CLARIN Federated Content Search (CLARIN-FCS) - Core 2.0

1. Introduction

The goal of the *CLARIN Federated Content Search (CLARIN-FCS) - Core* specification is to introduce an *interface specification* 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.

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

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 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.

1.3. Normative References

RFC2119
Key words for use in RFCs to Indicate Requirement Levels, IETF RFC 2119, March 1997, http://www.ietf.org/rfc/rfc2119.txt

XML-Namespaces
Namespaces in XML 1.0 (Third Edition), W3C, 8 December 2009, http://www.w3.org/TR/2009/REC-xml-names-20091208/

OASIS-SRU-Overview
searchRetrieve: Part 0. Overview Version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part0-overview/searchRetrieve-v1.0-os-part0-overview.doc (HTML), (PDF)

OASIS-SRU-APD
searchRetrieve: Part 1. Abstract Protocol Definition Version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part1-apd/searchRetrieve-v1.0-os-part1-apd.doc (HTML) (PDF)

OASIS-SRU12
searchRetrieve: Part 2. SRU searchRetrieve Operation: APD Binding for SRU 1.2 Version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part2-sru1.2/searchRetrieve-v1.0-os-part2-sru1.2.doc (HTML) (PDF)

OASIS-SRU20
searchRetrieve: Part 3. SRU searchRetrieve Operation: APD Binding for SRU 2.0 Version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part3-sru2.0/searchRetrieve-v1.0-os-part3-sru2.0.doc (HTML) (PDF)

OASIS-CQL
searchRetrieve: Part 5. CQL: The Contextual Query Language version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part5-cql/searchRetrieve-v1.0-os-part5-cql.doc (HTML) (PDF)

SRU-Explain
searchRetrieve: Part 7. SRU Explain Operation version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part7-explain/searchRetrieve-v1.0-os-part7-explain.doc (HTML) (PDF)

SRU-Scan
searchRetrieve: Part 6. SRU Scan Operation version 1.0, OASIS, January 2013, http://docs.oasis-open.org/search-ws/searchRetrieve/v1.0/os/part6-scan/searchRetrieve-v1.0-os-part6-scan.doc (HTML) (PDF)

LOC-SRU12
SRU Version 1.2: SRU Search/Retrieve Operation, Library of Congress, http://www.loc.gov/standards/sru/sru-1-2.html

LOC-DIAG
SRU Version 1.2: SRU Diagnostics List, Library of Congress, http://www.loc.gov/standards/sru/diagnostics/diagnosticsList.html

UD-POS
Universal Dependencies, Universal POS tags v2.0, https://universaldependencies.github.io/u/pos/index.html

SAMPA
Dafydd Gibbon, Inge Mertins, Roger Moore (Eds.): Handbook of Multimodal and Spoken Language Systems. Resources, Terminology and Product Evaluation, Kluwer Academic Publishers, Boston MA, 2000, ISBN 0-7923-7904-7

CLARIN-FCS-DataViews
CLARIN Federated Content Search (CLARIN-FCS) - Data Views, SCCTC FCS Task-Force, April 2014, https://trac.clarin.eu/wiki/FCS/Dataviews

1.4. Non-Normative References

CQP-TUTORIAL
Evert et al.: The IMS Open Corpus Workbench (CWB) CQP Query Language Tutorial, CWB Version 3.0, February 2010, http://cwb.sourceforge.net/files/CQP_Tutorial/

RFC6838
Media Type Specifications and Registration Procedures, IETF RFC 6838, January 2013, http://www.ietf.org/rfc/rfc6838.txt

RFC3023
XML Media Types, IETF RFC 3023, January 2001, http://www.ietf.org/rfc/rfc3023.txt

1.5. Typographic and XML Namespace conventions

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-Namespaces 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.

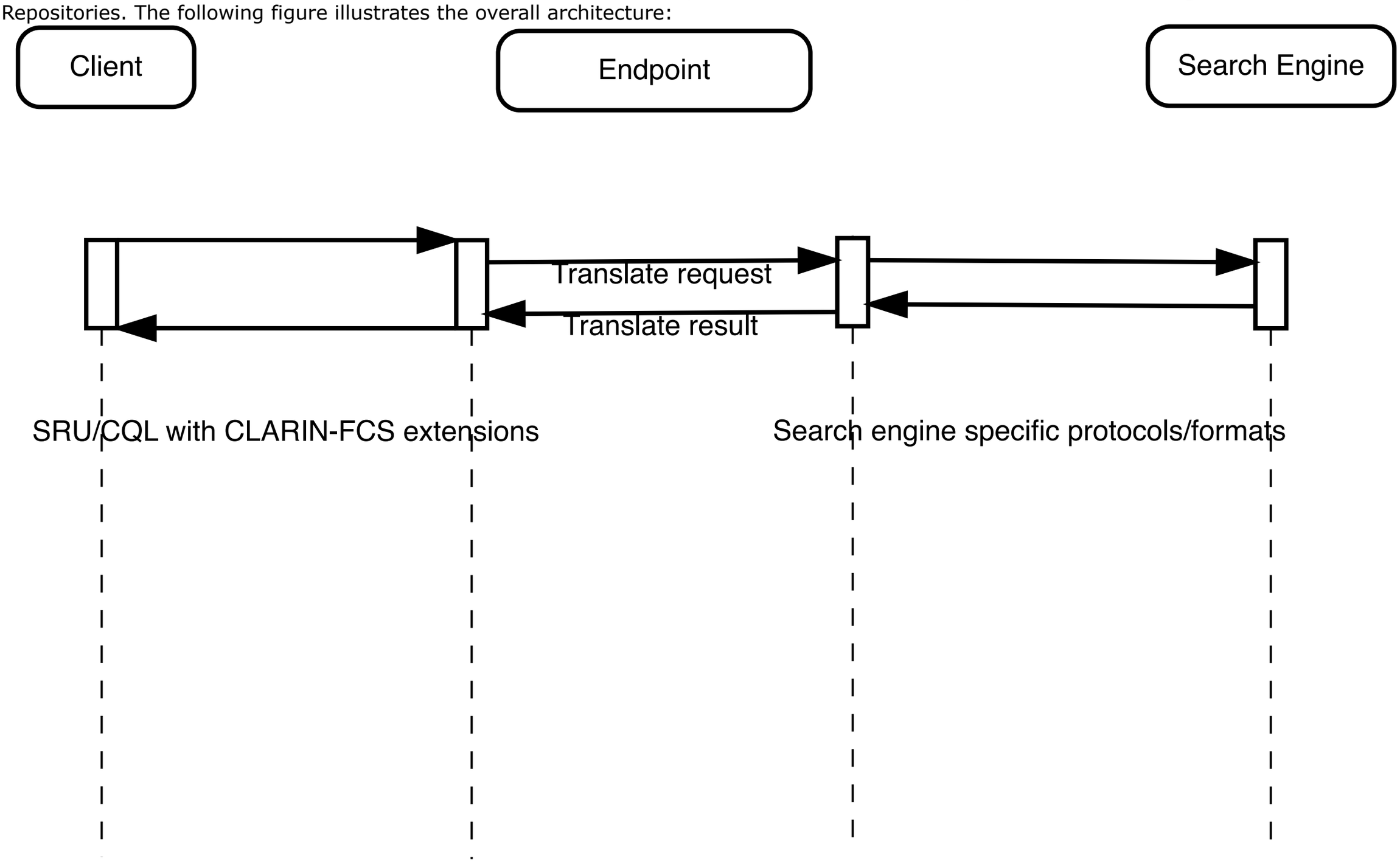
Prefix	Namespace Name	Comment	Recommended Syntax
`fcs`	`http://clarin.eu/fcs/resource`	CLARIN-FCS Resources	prefixed
`ed`	`http://clarin.eu/fcs/endpoint-description`	CLARIN-FCS Endpoint Description	prefixed
`hits`	`http://clarin.eu/fcs/dataview/hits`	CLARIN-FCS Generic Hits Data View	prefixed

