Distributed Resource Management Application API Version 2 (DRMAA) - C Language Binding

Status of This Document

OGF Proposed Recommendation (GFD-R-P.198)

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Abstract

This document describes the C language binding for the Distributed Resource Management Application API Version 2 (DRMAA). The intended audience for this specification are DRMAA implementors.

1 Corresponding authors
Notational Conventions

In this document, C language elements and definitions are represented in a fixed-width font.

The key words “MUST” “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” are to be interpreted as described in RFC 2119 [1].
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1 Introduction

The Distributed Resource Management Application API Version 2 (DRMAA) specification defines an interface for tightly coupled, but still portable access to the majority of DRM systems. The scope is limited to job submission, job control, reservation management, and retrieval of job and machine monitoring information.

The DRMAA root specification [2] describes the abstract API concepts and the behavioral rules of a compliant implementation, while this document standardizes the representation of API concepts in the C programming language.

2 General Design

The mapping of DRMAA root specification concepts to C follows a set of design principles. Implementation-specific extensions of the DRMAA C API SHOULD follow these conventions:

- Namespacing of the DRMAA API, as demanded by the root specification, is realized with the \texttt{drmaa2} prefix for lower- and upper-case identifiers.
- In identifier naming, "job" is shortened as "j" and "reservation" is shortened as "r" for improved readability.
- The root specification demands a consistent parameter passing strategy for non-scalar values. All such values are passed as call-by-reference parameter in the C binding.
- Structs and enums are typedef'ed for better readability.
- Struct types have an \_s suffix with their name. Structures with a non-standardized layout are defined as forward references for the DRMAA library implementation.
- Functions with IDL return type \texttt{void} have \texttt{drmaa2\_error} as return type.
- The IDL \texttt{boolean} type maps to the \texttt{drmaa2\_bool} type.
- The IDL \texttt{long} type maps to \texttt{long long} in C. One exception is the \texttt{exitStatus} variable, which is defined as \texttt{int} in order to provide a more natural mapping to existing operating system interfaces.
- The IDL \texttt{string} type is mapped in two different ways. Attributes and parameters with string values typically created by the implementation are mapped to the \texttt{drmaa2\_string} type. The application frees such memory by calling the newly introduced function \texttt{drmaa2\_string\_free}. All other string parameters are mapped to the \texttt{const char *} type. Implementations MUST accept calls to \texttt{drmaa2\_string\_free} for all string pointers, regardless of their type.
- The language binding defines one UNSET macro per utilized C data type (\texttt{DRMAA2\_UNSET\_*}).
- The language binding defines separate UNSET members for each enumeration, to avoid C compiler complaints when using a common UNSET value for enumerations. Their values MUST all equal to \texttt{DRMAA2\_UNSET\_ENUM}, so that both variants can be used.
- All numerical types are signed, in order to support \texttt{-1} as numerical UNSET value.
- Both \texttt{AbsoluteTime} and \texttt{TimeAmount} map directly to \texttt{time\_t}. RFC 822 support as mandated by the root specification is given by the \texttt{\%z} formatter for \texttt{sprintf}. 

\texttt{drmaa-wg@ogf.org}
• Multiple output parameters are realized by declaring all but one of them as pointer variable. For this reason, the substate parameter in `drmaa2_j_get_state` SHALL be interpreted as pointer to a string variable created by the DRMAA library.

• The `const` declarator is used to mark parameters declared as `readonly` in the root specification.

• The two string list types in DRMAA, ordered and unordered, are mapped to one ordered list with the `DRMAA2_STRING_LIST` type.

• The `any` member for job sub-state information is defined as `drmaa2_string` to achieve application portability.

Application-created structs should be allocated by the additional support methods (such as `drmaa2_jinfo_create`) to realize the necessary initialization to UNSET. This SHOULD be properly documented by the implementation.

The following structures are only used in result values. For this reason, the according allocation functions are not part of the API:

• `drmaa2_string`
• `drmaa2_slotinfo`
• `drmaa2_rinfo`
• `drmaa2_notification`
• `drmaa2_queueinfo`
• `drmaa2_version`
• `drmaa2_machineinfo`

The interface membership of a function is sometimes expressed by an additional prefix, as shown in Table 1.

