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SAGA-RG

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SAGA API Bindings: Python

Status of This Document

This document informs implementors of the SAGA API in the Python programming language, and acts as syntactic and semantic reference. Distribution of this document is unlimited.

Abstract

This document provides information to the grid community, proposing a standard for a Python language binding to the Simple API for Grid Applications (SAGA). As a SAGA language binding, it depends upon the SAGA Core API Specification [6], the currently defined SAGA API extension packages [7, 8, 4, 5], and on the draft Resource API Extension [9].

[1] editor

Contents

1 Introduction

1.1 Notational Conventions

In structure, notation and conventions, this documents follows those of the SAGA Core API specification [6], unless noted otherwise.

1.2 Security Considerations

As the SAGA API is to be implemented on different types of Grid (and non-Grid) middleware, it does not specify a single security model, but rather provides hooks to interface to various security models – see the documentation of the `saga::context` class in the SAGA Core API specification [6] for details.

A SAGA implementation is considered secure if and only if it fully supports (i.e. implements) the security models of the middleware layers it builds upon, and neither provides any (intentional or unintentional) means to by-pass these security models, nor weakens these security models' policies in any way.

2 SAGA Python Bindings

This section will motivate and discuss the general design principles for the SAGA Python bindings. That results in a set of rules which prescribe the translation of the SAGA API as specified in GFD.90 and in the SAGA API Extension specification documents. Those rules SHOULD also be applied to future SAGA API extensions.

The explicit python bindings are listed in appendix A.

2.1 Python Version

This language binding specification targets Python version 2.x and 3.x. We do not expect implementations to support that whole range of versions – but the bindings themselves should not be a limiting factor in that respect.

2.2 Class Hierarchy Considerations

As for other language bindings (i.e. C++, Java), the package names will not be part of the module hierarchy for the SAGA Core Look & Feel classes. For functional API packages, the package name is part of the module path: i.e., `saga.Context` instead of `saga.context.Context`, but `saga.job.Service` instead of `saga.JobService`.

The SAGA API defines an interface and class hierarchy which is normally followed by language bindings. For Python, a strict adherence to that hierarchy is neither required nor useful: Python's duck-typing paradigm [1] encourages the flattening of inherited base classes into the actual object implementations. The paragraphs below discuss the cases where this is used in the SAGA Python bindings.

2.2.1 SAGA Object Interface

Most SAGA classes as specified in GFD.90 inherit from the base `saga.object` class. That class provides a unique object ID for class instances, deep copy semantics, object type inspection and access to the `saga.session` instance which manages that object.

Python provides most of these facilities natively: it has type inspection and unique object IDs, and the core python library comes with a generic deep copy call. The python bindings are thus not expected to implement the `saga.object`

class, but MAY attach the remaining `get_session()` method directly to the respective object types (for reasons discussed later, the session will also be exposed as an object property). Instead, all SAGA objects MUST (directly or indirectly inherit from Python's base `object` class, and are thus rendered as *'new style'* classes [2].

2.2.2 SAGA Namespace Package

The GFD.90 'namespace' package defines a common interface for several downstream packages which, amongst others, interface to entities organized in namespaces, such as physical files, logical files (replicas), information services, etc. The namespace package thus functions as an interface package, and implementations MAY flatten it into the respective deriving class implementations. While that would not allows the direct instantiation namespace class entities, Python's duck typing and loose type system would still allow the use of interchangeable derivatives.

2.2.3 SAGA Buffer Class

The `saga.Buffer` class of GFD.90 is used for a variety of I/O operations, on streams, files, messages, RPC-calls etc. Its primary purpose (as opposed to using plain data arrays) is to support both implementation and user managed memory segments, and thus to support zero copy implementations for I/O operations.

Python applications traditionally tend not to interfere with Python level memory management – for example, zero copy implementations are not a first level concern. The Python bindings thus do not define a separate `buffer` class – they instead use strings (which can contain encoded data). This also holds for classes which would normally inherit from `saga.Buffer`, e.g for the `rpc.Parameter` and `message.Message` classes.

2.3 SAGA Attributes and Python Properties

Python's native way to express class attributes is to expose them as class or object properties. The SAGA Python bindings follow that model. SAGA Attributes have, however, a slightly different semantic in most cases: they do not represent attributes of the local application class instance, but mostly properties of remote entities that these class instances represent. In that context, it must be noted that they:

- cannot be accessed via asynchronous operations,

- cannot be monitored via callbacks,
- cannot be inspected for vector / scalar types,
- cannot be listed (directly),
- may not be extensible (unlike in python proper).

For those reasons, a GFD.90-like attribute interface is also provided in Python. Following similar arguments, the property interface is also provided as complement to various `get_xyz()` methods (readonly), and to `get_xyz()/set_xyz()` pairs (read/write). Finally, the property interface is in some cases used to expose local object state in general. For example, a `saga.Session` object will expose a `contexts` property, a list whose manipulation maps to the default `add_context()/remove_context()` methods.

Another way to expose attributes in Python is the dict(ionary) interface. Compared to the property interface, a dict additionally allows inspection of and iteration over attribute keys. Despite that additionally exposed semantics (which maps well to the GFD.90 attribute semantics), the SAGA Python bindings will not be expressed via the dict interface, to keep the binding focused and simple.

As in GFD.90, attribute and metric names are specified in 'CamelCase'. As per Python convention [3], property names are changed to `'under_score'` notation.

2.4 Additional Python Properties

Appendix A specifies explicitly where getter and setter functions are mapped to python properties, in the following notation:

```
host = property (get_host, set_host)
```

In cases where properties are used to manage sets of components, we map setter, getter and list-like methods to a mutable property list:

```
s  = saga.Session (...)
c1 = saga.Context (...)
c2 = saga.Context (...)

s.add_context (c1)
s.add_context (c2)

for c_id in s.list_contexts () :
  c = s.get_context (id)
  print c.type
```

is then equivalent to:

```
s  = saga.Session (...)

s.contexts.append (saga.Context (...))
s.contexts.append (saga.Context (...))

for c in s.contexts :
  print c.type
```

The informal notation for that case as used in Appendix A is:

```
contexts = property (...)  # mutable list [saga.Contexts]
```

2.5 Attribute Value Types

GFD.90 defines the attribute value types, but explicitly maps those to strings. As Python provides flexible and transparent means of type conversion, the Python bindings support natively typed attribute values.

The `saga.job.Description`'s `Environment` attribute is typed as list of strings, where the strings are formatted as `"key=value"`. Additionally, the Python bindings allow to express that attribute's value as a python dictionary.

The `Time` attribute type can be expressed as defined in GFD.90 (i.e. as defined by `ctime(2)` or as number of seconds since epoch), or as string representation of Python's `datetime.datetime` objects.

2.6 Enums and Defines

The SAGA API includes a number of enums, which are usually related to classes within a specific API package. Python does not have a native notion of enums. We follow the recommendation in [3] to define constants on a module level, written in all capital letters with underscores separating words.

Further, GFD.90 recommends bindings to define constants expressions for predefined attribute and metric names. Those are also defined as module variables.

Note that module variables (enums and string defines) are in all `UPPER_CASE`, as suggested by [3].

2.7 Callbacks and Callables

Python is relatively flexible in passing, managing and invoking function pointers. In particular, it is rather easy to express callbacks in Python – the user simply passes a Python `callable` with a matching method signature, and this is getting called as needed. At this point it does not matter if the passed entity is a proper method, an object instance, or anything else – as long as it can be called.

The Python language binding adheres to GFD.90, and introduces a `Callback` class, which can be inherited and passed to watch monitorable metrics. But at the same time, that class is actually a callable (it implements `__call__`), and applications can thus pass any other callable just as well, including proper python methods, class member methods, etc.

