

FOUNDATION FOR INTELLIGENT PHYSICAL AGENTS

FIPA Quality of Service Ontology Specification

Document title	FIPA Quality of Service Ontology Specification		
Document number	XXXX FIPA00094	Document source	FIPA Nomadic Application Support TC
Document status		Date of this status	2002/ 10/18 09/24
Supersedes			
Contact	fab@fipa.org		
Change history			
2002/09/24	Initial version — Extracted from Nomadic Application Support Specification (XC00014)		

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—<http://www.fipa.org/>

Geneva, Switzerland

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62 **1 Scope**

63 This document is part of the FIPA specifications and deals with Quality of Service ontology. This specification contains
64 specifications for an ontology for representing the Quality of Service of Message Transport Service.

65

65 2 Overview

66 The ability to automatically adjust to changes in a transparent and integrated fashion is essential for *nomadicity*;
67 nomadic end-users are usually professionals in areas other than computing. Furthermore, today's mobile computer
68 systems are already very complex to use as productivity tools. Thus, nomadic end-users need all the support that a
69 FIPA agent-based distributed system can deliver and adaptability to the changes in the environment of nomadic end-
70 users is an important issue. To be able to adapt to the changes, an agent must be aware of the changes in the
71 environment.

72
73 The `fipa-qos` ontology can be used by agents when communicating about the QoS. The ontology provides basic
74 vocabulary for QoS. Additionally, the `fipa-qos` ontology supports two methods to get QoS information: a single query
75 and a subscription. For example, an agent may query current QoS values from another agent using, for example, the
76 [fipa-query interaction protocol \[FIPA00027\]](#), or the agent may subscribe to notifications when something interesting
77 happens in the QoS using the [fipa-subscribe interaction protocol \[FIPA00035\]](#). These notifications may be
78 dispatched at a predefined interval or when some changes in the QoS occur. The former mechanism (periodic
79 notification) can be used if the agent wants to be informed about the QoS values on a regular basis, for example the
80 value of the throughput every five seconds. The latter mechanism (on occurrence notification) is useful when the agent
81 does not care about QoS values until something relevant to its task happens. For example, an agent that is sending
82 real-time data may need to be informed, when the throughput value drops below the given threshold.

83

84

84 3 Quality of Service Ontology

85 3.1 Object Descriptions

86 This section describes a set of frames, that represent the classes of objects in the domain of discourse within the
87 framework of the `fipa-qos` ontology.

88
89 The following terms are used to describe the objects of the domain:

- 91 • **Frame.** This is the mandatory name of this entity, that must be used to represent each instance of this class.
- 92
- 93 • **Ontology.** This is the name of the ontology, whose domain of discourse includes the parameters described in the
94 table.
- 95
- 96 • **Parameter.** This is the mandatory name of a parameter of this frame.
- 97
- 98 • **Description.** This is a natural language description of the semantics of each parameter.
- 99
- 100 • **Presence.** This indicates whether each parameter is mandatory or optional.
- 101
- 102 • **Type.** This is the type of the values of the parameter: Integer, Word, String, URL, Term, Set or Sequence.
- 103
- 104 • **Reserved Values.** This is a list of FIPA-defined constants that can assume values for this parameter.
- 105

106 3.1.1 Quality of Service Description

107 This type of object represents the quality of service of the transport protocol or communication channel.

108

Frame	qos			
Ontology	fipa-qos			
Parameter	Description	Presence ¹	Type	Reserved Values
Line-rate	The bandwidth in one direction over the link.	Optional	rate-value	
throughput	The number of user data bits successfully transferred in one direction across the link ² . Successful transfer means that no user data bits are lost, added or inverted in transfer.	Optional	rate-value	
throughput-std-dev	The current standard deviation of the throughput within a time unit.	Optional	rate-value	
Rtt	The round trip time which is the time required for a data segment to be transmitted to a peer entity and a corresponding acknowledgement sent back to the originating entity.	Optional	time-value	
rtt-std-dev	The standard deviation of the round-trip time within a time unit.	Optional	time-value	
delay	The (nominal) time required for a	Optional	time-value	

¹ While all of the parameters for this object are optional, a valid `qos` object will contain at least one parameter.