<table>
<thead>
<tr>
<th>DRMAA interface</th>
<th>C binding prefix</th>
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<td>drmaa2_</td>
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<td>SessionManager</td>
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<td>JobTemplate</td>
<td>drmaa2_.jtemplate_</td>
</tr>
<tr>
<td>ReservationTemplate</td>
<td>drmaa2_.rtemplate_</td>
</tr>
</tbody>
</table>

Table 1: Mapping of DRMAA interface name to C method prefix

The C binding specifies the function pointer type `drmaa2_callback` for a notification callback function. This represents the `DrmaaCallback` interface from the root specification. The new constant value `DRMAA2_UNSET_CALLBACK` can be used by the application for the de-registration of callback functions.
2.1 Error Handling

The list of exceptions in the DRMAA root specification is mapped to the new enumeration `drma2_error`. The enumeration member `DRMAA2_LASTERROR` is intended to ensure application portability while allowing additional implementation-specific error codes. It MUST always be the enumeration member with the highest value.

The language binding adds two new functions for fetching error number and error message of the last error that occurred: `drma2_lasterror` and `drma2_lasterror_text`. These functions MUST operate in a thread-safe manner, meaning that both error informations are managed per application thread by the DRMAA implementation.

2.2 Resource Limits

The DRMAA2 root specification demands the definition of a set of string constants, declared in the header file:

```c
extern const char *const DRMAA2_CORE_FILE_SIZE;
extern const char *const DRMAA2_CPU_TIME;
extern const char *const DRMAA2_DATA_SIZE;
extern const char *const DRMAA2_FILE_SIZE;
extern const char *const DRMAA2_OPEN_FILES;
extern const char *const DRMAA2_STACK_SIZE;
extern const char *const DRMAA2_VIRTUAL_MEMORY;
extern const char *const DRMAA2_WALLCLOCK_TIME;
```

The implementation part MUST initialize these variables as follows:

```c
const char *const DRMAA2_CORE_FILE_SIZE = "CORE_FILE_SIZE";
const char *const DRMAA2_CPU_TIME = "DRMAA2_CPU_TIME";
const char *const DRMAA2_DATA_SIZE = "DRMAA2_DATA_SIZE";
const char *const DRMAA2_FILE_SIZE = "DRMAA2_FILE_SIZE";
const char *const DRMAA2_OPEN_FILES = "DRMAA2_OPEN_FILES";
const char *const DRMAA2_STACK_SIZE = "DRMAA2_STACK_SIZE";
const char *const DRMAA2_VIRTUAL_MEMORY = "DRMAA2_VIRTUAL_MEMORY";
const char *const DRMAA2_WALLCLOCK_TIME = "DRMAA2_WALLCLOCK_TIME";
```

2.3 Lists and Dictionaries

The C language binding adds generic support functions for the collection data types used by the root specification. The newly defined `drma2_lasterror` and `drma2_lasterror_text` functions MUST return according error information for these operations.

Both `drma2_list_create` and `drma2_dict_create` have an optional parameter `callback`. It allows the application or the implementation to store a callback pointer to an element cleanup function. It MUST be allowed for the application to provide `DRMAA2_UNSET_CALLBACK` instead of a valid callback pointer. The implementation MUST provide a default callback implementation for all list and dictionary types. This can be used by both the application and the implementation itself.

The following list operations are defined:
`drmaa2_list_create` Creates a new list instance for the specified type of items. Returns a pointer to the list or NULL on error.

`drmaa2_list_free` Frees the list and the contained members. If a callback function was provided on list creation, it SHALL be called once per list item.

`drmaa2_list_get` Gets the list element at the indicated position. The element index starts at zero. If the index is invalid, the function returns NULL.

`drmaa2_list_add` Adds a new item at the end of the list and returns a success indication. The list MUST contain only the provided pointer, not a deep copy of the provided data structure.

`drmaa2_list_del` Removes the list element at the indicated position and returns a success indication. If a callback function was provided on list creation, it SHALL be called before this function returns.

`drmaa2_list_size` Returns the number of elements in the list. If the list is empty, then the function returns 0, which SHALL NOT be treated as an error case.