2.7.1 Shallow versus Deep Copy

The SAGA specification prescribes shallow copy behaviour by default, and deep copy is available as an explicit function call. That reflects the default semantics in Python, where assignments are shallow copies by default. Unless a deep copy s explicitly required by the SAGA specification (for example when passing a job description), implementations MUST provide the default Python behaviour.

3 Intellectual Property Issues

3.1 Contributors

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A Python Binding as Interface Code

This appendix contains the normative Python Bindings, as Python source code. Any Python implementation of SAGA SHOULD define this and only this interface. Note that Python does not allows specification of method return types, nor does it enforce types in the first place. The return types for methods are given as comments, and MUST be respected by the implementation.

```
# ------------------------------------------------------------------------------
# Core API: saga/exception.py
# ===========================

# ------------------------------------------------------------------------------
#
class SagaException (Exception) :

  def __init__      (self, message, api_object=None) : pass
  #   message:   string
  #   object:    <object type>
  #   ret:       obj

  def get_message        (self)                      : pass
  #   ret:       string

  def get_object         (self)                      : pass
  #   ret:       any

  def get_traceback      (self)                      : pass
  #   ret:       string

  def get_all_exceptions (self)                      : pass
  #   ret:       list [Exception]

  def get_all_messages   (self)                      : pass
  #   ret:       list [string]

  def get_traceback      (self)                      : pass
  #   ret:       string

  def get_type           (self)                      :
      return self.__class__.__name__

  def __str__            (self)                      :
      return self.get_message ()

  message    = property (get_message)         # string
  object     = property (get_object)          # object type
  traceback  = property (get_traceback)       # string
  exceptions = property (get_all_exceptions)  # list [Exception]
  messages   = property (get_all_message)     # list [string]
#
# ------------------------------------------------------------------------------



# ------------------------------------------------------------------------------
#
class NotImplemented       (SagaException)   : pass
class IncorrectURL         (SagaException)   : pass
class BadParameter         (SagaException)   : pass
class AlreadyExists        (SagaException)   : pass
class DoesNotExist         (SagaException)   : pass
class IncorrectState       (SagaException)   : pass
```

```
class PermissionDenied     (SagaException)   : pass
class AuthorizationFailed  (SagaException)   : pass
class AuthenticationFailed (SagaException)   : pass
class Timeout              (SagaException)   : pass
class NoSuccess            (SagaException)   : pass
#
# ------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/object.py
# ========================

# The saga.Object class in python would be almost empty, as get_type()
# is not needed (python has type inspection); get_id() is not needed
# (python object instances have IDs); and clone() is not needed
# (python core library provides deep copy) -- the last call,
# get_session(), MUST be added to all session managed saga
# objects (as getter, and as 'session' property).

#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/url.py
# =====================

# ------------------------------------------------------------------------------
#
class Url (object) :

  def __init__       (self, url_string) : pass
  #   url:     string
  #   ret:     None

  def __str__        (self)             : pass
  #   ret:     string

  def translate      (self, scheme)     : pass
  #   scheme:  string
  #   ret:     saga.Url


  scheme    = property (get_scheme,   set_scheme  )  # string
  host      = property (get_host,     set_host    )  # string
  port      = property (get_port,     set_port    )  # int
  fragment  = property (get_fragment, set_fragment)  # string
  path      = property (get_path,     set_path    )  # string
  query     = property (get_query,    set_query   )  # string
  userinfo  = property (get_userinfo, set_userinfo)  # string
  username  = property (get_username, set_username)  # string
  userpass  = property (get_userpass, set_userpass)  # string
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/context.py
# =========================

# ------------------------------------------------------------------------------
# Context attributes:
#
TYPE            = "Type"
SERVER          = "Server"
CERT_REPOSITORY = "CertRepository"
USER_PROXY      = "UserProxy"
USER_CERT       = "UserCert"
USER_KEY        = "UserKey"
USER_ID         = "UserID"
USER_PASS       = "UserPass"
USER_VO         = "UserVO"
LIFETIME        = "LifeTime"
REMOTE_ID       = "RemoteID"
REMOTE_HOST     = "RemoteHost"
REMOTE_PORT     = "RemotePort"

# ------------------------------------------------------------------------------
#
class Context (attributes.Attributes) :

  def __init__     (self, ctype=None)  : pass
  #   cytpe: string     # type is a reserved word, thus "ctype"
  #   ret:   None
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/session.py
# =========================

# ------------------------------------------------------------------------------
#
class Session (object) :

  def __init__       (self, default=True) : pass
  #   default: bool
  #   ret:     None
      self.contexts = []   # mutable list [saga.Contexts]

  def add_context    (self, ctx)            : pass
  #   ctx:     saga.Context
  #   ret:     None

  def remove_context (self, ctx)            : pass
  #   ctx:     saga.Context
  #   ret:     None

  def list_contexts  (self)                 : pass
  #   ret:     list[saga.Context]

  def __str__        (self)                 :
      return "Registered contexts: %s" % (str(self.contexts))
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/permissions.py
# =============================

# ------------------------------------------------------------------------------
# permission flags enum:
#
QUERY =  1
READ  =  2
WRITE =  4
EXEC  =  8
OWNER = 16
ALL   = 31
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Permissions (task.Async) :

  def permissions_allow (self, ugid, perm, ttype=None) : pass
  #   ugid :       string
  #   perm :       flags enum
  #   ttype:       saga.task.type enum
  #   ret:         None / saga.Task

  def permissions_deny  (self, ugid, perm, ttype=None) : pass
  #   ugid :       string
  #   perm :       flags enum
  #   ttype:       saga.task.type enum
  #   ret:         None / saga.Task

  def permissions_check (self, ugid, perm, ttype=None) : pass
  #   ugid :       string
  #   perm :       flags enum
  #   ttype:       saga.task.type enum
  #   ret:         bool / saga.Task

  def permissions_list  (self,             ttype=None) : pass
  #   ttype:       saga.task.type enum
  #   ret:         dict {string ugid : flags enum} / saga.Task

  def get_owner         (self,             ttype=None) : pass
  #   ttype:       saga.task.type enum
  #   ret:         string / saga.Task

  def get_group         (self,             ttype=None) : pass
  #   ttype:       saga.task.type enum
  #   ret:         string / saga.Task


  permissions = property (permissions_list)  # dict {string ugid : flags enum}
  owner       = property (get_owner)         # string
  group       = property (get_group)         # string
```

```
#
# ------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/attributes.py
# ============================

# ------------------------------------------------------------------------------
#
class Attributes (object, task.Async) :

  def set_attribute          (self, key, val, ttype=None)  : pass
  #   key:         string
  #   val:         string / dict / any
  #   ttype:       saga.task.type enum
  #   ret:         None / saga.Task

  def get_attribute          (self, key,      ttype=None)  : pass
  #   key:         string key
  #   ttype:       saga.task.type enum
  #   ret:         string / dict / any / saga.Task

  def remove_attribute       (self, key,      ttype=None)  : pass
  #   key:         string
  #   ttype:       saga.task.type enum
  #   ret:         None / saga.Task

  def list_attributes        (self,           ttype=None)  : pass
  #   ttype:       saga.task.type enum
  #   ret:         [string] / saga.Task

  def find_attributes        (self, pat,      ttype=None)  : pass
  #   pat:         string
  #   ttype:       saga.task.type enum
  #   ret:         [string] / saga.Task

  def attribute_exists       (self, key,      ttype=None)  : pass
  #   key:         bool
  #   ttype:       saga.task.type enum
  #   ret:         bool / saga.Task

  def attribute_is_readonly  (self, key,      ttype=None)  : pass
  #   key:         bool
  #   ttype:       saga.task.type enum
  #   ret:         bool / saga.Task

  def attribute_is_writable  (self, key,      ttype=None)  : pass
  #   key:         bool
  #   ttype:       saga.task.type enum
  #   ret:         bool / saga.Task

  def attribute_is_removable (self, key,      ttype=None)  : pass
  #   key:         bool
  #   ttype:       saga.task.type enum
  #   ret:         bool / saga.Task

  def as_dict                (self,           ttype=None)  : pass
