

Introduction

This document explains the large memory pool function that is supported by following products.

- HI7300/PX V.1.03 Release 00 or later

Note, the contents of this document are not reflected in the user's manual of the product.

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1. Summary

The large memory pool function is the implementation to improve the processing time of the variable-size memory pool function.

A big difference with the variable-size memory pool is not to support the function to wait for the acquisition of memory block. Table 1 shows function difference with variable-size memory pool.

Table 1 Function Difference with Variable-size Memory Pool

Item		Variable-size Memory Pool	Large Memory Pool
Number of memory pools		Multiple memory pools can be used.	1
Attribute		VTA_UNFRAGMENT can be specified.	None
Service call	Create	cre_mpl, icre_mpl, acre_mpl, iacre_mpl	vcre_Impl, ivcre_Impl
	Delete	del_mpl	vdel_Impl
	Acquire (polling)	pget_mpl, ipget_mpl	vpget_Impl, ivpget_Impl
	Acquire (wait)	get_mpl	None
	Acquire (wait with time-out)	tget_mpl	None
	Release	rel_mpl, irel_mpl	vrel_Impl, ivrel_Impl
	Refer	ref_mpl, iref_mpl	vref_Impl, ivref_Impl, vref_Impl2, ivref_Impl2

2. Service Call

This chapter explains the specification of service calls for large memory pool by the same form as the manual.

Table 2 Service Calls for large Memory Pool

Service Call	Description	System State ^{**1}
		T/N/E/D/U/L/C
vcre_Impl	Creates large memory pool	T/E/D/U
ivcre_Impl		N/E/D/U
vdel_Impl	Deletes large memory pool	T/E/D/U
vpget_Impl	Acquires memory block	T/E/D/U
ivpget_Impl		N/E/D/U
vrel_Impl	Releases memory block	T/E/D/U
ivrel_Impl		N/E/D/U
vref_Impl	Refers to large memory pool state	T/E/D/U
ivref_Impl		N/E/D/U
vref_Impl2	Refers to large memory pool state (Simple version)	T/E/D/U
ivref_Impl2		N/E/D/U

Notes: 1 T: Can be called from task context
 N: Can be called from non-task context
 E: Can be called from dispatch-enabled state
 D: Can be called from dispatch-disabled state
 U: Can be called from CPU-unlocked state
 L: Can be called from CPU-locked state
 C: Can be called from CPU exception handler

2.1 Creates Large Memory Pool (vcre_impl, ivcre_impl)

C-Language API:

```
ER ercd = vcre_impl(VT_CLMPL *pk_clmpl);
```

```
ER ercd = ivcre_impl(VT_CLMPL *pk_clmpl);
```

Parameters:

VT_CLMPL *pk_clmpl	R4	Pointer to the packet where the large memory pool creation information is stored
--------------------	----	--

Return Parameters:

ER ercd	R0	Normal end (E_OK) or error code
---------	----	---------------------------------

Packet Structure:

```
typedef struct {
    ATR    implatr;      +0    4    Large memory pool attribute
    SIZE   implsz;      +4    4    Size of the large memory pool (Number of bytes)
    VP     impl;        +8    4    Start address of the large memory pool area
    UINT   minblksz;    +12   4    Minimum block size
    UINT   sctnum;      +16   4    Maximum number of sectors
} VT_CLMPL;
```

Error Codes:

E_RSATR	[k]	Reserved attribute
E_PAR	[k]	Parameter error <ul style="list-style-type: none"> (1) pk_clmpl is other than a multiple of four (2) implsz is other than a multiple of four (3) implsz \geq H'80000000 (4) impl is other than a multiple of four if impl is not NULL (5) minblksz is neither 8, 16, 32, 64, 128, 256, 512, 1024, 2048 nor 4096. (6) sctnum == 0 (7) implsz < minblksz \times 32 (8) minblksz == 8 if VTA_ALIGN16 is specified (9) minblksz == 8 or 16 if VTA_ALIGN32 is specified
E_NOMEM	[k]	Insufficient memory <ul style="list-style-type: none"> (1) Insufficient space in the system pool (2) Insufficient space in the resource pool
E_OBJ	[k]	Object status is invalid (Large memory pool already exists)
E_NOSPT	[k]	No support Compiler option "-def=USE_LMPL" is not specified for "kernel_def.c"
E_MACV	[k]	Memory access violation

Note : The context error (E_CTX) is not detected when this service call is called from the system state that is not permitted.

Function:

These service calls create the large memory pool.

Note, the large memory pool cannot be created by using the configurator.

(1) Implatr

For alignment of the addresses of memory blocks to be acquired from the large memory pool, any one of the following attributes can be specified when necessary.