Similarly, a set of new functions for dictionary handling is introduced:

`drmaa2_dict_create` Creates a new dictionary instance. Returns a pointer to the dictionary or NULL on error.

`drmaa2_dict_free` Frees the dictionary and the contained members. If a callback function was provided on dictionary creation, it SHALL be called once per dictionary entry.

`drmaa2_dict_list` Gets all dictionary keys as DRMAA `drmaa2_string_list`. If the dictionary is empty, a valid string list with zero elements SHALL be returned. The application is expected to use `drmaa2_list_free` for freeing the returned data structure.

`drmaa2_dict_has` Returns a boolean indication if the given key exists in the dictionary. On error, the function SHALL return FALSE.

`drmaa2_dict_get` Gets the dictionary value for the specified key. If the key is invalid, the function returns NULL.

`drmaa2_dict_del` Removes the dictionary entry with the given key and returns a success indication. If a callback function was provided on dictionary creation, it SHALL be called before this function returns.

`drmaa2_dict_set` Sets the specified dictionary key to the specified value. Key and value strings MUST be stored as the provided character pointers. If the dictionary already has an entry for this name, the value is replaced and the old value is removed. If a callback was provided on dictionary creation, it SHALL be called with a NULL pointer for the key and the pointer of the previous value.

### 3 Memory Management

The majority of data structures returned by an implementation is newly created on the heap. All those structures need to be freed by a call to the according counterpart function (`drmaa2_*_free`) by the application. This should be clearly indicated in the end-user documentation, otherwise memory leaks may occur.

The following functions are expected to return only pointers to existing data, which demands no subsequent freeing of the returned data:

- `drmaa2_dict_get`
The following functions, when successfully executed, return newly allocated data. Their results must either be free directly, or indirectly be freeing the surrounding wrapper structure.

Implementations MAY register their matching default callback for the returned data structure:

- `drmaa2_get_drms_name`
- `drmaa2_get_drms_version`
- `drmaa2_describe_attribute`
- `drmaa2_dict_create`
- `drmaa2_dict_list`
- `drmaa2_get_instance_value`
- `drmaa2_get_jsession_names`
- `drmaa2_get_rsession_names`
- `drmaa2_jarray_get_id`
- `drmaa2_jarray_get_jobs`
- `drmaa2_jarray_get_jtemplate`
- `drmaa2_jarray_get_session_name`
- `drmaa2_j_get_id`
- `drmaa2_j_get_info`
- `drmaa2_j_get_get_jt`
- `drmaa2_j_get_session_name`
- `drmaa2_jinfo_create`
- `drmaa2_jinfo_impl_spec`
- `drmaa2_jsession_get_contact`
- `drmaa2_jsession_get_jarray`
- `drmaa2_jsession_get_job_categories`
- `drmaa2_jsession_get_jobs`
- `drmaa2_jsession_get_session_name`
- `drmaa2_jsession_run_bulk_jobs`
- `drmaa2_jsession_run_job`
- `drmaa2_jtemplate_create`
4 Implementation-specific Extensions

The DRMAA root specification allows the product-specific extension of the DRMAA API in a standardized way.

New methods added to a DRMAA implementation SHOULD follow the conventions from section 2.

New attributes SHOULD use a product-specific prefix for a clear separation of non-portable and portable parts of the API. The struct definitions in drmaa2.h SHALL remain unmodified in all cases. Therefore, these attributes are expected to only be accessible through drmaa2_get_instance_value and drmaa2_set_instance_value. Implementations can store their specific additional attributes behind the standardized implementationSpecific pointer in drmaa2_jinfo_s, drmaa2_rinfo_s, drmaa2_slotinfo_s, drmaa2_jtemplate_s, drmaa2_rtemplate_s, drmaa2_notification_s, drmaa2_queueinfo_s, drmaa2_version_s, and drmaa2_machineinfo_s.

5 Complete Header File

The following text shows the complete C header file for the DRMAAv2 application programming interface. DRMAA-compliant C libraries MUST declare all functions and data structures described here. Implementations MAY add custom parts in adherence to the extensibility principles of this specification and the root specification.