  #   ttype:       saga.task.type enum
```

```
  #   ret:         dict {key : val} / saga.Task

  # Attributes are also exposed as Python properties.
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/metric.py
# =========================

# ------------------------------------------------------------------------------
# Metric attributes:
#
NAME        = "Name"
DESCRIPTION = "Description"
MODE        = "Mode"
UNIT        = "Unit"
TYPE        = "Type"
VALUE       = "Value"
#
# ------------------------------------------------------------------------------

# ------------------------------------------------------------------------------
#
class Callback (object) :

  def cb (self, monitorable, metric, ctx)                    : pass
  #   monitorable: any
  #   metric :     saga.Metric
  #   ctx:         saga.Context
  #   ret:         bool

  def __call__ (self, monitorable, metric, ctx) :
      return self.cb (monitorable, metric, ctx)
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Metric (attributes.Attributes) :

  def __init__     (self, name, desc, mode, unit, type, val) : pass
  #   name :       string
  #   desc :       string
  #   mode :       string
  #   unit :       string
  #   type :       string
  #   val  :       any
  #   ret  :       None

  def add_callback (self, cb)                                : pass
  #   cb:          saga.Callback / Python callable
  #   ret:         cb_id

  def remove_callback (self, cb_id)                          : pass
  #   cb_id:       any
  #   ret:         None

  def fire         (self)                                    : pass
  #   ret:         None
```

```
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Monitorable (object) :

  def list_metrics (self)                                    : pass
  #   ret:         list [string]

  def get_metric   (self, name)                              : pass
  #   name:        string
  #   ret:         saga.Metric

  def add_callback (self, name, cb)                          : pass
  #   name:        string
  #   cb:          saga.Callback
  #   ret:         int

  def remove_callback (self, name, cb_id)                    : pass
  #   name:        string
  #   cb_id:       any
  #   ret:         None

  def list_callbacks (self)                                  : pass
  #   ret:         dict {name:string : list [saga.Callback / Python callable]}


  metrics   = property (list_metrics)    # list [string]
  callbacks = property (list_callbacks)
                # dict {name:string : list [saga.Callback / Python callable]}
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Steerable (Monitorable) :

  def add_metric     (self, metric) : pass
  #   metric:        saga.Metric
  #   ret:           None

  def remove_metric  (self, name)   : pass
  #   name:          string
  #   ret:           None

  def fire_metric    (self, name)   : pass
  #   name:          string
  #   ret:           None
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Core API: saga/task.py
# ======================

# ------------------------------------------------------------------------------
# task state enum:
#
UNKNOWN  = "Unknown"
NEW      = "New"
RUNNING  = "Running"
DONE     = "Done"
CANCELED = "Canceled"
FAILED   = "Failed"

# ------------------------------------------------------------------------------
# TaskContainer wait_mode enum:
#
ALL      = "All"
ANY      = "Any"

# ------------------------------------------------------------------------------
# Task type enum:
#
SYNC     = "Sync"
ASYNC    = "Async"
TASK     = "Task"

# ------------------------------------------------------------------------------
# Task and TaskContainer metrics:
#
STATE    = "State"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Async () : pass   # tagging interface
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Task (monitoring.Monitorable) :

  def run           (self)                          : pass
  #   ret:          None

  def wait          (self, timeout=None)            : pass
  #   timeout:      float
  #   ret:          None

  def cancel        (self, timeout=None)            : pass
  #   timeout:      float
```

```
  #   ret:          None

  def get_state     (self)                          : pass
  #   ret:          Task state enum

  def get_result    (self)                          : pass
  #   ret:          <result type>

  def get_object    (self)                          : pass
  #   ret:          <object type>

  def get_exception (self)                          : pass
  #   ret:          SagaException

  def re_raise      (self)                          : pass
  #   ret:          None, raises exception


  state     = property (get_state)       # state enum
  result    = property (get_result)      # result type
  object    = property (get_object)      # object type
  exception = property (get_exception)   # exception type
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class TaskContainer (monitoring.Monitorable) :

  def __init__      (self)                          : pass
  #   ret:          None

  def add           (self, task)                    : pass
  #   task:         saga.Task
  #   ret:          None

  def remove        (self, task)                    : pass
  #   task:         saga.Task
  #   ret:          None

  def run           (self)                          : pass
  #   ret:          None

  def wait          (self, waitmode=ALL, timeout=None):pass
  #   waitmode:     Task waitmode enum
  #   timeout:      float
  #   ret:          list [saga.Task]

  def cancel        (self, timeout=None)            : pass
  #   timeout:      float
  #   ret:          None

  def get_size      (self)                          : pass
  #   ret:          int

  def get_tasks     (self)                          : pass
```

```
  #   ret:          list [saga.Task]

  def get_states    (self)                          : pass
  #   ret:          list [Task state enum]


  size   = property (get_size)                # int
  tasks  = property (add, remove, get_tasks)  # mutable list [saga.Task]
  states = property (get_states)              # list [state enum]
#
# ------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Job API Package : saga/job/job.py
# ================================

# ------------------------------------------------------------------------------
# job states enum:
#
UNKNOWN               = task.UNKNOWN
NEW                   = task.NEW
RUNNING               = task.RUNNING
DONE                  = task.DONE
CANCELED              = task.CANCELED
FAILED                = task.FAILED
SUSPENDED             = "Suspended"

# ------------------------------------------------------------------------------
# JobDescription attributes:
#
EXECUTABLE            = "Executable"
ARGUMENTS             = "Arguments"
ENVIRONMENT           = "Environment"    # dict {string:string} or list [string]
WORKING_DIRECTORY     = "WorkingDirectory"
INTERACTIVE           = "Interactive"
INPUT                 = "Input"
OUTPUT                = "Output"
ERROR                 = "Error"
PROJECT               = "Project"
FILE_TRANSFER         = "FileTransfer"
CLEANUP               = "Cleanup"
JOB_START_TIME        = "JobStartTime"
WALL_TIME_LIMIT       = "WallTimeLimit"
TOTAL_CPU_TIME        = "TotalCPUTime"
TOTAL_PHYSICAL_MEMORY = "TotalPhysicalMemory"
CPU_ARCHITECTURE      = "CPUArchitecture"
OPERATING_SYSTEM_TYPE = "OperatingSystemType"
CANDIDATE_HOSTS       = "CandidateHosts"
QUEUE                 = "Queue"
SPMD_VARIATION        = "SPMDVariation"
TOTAL_CPU_COUNT       = "TotalCPUCount"
NUMBER_OF_PROCESSES   = "NumberOfProcesses"
PROCESSES_PER_HOST    = "ProcessesPerHost"
THREADS_PER_PROCESS   = "ThreadsPerProcess"
JOB_CONTACT           = "JobContact"

# ------------------------------------------------------------------------------
# Job attributes:
#
ID                    = "ID"
EXECUTION_HOSTS       = "ExecutionHosts"
CREATED               = "Created"
STARTED               = "Started"
FINISHED              = "Finished"
EXIT_CODE             = "ExitCode"
TERMSIG               = "Termsig"
# WORKING_DIRECTORY   = "WorkingDirectory"  # see description attribute
```

```
# ------------------------------------------------------------------------------
# Job metrics:
#
STATE                = "State"
STATE_DETAIL         = "StateDetail"
SIGNAL               = "Signal"
CPU_TIME             = "CPUTime"
MEMORY_USE           = "MemoryUse"
VMEMORY_USE          = "VmemoryUse"
PERFORMANCE          = "Performance"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Description (attributes.Attributes) :
  pass
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Service (task.Async) :

  def __init__    (self, rm=None, session=None)             : pass
  #   rm:         saga.Url / string
  #   session:    saga.Session
  #   ret:        obj

  def create      (self, rm=None, session=None, ttype=None) : pass
  #   rm:         saga.Url / string
  #   session:    saga.Session
  #   ttype:      saga.task.type enum
  #   ret:        saga.Task

  def get_session (self)                                    : pass
  #   ret:        saga.Session

  def close       (self)                                    : pass
  #   ret:        None

  def create_job  (self, job_desc,        ttype=None)       : pass
  #   jd:         saga.job.Description
  #   ttype:      saga.task.type enum
  #   ret:        saga.job.Job / saga.Task

  def run_job     (self, cmd, host=None,  ttype=None)       : pass
