint that has an Endpoint Description, as described in Example 5, a Client would need to
### 4. Normative Appendix

#### 4.1. List of extra request parameters

The following extra request parameters are used in CLARIN-FCS. The column SRU operations lists the SRU operation, for which this extra request parameter is to be used. Clients MUST NOT use the parameter for an operation that is not listed in this column. However, if a Client sends an invalid parameter, an Endpoint SHOULD issue a fatal diagnostic “Unsupported Parameter” (info:srw/diagnostic/1/8) and stop processing the request. Alternatively, an Endpoint MAY silently ignore the invalid parameter.

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>SRU operations</th>
<th>Allowed values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>x-fcs-endpoint-description</td>
<td>explain</td>
<td>true; all other values are reserved and MUST not be used by Clients</td>
<td>If the parameter is given (with the value true), the Endpoint MUST include an Endpoint Description in the &lt;srudescriptions&gt; element of the response.</td>
</tr>
<tr>
<td>x-fcs-context</td>
<td>searchRetrieve</td>
<td>A comma-separated list of persistent identifiers</td>
<td>The Endpoint MUST restrict the search to the resources identified by the persistent identifiers.</td>
</tr>
<tr>
<td>x-fcs-dataviews</td>
<td>searchRetrieve</td>
<td>A comma-separated list of Data View identifiers</td>
<td>The Endpoint SHOULD include the additional need-to-request type Data Views in the response.</td>
</tr>
<tr>
<td>x-fcs-rewrites-allowed</td>
<td>searchRetrieve</td>
<td>true; all other values are reserved and MUST not be used by Clients. Clients MUST only use this parameter when performing an Advanced Search request.</td>
<td>If the parameter is given (with the value true), the Endpoint MAY rewrite the query to a simpler query to allow for more recall.</td>
</tr>
</tbody>
</table>

For SRU 2.0 the request parameter queryType MUST be used unless the query language is CQL which is the default. For using FCS-QL the value must be fcs. # # List of diagnostics

Apart from the SRU diagnostics defined in OASIS-SRU-12, Appendix C and LOC-DIAG, the following diagnostics are used in CLARIN-FCS. The column “Details Format” specifies what SHOULD be returned in the details field. If this column is blank, the format is “undefined” and the Endpoint MAY return whatever it feels appropriate, including nothing. The column “Impact” specifies, if the endpoint should continue (“non-fatal”) or should stop (“fatal”) processing.

<table>
<thead>
<tr>
<th>Identifier URI</th>
<th>Description</th>
<th>Details Format</th>
<th>Impact</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/1">http://clarin.eu/fcs/diagnostic/1</a></td>
<td>Persistent identifier passed by the Client for restricting the search is invalid.</td>
<td>The offending persistent identifier.</td>
<td>non-fatal</td>
<td>If more than one invalid persistent identifiers were submitted by the Client, the Endpoint MUST generate a separate diagnostic for each invalid persistent identifier.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/2">http://clarin.eu/fcs/diagnostic/2</a></td>
<td>Resource set too large. Query context automatically adjusted.</td>
<td>The persistent identifier of the resource to which the query context was adjusted.</td>
<td>non-fatal</td>
<td>If an Endpoint limited the query context to more than one resource, it MUST generate a separate diagnostic for each resource to which the query context was adjusted.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/4">http://clarin.eu/fcs/diagnostic/4</a></td>
<td>Requested Data View not valid for this resource.</td>
<td>The Data View MIME type.</td>
<td>non-fatal</td>
<td>If more than one invalid Data View was requested, the Endpoint MUST generate a separate diagnostic for each invalid Data View.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/10">http://clarin.eu/fcs/diagnostic/10</a></td>
<td>General query syntax error.</td>
<td>Detailed error message why the query could not be parsed.</td>
<td>fatal</td>
<td>Endpoints MUST use this diagnostic only if the Client performed an Advanced Search request.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/11">http://clarin.eu/fcs/diagnostic/11</a></td>
<td>Query too complex. Cannot perform Query.</td>
<td>Details why could not be performed, e.g. unsupported layer or unsupported combination of operators.</td>
<td>fatal</td>
<td>Endpoints MUST use this diagnostic only if the Client performed an Advanced Search request.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/12">http://clarin.eu/fcs/diagnostic/12</a></td>
<td>Query was rewritten.</td>
<td>Details how the query was rewritten.</td>
<td>non-fatal</td>
<td>Endpoints MUST use this diagnostic only if the Client performed an Advanced Search request.</td>
</tr>
<tr>
<td><a href="http://clarin.eu/fcs/diagnostic/14">http://clarin.eu/fcs/diagnostic/14</a></td>
<td>General processing hint.</td>
<td>E.g. “No matches, because layer ‘XY’ is not available in your selection of resources”</td>
<td>non-fatal</td>
<td>Endpoints MUST use this diagnostic only if the Client performed an Advanced Search request.</td>
</tr>
</tbody>
</table>