The source file is also available at http://www.drma.org.
```c
#include <time.h>

extern const char *const DRMAA2_CORE_FILE_SIZE ;
extern const char *const DRMAA2_CPU_TIME ;
extern const char *const DRMAA2_DATA_SIZE ;
extern const char *const DRMAA2_FILE_SIZE ;
extern const char *const DRMAA2_OPEN_FILES ;
extern const char *const DRMAA2_STACK_SIZE ;
extern const char *const DRMAA2_VIRTUAL_MEMORY ;
extern const char *const DRMAA2_WALLCLOCK_TIME ;

typedef enum drmaa2_jstate {
    DRMAA2_UNSET_JSTATE = -1,
    DRMAA2_UNDETERMINED = 0,
    DRMAA2_QUEUED = 1,
    DRMAA2_QUEUED_HELD = 2,
    DRMAA2_RUNNING = 3,
    DRMAA2_SUSPENDED = 4,
    DRMAA2_REQUEUED = 5,
    DRMAA2_REQUEUED_HELD = 6,
    DRMAA2_DONE = 7,
    DRMAA2_FAILED = 8
} drmaa2_jstate ;

typedef enum drmaa2_os {
    DRMAA2_UNSET_OS = -1,
    DRMAA2_OTHER_OS = 0,
    DRMAA2_AIX = 1,
    DRMAA2_BSD = 2,
    DRMAA2_LINUX = 3,
    DRMAA2_HPUX = 4,
    DRMAA2_IRIX = 5,
    DRMAA2_MACOS = 6,
    DRMAA2_SUNOS = 7,
    DRMAA2_TRU64 = 8,
    DRMAA2_UNIXWARE = 9,
    DRMAA2_WIN = 10,
    DRMAA2_WINNT = 11
} drmaa2_os ;

typedef enum drmaa2_cpu {
    DRMAA2_UNSET_CPU = -1,
    DRMAA2_OTHER_CPU = 0,
    DRMAA2_ALPHA = 1,
    DRMAA2_ARM = 2,
    DRMAA2_ARM64 = 3,
    DRMAA2_CELL = 4,
    DRMAA2_PARISC = 5,
    DRMAA2_PARISC64 = 6,
    DRMAA2_X86 = 7,
    DRMAA2_X64 = 8,
    DRMAA2_IA64 = 9,
    DRMAA2_MIPS = 10,
    DRMAA2_MIPS64 = 11,
    DRMAA2_PPC = 12,
    DRMAA2_PPC64 = 13,
    DRMAA2_SPARC = 14,
    DRMAA2_SPARC64 = 15,
    DRMAA2_PPC64LE = 16
} drmaa2_cpu ;

typedef enum drmaa2_event {
    DRMAA2_UNSET_EVENT = -1,
    DRMAA2_NEW_STATE = 0,
    DRMAA2_MIGRATED = 1,
    DRMAA2_ATTRIBUTE_CHANGE = 2
} drmaa2_event ;
```
typedef enum drmaa2_capability {
    DRMAA2_UNSET_CAPABILITY = -1,
    DRMAA2_ADVANCE_RESERVATION = 0,
    DRMAA2_RESERVE_SLOTS = 1,
    DRMAA2 CALLBACK = 2,
    DRMAA2_BULK_JOBS_MAXPARALLEL = 3,
    DRMAA2_JT_EMAIL = 4,
    DRMAA2_JT_StAGING = 5,
    DRMAA2_JT_DEADLINE = 6,
    DRMAA2_JT_MAXSLOTS = 7,
    DRMAA2_JT_ACCOUNTINGID = 8,
    DRMAA2_RT_STARTNOW = 9,
    DRMAA2_RT_DURATION = 10,
    DRMAA2_RT_MACHINEOS = 11,
    DRMAA2_RT_MACHINEARCH = 12
} drmaa2_capability;

typedef enum drmaa2_bool {
    DRMAA2_FALSE = 0,
    DRMAA2_TRUE = 1
} drmaa2_bool;

