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# Unstructured Information Management Architecture (UIMA) Version 1.0

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##### Related work:

This specification is related to:

- OASIS Unstructured Operation Markup Language (UOML). The UIMA specification, however, is independent of any particular model for representing or manipulating unstructured content.

##### Declared XML Namespace(s):

<http://docs.oasis-open.org/uima/ns/base.ecore>  
<http://docs.oasis-open.org/uima/ns/peMetadata.ecore>  
<http://docs.oasis-open.org/uima/ns/pe.ecore>  
<http://docs.oasis-open.org/uima/ns/peService>

##### Abstract:

Unstructured information may be defined as the direct product of human communication. Examples include natural language documents, email, speech, images and video. The UIMA specification defines platform-independent data representations and interfaces for software components or services called *analytics*, which analyze unstructured information and assign semantics to regions of that unstructured information.

**Status:**

This document was last revised or approved by the UIMA TC on the above date. The level of approval is also listed above. Check the "Latest Approved Version" location noted above for possible later revisions of this document.

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---

# 1 Introduction

2 Unstructured information may be defined as the direct product of human communication. Examples  
3 include natural language documents, email, speech, images and video. It is information that was not  
4 specifically encoded for machines to process but rather authored by humans for humans to understand.  
5 We say it is “unstructured” because it lacks explicit semantics (“structure”) required for applications to  
6 interpret the information as intended by the human author or required by the end-user application.

7  
8 Unstructured information may be contrasted with the information in classic relational databases where the  
9 intended interpretation for every field data is explicitly encoded in the database by column headings.  
10 Consider information encoded in XML as another example. In an XML document some of the data is  
11 wrapped by tags which provide explicit semantic information about how that data should be interpreted.  
12 An XML document or a relational database may be considered semi-structured in practice, because the  
13 content of some chunk of data, a blob of text in a text field labeled “description” for example, may be of  
14 interest to an application but remain without any explicit tagging—that is, without any explicit semantics or  
15 structure.

16  
17 Unstructured information represents the largest, most current and fastest growing source of knowledge  
18 available to businesses and governments worldwide. The web is just the tip of the iceberg. Consider, for  
19 example, the droves of corporate, scientific, social and technical documentation including best practices,  
20 research reports, medical abstracts, problem reports, customer communications, contracts, emails and  
21 voice mails. Beyond these, consider the growing number of broadcasts containing audio, video and  
22 speech. These mounds of natural language, speech and video artifacts often contain nuggets of  
23 knowledge critical for analyzing and solving problems, detecting threats, realizing important trends and  
24 relationships, creating new opportunities or preventing disasters.

25  
26 For unstructured information to be processed by applications that rely on specific semantics, it must be  
27 first analyzed to assign application-specific semantics to the unstructured content. Another way to say this  
28 is that the unstructured information must become “structured” where the added structure explicitly  
29 provides the semantics required by target applications to interpret the data correctly.

30  
31 An example of assigning semantics includes labeling regions of text in a text document with appropriate  
32 XML tags that, for example, might identify the names of organizations or products. Another example may  
33 extract elements of a document and insert them in the appropriate fields of a relational database or use  
34 them to create instances of concepts in a knowledgebase. Another example may analyze a voice stream  
35 and tag it with the information explicitly identifying the speaker or identifying a person or a type of physical  
36 object in a series of video frames.

37  
38 In general, we refer to a segment of unstructured content (e.g., a document, a video etc.) as an **artifact**  
39 and we refer to the act of assigning semantics to a region of an artifact as **analysis**. A software  
40 component or service that performs the analysis is referred to as an **analytic**. The results of the analysis  
41 of an artifact by an analytic are referred to as **artifact metadata**.

42  
43 Analytics are typically reused and combined together in different flows to perform application-specific  
44 aggregate analyses. For example, in the analysis of a document the first analytic may simply identify and  
45 label the distinct tokens or words in the document. The next analytic might identify parts of speech, the  
46 third might use the output of the previous two to more accurately identify instances of persons,  
47 organizations and the relationships between them

49 While different platform-specific, software frameworks have been developed with varying features in  
50 support of building and integrating component analytics (e.g., Apache UIMA, Gate, Catalyst, Tipster,  
51 Mallet, Talent, Open-NLP, LingPipe etc.), no clear standard has emerged for enabling the interoperability  
52 of analytics across platforms, frameworks and modalities (text, audio, video, etc.) Significant advances in  
53 the field of unstructured information analysis require that it is easier to combine best-of-breed analytics  
54 across these dimensions.

55

56 The UIMA specification defines platform-independent data representations and interfaces for text and  
57 multi-modal analytics. The principal objective of the UIMA specification is to support interoperability  
58 among *analytics*. This objective is subdivided into the following four design goals:

59

- 60     1. **Data Representation.** Support the common representation of *artifacts* and *artifact metadata*  
61       independently of *artifact modality* and *domain model* and in a way that is independent of the  
62       original representation of the artifact.
- 63     2. **Data Modeling and Interchange.** Support the platform-independent interchange of *analysis data*  
64       (*artifact and its metadata*) in a form that facilitates a formal modeling approach and alignment with  
65       existing programming systems and standards.
- 66     3. **Discovery, Reuse and Composition.** Support the discovery, reuse and composition of  
67       independently-developed *analytics*.
- 68     4. **Service-Level Interoperability.** Support concrete interoperability of independently developed  
69       *analytics* based on a common service description and associated SOAP bindings.

70

71     The text of this specification is normative with the exception of the Introduction and Examples (Appendix  
72       B).

## 73     1.1 Terminology

74     The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD  
75       NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described  
76       in [\[RFC2119\]](#).

## 77     1.2 Normative References

- 78     [\[RFC2119\]](#) S. Bradner, *Key words for use in RFCs to Indicate Requirement Levels*,  
79       <http://www.ietf.org/rfc/rfc2119.txt>, IETF RFC 2119, March 1997.
- 80     [\[MOF1\]](#) Object Management Group. Meta Object Facility (MOF) 2.0 Core Specification.  
81       <http://www.omg.org/docs/ptc/04-10-15.pdf>
- 82     [\[OCL1\]](#) Object Management Group. Object Constraint Language Version 2.0.  
83       <http://www.omg.org/technology/documents/formal/ocl.htm>
- 84     [\[OSGi1\]](#) OSGi Alliance. OSGi Service Platform Core Specification, Release 4, Version 4.1.  
85       Available from <http://www.osgi.org>.
- 86     [\[SOAP1\]](#) W3C. SOAP Version 1.2 Part 1: Messaging Framework (Second Edition).  
87       <http://www.w3.org/TR/soap12-part1/>
- 88     [\[UML1\]](#) Object Management Group. Unified Modeling Language (UML), version 2.1.2.  
89       <http://www.omg.org/technology/documents/formal/uml.htm>
- 90     [\[XMI1\]](#) Object Management Group. XML Metadata Interchange (XMI) Specification, Version 2.0.  
91       <http://www.omg.org/docs/formal/03-05-02.pdf>

- 95        [XML1]    W3C. Extensible Markup Language (XML) 1.0 (Fourth Edition).  
96                  <http://www.w3.org/TR/REC-xml>  
97        [XML2]    W3C. Namespaces in XML 1.0 (Second Edition). <http://www.w3.org/TR/REC-xml-names/>  
98        [XMLS1]   XML Schema Part 1: Structures Second Edition. <http://www.w3.org/TR/2004/REC-xmlschema-1-20041028/structures.html>  
99  
100      [XMLS2]   XML Schema Part 2: Datatypes Second Edition. <http://www.w3.org/TR/2004/REC-xmlschema-2-20041028/datatypes.html>.  
101  
102

### 103      1.3 Non-Normative References

- 104      [BPEL1]    [http://www.oasis-open.org/committees/tc\\_home.php?wg\\_abbrev=wsbpel](http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel)  
105      [EcoreEMOF1]    <http://dev.eclipse.org/newslists/news.eclipse.tools.emf/msg04197.html>  
106  
107      [EMF1]    The Eclipse Modeling Framework (EMF) Overview.  
108                  <http://help.eclipse.org/help33/index.jsp?topic=/org.eclipse.emf.doc//references/overview/EMF.html>  
109  
110      [EMF2]    Budinsky et al. Eclipse Modeling Framework. Addison-Wesley. 2004.  
111      [EMF3]    Budinsky et al. Eclipse Modeling Framework, Chapter 2, Section 2.3  
112                  <http://www.awprofessional.com/content/images/0131425420/samplechapter/budinskych02.pdf>  
113  
114      [KLT1]    David Ferrucci, William Murdock, Chris Welty, "Overview of Component Services for  
Knowledge Integration in UIMA (a.k.a. SUKI)" IBM Research Report RC24074  
115  
116      [XMI2]    Grose et al. Mastering XMI. Java Programming with XMI, XML, and UML. John Wiley &  
117                  Sons, Inc. 2002

---

## 118 2 Basic Concepts and Terms

119 This specification defines and uses the following terms:

120 **Unstructured Information** is typically the direct product of human communications. Examples include  
121 natural language documents, email, speech, images and video. It is information that was not encoded for  
122 machines to understand but rather authored for humans to understand. We say it is “unstructured”  
123 because it lacks explicit semantics (“structure”) required for computer programs to interpret the  
124 information as intended by the human author or required by the application.

125

126 **Artifact** refers to an application-level unit of information that is subject to analysis by some application.  
127 Examples include a text document, a segment of speech or video, a collection of documents, and a  
128 stream of any of the above. Artifacts are physically encoded in one or more ways. For example, one way  
129 to encode a text document might be as a Unicode string.

130

131 **Artifact Modality** refers to mode of communication the artifact represents, for example, text, video or  
132 voice.

133

134 **Artifact Metadata** refers to structured data elements recorded to describe entire artifacts or parts of  
135 artifacts. A piece of artifact metadata might indicate, for example, the part of the document that  
136 represents its title or the region of video that contains a human face. Another example of metadata might  
137 indicate the topic of a document while yet another may tag or annotate occurrences of person names in a  
138 document etc. Artifact metadata is logically distinct from the artifact, in that the artifact is the data being  
139 analyzed and the artifact metadata is the result of the analysis – it is data about the artifact.

140

141 **Domain Model** refers to a conceptualization of a system, often cast in a formal modeling language. In this  
142 specification we use it to refer to any model which describes the structure of artifact metadata. A domain  
143 model provides a formal definition of the types of data elements that may constitute artifact metadata. For  
144 example, if some artifact metadata represents the organizations detected in a text document (the artifact)  
145 then the type Organization and its properties and relationship to other types may be defined in a domain  
146 model which the artifact metadata instantiates.

147

148 **Analysis Data** is used to refer to the logical union of an artifact and its metadata.

149

150 **Analysis Operations** are abstract functions that perform some analysis on artifacts and/or their metadata  
151 and produce some result. The results may be the addition or modification to artifact metadata and/or the  
152 generation of one or more artifacts. An example is an “Annotation” operation which may be defined by the  
153 type of artifact metadata it produces to describe or annotate an artifact. Analysis operations may be  
154 ultimately bound to software implementations that perform the operations. Implementations may be  
155 realized in a variety of software approaches, for example web-services or Java classes.

156

157 An **Analytic** is a software object or network service that performs an Analysis Operation.

158

159 A **Flow Controller** is a component or service that decides the workflow between a set of analytics.

160

161 A **Processing Element (PE)** is either an Analytic or a Flow Controller. PE is the most general type of  
162 component/service that developers may implement.

163

164   **Processing Element Metadata (PE Metadata)** is data that describes a Processing Element (PE) by  
165   providing information used for discovering, combining, or reusing the PE for the development of UIM  
166   applications. PE Metadata would include Behavioral Metadata for the operation which the PE implements.  
167

---

## 168 3 Elements of the UIMA Specification

169 In this section we provide an overview of the seven elements of the UIMA standard. The full specification  
170 for each element will be defined in Section 4.

### 171 3.1 Common Analysis Structure (CAS)

172 The Common Analysis Structure or CAS is the common data structure shared by all UIMA analytics to  
173 represent the unstructured information being analyzed (the **artifact**) as well as the metadata produced by  
174 the analysis workflow (the **artifact metadata**).

175

176 The CAS represents an essential element of the UIMA specification in support of interoperability since it  
177 provides the common foundation for sharing data and results across analytics.

178

179 The CAS is an Object Graph where Objects are instances of Classes and Classes are Types in a **type**  
180 **system** (see next section).

181

182 A general and motivating UIMA use case is one where analytics label or *annotate* regions of unstructured  
183 content. A fundamental approach to representing annotations is referred to as the “stand-off” annotation  
184 model. In a “stand-off” annotation model, annotations are represented as objects of a domain model that  
185 “point into” or reference elements of the unstructured content (e.g., document or video stream) rather than  
186 as inserted tags that affect and/or are constrained by the original form of the content.

187

188 To support the stand-off annotation model, UIMA defines two fundamental types of objects in a CAS:

- 189 • **Sofa**, or subject of analysis, which holds the artifact;
- 190 • **Annotation**, a type of artifact metadata that points to a region within a Sofa and “annotates” (labels) the  
191 designated region in the artifact.

192 The Sofa and Annotation types are formally defined as part of the UIMA Base Type System (see Section  
193 3.3).

194

195 The CAS provides a domain neutral, object-based representation scheme that is aligned with UML  
196 [UML1]. UIMA defines an XML representation of analysis data using the XML Metadata Interchange  
197 (XMI) specification [XMI1][XMI2].

198

199 The CAS representation can easily be elaborated for specific domains of analysis by defining domain-  
200 specific types; interoperability can be achieved across programming languages and operating systems  
201 through the use of the CAS representation and its associated type system definition.

202

203 For the full CAS specification, see Section 4.1.

### 204 3.2 Type System Model

205 To support the design goal of data modeling and interchange, UIMA requires that a CAS conform to a  
206 user-defined schema, called a **type system**.

207

208 A type system is a collection of inter-related **type** definitions. Each type defines the structure of any object  
209 that is an instance of that type. For example, Person and Organization may be types defined as part of a

210 type system. Each type definition declares the attributes of the type and describes valid fillers for its  
211 attributes. For example lastName, age, emergencyContact and employer may be attributes of the Person  
212 type. The type system may further specify that the lastName must be filled with exactly one string value,  
213 age exactly one integer value, emergencyContact exactly one instance of the same Person type and  
214 employer zero or more instances of the Organization type.

215

216 The **artifact metadata** in a CAS is represented by an object model. Every object in a CAS must be  
217 associated with a Type. The UIMA Type-System language therefore is a declarative language for defining  
218 object models.

219

220 Type Systems are user-defined. UIMA does not specify a particular set of types that developers must use.  
221 Developers define type systems to suit their application's requirements. A goal for the UIMA community,  
222 however, would be to develop a common set of type-systems for different domains or industry verticals.  
223 These common type systems can significantly reduce the efforts involved in integrating independently  
224 developed analytics. These may be directly derived from related standards efforts around common tag  
225 sets for legal information or common ontologies for biological data, for example.

226

227 Another UIMA design goal is to support the composition of independently developed **analytics**. The  
228 behavior of analytics may be specified in terms of type definitions expressed in a type system language.  
229 For example an analytic must define the types it requires in an input CAS and those that it may produce  
230 as output. This is described as part of the analytic's Behavioral Metadata (See Section 3.5). For example,  
231 an analytic may declare that given a plain text document it produces instances of Person annotations  
232 where Person is defined as a particular type in a type system.

233

234 The UIMA Type System Model is designed to provide the following features:

- **Object-Oriented.** Type systems defined with the UIMA Type System Model are isomorphic to classes in object-oriented representations such as UML, and are easily mapped or compiled into deployment data structures in a particular implementation framework.
- **Inheritance.** Types can extend other types, thereby inheriting the features of their parent type.
- **Optional and Required Features.** The features associated with types can be optional or required, depending on the needs of the application.
- **Single and Multi-Valued Features with Range Constraints.** The features associated with types can be single-valued or multi-valued, depending on the needs of the application. The legal range of values for a feature (its range constraint) may be specified as part of the feature definition.
- **Alignment with UML standards and Tooling.** The UIMA Type System model can be directly expressed using existing UML modeling standards, and is designed to take advantage of existing tooling for UML modeling.

247

248 Rather than invent a language for defining the UIMA Type System Model, we have explored standard  
249 modeling languages.

250

251 The OMG has defined representation schemes for describing object models including UML and its  
252 subsets (modeling languages with increasingly lower levels of expressivity). These include MOF and  
253 EMOF (the essential MOF) [[MOF1](#)].

254

255 Ecore is the modeling language of the Eclipse Modeling Framework (EMF) [[EMF1](#)]. It affords the  
256 equivalent modeling semantics provided by EMOF with some minor syntactic differences – see Section  
257 B.2.2.

258

259 UIMA adopts Ecore as the type system representation, due to the alignment with standards and the  
260 availability of EMF tooling.

261

262 For the full Type System Model specification, see Section 4.2.

### 263 **3.3 Base Type System**

264 The UIMA Base Type System is a standard definition of commonly-used, domain-independent types. It  
265 establishes a basic level of interoperability among applications.

266

267 The most significant part of the Base Type System is the *Annotation and Sofa (Subject of Analysis) Type*  
268 *System*. In UIMA, a CAS stores the artifact (i.e., the unstructured content that is the subject of the  
269 analysis) and the artifact metadata (i.e., structured data elements that describe the artifact). The  
270 metadata generated by an analytic may include a set of annotations that label regions of the artifact with  
271 respect to some domain model (e.g., persons, organizations, events, times, opinions, etc). These  
272 annotations are logically and physical distinct from the subject of analysis, so this model is referred to as  
273 the “*stand-off*” model for annotations.

274

275 In UIMA the original content is not affected in the analysis process. Rather, an object graph is produced  
276 that *stands off* from and annotates the content. Stand-off annotations in UIMA allow for multiple content  
277 interpretations of graph complexity to be produced, co-exist, overlap and be retracted without affecting  
278 the original content representation. The object model representing the stand-off annotations may be used  
279 to produce different representations of the analysis results. A common form for capturing document  
280 metadata for example is as in-line XML. An analytic in a UIM application, for example, can generate from  
281 the UIMA representation an in-line XML document that conforms to some particular domain model or  
282 markup language. Alternatively it can produce an XMI or RDF document.

283

284 The Base Type System also includes the following:

- 285 • Primitive Types (defined by Ecore)  
286 • Views (Specific collections of objects in a CAS)  
287 • Source Document Information (Records information about the original source of unstructured  
288 information in the CAS)

289

290 For the full Base Type System specification, see Section 4.3.

### 291 **3.4 Abstract Interfaces**

292 The UIMA Abstract Interfaces define the standard component types and operations that UIMA services  
293 implement. The abstract definitions in this section lay the foundation for the concrete service specification  
294 described in Section 3.7.

295

296 All types of UIMA services operate on the Common Analysis Structure (CAS). As defined in Section 3.1,  
297 the CAS is the common data structure that represents the unstructured information being analyzed as  
298 well as the metadata produced by the analysis workflow.

299

300 The supertype of all UIMA components is called the *Processing Element (PE)*. The ProcessingElement  
301 interface defines the following operations, which are common to all subtypes of ProcessingElement:

- 302 • `getMetadata`, which takes no arguments and returns the *PE Metadata* for the service.  
303 • `setConfigurationParameters`, which takes a ConfigurationParameterSettings object that  
304 contains a set of (name, values) pairs that identify configuration parameters and the values to  
305 assign to them.

306  
307 An *Analytic* is a subtype of PE that performs analysis of CASes. There are two subtypes, *Analyzer* and  
308 *CAS Multiplier*.  
309  
310 An *Analyzer* processes a CAS and possibly updates its contents. This is the most common type of UIMA  
311 component. The Analyzer interface defines the operations:  
312     

- `processCas`, which takes a single CAS plus a list of Sofas to analyze, and returns either an  
313         updated CAS, or a set of updates to apply to the CAS.
- `processCasBatch`, which takes multiple CASes, each with a list of Sofas to analyze, and returns  
315         a response that contains, for each of the input CASes: an updated CAS, a set of updates to apply  
316         to the CAS, or an exception.

  
317  
318 A *CAS Multiplier* processes a CAS and possibly creates new CASes. This is useful for example to  
319 implement a “segmenter” Analytic that takes an input CAS and divides it into pieces, outputting each  
320 piece as a new CAS. A CAS multiplier can also be used to merge information from multiple CASes into  
321 one output CAS. The CAS Multiplier interface defines the following operations:  
322     

- `inputCas`, which takes a CAS plus a list of Sofas, but returns nothing.
- `getNextCas`, which takes no input and returns a CAS. This returns the next output CAS. An  
324         empty response indicates no more output CASes.
- `retrieveInputCas`, which takes no arguments and returns the original input CAS, possibly  
326         updated.
- `getNextCasBatch`, which takes a maximum number of CASes to return and a maximum amount  
328         of time to wait (in milliseconds), and returns a response that contains: Zero or more  
329         CASes (up to the maximum number specified), a Boolean indicating whether any more CASes  
330         remain, and an estimate of the number of CASes remaining (if known).

  
331  
332 A *Flow Controller* is a subtype of PE that determines the route CASes take through multiple Analytics.  
333 The Flow Controller interface defines the following operations:  
334     

- `addAvailableAnalytics`, which provides the Flow Controller with access to the Analytic  
335         Metadata for all of the Analytics that the Flow Controller may route CASes to. This takes a map  
336         from String keys to ProcessingElementMetadata objects. This may be called multiple times, if  
337         new analytics are added to the system after the original call is made.
- `removeAvailableAnalytics`, which takes a set of Keys and instructs the Flow Controller to  
339         remove some Analytics from consideration as possible destinations.
- `setAggregateMetadata`, which provides the Flow Controller with Processing Element Metadata  
341         that identifies and describes the desired behavior of the entire flow of components that the  
342         FlowController is managing. The most common use for this is to specify the desired outputs of  
343         the aggregate, so that the Flow Controller can make decisions about which analytics need to be  
344         invoked in order to produce those outputs.
- `getNextDestinations`, which takes a CAS and returns one or more destinations for this CAS.
- `continueOnFailure`, which can be called by the aggregate/application when a Step issued by  
347         the FlowController failed. The FlowController returns true if it can continue, and can change the  
348         subsequent flow in any way it chooses based on the knowledge that a failure occurred. The  
349         FlowController returns false if it cannot continue.

  
350  
351 For the full Abstract Interfaces specification, see Section 4.4.

## 352 **3.5 Behavioral Metadata**

353 The Behavioral Metadata of an analytic declaratively describes what the analytic does; for example, what  
354 types of CASs it can process, what elements in a CAS it analyzes, and what sorts of effects it may have  
355 on CAS contents as a result of its application.

- 356
- 357 Behavioral Metadata is designed to achieve the following goals:
- 358 1. **Discovery:** Enable both human developers and automated processes to search a repository and  
359 locate components that provide a particular function (i.e., works on certain input, produces certain  
360 output)
- 361
- 362 2. **Composition:** Support composition either by a human developer or an automated process.
- 363     a. Analytics should be able to declare what they do in enough detail to assist manual  
364 and/or automated processes in considering their role in an application or in the  
365 composition of aggregate analytics.
- 366     b. Through their Behavioral Metadata, Analytics should be able to declare enough detail  
367 as to enable an application or aggregate to detect “invalid” compositions/workflows  
368 (e.g., a workflow where it can be determined that one of the Analytic’s preconditions  
369 can never be satisfied by the preceding Analytic).
- 370
- 371 3. **Efficiency:** Facilitate efficient sharing of CAS content among cooperating analytics. If analytics  
372 declare which elements of the CAS (e.g., views) they need to receive and which elements they do not  
373 need to receive, the CAS can be filtered or split prior to sending it to target analytics, to achieve  
374 transport and parallelization efficiencies respectively.
- 375
- 376 Behavioral Metadata breaks down into the following categories:
- 377 • **Analyzes:** Types of objects (Sofas) that the analytic intends to produce annotations over.
- 378 • **Required Inputs:** Types of objects that must be present in the CAS for the analytic to operate.
- 379 • **Optional Inputs:** Types of objects that the analytic would consult if they were present in the CAS.
- 380 • **Creates:** Types of objects that the analytic may create.
- 381 • **Modifies:** Types of objects that the analytic may modify.
- 382 • **Deletes:** Types of objects that the analytic may delete.
- 383
- 384 Note that analytics are not required to declare behavioral metadata. If an analytic does not provide  
385 behavioral metadata, then an application using the analytic cannot assume anything about the operations  
386 that the analytic will perform on a CAS.
- 387
- 388 For the full Behavioral Metadata specification, see Section 4.5.
- 389 

## 3.6 Processing Element Metadata
- 390 All UIMA Processing Elements (PEs) must publish **processing element metadata**, which describes the  
391 analytic to support discovery and composition. This section of the spec defines the structure of this  
392 metadata and provides an XML schema in which PEs must publish this metadata.
- 393
- 394 The PE Metadata is subdivided into the following parts:
- 395
- 396 1. **Identification Information.** Identifies the PE. It includes for example a symbolic/unique name, a  
397 descriptive name, vendor and version information.
- 398 2. **Configuration Parameters.** Declares the names of parameters used by the PE to affect its  
399 behavior, as well as the parameters’ default values.
- 400 3. **Behavioral Metadata.** Describes the PEs input requirements and the operations that the PE  
401 may perform, as described in Section 3.5.
- 402 4. **Type System.** Defines types used by the PE and referenced from the behavioral specification.
- 403 5. **Extensions.** Allows the PE metadata to contain additional elements, the contents of which are  
404 not defined by the UIMA specification. This can be used by framework implementations to

405 extend the PE metadata with additional information that may be meaningful only to that  
406 framework.

407

408 For the full Processing Element Metadata specification, see Section 4.6.

409 **3.7 WSDL Service Descriptions**

410 This specification element facilitates interoperability by specifying a WSDL [[WSDL1](#)] description of the  
411 UIMA interfaces and a binding to a concrete SOAP interface that compliant frameworks and services  
412 MUST implement.

413

414 This SOAP interface implements the Abstract Interfaces described in Section 3.4. The use of SOAP  
415 facilitates standard use of web services as a CAS transport.

416

417 For the full WSDL Service Descriptions specification, see Section 4.7.

418

---

419 **4 Full UIMA Specification**

420 **4.1 The Common Analysis Structure (CAS)**

421 **4.1.1 Basic Structure: Objects and Slots**

422 At the most basic level a CAS contains an object graph – a collection of objects that may point to or  
423 cross-reference each other. Objects are defined by a set of properties which may have values. Values  
424 can be primitive types like numbers or strings or can refer to other objects in the same CAS.

425

426 This approach allows UIMA to adopt general object-oriented modeling and programming standards for  
427 representing and manipulating artifacts and artifact metadata.

428

429 UIMA uses the Unified Modeling Language (UML) [UML1] to represent the structure and content of a  
430 CAS.

431

432 In UML an **object** is a data structure that has 0 or more slots. We can think of a slot as representing an  
433 object's properties and values. Formally a **Slot** in UML is a (feature, value) pair. Features in UML  
434 represent an object's properties. A slot represents an assignment of one or more values to a feature.  
435 Values can be either primitives (strings or various numeric types) or references to other objects.

436

437 UML uses the notion of classes to represent the required structure of objects. Classes define the slots  
438 that objects must have. We refer to a set of classes as a **type system**.

439 **4.1.2 Relationship to Type System**

440 Every object in a CAS is an instance of a class defined in a UIMA **type system**.

441

442 A type system defines a set of classes. A class may have multiple features. Features may either be  
443 attributes or references.

444

445 All features define their type. The type of an attribute is a primitive data type. The type of a reference is a  
446 class. Features also have a cardinality (defined by a lower bound and a upper bound), which define how  
447 many values they may take. We sometimes refer to features with an upper bound greater than one as  
448 multi-valued features.

449

450 An object has one slot for each feature defined by its class.

451

452 Slots for attributes take primitive values; slots for references take objects as values. In general a slot may  
453 take multiple values; the number of allowed values is defined by the lower bound and upper bound of the  
454 feature.

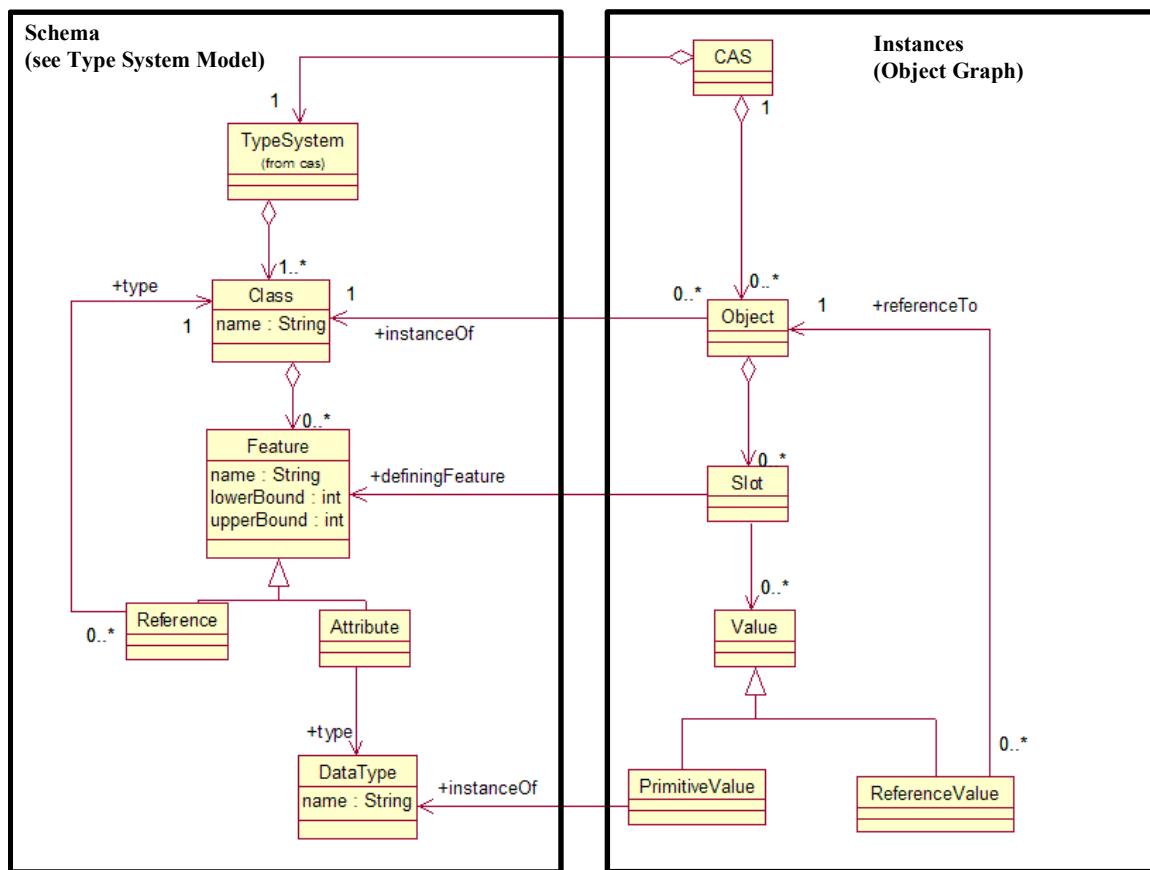
455

456 The metamodel describing how a CAS relates to a type system is diagrammed in Figure 1.

457

458 Note that some UIMA components may manipulate a CAS without knowledge of its type system. A  
459 common example is a CAS Store, which might allow the storage and retrieval of any CAS regardless of  
460 what its type system might be.