`adv`	`http://clarin.eu/fcs/dataview/advanced`	CLARIN-FCS Advanced Data View	prefixed
`sru`	`http://docs.oasis-open.org/ns/search-ws/sruResponse`	SRU Version 2.0	prefixed
`diag`	`http://docs.oasis-open.org/ns/search-ws/diagnostic`	SRU Version 2.0 Diagnostics	prefixed
`zr`	`http://explain.z3950.org/dtd/2.0/`	SRU/ZeeRex Explain	prefixed
`sru`	`http://www.loc.gov/zing/srw/`	SRU Version 1.2, *only compatibility mode*	prefixed
`diag`	`http://www.loc.gov/zing/srw/diagnostic/`	SRU Version 1.2 Diagnostics, *only compatibility mode*	prefixed

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:

Name	Capability Identifier	Summary
Basic Search	`http://clarin.eu/fcs/capability/basic-search`	Simple full-text searching
Advanced Search	`http://clarin.eu/fcs/capability/advanced-search`	Searching in structured and/or annotated data

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 `<ed:EndpointDescription>` element, that contains the following attributes and children:

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

- one `<ed:SupportedDataViews>` element (`REQUIRED`)
  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>` `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` and a `@delivery-policy` 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 `MUST NOT` contain the characters `,` (comma) or `;` (semicolon)
- one `<ed:SupportedLayers>` element (`REQUIRED` if Endpoint supports *Advanced Search* capability)
  A list of Layers that are generally supported by this Endpoint. This list is composed of one or more `<ed:SupportedLayer>` elements. The content of a `<ed:SupportedLayer>` `MUST` be the identifier of a Layer (see section "Layers"), e.g. `orth`. Each `<ed:SupportedLayer>` element `MUST` carry an `@id` and a `@delivery-policy` 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). The `@result-id` attribute is used in the Advanced Data View (see section "Advanced Data View"). Each `<ed:SupportedLayer>` 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.
  This list `MUST NOT` include duplicate entries, i.e. no Layer with the same `@result-id` MIME type must appear more than once.
  The value of the `@id` or `@result-id` attribute `MUST NOT` contain the characters `,` (comma) or `;` (semicolon) The value of the `@qualifier` attribute `MUST NOT` contain characters other than `a`-`z`, `A`-`Z`, `0`-`9` and `-` (hyphen), and the first character `MUST` be one of `a`-`z` or `A`-`Z`. The `<ed:SupportedLayer>` element `MAY` carry an `@alt-value-info` and `@alt-value-info-uri` attribute; `@alt-value-info` `SHOULD` contain a short description about the layer, e.g. the original tag set used; `@alt-value-info-uri` `MUST` contain a well-formed URI and `SHOULD` point to a web site with further information, e.g. about the original tag set and how the translation to FCS is done. Client, e.g. the Aggregator, can display this information together with the search result.
- one `<ed:Resources>` element (`REQUIRED`)
  A list of (top-level) 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:Resources>` has a mandatory `@pid` attribute that contains persistent identifier of the resource. This value `MUST` be the same as the *MdSelfLink* of the CMDI record describing the resource. The `<ed:Resources>` 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 (relevant) available *within* the resource, however this list `MUST NOT` contain duplicate entries.
- 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 the 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:Resources>` element (`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:ed="http://clarin.eu/fcs/endpoint-description" version="2">
    <ed:Capabilities>
        <ed:Capability>http://clarin.eu/fcs/capability/basic-search</ed:Capability>
    </ed:Capabilities>
    <ed:SupportedDataViews>
        <ed:SupportedDataView id="hits" delivery-policy="send-by-default">application/x-clarin-fcs-
hits+xml</ed:SupportedDataView>
    </ed:SupportedDataViews>
    <ed:Resources>
        <!-- just one top-level resource at the Endpoint -->
        <ed:Resource pid="http://hdl.handle.net/4711/0815">
            <ed:Title xml:lang="de">Goethe Korpus</ed:Title>
            <ed:Title xml:lang="en">Goethe corpus</ed:Title>
            <ed:Description xml:lang="de">Der Goethe Korpus des IDS Mannheim.</ed:Description>
            <ed:Description xml:lang="en">The Goethe corpus of IDS Mannheim.</ed:Description>
            <ed:LandingPageURI>http://repos.example.org/corpus1.html</ed:LandingPageURI>
            <ed:Languages>
                <ed:Language>deu</ed:Language>
            </ed:Languages>
            <ed:AvailableDataViews ref="hits" />
        </ed:Resource>
    </ed:Resources>
</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:SupporedDataView>` element with the `@id` with a value of `hits`.

Example 5:

```
<ed:EndpointDescription xmlns:ed="http://clarin.eu/fcs/endpoint-description" version="2">
    <ed:Capabilities>
        <ed:Capability>http://clarin.eu/fcs/capability/basic-search</ed:Capability>
    </ed:Capabilities>
    <ed:SupportedDataViews>
        <ed:SupportedDataView id="hits" delivery-policy="send-by-default">application/x-clarin-fcs-
hits+xml</ed:SupportedDataView>
        <ed:SupportedDataView id="cmdi" delivery-policy="need-to-request">application/x-
cmdi+xml</ed:SupportedDataView>
    </ed:SupportedDataViews>
    <ed:Resources>
        <!-- top-level resource 1 -->
        <ed:Resource pid="http://hdl.handle.net/4711/0815">
            <ed:Title xml:lang="de">Goethe Korpus</ed:Title>
            <ed:Title xml:lang="en">Goethe corpus</ed:Title>
            <ed:Description xml:lang="de">Der Goethe Korpus des IDS Mannheim.</ed:Description>
            <ed:Description xml:lang="en">The Goethe corpus of IDS Mannheim.</ed:Description>
            <ed:LandingPageURI>http://repos.example.org/corpus1.html</ed:LandingPageURI>
            <ed:Languages>
                <ed:Language>deu</ed:Language>
            </ed:Languages>
            <ed:AvailableDataViews ref="hits" />
        </ed:Resource>
        <!-- top-level resource 2 -->
        <ed:Resource pid="http://hdl.handle.net/4711/0816">
            <ed:Title xml:lang="de">Zeitungskorpus des Mannheimer Morgen</ed:Title>
            <ed:Title xml:lang="en">Mannheimer Morgen newspaper corpus</ed:Title>
            <ed:LandingPageURI>http://repos.example.org/corpus2.html</ed:LandingPageURI>
            <ed:Languages>
                <ed:Language>deu</ed:Language>
            </ed:Languages>
            <ed:AvailableDataViews ref="hits cmdi" />
            <ed:Resources>
                <!-- sub-resource 1 of top-level resource 2 -->
                <ed:Resource pid="http://hdl.handle.net/4711/0816-1">
                    <ed:Title xml:lang="de">Zeitungskorpus des Mannheimer Morgen (vor 1990)</ed:Title>
                    <ed:Title xml:lang="en">Mannheimer Morgen newspaper corpus (before 1990)</ed:Title>
                    <ed:LandingPageURI>http://repos.example.org/corpus2.html#sub1</ed:LandingPageURI>
                    <ed:Languages>
                        <ed:Language>deu</ed:Language>
                    </ed:Languages>
                    <ed:AvailableDataViews ref="hits cmdi" />
                </ed:Resource>
                <!-- sub-resource 2 of top-level resource 2 -->
                <ed:Resource pid="http://hdl.handle.net/4711/0816-2">
                    <ed:Title xml:lang="de">Zeitungskorpus des Mannheimer Morgen (nach 1990)</ed:Title>
                    <ed:Title xml:lang="en">Mannheimer Morgen newspaper corpus (after 1990)</ed:Title>
                    <ed:LandingPageURI>http://repos.example.org/corpus2.html#sub2</ed:LandingPageURI>
                    <ed:Languages>
                        <ed:Language>deu</ed:Language>
                    </ed:Languages>
                    <ed:AvailableDataViews ref="hits cmdi" />
                </ed:Resource>
            </ed:Resources>
        </ed:Resource>
    </ed:Resources>
</ed:EndpointDescription>
```