typedef enum drmaa2_error {
    DRMAA2_UNSET_ERROR = -1,
    DRMAA2_SUCCESS = 0,
    DRMAA2_DENIED_BY_DRMS = 1,
    DRMAA2_DRM_COMMUNICATION = 2,
    DRMAA2_TRY_LATER = 3,
    DRMAA2_SESSION_MANAGEMENT = 4,
    DRMAA2_TIMEOUT = 5,
    DRMAA2_INTERNAL = 6,
    DRMAA2_INVALID_ARGUMENT = 7,
    DRMAA2_INVALID_SESSION = 8,
    DRMAA2_INVALID_STATE = 9,
    DRMAA2_OUT_OF_RESOURCE = 10,
    DRMAA2_UNSUPPORTED_ATTRIBUTE = 11,
    DRMAA2_UNSUPPORTED_OPERATION = 12,
    DRMAA2_IMPLEMENTATION_SPECIFIC = 13,
    DRMAA2_LASTERROR = 14
} drmaa2_error;

typedef char * drmaa2_string;
void drmaa2_string_free ( drmaa2_string *);

drmaa2_error drmaa2_lasterror (void);
drmaa2_string drmaa2_lasterror_text (void);

struct drmaa2_list_s; /* forward*/
typedef struct drmaa2_list_s * drmaa2_list;
typedef struct drmaa2_list_s * drmaa2_string_list;
typedef struct drmaa2_list_s * drmaa2_j_list;
typedef struct drmaa2_list_s * drmaa2_queueinfo_list;
typedef struct drmaa2_list_s * drmaa2_machineinfo_list;
typedef struct drmaa2_list_s * drmaa2_slotinfo_list;
typedef struct drmaa2_list_s * drmaa2_r_list;

typedef enum drmaa2_listtype {
    DRMAA2_UNSET_LISTTYPE = -1,
    DRMAA2_STRINGLIST = 0,
    DRMAA2_JOBLIST = 1,
    DRMAA2_QUEUEINFOLIST = 2,
    DRMAA2_MACHINEINFOLIST = 3,
    DRMAA2_SLOTINFOLIST = 4,
    DRMAA2_RESERVATIONLIST = 5
} drmaa2_listtype;

typedef void (*drmaa2_list_entryfree)(void **value);
void drmaa2_string_list_default_callback (void **value);
void drmaa2_j_list_default_callback (void **value);
void drmaa2_queueinfo_list_default_callback (void **value);
void drmaa2_machineinfo_list_default_callback (void **value);

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void drma2_slotinfo_list_default_callback (void **value);
void drmaa2_r_list_default_callback (void **value);

drmaa2_list drmaa2_list_create (const drmaa2_listtype t, const drmaa2_list_entryfree callback);
void drmaa2_list_free (drmaa2_list *l);
const void * drmaa2_list_get (const drmaa2_list l, const long pos);
drmaa2_error drmaa2_list_add (drmaa2_list l, const void *value);
drmaa2_error drmaa2_list_del (drmaa2_list l, const long pos);
long drmaa2_list_size (const drmaa2_list l);

struct drmaa2_dict_s;  /* forward */
typedef struct drmaa2_dict_s * drmaa2_dict;

typedef void
drama2_dict_default_callback (char **key, char **val);
void
drmaa2_dict_default_callback (char** key, char** value);

drmaa2_dict drmaa2_dict_create (const drmaa2_dict_entryfree callback);
void drmaa2_dict_free (drmaa2_dict *d);
drmaa2_string_list drmaa2_dict_list (const drmaa2_dict d);
const char * drmaa2_dict_get (const drmaa2_dict d, const char *key);
const char * drmaa2_dict_get (const drmaa2_dict d, const char *key);
drmaa2_error drmaa2_dict_del (drmaa2_dict d, const char *key);
drmaa2_error drmaa2_dict_del (drmaa2_dict d, const char *key);

#define DRMAA2_ZERO_TIME ((time_t) 0)
#define DRMAA2_INFINITE_TIME ((time_t) -1)
#define DRMAA2_NOW ((time_t) -2)
#define DRMAA2_HOME_DIR "$DRMAA2_HOME_DIR$
#define DRMAA2_WORKING_DIR "$DRMAA2_WORKING_DIR$
#define DRMAA2_INDEX "$DRMAA2_INDEX$
#define DRMAA2_UNSET_BOOL DRMAA2_FALSE
#define DRMAA2_UNSET_STRING NULL
#define DRMAA2_UNSET_NUM -1
#define DRMAA2_UNSET_ENUM -1
#define DRMAA2_UNSET_LIST NULL
#define DRMAA2_UNSET_DICT NULL
#define DRMAA2_UNSET_TIME ((time_t) -3)
#define DRMAA2_UNSET_CALLBACK NULL
#define DRMAA2_UNSET_VERSION NULL