461



462

463

Figure 1: CAS Specification UML

464

### 4.1.3 The XMI CAS Representation

466 A UIMA CAS is represented as an XML document using the XMI (XML Metadata Interchange) standard  
467 [XMI1, XMI2]. XMI is an OMG standard for expressing object graphs in XML.

468  
469 XMI was chosen because it is an established standard, aligned with the object-graph representation of  
470 the CAS, aligned with UML and with object-oriented programming, and supported by tooling such as the  
471 Eclipse Modeling Framework [EMF1].

### 4.1.4 CAS Formal Specification

#### 4.1.4.1 Structure

474 UIMA CAS XML MUST be a valid XMI document as defined by the XMI Specification [XMI1].

475  
476 This implies that UIMA CAS XML MUST be a valid instance of the XML Schema for XMI, listed in  
477 Appendix C.1.

#### 4.1.4.2 Constraints

479 If the root element of the XML CAS contains an xsi:schemaLocation attribute, the CAS is said to be linked  
480 to an Ecore Type System. The xsi:schemaLocation attribute defines a mapping from namespace URI to

481 physical URI as defined by the XML Schema specification [XMLS1]. Each of these physical URIs MUST  
482 be a valid Ecore document as defined by the XML Schema for Ecore, presented in Appendix C.2.

483

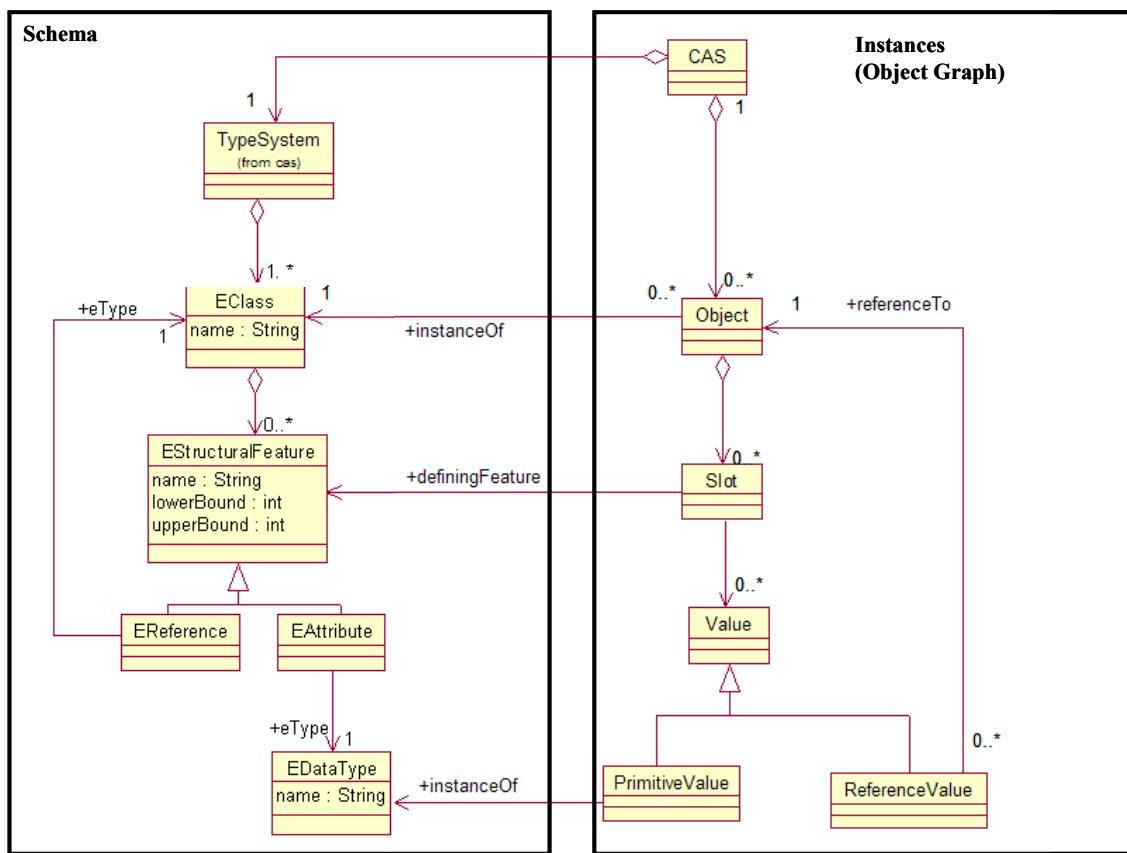
484 A CAS that is linked to an Ecore Type System MUST be valid with respect to that Ecore Type System, as  
485 defined in Section 4.2.2.2.

## 486 **4.2 The Type System Model**

### 487 **4.2.1 Ecore as the UIMA Type System Model**

488 A UIMA Type System is represented using Ecore. Figure 2 shows how Ecore is used to define the  
489 schema for a CAS.

490



491

492 **Figure 2: Ecore defines schema for CAS**

493

494 For an introduction to Ecore and an example of a UIMA Type System represented in Ecore, see Appendix  
495 B.2.

## 496 **4.2.2 Type System Model Formal Specification**

### 497 **4.2.2.1 Structure**

498 *UIMA Type System XML* MUST be a valid Ecore/XMI document as defined by Ecore and the XMI  
499 Specification [XMI1].

500  
501 This implies that UIMA Type System XML MUST be a valid instance of the XML Schema for Ecore, given  
502 in Section C.2.

503 **4.2.2.2 Semantics**

504 A CAS is valid with respect to an Ecore type system if each object in the CAS is a valid instance of its  
505 corresponding class (EClass) in the type system, as defined by XMI [XMI1], UML [UML1] and MOF  
506 [MOF1].

507 **4.3 Base Type System**

508 The XML namespace for types defined in the UIMA base model is <http://docs.oasis-open.org/uima/ns/base.ecore>. (With the exception of types defined as part of Ecore, listed in Section  
509 4.3.1, whose namespace is defined by Ecore.).

511

512 Examples showing how the Base Type System is used in UIMA examples can be found in Appendix B.3.

513 **4.3.1 Primitive Types**

514 UIMA uses the following primitive types defined by Ecore, which are analogous to the Java (and Apache  
515 UIMA) primitive types:

516

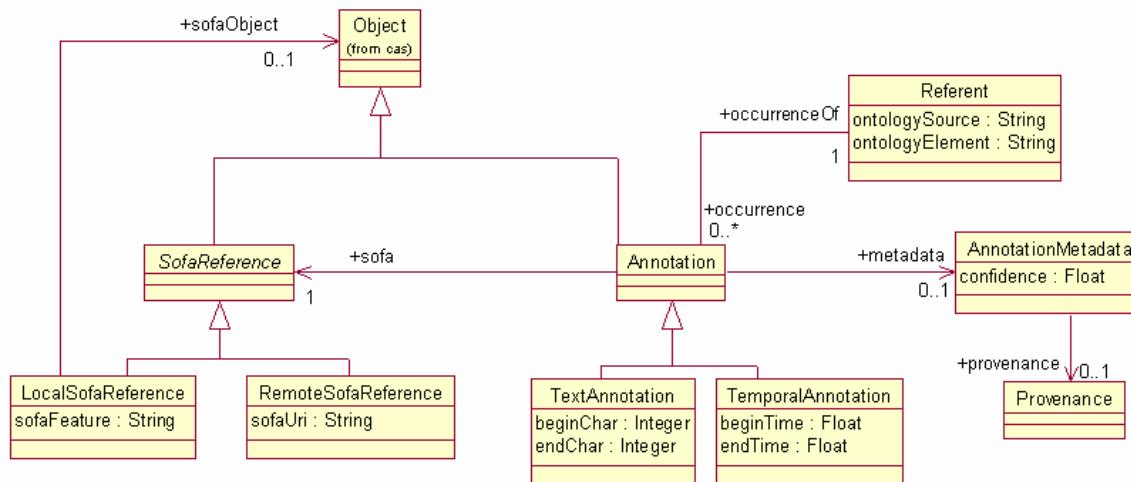
- 517 • EString
- 518 • EBoolean
- 519 • EByte (8 bits)
- 520 • EShort (16 bits)
- 521 • EInt (32 bits)
- 522 • ELong (64 bits)
- 523 • EFloat (32 bits)
- 524 • EDouble (64 bits)

525

526 Also Ecore defines the type EObject, which is defined as the superclass of all non-primitive types  
527 (classes).

528 **4.3.2 Annotation and Sofa Base Type System**

529 The Annotation and Sofa Base Type System defines a standard way for Annotations to refer to regions  
530 within a Subject of Analysis (Sofa). The UML for the Annotation and Sofa Base Type System is given in  
531 Figure 3. The discussion in the following subsections refers to this figure.



532

533

**Figure 3: Annotation and Sofa Base Type System UML**

534

#### 535 **4.3.2.1 Annotation and Sofa Reference**

536 The UIMA Base Type System defines a standard object type called Annotation for representing stand-off  
 537 annotations. The Annotation type represents a type of object that is linked to a Subject of Analysis (Sofa).

538

539 The Sofa is the value of a slot in another object. Since a reference directly to a *slot* on an *object* (rather  
 540 than just an *object* itself) is not a concept directly supported by typical object oriented programming  
 541 systems or by XMI, UIMA defines a base type called LocalSofaReference for referring to Sofas from  
 542 annotations. UIMA also defines a RemoteSofaReference type that allows an annotation to refer to a  
 543 subject of analysis that is not located in the CAS.

#### 544 **4.3.2.2 References to Regions of Sofas**

545 An annotation typically points to a region of the artifact data. One of UIMA's design goals is to be  
 546 independent of modality. For this reason UIMA does not constrain the data type that can function as a  
 547 subject of analysis and allows for different implementations of the linkage between an annotation and a  
 548 region of the artifact data.

549

550 The Annotation class has subclasses for each artifact modality, which define how the Annotation refers to  
 551 a region within the Sofa. The Standard defines subclasses for common modalities – Text and Temporal  
 552 (audio or video segments). Users may define other subclasses.

553

554 In TextAnnotation, beginChar and endChar refer to Unicode character offsets in the corresponding Sofa  
 555 string. For TemporalAnnotation, beginTime and endTime are offsets measured in seconds from the start  
 556 of the Sofa. Note that applications that require a different interpretation of these fields must accept the  
 557 standard values and handle their own internal mappings.

558

559 Annotations with discontiguous spans are not part of the Base Type System, but could be implemented  
 560 with a user-defined subclass of the `Annotation` type.

561 **4.3.2.3 Referents**

562 In general, an `Annotation` is a reference to some element in a domain ontology. (For example, the text  
563 “John Smith” and “he” might refer to the same person John Smith.) The UIMA Base Type System defines  
564 a standard way to encode this information, using the `Annotation` and `Referent` types, and  
565 `occurrences/occurrenceOf` features.

566

567 The value of the `Annotation`’s `occurrenceOf` feature is the `Referent` object that identifies the domain  
568 element to which that `Annotation` refers. All of the `Annotation` objects that refer to the same thing should  
569 share the same `Referent` object. The `Referent`’s `occurrences` feature is the inverse relationship,  
570 pointing to all of the `Annotation` objects that refer to that `Referent`.

571

572 A `Referent` need not be a physical object. For example, `Event` and `Relation` are also considered kinds of  
573 `Referent`.

574

575 The domain ontology can either be defined directly in the CAS type system or in an external ontology  
576 system. If the domain ontology is defined directly in the CAS, then domain classes should be subclasses  
577 of the `Referent` class. If the domain ontology is defined in an external ontology system, then the feature  
578 `Referent.ontologySource` should be used to identify the target ontology and the feature  
579 `Referent.ontologyElement` should be used to identify the target element within that ontology. The  
580 format of these identifiers is not defined by UIMA.

581 **4.3.2.4 Additional Annotation Metadata**

582 In many applications, it will be important to capture metadata about each annotation. In the Base Type  
583 System, we introduce an `AnnotationMetadata` class to capture this information. This class provides  
584 fields for `confidence`, a float indicating how confident the annotation engine that produced the annotation  
585 was in that annotation, and `provenance`, a `Provenance` object which stores information about the source  
586 of an annotation. Users may subclass `AnnotationMetadata` and `Provenance` as needed to capture  
587 additional application-specific information about annotations.

588 **4.3.3 View Base Type System**

589 A `View`, depicted in Figure 4, is a named collection of `objects` in a CAS. In general a view can represent  
590 any subset of the `objects` in the CAS for any purpose. It is intended however that Views represent  
591 different perspectives of the artifact represented by the CAS. Each View is intended to partition the  
592 artifact metadata to capture a specific perspective.

593

594 For example, given a CAS representing a document, one View may capture the metadata describing an  
595 English translation of the document while another may capture the metadata describing a French  
596 translation of the document.

597 In another example, given a CAS representing a document, one view may contain an analysis produced  
598 using company-confidential data another may produce an analysis using generally available data.

599

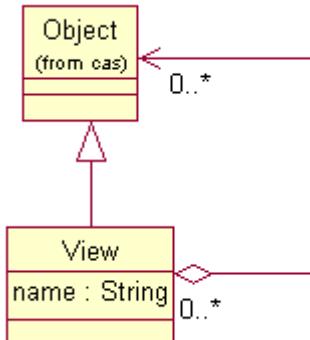


Figure 4: View Type

600

601

602

603 UIMA does not require the use of Views. However, our experiences developing Apache UIMA suggest  
 604 that it is a useful design pattern to organize the metadata in a complex CAS by partitioning it into Views.  
 605 Individual analytics may then declare that they require certain Views as input or produce certain Views as  
 606 output.

607

608 Any application-specific type system could define a *class* that represents a named collection of *objects*  
 609 and then refer to that *class* in an analytic's behavioral specification. However, since it is a common design  
 610 pattern we define a standard View *class* to facilitate interoperability between components that operate on  
 611 such collections of *objects*.

612

613 The members of a view are those *objects* explicitly asserted to be contained in the View. Referring to the  
 614 UML in Figure 4, we mean that there is an explicit reference from the View to the member *object*.  
 615 Members of a view may have references to other *objects* that are not members of the same View. A  
 616 consequence of this is that we cannot in general "export" the members of a View to form a new self-  
 617 contained CAS, as there could be dangling references. We define the **reference closure of a view** to  
 618 mean the collection of objects that includes all of the members of the view but also contains all other  
 619 *objects* referenced either directly or indirectly from the members of the view.

#### 620 4.3.3.1 Anchored View

621 A common and intended use for a View is to contain metadata that is associated with a specific  
 622 interpretation or perspective of an artifact. An application, for example, may produce an analysis of both  
 623 the XML tagged view of a document and the de-tagged view of the document.

624

625 AnchoredView is as a subtype of View that has a named association with exactly one particular *object* via  
 626 the standard *feature sofa*.

627

628 An AnchoredView requires that all Annotation *objects* that are members of the AnchoredView have their  
 629 sofa *feature* refer to the same SofaReference that is referred to by the View's sofa *feature*.

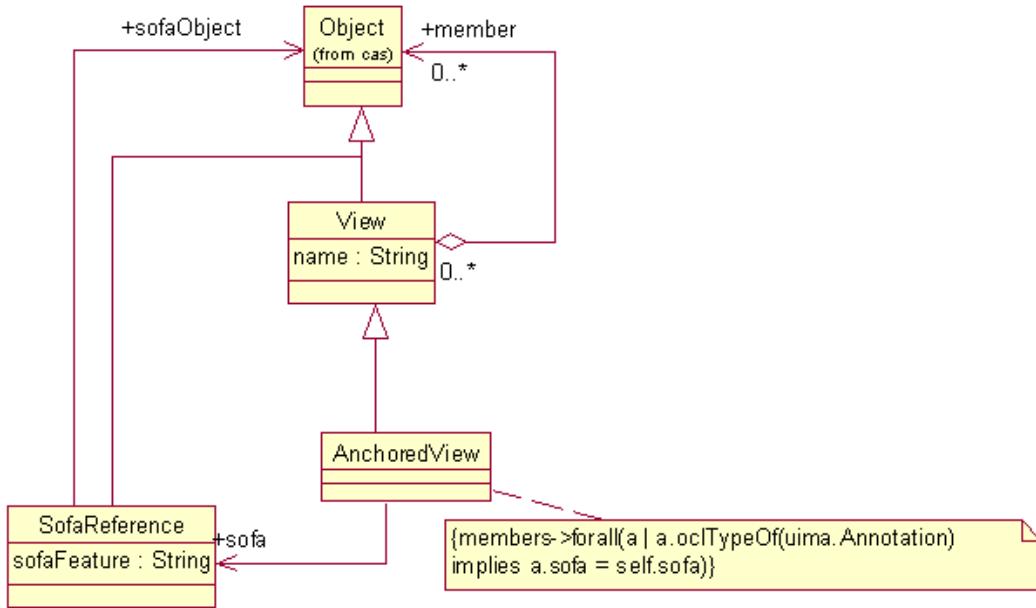
630

631 Simply put, all annotations in an AnchoredView annotate the same subject of analysis.

632

633 Figure 5 shows a UML diagram for the AnchoredView type, including an OCL constraint  
 634 expression[OCL1] specifying the restriction on the sofa feature of its member annotations.

635



636

637

**Figure 5: Anchored View Type**

638

639 The concept of an AnchoredView addresses common use cases. For example, an analytic written to  
 640 analyze the detagged representation of a document will likely only be able to interpret Annotations that  
 641 label and therefore refer to regions in that detagged representation. Other Annotations, for example  
 642 whose offsets referred back to the XML tagged representation or some other subject of analysis would  
 643 not be correctly interpreted since they point into and describe content the analytic is unaware of.

644

645 If a chain of analytics are intended to all analyze the same representation of the artifact, they can all  
 646 declare that AnchoredView as a precondition in their Behavioral Specification (see Section 4.5 Behavioral  
 647 Metadata). With AnchoredViews, all the analytics in the chain can simply assume that all regional  
 648 references of all Annotations that are members of the AnchoredView refer to the AnchoredView's sofa.  
 649 This saves them the trouble of filtering Annotations to ensure they all refer to a particular sofa.

#### 650 **4.3.4 Source Document Information**

651 Often it is useful to record in a CAS some information about the original source of the unstructured data  
 652 contained in that CAS. In many cases, this could just be a URL (to a local file or a web page) where the  
 653 source data can be found.

SourceDocumentInformation
uri : String
offsetInSource : Integer
documentSize : Integer

654

**Figure 6: Source Document Information UML**

656 Figure 6 contains the specification of a **SourceDocumentInformation** type included in the Base Type  
 657 System that can be stored in a CAS and used to capture this information. Here, the offsetInSource and  
 658 documentSize attributes must be byte offsets into the source, since that source may be in any modality.

659 **4.3.5 Base Type System Formal Specification**

660 The Base Type System is formally defined by the Ecore model in Appendix C.3. UIMA services and  
661 applications SHOULD use the Base Type System to facilitate interoperability with other UIMA services  
662 and applications. The XML namespace <http://docs.oasis-open.org/uima/ns/base.ecore> is  
663 reserved for use by the Base Type System Ecore model, and user-defined Type Systems (such as those  
664 referenced in PE metadata as discussed in Section 4.6.1.3) MUST NOT define their own type definitions  
665 in this namespace.

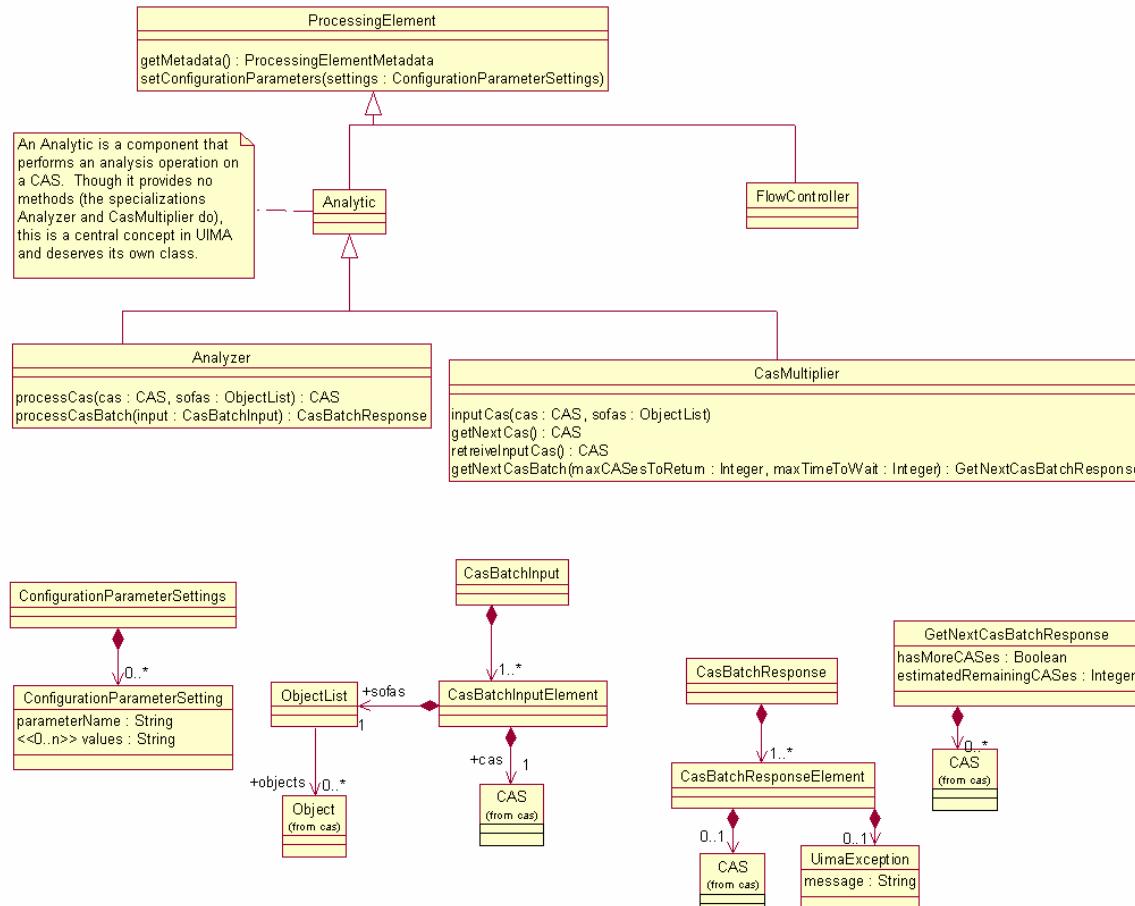
666 **4.4 Abstract Interfaces**

667 **4.4.1 Abstract Interfaces URL**

668 The UIMA specification defines two fundamental types of Processing Elements (PEs) that developers  
669 may implement: *Analytics* and *Flow Controllers*. Refer to Figure 7 for a UML model of the Analytic  
670 interfaces and Figure 8 for a UML model of the FlowController interface. A summary of the operations  
671 defined by each interface is given in Section 3.4.

672 **4.4.1.1 Analytic**

673 An Analytic is a component that performs analysis on CASes. There are two specializations: Analyzer  
674 and CasMultiplier. The Analyzer interface supports Analytics that take a CAS as input and output the  
675 same CAS, possibly updated. The CasMultiplier interface supports zero or more output CASes per input  
676 CAS.



677

678

**Figure 7: Abstract Interfaces UML (Flow Controller Detail Omitted)**

679

#### 680 **4.4.1.2 Flow Controller**

681 A *Flow Controller* is a component that determines the route CASes take through multiple Analytics

682

683 Note that the FlowController is not responsible for knowing how to actually invoke a constituent analytic.  
 684 Invoking the constituent analytic is the job of the application or aggregate framework that encapsulates  
 685 the FlowController. This is an important separation of concerns since applications or frameworks may  
 686 use arbitrary protocols to communicate with constituent analytics and it is not reasonable to expect a  
 687 reusable FlowController to understand all possible protocols.

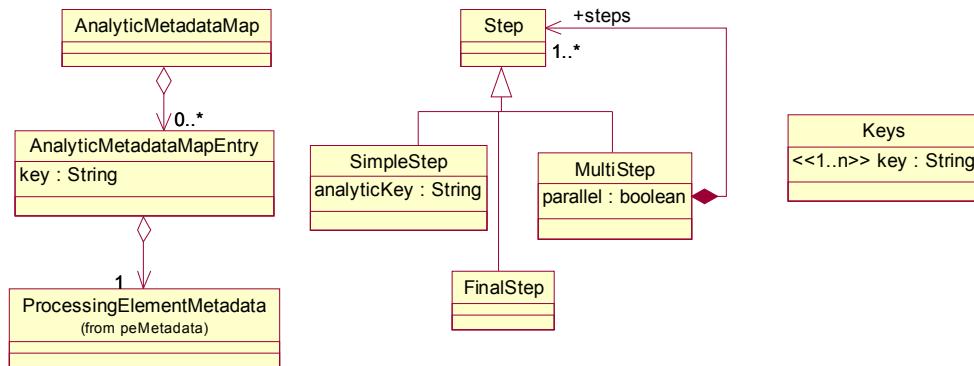
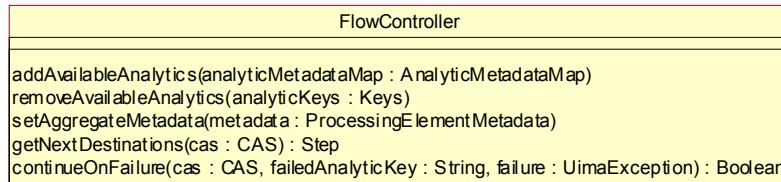
688

689 A FlowController, being a subtype of ProcessingElement, may have configuration parameters. For  
 690 example, a configuration parameter may refer to a description of the desired flow in some flow language  
 691 such as BPEL [BPEL1]. This is one way to create a reusable Flow Controller implementation that can be  
 692 applied in many applications or aggregates.

693

694 A Flow Controller may not modify the CAS. However, a concrete implementation of the Flow Controller  
 695 interface could provide additional operations on the Flow Controller which allow it to return data. For  
 696 example, it could return a Flow data structure to allow the application to get information about the flow  
 697 history.

698



699

**Figure 8: Flow Controller Abstract Interface UML**

#### 701 **4.4.2 Abstract Interfaces Formal Specification**

702 The following subsections specify requirements that a particular type of UIMA service must provide an  
 703 operation with certain inputs and outputs. For example, a UIMA PE service must implement a

704 getMetaData operation that returns standard UIMA PE Metadata. In all cases, the protocol for invoking  
705 this operation is not defined by the standard. However, the format in which data is sent to and from the  
706 service MUST be the standard UIMA XML representation. Implementations MAY define additional  
707 operations that use other formats.

#### 708 **4.4.2.1 ProcessingElement.getMetaData**

709 A UIMA Processing Element (PE) Service MUST implement an operation named `getMetaData`. This  
710 operation MUST take zero arguments and MUST return PE Metadata XML as defined in Section 4.6.2. In  
711 the following sections, we use the term “this PE Service’s Metadata” to refer to the PE Metadata returned  
712 by this operation.

#### 713 **4.4.2.2 ProcessingElement.setConfigurationParameters**

714 A UIMA Processing Element (PE) Service MUST implement an operation named  
715 `setConfigurationParameters`. This operation MUST accept one argument, an instance of the  
716 `ConfigurationParameterSettings` type defined by the XML Schema in Section C.8.

717

718 The PE Service MUST return an error if the `ConfigurationParameterSettings` object passed to this  
719 method contains any of:

- 720 1. a `parameterName` that does not match any of the parameter names declared in this PE Service’s  
721 Metadata.
- 722 2. multiple values for a parameter that is not declared as `multiValued` in this PE Service’s Metadata.
- 723 3. a value that is not a valid instance of the type of the parameter as declared in this PE Service’s  
724 Metadata. To be a valid instance of the UIMA configuration parameter type, the value must be a  
725 valid instance of the corresponding XML Schema datatype in Table 1: Mapping of UIMA  
726 Configuration Parameter Types to XML Schema Datatypes, as defined by the XML Schema  
727 specification [XMLS2].

728

UIMA Configuration Parameter Type	XML Schema Datatype
String	string
Integer	int
Float	float
Boolean	boolean
ResourceURL	anyURI

729 **Table 1: Mapping of UIMA Configuration Parameter Types to XML Schema Datatypes**

730

731 After a client calls `setConfigurationParameters`, those parameter settings MUST be applied to all  
732 subsequent requests from that client, until such time as a subsequent call to `setConfigurationParameters`  
733 specifies new values for the same parameter(s). If the PE service is shared by multiple clients, the PE  
734 service MUST provide a way to keep their configuration parameter settings separate.