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 identifier `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:

```
<ed:EndpointDescription xmlns:ed="http://clarin.eu/fcs/endpoint-description" version="2">
  <ed:Capabilities>
    <ed:Capability>http://clarin.eu/fcs/capability/basic-search</ed:Capability>
    <ed:Capability>http://clarin.eu/fcs/capability/advanced-search</ed:Capability>
  </ed:Capabilities>
  <ed:SupportedDataViews>
    <ed:SupportedDataView id="hits" delivery-policy="send-by-default">application/x-clarin-fcs-
hits+xml</ed:SupportedDataView>
    <ed:SupportedDataView id="adv" delivery-policy="send-by-default">application/x-clarin-fcs-
adv+xml</ed:SupportedDataView>
  </ed:SupportedDataViews>
  <ed:SupportedLayers>
    <ed:SupportedLayer id="word" result-id="http://spraakbanken.gu.se/ns/fcs/layer/word">text</ed:SupportedLayer>
    <ed:SupportedLayer id="orth" result-id="http://endpoint.example.org/Layers/orth"
type="empty">orth</ed:SupportedLayer>
    <ed:SupportedLayer id="lemma" result-id="http://spraakbanken.gu.se/ns/fcs/layer/lemma">lemma</ed:SupportedLayer>
    <ed:SupportedLayer id="pos" result-id="http://spraakbanken.gu.se/ns/fcs/layer/pos"
                       alt-value-info="SUC tagset"
                       alt-value-info-uri="https://spraakbanken.gu.se/parole/Docs/SUC2.0-manual.pdf"
                       qualifier="suc">pos</ed:SupportedLayer>
    <ed:SupportedLayer id="pos2" result-id="http://spraakbanken.gu.se/ns/fcs/layer/pos2"
                       alt-value-info="2nd tagset"
                       qualifier="t2">pos</ed:SupportedLayer>
  </ed:SupportedLayers>

    <ed:Resources>
```

```
        <!-- just one top-level resource at the Endpoint -->
        <ed:Resource pid="hdl:10794/suc">
          <ed:Title xml:lang="sv">SUC-korpusen</ed:Title>
          <ed:Title xml:lang="en">The SUC corpus</ed:Title>
          <ed:Description xml:lang="sv">Stockholm-Umeå-korpusen hos Språkbanken.</ed:Description>
          <ed:Description xml:lang="en">The Stockholm-Umeå corpus at Språkbanken.</ed:Description>
          <ed:LandingPageURI>https://spraakbanken.gu.se/resurser/suc</ed:LandingPageURI>
          <ed:Languages>
             <ed:Language>swe</ed:Language>
          </ed:Languages>
          <ed:AvailableDataViews ref="hits adv" />
          <ed:AvailableLayers ref="word lemma pos pos2" />
        </ed:Resource>
    </ed:Resources>
</ed:EndpointDescription>
```

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-fomed 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* and *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"
"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.

CLARIN-FCS defines a set of searchable annotation layers with certain semantics and syntax. Endpoints `SHOULD` support as many different, of course depending on the resource type, annotation layers as possible.

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.

Layer Type Identifier	Annotation Layer Description	Syntax	Examples (without quotes)
`text`	Textual representation of resource, also the layer that is used in Basic Search	*String*	"Dog", "cat" "walking", "better"
`lemma`	Lemmatisation	*String*	"good", "walk", "dog"
`pos`	Part-of-Speech annotations	Universal POS tags	"NOUN", "VERB", "ADJ"
`orth`	Orthographic transcription of (mostly) spoken resources	*String*	"dug", "cat", "wolking"
`norm`	Orthographic normalization of (mostly) spoken resources	*String*	"dog", "cat", "walking", "best"
`phonetic`	Phonetic transcription	SAMPA	"'du:", "'vi:-d6 'ha:-b@n"

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.

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"]
"blaue|grüne" [pos = "NOUN"]
"dogs" []{3,} "cats" within s
[z:pos = "ADJ"]
[z:pos = "ADJ" & q:pos = "ADJ"]
```

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

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 NOT` 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. Result Format

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.

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.

A Resource `SHOULD` be the most precise unit of data that is directly addressable as a "whole". A Resource `SHOULD` contain a Resource Fragment, if the hit consists of just a part of the Resource unit (for example if the hit is a sentence within a large text). A Resource Fragment `SHOULD` be addressable within a resource, i.e. it has an offset or a resource-internal identifier. Using Resource Fragments is `OPTIONAL`, but Endpoints are encouraged to use them. If the Endpoint encodes a hit with a Resource Fragment, the actual hit `SHOULD` be encoded as a Data View within the Resource Fragment.

Endpoints `SHOULD` always provide a link to the resource itself, i.e. each Resource or Resource Fragment `SHOULD` be identified by a persistent identifier or providing a URI, that is unique for the Endpoint. Even if direct linking is not possible, i.e. due to licensing issues, the Endpoints `SHOULD` provide a URI to link to a web-page describing the corpus or collection, including instruction on how to obtain it. Endpoints `SHOULD` provide links that are as specific as possible (and logical), i.e. if a sentence within a resource cannot be addressed directly, the Resource Fragment `SHOULD NOT` contain a persistent identifier or an URI.

If the Endpoint can provide both, a persistent identifier as well as a URI, for either Resource or Resource Fragment, then they `SHOULD` provide both. When working with results, Clients `SHOULD` prefer persistent identifiers over regular URIs.

Resource and Resource Fragment are serialized in XML and Endpoints `MUST` generate responses that are valid according to the XML schema "Resource.xsd" (download). A Resource is encoded in the form of a `<fcs:Resource>` element, a *Resource Fragment* in the form of a `<fcs:ResourceFragment>` element. The content of a Data View is wrapped in a `<fcs:DataView>` element. `<fcs:Resource>` is the top-level element and `MAY` contain zero or more `<fcs:DataView>` elements and `MAY` contain zero or more `<fcs:ResourceFragment>` elements. A `<fcs:ResourceFragment>` element `MUST` contain one or more `<fcs:DataView>` elements.

The elements `<fcs:Resource>`, `<fcs:ResourceFragment>` and `<fcs:DataView>` `MAY` carry a `@pid` and/or a `@ref` attribute, which allows linking to the original data represented by the Resource, Resource Fragment, or Data View. A `@pid` attribute `MUST` contain a valid persistent identifier, a `@ref` `MUST` contain valid URI, i.e. a "plain" URI without the additional semantics of being a persistent reference. If the Endpoint cannot provide a `@pid` attribute for a `<fcs:Resource>`, they `SHOULD` provide a `@ref` attribute. Endpoint `SHOULD` add either a `@pid` or `@ref` attribute to either the `<fcs:Resource>` or the `<fcs:ResourceFragment>` element, if possible to both elements. Endpoints are `RECOMMENDED` to give `@pid` attributes, if they can provide them.

Endpoints `MUST` use the identifier `http://clarin.eu/fcs/resource` for the *responseItemType* (= content for the `<sru:recordSchema>` element) in SRU responses.

Endpoints `MAY` serialize hits as multiple Data Views, however they `MUST` provide the Generic Hits (HITS) Data View either encoded as a Resource Fragment (if applicable), or otherwise within the Resource (if there is no reasonable Resource Fragment). Other Data Views `SHOULD` be put in a place that is logical for their content (as is to be determined by the Endpoint), e.g. a metadata Data View would most likely be put directly below Resource and a Data View representing some annotation layers directly around the hit is more likely to belong within a Resource Fragment.

Example 1:

```
<fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/00-15">
  <fcs:DataView type="application/x-clarin-fcs-hits+xml">
      <!-- data view payload omitted -->
  </fcs:DataView>
</fcs:Resource>
```

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:

```
<fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/08-15">
  <fcs:ResourceFragment>
    <fcs:DataView type="application/x-clarin-fcs-hits+xml">
      <!-- data view payload omitted -->
    </fcs:DataView>
  </fcs:ResourceFragment>
</fcs:Resource>
```

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:

```
<fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource"
              pid="http://hdl.handle.net/4711/08-15" ref="http://repos.example.org/file/text_08_15.html">
  <fcs:DataView type="application/x-cmdi+xml"
                pid="http://hdl.handle.net/4711/08-15-1" ref="http://repos.example.org/file/08_15_1.cmdi">
      <!-- data view payload omitted -->
  </fcs:DataView>
  <fcs:ResourceFragment pid="http://hdl.handle.net/4711/08-15-2"
ref="http://repos.example.org/file/text_08_15.html#sentence2">
    <fcs:DataView type="application/x-clarin-fcs-hits+xml">
      <!-- data view payload omitted -->
    </fcs:DataView>
  </fcs:ResourceFragment>
</fcs:Resource>
```

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_1.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/text_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.

Generic Hits (HITS)

Description	The representation of the hit
MIME type	`application/x-clarin-fcs-hits+xml`
Payload Disposition	*inline*
Payload Delivery	*send-by-default* (`REQUIRED`)
Recommended Short Identifier	`hits` (`RECOMMENDED`)
XML Schema	DataView-Hits.xsd (download)

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):

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

- Example (multiple hit markers):

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

Advanced (ADV)

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

The *Advanced (ADV)* Data View serves as the natual 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

Data	t		d	a		'	s		d	e		e	n	i	g	e		e	c	h	t	e		h	o	o	p		v	o	o	r		o	n	s		m	e	n	s	e	n
Offset	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43

Example: several annotation layers for the sentence

Offset (Start, End)	1,1	3,4	6,7	9,10	12,16	18,22	24,27	29,32	34,36	38,43
Layer *orth*	t	da	's	de	enige	echte	hoop	voor	ons	mensen
Layer *pos*	X	PRON	VERB	DET	DET	ADJ	NOUN	ADP	PRON	NOUN
Layer *lemma*	_	dat	zijn	de	enig	echt	hoop	voor	ons	mens
Layer *phonetic*	t@	dAz	dAz	d@	en@G@	Ext@	hop	for	Ons	mEns@

Example: XML serialization

```
<Advanced>
    <Segments unit="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>
```

```
    <Layers>
        <Layer id="http://endpoint.example.org/Layers/orth1">
            <Span ref="s1">t</Span>
            <Span ref="s2">da</Span>
            <Span ref="s3">'s</Span>
            <Span ref="s4">de</Span>
            <Span ref="s5">enige</Span>
            <Span ref="s6">echte</Span>
            <Span ref="s7">hoop</Span>
            <Span ref="s8">voor</Span>
            <Span ref="s9">ons</Span>
            <Span ref="s10">mensen</Span>
        </Layer>

        <Layer id="http://endpoint.example.org/Layers/pos1">
            <Span ref="s1"  alt-value="SPEC(afgebr)">X</Span>
            <Span ref="s2"  alt-value="VNW(aanw,pron,stan,vol,3o,ev)">PRON</Span>
            <Span ref="s3"  alt-value="WW(pv,tgw,ev)">VERB</Span>
            <Span ref="s4"  alt-value="LID(bep,stan,rest)">DET</Span>
            <Span ref="s5"  alt-value="VNW(onbep,det,stan,prenom,met-e,rest)">DET</Span>
            <Span ref="s6"  alt-value="ADJ(prenom,basis,met-e,stan)">ADJ</Span>
            <Span ref="s7"  alt-value="N(soort,ev,basis,zijd,stan)">NOUN</Span>
            <Span ref="s8"  alt-value="VZ(init)">ADP</Span>
            <Span ref="s9"  alt-value="VNW(pr,pron,obl,vol,1,mv)">PRON</Span>
            <Span ref="s10" alt-value="N(soort,mv,basis)">NOUN</Span>
        </Layer>

        <Layer id="http://endpoint.example.org/Layers/lemma1">
            <Span ref="s1">_</Span>
            <Span ref="s2">dat</Span>
            <Span ref="s3">zijn</Span>
            <Span ref="s4" >de</Span>
            <Span ref="s5">enig</Span>
            <Span ref="s6" highlight="h1">echt</Span>
            <Span ref="s7" highlight="h1">hoop</Span>
            <Span ref="s8">voor</Span>
            <Span ref="s9">ons</Span>
            <Span ref="s10">mens</Span>
        </Layer>

