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2 **FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS**

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5 **FIPA JXTA Discovery Middleware**

6 **Specification**

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56 **1 Scope**

57 This document deals with the application of JXTA [JXTA] as discovery middleware (DM) for the Agent Discovery
58 Service (ADS). This specification forms part of the FIPA Agent Discovery Service Specification [<<Agent
59 Discovery Service Specification>>] and contains specifications for:

- 60
- 61 • The necessary extensions to JXTA to be usable as DM within the ADS.
 - 62
 - 63 • The interface for the interaction of JXTA DMs.

64 2 JXTA Discovery Middleware

65 JXTA technology is a set of open protocols that allow any connected device on the network to communicate in a
66 peer-to-peer manner. For details see [JXTA].

67 2.1 Discovery Middleware Component Name

68 The name assigned to this discovery middleware component is:
69 `fipa.ads.dm.jxta.std`

71 2.2 New JXTA Components

72 JXTA advertisements are used to describe any kind of resource within the network. A DF-like, template based
73 discovery realized with the means of JXTA needs a mechanism to find arbitrary attribute/value pairs within JXTA
74 advertisements. The new components, which are necessary to realize this, are a new:

- 76 • JXTA service (see section 2.2.1)
- 77
- 78 • JXTA peer group (see section 2.2.2)
- 79
- 80 • JXTA advertisement type (see section 2.2.3)
- 81

82 2.2.1 Generic Discovery Service

83 This specification does not specify how the Generic Discovery Service (GDS) must look like, but the GDS must
84 provide the DM functionality specified in [`<<Agent Discovery Service Specification>>`].

85
86 A JXTA Module Class ID uniquely identifies a class of JXTA modules, for instance JXTA services, that provide a
87 certain functionality. The JXTA Module Class ID for GDS services offering the DM functionality specified in
88 [`<<Agent Discovery Service Specification>>`] is:

89 `urn:jxta:uuid-A4182DD0DC504CD48CC4A441E56627B405`

90
91 A JXTA Module Specification ID uniquely identifies a set of protocol compatible modules. The JXTA Module
92 Specification ID for GDS services offering the DM functionality specified in [`<<Agent Discovery Service
93 Specification>>`] and implementing the Generic Discovery Protocol as specified in 2.3.1 is:

94 `urn:jxta:uuid-A4182DD0DC504CD48CC4A441E56627B4F15B15DB91E74BC28945908432FC790406`

95
96 The version of the JXTA Module Specification belonging to the GDS services offering the DM functionality
97 specified in [`<<Agent Discovery Service Specification>>`] and implementing the Generic Discovery Protocol is: 1.0

99 2.2.2 Agent Peer Group

100 The Agent Peer Group (APG) is a child of the JXTA Net Peer Group. The APG must be joined during the startup of
101 the DM, because the APG hosts the GDS and is the scope of the GDS. Other services that may also be hosted by
102 the APG are outside the scope of this specification.

103
104 A JXTA Peer Group ID uniquely identifies a JXTA peer group. The JXTA Peer Group ID assigned to the APG is:

105 `urn:jxta:uuid-A19999539B18489C8E47860E6C89549E02`

106
107 The JXTA Module Specification ID for the APG uniquely identifies the module providing the implementation of the
108 peer group module on the JXTA peer. The JXTA Module Specification ID for the APG is:

109 `urn:jxta:uuid-DEADBEEFDEAFBABAFAFEEDBABE00000001994191D8846242F8AF4FBB14AF2CDFAF06`

110

111 2.2.3 Generic Discovery Advertisements

112 A Generic Discovery Advertisement (GDA) is used to handle agent or service descriptions, for example FIPA `df-`
 113 `agent-descriptions` [FIPA00023], at the level of JXTA. A GDA consists of meta information elements and of
 114 elements describing agents or services

115

116 The `PublishingTime` meta information element contains the time in milliseconds since 1970, when the GDA
 117 was published, i.e. made available publicly in the network.

118

119 The `Id` meta information element is used to specify the content type of the GDA, i.e. it defines how the elements of
 120 the GDA, except the meta information elements, must be interpreted. Table 1 summarizes the currently available
 121 GDA content types.