  #   cmd:        string
  #   host:       string
  #   ttype:      saga.task.type enum
  #   ret:        saga.job.Job / saga.Task

  def list        (self,                  ttype=None)       : pass
  #   ttype:      saga.task.type enum
```

```
  #   ret:        list [string] / saga.Task

  def get_url     (self,                  ttype=None)       : pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.Url / saga.Task

  def get_job     (self, job_id,          ttype=None)       : pass
  #   job_id:     string
  #   ttype:      saga.task.type enum
  #   ret:        saga.job.Job / saga.Task

  def get_self    (self,                  ttype=None)       : pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.job.Self / saga.Task


  session = property (get_session)  # saga.Session
  url     = property (get_url)      # saga.Url
  jobs    = property (list)         # list [string]
  self    = property (get_self)     # saga.job.Self
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Job (task.Task,  attributes.Attributes,
           task.Async, permissions.Permissions) :

  def get_session (self)                            : pass
  #   ret:        saga.Session

  def close       (self)                            : pass
  #   ret:        None

  def get_id      (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        string / saga.Task

  def get_description (self,         ttype=None)      pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.job.Description / saga.Task

  def get_stdin   (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        os.File / saga.Task

  def get_stdout  (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        os.File / saga.Task

  def get_stderr  (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        os.File / saga.Task

  def suspend     (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
```

```
  #   ret:        None / saga.Task

  def resume      (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def checkpoint  (self,              ttype=None)    : pass
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def migrate     (self, jd,          ttype=None)    : pass
  #   jd:         saga.job.Description
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def signal      (self, signum,      ttype=None)    : pass
  #   signum:     int
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task


  session     = property (get_session)      # saga.Session
  id          = property (get_id)           # string
  description = property (get_description)  # Description
  stdin       = property (get_stdin)        # os.File
  stdout      = property (get_stdout)       # os.File
  stderr      = property (get_stderr)       # os.File
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Self (Job, monitoring.Steerable) : pass
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Namespace API Package: saga/namespace/namespace.py
# ================================================

# ------------------------------------------------------------------------------
# namespace flags enum:
#
OVERWRITE        =  1
RECURSIVE        =  2
DEREFERENCE      =  4
CREATE           =  8
EXCLUSIVE        = 16
LOCK             = 32
CREATE_PARENTS   = 64
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Entry (permissions.Permissions, task.Async) :

  def __init__       (self, path, flags=0, session=None)            : pass
  #   path:          saga.Url
  #   session:       saga.Session
  #   flags:         flags enum
  #   ret:           None

  def create         (self, path, flags=0, session=None, ttype=None) : pass
  #   path:          saga.Url
  #   session:       saga.Session
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           saga.Task

  def get_session    (self)                                         : pass
  #   ret:           saga.Session

  def close          (self)                                         : pass
  #   ret:           None

  def get_url        (self,                              ttype=None) : pass
  #   ttype:         saga.task.type enum
  #   ret:           saga.Url / saga.Task

  def get_cwd        (self,                              ttype=None) : pass
  #   ttype:         saga.task.type enum
  #   ret:           string / saga.Task

  def get_name       (self,                              ttype=None) : pass
  #   ttype:         saga.task.type enum
  #   ret:           string / saga.Task

  def is_dir         (self,                              ttype=None) : pass
  #   ttype:         saga.task.type enum
```

```
#   ret:           bool / saga.Task

def is_entry       (self,                              ttype=None) : pass
#   ttype:         saga.task.type enum
#   ret:           bool / saga.Task

def is_link        (self,                              ttype=None) : pass
#   ttype:         saga.task.type enum
#   ret:           bool / saga.Task

def read_link      (self,                              ttype=None) : pass
#   ttype:         saga.task.type enum
#   ret:           saga.Url / saga.Task

def copy           (self, tgt, flags=0,                ttype=None) : pass
#   tgt:           saga.Url
#   flags:         enum flags
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def link           (self, tgt, flags=0,                ttype=None) : pass
#   tgt:           saga.Url
#   flags:         enum flags
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def move           (self, tgt, flags=0,                ttype=None) : pass
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def remove         (self, flags=0,                     ttype=None) : pass
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def close          (self, timeout=None,                ttype=None) : pass
#   timeout:       float
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def permissions_allow (self, id, perms, flags=0,       ttype=None) : pass
#   id:            string
#   perms:         saga.permissions.flags enum
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def permissions_deny  (self, id, perms, flags=0,       ttype=None) : pass
#   id:            string
#   perms:         saga.permissions.flags enum
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task
```

```
  session  = property (get_session)  # saga.Session
  url      = property (get_url)      # saga.Url
  cwd      = property (get_cwd)      # string
  name     = property (get_name)     # string
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Directory (Entry) :

  def open           (self, path, flags=0,              ttype=None) : pass
  #   path:          saga.Url
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           Entry / saga.Task

  def open_dir       (self, path, flags=0,              ttype=None) : pass
  #   path:          saga.Url
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           Direct. / saga.Task

  def change_dir     (self, url,                        ttype=None) : pass
  #   url:           saga.Url
  #   ttype:         saga.task.type enum
  #   ret:           None / saga.Task

  def list           (self, pattern=".", flags=0,       ttype=None) : pass
  #   pattern:       string
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           list [saga.Url] / saga.Task

  def find           (self, pattern, flags=RECURSIVE,   ttype=None) : pass
  #   pattern:       string
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           list [saga.Url] / saga.Task

  def exists         (self, path,                       ttype=None) : pass
  #   path:          saga.Url
  #   ttype:         saga.task.type enum
  #   ret:           bool / saga.Task

  def is_dir         (self, path,                       ttype=None) : pass
  #   path:          saga.Url
  #   ttype:         saga.task.type enum
  #   ret:           bool / saga.Task

  def is_entry       (self, path,                       ttype=None) : pass
  #   path:          saga.Url
  #   ttype:         saga.task.type enum
  #   ret:           bool / saga.Task

  def is_link        (self, path,                       ttype=None) : pass
```

```
#   path:          saga.Url
#   ttype:         saga.task.type enum
#   ret:           bool / saga.Task

def read_link      (self, path,                          ttype=None) : pass
#   path:          saga.Url
#   ttype:         saga.task.type enum
#   ret:           saga.Url / saga.Task

def get_num_entries (self,                               ttype=None) : pass
#   ttype:         saga.task.type enum
#   ret:           int / saga.Task

def get_entry      (self, num,                           ttype=None) : pass
#   num:           int
#   ttype:         saga.task.type enum
#   ret:           saga.Url / saga.Task

def copy           (self, src, tgt, flags=0,             ttype=None) : pass
#   src:           saga.Url
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def link           (self, src, tgt, flags=0,             ttype=None) : pass
#   src:           saga.Url
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def move           (self, src, tgt, flags=0,             ttype=None) : pass
#   src:           saga.Url
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def remove         (self, tgt, flags=0,                  ttype=None) : pass
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def make_dir       (self, tgt, flags=0,                  ttype=None) : pass