        <Layer id="http://endpoint.example.org/Layers/phon">
            <Span ref="s1">t@</Span>
            <Span ref="s2" highlight="h2">dAz</Span>
            <Span ref="s3">dAz</Span>
            <Span ref="s4">d@</Span>
            <Span ref="s5">en@G@</Span>
            <Span ref="s6">Ext@</Span>
            <Span ref="s7">hop</Span>
            <Span ref="s8">for</Span>
            <Span ref="s9">Ons</Span>
            <Span ref="s10">mEns@</Span>
        </Layer>
    </Layers>
</Advanced>
```

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 talk an Endpoint.

Clients `MUST` be able to process the legacy XML namespaces:

- `http://www.loc.gov/zing/srw/` for SRU response documents, and
- `http://www.loc.gov/zing/srw/diagnostic/` for diagnostics within SRU response documents.

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.

An Endpoint `MAY` add arbitrary XML fragments to the extension hooks provided in the `<fcs:Resource>` element (see the XML schema for "Resource.xsd"). The XML fragment for the extension `MUST` use a custom XML namespace name for the extension. Endpoints `MUST NOT` use XML namespace names that start with the prefixes `http://clarin.eu`, `http://www.clarin.eu/`, `https://clarin.eu` or `https://www.clarin.eu/`.

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 for searching and retrieving records and CQL (Contextual Query Language) specifies extensible query language. SRU 2.0 allows using additional custom query languages. CLARIN-FCS Core 2.0 uses FCS-QL for the Advanced Search capability.

Endpoints and Clients `MUST` implement the SRU/CQL protocol suite as defined in OASIS-SRU-Overview, OASIS-SRU-APD, OASIS-CQL, SRU-Explain, SRU-Scan, especially with respect to:

- Data Model,
- Query Model,
- Processing Model,
- Result Set Model, and
- Diagnostics Model

Endpoints and Clients `MUST` implement the APD Binding for SRU 2.0, as defined in OASIS-SRU-20.
Clients `MUST` implement APD Binding for SRU 1.2, as defined in OASIS-SRU-12.
Clients `MAY` also implement APD binding for version 1.1.
NOTE: when implementing SRU 1.2 Endpoints and Clients `MUST` behave like described in the section Backwards Compatibility.

Endpoints or Clients `MUST` support CQL conformance *Level 2* (as defined in OASIS-CQL, section 6), i.e. be able to *parse* (Endpoints) or *serialize* (Clients) all of CQL and respond with appropriate error messages to the search/retrieve protocol interface.

NOTE: this does *not imply*, that Endpoints are *required* to support all of CQL, but rather that they are able to *parse* all of CQL and generate the appropriate error message, if a query includes a feature they do not support.

Endpoints `MUST` generate diagnostics according to OASIS-SRU-20, Appendix D for error conditions or to indicate unsupported features.
Unfortunately, the OASIS specification does not provides a comprehensive list of diagnostics for CQL-related errors. Therefore, Endpoints `MUST` use diagnostics from LOC-DIAG, section "Diagnostics Relating to CQL" for CQL related errors.

Endpoints `MUST` support the HTTP GET OASIS-SRU-20, Appendix B.1 and HTTP POST OASIS-SRU-20, Appendix B.2 lower level protocol binding.
Endpoints `MAY` also support the SOAP OASIS-SRU-20, Appendix B.3 binding.

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 `<sru:record>` element that contains an *SRU Explain* record. The `<sru: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:serverInfo>` 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:configInfo>` 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 `<sru: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 the Endpoint Description 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&x-fcs-endpoint-description=true
```

- HTTP Response: Endpoint → Client:

```
<?xml version='1.0' encoding='utf-8'?>
<sru:explainResponse xmlns:sru="http://www.loc.gov/zing/srw/">
  <sru:version>1.2</sru:version>
  <sru:record>
    <sru:recordSchema>http://explain.z3950.org/dtd/2.0/</sru:recordSchema>
    <sru:recordPacking>xml</sru:recordPacking>
    <sru:recordData>
      <zr:explain xmlns:zr="http://explain.z3950.org/dtd/2.0/">
        <!-- <zr:serverInfo > is REQUIRED -->
        <zr:serverInfo protocol="SRU" 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 Korpus</zr:title>
          <zr:description lang="de">Der Goethe Korpus des 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">
            <zr:title lang="en" primary="true">CLARIN Federated Content Search</zr:title>
          </zr:schema>
        </zr:schemaInfo>
        <!-- <zr:configInfo> is OPTIONAL -->
        <zr:configInfo>
          <zr:default type="numberOfRecords">250</zr:default>
```

```
          <zr:setting type="maximumRecords">1000</zr:setting>
        </zr:configInfo>
      </zr:explain>
    </sru:recordData>
  </sru:record>
  <!-- <sru:echoedExplainRequest> is OPTIONAL -->
  <sru:echoedExplainRequest>
    <sru:version>1.2</sru:version>
    <sru:baseUrl>http://repos.example.org/fcs-endpoint</sru:baseUrl>
  </sru:echoedExplainRequest>
  <sru:extraResponseData>
    <ed:EndpointDescription xmlns:ed="http://clarin.eu/fcs/endpoint-description" version="1">
      <ed:Capabilities>
          <ed:Capability>http://clarin.eu/fcs/capability/basic-search</ed:Capability>
      </ed:Capabilities>
      <ed:SupportedDataViews>
          <ed:SupportedDataView id="hits" delivery-policy="send-by-default">application/x-clarin-fcs-
hits+xml</ed:SupportedDataView>
      </ed:SupportedDataViews>
      <ed:Resources>
          <!-- just one top-level resource at the Endpoint -->
          <ed:Resource pid="http://hdl.handle.net/4711/0815">
              <ed:Title xml:lang="de">Goethe Corpus</ed:Title>
              <ed:Title xml:lang="en">Goethe Korpus</ed:Title>
              <ed:Description xml:lang="de">Der Goethe Korpus des IDS Mannheim.</ed:Description>
              <ed:Description xml:lang="en">The Goethe corpus of IDS Mannheim.</ed:Description>
              <ed:LandingPageURI>http://repos.example.org/corpus1.html</ed:LandingPageURI>
              <ed:Languages>
                  <ed:Language>deu</ed:Language>
              </ed:Languages>
              <ed:AvailableDataViews ref="hits"/>
          </ed:Resource>
      </ed:Resources>
    </ed:EndpointDescription>
  </sru:extraResponseData>
</sru: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&x-fcs-endpoint-description=true
```

- HTTP Response: Endpoint → Client:

```
<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:explain>
        <zr:serverInfo protocol="SRU" version="2.0" transport="http">
          <zr:host>127.0.0.1</zr:host>
          <zr:port>8080</zr:port>
          <zr:database>korp-endpoint</zr:database>
        </zr:serverInfo>
        <zr:databaseInfo>
          <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" primary="true">Språkbanken</zr:author>
        </zr:databaseInfo>
        <zr:indexInfo>
          <zr:set identifier="http://clarin.eu/fcs/resource" name="fcs">
            <zr:title lang="se">Clarins innehållssökning</zr:title>
            <zr:title lang="en" primary="true">CLARIN Content Search</zr:title>
          </zr:set>
          <zr:index search="true" scan="false" sort="false">
            <zr:title lang="en" primary="true">Words</zr:title>
            <zr:map primary="true">
              <zr:name set="fcs">words</zr:name>
            </zr:map>
          </zr:index>
        </zr:indexInfo>
        <zr:schemaInfo>
          <zr:schema identifier="http://clarin.eu/fcs/resource" name="fcs">
            <zr:title lang="en" primary="true">CLARIN Content Search</zr:title>
          </zr:schema>
        </zr:schemaInfo>
        <zr:configInfo>
          <zr:default type="numberOfRecords">250</zr:default>
          <zr:setting type="maximumRecords">1000</zr:setting>
        </zr:configInfo>
      </zr:explain>
    </sruResponse:recordData>
  </sruResponse:record>
  <sruResponse:echoedExplainRequest>
    <sruResponse:version>2.0</sruResponse:version>
  </sruResponse:echoedExplainRequest>
  <sruResponse:extraResponseData>
    <ed:EndpointDescription version="2">
      <ed:Capabilities>
        <ed:Capability>http://clarin.eu/fcs/capability/basic-search</ed:Capability>
```

```
      <ed:Capability>http://clarin.eu/fcs/capability/advanced-search</ed:Capability>
    </ed:Capabilities>
    <ed:SupportedDataViews>
      <ed:SupportedDataView id="hits" delivery-policy="send-by-default">application/x-clarin-fcs-
hits+xml</ed:SupportedDataView>
      <ed:SupportedDataView id="adv" delivery-policy="send-by-default">application/x-clarin-fcs-
adv+xml</ed:SupportedDataView>
    </ed:SupportedDataViews>
    <ed:SupportedLayers>
      <ed:SupportedLayer id="word" result-
id="http://spraakbanken.gu.se/ns/fcs/layer/word">text</ed:SupportedLayer>
      <ed:SupportedLayer id="lemma" result-
id="http://spraakbanken.gu.se/ns/fcs/layer/lemma">lemma</ed:SupportedLayer>
      <ed:SupportedLayer id="pos" result-id="http://spraakbanken.gu.se/ns/fcs/layer/pos">pos</ed:SupportedLayer>
    </ed:SupportedLayers>
    <ed:Resources>
      <ed:Resource pid="hdl:10794/suc">
        <ed:Title xml:lang="sv">SUC-korpusen</ed:Title>
        <ed:Title xml:lang="en">The SUC corpus</ed:Title>
        <ed:Description xml:lang="sv">Stockholm-Umeå-korpusen hos Språkbanken.</ed:Description>
        <ed:Description xml:lang="en">The Stockholm-Umeå corpus at Språkbanken.</ed:Description>
        <ed:LandingPageURI>https://spraakbanken.gu.se/resurser/suc</ed:LandingPageURI>
        <ed:Languages>
          <ed:Language>swe</ed:Language>
        </ed:Languages>
        <ed:AvailableDataViews ref="hits adv"/>
        <ed:AvailableLayers ref="word lemma pos"/>
      </ed:Resource>
    </ed:Resources>
  </ed:EndpointDescription>
</sruResponse:extraResponseData>
</sruResponse:explainResponse>
```