735

#### 736 **4.4.2.3 Analyzer.processCas**

737 A UIMA Analyzer Service MUST implement an operation named `processCas`. This operation MUST  
738 accept two arguments. The first argument is a CAS, represented in XMI as defined in Section 4.1.4. The  
739 second argument is a list of `xmi:id`s that identify `SofaReference` objects which the Analyzer is expected

740 to analyze. This operation MUST return a valid XMI document which is either a valid CAS (as defined in  
741 Section4.1.4) or a description of changes to be applied to the input CAS using the XMI differences  
742 language defined in [XMI1].

743

744 The output CAS of this operation represents an update of the input CAS. Formally, this means :

- 745 1. All objects in the input CAS must appear in the output CAS, except where an explicit delete or  
746 modification was performed by the service (which is only allowed if such operations are declared  
747 in the Behavioral Metadata element of this service's PE Metadata).
- 748 2. For the processCas operation, an object that appears in both the input CAS and output CAS must  
749 have the same value for xmi:id.
- 750 3. No newly created object in the output CAS may have the same xmi:id as any object in the input  
751 CAS.

752

753 The input CAS may contain a reference to its type system (see Section B.1.6). If it does not, then the  
754 PE's type system (see Section 4.6.1.3) may provide definitions of the types. If the CAS contains an  
755 instance of a type that is not defined in either place, then the PE MUST return that object, unmodified.

756

#### 757 **4.4.2.4 Analyzer.processCasBatch**

758 A UIMA Analyzer Service MUST implement an operation named `processCasBatch`. This operation  
759 MUST accept an argument which consists of one or more CASes, each with an associated list of xmi:ids  
760 that identify `SofaReference` objects in that CAS. This operation MUST return a response that consists of  
761 multiple elements, one for each input CAS, where each element is either valid XMI document which is  
762 either a valid CAS (as defined in Section4.1.4), a description of changes to be applied to the input CAS  
763 using the XMI differences language defined in [XMI1], or an exception message.

764

765 The CASes that result from calling `processCasBatch` MUST be identical to the CASes that would result  
766 from several individual `processCas` operations, each taking only one of the CASes as input.

767

768 If an application needs to consider an entire set of CASes in order to make decisions about annotating  
769 each individual CAS, it is up to the application to implement this. An example of how to do this would be  
770 to use an external resource such as a database, which is populated during one pass and read from  
771 during a subsequent pass.

#### 772 **4.4.2.5 CasMultiplier.inputCas**

773 A UIMA CAS Multiplier service MUST implement an operation named `inputCas`. This operation MUST  
774 accept two arguments. The first argument is a CAS, represented in XMI as defined in Section 4.1.4. The  
775 second argument is a list of xmi:ids that identify `SofaReference` objects which the Analyzer is expected  
776 to analyze. This operation returns nothing.

777

778 The CAS that is passed to this operation becomes this CAS Multiplier's *active CAS*.

#### 779 **4.4.2.6 CasMultiplier.getNextCas**

780 A UIMA CAS Multiplier service MUST implement an operation named `getNextCas`. This operation  
781 MUST take zero arguments. This operation MUST return a valid CAS as defined in Section4.1.4, or a  
782 result indicating that there are no more CASes available.

783

784 If the client calls `getNextCas` when this CAS Multiplier has no active CAS, then this CAS Multiplier MUST  
785 return an error.

#### 786 **4.4.2.7 CasMultiplier.retrieveInputCas**

787 A UIMA CAS Multiplier service MUST implement an operation named `retrieveInputCas`. This operation  
788 MUST take zero arguments and MUST return a valid XMI document which is either a valid CAS (as  
789 defined in Section 4.1.4) or a description of changes to be applied to the CAS Multiplier's active CAS  
790 using the XMI differences language defined in [XMI1].

791

792 If the client calls `retrieveInputCas` when this CAS Multiplier has no active CAS, then this CAS Multiplier  
793 MUST return an error.

794

795 After this method completes, this service no longer has an active CAS, until the client's next call to  
796 `inputCas`.

#### 797 **4.4.2.8 CasMultiplier.getNextCasBatch**

798 A UIMA CAS Multiplier service MUST implement an operation named `getNextCasBatch`. This  
799 operation MUST take two arguments, both of which are integers. The first argument (named  
800 `maxCASEsToReturn`) specifies the maximum number of CASEs to be returned, and the second argument  
801 (named `maxTimeToWait`) indicates the maximum number of milliseconds to wait. This operation MUST  
802 return an object with three fields:

- 803 1. Zero or more valid CASEs as defined in Section 4.1.4. The number of CASEs MUST NOT  
804 exceed the value of the `maxCASEsToReturn` argument.
- 805 2. a Boolean indicating whether more CASE remain to be retrieved.
- 806 3. An estimated number of remaining CASEs. The estimated number of remaining CASEs may be  
807 set to -1 to indicate an unknown number.

808

809 The call to `getNextCasBatch` SHOULD attempt to complete and return a response in no more than the  
810 amount of time specified (in milliseconds) by the `maxTimeToWait` argument.

811

812 If the client calls `getNextCasBatch` when this CAS Multiplier has no active CAS, then this CAS Multiplier  
813 MUST return an error.

814

815 CASEs returned from `getNextCasBatch` MUST be equivalent to the CASEs that would be returned from  
816 individual calls to `getNextCas`.

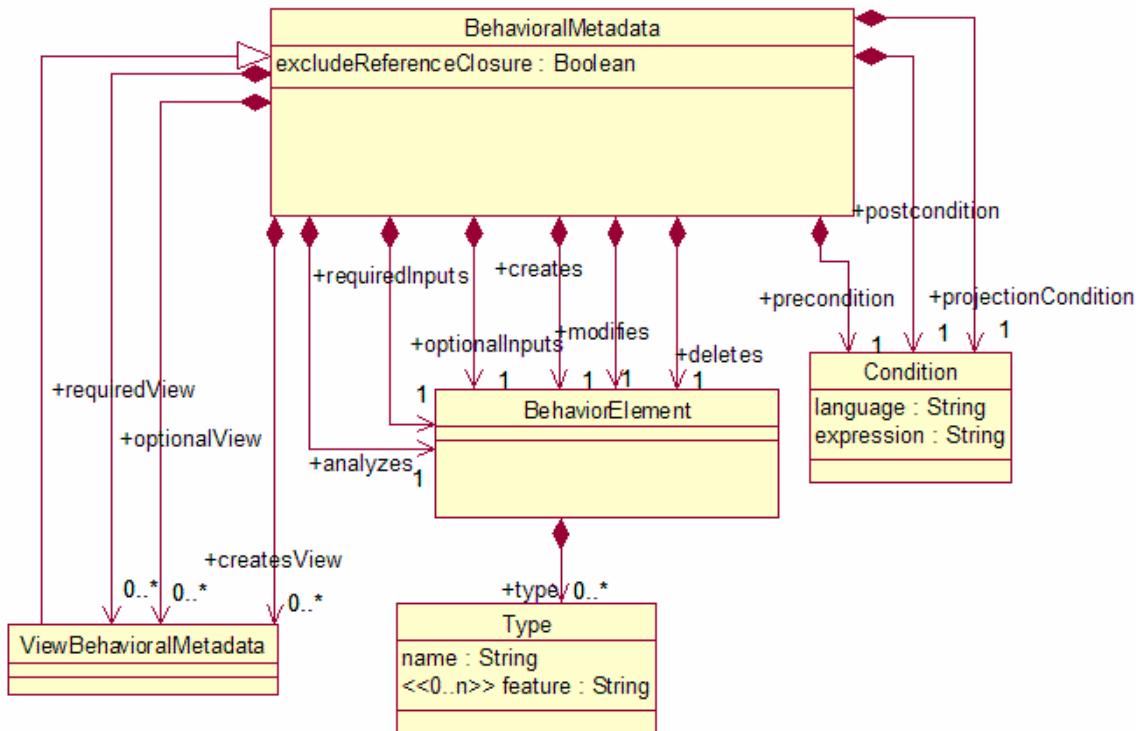
#### 817 **4.4.2.9 FlowController.addAvailableAnalytics**

818 A UIMA Flow Controller service MUST implement an operation named `addAvailableAnalytics`. This  
819 operation MUST accept one argument, a Map from String keys to PE Metadata objects. Each of the  
820 String keys passed to this operation is added to the set of *available analytic* keys for this Flow Controller  
821 service.

#### 822 **4.4.2.10 FlowController.removeAvailableAnalytics**

823 A UIMA Flow Controller service MUST implement an operation named `removeAvailableAnalytics`.  
824 This operation MUST accept one argument, which is a collection of one or more String keys. If any of the  
825 String keys passed to this operation are not a member of the set of *available analytic* keys for this Flow  
826 Controller service, an error MUST be returned. Each of the String keys passed to this operation is  
827 removed from the set of *available analytic* keys for this FlowController service.

- 828 **4.4.2.11 FlowController.setAggregateMetadata**
- 829 A UIMA Flow Controller service MUST implement an operation named `setAggregateMetadata`. This  
830 operation MUST take one argument, which is valid PE Metadata XML as defined in Section 4.6.2.  
831
- 832 There are no formal requirements on what the Flow Controller does with this PE Metadata, but the  
833 intention is for the PE Metadata to specify the desired outputs of the workflow, so that the Flow Controller  
834 can make decisions about which analytics need to be invoked in order to produce those outputs.
- 835 **4.4.2.12 FlowController.getNextDestinations**
- 836 A UIMA Flow Controller service MUST implement an operation named `getNextDestinations`. This  
837 operation MUST accept one argument, which is an XML CAS as defined in Section 4.1.4 and MUST  
838 return an instance of the `Step` type defined by the XML Schema in Section C.8.  
839
- 840 The different types of Step objects are defined in the UML diagram in Figure 8 and XML schema in  
841 Appendix C.8. Their intending meanings are as follows:
- 842 • `SimpleStep` identifies a single Analytic to be executed. The Analytic is identified by the String key  
843 that was associated with that Analytic in the `AnalyticMetadataMap`.
- 844 • `MultiStep` identifies one or more Steps that should be executed next. The `MultiStep` also indicates  
845 whether these steps must be performed sequentially or whether they may be performed in parallel.
- 846 • `FinalStep` which indicates that there are no more destinations for this CAS, i.e., that processing of  
847 this CAS has completed.
- 848 Each analyticKey field of a Step object returned from the `getNextDestinations` operation MUST be a  
849 member of the set of *active analytic keys* of this Flow Controller service.
- 850 **4.4.2.13 FlowController.continueOnFailure**
- 851 A UIMA FlowController service MUST define an operation named `continueOnFailure`. This operation  
852 MUST accept three arguments as follows. The first argument is an XML CAS as defined in Section 4.1.4.  
853 The second argument is a String key. The third argument is an instance of the `UimaException` type  
854 defined in the XML schema in Section C.8.
- 855
- 856 If the String key is not a member of the set of *active analytic keys* of this Flow Controller, then an error  
857 must be returned.
- 858
- 859 This method is intended to be called by the client when there was a failure in executing a Step issued by  
860 the FlowController. The client is expected to pass the CAS that failed, the analytic key from the Step  
861 object that was being executed, and the exception that occurred.
- 862
- 863 Given that the above assumptions hold, the `continueOnFailure` operation SHOULD return true if a further  
864 call to `getNextDestinations` would succeed, and false if a further call to `getNextDestinations` would fail.  
865
- 866 **4.5 Behavioral Metadata**
- 867 **4.5.1 Behavioral Metadata UML**
- 868 The following UML diagram defines the UIMA Behavioral Metadata representation:



869

870

**Figure 9: Behavioral Metadata UML**

871

## 872 **4.5.2 Behavioral Metadata Elements and XML Representation**

873 Behavioral Metadata breaks down into the following categories:

- 874 • **Analyzes**: Types of objects (Sofas) that the analytic intends to produce annotations over.
- 875 • **Required Inputs**: Types of objects that must be present in the CAS for the analytic to operate.
- 876 • **Optional Inputs**: Types of objects that the analytic would consult if they were present in the CAS.
- 877 • **Creates**: Types of objects that the analytic may create.
- 878 • **Modifies**: Types of objects that the analytic may modify.
- 879 • **Deletes**: Types of objects that the analytic may delete.

880

881 The representation of these elements in XML is defined by the **BehavioralMetadata** element definition in  
882 the XML schema given in Appendix C.6. For examples and discussion, see Appendix B.5.

## 883 **4.5.3 Formal Semantics for Behavioral Metadata**

884 All Behavioral Metadata elements may be mapped to three kinds of expressions in a formal language: a  
885 **Precondition**, a **Postcondition**, and a **Projection Condition**.

886

887 A **Precondition** is a predicate that qualifies CASs that the analytic considers valid input. More precisely  
888 the analytic's behavior would be considered unspecified for any CAS that did not satisfy the pre-condition.  
889 The pre-condition may be used by a framework or application to filter or skip CASs routed to an analytic  
890 whose pre-condition is not satisfied by the CASs. A human assembler or automated composition process  
891 can interpret the pre-conditions to determine if the analytic is suitable for playing a role in some aggregate  
892 composition.

893

894 A *Postcondition* is a predicate that is declared to be true of any CAS after having been processed by the  
895 analytic, assuming that the CAS satisfied the precondition when it was input to the analytic.  
896  
897 For example, if the pre-condition requires that valid input CASs contain People, Places and  
898 Organizations, but the Postconditions of the previously run Analytic asserts that the CAS will not contain  
899 all of these objects, then the composition is clearly invalid.  
900  
901 A *Projection Condition* is a predicate that is evaluated over a CAS and which evaluates to a subset of the  
902 objects in the CAS. This is the set of objects that the Analytic declares that it will consider to perform its  
903 function.  
904  
905 The following is a high-level description of the mapping from Behavioral Metadata Elements to  
906 preconditions, postconditions, and projection conditions. For a precise definition of the mapping, see  
907 Section 4.5.4.3.  
908  
909 An `analyzes` or `requiredInputs` predicate translates into a precondition that all input CASes contain the  
910 objects that satisfy the predicates.  
911  
912 A `deletes` predicate translates into a postcondition that for each object O in the input CAS, if O does not  
913 satisfy the `deletes` predicate, then O is present in the output CAS.  
914  
915 A `modifies` predicate translates into a postcondition that for each object O in the input CAS, if O does not  
916 satisfy the `modifies` predicate, and if O is present in the output CAS (i.e. it was not deleted), then O has  
917 the same values for all of its slots.  
918  
919 For views, we add the additional constraint that objects are members of that View (and therefore  
920 annotations refer to the View's sofa). For example:  
921 

```
<requiredView sofaType="org.example:TextDocument">
  <requiredInputs>
    <type>org.example:Token</type>
  </requiredInputs>
</requiredView>
```

  
922  
923 This translates into a precondition that the input CAS must contain an anchored view V where V is linked  
924 to a Sofa of type TextDocument and V.members contains at least one object of type Token.  
925  
926 Finally, the projection condition is formed from a disjunction of the “`analyzes`,” “`required inputs`,” and  
927 “`optional inputs`” predicates, so that any object which satisfies any of these predicates will satisfy the  
928 projection condition.  
929  
930 UIMA does not mandate a particular expression language for representing these conditions.  
931 Implementations are free to use any language they wish. However, to ensure a standard interpretation of  
932 the standard UIMA Behavior Elements, the UIMA specification defines how the Behavior Elements map  
933 to preconditions, postconditions, and projection conditions in the Object Constraint Language [OCL1], an  
934 OMG standard. See Section 4.5.4.3 for details.

939 **4.5.4 Behavioral Metadata Formal Specification**

940 **4.5.4.1 Structure**

941 *UIMA Behavioral Metadata XML* is a part of *UIMA Processing Element Metadata XML*. Its structure is  
942 defined by the definitions of the BehavioralMetadata class in the Ecore model in C.3.

943

944 This implies that UIMA Behavioral Metadata XML must be a valid instance of the BehavioralMetadata  
945 element definition in the XML schema given in Section C.6.

946 **4.5.4.2 Constraints**

947 Field values must satisfy the following constraints:

948 **4.5.4.2.1 Type**

- 949 • name must be a valid QName (Qualified Name) as defined by the Namespaces for XML specification  
950 [XML2]. The namespace of this QName must match the namespace URI of an EPackage defined in an  
951 Ecore model referenced by the PE's *TypeSystemReference*. The local part of the QName must match  
952 the name of an EClass within that EPackage.
- 953 • Values for the `feature` attribute must not be specified unless the Type is contained in a `modifies`  
954 element.
- 955 • Each value of feature must be a valid UnprefixedName as specified in [XML2], and must match the  
956 name of an EStructuralFeature in the EClass corresponding to the value of the name field as described  
957 in the previous bullet.

958 **4.5.4.2.2 Condition**

- 959 • language must be one of:
  - 960 ○ The exact string OCL. If the value of the language field is OCL, then the value of the  
961 expression field must be a valid OCL expression as defined by [OCL1].
  - 962 ○ A user-defined language, which must be a String containing the '.' Character (for example  
963 "org.example.MyLanguage"). Strings not containing the '.' are reserved by the UIMA  
964 standard and may be defined at a later date.

965 **4.5.4.3 Semantics**

966 To give a formal meaning to the *analyzes*, *required inputs*, *optional inputs*, *creates*, *modifies*, and *deletes*  
967 expressions, UIMA defines how these map into formal preconditions, postconditions, and projection  
968 conditions in the Object Constraint Language [OCL1], an OMG standard.

969

970 The UIMA specification defines this mapping in order to ensure a standard interpretation of UIMA  
971 Behavioral Metadata Elements. There is no requirement on any implementation to evaluate or enforce  
972 these expressions. Implementations are free to use other languages for expressing and/or processing  
973 preconditions, postconditions, and projection conditions.

974 **4.5.4.3.1 Mapping to OCL Precondition**

975 An OCL precondition is formed from the `analyzes`, `requiredInputs`, and `requiredView`  
976 BehavioralMetadata elements as follows.

977

978 In these OCL expressions the keyword `input` refers to the collection of objects in the CAS when it is input  
979 to the analytic.

980

981 For each type  $T$  in an `analyzes` or `requiredInputs` element, produce the OCL expression:

```
982     input->exists(p | p.oclKindOf(T))
```

983

984 For each `requiredView` element that contains `analyzes` or `requiredInputs` elements with types  $T_1, T_2, \dots, T_n$ , produce the OCL expression:

```
986     input->exists(v | ViewExpression and v.members->exists(p | p.oclKindOf(T2))  
987     and ... and v.members->exists(p | p.oclKindOf(Tn)))
```

988 There may be zero `analyzes` or `requiredInputs` elements, in which case there will be no `v.members` clauses in the OCL expression.

990

991 In the above we define `ViewExpression` as follows:

992 If the `requiredView` element has no value for its `sofaType` slot, then `ViewExpression` is:

```
993     v.oclKindOf(uima::cas::View)
```

994 If the `requiredView` has a `sofaType` slot with value then `ViewExpression` is defined as:

```
995     v.oclKindOf(uima::cas::AnchoredView) and v.sofa.sofaObject.oclKindOf(S)
```

996

997 The final precondition expression for the analytic is the conjunction of all the expressions generated from  
998 the productions defined in this section, as well as any explicitly declared precondition as defined in  
999 Section B.5.5.

1000 **4.5.4.3.2 Mapping to OCL Postcondition**

1001 In these OCL expressions the keyword `input` refers to the collection of objects in the CAS when it was  
1002 input to the analytic, and the keyword `result` refers to the collection of objects in the CAS at the end of  
1003 the analytic's processing. Also note that the suffix `@pre` applied to any attribute references the value of  
1004 that attribute at the start of the analytic's operation.

1005

1006 For types  $T_1, T_2, \dots, T_n$  specified in `creates` elements, produce the OCL expression:

```
1007     result->forAll(p | input->includes(p) or p.oclKindOf(T1) or p.oclKindOf(T2) or  
1008     ... or p.oclKindOf(Tn))
```

1009

1010 For types  $T_1, T_2, \dots, T_n$  specified in  `deletes` elements, produce the OCL expression:

```
1011     input->forAll(p | result->includes(p) or p.oclKindOf(T1) or p.oclKindOf(T2) or  
1012     ... or p.oclKindOf(Tn))
```

1013

1014 For each `modifies` element specifying type  $T$  with features  $F=\{F_1, F_2, \dots, F_n\}$ , for each feature  $g$  defined  
1015 on type  $T$  where  $g \notin F$ , produce the OCL expression:

```
1016     result->forAll(p | (input->includes(p) and p.oclKindOf(T)) implies p.g =  
1017     p.g@pre)
```

1018

1019 For each `createsView`, `requiredView` or `optionalView` containing `creates` elements with types  
1020  $T_1, T_2, \dots, T_n$ , produce the OCL expression:

```
1021     result->forAll(v | (ViewExpression) implies v.members->forAll(p |  
1022     v.members->includes(p) or p.oclKindOf(T1) or p.oclKindOf(T2) or ... or  
1023     p.oclKindOf(Tn)))
```

1024 where ViewExpression is as defined in Section 4.5.4.3.1.  
1025  
1026 For each requiredView or optionalView containing deletes elements with types T1,T2,...,Tn, produce  
1027 the OCL expression:

```
1028     result->forAll(v | (ViewExpression) implies v.members@pre->forAll(p |
1029     v.members->includes(p) or p.oclkIndOf(T1) or p.oclkIndOf(T2) or ... or
1030     p.oclkIndOf(Tn))
```

1031 where ViewExpression is as defined in Section 4.5.4.3.1.  
1032  
1033 Within each requiredView or optionalView, for each modifies element specifying type T with features  
1034 F={F1, F2, ...Fn}, for each feature g defined on type T where gnotinF, produce the OCL expression:

```
1035     result->forAll(v | (ViewExpression) implies v.members->forAll(p |
1036     (v.members@pre->includes(p) and p.oclkIndOf(T)) implies p.g = p.g@pre))
```

1037 where ViewExpression is as defined in Section 4.5.4.3.1.  
1038  
1039 The final postcondition expression for the analytic is the conjunction of all the expressions generated from  
1040 the productions defined in this section, as well as any explicitly declared postcondition as defined in  
1041 Section B.5.5.

#### 1042 4.5.4.3.3 Mapping to OCL Projection Condition

1043 In these OCL expressions the keyword input refers to the collection of objects in the entire CAS when it  
1044 is about to be delivered to the analytic. The OCL expression evaluates to a collection of objects that the  
1045 analytic declares it will consider while performing its operation. When an application or framework calls  
1046 this analytic, it MUST deliver to the analytic all objects in this collection.

1047  
1048 If the excludeReferenceClosure attribute of the BehavioralMetadata is set to false (or omitted), then the  
1049 application or framework MUST also deliver all objects that are referenced (directly or indirectly) from any  
1050 object in the collection resulting from evaluation of the projection condition.  
1051  
1052 For types T1, T2, ... Tn specified in analyzes, requiredInputs, or optionalInputs elements, produce  
1053 the OCL expression:

```
1054     input->select(p | p.oclkIndOf(T1) or p.oclkIndOf(T2) or ... or
1055     p.oclkIndOf(Tn))
```

1056  
1057 For each requiredView or optionalView produce the OCL expression:

```
1058     input->select(v | ViewExpression)
```

1059 where ViewExpression is as defined in Section 4.5.4.3.1.  
1060  
1061 If the requiredView or optionalView contains types T1, T2,...Tn specified in analyzes,  
1062 requiredInputs, or optionalInputs elements, produce the OCL expression:

```
1063     input->select(v | ViewExpression)->collect(v.members()->select(p |
1064     p.oclkIndOf(T1) or p.oclkIndOf(T2) or ... or p.oclkIndOf(Tn)))
```

1065

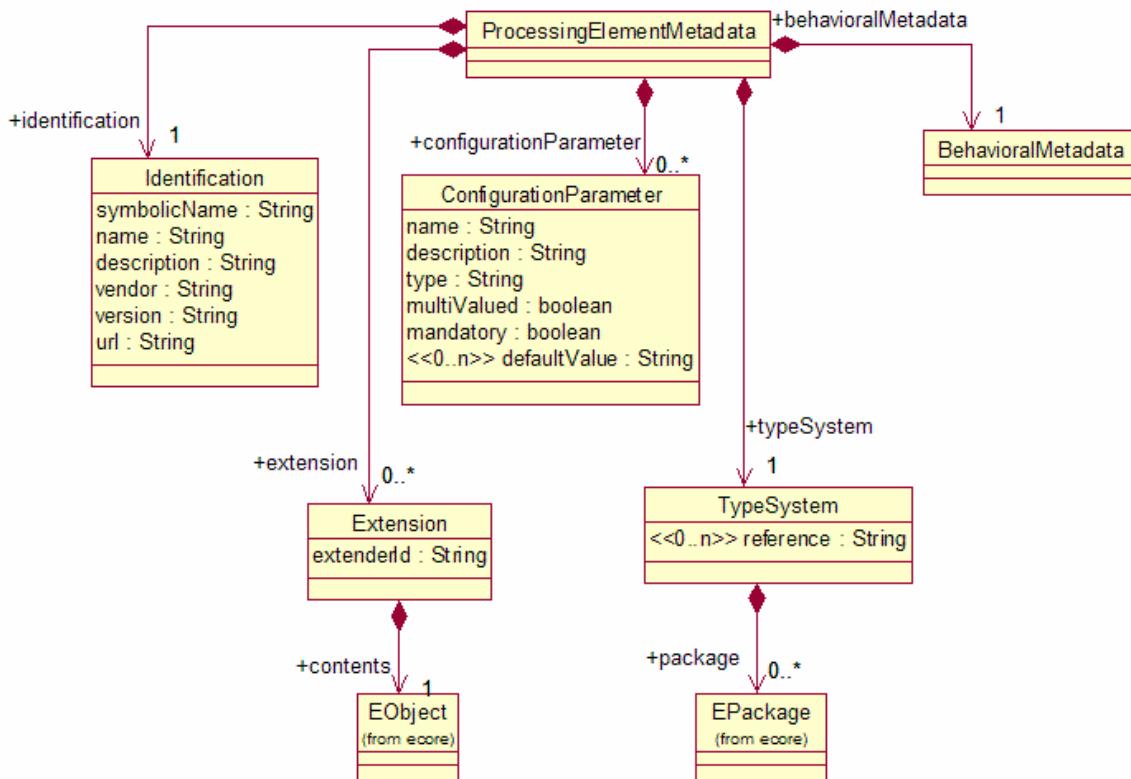
1066 The final projection condition expression for the analytic is the result of the OCL `union` operator applied  
1067 consecutively to all of the expressions generated from the productions defined in this section, as well as  
1068 any explicitly declared projection condition as defined in Section B.5.5.

1069

## 1070 4.6 Processing Element Metadata

1071 Figure 10 is a UML model for the PE metadata. We describe each subpart of the PE metadata in detail in  
1072 the following sections.

1073



1074

Figure 10: Processing Element Metadata UML Model

1075

### 1076 4.6.1 Elements of PE Metadata

#### 1078 4.6.1.1 Identification Information

1079 The Identification Information section of the descriptor defines a small set of properties that developers  
1080 should fill in with information that describes their PE. The main objectives of this information are to:

- 1081 1. Provide human-readable information about the analytic to assist developers in understanding  
1082 what the purpose of each PE is.  
1083 2. Facilitate the development of repositories of PEs.

1084

1085 The following properties are included:

- 1086 1. Symbolic Name: A unique name (such as a Java-style dotted name) for this PE.

- 1087        2. Name: A human-readable name for the PE. Not necessarily unique.  
1088        3. Description: A textual description of the PE.  
1089        4. Version: A version number. This is necessary for PE repositories that need to distinguish  
1090           different versions of the same component. The syntax of a version number is as defined in  
1091           [OSGi1]: up to four dot-separated components where the first three must be numeric but the  
1092           fourth may be alphanumeric. For example 1.2.3.4 and 1.2.3.abc are valid version numbers but  
1093           1.2.abc is not.  
1094        5. Vendor: The provider of the component.  
1095        6. URL: website providing information about the component and possibly allowing download of the  
1096           component

1097

#### 1098        4.6.1.2 Configuration Parameters

1099        PEs may be configured to operate in different ways. UIMA provides a standard way for PEs to declare  
1100           configuration parameters so that application developers are aware of the options that are available to  
1101           them.

1102

1103        UIMA provides a standard interface for setting the values of parameters; see Section 4.4 Abstract  
1104           Interfaces.

1105

1106        For each configuration parameter we should allow the PE developer to specify:

- 1107
- 1108        1. The name of the parameter  
1109        2. A description for the parameter  
1110        3. The type of value that the parameter may take  
1111        4. Whether the parameter accepts multiple values or only one  
1112        5. Whether the parameter is mandatory  
1113        6. A default value or values for the parameter

1114

1115        One common use of configuration parameters is to refer to external resource data, such as files  
1116           containing patterns or statistical models. Frameworks such as Apache UIMA may wish to provide  
1117           additional support for such parameters, such as resolution of relative URLs (using classpath/datapath)  
1118           and/or caching of shared data. It is therefore important for the UIMA configuration parameter schema to  
1119           be expressive enough to distinguish parameters that represent resource locations from parameters that  
1120           are just arbitrary strings.

1121

1122        The type of a parameter must be one of the following:

- 1123
- 1124        • String
  - 1125        • Integer (32-bit)
  - 1126        • Float (32-bit)
  - 1127        • Boolean
  - 1127        • ResourceURL

1128

1129        The ResourceURL satisfies the requirement to explicitly identify parameters that represent resource  
1130           locations.

1131

1132        Note that parameters may take multiple values so it is not necessary to have explicit parameter types  
1133           such as StringArray, IntegerArray, etc.

1135 As a best practice, analytics SHOULD NOT declare configuration settings that would affect their  
1136 Behavioral Metadata. UIMA does not provide any mechanism to keep the behavioral specification in sync  
1137 with the different configurations.