typedef struct {
  drmaa2_string jobId;
  drmaa2_string jobName;
  int exitStatus;
  drmaa2_string terminatingSignal;
  drmaa2_string annotation;
  drmaa2_jstate jobState;
  drmaa2_string jobSubState;
  drmaa2_slotinfo_list allocatedMachines;
  drmaa2_string submissionMachine;
  drmaa2_string jobOwner;
  long long slots;
  drmaa2_string queueName;
  time_t wallclockTime;
  long long cpuTime;
  time_t submissionTime;
  time_t dispatchTime;
  time_t finishTime;
  void * implementationSpecific;
} drmaa2_jinfo_s;
typedef drmaa2_jinfo_s * drmaa2_jinfo;

drmaa2_jinfo drmaa2_jinfo_create (void);
void drmaa2_jinfo_free (drmaa2_jinfo *ji);

typedef struct {
  drmaa2_string machineName;
  long long slots;
  void * implementationSpecific;
} drmaa2_slotinfo_s;
typedef drmaa2_slotinfo_s * drmaa2_slotinfo;

drmaa2_slotinfo drmaa2_slotinfo_create (void);
void drmaa2_slotinfo_free (drmaa2_slotinfo *si);

drmaa-wg@ogf.org
typedef drmaa2_slotinfo_s * drmaa2_slotinfo;

void drmaa2_slotinfo_free (drmaa2_slotinfo * si);

typedef struct {
  drmaa2_string reservationId;
  drmaa2_string reservationName;
  time_t reservedStartTme;
  time_t reservedEndTime;
  drmaa2_string_list usersACL;
  long long reservedSlots;
  drmaa2_slotinfo_list reservedMachines;
  void * implementationSpecific;
} drmaa2_rinfo_s;

typedef drmaa2_rinfo_s * drmaa2_rinfo;

void drmaa2_rinfo_free (drmaa2_rinfo * ri);

typedef struct {
  drmaa2_string remoteCommand;
  drmaa2_string_list args;
  drmaa2_bool submitAsHold;
  drmaa2_bool rerunnable;
  drmaa2_dict jobEnvironment;
  drmaa2_string workingDirectory;
  drmaa2_string_list email;
  drmaa2_bool emailOnStarted;
  drmaa2_bool emailOnTerminated;
  drmaa2_string jobName;
  drmaa2_string inputPath;
  drmaa2_string outputPath;
  drmaa2_string errorPath;
  drmaa2_bool joinFiles;
  drmaa2_string reservationId;
  drmaa2_string queueName;
  long long minSlots;
  long long maxSlots;
  long long priority;
  drmaa2_string_list candidateMachines;
  long long minPhysMemory;
  drmaa2_os machineOS;
  drmaa2_cpu machineArch;
  time_t startTime;
  time_t deadlineTime;
  drmaa2_dict stageInFiles;
  drmaa2_dict stageOutFiles;
  drmaa2_dict resourceLimits;
  drmaa2_string accountingId;
  void * implementationSpecific;
} drmaa2_jtemplate_s;

typedef drmaa2_jtemplate_s * drmaa2_jtemplate;

drmaa2_jtemplate drmaa2_jtemplate_create (void);

void drmaa2_jtemplate_free (drmaa2_jtemplate * jt);

typedef struct {
  drmaa2_string reservationName;
  time_t startTime;
  time_t endTime;
  time_t duration;
  long long minSlots;
  long long maxSlots;
  drmaa2_string jobCategory;
  drmaa2_string_list usersACL;
  drmaa2_string_list candidateMachines;
  long long minPhysMemory;
  drmaa2_os machineOS;
  drmaa2_cpu machineArch;
  void * implementationSpecific;
} drmaa2_jtemplate_s;
typedef drma2_rtemplate_s * drma2_rtemplate;
drma2_rtemplate drma2_rtemplate_create ( void);
void drma2_rtemplate_free ( drma2_rtemplate * rt);