122

GDA Content Type	Interpret Content as	Note
Df-agent-description	FIPA <code>df-agent-description</code>	see [FIPA00023] and 2.2.3.1

Table 1: Possible Content Types of a GDA

123

124 2.2.3.1 Generic Discovery Advertisements with `df-agent-description` Content

125 In a GDA with `df-agent-description` content, value sets and value sequences of the FIPA `df-agent-`
 126 `description` parameters are broken up to single advertisement elements. For value sequences the order of the
 127 single elements in the advertisement is according to the order of values within a sequence of a FIPA `df-agent-`
 128 `description`.

129

130 The XML Schema¹ [W3C] of a GDA with DFAD content is as follows:

131

```

132 <xs:element name="GenericDiscoveryAdv" type="fipa:GenericDiscoveryAdv"/>
133 <xs:complexType name="GenericDiscoveryAdv">
134   <xs:sequence>
135     <xs:element name="Id" type="DFAD"/>
136     <xs:element name="PublishingTime" type="xs:unsignedInt"/>
137
138     <xs:complexType name="agentID" minOccurs="0"2>
139       <xs:sequence>
140         <xs:element name="name" type="xs:string"/>
141         <xs:element name="address" type="xs:string"
142           maxOccurs="unbounded" minOccurs="0"/>
143         <xs:element name="resolver" type="agentID"
144           maxOccurs="unbounded" minOccurs="0"/>
145       </xs:sequence>
146     </xs:complexType>
147
148     <xs:complexType name="service" maxOccurs="unbounded" minOccurs="0">
149       <xs:sequence>
150         <xs:element name="name" type="xs:string" minOccurs="0"/>
151         <xs:element name="type" type="xs:string" minOccurs="0"/>
152         <xs:element name="protocol" type="xs:string"
153           maxOccurs="unbounded" minOccurs="0"/>
154         <xs:element name="ontology" type="xs:string"
155           maxOccurs="unbounded" minOccurs="0"/>
156         <xs:element name="language" type="xs:string"
157           maxOccurs="unbounded" minOccurs="0"/>
158         <xs:element name="ownership" type="xs:string" minOccurs="0"/>
159         <xs:complexType name="property" maxOccurs="unbounded" minOccurs="0">
160           <xs:sequence>

```

¹ As stated in [Sun], service and protocol authors are recommended to specify advertisements and messages by using the XML Schema language.

² The default value for the `minOccurs` and `maxOccurs` attributes is 1.

```

161         <xs:element name="name" type="xs:string"/>
162         <xs:element name="type" type="xs:string"/>
163     </xs:sequence>
164 </xs:complexType>
165 </xs:sequence>
166 </xs:complexType>
167
168 <xs:element name="protocol" type="xs:string"
169     maxOccurs="unbounded" minOccurs="0"/>
170 <xs:element name="ontology" type="xs:string"
171     maxOccurs="unbounded" minOccurs="0"/>
172 <xs:element name="language" type="xs:string"
173     maxOccurs="unbounded" minOccurs="0"/>
174 <xs:element name="lease-time" type="xs:unsignedInt" minOccurs="0"/>
175 </xs:sequence>
176 </xs:complexType>
177
178 <xs:simpleType name="DFAD">
179     <xs:restriction base="xs:string">
180         <xs:pattern value="df\ -agent\ -description"/>
181     </xs:restriction>
182 </xs:simpleType>
183

```

184 2.3 Interface Definition

185 To enable the interaction of JXTA DMs on different agent platforms (AP), the Generic Discovery Protocol (GDP) is
 186 used to exchange GDAs. The GDP is implemented by the GDS, because it is a part of the GDS. All GDS
 187 implementations, which use the JXTA Module Specification ID defined in 2.2.1, must implement the GDP as
 188 specified in 2.3.1.
 189

190 2.3.1 Generic Discovery Protocol

191 The GDP is a request/response protocol to discover GDAs. The GDP comprises two messages, the
 192 `GenericDiscoveryQuery` message and the `GenericDiscoveryResponse` message.
 193