#   tgt:           saga.Url
#   flags:         flags enum
#   ttype:         saga.task.type enum
#   ret:           None / saga.Task

def permissions_deny  (self, tgt, id, perms, flags=0,    ttype=None) : pass
#   tgt:           saga.Url
#   id:            string
#   perms:         saga.permission.flags enum
#   flags:         flags enum
#   ttype:         saga.task.type enum
```

```
  #   ret:           None / saga.Task

  def permissions_allow (self, tgt, id, perms, flags=0,  ttype=None) : pass
  #   tgt:           saga.Url
  #   id:            string
  #   perms:         saga.permissions.flags enum
  #   flags:         flags enum
  #   ttype:         saga.task.type enum
  #   ret:           None / saga.Task


  num_entries = property (get_num_entries)  # int
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Filesystem API Package: saga/filesystem/filesystem.py
# ================================================

# ------------------------------------------------------------------------------
# filesystem flags enum:
#
OVERWRITE      =    1
RECURSIVE      =    2
DEREFERENCE    =    4
CREATE         =    8
EXCLUSIVE      =   16
LOCK           =   32
CREATE_PARENTS =   64
TRUNCATE       =  128
APPEND         =  256
READ           =  512
WRITE          = 1024
READ_WRITE     = 1536
BINARY         = 2048

# ------------------------------------------------------------------------------
# filesystem seek_mode enum:
#
START          = "Start"
CURRENT        = "Current"
END            = "End"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class File (namespace.Entry) :

  def __init__  (self, path, flags=READ, session=None           ) : pass
  #   path:     saga.Url
  #   session:  saga.Session
  #   flags:    flags enum
  #   ret:      None
  #
  def create    (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:     saga.Url
  #   session:  saga.Session
  #   flags:    flags enum
  #   ttype:    saga.task.type enum
  #   ret:      saga.Task

  def is_file   (self,                                 ttype=None) : pass
  #   ttype:    saga.task.type enum
  #   ret:      bool / saga.Task

  def get_size  (self,                                 ttype=None) : pass
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task
```

```
  def read      (self, size=None,                       ttype=None) : pass
  #   size :    int
  #   ttype:    saga.task.type enum
  #   ret:      string / bytearray / saga.Task

  def write     (self, data,                            ttype=None) : pass
  #   data :    string / bytearray
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def seek      (self, offset, whence=START,            ttype=None) : pass
  #   offset:   int
  #   whence:   seek_mode enum
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def read_v    (self, iovecs                           ttype=None) : pass
  #   iovecs:   list [tuple (int, int)]
  #   ttype:    saga.task.type enum
  #   ret:      list [bytearray] / saga.Task

  def write_v   (self, data,                            ttype=None) : pass
  #   data:     list [tuple (int, string / bytearray)]
  #   ttype:    saga.task.type enum
  #   ret:      list [int] / saga.Task

  def size_p    (self, pattern,                         ttype=None) : pass
  #   pattern:  string
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def read_p    (self, pattern,                         ttype=None) : pass
  #   pattern:  string
  #   ttype:    saga.task.type enum
  #   ret:      string / bytearray / saga.Task

  def write_p   (self, pattern, data,                   ttype=None) : pass
  #   pattern:  string
  #   data:     string / bytearray
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def modes_e   (self,                                  ttype=None) : pass
  #   ttype:    saga.task.type enum
  #   ret:      list [string] / saga.Task

  def size_e    (self, emode, spec,                     ttype=None) : pass
  #   emode:    string
  #   spec:     string
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def read_e    (self, emode, spec,                     ttype=None) : pass
  #   emode:    string
  #   spec:     string
  #   ttype:    saga.task.type enum
```

```
  #   ret:      bytearray / saga.Task

  def write_e   (self, emode, spec, data,              ttype=None) : pass
  #   emode:    string
  #   spec:     string
  #   data:     string / bytearray
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  size    = property (get_size)  # int
  modes_e = property (modes_e)   # list [string]
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Directory (namespace.Directory) :

  def __init__  (self, path, flags=READ, session=None)             : pass
  #   path:     saga.Url
  #   session:  saga.Session
  #   flags:    flags enum
  #   ret:      None

  def create    (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:     saga.Url
  #   session:  saga.Session
  #   flags:    flags enum
  #   ttype:    saga.task.type enum
  #   ret:      saga.Task

  def open      (self, name, flags=READ,               ttype=None) : pass
  #   name:     saga.Url
  #   flags:    saga.namespace.flags enum
  #   ttype:    saga.task.type enum
  #   ret:      saga.filesystem.File / saga.Task

  def open_dir  (self, name, flags=READ,               ttype=None) : pass
  #   name:     saga.Url
  #   flags:    saga.namespace.flags enum
  #   ttype:    saga.task.type enum
  #   ret:      saga.filesystem.Directory / saga.Task

  def get_size  (self, name=None, flags=None,          ttype=None) : pass
  #   name:     saga.Url
  #   flags:    saga.namespace.flags enum
  #   ttype:    saga.task.type enum
  #   ret:      int / saga.Task

  def is_file   (self, name=None,                      ttype=None) : pass
  #   name:     saga.Url
  #   ttype:    saga.task.type enum
  #   ret:      bool / saga.Task
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Replica API Package: saga/replica/replica.py
# ==============================================

# ------------------------------------------------------------------------------
# replica flags enum:
#
OVERWRITE      =    1
RECURSIVE      =    2
DEREFERENCE    =    4
CREATE         =    8
EXCLUSIVE      =   16
LOCK           =   32
CREATE_PARENTS =   64
#                 128 # reserved for TRUNCATE
#                 256 # reserved for APPEND
READ           =  512
WRITE          = 1024
READ_WRITE     = 1536
#                2048 # reserved for BINARY
#
# ------------------------------------------------------------------------------

# ------------------------------------------------------------------------------
#
class LogicalFile (namespace.Entry, attributes.Attributes) :

  def __init__        (self, path, flags=READ, session=None)             : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ret:            None

  def create          (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            saga.Task

  def is_file         (self,                   ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            bool / saga.Task

  def add_location    (self, name,             ttype=None) : pass
  #   name:           saga.Url
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def remove_location (self, name,             ttype=None) : pass
  #   name:           saga.Url
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def update_location (self, old, new,         ttype=None) : pass
```

```
  #   old:            saga.Url
  #   new:            saga.Url
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def list_locations  (self,                  ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            list [saga.Url] / saga.Task

  def replicate       (self, name, flags=None, ttype=None) : pass
  #   name:           saga.Url
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def upload          (self, name, flags=None, ttype=None) : pass
  #   name:           saga.Url
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def replicate       (self, name, flags=None, ttype=None) : pass
  #   name:           saga.Url
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class LogicalDirectory (namespace.Directory, attributes.Attributes) :

  def __init__        (self, path, flags=READ, session=None)            : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ret:            None

  def create          (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            saga.Task

  def is_file         (self, name,            ttype=None) : pass
  #   name:           saga.url
  #   ttype:          saga.task.type enum
  #   ret:            bool / saga.Task

  def open_dir        (self, name, flags=READ, ttype=None) : pass
  #   name:           saga.url
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            Directory / saga.Task
```

```
  def open            (self, name, flags=READ, ttype=None) : pass
  #   name:           saga.Url
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            LogicalFile / saga.Task

  def find_attributes (self, name_pattern, attr_pattern,
                       flags=RECURSIVE,        ttype=None) : pass
  #   name_pattern:   string
  #   attr_pattern:   string
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            list [saga.Url] / saga.Task
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Stream API Package: saga/stream/stream.py
# ========================================

# ------------------------------------------------------------------------------
# stream state enum
#
NEW             = "New"
OPEN            = "Open"