typedef struct {
    drma2_event event;
    drma2_string jobId;
    drma2_string sessionName;
    drma2_jstate jobState;
    void * implementationSpecific;
} drma2_notification_s;
typed drma2_notification_s * drma2_notification;
void drma2_notification_free ( drma2_notification * n);

typedef struct {
    drma2_string name;
    void * implementationSpecific;
} drma2_queueinfo_s;
typed drma2_queueinfo_s * drma2_queueinfo;
void drma2_queueinfo_free ( drma2_queueinfo * qi);

typedef struct {
    drma2_string major;
    drma2_string minor;
    void * implementationSpecific;
} drma2_version_s;
typed drma2_version_s * drma2_version;
void drma2_version_free ( drma2_version * v);

typedef struct {
    drma2_string name;
    drma2_bool available;
    long long sockets;
    long long coresPerSocket;
    float load;
    long long physMemory;
    long long virtMemory;
    drma2_os machineOS;
    drma2_version machineOSVersion;
    drma2_cpu machineArch;
    void * implementationSpecific;
} drma2_machineinfo_s;
typed drma2_machineinfo_s * drma2_machineinfo;
void drma2_machineinfo_free ( drma2_machineinfo * mi);

drma2_string_list drma2_jtemplate_impl_spec ( void);
drma2_string_list drma2_jinfo_impl_spec ( void);
drma2_string_list drma2_rtemplate_impl_spec ( void);
drma2_string_list drma2_rinfo_impl_spec ( void);
drma2_string_list drma2_queueinfo_impl_spec ( void);
drma2_string_list drma2_machineinfo_impl_spec ( void);
drma2_string_list drma2_notification_impl_spec ( void);
drma2_string drma2_get_instance_value ( const void * instance , const char * name);
drma2_string drma2_describe_attribute ( const void * instance , const char * name);
drma2_error drma2_set_instance_value ( void * instance, const char * name, const char * value);
typed void (*drma2_callback)(drma2_notification * notification);

struct drma2_jsession_s; /* forward*/
struct drma2_rsession_s; /* forward*/
struct drma2_msession_s; /* forward*/
struct drma2_j_s; /* forward*/
struct drma2_jarray_s; /* forward*/


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struct drma2_r_s;

/* forward */
typedef struct drma2_jsession_s * drma2_jsession;
typedef struct drma2_rsession_s * drma2_rsession;
typedef struct drma2_msession_s * drma2_msession;
typedef struct drma2_j_s * drma2_j;
typedef struct drma2_jarray_s * drma2_jarray;
typedef struct drma2_r_s * drma2_r;

void drma2_jsession_free (drma2_jsession * js);
void drma2_rsession_free (drma2_rsession * rs);
void drma2_msession_free (drma2_msession * ms);
void drma2_j_free (drma2_j * j);
void drma2_jarray_free (drma2_jarray * ja);
void drma2_r_free (drma2_r * r);

drma2_string drma2_rsession_get_contact (const drma2_rsession rs);
void drma2_rsession_get_contact (const drma2_rsession rs);
void drma2_rsession_get_contact (const drma2_rsession * rs);
void drma2_rsession_get_contact (drma2_rsession * rs);
void drma2_r_free (drma2_r * r);

drma2_string drma2_rsession_get_session_name (const drma2_rsession rs);
void drma2_rsession_get_session_name (const drma2_rsession rs);
void drma2_rsession_get_session_name (const drma2_rsession * rs);
void drma2_rsession_get_session_name (drma2_rsession * rs);
void drma2_r_free (drma2_r * r);

drma2_r drma2_rsession_get_reservation (const drma2_rsession rs , const drma2_string reservationId);
void drma2_rsession_get_reservation (const drma2_rsession rs , const drma2_string reservationId);
void drma2_rsession_get_reservation (const drma2_rsession * rs , const char * reservationId);
void drma2_rsession_get_reservation (drma2_rsession * rs , const char * reservationId);
void drma2_r_free (drma2_r * r);