3.3. 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 *responseItemType* ("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 version='1.0' encoding='utf-8'?>
<sru:searchRetrieveResponse xmlns:sru="http://www.loc.gov/zing/srw/">
  <sru:version>1.2</sru:version>
  <sru:numberOfRecords>6</sru:numberOfRecords>
  <sru:records>
    <sru:record>
      <sru:recordSchema>http://clarin.eu/fcs/resource</sru:recordSchema>
      <sru:recordPacking>xml</sru:recordPacking>
      <sru:recordData>
        <fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/08-15">
          <fcs:ResourceFragment>
            <fcs:DataView type="application/x-clarin-fcs-hits+xml">
              <hits:Result xmlns:hits="http://clarin.eu/fcs/dataview/hits">
                The quick brown <hits:Hit>cat</hits:Hit> jumps over the lazy dog.
              </hits:Result>
            </fcs:DataView>
          </fcs:ResourceFragment>
        </fcs:Resource>
      </sru:recordData>
      <sru:recordPosition>1</sru:recordPosition>
    </sru:record>
    <!-- more <sru:records> omitted for brevity -->
  </sru:records>
  <!-- <sru:echoedSearchRetrieveRequest> is OPTIONAL -->
  <sru:echoedSearchRetrieveRequest>
    <sru:version>1.2</sru:version>
    <sru:query>cat</sru:query>
    <sru:xQuery xmlns="http://www.loc.gov/zing/cql/xcql/">
      <searchClause>
        <index>cql.serverChoice</index>
        <relation>
          <value>=</value>
        </relation>
        <term>cat</term>
      </searchClause>
    </sru:xQuery>
```

```
    <sru:startRecord>1</sru:startRecord>
    <sru:baseUrl>http://repos.example.org/fcs-endpoint</sru:baseUrl>
  </sru:echoedSearchRetrieveRequest>
</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'?>
<sruResponse:searchRetrieveResponse>
  <sruResponse:version>2.0</sruResponse:version>
  <sruResponse:numberOfRecords>33260</sruResponse:numberOfRecords>
  <sruResponse:records>
    <sruResponse:record>
      <sruResponse:recordSchema>http://clarin.eu/fcs/resource</sruResponse:recordSchema>
      <sruResponse:recordXMLEscaping>xml</sruResponse:recordXMLEscaping>
      <sruResponse:recordData>
        <fcs:Resource pid="ABOUNDERRATTELSER2012-32245">
          <fcs:ResourceFragment>
            <fcs:DataView type="application/x-clarin-fcs-hits+xml">
              <hits:Result>Youtube-videon har väckt debatt om polisernas <hits:Hit>användning</hits:Hit> av våld
.</hits:Result>
            </fcs:DataView>
          </fcs:ResourceFragment>
        </fcs:Resource>
      </sruResponse:recordData>
      <sruResponse:recordPosition>1</sruResponse:recordPosition>
    </sruResponse:record>
    <!-- 249 records not shown -->
  </sruResponse:records>
  <sruResponse:nextRecordPosition>251</sruResponse:nextRecordPosition>
  <sruResponse:echoedSearchRetrieveRequest>
  <sruResponse:version>2.0</sruResponse:version>
  <sruResponse:query>"användning"</sruResponse:query>
  <sruResponse:xQuery>
    <searchClause>
      <index>cql.serverChoice</index>
      <relation><value>=</value></relation>
      <term>användning</term>
    </searchClause>
  </sruResponse:xQuery>
  <sruResponse:startRecord>1</sruResponse:startRecord>
</sruResponse:echoedSearchRetrieveRequest>
<sruResponse:resultCountPrecision>info:srw/vocabulary/resultCountPrecision/1/exact</sruResponse:resultCountPrecisi

</sruResponse: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=%5bword%3d%22anv%C3%A4ndning%22%5d&x-cmd-resource-info=true
```

- HTTP Response: Endpoint → Client:

```
<?xml version='1.0' encoding='utf-8'?>
<sruResponse:searchRetrieveResponse>
  <sruResponse:version>2.0</sruResponse:version>
  <sruResponse:numberOfRecords>33260</sruResponse:numberOfRecords>
  <sruResponse:records>
    <sruResponse:record>
      <sruResponse:recordSchema>http://clarin.eu/fcs/resource</sruResponse:recordSchema>
      <sruResponse:recordXMLEscaping>xml</sruResponse:recordXMLEscaping>
      <sruResponse:recordData>
        <fcs:Resource pid="ABOUNDERRATTELSER2012-32245">
          <fcs:ResourceFragment>
            <fcs:DataView type="application/x-clarin-fcs-hits+xml">
              <hits:Result>Youtube-videon har väckt debatt om polisernas <hits:Hit>användning</hits:Hit> av våld
.</hits:Result>
            </fcs:DataView>
            <fcs:DataView type="application/x-clarin-fcs-adv+xml">
              <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>
                    <adv:Span ref="s2">|ha|</adv:Span>
```

