

1

2

## **Execution Environment and Basic Execution Service Model in OGSA™ Grids**

3

4

5

### Status of This Document

6

This document provides information to the Grid community on modeling an Execution Environment and a Basic Execution Service. It does not define any standards or technical recommendations. Distribution is unlimited.

7

8

9

### Copyright Notice

10

Copyright © Open Grid Forum (2006-2007). All Rights Reserved.

11

12

### Trademarks

13

OGSA is a trademark of the Open Grid Forum.

14

15

### Abstract

16

This memo provides information to the Grid community on the information modeling of execution environment and a basic execution service for OGSA (Open Grid Services Architecture). It defines the proposed execution environment element and basic execution service element for inclusion in DMTF's Common Information Model. Specific execution environments, such as the OGSA Basic Execution Services execution environment, should be defined as profiles and/or extension elements of execution environment. Operations specific to a service should not be part of the execution environment. Distribution is unlimited.

17

18

19

20

21

22

23

24 **Contents**

25

26 1. Overview .....3

27 2. The Execution Environment Model .....3

28 3. The Basic Execution Service Model .....4

29 4. UML .....4

30 5. Discussion of the Model Elements .....6

31 5.1 New Classes .....6

32 5.2 New Associations .....7

33 5.3 Re-use of Existing Classes .....7

34 5.4 Properties Added to Existing Classes .....7

35 5.5 Methods Added to Existing Classes .....7

36 6. Managed Object Format (MOF) .....7

37 7. Security Considerations .....11

38 8. Contributions .....12

39 9. Intellectual Property Statement .....12

40 10. Disclaimer .....12

41 11. Full Copyright Notice .....12

42 12. References .....13

43

44

## 44 1. Overview

45 The OGF Basic Execution Service (BES) specification [BES], GFD.108, defines Web Services  
46 interfaces for creating, monitoring, and controlling computational entities such as UNIX or Windows  
47 processes, Web Services, or parallel programs—what we call *activities*. Clients define activities  
48 using the Job Submission Description Language (JSDL). A BES implementation executes each  
49 activity that it accepts on an appropriate computational resource, which—depending on the BES  
50 implementation and the type(s) of activities supported—may be a single computer, a cluster  
51 managed through a resource manager such as Load Leveler, Sun Grid Engine, Portable Batch  
52 System, or Condo, a Web Service hosting environment, or even another BES implementation.

53 This document defines the DMTF/CIM model elements necessary to express the concepts of an  
54 execution environment and basic execution service abstracted from the OGF Basic Execution  
55 Service [BES].

56 The Execution Environment model describes the managed objects and their relationships for  
57 defining the execution environment for activities in a grid. The Basic Execution Service model  
58 defines the service. This service can act on the execution environment. The CIMv2.15 final  
59 schema [CIM2.15final] is the foundation for the development of these two models. It is expected  
60 that these two models will be folded into CIMv2.16 experimental [CIM2.16exp].

61 In this document we provide the models in UML and DMTF CIM Managed Object Format (MOF).  
62 DMTF provides the XML representation via an automatic conversion tool (MOF to CIM-XML via  
63 CIM DTD as well as WS-CIM).

## 64 2. The Execution Environment Model

65 OGSA defines an execution environment as a collection of resources in which a task can execute.  
66 An execution environment may be, for example, a queuing service, a Unix host, a J2EE  
67 environment, or a collection of specific resources. An execution environment may contain zero or  
68 more execution environments. An execution environment has resource properties that describe  
69 both static and dynamic information, e.g. OS version, types of executables allowed, policies,  
70 security, load, QoS information. An execution environment may implement some subset of the  
71 manageability interfaces such as Web Services Distributed Management (WSDM)<sup>1</sup> or WS-  
72 Management.<sup>2</sup> The execution environment has various relationships to other resources. The  
73 execution environment may use various services such as reservation services, logging services,  
74 information services, job management services, and provisioning services.