drma2_string drma2_rsession_get_reservations (const drma2_rsession rs);
void drma2_rsession_get_reservations (const drma2_rsession rs);
void drma2_rsession_get_reservations (const drma2_rsession * rs);
void drma2_rsession_get_reservations (drma2_rsession * rs);
void drma2_r_free (drma2_r * r);

drma2_rtemplate drma2_rsession_get_reservation_template (const drma2_rsession rs , const drma2_string reservationId);
void drma2_rsession_get_reservation_template (const drma2_rsession rs , const drma2_string reservationId);
void drma2_rsession_get_reservation_template (const drma2_rsession * rs , const char * reservationId);
void drma2_rsession_get_reservation_template (drma2_rsession * rs , const char * reservationId);
void drma2_r_free (drma2_r * r);

...
6 Security Considerations

The DRMAA root specification [2] describes the behavioral aspects of a standard-compliant implementation. This includes also security aspects.

Software written in C language has well-known security attack vectors, especially with memory handling. Implementors MUST clarify in their documentation which kind of memory management is expected by the application. Implementations MUST also consider the possibility for multi-threaded applications performing re-entrant calls to the library. The root specification clarifies some of these scenarios.
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11 References


A  Errata (July 2015)

The following changes were applied in the July 2015 revision of this document:

The author affiliations and ordering was updated.

Issue #115, #104:
Section 3 was introduced to describe the rules of memory management from the application point of view.

Issue #59:
The numeric parameters of `drmaa2_jsession_run_bulk_jobs` are now `const`. The `pos` parameter of `drmaa2_list_del` is now `const`. The `pos` parameter of `drmaa2_list_get` is now `const`. This modification is backward-compatible.

Issue #57:
`drmaa2_limit` needed to be removed, since (numeric) enumeration members cannot become keys in dictionaries. Instead, a set of according constants was introduced, as explained in the newly introduced Section 2.2. The text also explains how these constants must be initialized by the implementation code. This modification is not backward-compatible, since the original version was not implementable.

Issue #116:
`drmaa2_dict_default_callback` and a set of default list callbacks were introduced. This modification is backward-compatible.

Issue #160, #162:
All `struct` definitions got an additional `implementationSpecific` member. It is intended to store the implementation-specific attributes, as now explained in Section 4. This modification is not backward-compatible, since the `drmaa2.h` header file changes. All relevant implementations are already updated.

Issue #255:
All enumerations got an additional `UNSET` value. The motivation is now explained in 1. `drmaa2_listtype` was completed with numeric defaults, similar to the other enumerations. This modification is backward-compatible for the known implementations and their compilers.

Issue #113:
`drmaa2_get_all_machines()` returns a list of `drmaa2_machineinfo_s` instances, which contains a pointer to a `drmaa2_version_s` struct. This demanded the addition of `DRMA2_UNSET_VERSION`. This modification is backward-compatible.

Issue #165:
The `allocatedMachines` attribute in `drmaa2_jinfo_s` has now the type `drmaa2_slotinfo_list`, in accordance to the root specification.

Issue #114:
For consistency reasons, the following renaming took place:

- `drmaa2_jarray_get_job_template` becomes `drmaa2_jarray_get_jtemplate`
- `drmaa2_j_get_jt` becomes `drmaa2_j_get_jtemplate`
This modification is not backward-compatible, since the `drmaa2.h` header file changes. All relevant implementations are already updated.

Issue #63:
All numerical types are signed, in order to support -1 as numerical UNSET value. For this reason, the numerical parameters of `drmaa2_jsession_run_bulk_jobs` were changed to `long long`. This modification is not backward-compatible, since the `drmaa2.h` header file changes. All relevant implementations are already updated.

Issue #163:
The two new functions `drmaa2_j_reap` and `drmaa2_jarray_reap` were introduced, in accordance to the July 2015 errata of the root specification.

Issue #102:
The July 2015 root specification errata adds `jobName` to the `JobInfo` structure, which is now also reflected in `drmaa2_jinfo_s`. This modification is not backward-compatible, since the `drmaa2.h` header file changes. All relevant implementations are already updated.

Issue #287:
A new element for the PowerPC 64bit little-endian architecture (PPC64LE) was added to the `drmaa2_cpu` enumeration. This modification is not backward-compatible, since the `drmaa2.h` header file changes. All relevant implementations are already updated.