#### 1138 **4.6.1.3 Type System**

1139 There are two ways that PE metadata may provide type system information: It can either include it or refer  
1140 to it. This specification is only concerned with the format of that reference or inclusion. For the actual  
1141 definition of the type system, we have adopted the Ecore/XMI representation. See Section 4.2 for details.  
1142

1143 If reference is chosen as the way to provide the type system information, then the `reference` field of the  
1144 `TypeSystem` object must be set to a valid URI (or multiple URIs). URIs are used as references by many  
1145 web-based standards (e.g., RDF), and they are also used within Ecore. Thus we use a URI to refer to the  
1146 type system. To achieve interoperability across frameworks, each URI should be a URL which resolves  
1147 to a location where Ecore/XMI type system data is located.  
1148

1149 If embedding is chosen as the way to provide the type system information, then the `package` reference of  
1150 the `TypeSystem` object must be set to one or more `EPackages`, where an `EPackage` contains  
1151 subpackages and/or classes as defined by Ecore.  
1152

1153 The role of this type system is to provide definitions of the types referenced in the PE's behavioral  
1154 metadata. It is important to note that this is not a restriction on the CASes that may be input to the PE (if  
1155 that is desired, it can be expressed using a precondition in the behavioral specification). If the input CAS  
1156 contains instances of types that are not defined by the PE's type system, then the CAS itself may indicate  
1157 a URI where definitions of these types may be found (see B.1.6 Linking an XMI Document to its Ecore  
1158 Type System). Also, some PE's may be capable of processing CASes without being aware of the type  
1159 system at all.  
1160

1161 Some analytics may be capable of operating on any types. These analytics need not refer to any specific  
1162 type system and in their behavioral metadata may declare that they analyze or inspect instances of the  
1163 most general type (`EObject` in Ecore).

#### 1164 **4.6.1.4 Behavioral Metadata**

1165 The Behavioral Metadata is discussed in detail in 4.5.

#### 1166 **4.6.1.5 Extensions**

1167 Extension objects allow a framework implementation to extend the PE metadata descriptor with additional  
1168 elements, which other frameworks may not necessarily respect. For example Apache UIMA defines an  
1169 element `fslIndexCollection` that defines the CAS indexes that the component uses. Other frameworks  
1170 could ignore that.  
1171

1172 This extensibility is enabled by the Extension class in Figure 10. The Extension class defines two  
1173 features, `extenderId` and `contents`.

1174  
1175 The `extenderId` feature identifies the framework implementation that added the extension, which allows  
1176 framework implementations to ignore extensions that they were not meant to process.  
1177

1178 The contents feature can contain any `EObject`. (`EObject` is the superclass of all classes in Ecore.) To add  
1179 an extension, a framework must provide an Ecore model that defines the structure of the extension.

1180 **4.6.2 Processing Element Metadata Formal Specification**

1181 **4.6.2.1 Structure**

1182 *UIMA Processing Element Metadata XML* must be a valid XMI document that is an instance of the UIMA  
1183 Processing Element Metadata Ecore model given in Section C.3.

1184

1185 This implies that UIMA Processing Element Metadata XML must be a valid instance of the UIMA  
1186 Processing Element Metadata XML schema given in Section C.6.

1187 **4.6.2.2 Constraints**

1188 Field values must satisfy the following constraints

1189

1190 **Identification Information:**

- symbolicName must be a valid symbolic-name as defined by the OSGi specification [OSGi1].
- version must be a valid version as defined by the OSGi specification [OSGi1].
- url must be a valid URL as defined by [\[URL1\]](#).

1194

1195 **Configuration Parameter**

- name must be a valid Name as defined by the XML specification [XML1].
- type must be one of {String, Integer, Float, Boolean, ResourceURL}

1198

1199 **Type System Reference**

- uri must be a syntactically valid URI as defined by [\[URI1\]](#) It is application defined to check the reference validity of the URI and handle errors related to dereferencing the URI.

1202

1203 **Extensions**

- extenderId must be a valid Name as defined by the XML specification [XML1].

1205

1206 **4.7 Service WSDL Descriptions**

1207 In this section we describe the UIMA Service WSDL descriptions at a high level. The formal WSDL  
1208 document is given in Section C.7.

1209

1210 **4.7.1 Overview of the WSDL Definition**

1211 Before discussing the elements of the UIMA WSDL definition, as a convenience to the reader we first  
1212 provide an overview of WSDL excerpted from the WSDL Specification.

1213

#### **Excerpt from WSDL W3C Note [http://www.w3.org/TR/wsdl]**

As communications protocols and message formats are standardized in the web community, it becomes increasingly possible and important to be able to describe the communications in some structured way. WSDL addresses this need by defining an XML grammar for describing network services as collections of communication endpoints capable of exchanging messages. WSDL service definitions provide documentation for distributed systems and serve as a recipe for automating the details involved in applications communication.

A WSDL document defines services as collections of network endpoints, or ports. In WSDL, the abstract definition of endpoints and messages is separated from their concrete network deployment or data format bindings. This allows the reuse of abstract definitions: messages, which are abstract descriptions of the data being exchanged, and port types which are abstract collections of operations. The concrete protocol and data format specifications for a particular port type constitutes a reusable binding. A port is defined by associating a network address with a reusable binding, and a collection of ports define a service. Hence, a WSDL document uses the following elements in the definition of network services:

- Types – a container for data type definitions using some type system (such as XSD).
- Message – an abstract, typed definition of the data being communicated.
- Operation – an abstract description of an action supported by the service.
- Port Type – an abstract set of operations supported by one or more endpoints.
- Binding – a concrete protocol and data format specification for a particular port type.
- Port – a single endpoint defined as a combination of a binding and a network address.
- Service – a collection of related endpoints.

1214  
1215

#### **4.7.1.1 Types**

1217 Type Definitions for the UIMA WSDL service are defined using XML schema. These draw from other  
1218 elements of the specification. For example the `ProcessingElementMetadata` type, which is returned  
1219 from the `getMetadata` operation, is defined by the PE Metadata specification element.  
1220

#### **4.7.1.2 Messages**

1222 Messages are used to define the structure of the request and response of the various operations  
1223 supported by the service. Operations are described in the next section.  
1224

1225 Messages refer to the XML schema defined under the `<wsdl:types>` element. So wherever a message  
1226 includes a CAS (for example the `processCasRequest` and `processCasResponse`, we indicate that the  
1227 type of the data is `xmi:XMI` (a type defined by `XMI.xsd`), and where the message consists of PE metadata  
1228 (the `getMetadataResponse`), we indicate that the type of the data is `uima:ProcessingElementMetadata` (a  
1229 type defined by `UimaDescriptorSchema.xsd`).

1230  
1231 The messages defined by the UIMA WSDL service definition are:  
1232 For ALL PEs:  
1233 • getMetadataRequest – takes no arguments  
1234 • getMetadataResponse – returns ProcessingElementMetadata  
1235 • setConfigurationParametersRequest – takes one argument: ConfigurationParameterSettings  
1236 • setConfigurationParameterResponse – returns nothing  
1237  
1238 For Analyzers:  
1239 • processCasRequest – takes two arguments – a CAS and a list of Sofas (object IDs) to process  
1240 • processCasResponse – returns a CAS  
1241 • processCasBatchRequest – takes one argument, an Object that includes multiple CASes, each with an  
1242 associated list of Sofas (object IDs) to process  
1243 • processCasResponse – returns a list of elements, each of which is a CAS or an exception message  
1244  
1245 For CAS Multipliers:  
1246 • inputCasRequest – takes two arguments – a CAS and a list of Sofas (object IDs) to process  
1247 • inputCasResponse – returns nothing  
1248 • getNextCasRequest – takes no arguments  
1249 • getNextCasResponse – returns a CAS  
1250 • retrieveInputCasRequest – takes no arguments  
1251 • retrieveInputCasResponse – returns a CAS  
1252 • getNextCasBatchRequest – takes two arguments, an integer that specifies the maximum number of  
1253 CASes to return and an integer which specifies the maximum number of milliseconds to wait  
1254 • getNextCasBatchResponse – returns an object with three fields: a list of zero or more CASes, a  
1255 Boolean indicating whether any CASes remain to be retrieved, and an integer indicating the estimated  
1256 number of remaining CASes (-1 if not known).  
1257  
1258 For Flow Controllers:  
1259 • addAvailableAnalyticsRequest – takes one argument, a Map from String keys to PE Metadata objects.  
1260 • addAvailableAnalyticsResponse – returns nothing  
1261 • removeAvailableAnalyticsRequest – takes one argument, a collection of one or more String keys  
1262 • removeAvailableAnalyticsResponse – returns nothing  
1263 • setAggregateMetadataRequest – takes one argument – a ProcessingElementMetadata  
1264 • setAggregateMetadataResponse – returns nothing  
1265 • getNextDestinationsRequest – takes one argument, a CAS  
1266 • getNextDestionsResponse – returns a Step object  
1267 • continueOnFailureRequest – takes three arguments, a CAS, a String key, and a UimaException  
1268 • continueOnFailureResponse – returns a Boolean  
1269

### 4.7.1.3 Port Types and Operations

1270 A *port type* is a collection of *operations*, where each operation is an action that can be performed by the  
1271 service. We define a separate port type for each of the three interfaces defined in Section 4.4 Abstract  
1272 Interfaces.  
1273

1274  
1275 The port types and their operations defined by the UIMA WSDL definition are as follows. Each operation  
1276 refers to its input and output message, defined in the previous section. Operations also have fault  
1277 messages, returned in the case of an error.

1278

1279 • **Analyzer Port Type**

1280 • getMetadata

1281 • setConfigurationParameters

1282 • processCas

1283 • processCasBatch

1284

1285 • **CasMultiplier Port Type**

1286 • getMetadata

1287 • setConfigurationParameters

1288 • inputCas

1289 • getNextCas

1290 • retrieveInputCas

1291 • getNextCasBatch

1292

1293 **FlowController Port Type**

1294 • getMetadata

1295 • setConfigurationParameters

1296 • addAvailableAnalytics

1297 • removeAvailableAnalytics

1298 • setAggregateMetadata

1299 • getNextDestinations

1300 • continueOnFailure

1301 

#### 4.7.1.4 SOAP Bindings

1302 For each port type, we define a binding to the SOAP protocol. There are a few configuration choices to  
1303 be made:

1304

1305 In <wsdlsoap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>:

1306 • The style attribute defines that our operation is an RPC, meaning that our XML messages contain  
1307 parameters and return values. The alternative is "document" style, which is used for services that  
1308 logically send and receive XML documents without a parameter structure. This has an effect on  
1309 how the body of the SOAP message is constructed.

1310 • The transport operation defines that this binding uses the HTTP protocol (the SOAP spec allows  
1311 other protocols, such as FTP or SMTP, but HTTP is by far the most common)

1312 For each parameter (message part) in each abstract operation, we have a <wsdlsoap:body use="literal"/>  
1313 element:

1314 • The use of the <wsdlsoap:body> tag indicates that this parameter is sent in the body of the SOAP  
1315 message. Alternatively we could use <wsdlsoap:header> to choose to send parameters in the  
1316 SOAP header. This is an arbitrary choice, but a good rule of thumb is that the data being  
1317 processed by the service should be sent in the body, and "control information" (i.e., *how* the  
1318 message should be processed) can be sent in the header.

1319 • The use="literal" attribute states that the content of the message must *exactly* conform to the  
1320 XML Schema defined earlier in the WSDL definitions. The other option is "encoded", which treats  
1321 the XML Schema as an abstract type definition and applies SOAP encoding rules to determine  
1322 the exact XML syntax of the messages. The "encoded" style makes more sense if you are  
1323 starting from an abstract object model and you want to let the SOAP rules determine your XML  
1324 syntax. In our case, we already know what XML syntax we want (e.g., XMI), so the "literal" style  
1325 is more appropriate.

1326

1327 **4.7.2 Delta Responses**

1328 If an Analytic makes only a small number of changes to its input CAS, it will be more efficient if the service  
1329 response specifies the “deltas” rather than repeating the entire CAS. UIMA supports this by using the  
1330 XMI standard way to specify differences between object graphs [XMI1]. An example of such a delta  
1331 response is given in the next section.

1332 **4.7.3 Service WSDL Formal Specification**

1333 A *UIMA SOAP Service* MUST conform to the WSDL document given in Section C.7 and MUST  
1334 implement at least one of the portTypes and corresponding SOAP bindings defined in that WSDL  
1335 document, as defined in [WSDL1] and [SOAP1].

1336

1337 A *UIMA Analyzer SOAP Service* MUST implement the Analyzer portType and the AnalyzerSoapBinding.

1338

1339 A *UIMA CAS Multiplier SOAP Service* MUST implement the CasMultiplier portType and the  
1340 CasMultiplierSoapBinding.

---

1341

## 5 Conformance

- 1342 An XML document is conforming UIMA CAS XML if it satisfies the conditions defined in Section 4.1.4  
1343 CAS Formal Specification.
- 1344
- 1345 An XML document is conforming UIMA Type System XML if it satisfies the conditions defined in Section  
1346 4.2.2 Type System Model Formal Specification.
- 1347
- 1348 An XML document is conforming UIMA Behavioral Metadata XML if it satisfies the conditions defined in  
1349 Section 4.5.4 Behavioral Metadata Formal Specification.
- 1350
- 1351 An XML document is conforming UIMA Processing Element Metadata XML if it satisfies the conditions  
1352 defined in Section 4.6.2 Processing Element Metadata Formal Specification.
- 1353
- 1354 An implementation SHOULD use the Base Type System as defined in Section 4.3.5 Base Type System  
1355 Formal Specification.
- 1356
- 1357 An implementation is a conforming UIMA Processing Element (PE) Service if it satisfies the conditions  
1358 defined in Section 4.4.2 Abstract Interfaces Formal Specification.
- 1359
- 1360 An implementation is a conforming UIMA SOAP Service if it satisfied the conditions defined in Section  
1361 4.7.3 Service WSDL Formal Specification.
- 1362
- 1363 An implementation shall be a UIMA Processing Element (PE) Service or a UIMA SOAP Service.

---

1364

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1389  
1390

---

## 1391 **B. Examples (Not Normative)**

### 1392 **B.1 XMI CAS Example**

1393 This section describes how the CAS is represented in XMI, by way of an example. This is not normative.  
1394 The exact specification for XMI is defined by the OMG XMI standard [XMI1].

#### 1395 **B.1.1 XMI Tag**

1396 The outermost tag is typically <xmi:XMI> (this is just a convention; the XMI spec allows this tag to be  
1397 arbitrary). The outermost tag must, however, include an XMI version number and XML namespace  
1398 attribute:

1399  
1400   <xmi:XMI xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI">  
1401     <!-- CAS Contents here -->  
1402   </xmi:XMI>

1403  
1404 XML namespaces [XML1] are used throughout. The xmi namespace prefix is typically used to identify  
1405 elements and attributes that are defined by the XMI specification.

1406  
1407 The XMI document will also define one namespace prefix for each CAS namespace, as described in the  
1408 next section.

#### 1410 **B.1.2 Objects**

1411 Each *Object* in the CAS is represented as an XML element. The name of the element is the name of the  
1412 object's *class*. The XML namespace of the element identifies the *package* that contains that *class*.

1413  
1414 For example consider the following XMI document:

1415   <xmi:XMI xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"  
1416     xmlns:myorg="http://org/myorg.ecore">  
1417       ...  
1418       <myorg:Person xmi:id="1"/>  
1419       ...  
1420   </xmi:XMI>

1421  
1422 This XMI document contains an object whose class is named Person. The Person class is in the  
1423 package with URI http://org/myorg.ecore. Note that the use of the http scheme is a common convention,  
1424 and does not imply any HTTP communication. The .ecore suffix is due to the fact that the recommended  
1425 type system definition for a package is an ECore model.

1426  
1427 Note that the order in which Objects are listed in the XMI is not important, and components that process  
1428 XMI are not required to maintain this order.

1430 The xmi:id attribute can be used to refer to an object from elsewhere in the XMI document. It is not  
1431 required if the object is never referenced. If an xmi:id is provided, it must be unique among all xmi:ids on  
1432 all objects in this CAS.

1433

1434 All namespace prefixes (e.g., myorg) in this example must be bound to URIs using the  
1435 "xmlns..." attribute, as defined by the XML namespaces specification [XMLS1].

1436

### 1437 **B.1.3 Attributes (Primitive Features)**

1438 *Attributes* (that is, *features* whose values are of primitive types, for example, strings, integers and other  
1439 numeric types – see Base Type System for details) can be mapped either to XML attributes or XML  
1440 elements.

1441

1442 For example, an *object* of *class Person*, with slots:

1443

```
1444 begin = 14
1445 end = 25
1446 name = "Fred Center"
```

1447

1448 could be mapped to the attribute serialization as follows:

1449

```
1450 <xmi:XMI xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"
1451   xmlns:myorg="http://org/myorg.ecore">
1452 ...
1453   <myorg:Person xmi:id="1" begin="14" end="25" name="Fred Center"/>
1454 ...
1455 </xmi:XMI>
```

1456

1457 or alternatively to an element serialization as follows:

1458

```
1459 <xmi:XMI xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"
1460   xmlns:myorg="http://org/myorg.ecore">
1461 ...
1462   <myorg:Person xmi:id="1">
1463     <begin>14</begin>
1464     <end>25</end>
1465     <name>Fred Center</name>
1466   </myorg:Person>
1467 ...
1468 </xmi:XMI>
```

1469

1470 UIMA framework components that process XMI are required to support both. Mixing the two styles is  
1471 allowed; some *features* can be represented as attributes and others as elements.

## 1472 B.1.4 References (Object-Valued Features)

1473 Features that are references to other *objects* are serialized as ID references.

1474

1475 If we add to the previous CAS example an Object of Class Organization, with *feature* myCEO that is a  
1476 reference to the Person object, the serialization would be:

1477

```
<xmi:XMI xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI"
  xmlns:myorg="http://org/myorg.ecore">
  ...
  <myorg:Person xmi:id="1" begin="14" end="25" name="Fred Center"/>
  <myorg:Organization xmi:id="2" myCEO="1"/>
  ...
</xmi:XMI>
```

1485

1486 As with primitive-valued *features*, it is permitted to use an element rather than an attribute, and UIMA  
1487 framework components that process XMI are required to support both representations. However, the XMI  
1488 spec defines a slightly different syntax for this as is illustrated in this example:

1489

```
<myorg:Organization xmi:id="2">
  <myCEO href="#1"/>
<myorg.Organization>
```

1493

1494 Note that in the attribute representation, a reference *feature* is indistinguishable from an integer-valued  
1495 *feature*, so the meaning cannot be determined without prior knowledge of the type system. The element  
1496 representation is unambiguous.

## 1497 B.1.5 Multi-valued Features

1498 Features may have multiple values. Consider the example where the *object* of *class* Baz has a *feature*  
1499 myIntArray whose value is {2,4,6}. This can be mapped to:

1500

```
<myorg:Baz xmi:id="3" myIntArray="2 4 6"/>
```

1502

1503 or:

1504

```
<myorg:Baz xmi:id="3">
  <myIntArray>2</myIntArray>
  <myIntArray>4</myIntArray>
  <myIntArray>6</myIntArray>
</myorg:Baz>
```

1510

1511 Note that string arrays whose elements contain embedded spaces must use the latter mapping.

1512

1513 Multi-valued *references* serialized in a similar way. For example a *reference* that refers to the elements  
1514 with xmi:ids "13" and "42" could be serialized as:

```

1515
1516     <myorg:Baz xmi:id="3" myRefFeature="13 42"/>
1517
1518 or:
1519
1520     <myorg:Baz xmi:id="3">
1521         <myRefFeature href="#13"/>
1522         <myRefFeature href="#42"/>
1523     </myorg:Baz>
1524
1525 Note that the order in which the elements of a multi-valued feature are listed is meaningful, and
1526 components that process XMI documents must maintain this order.
1527

1528 B.1.6 Linking an XMI Document to its Ecore Type System
1529 The structure of a CAS is defined by a UIMA type system, which is represented by an Ecore model (see
1530 Section 4.2).
1531
1532 If the CAS Type System has been saved to an Ecore file, it is possible to store a link from an XMI
1533 document to that Ecore type system. This is done using an xsi:schemaLocation attribute on the root XMI
1534 element.
1535
1536 The xsi:schemaLocation attribute is a space-separated list that represents a mapping from the
1537 namespace URI (e.g., http://org/myorg.ecore) to the physical URI of the .ecore file containing the type
1538 system for that namespace. For example:
1539
1540 xsi:schemaLocation="http://org/myorg.ecore file:/c:/typesystems/myorg.ecore"
1541
1542 would indicate that the definition for the org.myorg CAS types is contained in the file
1543 c:/typesystems/myorg.ecore. You can specify a different mapping for each of your CAS namespaces. For
1544 details see [EMF2].
1545 B.1.7 XMI Extensions
1546 XMI defines an extension mechanism that can be used to record information that you may not want to
1547 include in your type system. This can be used for system-level data that is not part of your domain
1548 model, for example. The syntax is:
1549
1550     <xmi:Extension extenderId="NAME">
1551         <!-- arbitrary content can go inside the Extension element -->
1552     </xmi:Extension>
1553
1554 The extenderId attribute allows a particular "extender" (e.g., a UIMA framework implementation) to record
1555 metadata that's relevant only within that framework, without confusing other frameworks that my want to
1556 process the same CAS.
1557

```

1558 **B.2 Ecore Example**

1559 **B.2.1 An Introduction to Ecore**

1560 Ecore is well described by Budisnyk et al. in the book *Eclipse Modeling Framework* [EMF2]. Some brief  
1561 introduction to Ecore can be found in a chapter of that book available online [EMF3]. As a convenience to  
1562 the reader we include an excerpt from that chapter:

### Excerpt from Budinsky et al. *Eclipse Modeling Framework*

Ecore is a metamodel - a model for defining other models. Ecore uses very similar terminology to UML, but it is a small and simplified subset of full UML.

The following diagram illustrates the "Ecore Kernel", a simplified subset of the Ecore model.

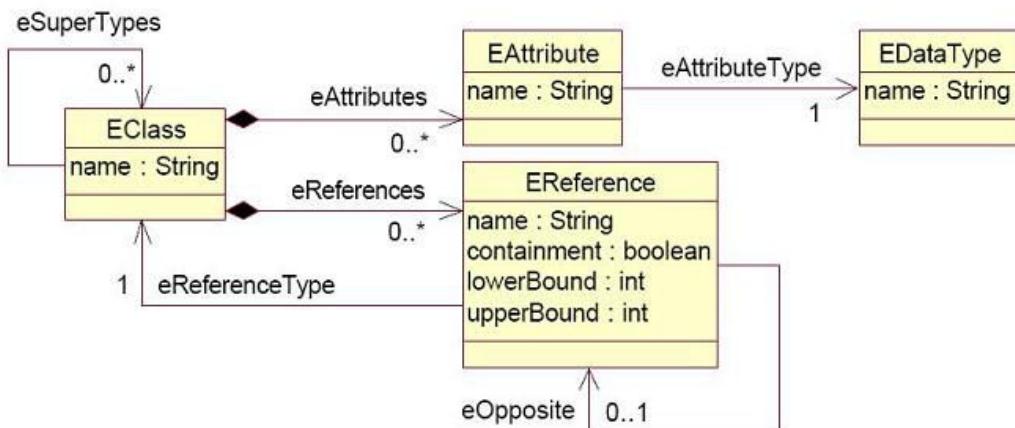


Figure 11: The Ecore Kernel

This model defines four types of objects, that is, four classes:

- **EClass** models classes themselves. Classes are identified by name and can contain a number of attributes and references. To support inheritance, a class can refer to a number of other classes as its supertypes.
- **EAttribute** models attributes, the components of an object's data. They are identified by name, and they have a type.
- **EDataType** models the types of attributes, representing primitive and object data types that are defined in Java, but not in EMF. Data types are also identified by name.
- **EReference** is used in modeling associations between classes; it models one end of the association. Like attributes, references are identified by name and have a type. However, this type must be the EClass at the other end of the association. If the association is navigable in the opposite direction, there will be another corresponding reference. A reference specifies lower and upper bounds on its multiplicity. Finally, a reference can be used to represent a stronger type of association, called containment; the reference specifies whether to enforce containment semantics.

1563  
1564

## 1565 B.2.2 Differences between Ecore and EMOF

1566 The primary differences between Ecore and EMOF are:

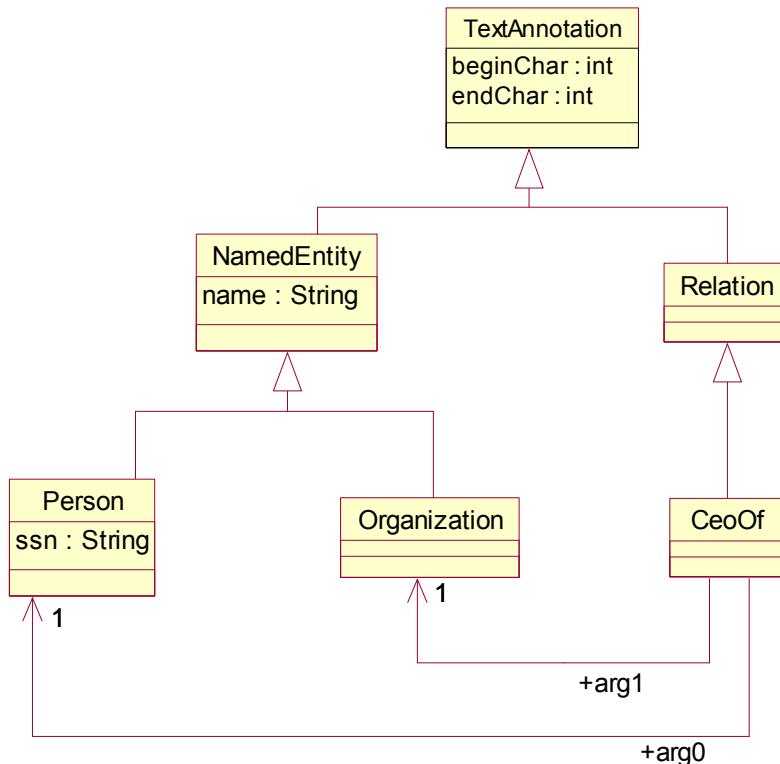
- 1567     • EMOF does not use the 'E' prefix for its metamodel elements. For example EMOF uses the terms  
 1568        *Class* and *Data Type* rather than Ecore's *EClass* and *EDataType*.  
 1569     • EMOF uses a single concept *Property* that subsumes both *EAttribute* and *EReference*.

1571 For a detailed mapping of Ecore terms to EMOF terms see [EcoreEMOF1].

### 1572 **B.2.3 Example Ecore Model**

1573 Figure 12 shows a simple example of an object model in UML. This model describes two types of Named  
 1574 Entities: Person and Organization. They may participate in a CeoOf relation (i.e., a Person is the CEO of  
 1575 an Organization). The NamedEntity and Relation types are subtypes of TextAnnotation (a standard UIMA  
 1576 base type, see 4.3), so they will inherit beginChar and endChar features that specify their location within a  
 1577 text document.

1578



1579  
 1580 **Figure 12: Example UML Model**

1581  
 1582 XMI [XMI1] is an XML format for representing object graphs. EMF tools may be used to automatically  
 1583 convert this to an Ecore model and generate an XML rendering of the model using XMI:

```

1584
1585 <?xml version="1.0" encoding="UTF-8"?>
1586 <ecore:EPackage xmi:version="2.0"
1587   xmlns:xmi="http://www.omg.org/XMI"
1588   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
1589   xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
1590   name="org" nsURI="http://org.ecore" nsPrefix="org">
  
```

```

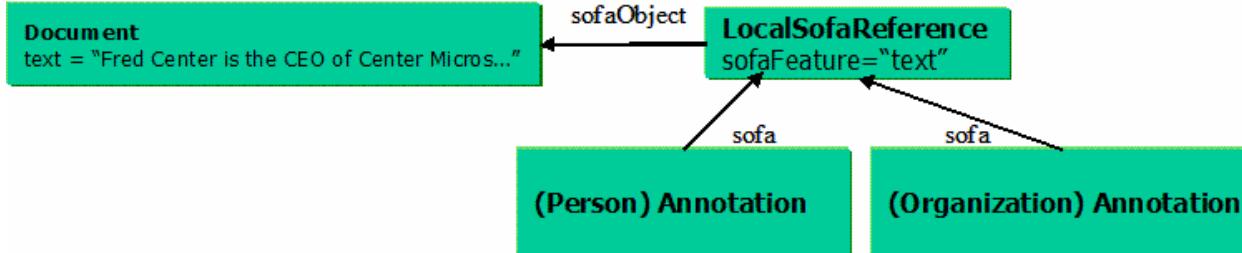
1591     <eSubpackages name="example" nsURI="http://org/example.ecore"
1592     nsPrefix="org.example">
1593         <eClassifiers xsi:type="ecore:EClass" name="NamedEntity"
1594         eSuperTypes="ecore:EClass http://docs.oasis-
1595         open.org/uima/ns/uima.ecore#/base/TextAnnotation">
1596             <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
1597             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EString"/>
1598         </eClassifiers>
1599         <eClassifiers xsi:type="ecore:EClass" name="Relation"
1600         eSuperTypes="ecore:EClass http://docs.oasis-
1601         open.org/uima/ns/uima.ecore#/base/TextAnnotation"/>
1602             <eClassifiers xsi:type="ecore:EClass" name="Person"
1603             eSuperTypes="#//example/NamedEntity">
1604                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="ssn"
1605                 eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EString"/>
1606             </eClassifiers>
1607             <eClassifiers xsi:type="ecore:EClass" name="CeoOf"
1608             eSuperTypes="#//example/Relation">
1609                 <eStructuralFeatures xsi:type="ecore:EReference" name="arg0"
1610                 lowerBound="1"
1611                     eType="#//example/Person"/>
1612                     <eStructuralFeatures xsi:type="ecore:EReference" name="arg1"
1613                 lowerBound="1"
1614                     eType="#//example/Organization"/>
1615             </eClassifiers>
1616             <eClassifiers xsi:type="ecore:EClass" name="TextDocument">
1617                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="text"
1618                 eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EString"/>
1619             </eClassifiers>
1620             <eClassifiers xsi:type="ecore:EClass" name="Organization"
1621             eSuperTypes="#//example/NamedEntity"/>
1622         </eSubpackages>
1623     </ecore:EPackage>
1624
1625 This XMI document is a valid representation of a UIMA Type System.
1626

```

## 1627 B.3 Base Type System Examples

### 1628 B.3.1 Sofa Reference

1629 Figure 13 illustrates an example of an annotation referring to its subject of analysis (Sofa).



1630  
1631

**Figure 13: Annotation and Subject of Analysis**

1632 The CAS contains an *object* of class Document with a *slot* text containing the string value, “Fred Center is  
1633 the CEO of Center Micros.”