```
      <adv:Span ref="s3">|väcka|</adv:Span>
      <adv:Span ref="s4">|debatt|</adv:Span>
      <adv:Span ref="s5">|om|</adv:Span>
      <adv:Span ref="s6">|polis|</adv:Span>
      <adv:Span ref="s7" highlight="h1">|användning|</adv:Span>
      <adv:Span ref="s8">|av|</adv:Span>
      <adv:Span ref="s9">|våld|</adv:Span>
      <adv:Span ref="sa">|</adv:Span>
    </adv:Layer>
    <adv:Layer id="http://spraakbanken.gu.se/ns/fcs/layer/word">
      <adv:Span ref="s1">Youtube-videon</adv:Span>
      <adv:Span ref="s2">har</adv:Span>
      <adv:Span ref="s3">väckt</adv:Span>
      <adv:Span ref="s4">debatt</adv:Span>
      <adv:Span ref="s5">om</adv:Span>
      <adv:Span ref="s6">polisernas</adv:Span>
      <adv:Span ref="s7" highlight="h1">användning</adv:Span>
      <adv:Span ref="s8">av</adv:Span>
      <adv:Span ref="s9">våld</adv:Span>
      <adv:Span ref="sa">.</adv:Span>
    </adv:Layer>
    <adv:Layer id="http://spraakbanken.gu.se/ns/fcs/layer/pos">
      <adv:Span ref="s1">PROPN</adv:Span>
      <adv:Span ref="s2">VERB</adv:Span>
      <adv:Span ref="s3">VERB</adv:Span>
      <adv:Span ref="s4">NOUN</adv:Span>
      <adv:Span ref="s5">ADP</adv:Span>
      <adv:Span ref="s6">NOUN</adv:Span>
      <adv:Span ref="s7" highlight="h1">NOUN</adv:Span>
      <adv:Span ref="s8">ADP</adv:Span>
      <adv:Span ref="s9">NOUN</adv:Span>
      <adv:Span ref="sa">PUNCT</adv:Span>
    </adv:Layer>
  </adv:Layers>
 </adv:Advanced>
</fcs:DataView>
</fcs:ResourceFragment>
</fcs:Resource>
</sruResponse:recordData>
<sruResponse:recordPosition>1</sruResponse:recordPosition>
</sruResponse:record>
<!-- 249 records not shown -->
</sruResponse:records>
<sruResponse:nextRecordPosition>251</sruResponse:nextRecordPosition>
<sruResponse:echoedSearchRetrieveRequest>
<sruResponse:version>2.0</sruResponse:version>
<sruResponse:startRecord>1</sruResponse:startRecord>
</sruResponse:echoedSearchRetrieveRequest>
<sruResponse:resultCountPrecision>info:srw/vocabulary/resultCountPrecision/1/exact</sruResponse:resultCountPrecisi

</sruResponse:searchRetrieveResponse>
```


In general, as you can se 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 diagnostics `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 request the Endpoint to *restrict the search* to a sub-resource of these Resources. In this case, the Client `MUST` pass a comma-separated list of persistent identifiers in the `x-fcs-context` extra request parameter of the *searchRetrieve* request. The Endpoint `MUST` then restrict the search to those Resources, which are identified by the persistent identifiers passed by the Client. If a Client requests too many resources for the Endpoint to handle with `x-fcs-context`, the Endpoint `MAY` issue a fatal diagnostic `http://clarin.eu/fcs/diagnostic/3` ("Resource set too large. Cannot perform Query.") and terminate processing. Alternatively, the Endpoint `MAY` also automatically adjust the scope and issue a non-fatal diagnostic `http://clarin.eu/fcs/diagnostic/2` (see above). And Endpoint `MUST NOT` issue a `http://clarin.eu/fcs/diagnostic/3` diagnostic in response to a request, if a Client performed the request *without* the `x-fcs-context` extra request parameter.

The Client can extract all valid persistent identifiers from the `@pid` attribute of the `<ed:Resource>` 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=cat&x-fcs-
context=http://hdl.handle.net/4711/0815
```

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=cat&x-fcs-
context=http://hdl.handle.net/4711/0815,http://hdl.handle.net/4711/0816-2
```

If an invalid persistent identifier is passed by the Client, the Endpoint `MUST` issue a `http://clarin.eu/fcs/diagnostic/1` diagnostic, i.e. add the appropriate XML fragment to the `<sru:diagnostics>` 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 identifier* 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

use the *Data View identifier* `cmdi` and submit the following request:

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

If an invalid *Data View identifier* is passed by the Client, the Endpoint `MUST` issue a `http://clarin.eu/fcs/diagnostic/4` diagnostic, i.e. add the appropriate XML fragment to the `<sru:diagnostics>` element of the response. The Endpoint `MAY` treat this condition as fatal, i.e. simply issue the diagnostic and perform no search, or it `MAY` treat it a non-fatal and perform the search.

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.

Parameter Name	SRU operations	Allowed values	Description
`x-fcs-endpoint-description`	explain	`true` ; all other values are reserved and `MUST` not be used by Clients	If the parameter is given (with the value `true`), the Endpoint `MUST` include an Endpoint Description in the `<sru:extraResponseData>` element of the *explain* response.
`x-fcs-context`	searchRetrieve	A comma-separated list of persistent identifiers	The Endpoint `MUST` restrict the search to the resources identified by the persistent identifiers.
`x-fcs-dataviews`	searchRetrieve	A comma-separated list of Data View identifiers	The Endpoint `SHOULD` include the additional *need-to-request* type Data Views in the response.
`x-fcs-rewrites-allowed`	searchRetrieve	`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.	If the parameter is given (with the value `true`), the Endpoint `MAY` rewrite the query to a simpler query to allow for more recall.

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.

Identifier URI	Description	Details Format	Impact	Note
`http://clarin.eu/fcs/diagnostic/1`	Persistent identifier passed by the Client for restricting the search is invalid.	The offending persistent identifier.	non-fatal	If more than one invalid persistent identifiers were submitted by the Client, the Endpoint `MUST` generate a separate diagnostic for each invalid persistent identifier.
`http://clarin.eu/fcs/diagnostic/2`	Resource set too large. Query context automatically adjusted.	The persistent identifier of the resource to which the query context was adjusted.	non-fatal	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.
`http://clarin.eu/fcs/diagnostic/3`	Resource set too large. Cannot perform Query.		fatal	
`http://clarin.eu/fcs/diagnostic/4`	Requested Data View not valid for this resource.	The Data View MIME type.	non-fatal	If more than one invalid Data View was requested, the Endpoint `MUST` generate a separate diagnostic for each invalid Data View.
`http://clarin.eu/fcs/diagnostic/10`	General query syntax error.	Detailed error message why the query could not be parsed.	fatal	Endpoints `MUST` use this diagnostic only if the Client performed an Advanced Search request.
`http://clarin.eu/fcs/diagnostic/11`	Query too complex. Cannot perform Query.	Details why could not be performed, e.g. unsupported layer or unsupported combination of operators.	fatal	Endpoints `MUST` use this diagnostic only if the Client performed an Advanced Search request.
`http://clarin.eu/fcs/diagnostic/12`	Query was rewritten.	Details how the query was rewritten.	non-fatal	Endpoints `MUST` use this diagnostic only if the Client performed an Advanced Search request with the `x-fcs-rewrites-allowed` request parameter.
`http://clarin.eu/fcs/diagnostic/14`	General processing hint.	E.g. "No matches, because layer 'XY' is not available in your selection of resources"	non-fatal	Endpoints `MUST` use this diagnostic only if the Client performed an Advanced Search request.

4.2. CLARIN FCS-QL Grammar Specification

#fcsQLEBNF 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

Endpoint.

Tokens are limited by `[` and `]` except for 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

```
[1] query                  ::= main-query within-part?