- VTA_ALIGN16 (H'00000010): Memory block addresses are adjusted to 16-byte boundaries.
- VTA_ALIGN32 (H'00000020): Memory block addresses are adjusted to 32-byte boundaries.

When neither one of them is specified, memory block addresses are adjusted to 4-byte boundaries.

(2) Implsiz

Parameter Implsiz specifies the size of the large memory pool to be created.

(3) Impl

Parameter Impl specifies the start address of a free area to be used as the large memory pool. The kernel manages Implsiz-byte area starting from address Impl as the large memory pool.

When attribute VTA_ALIGN16 or VTA_ALIGN32 is specified, the actual large memory pool area to be used starts from an address obtained by adjusting address Impl to a 16-bytes or 32-bytes boundary, which means that the usable memory pool size decreases for the adjusted size.

Note that the kernel does not check which domain can access the specified area. For example, if an address in the P1 or P2 area is specified for the large memory pool area, the area cannot be accessed from a user domain, but the kernel does not detect it.

When the memory object protection function is selected:

An area that can be read or written to from the kernel domain must be specified as the large memory pool area. If this rule is violated, an E_MACV error will be returned.

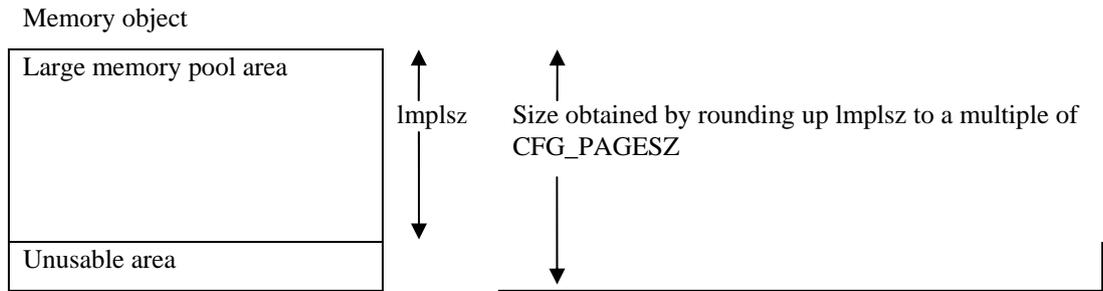
When NULL is specified for Impl, the kernel allocates an Implsiz-byte large memory pool area in the system pool.

When the memory object protection function is selected:

The large memory pool area allocated in the system pool by the kernel is a memory object having the following attributes.

- (1) Size: Implsiz is rounded up to a multiple of CFG_PAGESZ.

However, note that only the Implsiz bytes can be used for the large memory pool. As shown in the following figure, since the unusable area is included in the memory object where the large memory pool area is allocated, the unusable area has the same access permission as the large memory pool area, but the unusable area is not handled as the large memory pool.



- (2) Domain: When the service call is issued in a task context, the domain of the issuing task is assigned to the large memory pool, which is the same as the domain ID that can be obtained by calling `get_did`. When the service call is issued in a non-task context, the kernel domain is assigned.
- (3) Memory attribute: TA_RW|TA_CACHE|TA_WBACK
- (4) Access permission vector: An appropriate vector is specified so that only the assigned domain can read or write to the large memory pool as follows.
- For the kernel domain: TACT_KERNEL
 - For a user domain: TACT_PRW(domid)
(domid is the ID of the domain to which the issuing task belongs.)

(4) minblksz and sctnum

In the large memory pool, minute memory blocks are continuously arranged, and this is managed as sector. As a result, the fragmentation is reduced.

The size required for `Implmb` grows though minute memory block can be efficiently handled by enlarging `sctnum`.

The size of memory block that can be managed as sector is $\text{minblksz} \times 8$ (bytes) or less.

When `sctnum` is set to a larger value than $\text{Implsz} / (\text{minblksz} \times 32)$, $\text{Implsz} / (\text{minblksz} \times 32)$ is assumed.

This service call is a function not defined in the μ ITRON4.0 specification.

Error Detection through CFG_MEMCHK:

An `E_MACV` error will be returned in the following cases.

- (1) The domain of the caller does not have a read access permission for `pk_clmpl`, which means that an error will be returned if `prb_mem` is issued with the following parameters.
- `base = pk_clmpl`
 - `size = sizeof(VT_CLMPL)`
 - `domid = Domain of the caller`
 - `pmmode = TPM_READ`
- (2) When `pk_clmpl->Impl != NULL`, the kernel does not have a read/write access permission for the `Implsz`-byte area starting from address `Impl`, which means that an error will be returned if `prb_mem` is issued with the following parameters.
- `base = pk_clmpl->Impl`
 - `size = pk_clmpl->Implsz`
 - `domid = Kernel domain`
 - `pmmode = TPM_READ|TPM_WRITE`

2.2 Deletes Large Memory Pool (vdel_impl)

C-Language API:

```
ER ercd = vdel_impl(void);
```

Parameters:

None

Return Parameters:

ER ercd R0 Normal end (E_OK) or error code

Error Codes:

E_NOEXS	[k]	Undefined (The large memory pool does not exist)
E_CTX	[k]	Context error (Called from the system state that is not permitted)
E_NOSPT	[k]	No support Compiler option "-def=USE_LMPL" is not specified for "kernel_def.c"

Function:

This service call deletes the large memory pool.