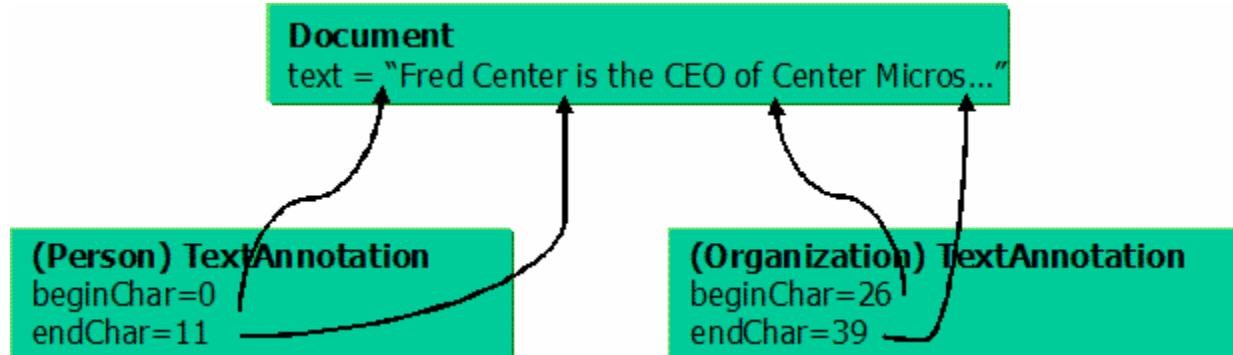
1634

1635 Two annotations, a Person annotation and an Organization annotation, refer to that string value. The  
1636 method of indicating a subrange of characters within the text string is shown in the next example. For  
1637 now, note that the LocalSofaReference object is used to indicate which object, and *which field (slot)*  
1638 *within that object*, serves as the Subject of Analysis (Sofa).

1639

### 1640 **B.3.2 References to Regions of Sofas**

1641 Figure 14 extends the previous example by showing how the `TextAnnotation` subtype of `Annotation` is  
1642 used to specify a range of character offsets to which the annotation applies.



1643

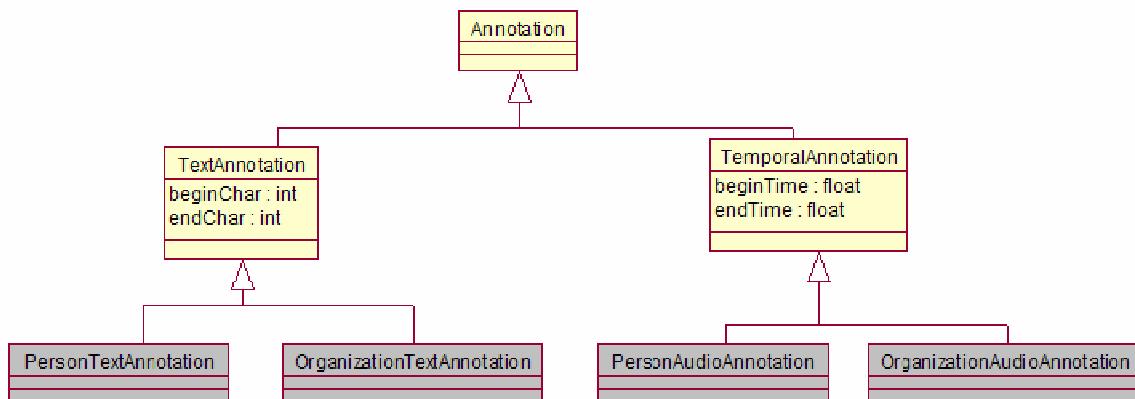
1644 **Figure 14: References from Annotations to Regions of the Sofa**

### 1645 **B.3.3 Options for Extending Annotation Type System**

1646 The standard types in the UIMA Base Type system are very high level. Users will likely wish to extend  
1647 these base types, for instance to capture the semantics of specific kinds of annotations. There are two  
1648 options for implementing these extensions. The choice of the extension model for the annotation type  
1649 system is up to the user and depends on application-specific needs or preferences.

1650

1651 The first option is to subclass the Annotation types, as in Figure 15. In this model, the `Annotation` subtype  
1652 for each modality will be independently subclassed according to the annotation types found in that  
1653 modality. One advantage of this approach is that all subtype classes remain subtypes of `Annotation`.  
1654 However, a disadvantage is that types that are annotations of the same semantic class, but for different  
1655 modalities, are not grouped together in the type system. We see in the figure that an annotation of a  
1656 reference to a Person or an Organization would have a distinct type depending on the nature of the Sofa  
1657 the reference occurred in.

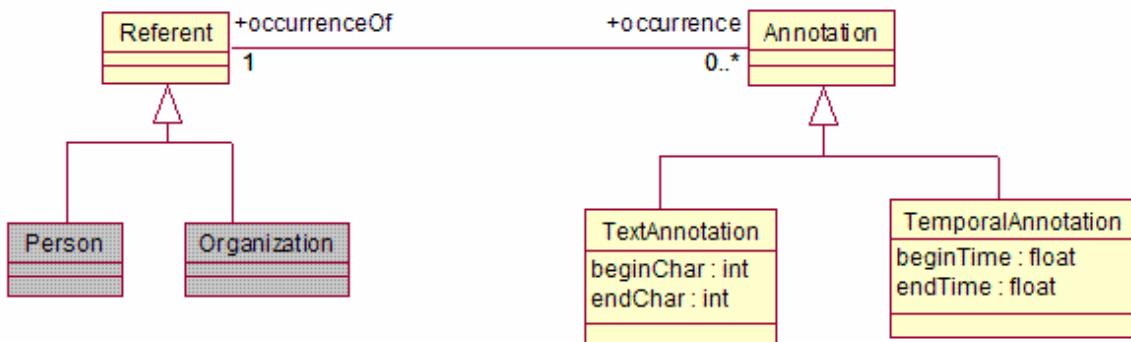


1658

1659 **Figure 15: Extending the base type system through subclassing.**

1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671

The second option, shown in Figure 16, is to create subtypes of Referent that subsumes the relevant semantic classes, and associate the Annotation with the appropriate Referent type. In this model, an Annotation is viewed as a reference to a Referent in a particular modality. The advantage of this approach is that all annotations corresponding to a particular Referent type (e.g. Person or Organization), regardless of the modality they are expressed in, will have the same occurrence value and can thus be easily grouped together. It does, however, push the semantic information about the annotation into an associated type that needs to be investigated rather than being immediately available in the type of the Annotation object. In other words, it introduces a level of indirection for accessing the semantic information about the Annotation. However, an additional advantage of this approach is that it allows for multiple Annotations to be associated with a single Referent, so that for instance multiple distinct references to a person in a text can be linked to a single Referent object representing that person.



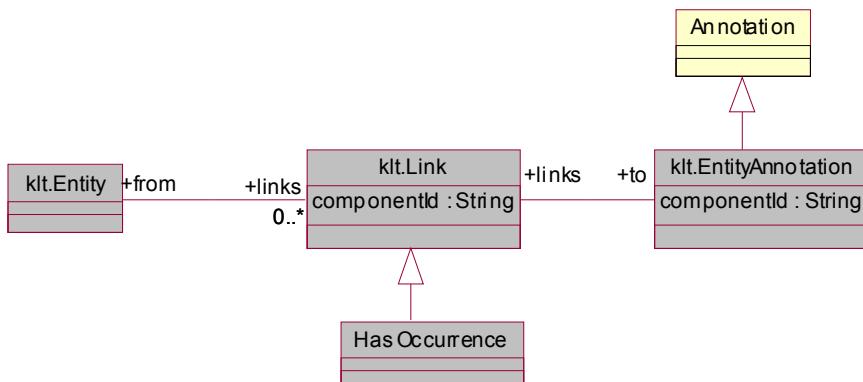
1672

Figure 16: Associate Annotation with Referent type

1674

### B.3.4 An Example of Annotation Model Extension

1676 The Base Type System is intended to specify only the top-level classes for the Annotation system used in  
1677 an application. Users will need to extend these classes in order to meet the particular needs of their  
1678 applications. An example of how an application might extend the base type system comes from  
1679 examining the redesign of IBM's Knowledge Level Types [KLT1] in terms of the standard. The current  
1680 model in KLT appears in Figure 17. It uses the Annotation class, but subclasses it with its own  
1681 EntityAnnotation, models coreference with a reified HasOccurrence link, and captures provenance  
1682 through a *componentId* attribute.



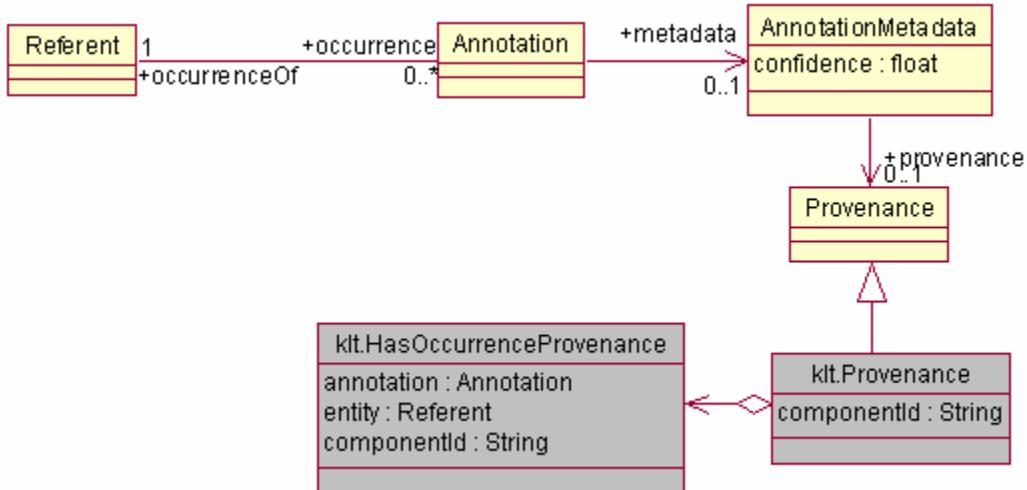
1683

Figure 17: IBM's Knowledge Level Types

1685

1686 Using the standard base type system, this type system could be refactored as in Figure 18. This  
1687 refactoring uses the standard definitions of **Annotation** and **Referent**. The **klt.Link** type, which was

1688 used to represent a HasOccurrence link between Entity and Annotation, is replaced by the direct  
 1689 occurrence/occurrenceOf features in the standard base type system. Provenance on the occurrence link  
 1690 is captured using a subclass of the Provenance type.

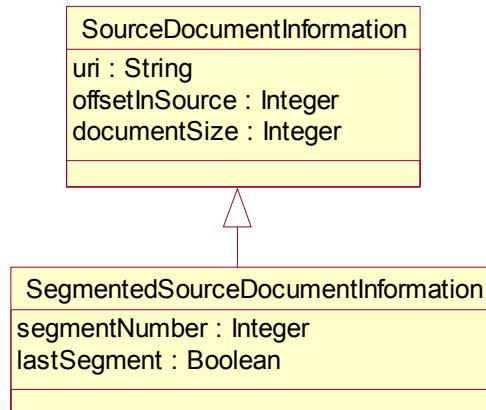


1691  
 1692  
 1693

**Figure 18: Refactoring of KLT using the standard base type system.**

### B.3.5 Example Extension of Source Document Information

1695 If an application needs to process multiple segments of an artifact and later merger the results, then  
 1696 additional offset information may also be needed on each segment. While not a standard part of the  
 1697 specification, a representative extension to the `SourceDocumentInformation` type to capture such  
 1698 information is shown in Figure 19. This `SegmentedSourceDocumentInformation` type adds features  
 1699 to track information about the segment of the source document the CAS corresponds to. Specifically, it  
 1700 adds an `Integer segmentNumber` to capture the segment number of this segment, and a `Boolean`  
 1701 `lastSegment` that is true when this segment is the last segment derived from the source document.



1702  
 1703  
 1704

**Figure 19: Segmented Source Document Information UML**

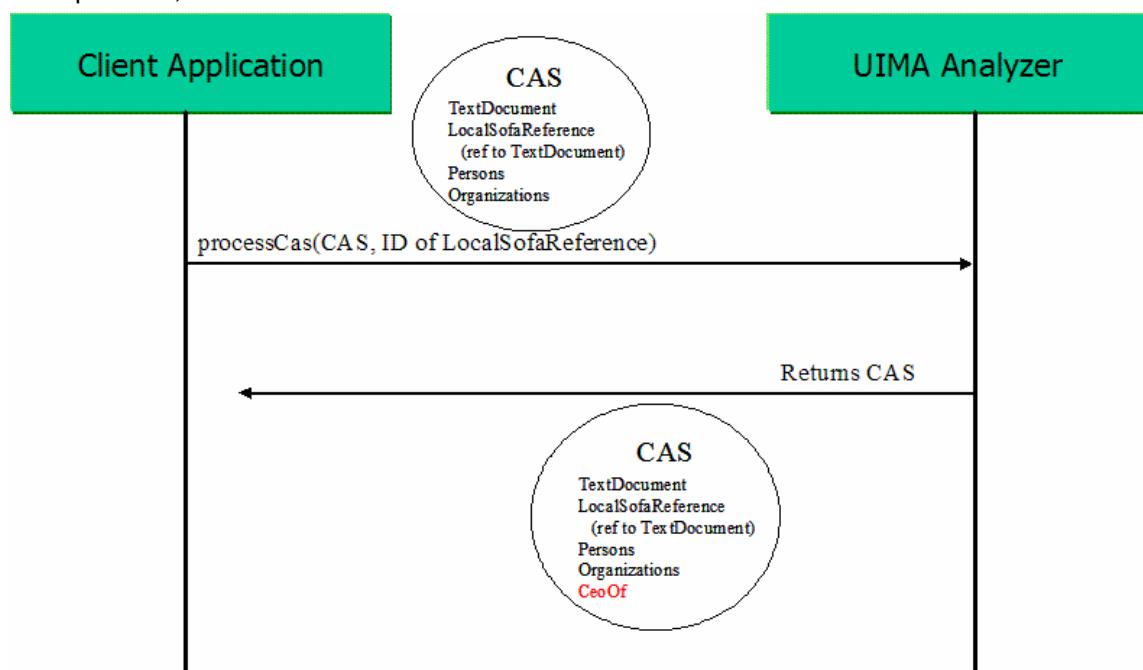
## 1705 B.4 Abstract Interfaces Examples

### 1706 B.4.1 Analyzer Example

1707 The sequence diagram in Figure 20 illustrates how a client interacts with a UIMA Analyzer service. In this  
1708 example the Analyzer is a "CEO Relation Detector," which given a text document with Person and  
1709 Organization annotations, can find occurrences of CeoOf relationships between them.

1710  
1711 The example shows that the client calls the `processCas(cas, sofas)` operation. The first argument is  
1712 the CAS to be processed (in XMI format). It contains a `TextDocument`, a `LocalSofaReference` (see  
1713 Section 4.3.2.1) that points to a text field in that `TextDocument`, and `Person` and `Organization` annotations  
1714 that annotate regions in the `TextDocument`. The second argument is the `xmi:id` of the  
1715 `LocalSofaReference` object, indicating that this object should be considered the subject of analysis (Sofa)  
1716 for this operation.

1717  
1718 The response from the `processCas` operation is a CAS (in XMI format), which in addition to the objects in  
1719 the input CAS, also contains `CeoOf` annotations.



1720  
1721 Figure 20: Analyzer Sequence Diagram

### 1722 B.4.2 CAS Multiplier Example

1723 The sequence diagram in Figure 21 illustrates how a client interacts with a UIMA CAS Multiplier service.  
1724 In this case the CAS Multiplier is a Video Segmente, which given a video stream divides it into individual  
1725 segments.

1726  
1727 The client first calls the `inputCas(cas, sofas)` operation. The first argument is a CAS containing a  
1728 reference to the video stream to analyze. Typically a large artifact such as a video stream is represented  
1729 in the CAS as a reference (using the `RemoteSofaReference` base type introduced in section 4.3.2.1),  
1730 rather than included directly in the CAS as is typically done with a text document. The second argument  
1731 to `inputCas` is the `xmi:id` of the `RemoteSofaReference` object, so that the service knows that this is the  
1732 subject of analysis for this operation.

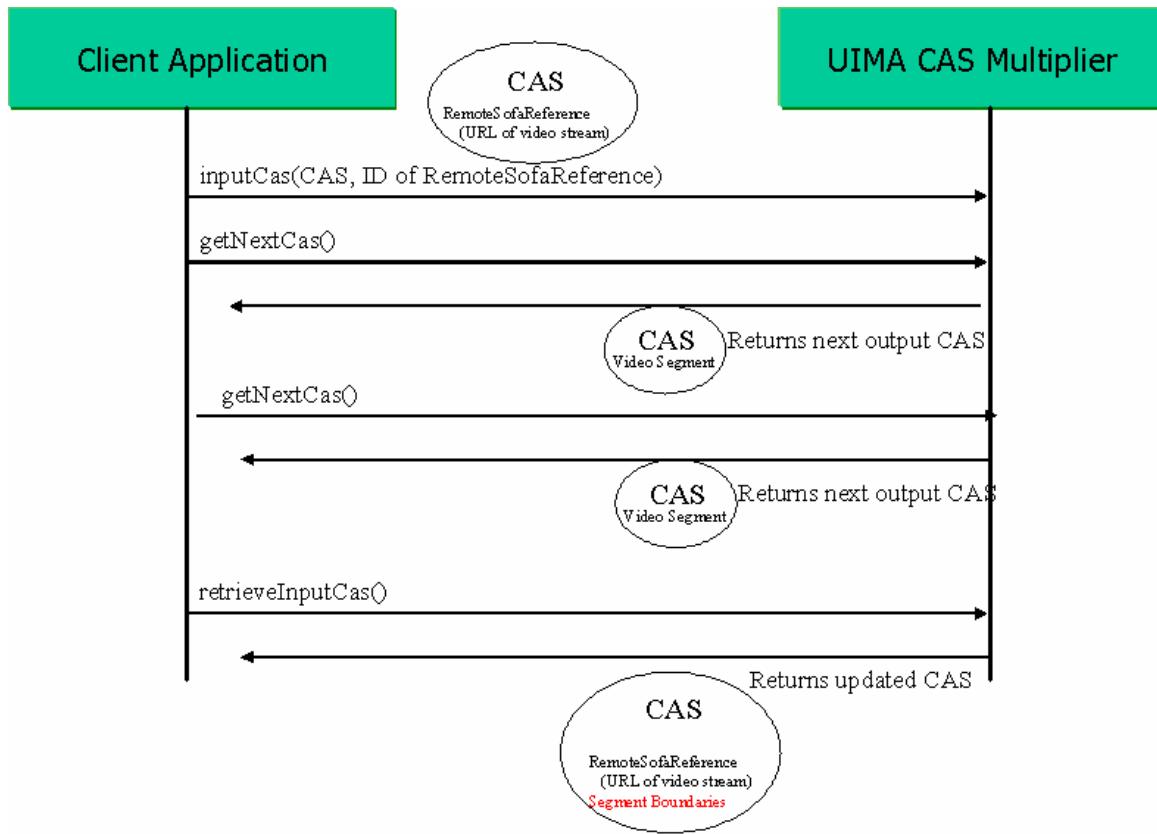
1733

1734 The client then calls the `getNextCas` operation. This returns a CAS containing the data for the first  
1735 segment (or possibly, a reference to it). The client repeatedly calls `getNextCas` to obtain each  
1736 successive segment. Eventually, `getNextCas` returns null to indicate there are no more segments.

1737

1738 Finally, the client calls the `retrieveInputCas` operation. This returns the original CAS, with additional  
1739 information added. In this example, the Video Segmenter adds information to the original CAS indicating  
1740 at what time offsets each of the segment boundaries were detected. Any other information from the  
1741 individual segment CASes could also be merged back into the original CAS.

1742



1743

1744 **Figure 21: CAS Multiplier Sequence Diagram**

1745

1746 Note that a CAS Multiplier may also be used to merge multiple input CASes into one output CAS. Upon  
1747 receiving the first `inputCas` call, the CAS Multiplier would return 0 output CASes and would wait for the  
1748 next `inputCas` call. It would continue to return 0 output CASes until it has seen some number of input  
1749 CASes, at which point it would then output the one merged CAS.

## 1750 **B.5 Behavioral Metadata Examples**

1751 For each of the Behavioral Metadata Elements (analyzes, required inputs, optional inputs, creates,  
1752 modifies, and deletes), there will be a corresponding XML element. For each element a list of type  
1753 names is declared.

1754

1755 To address some common situations where an analytic operates on a *view* (a collection of objects all  
1756 referring to the same subject of analysis), we also provide a simple way for behavioral metadata to refer  
1757 to views.

## 1758 B.5.1 Type Naming Conventions

1759 In the XML behavioral metadata, type names are represented in the same way as in Ecore and XMI.

1760

1761 In UML (and Ecore), a *Package* is a collection of classes and/or other packages. All classes must be  
1762 contained in a package.

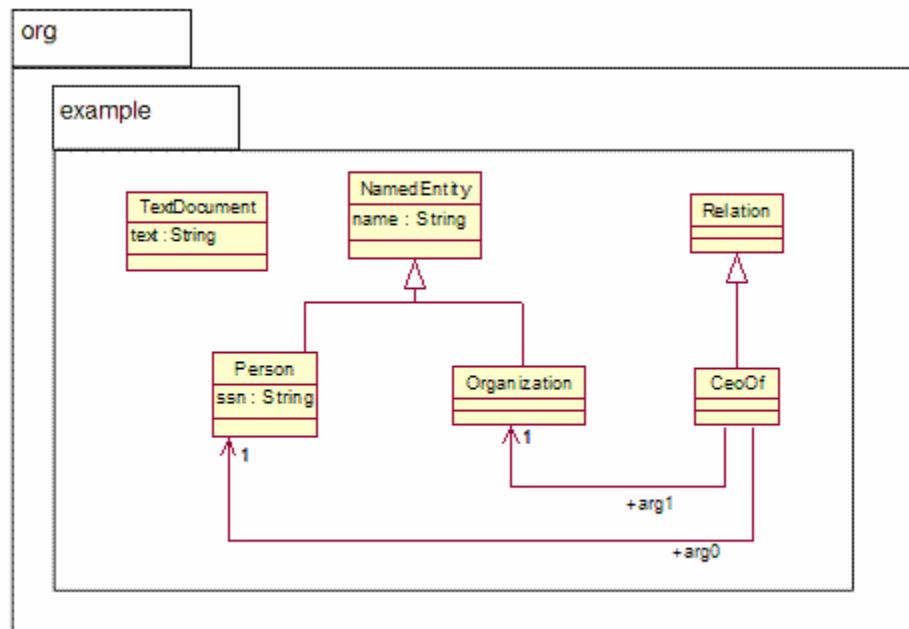
1763

1764 Figure 1 is a UML diagram of an example type system. It depicts a Package “org” containing a Package  
1765 “example” containing several classes.

1766

1767

1768



1769

1770 **Figure 22: Example Type System UML Model**

1771

1772 In the Ecore model, each package is assigned (by the developer) three identifiers: a *name*, a *namespace URI*, and a *namespace prefix*. The *name* is a simple string that must be unique within the containing  
1773 package (top-level package names must be globally unique). The namespace URI and namespace prefix  
1774 are standard concepts in the XML namespaces spec [2] are used to refer to that package in XML,  
1775 including the behavioral metadata as well as the XMI CAS. An example is given below.

1776

1777 Figure 23 shows the relevant parts of the Ecore definition for this type system. Some details have been  
1778 omitted (marked with an ellipsis) to show only the parts where packages and namespaces are concerned,  
1779 and only a subset of the classes in the diagram are shown.

1781

```

<ecore:EPackage ... name="org"
    nsURI="http://docs.oasis-open.org/uima/org.ecore"
    nsPrefix="org">

    <eSubpackages name="example" nsURI="http://docs.oasis-
open.org/uima/org/example.ecore"
        nsPrefix="org.example">
        <eClassifiers xsi:type="ecore:EClass" name="NamedEntity">
            ...
        </eClassifiers>
        <eClassifiers xsi:type="ecore:EClass" name="Person"
            eSuperTypes="#//example/NamedEntity"/>

```

1782

1783

**Figure 23: Partial Ecore Representation of Example Type System**

1784

1785 In this example, the namespace URI for the nested “example” project is <http://docs.oasis-open.org/uima/org/example.ecore><sup>1</sup>, and the corresponding prefix is `org.example`. It is  
1786 important to note that the URI and prefix are arbitrarily determined by the type system developer and  
1787 there is no required mapping from the package names “org” and “example” to the URI and prefix. In the  
1788 above example, the namespace prefix could have been set to “foo” and it would be completely valid.

1790

1791 Now, to refer to a type name within the behavioral metadata XML, we use the namespace URI and prefix  
1792 in the normal XML namespaces way, for example:

1793

```

1794 <behavioralMetadata xmlns:org.example="http://docs.oasis-
1795 open.org/uima/org/example.ecore">
1796     ...
1797     <type name="org.example:Person"/>
1798     ...
1799 </behavioralMetadata>

```

1800

1801 The “`xmlns`” attribute declares that the prefix “`org.example`” is bound to the URI <http://docs.oasis-open.org/uima/org/example.ecore>. Then, each time we want to refer to a type in that package, we use  
1802 the prefix “`org.example`.”

1804

<sup>1</sup> The use of the “`http`” scheme is a common XML namespace convention and does not imply that any actual http communication is occurring.

1805 Technically, the XML document does not have to use the same namespace prefix as what is in the Ecore  
1806 model. It is only a guideline. The namespace URI is what matters. For example, the above XML is  
1807 completely equivalent to the following

1808  
1809 <behavioralMetadata xmlns:foo="http://docs.oasis-  
1810 open.org/uima/org/example.ecore">  
1811     ...  
1812     <type name="foo:Person"/>  
1813     ...  
1814 </behavioralMetadata>

1815

1816 This is because the namespace URI is a globally unique identifier for the package, but the namespace  
1817 prefix need only be unique within the current XML document. For more information on XML namespace  
1818 syntax, see [XML1].

1819

1820 The above discussion centered on the representation of type names in XML. When specifying  
1821 preconditions, postconditions, and projection conditions (see Section B.5.5), the Object Constraint  
1822 Language (OCL) [OCL1] may be used. There is a different representation of type names needed within  
1823 OCL expressions. Since OCL is not primarily XML-based, it does not use the XML namespace URLs or  
1824 prefixes to refer to packages. Instead, OCL expressions refer directly to the simple package names  
1825 separated by double colons, as in "org::example::Person". For more information see [OCL1].

## 1826 **B.5.2 XML Syntax for Behavioral Metadata Elements**

1827 The following example is the behavioral metadata for an analytic that analyzes a `Sofa` of type  
1828 `TextDocument`, requires objects of type `Person`, and will inspect objects of type `Organization` if they are  
1829 present. It may create objects of type `CeoOf`.

1830

```
1831 <behavioralMetadata xmlns:org.example="http://docs.oasis-  
1832 open.org/uima/org/example.ecore" excludeReferenceClosure="true">  
1833   <analyzes>  
1834     <type name="org.example:TextDocument"/>  
1835   </analyzes>  
1836   <requiredInputs>  
1837     <type name="org.example:Person"/>  
1838   </requiredInputs>  
1839   <optionalInputs>  
1840     <type name="org.example:Organization"/>  
1841   </optionalInputs>  
1842   <creates>  
1843     <type name="org.example:CeoOf"/>  
1844   </creates>  
1845 </behavioralMetadata>
```

1846

1847 Note that the inheritance hierarchy declared in the type system is respected. So for example a CAS  
1848 containing objects of type `GovernmentOfficial` and `Country` would be valid input to this analytic,  
1849 assuming that the type system declared these to be subtypes of `org.example:Person` and  
1850 `org.example:Place`, respectively.

1851  
1852 The `excludeReferenceClosure` attribute on the Behavioral Metadata element, when set to true,  
1853 indicates that objects that are referenced from optional/required inputs of this analytic will not be  
1854 guaranteed to be included in the CAS passed to the analytic. This attribute defaults to false.  
1855  
1856 For example, assume in this example the `Person` object had an employer feature of type `Company`. With  
1857 `excludeReferenceClosure` set to true, the caller of this analytic is not required to include `Company`  
1858 objects in the CAS that is delivered to this analytic. If `Company` objects are filtered then the employer  
1859 feature would become null. If `excludeReferenceClosure` were not set, then `Company` objects would be  
1860 guaranteed to be included in the CAS.

### 1861 **B.5.3 Views**

1862 Behavioral Metadata may refer to a View, where a View may collect all annotations referring to a  
1863 particular Sofa.

1864  
1865 

```
<behavioralMetadata xmlns:org.example="http://docs.oasis-
```

  
1866 

```
open.org/uima/org/example.ecore">
```

  
1867   <requiredView sofaType="org.example:TextDocument">  
1868     <requiredInputs>  
1869       <type name="org.example:Token"/>  
1870     </requiredInputs>  
1871     <creates>  
1872       <type name="org.example:Person"/>  
1873     </creates>  
1874   </requiredView>  
1875   <optionalView sofaType="org.example:RawAudio">  
1876     <requiredInputs>  
1877       <type name="org.example:SpeakerBoundary"/>  
1878     </requiredInputs>  
1879     <creates>  
1880       <type name="org.example:AudioPerson"/>  
1881     </creates>  
1882   </optionalView>  
1883 </behavioralMetadata>  
1884

1885 This example requires a `TextDocument` Sofa and optionally accepts a `RawAudio` Sofa. It has different  
1886 input and output types for the different Sofas.