75 The existing CIM class ComputerSystem is used to model an execution environment (refer to  
76 Figure 1). The CIM definition of Computer System: “*ComputerSystem is a class derived from  
77 System that is a special collection of ManagedSystemElements. This collection is related to the  
78 providing of compute capabilities and MAY serve as an aggregation point to associate one or more  
79 of the following elements: FileSystem, OperatingSystem, Processor and Memory (Volatile and/or  
80 NonVolatile Storage)*”. This means that a very large number of attributes may be associated with  
81 an execution environment via the SystemComponent aggregation. The ComputerSystem class  
82 captures the basic semantics of an execution environment. It may be necessary to subclass  
83 ComputerSystem to express all the semantics of a specific execution environment, for example, to  
84 add an attribute or operation that is specific to that execution environment that is not already in a  
85 class aggregated by ComputerSystem. A service may act on an execution environment.

86 The state of whether the execution environment is accepting new activities is captured the use of  
87 the property EnabledState (enabled and disabled values) of EnabledLogicalElement. The concept

---

<sup>1</sup> [www.oasis-open.org/committees/wsdm](http://www.oasis-open.org/committees/wsdm)

<sup>2</sup> [www.dmtf.org/standards/wbem/wsman](http://www.dmtf.org/standards/wbem/wsman)

July 12, 2007

88 of an execution environment being contained within an execution environment is expressed via the  
89 HostedDependency association.

90 The execution environment for the Basic Execution Service (BES) aggregates and exposes  
91 attributes needed to make scheduling decisions. For ease of implementation, usability,  
92 extensibility, and interoperability, the details of what is contained in an execution environment  
93 should be defined by a profile.

94 Note: It is expected that additional CIM classes, attributes, and methods may be defined and need  
95 to be added to CIM as the specific execution environment profile work progresses. These will be  
96 documented in a separate informational document.

### 97 **3. The Basic Execution Service Model**

98 The Basic Execution Service is a service to which clients can send requests to initiate, monitor, and  
99 manage computational activities. Operationally, it uses information in a container and operates on  
100 activities within that container. This service is a subclass of the class CIM\_Service.

101 The class added to CIMv2.16 experimental in support of this service is marked as 'Experimental' in  
102 the CIM MOF and as {E} in the UML diagram in Figure 1 and appears in bold font for easier  
103 identification.

104 The model elements are discussed in a bit more detail in Section 5 following the presentation of the  
105 UML in Section 4. The Managed Object Format (MOF) description is given in Section 6. (MOF is a  
106 textual rendering of UML, defined in the CIM Specification [CIMspec] published by the DMTF).

### 107 **4. UML**

108 The figure below depicts the classes and properties of the container model. The new class with its  
109 attributes and methods are highlighted in red **bold**.

110



July 12, 2007

## 113 5. Discussion of the Model Elements

114 This section describes the classes, associations, properties, and methods proposed to be added to  
115 CIM v2.16 experimental in support of a execution environment model and a basic execution service  
116 model. Background material as well as details (inputs, output, formats) of the basic execution  
117 service operations can be found in the Open Grid Forum document 'Basic Execution Service',  
118 GFD.108 [BES].

### 119 5.1 New Classes

#### 120 5.1.1 Basic Execution Service

121 The grid Basic Execution service inherits from the CIM\_Service class. The Basic Execution service  
122 is related to Container through several existing associations with ManagedElement: (1)  
123 ServiceAvailToElement – the Basic Execution service is available within the Container, and (2)  
124 ServiceAffectsElement – the Basic Execution service uses resources within the container and  
125 hence those resources may affect performance, throughput, availability, etc. The StartService and  
126 StopService operations (inherited from CIM\_Service) are used to move the container associated  
127 with this service into a state where it is open for requests and closed for requests, respectively. For  
128 example, within the context of the OGSA Basic Execution Services specification, this means the  
129 container can start accepting new activities, and the operation maps to  
130 'StartAcceptingNewActivities()' interface and the container stops accepting new activities, and the  
131 operation maps to 'StopAcceptingNewActivities()' interface, respectively. The StartService and  
132 StopService operations set the attribute EnabledState (enabled or disabled) in the class  
133 EnabledLogicalElement in the execution environment.