² See [ITUX135].

	data segment to be transmitted to a peer entity.			
delay-std-dev	The standard deviation of the delay time within a time unit.	Optional	time-value	
Mean-up-time	The expected uptime of an established link.	Optional	time-value	
omission-rate	The probability that a data segment is not transmitted correctly over a link.	Optional	probability-value	
ber	The ratio of the number of bit errors to the total number of bits transmitted in a given time interval ³ .	Optional	probability-value	
frame-error-rate	The probability that a data segment is not transmitted correctly over a link.	Optional	probability-value	
conn-setup-delay	The (sampled) delay to establish a connection between communicating entities.	Optional	time-value	
conn-setup-failure-prob	The ratio of total call attempts that result in call setup failure to the total call attempts in a population of interest.	Optional	probability-value	
status	The connectivity status of the link. <code>connected</code> means that there (at least) logical connection between communicating entities. <code>disconnected</code> means that there is no connection between communicating entities, and the communicating entities are not establishing a connection at the moment. <code>connecting</code> means that there is no connection between communicating entities, but they are currently establishing a connection between them.	Optional	word	<code>connected</code> <code>disconnected</code> <code>connecting</code>

109 **3.1.2 Rate Value**

110 This type of object represents a data transfer value.

111

Frame Ontology	rate-value fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
direction	The direction in which this value is measured. <code>inbound</code> means the data transmission where the actor receives the data, and <code>outbound</code> means the data transmission where the actor transmits the data.	Mandatory	word	<code>inbound</code> <code>outbound</code>

³ See [ITUE800].

unit	The unit in which the value is represented. bits/s means bits per seconds. kbits/s means kilobits per seconds. One kilobit is 2 ¹⁰ bits. mbits/s means megabits per second. One megabit is 2 ²⁰ bits. gbits/s means gigabits per second. One gigabit is 2 ³⁰ bits.	Mandatory	word	gbits/s mbits/s kbits/s bits/s
value	The rate value.	Mandatory	number	

112

113 **3.1.3 Time Value**

114 This type of object represents a time value.

115

Frame Ontology	time-value fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
direction	The direction in which this value is measured. inbound means the data transmission where the actor receives the data, and outbound means the data transmission where the actor transmits the data.	Optional ⁴	word	inbound outbound
unit	The unit in which the value is represented. h means hours, m means minutes, s means seconds, and ms means milliseconds.	Mandatory	word	h m s ms
value	The time value.	Mandatory	number	

116

117 **3.1.4 Probability Value**

118 This type of object represents a probability value.

119

Frame Ontology	probability-value fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
direction	The direction in which this value is measured. inbound means the data transmission where the actor receives the data, and outbound means the data transmission where the actor transmits the data.	Optional	word	inbound outbound
value	The probability value which obeys the following axiom: 0 • value • 1	Mandatory	number	

120

121

⁴ This parameter is mandatory for those QoS values that have a different value depending upon the direction.

121 **3.1.5 Change Constraint**

122 This type of object represents constraints that limit quality of service notifications.

123

Frame Ontology	change-constraint fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
value	The description of the constraints.	Mandatory	expression	

124

125 **3.1.63.1.5 Time Type Constraint**

126 This type of object represents constraints the time type of a time value that limit quality of service notifications.

127

Frame Ontology	time-constrainttype fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
typevalue	The value of the time-type. The type of the constraint. If the type every is used, then the expression becomes true after value and thereafter at intervals of value. If the type after is used, then the expression becomes true only after value.	Mandatory	word	every after

128

129 **3.1.7 Subscription Identifier**

130 This type of object represents the identification of a QoS information subscription.

131

Frame Ontology	subscription-id fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
id	Unique identifier for QoS notification subscription.	Mandatory	word	

132

133 **3.1.83.1.6 Communication Channel Description**

134 This type of object represents a communication channel.

135

Frame Ontology	comm-channel fipa-qos			
Parameter	Description	Presence⁵	Type	Reserved Values
name	The logical name of the communication channel.	Optional	word	
target-addr	The target transport address of the communication channel. This may also be the address of a gateway ACC.	Optional	url	
options	A list of optional parameters for the communication channel.	Optional	Set of property	

⁵ Either the :name parameter or the :target-addr parameter must be present in this object.

136

137 **3.1.93.1.7** Transport Protocol Description

138 This type of object represents a transport protocol.

139

Frame Ontology	transport-protocol fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
name	The logical name of the transport protocol.	Mandatory	word	
gw-addr	The transport address of the gateway ACC.	Optional	url	
dest-addr	The transport address of the ultimate destination. If this address is present, but gw-addr is not, then the Control Agent may select the most appropriate gateway transport address to use.	Optional	URL	
options	A list of optional parameters for the transport protocol.	Optional	Set of property	

140

141 **3.1.103.1.8** Property Template

142 This is a special object that is useful for specifying parameter/value pairs.

143

Frame Ontology	property fipa-qos			
Parameter	Description	Presence	Type	Reserved Values
name	The name of the property.	Mandatory	string	
value	The value of the property	Mandatory	term	

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145

146

3.2 ~~Function and Predicate Descriptions~~

The following tables define usage and semantics of ~~the functions and~~ the predicates that are part of the `fipa-qos` ontology.