CLOSED          = "Closed"
# DROPPED       = "Dropped" # see metric
ERROR           = "Error"

# ------------------------------------------------------------------------------
# stream activity enum # see Metrics
#
# READ          = "Read"
# WRITE         = "Write"
# EXCEPTION     = "Exception"

# ------------------------------------------------------------------------------
# StreamService metric
#
CLIENT_CONNECT = "client_connect"

# ------------------------------------------------------------------------------
# Stream attributes
#
TIMEOUT         = "Timeout"
BLOCKING        = "Blocking"
COMPRESSION     = "Compression"
NODELAY         = "Nodelay"
RELIABLE        = "Reliable"

# ------------------------------------------------------------------------------
# Stream metrics
#
STATE           = "State"
READ            = "Read"
WRITE           = "Write"
EXCEPTION       = "Exception"
DROPPED         = "Dropped"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Service (monitoring.Monitorable, permissions.Permissions, task.Async) :
  def __init__    (self, name=None, session=None)             : pass
  #   name:       saga.Url
  #   session:    saga.Session
  #   ret:        None

  def create      (self, name=None, session=None,  ttype=None) : pass
```

```
  #   name:       saga.Url
  #   session:    saga.Session
  #   ttype:      saga.task.type enum
  #   ret:        saga.Task

  def get_session (self)                                    : pass
  #   ret:        saga.Session

  def close       (self)                                    : pass
  #   ret:        None

  def get_url     (self,                    ttype=None)     : pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.Url / saga.Task

  def serve       (self, timeout=None,      ttype=None)     : pass
  #   timeout:    float
  #   ttype:      saga.task.type enum
  #   ret:        Stream / saga.Task

  def close       (self, timeout=None,      ttype=None)     : pass
  #   timeout:    float
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task


  session = property (get_session)  # saga.Session
  url     = property (get_url)      # saga.Url
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Stream (attributes.Attributes, monitoring.Monitorable, task.Async) :

  def __init__    (self, name=None, session=None)             : pass
  #   name:       saga.Url
  #   session:    saga.Session
  #   ret:        None

  def create      (self, name=None, session=None,  ttype=None) : pass
  #   name:       saga.Url
  #   session:    saga.Session
  #   ttype:      saga.task.type enum
  #   ret:        saga.Task

  def get_session (self)                                    : pass
  #   ret:        saga.Session

  def close       (self)                                    : pass
  #   ret:        None

  def get_url     (self,                    ttype=None)     : pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.Url / saga.Task
```

```
  def get_context (self,                    ttype=None)       : pass
  #   ttype:      saga.task.type enum
  #   ret:        saga.Context / saga.Task

  def connect     (self,                    ttype=None)       : pass
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def wait        (self, what, timeout=None, ttype=None)      : pass
  #   what:       stream_activity enum
  #   timeout:    float
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def close       (self,       timeout=None, ttype=None)      : pass
  #   timeout:    float
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task

  def read        (self,       size=None,    ttype=None)      : pass
  #   size:       int
  #   ttype:      saga.task.type enum
  #   ret:        bytearray / saga.Task

  def write       (self, data, size=None,    ttype=None)      : pass
  #   data:       string / bytearray
  #   size:       int
  #   ttype:      saga.task.type enum
  #   ret:        None / saga.Task


  session = property (get_session)  # saga.Session
  url     = property (get_url)      # saga.Url
  context = property (get_context)  # saga.Context
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Remote Procedure Calls API Package: saga/rpc/rpc.py
# ================================================

# ------------------------------------------------------------------------------
# rpc io_mode enum:
#
IN    = "In"
OUT   = "Out"
INOUT = "InOut"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Parameter (object) :

  def __init__       (self, data=None, size=None, mode=IN)      : pass
  #   data:          string / bytearray
  #   size:          int
  #   mode:          mode enum
  #   ret:           None

  def set_io_mode    (self, mode)                               : pass
  #   mode:          mode enum
  #   ret:           None

  def get_io_mode    (self)                                     : pass
  #   ret:           mode enum

  def set_size       (self, size)                               : pass
  #   size:          int
  #   ret:           None

  def get_size       (self)                                     : pass
  #   ret:           int

  def set_data       (self, data)                               : pass
  #   data:          string / bytearray
  #   ret:           None

  def get_data       (self)                                     : pass
  #   ret:           bytearray

  def close          (self)                                     : pass
  #   ret:           None


  io_mode = property (get_io_mode, set_io_mode) # io_mode enum
  size    = property (get_size, set_size)       # int
  data    = property (get_data, set_data)       # bytearray
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
#
class RPC (permissions.Permissions, task.Async) :

  def __init__       (self, url, session=None)                 : pass
  #   url:           saga.Url / string
  #   session:       saga.Session
  #   ret:           None

  def create         (self, url, session=None, ttype=None)     : pass
  #   url:           saga.Url / string
  #   session:       saga.Session
  #   ttype:         saga.task.type enum
  #   ret:           saga.Task

  def get_session    (self)                                    : pass
  #   ret:           saga.Session

  def close          (self)                                    : pass
  #   ret:           None

  def get_url        (self)                                    : pass
  #   ret:           saga.Url

  def call           (self, parameters,       ttype=None)      : pass
  #   parameters:    list [Parameter]
  #   ttype:         saga.task.type enum
  #   ret:           None / saga.Task

  def close          (self, timeout=None,     ttype=None)      : pass
  #   timeout:       float
  #   ttype:         saga.task.type enum
  #   ret:           mode enum / saga.Task


  session = property (get_session)  # saga.Session
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Advert API Package: saga/advert/advert.py
# ========================================

# ------------------------------------------------------------------------------
# advert flags
#
OVERWRITE      =    1
RECURSIVE      =    2
DEREFERENCE    =    4
CREATE         =    8
EXCLUSIVE      =   16
LOCK           =   32
CREATE_PARENTS =   64
TRUNCATE       =  128
#                 256 # reserved for APPEND
READ           =  512
WRITE          = 1024
READ_WRITE     = 1536
#                2048 # reserved for BINARY

# ------------------------------------------------------------------------------
# Advert metrics
#
ATTRIBUTE      = "Attribute"
OBJECT         = "Object"
# TTL          = "TTL"  # collision

# ------------------------------------------------------------------------------
# AdvertDirectory metrics
#
ATTRIBUTE      = "Attribute"
CHANGE         = "Change"
NEW            = "New"     # CREATE from GFD.90 (conflict with flag_
DELETE         = "Delete"
TTL            = "TTL"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Advert (namespace.Entry, attributes.Attributes, task.Async) :

  def __init__        (self, path, flags=READ, session=None)            : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ret:            None

  def create          (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
```

```
  #   ret:            saga.Task

  def set_ttl         (self, ttl,             ttype=None) : pass
  #   ttl :           int
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def get_ttl         (self,                  ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            int / saga.Task

  def store_object    (self, object,          ttype=None) : pass
  #   object :        <object type>
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def retrieve_object (self,                  ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            any / saga.Task

  def delete_object   (self,                  ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class AdvertDirectory (namespace.Directory, attributes.Attributes, task.Async) :

  def __init__        (self, path, flags=READ, session=None)            : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ret:            None

  def create          (self, path, flags=READ, session=None, ttype=None) : pass
  #   path:           saga.Url
  #   session:        saga.Session
  #   flags:          flags enum
  #   ttype:          saga.task.type enum
  #   ret:            saga.Task

  def open            (self, name, flags=READ,              ttype=None) : pass