- 134 • CreateActivity  
135 This operation adds requests to the container. For example, within the context of the  
136 OGSA Basic Execution Services specification, this means that a new activity is added to  
137 the container, and the operation maps to the 'CreateActivity()' interface.
- 138 • TerminateActivity  
139 This operation requests that one or more items in the container be terminated. For  
140 example, within the context of the OGSA Basic Execution Services specification, this  
141 means that a new or existing activity in the container can be requested to be terminated,  
142 and the operation maps to the 'TerminateActivities()' interface.
- 143 • GetActivityStatus  
144 This operation requests the status of one or more items in the container. For example,  
145 within the context of the OGSA Basic Execution Services specification, this means that the  
146 status of one or more activities within the container can be obtained, and the operation  
147 maps to the 'GetActivityStatuses()' interface.
- 148 • GetActivityDocuments  
149 This operation requests activity document descriptions for a set of specified activities.  
150 These activity documents may be different from those initially passed to this basic  
151 execution service in the CreateActivity operation since this service may alter its contents to  
152 reflect policy or process within the service. For example, within the context of the OGSA  
153 Basic Execution Services specification, this means that the activity documents can be  
154 obtained, and the operation maps to the 'GetActivityDocuments()' interface.
- 155 • GetAttributesDocument  
156 This operation requests a document containing the basic execution service management  
157 attributes within the associated container. For example, within the context of the OGSA  
158 Basic Execution Services specification, this means that the attributes within a container  
159 may be obtained, and the operation maps to the 'GetAttributesDocument()' interface.

160 A new UMLPackagePath – Grid – is defined for this service class defined to keep model  
161 extensions related to grid together and aid in the formation of a federated CIM model in the future.

July 12, 2007

162

163 **5.2 New Associations**

164 None.

165 **5.3 Re-use of Existing Classes**

166 The class ComputerSystem is used to model the concept of an execution environment. See  
 167 Section 2 for details.

168 **5.4 Properties Added to Existing Classes**

169 None.

170 **5.5 Methods Added to Existing Classes**

171 None.

172 **6. Managed Object Format (MOF)**

173 The schema is described in Managed Object Format, defined in [CIMspec].

174 The MOF below reflects the UML diagram in this document. It is included to provide the details  
 175 and descriptions necessary to understand the UML. It has been approved by DMTF for inclusion in  
 176 CIMv2.16.

177

```

178 // =====
179 //  CIM_BasicExecutionService
180 // =====
181 [Experimental, Version ( "2.16.0" ),
182     UMLPackagePath ( "CIM::Core::Grid" ), Description (
183         "The basic execution service (BES) is a service to which "
184         "clients can send requests to initiate, monitor, and manage "
185         "computational activities and access information about the "
186         "BES.  A BasicExecutionService can act on one or more "
187         "execution environments - modeled, profiled, and instantiated "
188         "as a ComputerSystem.  There is no requirement that a "
189         "BasicExecutionService reside on the node of a "
190         "ComputerSystem on which it acts.  The "
191         "associations ServiceAvailToElement and ServiceAffectsElement "
192         "relate the BasicExecutionService to ComputerSystem.  The "
193         "association HostedDependency expresses the concept that an "
194         "execution environment may be contained within another "
195         "execution environment. "
196         "For example, in a grid or distributed/virtualized environment "
197         "the whole point for not explicitly stating which execution "
198         "environment to use up front is to allow some client software, "
199         "e.g. scheduler, orchestrator, provisioner, application, "
200         "to determine where to place "
201         "the activity (in which execution environment) based on the "
202         "input activity document (that activity's environment/resource "
203         "requirements). ")]
204 class CIM_BasicExecutionService : CIM_Service {
205
206     [Description (
207         "This operation adds requests to the execution environment. "
208         "For example, within the context of the OGSA Basic Execution "
209         "Services, this means that a new activity is added to an "
```