The following terms are used to describe the functions-predicates of the `fipa-qos` domain:

~~•Function. This is the symbol that identifies the function in the ontology.~~

- **Predicate.** This is the symbol that identifies the predicate in the ontology.
 - **Ontology.** This is the name of the ontology, whose domain of discourse includes the function or the predicate described in the table.
 - **Supported by.** This is the type of agent that supports this function or predicate.
 - **Description.** This is a natural language description of the semantics of the function or the predicate.
 - **Domain.** This indicates the domain over which the function predicate is defined. The arguments passed to the function or predicate must belong to the set identified by the domain.
- ~~•Range. This indicates the range to which the function maps the symbols of the domain. The result of the function is a symbol belonging to the set identified by the range.~~
- **Arity.** This indicates the number of arguments that a function or a predicate takes. If a function or a predicate can take an arbitrary number of arguments, then its arity is undefined.

3.2.1 ~~Request Monitoring Information~~

Predicate	<code>qos-information</code>
Ontology	<code>fipa-qos</code>
Supported by	MA
Description	<p>An agent asks for quality of service information from an MA. The agent may specify either a communication channel or transport protocol to request quality of service information from.</p> <p>The predicate is true, when the values of the QoS parameters defined in the <code>qos-qos</code> object are true for given communication channel or transport protocol (i.e., the QoS of communication channel or transport protocol is what stated in the QoS object). Otherwise the predicate is false.</p>
Domain	<code>comm-channel</code> ⁶ / ⁶ <code>transport-protocol</code> ⁷ <code>x_qos</code>
Arity	2

⁶ Where '/' is "exclusive or".

⁷ Where 'x' is "~~and~~" Cartesian product.

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3.2.2 Time Constraint

Predicate	<u>time-constraint</u>
Ontology	<u>fipa-qos</u>
Supported by	<u>MA</u>
Description	<u>If the time-type parameter has the value “every”, the predicate is true every time interval defined in the time-value parameter. If the time-type parameter has the value “after”, the predicate is true after the time specified the time-value parameter. Otherwise the predicate is false.</u>
Domain	<u>time-type x time-value</u>
Arity	<u>2</u>

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3.2.3 Match QoS Information

Predicate	<u>qos-match</u>
Ontology	<u>fipa-qos</u>
Supported by	<u>MA</u>
Description	<u>An agent may subscribe to notifications about changes to the quality of service from an MA.</u>
Domain	<u>qos-information x qos-information</u>
Arity	<u>2</u>

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3.2.3.1 Matching Criterion

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The qos-match predicate defined in this ontology mandates the implementation of the following matching criterion in order to determine the set of objects that satisfy the search criteria.

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The first thing to note about the matching operation is that the qos-match predicate receives, as its first argument, an object description that evaluates to a structured object that will be used as an object template during the execution of the qos-match action. In the following explanation, the expressions parameter template and value template are used to denote a parameter of the object template, and the value of the parameter of the object template, respectively.

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A registered object matches an object template if:

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1. The class name of the object (that is, the object type) is the same as the class name of the object description template, and,

191

192

193

2. Each parameter of the object template is matched by a parameter of the object description.

194

195

A parameter matches a parameter template if the parameter name is the same as the template parameter name, and its value matches the value template.

196

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Since the value of a parameter is a term, the rules for a term to match another term template must be given. Before, it must be acknowledged that the values of the parameters of descriptions kept by the MA can only be either SLConstants, SLSets, SLSequences or other object descriptions (for example, a service-description).

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The qos-match action evaluates functional expressions before the object template is matched against the descriptions kept by the MA. This means that if the value of a parameter of an object description is a functional term (for example, (plus 2 3)), then what is seen by the matching process is the result of evaluating the functional term within the context of the receiving agent. A constant matches a constant template if they are equal.