  #   name:           saga.Url
  #   flags:          saga.namespace.flags enum
  #   ttype:          saga.task.type enum
  #   ret:            saga.filesystem.File / saga.Task

  def open_dir        (self, name, flags=READ,              ttype=None) : pass
  #   name:           saga.Url
  #   flags:          saga.namespace.flags enum
  #   ttype:          saga.task.type enum
  #   ret:            saga.filesystem.Directory / saga.Task

  def set_ttl         (self,      ttl,        ttype=None) : pass
```

```
  #   ttl :           int
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def get_ttl         (self,                   ttype=None) : pass
  #   ttype:          saga.task.type enum
  #   ret:            int / saga.Task

  def set_ttl         (self, tgt, ttl,         ttype=None) : pass
  #   tgt :           saga.Url
  #   ttl :           int
  #   ttype:          saga.task.type enum
  #   ret:            None / saga.Task

  def get_ttl         (self, tgt,              ttype=None) : pass
  #   tgt :           saga.Url
  #   ttype:          saga.task.type enum
  #   ret:            int / saga.Task

  def find            (self, name_pattern, attr_pattern=None,
                       obj_type=None, flags=RECURSIVE, ttype=None) : pass
  #   name_pattern:   string
  #   attr_pattern:   string
  #   obj_type:       string
  #   flags:          flags enum
  #   ret:            list [saga.Url]

#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Message API Package: saga/message/message.py
# ============================================

# ------------------------------------------------------------------------------
# message state enum:
#
OPEN               = "Open"
CLOSED             = "Closed"

# ------------------------------------------------------------------------------
# default for message property enums:
#
ANY                = "Any"

# ------------------------------------------------------------------------------
# message topology enum:
#
POINT_TO_POINT     = "PointToPoint"
MULTICAST          = "Multicast"
PUBLISH_SUBSCRIBER = "PublishSubscriber"
PEER_TO_PEER       = "PeerToPeer"

# ------------------------------------------------------------------------------
# message reliability enum:
#
UNRELIABLE         = "Unreliable"
CONSISTENT         = "Consistent"
SEMI_RELIABLE      = "SemiReliable"
RELIABLE           = "Reliable"

# ------------------------------------------------------------------------------
# message atomicity enum:
#
AT_MOST_ONCE       = "AtMostOnce"
AT_LEAST_ONCE      = "AtLeastOnce"
EXACTLY_ONCE       = "ExactlyOnce"

# ------------------------------------------------------------------------------
# message correctness enum:
#
UNVERIFIED         = "Unverified"
VERIFIED           = "Verified"

# ------------------------------------------------------------------------------
# message ordering enum:
#
UNORDERED          = "Unordered"
ORDERED            = "Ordered"
GLOBALLY_ORDERED   = "GloballyOrdered"

# ------------------------------------------------------------------------------
# endpoint attributes:
#
TOPOLOGY           = "Topology"
```

```
RELIABILITY        = "Reliability"
ATOMICITY          = "Atomicity"
CORRECTNESS        = "Correctness"
ORDERING           = "Ordering"

# ------------------------------------------------------------------------------
# endpoint metrics:
#
STATE              = "State"
CONNECT            = "Connect"
CLOSED             = "Closed"
MESSAGE            = "Message"

# ------------------------------------------------------------------------------
# message attributes:
#
ID                 = "ID"
SENDER             = "Sender"
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Endpoint (monitoring.Monitorable, task.Async) :

  def __init__      (self, topology    = POINT_TO_POINT,
                           reliability = RELIABLE,
                           atomicity   = EXACTLY_ONCE,
                           ordering    = ORDERED,
                           correctness = VERIFIED
                           session     = None)                : pass
  #   topology:     topology    enum
  #   reliability:  reliability enum
  #   atomicity:    atomicity   enum
  #   ordering:     ordering    enum
  #   correctness:  correctness enum
  #   session:      saga.Session
  #   ret:          None

  def create        (self, topology    = POINT_TO_POINT,
                           reliability = RELIABLE,
                           atomicity   = EXACTLY_ONCE,
                           ordering    = ORDERED,
                           correctness = VERIFIED
                           session     = None,
                           ttype       = None)                : pass
  #   topology:     topology    enum
  #   reliability:  reliability enum
  #   atomicity:    atomicity   enum
  #   ordering:     ordering    enum
  #   correctness:  correctness enum
  #   session:      saga.Session
  #   ttype:        saga.task.type enum
  #   ret:          saga.Task

  def get_session   (self)                                   : pass
```

```
#   ret:          saga.Session

def close         (self)                                  : pass
#   ret:          None

def get_url       (self,                          ttype=None) : pass
#   ttype:        saga.task.type enum
#   ret:          saga.Url / saga.Task

def get_receivers (self,                          ttype=None) : pass
#   ttype:        saga.task.type enum
#   ret:          list [saga.Url] / saga.Task

def serve         (self, n=None, timeout=None,    ttype=None) : pass
#   n:            int
#   timeout:      float
#   ttype:        saga.task.type enum
#   ret:          None / saga.Task

def serve_once    (self,       timeout=None,      ttype=None) : pass
#   timeout:      float
#   ttype:        saga.task.type enum
#   ret:          Endpoint / saga.Task

def connect       (self, url=None, timeout=None, ttype=None) : pass
#   url:          saga.Url
#   timeout:      float
#   ttype:        saga.task.type enum
#   ret:          None / saga.Task

def close         (self, receiver=None,           ttype=None) : pass
#   receiver:     saga.Url
#   ttype:        saga.task.type enum
#   ret:          None / saga.Task

def send          (self, msg, receivers=None,     ttype=None) : pass
#   msg:          Message
#   receivers:    list [saga.Url]
#   ttype:        saga.task.type enum
#   ret:          None / saga.Task

def test          (self, sender=None, receiver=None,
                         timeout=None,            ttype=None) : pass
#   sender:       saga.Url
#   receiver:     saga.Url
#   timeout:      float
#   ttype:        saga.task.type enum
#   ret:          int / saga.Task

def recv          (self, sender=None, receiver=None,
                         timeout=None,            ttype=None) : pass
#   sender:       saga.Url
#   receiver:     saga.Url
#   timeout:      float
#   ttype:        saga.task.type enum
#   ret:          Message / saga.Task
```

```
  session   = property (get_session)    # saga.Session
  url       = property (get_url)        # saga.Url
  receivers = property (get_receivers)  # list [saga.Url]
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Message (saga.Attributes) :

  def __init__      (self, data=None, size=None)              : pass
  #   data:         string / bytearray
  #   size:         int
  #   ret:          None

  def get_sender    (self)                                    : pass
  #   ret:          saga.Url

  def set_id        (self, id)                                : pass
  #   id:           string
  #   ret:          None

  def get_id        (self)                                    : pass
  #   ret:          string

  def set_size      (self, size)                              : pass
  #   size:         int
  #   ret:          None

  def get_size      (self)                                    : pass
  #   ret:          int

  def set_data      (self, data)                              : pass
  #   data:         string / bytearray
  #   ret:          None

  def get_data      (self)                                    : pass
  #   ret:          bytearray

  def close         (self)                                    : pass
  #   ret:          None


  sender = property (get_sender)          # saga.Url
  id     = property (get_id, set_id)      # string
  size   = property (get_size, set_size)  # int
  data   = property (get_data, set_data)  # bytearray
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Service Discovery API Package: saga/sd/sd.py
# ============================================

# ------------------------------------------------------------------------------
# ServiceDescription attributes
#
ATTRIBUTE           = "Attribute"
OBJECT              = "Object"
UID                 = "UID"
SITE                = "Site"
NAME                = "Name"
IMPLEMENTOR         = "Implementor"
RELATED_SERVICE_IDS = "RelatedServiceIDs" # differs from get_related_services()
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Discoverer (object) :

  def __init__       (self, url=None, session=None)        : pass
  #   url:           saga.Url
  #   session:       saga.Session
  #   ret: None

  def get_session     (self)                               : pass
  #   ret:            saga.Session

  def close           (self)                               : pass
  #   ret:            None

  def list_services  (self,             service_filter=None,
                      data_filter=None, authz_filter=None) : pass