#### 4.2. CLARIN FCS-QL Grammar Specification

#fcsQLBNF The version of the CLARIN FCS-QL is tied to the FCS Core version starting with version 2.0.

FCS-QL was developed to bridge the extension of powerfulness in searching, familiarity of query language and ease of use. The grammar specification for the FCS-QL is heavily based on Poliqarp but also with inspiration from other query languages’ grammars. Building on the annotation layer metaphor with positional and structural attributes. Positional attributes can be seen as key-value pairs. Structural attributes can also have key-value pairs attached. Structural attributes themselves have the restrictions to be non-overlapping and non-recursive. The positional attributes depend on tokenization or segmentation of some kind being performed to produce tokens. A token is thus a subjective unit defined by a Repository manager and might vary in the same way values in other layers can.

An unqualified or qualified “attribute” denotes the annotation layer to be used, e.g. unqualified “word”, “lemma”, “pos” or qualified “ssts:pos”. The default attribute is “text” for compatibility with FCS 1.0 where simple wordforms in a pair of single or double quotes can be matched. Qualifiers and other identifiers MUST start with a character a-z or A-Z.

Character literals are unescaped to Unicode Normalization Form C (NFC). Regular expressions are passed on as such for interpretation by the
Tokens are limited by `[ ]` and `()` except when using default attribute "text". Within a token disjunctive or conjunctive positional attribute expressions referring any layer can be joined. These can also be grouped by `[ ]` and `()`. Token sequences address consecutive tokens unless matchall, i.e. `[ ]` and quantifiers are used.

**4.2.1. FCS-QL EBNF**

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] query</td>
<td><code>::= main-query within-part?</code></td>
</tr>
<tr>
<td>[2] main-query</td>
<td><code>::= simple-query</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[3] simple-query</td>
<td><code>::= '{' main_query '}'</code> /* grouping */</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[4] implicit-query</td>
<td><code>::= flagged-regexp</code></td>
</tr>
<tr>
<td>[6] within-part</td>
<td><code>::= simple-within-part</code></td>
</tr>
<tr>
<td>[7] simple-within-part</td>
<td><code>::= &quot;within&quot; simple-within-scope</code></td>
</tr>
<tr>
<td>[8] simple-within-scope</td>
<td><code>::= &quot;sentence&quot;</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[9] expression</td>
<td><code>::= basic-expression</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[10] basic-expression</td>
<td><code>::= '(' expression ')' /* grouping */</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[11] operator</td>
<td><code>::= '=' /* equals */</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[12] quantifier</td>
<td><code>::= '+' /* one-or-more */</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[13] flagged-regexp</td>
<td><code>::= regexp /* regexp-flags */</code></td>
</tr>
<tr>
<td>[14] regexp-flag</td>
<td><code>::= 'i' /* case-insensitive; Poliqarp/Perl compat */</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[15] regexp</td>
<td><code>::= quoted-string</code></td>
</tr>
<tr>
<td>[16] attribute</td>
<td><code>::= simple-attribute</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[17] simple-attribute</td>
<td><code>::= identifier</code></td>
</tr>
<tr>
<td>[18] qualified-attribute</td>
<td><code>::= identifier &quot;:&quot; identifier</code></td>
</tr>
<tr>
<td>[19] identifier</td>
<td><code>::= identifier-first-char identifier-char*</code></td>
</tr>
<tr>
<td>[20] identifier-first-char</td>
<td><code>::= [a-zA-Z]</code></td>
</tr>
<tr>
<td>[21] identifier-char</td>
<td><code>::= [a-zA-Z0-9\-]</code></td>
</tr>
<tr>
<td>[22] integer</td>
<td><code>::= [0-9]+</code></td>
</tr>
<tr>
<td>[23] quoted-string</td>
<td>`::= &quot;&quot; (char</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[24] char</td>
<td><code>::= &lt;any unicode codepoint excluding whitespace codepoints&gt;</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td>[25] ws</td>
<td><code>::= &lt;any whitespace codepoint&gt;</code></td>
</tr>
<tr>
<td>[26] escaped-char</td>
<td><code>::= '&quot;' /* backslash (\) */</code></td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
<tr>
<td></td>
<td>`</td>
</tr>
</tbody>
</table>
5. Non-normative Appendix