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Informally, a sequence matches a sequence template if the elements of the sequence template are matched by elements of the sequence appearing in the same order. Formally, the following recursive rules apply:

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- 210 1. An empty sequence matches an empty sequence, and,
 211
 212 2. The sequence (cons x sequence1) matches the sequence template (cons y sequence2) if:
 213 • x matches y and sequence1 matches sequence2, or,
 214 • sequence1 matches (cons y sequence2).
 215
 216 Finally, a set matches a set template if each element of the set template is matched by an element of the set template.
 217 Notice that it is possible that the same element of the set matches more than one element of the set template.
 218

219 3.2.3.2 Matching Examples

220 The following example matches the qos-information of communication channel named gsm every 10 seconds.

```
221 (iota ?x
222   (and
223     (time-constraint (time-type :value every) (time-value :value 10 :unit seconds))
224     (qos-matches ?x
225       (qos-information (comm-channel :name gsm))))))
```

229 The following example matches the qos-information of communication channel named gsm whenever the rtt value is 500 milliseconds.

```
230 (iota ?x
231   (qos-matches ?x
232     (qos-information
233       (comm-channel :name gsm)
234       (qos :rtt (rate-value :unit ms :value 500))))))
```

238 The following example matches the qos-information of communication channel named gsm whenever the rtt value is between 300 and 400 milliseconds.

```
239 (iota ?x
240   (exists ?y
241     (and
242       (qos-matches ?x
243         (qos-information
244           (comm-channel :name gsm)
245           (qos :rtt (rate-value :unit ms :value ?y))))))
246     (> ?y 300) (< ?y 400))))
```

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 250
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253 **3.2.2Subscribe to Changes**

Function	subscribe-notification
Ontology	fipa-qos
Supported by	MA
Description	An agent subscribes to notifications about changes to the quality of service from an MA. The comm-channel or transport-protocol parameter specifies the object the agent is interested in. The qos object specifies the QoS parameters that should be present in subsequent inform messages. The change-constraint or time-constraint parameter specifies the constraints when subsequent inform messages should be send. If the action is successful, the Monitor Agent will return a subscription identifier that can be used to cancel subscription. The returned subscription-id object must contain a unique identifier.
Domain	comm-channel_x, qos_x, change-constraints/time-constraints
Range	subscription-id
Arity	3

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255 **3.2.3Cancel Subscribed Notification**

Function	cancel-notification
Ontology	fipa-qos
Supported by	MA
Description	An agent cancels a subscription to notifications about changes to the quality of service from a Monitor Agent. The argument subscription-id identifies the subscription of which results the agent is no longer interested in. If the action is successful, the Monitor Agent does not send any notifications to the agent related to subscription-id identifier.
Domain	subscription-id
Range	The execution of this function results in a change of the state, but it has no explicit result. Therefore there is no range set.
Arity	4

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257 **3.3 Exceptions**

258 The exceptions for the `fipa-qos` ontology follow the same form and rules as specified in [FIPA00023].

259 **3.3.1 Not Understood Exception Propositions**

Communicative Act Ontology	<code>not-understood</code> <code>fipa-qos</code>	
Predicate Symbol	Arguments	Description
<code>unsupported-act</code>	<code>string</code>	The receiving agent does not support the specific communicative act; the string identifies the unsupported communicative act.
<code>unexpected-act</code>	<code>string</code>	The receiving agent supports the specified communicative act, but it is out of context; the string identifies the unexpected communicative act.
<code>unsupported-value</code>	<code>string</code>	The receiving agent does not support the value of a message parameter; the string identifies the message parameter name.

unrecognised-value	string	The receiving agent cannot recognise the value of a message parameter; the string identifies the message parameter name.
--------------------	--------	--

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3.3.2 Refusal Exception Proposition

Communicative Act Ontology	refuse fipa-qos	
Predicate symbol	Arguments	Description
unauthorised		The sending agent is not authorised to perform the function.
unsupported-function	string	The receiving agent does not support the function; the string identifies the unsupported function name.
missing-argument	string	A mandatory function argument is missing; the string identifies the missing function argument name.
unexpected-argument	string	A mandatory function argument is present which is not required; the string identifies the unrequired function argument.
unexpected-argument-count		The number of function arguments is incorrect.
missing-parameter	string string	A mandatory parameter is missing; the first string represents the object name and the second string represents the missing parameter name.
unexpected-parameter	string string	The receiving agent does not support the parameter; the first string represents the function name and the second string represents the unsupported parameter name.
unrecognised-parameter-value	string string	The receiving agent cannot recognise the value of a parameter; the first string represents the object name and the second string represents the parameter name of the unrecognised parameter value.
unrecognised-comm-channel	comm-channel	The specified communication channel is not recognised; the string identifies the communication channel.
unsupported-protocol	transport-protocol	The specified transport protocol is not supported; the string identifies the transport protocol.
unrecognised-subscription-id	subscription-id	The specified subscription identifier is not recognised; the string identifies the subscription identifier.

261

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3.3.3 Failure Exception Propositions

Communicative Act Ontology	failure fipa-qos	
Predicate symbol	Arguments	Description
internal-error	string	An internal error occurred; the string identifies the internal error.

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4 References

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265

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