The large memory pool area allocated in the system pool and the management area allocated in the resource pool are released.

The kernel will not perform any processing even when memory blocks have already been acquired.

This service call is a function not defined in the μ ITRON4.0 specification.

2.3 Acquires Memory Block (vpget_Impl, ivpget_Impl)

C-Language API:

```
ER ercd = vpget_Impl(UINT blkksz, VP *p_blk, VP *p_key);
```

```
ER ercd = ivpget_Impl(UINT blkksz, VP *p_blk, VP *p_key);
```

Parameters:

UINT	blkksz	R4	Memory block size (Number of bytes)
VP	*p_blk	R5	Pointer to the area where the start address of the memory block is to be returned
VP	*p_key	R6	Pointer to the area where the memory block management key is to be returned

Return Parameters:

ER	ercd	R0	Normal end (E_OK) or error code
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Error Codes:

E_PAR	[k]	Parameter error (1) p_blk is other than a multiple of four (2) blkksz is other than a multiple of four or 0 (3) $lmpsz^1 < blkksz$ (4) p_key is other than a multiple of four
E_TMOU	[k]	Polling Fail (There is no free area with blkksz bytes)
E_NOEXS	[k]	Undefined (The large memory pool does not exist)
E_NOSPT	[k]	No support Compiler option "-def=USE_LMPL" is not specified for "kernel_def.c"
E_NOMEM	[k]	Insufficient memory Insufficient space in the resource pool
E_MACV	[k]	Memory access violation

Note : The context error (E_CTX) is not detected when this service call is called from the system state that is not permitted.

Function:

These service calls acquire a memory block with the size specified by blkksz (number of bytes) from the large memory pool, and returns the start address of the acquired memory block to the area indicated by p_blk.

The blkksz is rounded up as shown in table 3.

¹ Large memory pool size specified by vcre_Impl or ivcre_Impl

Table 3 Rounding up blksize

VTA_ALIGN16 attribute	VTA_ALIGN32 attribute	Rounding up blksize
Not specified	Not specified	(1) When $blksize \leq (\minblksize^2 * 8)$: The blksize is rounded up to the power of 2 times the value of minblksize. (2) When $blksize > (\minblksize * 8)$: The blksize is rounded up to a multiple of 4.
Specified	Not specified	(1) When $blksize \leq (\minblksize * 8)$: The blksize is rounded up to the power of 2 times the value of minblksize. (2) When $blksize > (\minblksize * 8)$: The blksize is rounded up to a multiple of 16.
Not specified	Specified	(1) When $blksize \leq (\minblksize * 8)$: The blksize is rounded up to the power of 2 times the value of minblksize. (2) When $blksize > (\minblksize * 8)$: The blksize is rounded up to a multiple of 32.

After the memory block has been acquired, the size of the free space in the large memory pool will decrease by the size of rounded blksize.

For the large memory pool with attribute VTA_ALIGN16 or VTA_ALIGN32, the memory block address is a 16-byte or 32-byte boundary address, respectively.

The kernel consumes an area in the resource pool to manage the memory blocks. If there is not sufficient free space in the resource pool, an E_NOMEM error will be returned immediately.

The memory block management key is returned to the area pointed by p_key. The memory block management key should be specified at release of the memory block.

This service call is a function not defined in the μ TRON4.0 specification.

Error Detection through CFG_MEMCHK:

An E_MACV error will be returned in the following cases.

- (1) The domain of the caller does not have a read/write access permission for p_blk, which means that an error will be returned if prb_mem is issued with the following parameters.
 - base = p_blk
 - size = sizeof(VP)
 - domid = Domain of the caller
 - pmmode = TPM_READ|TPM_WRITE
- (2) The domain of the caller does not have a read/write access permission for p_key, which means that an error will be returned if prb_mem is issued with the following parameters.
 - base = p_key
 - size = sizeof(VP)
 - domid = Domain of the caller
 - pmmode = TPM_READ|TPM_WRITE

² The minblksize indicates the minimum block size specified by vcre_impl or ivcre_impl.