July 12, 2007

```

210         "execution environment, and the operation maps to the "
211         "CreateActivity() interface. "
212         "CreateActivity establishes the 'binding' between the "
213         "activity and the execution environment that will contain "
214         "it. Selection / implementation of how an execution "
215         "environment is outside the scope of basic execution service. "
216         "In a grid or distributed environment, this allows other "
217         "clients, e.g. schedulers, orchestrators, applications, "
218         "to make decisions on which execution environment to "
219         "select (place activity) based on the JSDL job description "
220         "(the input activity document that describes that activity's "
221         "environment/resource requirements. "
222         "The return value should be 0 "
223         "if the request was successfully executed and some other "
224         "value if an error occurred. The output the CreateActivity "
225         "method is an identifier which is used as input to other "
226         "methods in this class to identify the activity being "
227         "acted upon."),
228     ValueMap { "0", "1", "2", "3", "4", "5", "6", "..",
229               "4096", "4097..32767", "32768..65535" },
230     Values { "Operation Completed with No Error", "Not Supported",
231             "Unknown", "Not Authorized",
232             "Not Accepting New Activities",
233             "Unsupported Feature",
234             "Invalid Request Message",
235             "DMTF Reserved",
236             "Method Parameters Checked - Job Started",
237             "Method Reserved", "Vendor Specific" }"),
238     MappingStrings
239         { "MIF.OGF|GFD.108|CreateActivity.Faults" }}
240
241     uint32 CreateActivity(
242
243         [IN, Description (
244             "Describes a single request that is to be executed by an "
245             "execution environment."),
246         MappingStrings
247             { "MIF.OGF|GFD.108|CreateActivity.ActivityDocument",
248             "MIF.OGF|GFD.56|jsdl:JobDefinition" }]
249     string Request,
250
251     [IN ( false ), OUT, Description (
252         "Identifier associated with the requested execution. "
253         "This Identifier is used as input to other Basic "
254         "Execution service methods. "),
255     MappingStrings
256         { "MIF.OGF|GFD.108|CreateActivity.Response",
257         "MIF.OASIS|WS-Addressing",
258         "MIF.OGF|GFD.56|jsdl:JobDefinition" }]
259     string Identifier,
260
261     [IN ( false ), OUT, Description (
262         "Reference to the job (can be null if the task is "
263         "completed).")]
264     CIM_ConcreteJob REF Job
265 );
266

```

July 12, 2007

```

267     [Description (
268         "This operation requests that one or more items in an "
269         "execution environment be terminated.  For example, within "
270         "the context of the OGSA Basic Execution Services, this "
271         "means that a new or existing activity in the container "
272         "can be requested to be terminated, and the operation maps "
273         "to the TerminateActivities() interface.  The return value "
274         "should be 0 if the request was successfully executed and "
275         "some other value if an error occurred.  "
276         "The return code Invalid Request Message refers to the "
277         "input of an invalid identifier. "),
278     ValueMap { "0", "1", "2", "3", "..",
279               "4096", "4097..32767", "32768..65535" },
280     Values { "Operation Completed with No Error", "Not Supported",
281             "Unknown", "Invalid Activity Identifier",
282             "DMTF Reserved",
283             "Method Parameters Checked - Job Started",
284             "Method Reserved", "Vendor Specific" }"),
285     MappingStrings
286         { "MIF.OGF|GFD.108|TerminateActivities.Faults" }}
287
288 uint32 TerminateActivity(
289
290     [IN, Description (
291         "Identifies one or more items in an execution "
292         "environment that are to be terminated."),
293     MappingStrings
294         { "MIF.OGF|GFD.108|TerminateActivities.ActivityIdentifiers",
295         "MIF.OASIS|WS-Addressing" }]
296     string Identifier[],
297
298     [IN ( false ), OUT, Description (
299         "Boolean response value for each requested termination.  "
300         "A value of TRUE indicates successful termination."),
301     MappingStrings
302         { "MIF.OGF|GFD.108|TerminateActivities.Response" }]
303     boolean Response[],
304
305     [IN ( false ), OUT, Description (
306         "Reference to the job (can be null if the task is "
307         "completed).")]
308     CIM_ConcreteJob REF Job
309 );
310
311 [Description (
312     "This operation requests the status of one or more items in "
313     "an execution environment.  For example, within the context "
314     "of the OGSA Basic Execution Services, this means that the "
315     "status of one or more activities within an execution "
316     "environment can be obtained, and the operation maps to the "
317     "GetActivityStatuses() interface.  The return value should "
318     "be 0 if the request was successfully executed and some "
319     "other value if an error occurred.  "
320     "The return code Invalid Request Message refers to the "
321     "input of an invalid identifier. "),
322     ValueMap { "0", "1", "2", "3", "..",
323               "4096", "4097..32767", "32768..65535" },

