

**NAME**

**osd**, **osd\_register**, **osd\_deregister**, **osd\_set**, **osd\_reserve**, **osd\_set\_reserved**, **osd\_free\_reserved**, **osd\_get**, **osd\_del**, **osd\_call**, **osd\_exit** - Object Specific Data

**SYNOPSIS**

```
#include <sys/osd.h>
```

```
typedef void
```

```
(*osd_destructor_t)(void *value);
```

```
typedef int
```

```
(*osd_method_t)(void *obj, void *data);
```

```
int
```

```
osd_register(u_int type, osd_destructor_t destructor, osd_method_t *methods);
```

```
void
```

```
osd_deregister(u_int type, u_int slot);
```

```
int
```

```
osd_set(u_int type, struct osd *osd, u_int slot, void *value);
```

```
void **
```

```
osd_reserve(u_int slot);
```

```
int
```

```
osd_set_reserved(u_int type, struct osd *osd, u_int slot, void **rsv, void *value);
```

```
void
```

```
osd_free_reserved(void **rsv);
```

```
void *
```

```
osd_get(u_int type, struct osd *osd, u_int slot);
```

```
void
```

```
osd_del(u_int type, struct osd *osd, u_int slot);
```

```
int
```

```
osd_call(u_int type, u_int method, void *obj, void *data);
```

```
void  
osd_exit(u_int type, struct osd *osd);
```

## DESCRIPTION

The **osd** framework provides a mechanism to dynamically associate arbitrary data at run-time with any kernel data structure which has been suitably modified for use with **osd**. The one-off modification required involves embedding a *struct osd* inside the kernel data structure.

An additional benefit is that after the initial change to a structure is made, all subsequent use of **osd** with the structure involves no changes to the structure's layout. By extension, if the data structure is part of the ABI, **osd** provides a way of extending the structure in an ABI preserving manner.

The details of the embedded *struct osd* are not relevant to consumers of the **osd** framework and should not be manipulated directly.

Data associated with a structure is referenced by the **osd** framework using a type/slot identifier pair. Types are statically defined in `<sys/osd.h>` and provide a high-level grouping for slots to be registered under. Slot identifiers are dynamically assigned by the framework when a data type is registered using **osd\_register()** and remains valid until a corresponding call to **osd\_deregister()**.

## Functions

The **osd\_register()** function registers a type/slot identifier pair with the **osd** framework for use with a new data type. The function may sleep and therefore cannot be called from a non-sleepable context. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` the slot identifier should be allocated under. The *destructor* argument specifies an optional `osd_destructor_t` function pointer that will be called for objects of the type being registered which are later destroyed by the **osd\_del()** function. NULL may be passed if no destructor is required. The *methods* argument specifies an optional array of `osd_method_t` function pointers which can be later invoked by the **osd\_call()** function. NULL may be passed if no methods are required. The *methods* argument is currently only useful with the `OSD_JAIL` type identifier.

The **osd\_deregister()** function deregisters a previously registered type/slot identifier pair. The function may sleep and therefore cannot be called from a non-sleepable context. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` the slot identifier is allocated under. The *slot* argument specifies the slot identifier which is being deregistered and should be the value that was returned by **osd\_register()** when the data type was registered.

The **osd\_set()** function associates a data object pointer with a kernel data structure's *struct osd* member. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` the slot identifier is allocated under. The *osd* argument is a pointer to the kernel data structure's *struct osd* which will have

the *value* pointer associated with it. The *slot* argument specifies the slot identifier to assign the *value* pointer to. The *value* argument points to a data object to associate with *osd*.

The **osd\_set\_reserved()** function does the same as **osd\_set()**, but with an extra argument *rsv* that is internal-use memory previously allocated via **osd\_reserve()**.

The **osd\_get()** function returns the data pointer associated with a kernel data structure's *struct osd* member from the specified type/slot identifier pair. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` the slot identifier is allocated under. The *osd* argument is a pointer to the kernel data structure's *struct osd* to retrieve the data pointer from. The *slot* argument specifies the slot identifier to retrieve the data pointer from.

The **osd\_del()** function removes the data pointer associated with a kernel data structure's *struct osd* member from the specified type/slot identifier pair. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` the slot identifier is allocated under. The *osd* argument is a pointer to the kernel data structure's *struct osd* to remove the data pointer from. The *slot* argument specifies the slot identifier to remove the data pointer from. If an *osd\_destructor\_t* function pointer was specified at registration time, the destructor function will be called and passed the data pointer for the type/slot identifier pair which is being deleted.