2.4 Releases Memory Block (vrel_Impl, ivrel_Impl)

C-Language API:

```
ER ercd = vrel_Impl(VP blk, VP key);
```

```
ER ercd = ivrel_Impl(VP blk, VP key);
```

Parameters:

VP	blk	R4	Start address of memory block
VP	key	R5	memory block management key

Return Parameters:

ER	ercd	R0	Normal end (E_OK) or error code
----	------	----	---------------------------------

Error Codes:

E_PAR	[k]	Parameter error
		(1) blk is other than a multiple of four
		(2) blk is other than the memory block start address
		(3) key is illegal.
E_NOEXS	[k]	Undefined (The large memory pool does not exist)
E_NOSPT	[k]	No support
		Compiler option "-def=USE_LMPL" is not specified for "kernel_def.c"

Note : The context error (E_CTX) is not detected when this service call is called from the system state that is not permitted.

Function:

These service calls release a memory block to the large memory pool.

The start address of the memory block acquired by service call `vpget_Impl` or `ivpget_Impl` must be specified as parameter `blk`. The memory block management key acquired by service call `vpget_Impl` or `ivpget_Impl` must be specified as parameter `key`.

This service call is a function not defined in the μ ITRON4.0 specification.

2.5 Refers to Large Memory Pool State (vref_Impl, ivref_Impl, vref_Impl2, ivref_Impl2)

C-Language API:

```
ER ercd = vref_Impl(T_RMPL *pk_rImpl)
ER ercd = ivref_Impl(T_RMPL *pk_rImpl)
ER ercd = vref_Impl2(T_RMPL *pk_rImpl)
ER ercd = ivref_Impl2(T_RMPL *pk_rImpl)
```

Parameters:

T_RMPL *pk_rImpl	R4	Pointer to the packet where the large memory pool state is to be returned
------------------	----	---

Return Parameters:

ER ercd	R0	Normal end (E_OK) or error code
---------	----	---------------------------------

Packet Structure:

```
typedef struct {
    ID    wtskid;      +0    4    Wait task ID
    SIZE  fmpksz;     +4    4    Total size of free memory (Number of bytes)
    UINT  fblksz;     +8    4    Maximum free memory size (Number of bytes)
} T_RMPL;
```

Error Codes:

E_PAR	[k]	Parameter error (1) pk_rImpl is other than a multiple of four
E_NOEXS	[k]	Undefined (The large memory pool does not exist)
E_NOSPT	[k]	No support Compiler option "-def=USE_LMPL" is not specified for "kernel_def.c"
E_MACV	[k]	Memory access violation

Note : The context error (E_CTX) is not detected when this service call is called from the system state that is not permitted.

Function:

These service calls return the large memory pool state to the area indicated by `pk_rlmpl`.

(1) **wtskid**

Always `TSK_NONE(0)` is returned.

(2) **fimplsz**

Total size of free memory is returned.

(3) **fblksz**

The free area is usually fragmented. The block up to the size `fblksz` can be acquired immediately by calling service call `vpget_lmpl` or `ivpget_lmpl`.

The `vref_lmpl` and `ivref_lmpl` return the size of the maximum contiguous free area.

The `vref_lmpl2` and `ivref_lmpl2` return the size close to size of the maximum contiguous free area. There is a possibility where a free area that is larger than `fblksz`.

This service call is a function not defined in the μ ITRON4.0 specification.

Note:

1. `vref_lmpl`, `ivref_lmpl`
The processing time depends on the number of free area.
2. `vref_lmpl2`, `ivref_lmpl2`
The worst processing time is fixation.

3. Estimation of Resource Pool Size

The following descriptions are added to "13.2.2 When Object is Created" in the "HI7300/PX User's Manual (REJ10J1198-0200)".

(8) **Large memory pool**

(a) **When allocating the large memory pool from system pool**

If the kernel is specified to allocate the pool area when creating the large memory pool, the pool area is allocated from the system pool. However, the resource pool is used for the size of VTSZ_SPLALCMB at maximum for managing the pool area. The contents of this macro are shown below.

- When CFG_PROTMEM is selected
VTSZ_SPLALCMB = 60
- When CFG_PROTMEM is not selected
VTSZ_SPLALCMB = 36

(b) **Large memory pool management**

The resource pool is requested for the size of VTSZ_LMPLMB (Maximum number of sectors). The contents of this macro are shown below

```
VTSZ_LMPLMB(Maximum number of sectors)
= 24 * (Maximum number of sectors) + 224
```

And the following descriptions are added to "13.2.3 Sizes Used and Released at Other Timings".

(5) **Large memory pool : vpget_impl, ivpget_impl**

When acquiring a memory block, the resource pool is requested for the size of VTSZ_BLKMB at maximum. The contents of this macro are shown below.

```
VTSZ_BLKMB = 36
```

This area is released when the block is released or the large memory pool is deleted.

4. Configuration

Please do the following to use the large memory pool.

(1) **Compiler option for "kernel_def.c"**

Specify "-def=USE_LMPL" for "kernel_def.c".

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