194 The `GenericDiscoveryQuery` is used for emitting discovery queries. The `Pattern` attribute of the
 195 `GenericDiscoveryQuery` is a required element and must contain a GDA that acts as the search pattern. The
 196 `Threshold` attribute is an optional element defining the maximum number of advertisements that should be sent
 197 by a peer responding to this query.
 198

199 The XML Schema of a `GenericDiscoveryQuery` is as follows:

```

200
201 <xs:element name="GenericDiscoveryQuery" type="fipa:GenericDiscoveryQuery"/>
202 <xs:complexType name="GenericDiscoveryQuery">
203     <xs:sequence>
204         <xs:element name="Pattern" type="fipa:GenericDiscoveryAdv"/>
205         <xs:element name="Threshold" type="xs:unsignedInt" minOccurs="0"/>
206     </xs:sequence>
207 </xs:complexType>
208

```

209 The `GenericDiscoveryResponse` message is used for returning matching GDAs in response to a
 210 `GenericDiscoveryQuery`. The `Count` attribute of the `GenericDiscoveryResponse` message is a required
 211 element and contains the number of returned results, i.e. the number of `Response` elements. A
 212 `GenericDiscoveryResponse` message contains one or more `Response` elements, each one wrapping a GDA
 213 that matches the previously received GDA search pattern.
 214

215 The XML Schema of a `GenericDiscoveryResponse` is as follows:

```

216
217 <xs:element name="GenericDiscoveryResponse" type="fipa:GenericDiscoveryResponse"/>

```

```
218 <xs:complexType name="GenericDiscoveryResponse">
219   <xs:sequence>
220     <xs:element name="Count" type="xs:unsignedInt"/>
221     <xs:element name="Response" type="fipa:GenericDiscoveryAdv"
222               maxOccurs="unbounded"/>
223   </xs:sequence>
224 </xs:complexType>
225
```


226 **3 References**

227 [FIPA00023] FIPA Agent Management Specification. Foundation for Intelligent Physical Agents, 2002.
228 <http://www.fipa.org/specs/fipa00023/>

229 [JXTA] Project JXTA.
230 <http://www.jxta.org/>

231 [W3C] XML Schema Part 1: Structures. World Wide Web Consortium (W3C), May 2001.
232 <http://www.w3.org/TR/xmlschema-1/>

233 [Sun] JXTA v2.0 Protocols Specification. Sun Microsystems, March 2003.
234 <http://spec.jxta.org/nonav/v1.0/docbook/JXTAProtocols.html>
235

236 4 Informative Annex A – Generic Discovery Advertisement Example

237 As an example the GDA of the job-agent is shown below. The GDA is of content type df-agent-
238 description and describes the agent itself, two of its supported services, one supported ontology and the
239 duration how long the df-agent-description is valid.

```
240  
241 <?xml version="1.0"?>  
242 <!DOCTYPE fipa:GenericDiscoveryAdv>  
243  
244 <fipa:GenericDiscoveryAdv xmlns:fipa="http://www.fipa.org">  
245 <Id>df-agent-description</Id>  
246 <PublishingTime>2753606022</PublishingTime>  
247  
248 <agentID>  
249 <name>job-agent@foo.com </name>  
250 <address>iiop://foo.com/acc</address>  
251 </agentID>  
252  
253 <service>  
254 <name>job-application</name>  
255 <protocol>application-proto</protocol>  
256 </service>  
257  
258 <service>  
259 <name>job-offer</name>  
260 <protocol>offer-proto</protocol>  
261 </service>  
262  
263 <ontology>job-onto</ontology>  
264 <lease-time>3600000</lease-time>  
265 </fipa:GenericDiscoveryAdv>
```

266 5 Informative Annex B – Generic Discovery Protocol Example

267 A `GenericDiscoveryQuery`, which can be emitted to discover the job agent, is shown below. This kind of
 268 message is used as part of the GDP in the discovery process of the GDS. The `GenericDiscoveryQuery` wraps
 269 within the `Pattern` element a GDA with content type `df-agent-description`. The GDA is used as `df-`
 270 `agent-description` search template. The `PublishingTime` element of the `df-agent-description`
 271 advertisement is zero because a search template is never published.