1887  
1888 As with an optional input, an “optional view” is one that the analytic would consider if it were present in the  
1889 CAS. Views that do not satisfy the required view or optional view expressions might not be delivered to  
1890 the analytic.

1891  
1892 The meaning of an `optionalView` having a `requiredInput` is that a view not containing the required input  
1893 types is not considered to satisfy the `optionalView` expression and might not be delivered to the analytic.

1895 An analytic can also declare that it creates a View along with an associated Sofa and annotations. For  
 1896 example, this Analytic transcribes audio to text, and also outputs Person annotations over that text:  
 1897

```

1898 <behavioralMetadata xmlns:org.example="http://docs.oasis-
1899 open.org/uima/org/example.ecore">
1900   <requiredView sofaType="org.example:RawAudio">
1901     <requiredInputs>
1902       <type name="org.example:SpeakerBoundary"/>
1903     </requiredInputs>
1904   </requiredView>
1905   <createsView sofaType="org.example:TextDocument">
1906     <creates>
1907       <type name="org.example:Person"/>
1908     </creates>
1909   </createsView>
1910 </behavioralMetadata>
```

## 1911 **B.5.4 Specifying Which Features Are Modified**

1912 For the “modifies” predicate we allow an additional piece of information: the names of the features that  
 1913 may be modified. This is primarily to support discovery. For example:

```

1914
1915 <behavioralMetadata xmlns:org.example="http://docs.oasis-
1916 open.org/uima/org/example.ecore">
1917   <requiredInputs>
1918     <type name="org.example:Person"/>
1919   </requiredInputs>
1920   <modifies>
1921     <type name="org.example:Person">
1922       <feature name="ssn"/>
1923     </type>
1924   </modifies>
1925 </behavioralMetadata>
```

1926  
 1927 This Analytic inputs Person objects and updates their ssn features.  
 1928

## 1929 **B.5.5 Specifying Preconditions, Postconditions, and Projection Conditions**

1930 Although we expect it to be rare, analytic developers may declare preconditions, postconditions, and  
 1931 projection conditions directly. The syntax for this is straightforward:

```

1932
1933 <behavioralMetadata>
1934   <precondition language="OCL"
1935     expression="exists(s | s.oclKindOf(org::example::Sofa) and
1936     s.mimeMajor = 'audio')"/>
1937   <postcondition language="OCL"
```

```

1938         expr="exists(p | p.oclKindOf(org::example::Sofa) and s.mimeTypeMajor =
1939 'text')"/>
1940     <projectionCondition language="OCL"
1941         expr=" select(p | p.oclKindOf(org::example::NamedEntity))"/>
1942   </behavioralMetadata>
1943
1944 UIMA does not define what language must be used for expression these conditions. OCL is just one
1945 example.
1946
1947 Preconditions and postconditions are expressions that evaluate to a Boolean value. Projection conditions
1948 are expressions that evaluate to a collection of objects.
1949
1950 Behavioral Metadata can include these conditions as well as the other elements (analyzes,
1951 requiredInputs, etc.). In that case, the overall precondition and postcondition of the analytic are a
1952 combination of the user-specified conditions and the conditions derived from the other behavioral
1953 metadata elements as described in the next section. (For precondition and postcondition it is a
1954 conjunction; for projection condition it is a union.)
1955

```

## 1956 **B.6 Processing Element Metadata Example**

1957 The following XML fragment is an example of Processing Element Metadata for a “CeoOf Relation  
1958 Detector” analytic.

```

1959 <pemd:ProcessingElementMetadata xmi:version="2.0"
1960   xmlns:xmi="http://www.omg.org/XMI" xmlns:pemd="http://docs.oasis-
1961   open.org/uima/ns/peMetadata.ecore">
1962   <identification
1963     symbolicName="org.oasis-open.uima.example.CeoRelationAnnotator"
1964     name="Ceo Relation Annotator"
1965     description="Detects CeoOf relationships between Persons and
1966     Organizations in a text document."
1967     vendor="OASIS"
1968     version="1.0.0"/>
1969
1970   <configurationParameter
1971     name="PatternFile"
1972     description="Location of external file containing patterns that
1973     indicate a CeoOf relation in text."
1974     type="ResourceURL">
1975     <defaultValue>myResources/ceoPatterns.dat</defaultValue>
1976   </configurationParameter>
1977
1978   <typeSystem
1979     reference="http://docs.oasis-
1980     open.org/uima/types/exampleTypeSystem.ecore"/>
1981
1982   <behavioralMetadata>
1983     <analyzes>
1984       <type name="org.example:Document"/>
1985     </analyzes>
1986     <requiredInputs>
1987       <type name="org.example:Person"/>
1988       <type name="org.example:Organization"/>
1989     </requiredInputs>

```

```

1990     <creates>
1991         <type name="org.example:CeoOf"/>
1992     </creates>
1993 </behavioralMetadata>
1994
1995     <extension extenderId="org.apache.uima">
1996         ...
1997     </extension>
1998 </pemd:ProcessingElementMetadata>

```

## 1999 B.7 SOAP Service Example

2000 Returning to our example of the CEO Relation Detector analytic, this section gives examples of SOAP  
 2001 messages used to send a CAS to and from the analytic.

2002

2003 The processCas request message is shown here:

```

2004 <soapenv:Envelope...>
2005     <soapenv:Body>
2006         <processCas xmlns="">
2007             <cas xmi:version="2.0" ... >
2008                 <org.example:Document xmi:id="1"
2009                     text="Fred Center is the CEO of Center Micros."/>
2010                 <base:LocalSofaReference xmi:id="2" sofaObject="1"
2011                     sofaFeature="text"/>
2012                     <org.example:Person xmi:id="3" sofa="2" begin="0" end="11"/>
2013                     <org.example:Organization xmi:id="4" sofa="2" begin="26" end="39"/>
2014             </cas>
2015             <sofas objects="1"/>
2016         </processCas>
2017     </soapenv:Body>
2018 </soapenv:Envelope>

```

2019 This message is simply an XMI CAS wrapped in an appropriate SOAP envelope, indicating which  
 2020 operation is being invoked (processCas).

2021

2022 The processCas response message returned from the service is shown here:

2023

```

2024 <soapenv:Envelope...>
2025     <soapenv:Body>
2026         <processCas xmlns="">
2027             <cas xmi:version="2.0" ... >
2028                 <org.example:Document xmi:id="1"
2029                     text="Fred Center is the CEO of Center Micros."/>
2030                 <base:SofaReference xmi:id="2" sofaObject="1" sofaFeature="text"/>
2031                 <org.example:Person xmi:id="3" sofa="2" begin="0" end="11"/>
2032                 <org.example:Organization xmi:id="4" sofa="2" begin="26" end="39"/>
2033                 <org.example:CeoOf xmi:id="5" sofa="2" begin="0" end="31" arg0="3"
2034                 arg1="4"/>
2035             </cas>
2036         </processCas>
2037     </soapenv:Body>
2038 </soapenv:Envelope>

```

2039 Again this is just an XMI CAS wrapped in a SOAP envelope. Note that the "CeoOf" object has been  
 2040 added to the CAS.

2041

2042 Alternatively, the service could have responded with a “delta” using the XMI differences language. Here  
2043 is an example:

```
2044 <soapenv:Envelope...>
2045   <soapenv:Body>
2046     <processCas xmlns="">
2047       <cas xmi:version="2.0" ... >
2048         <xmi:Difference>
2049           <target href="input.xmi"/>
2050           <xmi:Add addition="5">
2051             </xmi:Difference>
2052             <org.example:CeoOf xmi:id="5" sofa="2" begin="0" end="31" arg0="3"
2053 arg1="4"/>
2054           </cas>
2055         </processCas>
2056       </soapenv:Body>
2057     </soapenv:Envelope>
```

2058

2059 Note that the `target` element is defined in the XMI specification to hold an href to the original XMI file to  
2060 which these differences will get applied. In UIMA we don't really have a URI for that - it is just the input to  
2061 the Process CAS Request. The example conventionally uses `input.xmi` for this URI.

---

## 2062 C. Formal Specification Artifacts

2063 This section includes artifacts such as Ecore models and XML Schemata, which formally define elements  
2064 of the UIMA specification.

### 2065 C.1 XMI XML Schema

2066 This XML schema is defined by the XMI specification [XMI1] and repeated here for completeness:

```
2067
2068 <?xml version="1.0" encoding="UTF-8"?>
2069 <xsd:schema xmlns:xmi="http://www.omg.org/XMI"
2070   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
2071   targetNamespace="http://www.omg.org/XMI">
2072   <xsd:attribute name="id" type="xsd:ID"/>
2073   <xsd:attributeGroup name="IdentityAttribs">
2074     <xsd:attribute form="qualified" name="label" type="xsd:string"
2075       use="optional"/>
2076     <xsd:attribute form="qualified" name="uuid" type="xsd:string"
2077       use="optional"/>
2078   </xsd:attributeGroup>
2079   <xsd:attributeGroup name="LinkAttribs">
2080     <xsd:attribute name="href" type="xsd:string" use="optional"/>
2081     <xsd:attribute form="qualified" name="idref" type="xsd:IDREF"
2082       use="optional"/>
2083   </xsd:attributeGroup>
2084   <xsd:attributeGroup name="ObjectAttribs">
2085     <xsd:attributeGroup ref="xmi:IdentityAttribs"/>
2086     <xsd:attributeGroup ref="xmi:LinkAttribs"/>
2087     <xsd:attribute fixed="2.0" form="qualified" name="version"
2088       type="xsd:string" use="optional"/>
2089     <xsd:attribute form="qualified" name="type" type="xsd:QName"
2090       use="optional"/>
2091   </xsd:attributeGroup>
2092   <xsd:complexType name="XMI">
2093     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2094       <xsd:any processContents="strict"/>
2095     </xsd:choice>
2096     <xsd:attributeGroup ref="xmi:IdentityAttribs"/>
2097     <xsd:attributeGroup ref="xmi:LinkAttribs"/>
2098     <xsd:attribute form="qualified" name="type" type="xsd:QName"
2099       use="optional"/>
2100     <xsd:attribute fixed="2.0" form="qualified" name="version"
2101       type="xsd:string" use="required"/>
```

```

2102    </xsd:complexType>
2103    <xsd:element name="XMI" type="xmi:XMI"/>
2104    <xsd:complexType name="PackageReference">
2105        <xsd:choice maxOccurs="unbounded" minOccurs="0">
2106            <xsd:element name="name" type="xsd:string"/>
2107            <xsd:element name="version" type="xsd:string"/>
2108        </xsd:choice>
2109        <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2110            <xsd:attribute name="name" type="xsd:string" use="optional"/>
2111        </xsd:complexType>
2112        <xsd:element name="PackageReference"
2113            type="xmi:PackageReference"/>
2114        <xsd:complexType name="Model">
2115            <xsd:complexContent>
2116                <xsd:extension base="xmi:PackageReference"/>
2117            </xsd:complexContent>
2118        </xsd:complexType>
2119        <xsd:element name="Model" type="xmi:Model"/>
2120        <xsd:complexType name="Import">
2121            <xsd:complexContent>
2122                <xsd:extension base="xmi:PackageReference"/>
2123            </xsd:complexContent>
2124        </xsd:complexType>
2125        <xsd:element name="Import" type="xmi:Import"/>
2126        <xsd:complexType name="MetaModel">
2127            <xsd:complexContent>
2128                <xsd:extension base="xmi:PackageReference"/>
2129            </xsd:complexContent>
2130        </xsd:complexType>
2131        <xsd:element name="MetaModel" type="xmi:MetaModel"/>
2132        <xsd:complexType name="Documentation">
2133            <xsd:choice maxOccurs="unbounded" minOccurs="0">
2134                <xsd:element name="contact" type="xsd:string"/>
2135                <xsd:element name="exporter" type="xsd:string"/>
2136                <xsd:element name="exporterVersion" type="xsd:string"/>
2137                <xsd:element name="longDescription" type="xsd:string"/>
2138                <xsd:element name="shortDescription" type="xsd:string"/>
2139                <xsd:element name="notice" type="xsd:string"/>
2140                <xsd:element name="owner" type="xsd:string"/>
2141            </xsd:choice>
2142            <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2143                <xsd:attribute name="contact" type="xsd:string" use="optional"/>
2144                <xsd:attribute name="exporter" type="xsd:string"

```

```

2145      use="optional"/>
2146      <xsd:attribute name="exporterVersion" type="xsd:string"
2147          use="optional"/>
2148      <xsd:attribute name="longDescription" type="xsd:string"
2149          use="optional"/>
2150      <xsd:attribute name="shortDescription" type="xsd:string"
2151          use="optional"/>
2152      <xsd:attribute name="notice" type="xsd:string" use="optional"/>
2153      <xsd:attribute name="owner" type="xsd:string" use="optional"/>
2154  </xsd:complexType>
2155  <xsd:element name="Documentation" type="xmi:Documentation"/>
2156  <xsd:complexType name="Extension">
2157      <xsd:choice maxOccurs="unbounded" minOccurs="0">
2158          <xsd:any processContents="lax"/>
2159      </xsd:choice>
2160      <xsd:attributeGroup ref="xmi:ObjectAttribs"/>
2161      <xsd:attribute name="extender" type="xsd:string"
2162          use="optional"/>
2163      <xsd:attribute name="extenderID" type="xsd:string"
2164          use="optional"/>
2165  </xsd:complexType>
2166  <xsd:element name="Extension" type="xmi:Extension"/>
2167  <xsd:complexType name="Difference">
2168      <xsd:choice maxOccurs="unbounded" minOccurs="0">
2169          <xsd:element name="target">
2170              <xsd:complexType>
2171                  <xsd:choice maxOccurs="unbounded" minOccurs="0">
2172                      <xsd:any processContents="skip"/>
2173                  </xsd:choice>
2174                  <xsd:anyAttribute processContents="skip"/>
2175              </xsd:complexType>
2176          </xsd:element>
2177          <xsd:element name="difference" type="xmi:Difference"/>
2178          <xsd:element name="container" type="xmi:Difference"/>
2179      </xsd:choice>
2180      <xsd:attributeGroup ref="xmi:ObjectAttribs"/>
2181      <xsd:attribute name="target" type="xsd:IDREFS" use="optional"/>
2182      <xsd:attribute name="container" type="xsd:IDREFS"
2183          use="optional"/>
2184  </xsd:complexType>
2185  <xsd:element name="Difference" type="xmi:Difference"/>
2186  <xsd:complexType name="Add">
2187      <xsd:complexContent>

```

```

2188     <xsd:extension base="xmi:Difference">
2189         <xsd:attribute name="position" type="xsd:string"
2190             use="optional"/>
2191         <xsd:attribute name="addition" type="xsd:IDREFS"
2192             use="optional"/>
2193     </xsd:extension>
2194   </xsd:complexContent>
2195 </xsd:complexType>
2196 <xsd:element name="Add" type="xmi:Add"/>
2197 <xsd:complexType name="Replace">
2198   <xsd:complexContent>
2199     <xsd:extension base="xmi:Difference">
2200         <xsd:attribute name="position" type="xsd:string"
2201             use="optional"/>
2202         <xsd:attribute name="replacement" type="xsd:IDREFS"
2203             use="optional"/>
2204     </xsd:extension>
2205   </xsd:complexContent>
2206 </xsd:complexType>
2207 <xsd:element name="Replace" type="xmi:Replace"/>
2208 <xsd:complexType name="Delete">
2209   <xsd:complexContent>
2210     <xsd:extension base="xmi:Difference"/>
2211   </xsd:complexContent>
2212 </xsd:complexType>
2213 <xsd:element name="Delete" type="xmi:Delete"/>
2214 <xsd:complexType name="Any">
2215   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2216     <xsd:any processContents="skip"/>
2217   </xsd:choice>
2218   <xsd:anyAttribute processContents="skip"/>
2219 </xsd:complexType>
2220 </xsd:schema>

```

## 2221 C.2 Ecore XML Schema

2222 This XML schema is defined by Ecore [EMF1] and repeated here for completeness:

```

2223 <?xml version="1.0" encoding="UTF-8"?>
2224 <xsd:schema xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
2225   xmlns:xmi="http://www.omg.org/XMI"
2226   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
2227   targetNamespace="http://www.eclipse.org/emf/2002/Ecore">
2228   <xsd:import namespace="http://www.omg.org/XMI" schemaLocation="XMI.xsd"/>
2229   <xsd:complexType name="EAttribute">
2230     <xsd:complexContent>

```

```

2231      <xsd:extension base="ecore:EStructuralFeature">
2232          <xsd:attribute name="id" type="xsd:boolean"/>
2233      </xsd:extension>
2234  </xsd:complexContent>
2235 </xsd:complexType>
2236 <xsd:element name="EAttribute" type="ecore:EAttribute"/>
2237 <xsd:complexType name="EAnnotation">
2238     <xsd:complexContent>
2239         <xsd:extension base="ecore:EModelElement">
2240             <xsd:choice maxOccurs="unbounded" minOccurs="0">
2241                 <xsd:element name="details" type="ecore:EStringToStringMapEntry"/>
2242                 <xsd:element name="contents" type="ecore:EObject"/>
2243                 <xsd:element name="references" type="ecore:EObject"/>
2244             </xsd:choice>
2245             <xsd:attribute name="source" type="xsd:string"/>
2246             <xsd:attribute name="references" type="xsd:string"/>
2247         </xsd:extension>
2248     </xsd:complexContent>
2249 </xsd:complexType>
2250 <xsd:element name="EAnnotation" type="ecore:EAnnotation"/>
2251 <xsd:complexType name="EClass">
2252     <xsd:complexContent>
2253         <xsd:extension base="ecore:EClassifier">
2254             <xsd:choice maxOccurs="unbounded" minOccurs="0">
2255                 <xsd:element name="eSuperTypes" type="ecore:EClass"/>
2256                 <xsd:element name="eOperations" type="ecore:EOperation"/>
2257                 <xsd:element name="eStructuralFeatures"
2258 type="ecore:EStructuralFeature"/>
2259             </xsd:choice>
2260             <xsd:attribute name="abstract" type="xsd:boolean"/>
2261             <xsd:attribute name="interface" type="xsd:boolean"/>
2262             <xsd:attribute name="eSuperTypes" type="xsd:string"/>
2263         </xsd:extension>
2264     </xsd:complexContent>
2265 </xsd:complexType>
2266 <xsd:element name="EClass" type="ecore:EClass"/>
2267 <xsd:complexType abstract="true" name="EClassifier">
2268     <xsd:complexContent>
2269         <xsd:extension base="ecore:ENamedElement">
2270             <xsd:attribute name="instanceClassName" type="xsd:string"/>
2271         </xsd:extension>
2272     </xsd:complexContent>
2273 </xsd:complexType>

```

```

2274 <xsd:element name="EClassifier" type="ecore:EClassifier"/>
2275 <xsd:complexType name="EDataType">
2276   <xsd:complexContent>
2277     <xsd:extension base="ecore:EClassifier">
2278       <xsd:attribute name="serializable" type="xsd:boolean"/>
2279     </xsd:extension>
2280   </xsd:complexContent>
2281 </xsd:complexType>
2282 <xsd:element name="EDataType" type="ecore:EDataType"/>
2283 <xsd:complexType name="EEEnum">
2284   <xsd:complexContent>
2285     <xsd:extension base="ecore:EDataType">
2286       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2287         <xsd:element name="eLiterals" type="ecore:EEEnumLiteral"/>
2288       </xsd:choice>
2289     </xsd:extension>
2290   </xsd:complexContent>
2291 </xsd:complexType>
2292 <xsd:element name="EEEnum" type="ecore:EEEnum"/>
2293 <xsd:complexType name="EEEnumLiteral">
2294   <xsd:complexContent>
2295     <xsd:extension base="ecore:ENamedElement">
2296       <xsd:attribute name="value" type="xsd:int"/>
2297       <xsd:attribute name="literal" type="xsd:string"/>
2298     </xsd:extension>
2299   </xsd:complexContent>
2300 </xsd:complexType>
2301 <xsd:element name="EEEnumLiteral" type="ecore:EEEnumLiteral"/>
2302 <xsd:complexType name="EFactory">
2303   <xsd:complexContent>
2304     <xsd:extension base="ecore:EModelElement"/>
2305   </xsd:complexContent>
2306 </xsd:complexType>
2307 <xsd:element name="EFactory" type="ecore:EFactory"/>
2308 <xsd:complexType abstract="true" name="EModelElement">
2309   <xsd:complexContent>
2310     <xsd:extension base="ecore:EObject">
2311       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2312         <xsd:element name="eAnnotations" type="ecore:EAnnotation"/>
2313       </xsd:choice>
2314     </xsd:extension>
2315   </xsd:complexContent>
2316 </xsd:complexType>

```

```

2317 <xsd:element name="EModelElement" type="ecore:EModelElement"/>
2318 <xsd:complexType abstract="true" name="ENamedElement">
2319   <xsd:complexContent>
2320     <xsd:extension base="ecore:EModelElement">
2321       <xsd:attribute name="name" type="xsd:string"/>
2322     </xsd:extension>
2323   </xsd:complexContent>
2324 </xsd:complexType>
2325 <xsd:element name="ENamedElement" type="ecore:ENamedElement"/>
2326 <xsd:complexType name="EObject">
2327   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2328     <xsd:element ref="xmi:Extension"/>
2329   </xsd:choice>
2330   <xsd:attribute ref="xmi:id"/>
2331   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2332 </xsd:complexType>
2333 <xsd:element name="EObject" type="ecore:EObject"/>
2334 <xsd:complexType name="EOperation">
2335   <xsd:complexContent>
2336     <xsd:extension base="ecore:ETypedElement">
2337       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2338         <xsd:element name="eParameters" type="ecore:EParameter"/>
2339         <xsd:element name="eExceptions" type="ecore:EClassifier"/>
2340       </xsd:choice>
2341       <xsd:attribute name="eExceptions" type="xsd:string"/>
2342     </xsd:extension>
2343   </xsd:complexContent>
2344 </xsd:complexType>
2345 <xsd:element name="EOperation" type="ecore:EOperation"/>
2346 <xsd:complexType name="EPackage">
2347   <xsd:complexContent>
2348     <xsd:extension base="ecore:ENamedElement">
2349       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2350         <xsd:element name="eClassifiers" type="ecore:EClassifier"/>
2351         <xsd:element name="eSubpackages" type="ecore:EPackage"/>
2352       </xsd:choice>
2353       <xsd:attribute name="nsURI" type="xsd:string"/>
2354       <xsd:attribute name="nsPrefix" type="xsd:string"/>
2355     </xsd:extension>
2356   </xsd:complexContent>
2357 </xsd:complexType>
2358 <xsd:element name="EPackage" type="ecore:EPackage"/>
2359 <xsd:complexType name="EParameter">

```

```

2360      <xsd:complexContent>
2361          <xsd:extension base="ecore:ETypedElement"/>
2362      </xsd:complexContent>
2363  </xsd:complexType>
2364  <xsd:element name="EParameter" type="ecore:EParameter"/>
2365  <xsd:complexType name="EReference">
2366      <xsd:complexContent>
2367          <xsd:extension base="ecore:EStructuralFeature">
2368              <xsd:choice maxOccurs="unbounded" minOccurs="0">
2369                  <xsd:element name="eOpposite" type="ecore:EReference"/>
2370              </xsd:choice>
2371              <xsd:attribute name="containment" type="xsd:boolean"/>
2372              <xsd:attribute name="resolveProxies" type="xsd:boolean"/>
2373              <xsd:attribute name="eOpposite" type="xsd:string"/>
2374          </xsd:extension>
2375      </xsd:complexContent>
2376  </xsd:complexType>
2377  <xsd:element name="EReference" type="ecore:EReference"/>
2378  <xsd:complexType abstract="true" name="EStructuralFeature">
2379      <xsd:complexContent>
2380          <xsd:extension base="ecore:ETypedElement">
2381              <xsd:attribute name="changeable" type="xsd:boolean"/>
2382              <xsd:attribute name="volatile" type="xsd:boolean"/>
2383              <xsd:attribute name="transient" type="xsd:boolean"/>
2384              <xsd:attribute name="defaultValueLiteral" type="xsd:string"/>
2385              <xsd:attribute name="unsettable" type="xsd:boolean"/>
2386              <xsd:attribute name="derived" type="xsd:boolean"/>
2387          </xsd:extension>
2388      </xsd:complexContent>
2389  </xsd:complexType>
2390  <xsd:element name="EStructuralFeature" type="ecore:EStructuralFeature"/>
2391  <xsd:complexType abstract="true" name="ETypedElement">
2392      <xsd:complexContent>
2393          <xsd:extension base="ecore:ENamedElement">
2394              <xsd:choice maxOccurs="unbounded" minOccurs="0">
2395                  <xsd:element name="eType" type="ecore:EClassifier"/>
2396              </xsd:choice>
2397              <xsd:attribute name="ordered" type="xsd:boolean"/>
2398              <xsd:attribute name="unique" type="xsd:boolean"/>
2399              <xsd:attribute name="lowerBound" type="xsd:int"/>
2400              <xsd:attribute name="upperBound" type="xsd:int"/>
2401              <xsd:attribute name="eType" type="xsd:string"/>
2402          </xsd:extension>

```

```

2403     </xsd:complexContent>
2404   </xsd:complexType>
2405   <xsd:element name="ETypedElement" type=".ecore:ETypedElement"/>
2406   <xsd:complexType name="EStringToStringMapEntry">
2407     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2408       <xsd:element ref="xmi:Extension"/>
2409     </xsd:choice>
2410     <xsd:attribute ref="xmi:id"/>
2411     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2412     <xsd:attribute name="key" type="xsd:string"/>
2413     <xsd:attribute name="value" type="xsd:string"/>
2414   </xsd:complexType>
2415   <xsd:element name="EStringToStringMapEntry"
2416 type=".ecore:EStringToStringMapEntry"/>
2417 </xsd:schema>
2418

```

### 2419 C.3 Base Type System Ecore Model

2420 This Ecore model formally defines the UIMA Base Type System.

```

2421 <?xml version="1.0" encoding="UTF-8"?>
2422 <ecore:EPackage xmi:version="2.0"
2423   xmlns:xmi="http://www.omg.org/XMI"
2424   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2425   xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore" name="uima"
2426   nsURI="http://docs.oasis-open.org/uima/ns/uima.ecore" nsPrefix="uima">
2427   <eSubpackages name="base" nsURI="http://docs.oasis-
2428 open.org/uima/ns/base.ecore" nsPrefix="uima.base">
2429     <eClassifiers xsi:type="ecore:EClass" name="Annotation">
2430       <eStructuralFeatures xsi:type="ecore:EReference" name="sofa"
2431       lowerBound="1"
2432         eType="#//base/SofaReference"/>
2433         <eStructuralFeatures xsi:type="ecore:EReference" name="metadata"
2434         eType="#//base/AnnotationMetadata"/>
2435         <eStructuralFeatures xsi:type="ecore:EReference" name="occurrenceOf"
2436         lowerBound="1"
2437           eType="#//base/Entity" eOpposite="#//base/Entity/occurrence"/>
2438     </eClassifiers>
2439     <eClassifiers xsi:type="ecore:EClass" name="SofaReference"
2440     abstract="true">
2441       <eClassifiers xsi:type="ecore:EClass" name="LocalSofaReference"
2442       eSuperTypes="#//base/SofaReference">
2443         <eStructuralFeatures xsi:type="ecore:EAttribute" name="sofaFeature"
2444         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2445         <eStructuralFeatures xsi:type="ecore:EReference" name="sofaObject"
2446         eType="ecore:EClass http://www.eclipse.org/emf/2002/Ecore#//EObject"/>
2447       </eClassifiers>
2448       <eClassifiers xsi:type="ecore:EClass" name="RemoteSofaReference"
2449       eSuperTypes="#//base/SofaReference">
2450         <eStructuralFeatures xsi:type="ecore:EAttribute" name="sofaUri"
2451         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2452       </eClassifiers>

```

```

2453     <eClassifiers xsi:type="ecore:EClass" name="TextAnnotation"
2454     eSuperTypes="#//base/Annotation">
2455         <eStructuralFeatures xsi:type="ecore:EAttribute" name="beginChar"
2456         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EInt"/>
2457             <eStructuralFeatures xsi:type="ecore:EAttribute" name="endChar"
2458             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EInt"/>
2459         </eClassifiers>
2460         <eClassifiers xsi:type="ecore:EClass" name="TemporalAnnotation"
2461         eSuperTypes="#//base/Annotation">
2462             <eStructuralFeatures xsi:type="ecore:EAttribute" name="beginTime"
2463             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EFloat"/>
2464                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="endTime"
2465                 eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EFloat"/>
2466             </eClassifiers>
2467             <eClassifiers xsi:type="ecore:EClass" name="AnnotationMetadata">
2468                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="confidence"
2469                 eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EFloat"/>
2470                     <eStructuralFeatures xsi:type="ecore:EReference" name="provenance"
2471                     eType="#//base/Provenance"/>
2472             </eClassifiers>
2473             <eClassifiers xsi:type="ecore:EClass" name="Provenance"/>
2474             <eClassifiers xsi:type="ecore:EClass" name="Entity">
2475                 <eStructuralFeatures xsi:type="ecore:EReference" name="occurrence"
2476                 upperBound="-1"
2477                     eType="#//base/Annotation"
2478                     eOpposite="#//base/Annotation/occurrenceOf"/>
2479                 </eClassifiers>
2480                 <eClassifiers xsi:type="ecore:EClass" name="SourceDocumentInformation">
2481                     <eStructuralFeatures xsi:type="ecore:EAttribute" name="uri"
2482                     eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EString"/>
2483                         <eStructuralFeatures xsi:type="ecore:EAttribute" name="offsetInSource"
2484                         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EInt"/>
2485                             <eStructuralFeatures xsi:type="ecore:EAttribute" name="documentSize"
2486                             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EInt"/>
2487                         </eClassifiers>
2488                         <eClassifiers xsi:type="ecore:EClass" name="AnchoredView"
2489                         eSuperTypes="#//base/View">
2490                             <eStructuralFeatures xsi:type="ecore:EReference" name="sofa"
2491                             upperBound="-1"
2492                                 eType="#//base/SofaReference"/>
2493                             </eClassifiers>
2494                             <eClassifiers xsi:type="ecore:EClass" name="View">
2495                                 <eStructuralFeatures xsi:type="ecore:EReference" name="IndexRepository"
2496                                 lowerBound="1"/>
2497                                     <eStructuralFeatures xsi:type="ecore:EReference" name="member"
2498                                     upperBound="-1"
2499                                         eType="ecore:EClass
2500                                         http://www.eclipse.org/emf/2002/Ecore#/EObject"/>
2501                                         <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
2502                                         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#/EString"/>
2503                                         </eClassifiers>
2504                                     </eSubpackages>
2505                                 </ecore:EPackage>