5.1. Syntax variant for Handle system Persistent Identifier URIs

Persistent Identifiers from the Handle system are defined in two syntax variants: a regular URI format for the Handle protocol, i.e. with a \texttt{hdl:} prefix, or actionable URIs with a \texttt{http://hdl.handle.net/} prefix. Generally, CLARIN software should support both syntax variants, therefore the CLARIN-FCS Interface Specification does not endorse a specific syntax variant. However, Endpoints are recommended to use the \textit{actionable} syntax variant.

5.2. Referring to an Endpoint from a CMDI record

Centers are encouraged to provide links to their CLARIN-FCS Endpoints in the metadata records for their resources. Other services, like the VLO, can use this information for automatically configuring an Aggregator for searching resources at the Endpoint. To refer to an Endpoint, a \texttt{<cmdi:ResourceProxy>} element with child-element \texttt{<cmdi:ResourceType>} set to the value \texttt{SearchService} and a \texttt{@mimetype} attribute with a value of \texttt{application/sru+xml} need to be added to the CMDI record. The content of the \texttt{<cmdi:ResourceRef>} element must contain a URI that points to the Endpoint web service.

Example:

```xml
<cmdi:CMD xmlns:cmdi="http://www.clarin.eu/cmdi/" CMDVersion="1.1">
  <cmdi:Header/>
  <cmdi:MdSelfLink>http://hdl.handle.net/4711/0815</cmdi:MdSelfLink>
  <cmdi:ResourceProxy id="t4711">
    <cmi:ResourceRef http://repos.example.org/fcs-endpoint>
      <cmi:ResourceType>SearchService</cmi:ResourceType>
      <cmi:ResourceProxy></cmi:ResourceProxy>
    </cmdi:ResourceRef>
  </cmdi:ResourceProxyList>
</cmdi:CMD>
```

```xml
<!-- Endpoint custom extensions #extensionExample The CLARIN-FCS protocol specification allows Endpoints to add custom data to their responses, e.g. to provide hints to an (XSLT/XQuery) application that works directly on CLARIN-FCS. It could use the custom data to generate back and forward links for a GUI to navigate in a result set.

The following example illustrates how extensions can be embedded into the Result Format:

```xml
<cmdi:CMD xmlns:cmdi="http://www.clarin.eu/cmdi/" CMDVersion="1.1">
  <cmdi:Header/>
  <cmdi:MdSelfLink>http://hdl.handle.net/4711/0815</cmdi:MdSelfLink>
  <cmdi:ResourceProxy id="t4711">
    <cmi:ResourceRef http://repos.example.org/fcs-endpoint>
      <cmi:ResourceType>SearchService</cmi:ResourceType>
      <cmi:ResourceProxy></cmi:ResourceProxy>
    </cmdi:ResourceRef>
  </cmdi:ResourceProxyList>
</cmdi:CMD>
```

```xml
<br>
```
5.3. Endpoint highlight hints for repositories

An Aggregator can use the `@ref` attributes of the `<fcs:Resource>`, `<fcs:ResourceFragment>` or `<fcs:DataView>` elements to provide a link for the user to directly jump to the resource at a Repository. To support hit highlighting, an Endpoint can augment the URI in the `@ref` attribute with query parameters to implement hit highlighting in the Repository.

In the following example, the URI `http://repos.example.org/resource.cgi/<pid>` is a CGI script that displays a given resource at the Repository in HTML format and uses the `highlight` query parameter to add highlights to the resource. Of course, it's up to the Endpoint and the Repository, if and how they implement such a feature.