The **osd\_call()** function calls the specified *osd\_method\_t* function pointer for all currently registered slots of a given type on the specified *obj* and *data* pointers. The function may sleep and therefore cannot be called from a non-sleepable context. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` to call the method for. The *method* argument specifies the index into the *osd\_method\_t* array that was passed to **osd\_register()**. The *obj* and *data* arguments are passed to the method function pointer of each slot.

The **osd\_exit()** function removes all data object pointers from all currently registered slots for a given type for the specified kernel data structure's *struct osd* member. The *type* argument specifies which high-level type grouping from `<sys/osd.h>` to remove data pointers from. The *osd* argument is a pointer to the kernel data structure's *struct osd* to remove all data object pointers for all currently registered slots from.

## IMPLEMENTATION NOTES

**osd** uses a two dimensional matrix (array of arrays) as the data structure to manage the external data associated with a kernel data structure's *struct osd* member. The type identifier is used as the index into the outer array, and the slot identifier is used as the index into the inner array. To set or retrieve a data pointer for a given type/slot identifier pair, **osd\_set()** and **osd\_get()** perform the equivalent of `array[type][slot]`, which is both constant time and fast.

If **osd\_set()** is called on a *struct osd* for the first time, the array for storing data pointers is dynamically allocated using **malloc(9)** with **M\_NOWAIT** to a size appropriate for the slot identifier being set. If a subsequent call to **osd\_set()** attempts to set a slot identifier which is numerically larger than the slot used in the previous **osd\_set()** call, **realloc(9)** is used to grow the array to the appropriate size such that the slot identifier can be used. To maximise the efficiency of any code which calls **osd\_set()** sequentially on a number of different slot identifiers (e.g., during an initialisation phase) one should loop through the slot identifiers in descending order from highest to lowest. This will result in only a single **malloc(9)** call to create an array of the largest slot size and all subsequent calls to **osd\_set()** will proceed without any **realloc(9)** calls.

It is possible for **osd\_set()** to fail to allocate this array. To ensure that such allocation succeeds, **osd\_reserve()** may be called (in a non-blocking context), and it will pre-allocate the memory via **malloc(9)** with **M\_WAITOK**. Then this pre-allocated memory is passed to **osd\_set\_reserved()**, which will use it if necessary or otherwise discard it. The memory may also be explicitly discarded by calling **osd\_free\_reserved()**. As this method always allocates memory whether or not it is ultimately needed, it should be used only rarely, such as in the unlikely event that **osd\_set()** fails.

The **osd** API is geared towards slot identifiers storing pointers to the same underlying data structure type for a given **osd** type identifier. This is not a requirement, and **khelf(9)** for example stores completely different data types in slots under the **OSD\_KHELP** type identifier.

### Locking

**osd** internally uses a mix of **mutex(9)**, **rmlock(9)** and **sx(9)** locks to protect its internal data structures and state.

Responsibility for synchronising access to a kernel data structure's *struct osd* member is left to the subsystem that uses the data structure and calls the **osd** API.

**osd\_get()** only acquires an **rmlock** in read mode, therefore making it safe to use in the majority of contexts within the kernel including most fast paths.

### RETURN VALUES

**osd\_register()** returns the slot identifier for the newly registered data type.

**osd\_set()** and **osd\_set\_reserved()** return zero on success or **ENOMEM** if the specified type/slot identifier pair triggered an internal **realloc(9)** which failed (**osd\_set\_reserved()** will always succeed when *rsv* is non-NULL).

**osd\_get()** returns the data pointer for the specified type/slot identifier pair, or **NULL** if the slot has not been initialised yet.

**osd\_reserve()** returns a pointer suitable for passing to **osd\_set\_reserved()** or **osd\_free\_reserved()**.

**osd\_call()** returns zero if no method is run or the method for each slot runs successfully. If a method for a slot returns non-zero, **osd\_call()** terminates prematurely and returns the method's error to the caller.

## SEE ALSO

khelp(9)

## HISTORY

The Object Specific Data (OSD) facility first appeared in FreeBSD 8.0.

## AUTHORS

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