[2] main-query             ::= simple-query
                             | simple-query "|" main-query     /* or */
                             | simple-query main-query         /* sequence */
                             | simple-query quantifier         /* quantification */

[3] simple-query           ::= '(' main_query ')'              /* grouping */
                             | implicit-query
                             | segment-query

[4] implicit-query         ::= flagged-regexp

[5] segment-query          ::= "[" expression? "]"

[6] within-part            ::= simple-within-part

 [7] simple-within-part    ::= "within" simple-within-scope

 [8] simple-within-scope   ::= "sentence"
                             | "s"
                             | "utterance"
                             | "u"
                             | "paragraph"
                             | "p"
                             | "turn"
                             | "t"
                             | "text"
                             | "session"

[9] expression             ::= basic-expression
                             | expression "|" expression     /* or */
                             | expression "&" expression     /* and */

[10] basic-expression      ::= '(' expression ')'         /* grouping */
                             | "!" expression               /* not */
                             | attribute operator flagged-regexp

[11] operator              ::= "="                          /* equals */
                             | "!="                         /* non-equals */

[12] quantifier            ::= "+"                          /* one-or-more */
                             | "*"                          /* zero-or-more */
                             | "?"                          /* zero-or-one */
                             | "{" integer "}"              /* exactly n-times */
                             | "{" integer? "," integer "}"  /* at most */
                             | "{" integer "," integer? "}"  /* min-max */

[13] flagged-regexp        ::= regexp
                             | regexp "/" regexp-flag+

[14] regexp-flag           ::= "i"  /* case-insensitive; Poliqarp/Perl compat */
                             | "I"  /* case-sensitive; Poliqarp compat */
                             | "c"  /* case-insensitive, CQP compat */
                             | "C"  /* case-sensitive */
                             | "l"  /* literal matching, CQP compat*/
                             | "d"  /* diacritic agnostic matching, CQP compat */

[15] regexp                ::= quoted-string

[16] attribute             ::= simple-attribute
                             | qualified-attribute

[17] simple-attribute      ::= identifier

[18] qualified-attribute   ::= identifier ":" identifier

[19] identifier            ::= identifier-first-char identifier-char*

[20] identifier-first-char ::= [a-zA-Z]

[21] identifier-char       ::= [a-zA-Z0-9\-]

[22] integer               ::= [0-9]+

[23] quoted-string         ::= "'" (char | ws)* "'"  /* single-quotes */
                             | """ (char | ws)* """  /* double-quotes */

[24] char                  ::= <any unicode codepoint excluding whitespace codepoints>
                             | "\" escaped-char

[25] ws                    ::= <any whitespace codepoint>

[26] escaped-char          ::= "\"                                  /* backslash (\) */
                             | "'"                                  /* single quote (') */
                             | """                                  /* double quote (") */
                             | "n"                                  /* generic newline, i.e "\n", "\r", etc */
                             | "t"                                  /* character tabulation (U+0009) */
                             | '.'                                  /* regex: dot (= any character) */
```

```
                          | '^'                                     /* regex: caret (= beginning of string) */
                          | '$'                                     /* regex: dollar (= end of string) */
                          | '*'                                     /* regex: asterisk (= zero or more) */
                          | '+'                                     /* regex: plus (= one or more) */
                          | '?'                                     /* regex: question mark (= zero or one) */
                          | '('                                     /* regex: opening parenthesis */
                          | ')'                                     /* regex: closing parenthesis */
                          | '{'                                     /* regex: opening curly brace */
                          | '['                                     /* regex: opening square bracket */
                          | '|'                                     /* regex: vertical bar */
                          | "x" hex hex                             /* Unicode codepoint with hex value hh */
                          | "u" hex hex hex hex                     /* Unicode codepoint with hex value hhhh */
                          | "U" hex hex hex hex hex hex hex hex      /* Unicode codepoint with hex value hhhhhhhh */

[27] hex                  ::= [0-9a-fA-F]
```

4.2.2. Notes

- "simple-within-scope": possible values for scope
  - "sentence", "s", "utterance", "u": denote a matching scope of something like a sentence or utterance. provides compatibility with FCS 1.0 ("Generic Hits", "Each hit SHOULD be presented within the context of a complete sentence.")
  - "paragraph" | "p" | "turn" | "t": denote the next larger unit, e.g. something like a paragraph
  - "article" | "session": something like a whole document
- `[25]` and `[26]` "any $SOMETING codepoint" are a pain to get easily done in at least ANTLR and JavaCC. Especially in combination with `[27]`
- regex are not defined/guarded by this grammar

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 `hdl:` prefix, or *actionable* URIs with a `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 *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 `<cmdi:ResourceProxy>` element with child-element `<cmdi:ResourceType>` set to the value `SearchService` and a `@mimetype` attribute with a value of `application/sru+xml` need to be added to the CMDI record. The content of the `<cmdi:ResourceRef>` element must contain a URI that points to the Endpoint web service.

Example:

```
<cmdi:CMD xmlns:cmdi="http://www.clarin.eu/cmd/" CMDVersion="1.1">
  <cmdi:Header>
    <!-- ... -->
    <cmdi:MdSelfLink>http://hdl.handle.net/4711/0815</cmdi:MdSelfLink>
    <!-- ... -->
  </cmdi:Header>
  <cmdi:Resources>
    <cmdi:ResourceProxyList>
      <!-- ... -->
      <cmdi:ResourceProxy id="r4711">
        <cmdi:ResourceType mimetype="application/sru+xml">SearchService</cmdi:ResourceType>
        <cmdi:ResourceRef>http://repos.example.org/fcs-endpoint</cmdi:ResourceRef>
      </cmdi:ResourceProxy>
      <!-- ... -->
    </cmdi:ResourceProxyList>
  </cmdi:Resources>
  <!-- ... -->
</cmdi:CMD>
```

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:

```
<fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/0815">
    <fcs:DataView type="application/x-clarin-fcs-hits+xml">
      <hits:Result xmlns:hits="http://clarin.eu/fcs/dataview/hits">
        The quick brown <hits:Hit>fox</hits:Hit> jumps over the lazy <hits:Hit>dog</hits:Hit>.
      </hits:Result>
    </fcs:DataView>

    <!--
        NOTE: this is purely fictional and only serves to demonstrate how
              to add custom extensions to the result representation
              within CLARIN-FCS.
    -->

    <!--
        Example 1: a hypothetical Endpoint extension for navigation in a result
        set: it basically provides a set of hrefs, that a GUI can convert into
        navigation buttions.
    -->
    <nav:navigation xmlns:nav="http://repos.example.org/navigation">
        <nav:curr href="http://repos.example.org/resultset/4711/4611" />
        <nav:prev href="http://repos.example.org/resultset/4711/4610" />
        <nav:next href="http://repos.example.org/resultset/4711/4612" />
    </nav:navigation>
```

```
    <!--
       Example 2: a hypothetical Endpoint extension for directly referencing parent
       resources: it basically provides a link to the parent resource, that can be
       exploited by a GUI (e.g. build on XSLT/XQuery).
    -->
    <parent:Parent xmlns:parent="http://repos.example.org/parent"
                   ref="http://repos.example.org/path/to/parent/1235.cmdi" />
</fcs:Resource>
```

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.

```
<fcs:Resource xmlns:fcs="http://clarin.eu/fcs/resource" pid="http://hdl.handle.net/4711/0815">
  <fcs:DataView type="application/x-clarin-fcs-hits+xml" ref="http://repos.example.org/resource.cgi/4711/0815?
highlight=fox">
    <hits:Result xmlns:hits="http://clarin.eu/fcs/dataview/hits">
      The quick brown <hits:Hit>fox</hits:Hit> jumps over the lazy dog.
    </hits:Result>
  </fcs:DataView>
</fcs:Resource>
```