```

## 2506 C.4 Base Type System XML Schema

2507 This XML schema was generated from the Ecore model in Appendix C.3 by the Eclipse Modeling  
2508 Framework tools.

```

2509 <?xml version="1.0" encoding="UTF-8" standalone="no"?>
2510 <xsd:schema xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
2511   xmlns:uima.base="http://docs.oasis-open.org/uima/ns/base.ecore"
2512   xmlns:xmi="http://www.omg.org/XMI"
2513   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
2514   targetNamespace="http://docs.oasis-open.org/uima/ns/base.ecore">
2515     <xsd:import namespace="http://www.eclipse.org/emf/2002/Ecore"
2516       schemaLocation="ecore.xsd"/>
2517     <xsd:import namespace="http://www.omg.org/XMI"
2518       schemaLocation="../../../../plugin/org.eclipse.emf.ecore/model/XMI.xsd"/>
2519     <xsd:complexType name="Annotation">
2520       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2521         <xsd:element name="sofa" type="uima.base:SofaReference"/>
2522         <xsd:element name="metadata" type="uima.base:AnnotationMetadata"/>
2523         <xsd:element name="occurrenceOf" type="uima.base:Entity"/>
2524         <xsd:element ref="xmi:Extension"/>
2525       </xsd:choice>
2526       <xsd:attribute ref="xmi:id"/>
2527       <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2528       <xsd:attribute name="sofa" type="xsd:string"/>
2529       <xsd:attribute name="metadata" type="xsd:string"/>
2530       <xsd:attribute name="occurrenceOf" type="xsd:string"/>
2531     </xsd:complexType>
2532     <xsd:element name="Annotation" type="uima.base:Annotation"/>
2533     <xsd:complexType abstract="true" name="SofaReference">
2534       <xsd:choice maxOccurs="unbounded" minOccurs="0">
2535         <xsd:element ref="xmi:Extension"/>
2536       </xsd:choice>
2537       <xsd:attribute ref="xmi:id"/>
2538       <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2539     </xsd:complexType>
2540     <xsd:element name="SofaReference" type="uima.base:SofaReference"/>
2541     <xsd:complexType name="LocalSofaReference">
2542       <xsd:complexContent>
2543         <xsd:extension base="uima.base:SofaReference">
2544           <xsd:choice maxOccurs="unbounded" minOccurs="0">
2545             <xsd:element name="sofaObject" type="ecore:EObject"/>
2546           </xsd:choice>
2547             <xsd:attribute name="sofaFeature" type="xsd:string"/>
2548             <xsd:attribute name="sofaObject" type="xsd:string"/>
2549           </xsd:extension>
2550         </xsd:complexContent>
2551       </xsd:complexType>
2552       <xsd:element name="LocalSofaReference"
2553         type="uima.base:LocalSofaReference"/>
2554       <xsd:complexType name="RemoteSofaReference">
2555         <xsd:complexContent>
2556           <xsd:extension base="uima.base:SofaReference">
2557             <xsd:attribute name="sofaUri" type="xsd:string"/>
2558           </xsd:extension>
2559         </xsd:complexContent>
2560       </xsd:complexType>
2561       <xsd:element name="RemoteSofaReference"
2562         type="uima.base:RemoteSofaReference"/>
2563       <xsd:complexType name="TextAnnotation">
2564         <xsd:complexContent>
2565           <xsd:extension base="uima.base:Annotation">
2566             <xsd:attribute name="beginChar" type="xsd:int"/>

```

```

2567      <xsd:attribute name="endChar" type="xsd:int"/>
2568      </xsd:extension>
2569  </xsd:complexContent>
2570 </xsd:complexType>
2571 <xsd:element name="TextAnnotation" type="uima.base:TextAnnotation"/>
2572 <xsd:complexType name="TemporalAnnotation">
2573   <xsd:complexContent>
2574     <xsd:extension base="uima.base:Annotation">
2575       <xsd:attribute name="beginTime" type="xsd:float"/>
2576       <xsd:attribute name="endTime" type="xsd:float"/>
2577     </xsd:extension>
2578   </xsd:complexContent>
2579 </xsd:complexType>
2580 <xsd:element name="TemporalAnnotation"
2581 type="uima.base:TemporalAnnotation"/>
2582 <xsd:complexType name="AnnotationMetadata">
2583   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2584     <xsd:element name="provenance" type="uima.base:Provenance"/>
2585     <xsd:element ref="xmi:Extension"/>
2586   </xsd:choice>
2587   <xsd:attribute ref="xmi:id"/>
2588   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2589   <xsd:attribute name="confidence" type="xsd:float"/>
2590   <xsd:attribute name="provenance" type="xsd:string"/>
2591 </xsd:complexType>
2592 <xsd:element name="AnnotationMetadata"
2593 type="uima.base:AnnotationMetadata"/>
2594 <xsd:complexType name="Provenance">
2595   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2596     <xsd:element ref="xmi:Extension"/>
2597   </xsd:choice>
2598   <xsd:attribute ref="xmi:id"/>
2599   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2600 </xsd:complexType>
2601 <xsd:element name="Provenance" type="uima.base:Provenance"/>
2602 <xsd:complexType name="Entity">
2603   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2604     <xsd:element name="occurrence" type="uima.base:Annotation"/>
2605     <xsd:element ref="xmi:Extension"/>
2606   </xsd:choice>
2607   <xsd:attribute ref="xmi:id"/>
2608   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2609   <xsd:attribute name="occurrence" type="xsd:string"/>
2610 </xsd:complexType>
2611 <xsd:element name="Entity" type="uima.base:Entity"/>
2612 <xsd:complexType name="SourceDocumentInformation">
2613   <xsd:choice maxOccurs="unbounded" minOccurs="0">
2614     <xsd:element ref="xmi:Extension"/>
2615   </xsd:choice>
2616   <xsd:attribute ref="xmi:id"/>
2617   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2618   <xsd:attribute name="uri" type="xsd:string"/>
2619   <xsd:attribute name="offsetInSource" type="xsd:int"/>
2620   <xsd:attribute name="documentSize" type="xsd:int"/>
2621 </xsd:complexType>
2622 <xsd:element name="SourceDocumentInformation"
2623 type="uima.base:SourceDocumentInformation"/>
2624 <xsd:complexType name="AnchoredView">
```

```

2625     <xsd:complexContent>
2626         <xsd:extension base="uima.base:View">
2627             <xsd:choice maxOccurs="unbounded" minOccurs="0">
2628                 <xsd:element name="sofa" type="uima.base:SofaReference"/>
2629             </xsd:choice>
2630             <xsd:attribute name="sofa" type="xsd:string"/>
2631         </xsd:extension>
2632     </xsd:complexContent>
2633 </xsd:complexType>
2634 <xsd:element name="AnchoredView" type="uima.base:AnchoredView"/>
2635 <xsd:complexType name="View">
2636     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2637         <xsd:element name="IndexRepository" type="xmi:Any"/>
2638         <xsd:element name="member" type="ecore:EObject"/>
2639         <xsd:element ref="xmi:Extension"/>
2640     </xsd:choice>
2641     <xsd:attribute ref="xmi:id"/>
2642     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2643     <xsd:attribute name="name" type="xsd:string"/>
2644     <xsd:attribute name="IndexRepository" type="xsd:string"/>
2645     <xsd:attribute name="member" type="xsd:string"/>
2646 </xsd:complexType>
2647 <xsd:element name="View" type="uima.base:View"/>
2648 </xsd:schema>
2649

```

## 2650 C.5 PE Metadata Ecore Model

2651 This Ecore model formally defines the UIMA Processing Element Metadata and Behavioral Metadata.

```

2652 <?xml version="1.0" encoding="UTF-8"?>
2653 <ecore:EPackage xmi:version="2.0"
2654     xmlns:xmi="http://www.omg.org/XMI"
2655     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
2656     xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore" name="uima"
2657     nsURI="http://docs.oasis-open.org/uima/ns/uima.ecore" nsPrefix="uima">
2658     <eSubpackages name="peMetadata" nsURI="http://docs.oasis-
2659 open.org/uima/ns/peMetadata.ecore"
2660     nsPrefix="uima.peMetadata">
2661         <eClassifiers xsi:type="ecore:EClass" name="Identification">
2662             <eStructuralFeatures xsi:type="ecore:EAttribute" name="symbolicName"
2663             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2664             <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
2665             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2666             <eStructuralFeatures xsi:type="ecore:EAttribute" name="description"
2667             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2668             <eStructuralFeatures xsi:type="ecore:EAttribute" name="vendor"
2669             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2670             <eStructuralFeatures xsi:type="ecore:EAttribute" name="version"
2671             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2672             <eStructuralFeatures xsi:type="ecore:EAttribute" name="url"
2673             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2674         </eClassifiers>
2675         <eClassifiers xsi:type="ecore:EClass" name="ConfigurationParameter">
2676             <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
2677             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2678             <eStructuralFeatures xsi:type="ecore:EAttribute" name="description"
2679             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>

```

```

2680      <eStructuralFeatures xsi:type="ecore:EAttribute" name="type"
2681      eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2682          <eStructuralFeatures xsi:type="ecore:EAttribute" name="multiValued"
2683          eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EBoolean"/>
2684              <eStructuralFeatures xsi:type="ecore:EAttribute" name="mandatory"
2685              eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EBoolean"/>
2686                  <eStructuralFeatures xsi:type="ecore:EAttribute" name="defaultValue"
2687                  upperBound="-1"
2688                      eType="ecore:EDataType
2689                      http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2690                          </eClassifiers>
2691                              <eClassifiers xsi:type="ecore:EClass" name="TypeSystem">
2692                                  <eStructuralFeatures xsi:type="ecore:EAttribute" name="reference"
2693                                  upperBound="-1"
2694                                      eType="ecore:EDataType
2695                                      http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2696                                          <eStructuralFeatures xsi:type="ecore:EReference" name="package"
2697                                          upperBound="-1"
2698                                              eType="ecore:EClass
2699                                              http://www.eclipse.org/emf/2002/Ecore#//EPackage" containment="true"/>
2700                                              </eClassifiers>
2701                                              <eClassifiers xsi:type="ecore:EClass" name="BehavioralMetadata">
2702                                                  <eStructuralFeatures xsi:type="ecore:EAttribute"
2703                                                  name="excludeReferenceClosure"
2704                                                      eType="ecore:EDataType
2705                                                      http://www.eclipse.org/emf/2002/Ecore#//EBooleanObject"/>
2706                                                          <eStructuralFeatures xsi:type="ecore:EReference" name="analyzes"
2707                                                          lowerBound="1"
2708                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2709                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="requiredInputs"
2710                                                              lowerBound="1"
2711                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2712                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="optionalInputs"
2713                                                              lowerBound="1"
2714                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2715                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="creates"
2716                                                              lowerBound="1"
2717                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2718                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="modifies"
2719                                                              lowerBound="1"
2720                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2721                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="deletes"
2722                                                              lowerBound="1"
2723                                                              eType="#//peMetadata/BehaviorElement" containment="true"/>
2724                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="precondition"
2725                                                              lowerBound="1"
2726                                                              eType="#//peMetadata/Condition" containment="true"/>
2727                                                              <eStructuralFeatures xsi:type="ecore:EReference" name="postcondition"
2728                                                              lowerBound="1"
2729                                                              eType="#//peMetadata/Condition" containment="true"/>
2730                                                              <eStructuralFeatures xsi:type="ecore:EReference"
2731                                                              name="projectionCondition"
2732                      lowerBound="1" eType="#//peMetadata/Condition" containment="true"/>
2733                      <eStructuralFeatures xsi:type="ecore:EReference" name="requiredView"
2734                      upperBound="-1"
2735                      eType="#//peMetadata/ViewBehavioralMetadata" containment="true"/>
2736                      <eStructuralFeatures xsi:type="ecore:EReference" name="optionalView"
2737                      upperBound="-1"

```

```

2738         eType="#//peMetadata/ViewBehavioralMetadata" containment="true"/>
2739         <eStructuralFeatures xsi:type="ecore:EReference" name="createsView"
2740         upperBound="-1"
2741             eType="#//peMetadata/ViewBehavioralMetadata" containment="true"/>
2742             </eClassifiers>
2743             <eClassifiers xsi:type="ecore:EClass" name="ProcessingElementMetadata">
2744                 <eStructuralFeatures xsi:type="ecore:EReference"
2745                 name="configurationParameter"
2746                     upperBound="-1" eType="#//peMetadata/ConfigurationParameter"
2747                     containment="true"/>
2748                     <eStructuralFeatures xsi:type="ecore:EReference" name="identification"
2749                     lowerBound="1"
2750                         eType="#//peMetadata/Identification" containment="true"/>
2751                         <eStructuralFeatures xsi:type="ecore:EReference" name="typeSystem"
2752                         lowerBound="1"
2753                             eType="#//peMetadata/TypeSystem" containment="true"/>
2754                             <eStructuralFeatures xsi:type="ecore:EReference"
2755                             name="behavioralMetadata" lowerBound="1"
2756                                 eType="#//peMetadata/BehavioralMetadata" containment="true"/>
2757                                 <eStructuralFeatures xsi:type="ecore:EReference" name="extension"
2758                                 upperBound="-1"
2759                                     eType="#//peMetadata/Extension" containment="true"/>
2760                                     </eClassifiers>
2761                                     <eClassifiers xsi:type="ecore:EClass" name="Extension">
2762                                         <eStructuralFeatures xsi:type="ecore:EAttribute" name="extenderId"
2763                                         eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2764                                         <eStructuralFeatures xsi:type="ecore:EReference" name="contents"
2765                                         lowerBound="1"
2766                                         eType="ecore:EClass
2767                                         http://www.eclipse.org/emf/2002/Ecore#//EObject" containment="true"/>
2768                                         </eClassifiers>
2769                                         <eClassifiers xsi:type="ecore:EClass" name="BehaviorElement">
2770                                             <eStructuralFeatures xsi:type="ecore:EReference" name="type"
2771                                         upperBound="-1"
2772                                             eType="#//peMetadata/Type" containment="true"/>
2773                                             </eClassifiers>
2774                                             <eClassifiers xsi:type="ecore:EClass" name="Type">
2775                                                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="name"
2776                                                 eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2777                                                 <eStructuralFeatures xsi:type="ecore:EAttribute" name="feature"
2778                                         upperBound="-1"
2779                                         eType="ecore:EDataType
2780                                         http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2781                                         </eClassifiers>
2782                                         <eClassifiers xsi:type="ecore:EClass" name="Condition">
2783                                             <eStructuralFeatures xsi:type="ecore:EAttribute" name="language"
2784                                             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2785                                             <eStructuralFeatures xsi:type="ecore:EAttribute" name="expression"
2786                                             eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
2787                                         </eClassifiers>
2788                                         <eClassifiers xsi:type="ecore:EClass" name="ViewBehavioralMetadata"
2789                                         eSuperTypes="#//peMetadata/BehavioralMetadata"/>
2790                                         </eSubpackages>
2791                                     </ecore:EPackage>
2792

```

## 2793 C.6 PE Metadata XML Schema

2794 This XML schema was generated from the Ecore model in Appendix C.5 by the Eclipse Modeling  
2795 Framework tools.

```
2796 <?xml version="1.0" encoding="UTF-8" standalone="no"?>
2797 <xsd:schema xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
2798   xmlns:uima.peMetadata="http://docs.oasis-open.org/uima/ns/peMetadata.ecore"
2799   xmlns:xmi="http://www.omg.org/XMI"
2800   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
2801   targetNamespace="http://docs.oasis-open.org/uima/ns/peMetadata.ecore">
2802   <xsd:import namespace="http://www.eclipse.org/emf/2002/Ecore"
2803     schemaLocation="ecore.xsd"/>
2804   <xsd:import namespace="http://www.omg.org/XMI"
2805     schemaLocation="../../../../plugin/org.eclipse.emf.ecore/model/XMI.xsd"/>
2806   <xsd:complexType name="Identification">
2807     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2808       <xsd:element ref="xmi:Extension"/>
2809     </xsd:choice>
2810     <xsd:attribute ref="xmi:id"/>
2811     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2812     <xsd:attribute name="symbolicName" type="xsd:string"/>
2813     <xsd:attribute name="name" type="xsd:string"/>
2814     <xsd:attribute name="description" type="xsd:string"/>
2815     <xsd:attribute name="vendor" type="xsd:string"/>
2816     <xsd:attribute name="version" type="xsd:string"/>
2817     <xsd:attribute name="url" type="xsd:string"/>
2818   </xsd:complexType>
2819   <xsd:element name="Identification" type="uima.peMetadata:Identification"/>
2820   <xsd:complexType name="ConfigurationParameter">
2821     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2822       <xsd:element name="defaultValue" nillable="true" type="xsd:string"/>
2823       <xsd:element ref="xmi:Extension"/>
2824     </xsd:choice>
2825     <xsd:attribute ref="xmi:id"/>
2826     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2827     <xsd:attribute name="name" type="xsd:string"/>
2828     <xsd:attribute name="description" type="xsd:string"/>
2829     <xsd:attribute name="type" type="xsd:string"/>
2830     <xsd:attribute name="multiValued" type="xsd:boolean"/>
2831     <xsd:attribute name="mandatory" type="xsd:boolean"/>
2832   </xsd:complexType>
2833   <xsd:element name="ConfigurationParameter"
2834     type="uima.peMetadata:ConfigurationParameter"/>
2835   <xsd:complexType name="TypeSystem">
2836     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2837       <xsd:element name="reference" nillable="true" type="xsd:string"/>
2838       <xsd:element name="package" type="ecore:EPackage"/>
2839       <xsd:element ref="xmi:Extension"/>
2840     </xsd:choice>
2841     <xsd:attribute ref="xmi:id"/>
2842     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2843   </xsd:complexType>
2844   <xsd:element name="TypeSystem" type="uima.peMetadata>TypeSystem"/>
2845   <xsd:complexType name="BehavioralMetadata">
2846     <xsd:choice maxOccurs="unbounded" minOccurs="0">
2847       <xsd:element name="analyzes" type="uima.peMetadata:BehaviorElement"/>
```

```

2848      <xsd:element name="requiredInputs"
2849      type="uima.peMetadata:BehaviorElement"/>
2850      <xsd:element name="optionalInputs"
2851      type="uima.peMetadata:BehaviorElement"/>
2852      <xsd:element name="creates" type="uima.peMetadata:BehaviorElement"/>
2853      <xsd:element name="modifies" type="uima.peMetadata:BehaviorElement"/>
2854      <xsd:element name="deletes" type="uima.peMetadata:BehaviorElement"/>
2855      <xsd:element name="precondition" type="uima.peMetadata:Condition"/>
2856      <xsd:element name="postcondition" type="uima.peMetadata:Condition"/>
2857      <xsd:element name="projectionCondition"
2858      type="uima.peMetadata:Condition"/>
2859      <xsd:element name="requiredView"
2860      type="uima.peMetadata:ViewBehavioralMetadata"/>
2861      <xsd:element name="optionalView"
2862      type="uima.peMetadata:ViewBehavioralMetadata"/>
2863      <xsd:element name="createsView"
2864      type="uima.peMetadata:ViewBehavioralMetadata"/>
2865      <xsd:element ref="xmi:Extension"/>
2866    </xsd:choice>
2867    <xsd:attribute ref="xmi:id"/>
2868    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2869    <xsd:attribute name="excludeReferenceClosure" type="xsd:boolean"/>
2870  </xsd:complexType>
2871  <xsd:element name="BehavioralMetadata"
2872  type="uima.peMetadata:BehavioralMetadata"/>
2873  <xsd:complexType name="ProcessingElementMetadata">
2874    <xsd:choice maxOccurs="unbounded" minOccurs="0">
2875      <xsd:element name="configurationParameter"
2876      type="uima.peMetadata:ConfigurationParameter"/>
2877      <xsd:element name="identification"
2878      type="uima.peMetadata:Identification"/>
2879      <xsd:element name="typeSystem" type="uima.peMetadata>TypeSystem"/>
2880      <xsd:element name="behavioralMetadata"
2881      type="uima.peMetadata:BehavioralMetadata"/>
2882      <xsd:element name="extension" type="uima.peMetadata:Extension"/>
2883      <xsd:element ref="xmi:Extension"/>
2884    </xsd:choice>
2885    <xsd:attribute ref="xmi:id"/>
2886    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2887  </xsd:complexType>
2888  <xsd:element name="ProcessingElementMetadata"
2889  type="uima.peMetadata:ProcessingElementMetadata"/>
2890  <xsd:complexType name="Extension">
2891    <xsd:choice maxOccurs="unbounded" minOccurs="0">
2892      <xsd:element name="contents" type="ecore:EObject"/>
2893      <xsd:element ref="xmi:Extension"/>
2894    </xsd:choice>
2895    <xsd:attribute ref="xmi:id"/>
2896    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2897    <xsd:attribute name="extenderId" type="xsd:string"/>
2898  </xsd:complexType>
2899  <xsd:element name="Extension" type="uima.peMetadata:Extension"/>
2900  <xsd:complexType name="BehaviorElement">
2901    <xsd:choice maxOccurs="unbounded" minOccurs="0">
2902      <xsd:element name="type" type="uima.peMetadata>Type"/>
2903      <xsd:element ref="xmi:Extension"/>
2904    </xsd:choice>
2905    <xsd:attribute ref="xmi:id"/>

```

```

2906      <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2907  </xsd:complexType>
2908  <xsd:element name="BehaviorElement"
2909 type="uima.peMetadata:BehaviorElement"/>
2910  <xsd:complexType name="Type">
2911    <xsd:choice maxOccurs="unbounded" minOccurs="0">
2912      <xsd:element name="feature" nillable="true" type="xsd:string"/>
2913      <xsd:element ref="xmi:Extension"/>
2914    </xsd:choice>
2915    <xsd:attribute ref="xmi:id"/>
2916    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2917      <xsd:attribute name="name" type="xsd:string"/>
2918  </xsd:complexType>
2919  <xsd:element name="Type" type="uima.peMetadata>Type"/>
2920  <xsd:complexType name="Condition">
2921    <xsd:choice maxOccurs="unbounded" minOccurs="0">
2922      <xsd:element ref="xmi:Extension"/>
2923    </xsd:choice>
2924    <xsd:attribute ref="xmi:id"/>
2925    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
2926      <xsd:attribute name="language" type="xsd:string"/>
2927      <xsd:attribute name="expression" type="xsd:string"/>
2928  </xsd:complexType>
2929  <xsd:element name="Condition" type="uima.peMetadata:Condition"/>
2930  <xsd:complexType name="ViewBehavioralMetadata">
2931    <xsd:complexContent>
2932      <xsd:extension base="uima.peMetadata:BehavioralMetadata"/>
2933    </xsd:complexContent>
2934  </xsd:complexType>
2935  <xsd:element name="ViewBehavioralMetadata"
2936 type="uima.peMetadata:ViewBehavioralMetadata"/>
2937</xsd:schema>

```

## 2938 C.7 PE Service WSDL Definition

2939 This WSDL document formally defines a UIMA SOAP Service.

```

2940 <?xml version="1.0" encoding="UTF-8"?>
2941 <wsdl:definitions
2942   targetNamespace="http://docs.oasis-open.org/uima/ns/peService"
2943   xmlns:service="http://docs.oasis-open.org/uima/ns/peService"
2944   xmlns:peMD="http://docs.oasis-open.org/uima/ns/peMetadata.ecore"
2945   xmlns:pe="http://docs.oasis-open.org/uima/ns/pe.ecore"
2946   xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
2947   xmlns:wsdlsoap="http://schemas.xmlsoap.org/wsdl/soap/"
2948   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
2949   xmlns:xmi="http://www.omg.org/XMI">
2950
2951  <wsdl:types>
2952    <!-- Import the PE Metadata Schema Definitions -->
2953    <xsd:import
2954      namespace="http://docs.oasis-open.org/uima/ns/peMetadata.ecore"
2955      schemaLocation="uima.peMetadataXMI.xsd"/>
2956
2957    <!-- Import the XMI schema. -->
2958    <xsd:import namespace="http://www.omg.org/XMI"
2959      schemaLocation="XMI.xsd"/>
2960
2961    <!-- Import other type definitions used as part of the service API. -->

```

```

2962     <xsd:import
2963         namespace="http://docs.oasis-open.org/uima/ns/pe.ecore"
2964         schemaLocation="uima.peServiceXMI.xsd"/>
2965     </wsdl:types>
2966
2967     <!-- Define the messages sent to and from the service. -->
2968
2969     <!-- Messages for all UIMA Processing Elements -->
2970     <wsdl:message name="getMetadataRequest">
2971     </wsdl:message>
2972
2973     <wsdl:message name="getMetadataResponse">
2974         <wsdl:part element="metadata"
2975             type="pemd:ProcessingElementMetadata" name="metadata"/>
2976     </wsdl:message>
2977
2978     <wsdl:message name="setConfigurationParametersRequest">
2979         <wsdl:part element="settings"
2980             type="pe:ConfigurationParameterSettings" name="settings"/>
2981     </wsdl:message>
2982
2983     <wsdl:message name="setConfigurationParametersResponse">
2984     </wsdl:message>
2985
2986     <wsdl:message name="uimaFault">
2987         <wsdl:part element="exception" type="pe:UimaException" name="exception"/>
2988     </wsdl:message>
2989
2990
2991     <!-- Messages for the Analyzer interface -->
2992
2993     <wsdl:message name="processCasRequest">
2994         <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
2995         <wsdl:part element="sofas" type="pe:ObjectList" name="sofas"/>
2996     </wsdl:message>
2997
2998     <wsdl:message name="processCasResponse">
2999         <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3000     </wsdl:message>
3001
3002     <wsdl:message name="processCasBatchRequest">
3003         <wsdl:part element="casBatchInput" type="pe:CasBatchInput"
3004             name="casBatchInput"/>
3005     </wsdl:message>
3006
3007     <wsdl:message name="processCasBatchResponse">
3008         <wsdl:part element="casBatchResponse" type="pe:CasBatchResponse"
3009             name="casBatchResponse"/>
3010     </wsdl:message>
3011
3012
3013     <!-- Messages for the CasMultiplier interface -->
3014     <wsdl:message name="inputCasRequest">
3015         <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3016         <wsdl:part element="sofas" type="pe:ObjectList" name="sofas"/>
3017     </wsdl:message>
3018
3019     <wsdl:message name="inputCasResponse">
```

```

3020    </wsdl:message>
3021
3022    <wsdl:message name="getNextCasRequest">
3023        </wsdl:message>
3024
3025    <wsdl:message name="getNextCasResponse">
3026        <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3027    </wsdl:message>
3028
3029    <wsdl:message name="retrieveInputCasRequest">
3030        </wsdl:message>
3031
3032    <wsdl:message name="retrieveInputCasResponse">
3033        <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3034    </wsdl:message>
3035
3036    <wsdl:message name="getNextCasRequest">
3037        <wsdl:part element="maxCAsesToReturn" type="xsd:integer"
3038 name="maxCAsesToReturn"/>
3039        <wsdl:part element="timeToWait" type="xsd:integer" name="timeToWait"/>
3040    </wsdl:message>
3041
3042    <wsdl:message name="getNextCasResponse">
3043        <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3044    </wsdl:message>
3045
3046    <wsdl:message name="getNextCasBatchRequest">
3047        <wsdl:part element="maxCAsesToReturn" type="xsd:integer"
3048 name="maxCAsesToReturn"/>
3049        <wsdl:part element="timeToWait" type="xsd:integer" name="timeToWait"/>
3050    </wsdl:message>
3051
3052    <wsdl:message name="getNextCasBatchResponse">
3053        <wsdl:part element="reponse" type="pe:GetNextCasBatchResponse"
3054 name="response"/>
3055    </wsdl:message>
3056
3057    <!-- Messages for the FlowController interface -->
3058
3059    <wsdl:message name="addAvailableAnalyticsRequest">
3060        <wsdl:part element="analyticMetadataMap"
3061            type="pe:AnalyticMetadataMap" name="analyticMetadataMap"/>
3062    </wsdl:message>
3063
3064    <wsdl:message name="addAvailableAnalyticsResponse">
3065    </wsdl:message>
3066
3067    <wsdl:message name="removeAvailableAnalyticsRequest">
3068        <wsdl:part element="analyticKeys" type="pe:Keys"
3069            name="analyticKeys"/>
3070    </wsdl:message>
3071
3072    <wsdl:message name="removeAvailableAnalyticsResponse">
3073    </wsdl:message>
3074
3075    <wsdl:message name="setAggregateMetadataRequest">
3076        <wsdl:part element="metadata"
3077            type="pemd:ProcessingElementMetadata" name="metadata"/>