```

July 12, 2007

```

324     Values { "Operation Completed with No Error", "Not Supported",
325             "Unknown", "Invalid Activity Identifier",
326             "DMTF Reserved",
327             "Method Parameters Checked - Job Started",
328             "Method Reserved", "Vendor Specific" }"),
329     MappingStrings
330         { "MIF.OGF|GFD.108|GetActivityStatuses.Faults" }}
331 uint32 GetActivityStatus(
332
333     [IN, Description (
334         "Identifies one or more items in an execution "
335         "environment whose status will be obtained."),
336     MappingStrings
337         { "MIF.OGF|GFD.108|GetActivityStatuses.ActivityIdentifiers",
338         "MIF.OASIS|WS-Addressing" }]
339     string Identifier[],
340
341     [IN ( false ), OUT, Description (
342         "A response for each requested status.  "),
343     MappingStrings
344         { "MIF.OGF|GFD.108|GetActivityStatuses.Response" }}
345     string StatusResponse[],
346
347     [IN ( false ), OUT, Description (
348         "Reference to the job (can be null if the task is "
349         "completed).")]
350     CIM_ConcreteJob REF Job
351 );
352
353 [Description (
354     "This operation requests activity document descriptions "
355     "for a set of specified set of activities.  These activity "
356     "documents may be different from those initially input in "
357     "the CreateActivity operation since this service may alter "
358     "its contents to reflect policy or process within the "
359     "service. "
360     "The return code Invalid Request Message refers to the "
361     "input of an invalid identifier. "),
362 ValueMap { "0", "1", "2", "3", "..",
363           "4096", "4097..32767", "32768..65535" },
364 Values { "Operation Completed with No Error", "Not Supported",
365         "Unknown", "Invalid Activity Identifier",
366         "DMTF Reserved",
367         "Method Parameters Checked - Job Started",
368         "Method Reserved", "Vendor Specific" }"),
369 MappingStrings
370     { "MIF.OGF|GFD.108|GetActivityDocuments.Faults" }}
371 uint32 GetActivityDocuments(
372
373     [IN, Description (
374         "Identifies one or more activities for which activity "
375         "documents are requested."),
376     MappingStrings
377         { "MIF.OGF|GFD.108|GetActivityDocuments.ActivityIdentifiers",
378         "MIF.OASIS|WS-Addressing" }]
379     string Identifier[],
380

```

July 12, 2007

```

381     [IN ( false ), OUT, Description (
382         "An array of activity document response elements."),
383     MappingStrings
384         { "MIF.OGF|GFD.108|GetActivityDocuments.Response" }]
385     string Response[],
386
387     [IN ( false ), OUT, Description (
388         "Reference to the job (can be null if the task is "
389         "completed).")]
390     CIM_ConcreteJob REF Job
391 );
392
393     [Description (
394         "This operation requests a document containing the basic "
395         "execution service management attributes."
396         "The return code Invalid Request Message refers to the "
397         "input of an invalid identifier. "),
398     ValueMap { "0", "1", "2", "..",
399         "4096", "4097..32767", "32768..65535" },
400     Values { "Operation Completed with No Error", "Not Supported",
401         "Unknown",
402         "DMTF Reserved",
403         "Method Parameters Checked - Job Started",
404         "Method Reserved", "Vendor Specific" }"),
405     MappingStrings
406         { "MIF.OGF|GFD.108|GetAttributesDocument.Faults" }]
407     uint32 GetAttributesDocument(
408
409     [IN ( false ), OUT, Description (
410         "A XML document containing the various attributes within "
411         "its associated container. "),
412     MappingStrings
413
414     { "MIF.OGF|GFD.108|GetAttributesDocument.BESResourceAttributesDocument",
415         "MIF.OGF|GFD.56|JSDL Core Element Set and Appendix 1" }]
416     string AttrsDoc[]
417
418     [IN ( false ), OUT, Description (
419         "Reference to the job (can be null if the task is "
420         "completed).")]
421     CIM_ConcreteJob REF Job
422 );
423
424 };
425

```

## 426 7. Security Considerations

427 This specification defines the model and XML Schema for containers and a basic execution  
428 service. While the interactions of containers with its activities must be secured, the security details  
429 are outside the scope of this specification. Instead, it is assumed that security is addressed in  
430 specifications that define how this model and XML Schema are bound to specific communication  
431 protocols (such as [CIMOPS]) and programming environments.