  #   service_filter: string
  #   data_filter:    string
  #   authz_filter:   string
  #   ret:            list [ServiceDescription]


  session = property (get_session)  # saga.Session
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class ServiceDescription (attributes.Attributes) :

  def get_url        (self)                         : pass
  #   ret:           saga.Url

  def get_data       (self)                         : pass
  #   ret:           ServiceData
```

```
  def get_related_services (self)                  : pass
  #   ret:           list [ServiceDescription]


  url              = property (get_url)              # saga.Url
  data             = property (get_data)             # ServiceData
  related_services = property (get_related_services) # list [ServiceDescription]
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class ServiceData (attributes.Attributes) : pass
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Information Service Navigator API Package: saga/isn/isn.py
# ============================================================

# ------------------------------------------------------------------------------
#
class EntityDataSet (object) :

  def __init__             (self, model, name, filter=None,
                            url=None, session=None)     : pass
  #   model:               string
  #   name:                string
  #   filter:              string
  #   url:                 saga.Url
  #   session:             saga.Session
  #   ret:                 None

  def get_session          (self)                       : pass
  #   ret:                 saga.Session

  def close                (self)                       : pass
  #   ret:                 None

  def get_url              (self)                       : pass
  #   ret:                 saga.Url

  def get_data             (self)                       : pass
  #   ret:                 list [EntityData]

  def get_related_entities (self, name, filter=None)    : pass
  #   name:                string
  #   filter:              string
  #   ret:                 EntityDataSet

  def list_related_entity_names (self)                  : pass
  #   ret:                 list [string]


  session = property (get_session)  # saga.Session
  url     = property (get_url)      # saga.Url
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class EntityData (attributes.Attributes) : pass
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
# Resource API Package: saga/resource/resource.py
# ================================================

# ------------------------------------------------------------------------------
# resource type enum
#
COMPUTE      =  1
NETWORK      =  2
STORAGE      =  4

# ------------------------------------------------------------------------------
# resource state enum
#
UNKNOWN      =  None
NEW          =  1
PENDING      =  2
ACTIVE       =  4
CANCELED     =  8
EXPIRED      = 16
DONE         = EXPIRED # alis
FAILED       = 32
FINAL        = CANCELED | DONE | FAILED

# ------------------------------------------------------------------------------
# resource attributes """
#
ID           = 'Id'
RTYPE        = 'Rtype'
STATE        = 'State'
STATE_DETAIL = 'StateDetail'
MANAGER      = 'Manager'
DESCRIPTION  = 'Description'

# ------------------------------------------------------------------------------
# resource description attributes
#
RTYPE        = "RType"
TEMPLATE     = "Template"
IMAGE        = 'Image'
DYNAMIC      = "Dynamic"
START        = "Start"
END          = "End"
DURATION     = "Duration"

# ------------------------------------------------------------------------------
# compute/network/storage resource description attributes
#
MACHINE_OS   = "MachineOS"
MACHINE_ARCH = "MachineArch"
SIZE         = "Size"
MEMORY       = "Memory"
ACCESS       = "Access"
#
# ------------------------------------------------------------------------------
```

```
# ------------------------------------------------------------------------------
#
class Description        (attributes.Attributes)  : pass
class ComputeDescription (Description)            : pass
class NetworkDescription (Description)            : pass
class StorageDescription (Description)            : pass
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class  Manager (attributes.Attributes, saga.Async) :

  def __init__          (self, url, session=None)               : pass
  #   url:              saga.Url
  #   session:          saga.Session
  #   ret:              None

  def create            (self, url, session=None, ttype=None)   : pass
  #   url:              saga.Url
  #   session:          saga.Session
  #   ttype:            saga.task.type enum
  #   ret:              saga.Task

  def get_session       (self)                                  : pass
  #   ret:              saga.Session

  def close             (self)                                  : pass
  #   ret:              None

  def get_url           (self,                    ttype=None)   : pass
  #   ret:              saga.Url

  def list              (self, rtype=None,        ttype=None)   : pass
  #   rtype:            rtype enum
  #   ttype:            saga.task.type enum
  #   ret:              list [string] / saga.Task

  def get_description   (self, id,                ttype=None)   : pass
  #   id:               string
  #   ttype:            saga.task.type enum
  #   ret:              Description / saga.Task

  def list_templates    (self, rtype=None,        ttype=None)   : pass
  #   rtype:            rtype enum
  #   ttype:            saga.task.type enum
  #   ret:              list [string] / saga.Task

  def get_template     (self, name,               ttype=None)   : pass
  #   name:             string
  #   ttype:            saga.task.type enum
  #   ret:              Description / saga.Task
```

```
  def aquire            (self, spec,              ttype=None)    : pass
  #   spec:             ResourceDescription / string
  #   ttype:            saga.task.type enum
  #   ret:              Compute / saga.Task

  def release           (self, id,                ttype=None)    : pass
  #   id:               string
  #   ttype:            saga.task.type enum
  #   ret:              None / saga.Task


  session   = property (get_session)                  # saga.Session
  url       = property (get_url)                      # saga.Url
  templates = property (list_templates, get_template)  # dict {string : Description}
  resources = property (get_resources)                # list [string]
#
# ------------------------------------------------------------------------------


# ------------------------------------------------------------------------------
#
class Resource (saga.Monitorable, saga.task.Async) :

  def __init__          (self, id, session=None)                : pass
  #   id:               string
  #   session:          saga.Session
  #   ret:              None

  def create            (self, id, session=None,  ttype=None)    : pass
  #   id:               string
  #   session:          saga.Session
  #   ttype:            saga.task.type enum
  #   ret:              saga.Task

  def get_session       (self)                                  : pass
  #   ret:              saga.Session

  def close             (self)                                  : pass
  #   ret:              None

  def get_id            (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              string  / saga.Task

  def get_type          (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              rtype enum / saga.Task

  def get_state         (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              state enum / saga.Task

  def get_state_detail  (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              string  / saga.Task

  def get_manager       (self,                    ttype=None)    : pass
```

```
  #   ttype:            saga.task.type enum
  #   ret:              Manager      / saga.Task

  def get_description   (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              Description  / saga.Task

  def reconfig          (self, rd,                ttype=None)    : pass
  #   rd:               Description
  #   ttype:            saga.task.type enum
  #   ret:              None / saga.Task

  def release           (self,                    ttype=None)    : pass
  #   ttype:            saga.task.type enum
  #   ret:              None / saga.Task

  def wait              (self, timeout=None,
                               state=Final,       ttype=None)    : pass
  #   timeout:          float
  #   state:            state enum
  #   ttype:            saga.task.type enum
  #   ret:              None / saga.Task

  session      = property (get_session)        # saga.Session
  id           = property (get_id)             # string
  rtype        = property (get_type)           # rtype enum
  state        = property (get_state)          # state enum
  state_detail = property (get_state_detail)   # string
  access       = property (get_access)         # string
  manager      = property (get_manager)        # Manager
  description  = property (get_description)    # Description
#
# ------------------------------------------------------------------------


# ------------------------------------------------------------------------
#
class Compute (Resource) : pass
class Storage (Resource) : pass
class Network (Resource) : pass
#
# ------------------------------------------------------------------------
```