272
 273 The `<` characters of the wrapped GDA are encoded by the escape sequence `<`. This is a means of JXTA to
 274 guarantee the appropriate processing of nested advertisements.

```
275
276
277 <?xml version="1.0"?>
278 <!DOCTYPE fipa:GenericDisocveryQuery>
279
280 <fipa:GenericDiscoveryQuery xmlns:fipa="http://www.fipa.org">
281
282   <Pattern>
283     &lt;?xml version="1.0"?>
284     &lt;!DOCTYPE fipa:GenericDiscoveryAdv>
285
286     &lt;fipa:GenericDiscoveryAdv xmlns:fipa="http://www.fipa.org">
287       &lt;Id>df-agent-description&lt;/Id>
288       &lt;PublishingTime>0&lt;/PublishingTime>
289
290       &lt;service>
291         &lt;name>job-application&lt;/name>
292         &lt;protocol>application-proto&lt;/protocol>
293       &lt;/service>
294
295       &lt;ontology>job-onto&lt;/ontology>
296     &lt;/fipa:GenericDiscoveryAdv>
297   </Pattern>
298
299   <Threshold>5</Threshold>
300
301 </fipa:GenericDiscoveryQuery>
```

304 A `GenericDiscoveryResponse` belonging to the previous query is shown below. One matching result is
 305 returned within the `Response` element, namely the `job-agent`.

```
306
307
308 <?xml version="1.0"?>
309 <!DOCTYPE fipa:GenericDisocveryResponse>
310
311 <fipa:GenericDiscoveryResponse xmlns:fipa="http://www.fipa.org">
312
313   <Count>1</Count>
314
315   <Response>
316     &lt;?xml version="1.0"?>
317     &lt;!DOCTYPE fipa:GenericDiscoveryAdv>
318
319     &lt;fipa:GenericDiscoveryAdv xmlns:fipa="http://www.fipa.org">
320       &lt;Id>df-agent-description&lt;/Id>
321       &lt;PublishingTime>2753606022&lt;/PublishingTime>
322
323       &lt;agentID>
324         &lt;name>job-agent@foo.com&lt;/name>
325         &lt;address>iiop://foo.com/acc&lt;/address>
```

```
326         &lt;/agentID>
327
328         &lt;service>
329             &lt;name>job-application&lt;/name>
330             &lt;protocol>application-proto&lt;/protocol>
331         &lt;/service>
332
333         &lt;service>
334             &lt;name>job-offer&lt;/name>
335             &lt;protocol>offer-proto&lt;/protocol>
336         &lt;/service>
337
338         &lt;ontology>job-onto&lt;/ontology>
339         &lt;lease-time>3600000&lt;/lease-time>
340
341     &lt;/fipa:GenericDiscoveryAdv>
342 </Response>
343
344 </fipa:GenericDiscoveryResponse>
```

345 **6 Informative Annex C – Notes for Developers**

- 346 1. A straight forward way to implement the GDS is to use JXTA's Resolver Service with its Peer Resolver
347 Protocol and to design the GDS similar as JXTA's Discovery Service with its Peer Discovery Protocol. The
348 Peer Resolver Protocol could be used to transport GDP messages. The functionality of JXTA's Discovery
349 Service could be extended to find arbitrary attribute/value pairs within GDAs.
350
- 351 2. The `Id` meta information element in the GDA can be used efficiently to access a certain type of advertisement
352 within JXTA's local cache. This cache is accessed via the JXTA Discovery Service. Therefore for example all
353 GDAs, which contain `df-agent-description` information and have an `Id` meta information element stating to be
354 a `df-agent-description`, can be retrieved from the JXTA cache via the JXTA Discovery Service.
355
- 356 3. The GDA's XML Schema definition uses the compositor `sequence`, which is a property of the model group
357 schema component described in [W3C]. Note that despite its use, the order of the elements contained within
358 these compositors is assumed to be arbitrary.
359 This modus operandi complies to the one applied in JXTA source code and results from the fact that the
360 current version of the XML Schema language offers no better suited compositor. The `all` compositor would
361 allow for an arbitrary order of contained elements, but limits the occurrence of a certain element to zero or one.
362 This would be an even bigger limitation in the context of a GDA that should contain for example several
363 service descriptions. For details see [W3C] section 3.8.