July 12, 2007

## 432 8. Contributions

433 The Author listed on the title page is committed to taking permanent stewardship for this document  
434 – receiving communication in the future and otherwise being responsive to its content. The contact  
435 information is provided below:

436  
437 Ellen Stokes  
438 IBM  
439 11400 Burnet Rd  
440 Austin, TX 78758  
441 [stokese@us.ibm.com](mailto:stokese@us.ibm.com)  
442 +1 512 778 5821

443

444 Other contributors include members of the OGF OGSA and BES workgroups and the DMTF  
445 CIMCore workgroup.

446

## 447 9. Intellectual Property Statement

448 The OGF takes no position regarding the validity or scope of any intellectual property or other  
449 rights that might be claimed to pertain to the implementation or use of the technology described in  
450 this document or the extent to which any license under such rights might or might not be available;  
451 neither does it represent that it has made any effort to identify any such rights. Copies of claims of  
452 rights made available for publication and any assurances of licenses to be made available, or the  
453 result of an attempt made to obtain a general license or permission for the use of such proprietary  
454 rights by implementers or users of this specification can be obtained from the OGF Secretariat.

455 The OGF invites any interested party to bring to its attention any copyrights, patents or patent  
456 applications, or other proprietary rights which may cover technology that may be required to  
457 practice this recommendation. Please address the information to the OGF Executive Director.

## 458 10. Disclaimer

459 This document and the information contained herein is provided on an “As Is” basis and the OGF  
460 disclaims all warranties, express or implied, including but not limited to any warranty that the use of  
461 the information herein will not infringe any rights or any implied warranties of merchantability or  
462 fitness for a particular purpose.

## 463 11. Full Copyright Notice

464 Copyright (C) Open Grid Forum (2006-2007). All Rights Reserved.

465 This document and translations of it may be copied and furnished to others, and derivative works  
466 that comment on or otherwise explain it or assist in its implementation may be prepared, copied,  
467 published and distributed, in whole or in part, without restriction of any kind, provided that the  
468 above copyright notice and this paragraph are included on all such copies and derivative works.  
469 However, this document itself may not be modified in any way, such as by removing the copyright  
470 notice or references to the OGF or other organizations, except as needed for the purpose of  
471 developing Grid Recommendations in which case the procedures for copyrights defined in the OGF  
472 Document process must be followed, or as required to translate it into languages other than  
473 English.

474 The limited permissions granted above are perpetual and will not be revoked by the OGF or its  
475 successors or assignees.

July 12, 2007

476 **12. References**

- 477 **[CIM2.15final]** CIM Schema, Version 2.15 Final, Distributed Management Task Force, April 17,  
478 2007, [http://www.dmtf.org/standards/cim/cim\\_schema\\_v215](http://www.dmtf.org/standards/cim/cim_schema_v215)
- 479 **[CIM2.16exp]** CIM Schema, Version 2.16 Experimental, Distributed Management Task Force,  
480 August 2007, [http://www.dmtf.org/standards/cim/cim\\_schema\\_v216](http://www.dmtf.org/standards/cim/cim_schema_v216)
- 481 **[CIMspec]** "CIM Infrastructure Specification, Version 2.3", Distributed Management Task Force,  
482 October 4, 2005, <http://www.dmtf.org/standards/documents/CIM/DSP0004.pdf>
- 483 **[CIMOPS]** "Specification for CIM Operations over HTTP, Version 1.2", DSP0200, Distributed  
484 Management Task Force, January 9, 2007,  
485 [http://www.dmtf.org/standards/published\\_documents/DSP200.html](http://www.dmtf.org/standards/published_documents/DSP200.html)
- 486 **[BES]** I. Foster, A. Grimshaw, P. Lane, W. Lee, M. Morgan, S. Pickles, D. Pulsipher, C. Smith, M.  
487 Theimer, "OGSA Basic Execution Services, Version 1.0", Open Grid Forum, GFD.108, July 2006,  
488 <http://www.ogf.org/gf/docs/?final>