```

```

3078    </wsdl:message>
3079
3080    <wsdl:message name="setAggregateMetadataResponse">
3081        </wsdl:message>
3082
3083    <wsdl:message name="getNextDestinationsRequest">
3084        <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3085    </wsdl:message>
3086
3087    <wsdl:message name="getNextDestinationsResponse">
3088        <wsdl:part element="step" type="pe:Step" name="step"/>
3089    </wsdl:message>
3090
3091    <wsdl:message name="continueOnFailureRequest">
3092        <wsdl:part element="cas" type="xmi:XMI" name="cas"/>
3093        <wsdl:part element="failedAnalyticKey" type="xsd:string"
3094            name="failedAnalyticKey"/>
3095        <wsdl:part element="failure" type="pe:UimaException" name="failure"/>
3096    </wsdl:message>
3097
3098    <wsdl:message name="continueOnFailureResponse">
3099        <wsdl:part element="continue" type="xsd:boolean" name="continue"/>
3100    </wsdl:message>
3101
3102    <!-- Define a portType for each of the UIMA interfaces -->
3103    <wsdl:portType name="Analyzer">
3104
3105        <wsdl:operation name="getMetadata">
3106            <wsdl:input message="service:getMetadataRequest"
3107                name="getMetadataRequest"/>
3108            <wsdl:output message="service:getMetadataResponse"
3109                name="getMetadataResponse"/>
3110            <wsdl:fault message="service:uimaFault"
3111                name="uimaFault"/>
3112        </wsdl:operation>
3113
3114        <wsdl:operation name="setConfigurationParameters">
3115            <wsdl:input
3116                message="service:setConfigurationParametersRequest"
3117                name="setConfigurationParametersRequest"/>
3118            <wsdl:output
3119                message="service:setConfigurationParametersResponse"
3120                name="setConfigurationParametersResponse"/>
3121            <wsdl:fault message="service:uimaFault"
3122                name="uimaFault"/>
3123        </wsdl:operation>
3124
3125        <wsdl:operation name="processCas">
3126            <wsdl:input message="service:processCasRequest"
3127                name="processCasRequest"/>
3128            <wsdl:output message="service:processCasResponse"
3129                name="processCasResponse"/>
3130            <wsdl:fault message="service:uimaFault"
3131                name="uimaFault"/>
3132        </wsdl:operation>
3133
3134        <wsdl:operation name="processCasBatch">
3135            <wsdl:input message="service:processCasBatchRequest"

```

```

3136         name="processCasBatchRequest"/>
3137     <wsdl:output message="service:processCasBatchResponse"
3138         name="processCasBatchResponse"/>
3139     <wsdl:fault message="service:uimaFault"
3140         name="uimaFault"/>
3141     </wsdl:operation>
3142 </wsdl:portType>
3143
3144 <wsdl:portType name="CasMultiplier">
3145
3146     <wsdl:operation name="getMetadata">
3147         <wsdl:input message="service:getMetadataRequest"
3148             name="getMetadataRequest"/>
3149         <wsdl:output message="service:getMetadataResponse"
3150             name="getMetadataResponse"/>
3151         <wsdl:fault message="service:uimaFault"
3152             name="uimaFault"/>
3153     </wsdl:operation>
3154
3155     <wsdl:operation name="setConfigurationParameters">
3156         <wsdl:input
3157             message="service:setConfigurationParametersRequest"
3158             name="setConfigurationParametersRequest"/>
3159         <wsdl:output
3160             message="service:setConfigurationParametersResponse"
3161             name="setConfigurationParametersResponse"/>
3162         <wsdl:fault message="service:uimaFault"
3163             name="uimaFault"/>
3164     </wsdl:operation>
3165
3166     <wsdl:operation name="inputCas">
3167         <wsdl:input message="service:inputCasRequest"
3168             name="inputCasRequest"/>
3169         <wsdl:output message="service:inputCasResponse"
3170             name="inputCasResponse"/>
3171         <wsdl:fault message="service:uimaFault"
3172             name="uimaFault"/>
3173     </wsdl:operation>
3174
3175     <wsdl:operation name="getNextCas">
3176         <wsdl:input message="service:getNextCasRequest"
3177             name="getNextCasRequest"/>
3178         <wsdl:output message="service:getNextCasResponse"
3179             name="getNextCasResponse"/>
3180         <wsdl:fault message="service:uimaFault"
3181             name="uimaFault"/>
3182     </wsdl:operation>
3183
3184     <wsdl:operation name="retrieveInputCas">
3185         <wsdl:input message="service:retrieveInputCasRequest"
3186             name="retrieveInputCasRequest"/>
3187         <wsdl:output message="service:retrieveInputCasResponse"
3188             name="retrieveInputCasResponse"/>
3189         <wsdl:fault message="service:uimaFault"
3190             name="uimaFault"/>
3191     </wsdl:operation>
3192
3193     <wsdl:operation name="getNextCasBatch">

```

```

3194     <wsdl:input message="service:getNextCasBatchRequest"
3195         name="getNextCasBatchRequest"/>
3196     <wsdl:output message="service:getNextCasBatchResponse"
3197         name="getNextCasBatchResponse"/>
3198     <wsdl:fault message="service:uimaFault"
3199         name="uimaFault"/>
3200   </wsdl:operation>
3201 </wsdl:portType>
3202
3203 <wsdl:portType name="FlowController">
3204
3205   <wsdl:operation name="getMetadata">
3206     <wsdl:input message="service:getMetadataRequest"
3207         name="getMetadataRequest"/>
3208     <wsdl:output message="service:getMetadataResponse"
3209         name="getMetadataResponse"/>
3210     <wsdl:fault message="service:uimaFault"
3211         name="uimaFault"/>
3212   </wsdl:operation>
3213
3214   <wsdl:operation name="setConfigurationParameters">
3215     <wsdl:input
3216         message="service:setConfigurationParametersRequest"
3217         name="setConfigurationParametersRequest"/>
3218     <wsdl:output
3219         message="service:setConfigurationParametersResponse"
3220         name="setConfigurationParametersResponse"/>
3221     <wsdl:fault message="service:uimaFault"
3222         name="uimaFault"/>
3223   </wsdl:operation>
3224
3225   <wsdl:operation name="addAvailableAnalytics">
3226     <wsdl:input message="service:addAvailableAnalyticsRequest"
3227         name="addAvailableAnalyticsRequest"/>
3228     <wsdl:output message="service:addAvailableAnalyticsResponse"
3229         name="addAvailableAnalyticsResponse"/>
3230     <wsdl:fault message="service:uimaFault"
3231         name="uimaFault"/>
3232   </wsdl:operation>
3233
3234   <wsdl:operation name="removeAvailableAnalytics">
3235     <wsdl:input
3236         message="service:removeAvailableAnalyticsRequest"
3237         name="removeAvailableAnalyticsRequest"/>
3238     <wsdl:output
3239         message="service:removeAvailableAnalyticsResponse"
3240         name="removeAvailableAnalyticsResponse"/>
3241     <wsdl:fault message="service:uimaFault"
3242         name="uimaFault"/>
3243   </wsdl:operation>
3244
3245   <wsdl:operation name="setAggregateMetadata">
3246     <wsdl:input message="service:setAggregateMetadataRequest"
3247         name="setAggregateMetadataRequest"/>
3248     <wsdl:output message="service:setAggregateMetadataResponse"
3249         name="setAggregateMetadataResponse"/>
3250     <wsdl:fault message="service:uimaFault"
3251         name="uimaFault"/>

```

```

3252     </wsdl:operation>
3253
3254     <wsdl:operation name="getNextDestinations">
3255         <wsdl:input message="service:getNextDestinationsRequest"
3256             name="getNextDestinationsRequest"/>
3257         <wsdl:output message="service:getNextDestinationsResponse"
3258             name="getNextDestinationsResponse"/>
3259         <wsdl:fault message="service:uimaFault"
3260             name="uimaFault"/>
3261     </wsdl:operation>
3262
3263     <wsdl:operation name="continueOnFailure">
3264         <wsdl:input message="service:continueOnFailureRequest"
3265             name="continueOnFailureRequest"/>
3266         <wsdl:output message="service:continueOnFailureResponse"
3267             name="continueOnFailureResponse"/>
3268         <wsdl:fault message="service:uimaFault"
3269             name="uimaFault"/>
3270     </wsdl:operation>
3271
3272 </wsdl:portType>
3273
3274 <!-- Define a SOAP binding for each portType. -->
3275 <wsdl:binding name="AnalyzerSoapBinding" type="service:Analyzer">
3276
3277     <wsdlsoap:binding style="rpc"
3278         transport="http://schemas.xmlsoap.org/soap/http"/>
3279
3280     <wsdl:operation name="getMetadata">
3281         <wsdlsoap:operation soapAction="" />
3282
3283         <wsdl:input name="getMetadataRequest">
3284             <wsdlsoap:body use="literal"/>
3285         </wsdl:input>
3286
3287         <wsdl:output name="getMetadataResponse">
3288             <wsdlsoap:body use="literal"/>
3289         </wsdl:output>
3290     </wsdl:operation>
3291
3292     <wsdl:operation name="setConfigurationParameters">
3293         <wsdlsoap:operation soapAction="" />
3294
3295         <wsdl:input name="setConfigurationParametersRequest">
3296             <wsdlsoap:body use="literal"/>
3297         </wsdl:input>
3298
3299         <wsdl:output name="setConfigurationParametersResponse">
3300             <wsdlsoap:body use="literal"/>
3301         </wsdl:output>
3302     </wsdl:operation>
3303
3304     <wsdl:operation name="processCas">
3305         <wsdlsoap:operation soapAction="" />
3306
3307         <wsdl:input name="processCasRequest">
3308             <wsdlsoap:body use="literal"/>
3309         </wsdl:input>

```

```

3310
3311      <wsdl:output name="processCasResponse">
3312          <wsdlsoap:body use="literal"/>
3313      </wsdl:output>
3314  </wsdl:operation>
3315
3316  <wsdl:operation name="processCasBatch">
3317      <wsdlsoap:operation soapAction="" />
3318
3319      <wsdl:input name="processCasBatchRequest">
3320          <wsdlsoap:body use="literal"/>
3321      </wsdl:input>
3322
3323      <wsdl:output name="processCasBatchResponse">
3324          <wsdlsoap:body use="literal"/>
3325      </wsdl:output>
3326  </wsdl:operation>
3327 </wsdl:binding>
3328
3329 <wsdl:binding name="CasMultiplierSoapBinding"
3330   type="service:CasMultiplier">
3331
3332     <wsdlsoap:binding style="rpc"
3333       transport="http://schemas.xmlsoap.org/soap/http"/>
3334
3335     <wsdl:operation name="getMetadata">
3336         <wsdlsoap:operation soapAction="" />
3337
3338         <wsdl:input name="getMetadataRequest">
3339             <wsdlsoap:body use="literal"/>
3340         </wsdl:input>
3341
3342         <wsdl:output name="getMetadataResponse">
3343             <wsdlsoap:body use="literal"/>
3344         </wsdl:output>
3345
3346         <wsdl:fault name="uimaFault">
3347             <wsdlsoap:fault use="literal"/>
3348         </wsdl:fault>
3349     </wsdl:operation>
3350
3351     <wsdl:operation name="setConfigurationParameters">
3352         <wsdlsoap:operation soapAction="" />
3353
3354         <wsdl:input name="setConfigurationParametersRequest">
3355             <wsdlsoap:body use="literal"/>
3356         </wsdl:input>
3357
3358         <wsdl:output name="setConfigurationParametersResponse">
3359             <wsdlsoap:body use="literal"/>
3360         </wsdl:output>
3361
3362         <wsdl:fault name="uimaFault">
3363             <wsdlsoap:fault use="literal"/>
3364         </wsdl:fault>
3365     </wsdl:operation>
3366
3367     <wsdl:operation name="inputCas">

```

```

3368     <wsdlsoap:operation soapAction="" />
3369
3370     <wsdl:input name="inputCasRequest">
3371         <wsdlsoap:body use="literal" />
3372     </wsdl:input>
3373
3374     <wsdl:output name="inputCasResponse">
3375         <wsdlsoap:body use="literal" />
3376     </wsdl:output>
3377
3378     <wsdl:fault name="uimaFault">
3379         <wsdlsoap:fault use="literal" />
3380     </wsdl:fault>
3381 </wsdl:operation>
3382
3383 <wsdl:operation name="getNextCas">
3384     <wsdlsoap:operation soapAction="" />
3385
3386     <wsdl:input name="getNextCasRequest">
3387         <wsdlsoap:body use="literal" />
3388     </wsdl:input>
3389
3390     <wsdl:output name="getNextCasResponse">
3391         <wsdlsoap:body use="literal" />
3392     </wsdl:output>
3393
3394     <wsdl:fault name="uimaFault">
3395         <wsdlsoap:fault use="literal" />
3396     </wsdl:fault>
3397 </wsdl:operation>
3398
3399 <wsdl:operation name="retrieveInputCas">
3400     <wsdlsoap:operation soapAction="" />
3401
3402     <wsdl:input name="retrieveInputCasRequest">
3403         <wsdlsoap:body use="literal" />
3404     </wsdl:input>
3405
3406     <wsdl:output name="retrieveInputCasResponse">
3407         <wsdlsoap:body use="literal" />
3408     </wsdl:output>
3409
3410     <wsdl:fault name="uimaFault">
3411         <wsdlsoap:fault use="literal" />
3412     </wsdl:fault>
3413 </wsdl:operation>
3414
3415 <wsdl:operation name="getNextCasBatch">
3416     <wsdlsoap:operation soapAction="" />
3417
3418     <wsdl:input name="getNextCasBatchRequest">
3419         <wsdlsoap:body use="literal" />
3420     </wsdl:input>
3421
3422     <wsdl:output name="getNextCasBatchResponse">
3423         <wsdlsoap:body use="literal" />
3424     </wsdl:output>
3425

```

```

3426      <wsdl:fault name="uimaFault">
3427          <wsdlsoap:fault use="literal"/>
3428      </wsdl:fault>
3429  </wsdl:operation>
3430 </wsdl:binding>
3431
3432 <wsdl:binding name="FlowControllerSoapBinding"
3433   type="service:FlowController">
3434
3435     <wsdlsoap:binding style="rpc"
3436       transport="http://schemas.xmlsoap.org/soap/http"/>
3437
3438     <wsdl:operation name="getMetadata">
3439       <wsdlsoap:operation soapAction="" />
3440
3441       <wsdl:input name="getMetadataRequest">
3442         <wsdlsoap:body use="literal"/>
3443       </wsdl:input>
3444
3445       <wsdl:output name="getMetadataResponse">
3446         <wsdlsoap:body use="literal"/>
3447       </wsdl:output>
3448
3449       <wsdl:fault name="uimaFault">
3450         <wsdlsoap:fault use="literal"/>
3451       </wsdl:fault>
3452     </wsdl:operation>
3453
3454   <wsdl:operation name="setConfigurationParameters">
3455     <wsdlsoap:operation soapAction="" />
3456
3457     <wsdl:input name="setConfigurationParametersRequest">
3458       <wsdlsoap:body use="literal"/>
3459     </wsdl:input>
3460
3461     <wsdl:output name="setConfigurationParametersResponse">
3462       <wsdlsoap:body use="literal"/>
3463     </wsdl:output>
3464
3465       <wsdl:fault name="uimaFault">
3466         <wsdlsoap:fault use="literal"/>
3467       </wsdl:fault>
3468     </wsdl:operation>
3469
3470   <wsdl:operation name="addAvailableAnalytics">
3471     <wsdlsoap:operation soapAction="" />
3472
3473     <wsdl:input name="addAvailableAnalyticsRequest">
3474       <wsdlsoap:body use="literal"/>
3475     </wsdl:input>
3476
3477     <wsdl:output name="addAvailableAnalyticsResponse">
3478       <wsdlsoap:body use="literal"/>
3479     </wsdl:output>
3480
3481       <wsdl:fault name="uimaFault">
3482         <wsdlsoap:fault use="literal"/>
3483       </wsdl:fault>

```

```

3484     </wsdl:operation>
3485
3486     <wsdl:operation name="removeAvailableAnalytics">
3487         <wsdlsoap:operation soapAction="" />
3488
3489         <wsdl:input name="removeAvailableAnalyticsRequest">
3490             <wsdlsoap:body use="literal" />
3491         </wsdl:input>
3492
3493         <wsdl:output name="removeAvailableAnalyticsResponse">
3494             <wsdlsoap:body use="literal" />
3495         </wsdl:output>
3496
3497         <wsdl:fault name="uimaFault">
3498             <wsdlsoap:fault use="literal" />
3499         </wsdl:fault>
3500     </wsdl:operation>
3501
3502     <wsdl:operation name="setAggregateMetadata">
3503         <wsdlsoap:operation soapAction="" />
3504
3505         <wsdl:input name="setAggregateMetadataRequest">
3506             <wsdlsoap:body use="literal" />
3507         </wsdl:input>
3508
3509         <wsdl:output name="setAggregateMetadataResponse">
3510             <wsdlsoap:body use="literal" />
3511         </wsdl:output>
3512
3513         <wsdl:fault name="uimaFault">
3514             <wsdlsoap:fault use="literal" />
3515         </wsdl:fault>
3516     </wsdl:operation>
3517
3518     <wsdl:operation name="getNextDestinations">
3519         <wsdlsoap:operation soapAction="" />
3520
3521         <wsdl:input name="getNextDestinationsRequest">
3522             <wsdlsoap:body use="literal" />
3523         </wsdl:input>
3524
3525         <wsdl:output name="getNextDestinationsResponse">
3526             <wsdlsoap:body use="literal" />
3527         </wsdl:output>
3528
3529         <wsdl:fault name="uimaFault">
3530             <wsdlsoap:fault use="literal" />
3531         </wsdl:fault>
3532     </wsdl:operation>
3533
3534     <wsdl:operation name="continueOnFailure">
3535         <wsdlsoap:operation soapAction="" />
3536
3537         <wsdl:input name="continueOnFailureRequest">
3538             <wsdlsoap:body use="literal" />
3539         </wsdl:input>
3540
3541         <wsdl:output name="continueOnFailureResponse">

```

```

3542         <wsdlsoap:body use="literal"/>
3543     </wsdl:output>
3544
3545     <wsdl:fault name="uimaFault">
3546         <wsdlsoap:fault use="literal"/>
3547     </wsdl:fault>
3548   </wsdl:operation>
3549 </wsdl:binding>
3550
3551 <!-- Define an example service as including both portTypes. This is
3552     just an example, not part of the UIMA Specification -->
3553 <wsdl:service name="MyAnalyticService">
3554   <wsdl:port binding="service:AnalyzerSoapBinding"
3555     name="AnalyzerSoapPort">
3556     <wsdlsoap:address
3557
3558   location="http://localhost:8080/axis/services/MyAnalyticService/AnalyzerPort"
3559 />
3560   </wsdl:port>
3561   <wsdl:port binding="service:CasMultiplierSoapBinding"
3562     name="CasMultiplierSoapPort">
3563     <wsdlsoap:address
3564
3565   location="http://localhost:8080/axis/services/MyAnalyticService/CasMultiplier
3566   Port"/>
3567   </wsdl:port>
3568 </wsdl:service>
3569 </wsdl:definitions>

```

## 3570 C.8 PE Service Data Types XML Schema (uima.peServiceXMI.xsd)

3571 This XML schema is referenced from the WSDL definition in Appendix C.7

```

3572 <?xml version="1.0" encoding="UTF-8" standalone="no"?>
3573 <xsd:schema xmlns:uima.pe="http://docs.oasis-open.org/uima/ns/pe.ecore"
3574   xmlns:uima.peMetadata="http://docs.oasis-open.org/uima/ns/peMetadata.ecore"
3575   xmlns:xmi="http://www.omg.org/XMI"
3576   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
3577   targetNamespace="http://docs.oasis-open.org/uima/ns/pe.ecore">
3578   <xsd:import namespace="http://docs.oasis-open.org/uima/ns/peMetadata.ecore"
3579     schemaLocation="uima.peMetadataXMI.xsd"/>
3580   <xsd:import namespace="http://www.omg.org/XMI"
3581     schemaLocation="../../../../plugin/org.eclipse.emf.ecore/model/XMI.xsd"/>
3582   <xsd:complexType name="ProcessingElement">
3583     <xsd:choice maxOccurs="unbounded" minOccurs="0">
3584       <xsd:element ref="xmi:Extension"/>
3585     </xsd:choice>
3586     <xsd:attribute ref="xmi:id"/>
3587     <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3588   </xsd:complexType>
3589   <xsd:element name="ProcessingElement" type="uima.pe:ProcessingElement"/>
3590   <xsd:complexType name="Analyzer">
3591     <xsd:complexContent>
3592       <xsd:extension base="uima.pe:Analytic"/>
3593     </xsd:complexContent>
3594   </xsd:complexType>
3595   <xsd:element name="Analyzer" type="uima.pe:Analyzer"/>
3596   <xsd:complexType name="CasMultiplier">

```

```

3597      <xsd:complexContent>
3598          <xsd:extension base="uima.pe:Analytic"/>
3599      </xsd:complexContent>
3600  </xsd:complexType>
3601  <xsd:element name="CasMultiplier" type="uima.pe:CasMultiplier"/>
3602  <xsd:complexType name="FlowController">
3603      <xsd:complexContent>
3604          <xsd:extension base="uima.pe:ProcessingElement"/>
3605      </xsd:complexContent>
3606  </xsd:complexType>
3607  <xsd:element name="FlowController" type="uima.pe:FlowController"/>
3608  <xsd:complexType name="AnalyticMetadataMap">
3609      <xsd:choice maxOccurs="unbounded" minOccurs="0">
3610          <xsd:element name="AnalyticMetadataMapEntry"
3611          type="uima.pe:AnalyticMetadataMapEntry"/>
3612          <xsd:element ref="xmi:Extension"/>
3613      </xsd:choice>
3614      <xsd:attribute ref="xmi:id"/>
3615      <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3616      <xsd:attribute name="AnalyticMetadataMapEntry" type="xsd:string"/>
3617  </xsd:complexType>
3618  <xsd:element name="AnalyticMetadataMap"
3619  type="uima.pe:AnalyticMetadataMap"/>
3620  <xsd:complexType name="AnalyticMetadataMapEntry">
3621      <xsd:choice maxOccurs="unbounded" minOccurs="0">
3622          <xsd:element name="ProcessingElementMetadata"
3623          type="uima.peMetadata:ProcessingElementMetadata"/>
3624          <xsd:element ref="xmi:Extension"/>
3625      </xsd:choice>
3626      <xsd:attribute ref="xmi:id"/>
3627      <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3628      <xsd:attribute name="key" type="xsd:string"/>
3629      <xsd:attribute name="ProcessingElementMetadata" type="xsd:string"/>
3630  </xsd:complexType>
3631  <xsd:element name="AnalyticMetadataMapEntry"
3632  type="uima.pe:AnalyticMetadataMapEntry"/>
3633  <xsd:complexType name="Analytic">
3634      <xsd:complexContent>
3635          <xsd:extension base="uima.pe:ProcessingElement"/>
3636      </xsd:complexContent>
3637  </xsd:complexType>
3638  <xsd:element name="Analytic" type="uima.pe:Analytic"/>
3639  <xsd:complexType name="Step">
3640      <xsd:choice maxOccurs="unbounded" minOccurs="0">
3641          <xsd:element ref="xmi:Extension"/>
3642      </xsd:choice>
3643      <xsd:attribute ref="xmi:id"/>
3644      <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3645  </xsd:complexType>
3646  <xsd:element name="Step" type="uima.pe:Step"/>
3647  <xsd:complexType name="SimpleStep">
3648      <xsd:complexContent>
3649          <xsd:extension base="uima.pe:Step">
3650              <xsd:attribute name="analyticKey" type="xsd:string"/>
3651          </xsd:extension>
3652      </xsd:complexContent>
3653  </xsd:complexType>
3654  <xsd:element name="SimpleStep" type="uima.pe:SimpleStep"/>

```

```

3655 <xsd:complexType name="MultiStep">
3656   <xsd:complexContent>
3657     <xsd:extension base="uima.pe:Step">
3658       <xsd:choice maxOccurs="unbounded" minOccurs="0">
3659         <xsd:element name="steps" type="uima.pe:Step"/>
3660       </xsd:choice>
3661       <xsd:attribute name="parallel" type="xsd:boolean"/>
3662     </xsd:extension>
3663   </xsd:complexContent>
3664 </xsd:complexType>
3665 <xsd:element name="MultiStep" type="uima.pe:MultiStep"/>
3666 <xsd:complexType name="FinalStep">
3667   <xsd:complexContent>
3668     <xsd:extension base="uima.pe:Step"/>
3669   </xsd:complexContent>
3670 </xsd:complexType>
3671 <xsd:element name="FinalStep" type="uima.pe:FinalStep"/>
3672 <xsd:complexType name="Keys">
3673   <xsd:choice maxOccurs="unbounded" minOccurs="0">
3674     <xsd:element name="key" nillable="true" type="xsd:string"/>
3675     <xsd:element ref="xmi:Extension"/>
3676   </xsd:choice>
3677   <xsd:attribute ref="xmi:id"/>
3678   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3679 </xsd:complexType>
3680 <xsd:element name="Keys" type="uima.pe:Keys"/>
3681 <xsd:complexType name="ObjectList">
3682   <xsd:choice maxOccurs="unbounded" minOccurs="0">
3683     <xsd:element name="objects" type="xmi:Any"/>
3684     <xsd:element ref="xmi:Extension"/>
3685   </xsd:choice>
3686   <xsd:attribute ref="xmi:id"/>
3687   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3688   <xsd:attribute name="objects" type="xsd:string"/>
3689 </xsd:complexType>
3690 <xsd:element name="ObjectList" type="uima.pe:ObjectList"/>
3691 <xsd:complexType name="UimaException">
3692   <xsd:choice maxOccurs="unbounded" minOccurs="0">
3693     <xsd:element ref="xmi:Extension"/>
3694   </xsd:choice>
3695   <xsd:attribute ref="xmi:id"/>
3696   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3697   <xsd:attribute name="message" type="xsd:string"/>
3698 </xsd:complexType>
3699 <xsd:element name="UimaException" type="uima.pe:UimaException"/>
3700 <xsd:complexType name="ConfigurationParameterSettings">
3701   <xsd:choice maxOccurs="unbounded" minOccurs="0">
3702     <xsd:element name="ConfigurationParameterSetting"
3703 type="uima.pe:ConfigurationParameterSetting"/>
3704     <xsd:element ref="xmi:Extension"/>
3705   </xsd:choice>
3706   <xsd:attribute ref="xmi:id"/>
3707   <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3708 </xsd:complexType>
3709 <xsd:element name="ConfigurationParameterSettings"
3710 type="uima.pe:ConfigurationParameterSettings"/>
3711 <xsd:complexType name="ConfigurationParameterSetting">
3712   <xsd:choice maxOccurs="unbounded" minOccurs="0">

```

```

3713      <xsd:element name="values" nillable="true" type="xsd:string"/>
3714      <xsd:element ref="xmi:Extension"/>
3715    </xsd:choice>
3716    <xsd:attribute ref="xmi:id"/>
3717    <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3718      <xsd:attribute name="parameterName" type="xsd:string"/>
3719    </xsd:complexType>
3720    <xsd:element name="ConfigurationParameterSetting"
3721      type="uima.pe:ConfigurationParameterSetting"/>
3722      <xsd:complexType name="CasBatchInput">
3723        <xsd:choice maxOccurs="unbounded" minOccurs="0">
3724          <xsd:element name="CasBatchInputElement"
3725            type="uima.pe:CasBatchInputElement"/>
3726            <xsd:element ref="xmi:Extension"/>
3727          </xsd:choice>
3728          <xsd:attribute ref="xmi:id"/>
3729          <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3730        </xsd:complexType>
3731        <xsd:element name="CasBatchInput" type="uima.pe:CasBatchInput"/>
3732        <xsd:complexType name="CasBatchInputElement">
3733          <xsd:choice maxOccurs="unbounded" minOccurs="0">
3734            <xsd:element name="cas" type="xmi:Any"/>
3735            <xsd:element name="sofas" type="uima.pe:ObjectList"/>
3736            <xsd:element ref="xmi:Extension"/>
3737          </xsd:choice>
3738          <xsd:attribute ref="xmi:id"/>
3739          <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3740        </xsd:complexType>
3741        <xsd:element name="CasBatchInputElement"
3742          type="uima.pe:CasBatchInputElement"/>
3743        <xsd:complexType name="CasBatchResponse">
3744          <xsd:choice maxOccurs="unbounded" minOccurs="0">
3745            <xsd:element name="CasBatchResponseElement"
3746              type="uima.pe:CasBatchResponseElement"/>
3747            <xsd:element ref="xmi:Extension"/>
3748          </xsd:choice>
3749          <xsd:attribute ref="xmi:id"/>
3750          <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3751        </xsd:complexType>
3752        <xsd:element name="CasBatchResponse" type="uima.pe:CasBatchResponse"/>
3753        <xsd:complexType name="CasBatchResponseElement">
3754          <xsd:choice maxOccurs="unbounded" minOccurs="0">
3755            <xsd:element name="CAS" type="xmi:Any"/>
3756            <xsd:element name="UimaException" type="uima.pe:UimaException"/>
3757            <xsd:element ref="xmi:Extension"/>
3758          </xsd:choice>
3759          <xsd:attribute ref="xmi:id"/>
3760          <xsd:attributeGroup ref="xmi:ObjectAttrs"/>
3761        </xsd:complexType>
3762        <xsd:element name="CasBatchResponseElement"
3763          type="uima.pe:CasBatchResponseElement"/>
3764        <xsd:complexType name="GetNextCasBatchResponse">
3765          <xsd:choice maxOccurs="unbounded" minOccurs="0">
3766            <xsd:element name="CAS" type="xmi:Any"/>
3767            <xsd:element ref="xmi:Extension"/>
3768          </xsd:choice>
3769          <xsd:attribute ref="xmi:id"/>
3770          <xsd:attributeGroup ref="xmi:ObjectAttrs"/>

```

```
3771      <xsd:attribute name="hasMoreCAses" type="xsd:boolean"/>
3772      <xsd:attribute name="estimatedRemainingCAses" type="xsd:int"/>
3773  </xsd:complexType>
3774  <xsd:element name="GetNextCasBatchResponse"
3775    type="uima.pe:GetNextCasBatchResponse"/>
3776 </xsd:schema>
```