Semaphore (6A)

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Semaphore

```
int semget ( key_t key, int nsems, int semflg );
int semop ( int semid, struct sembuf *sops, unsigned nsops);
int semctl ( int semid, int semnum, int cmd, union semun arg );
```

```
struct sembuf {
  ushort  sem_num;          /* semaphore index in array */
  short   sem_op;           /* semaphore operation */
  short   sem_flg;          /* operation flags */
};
```

```
/* arg for semctl system calls. */
union semun {
      int                   val;      /* value for SETVAL */
      struct semid_ds *     buf;      /* buffer for IPC_STAT & IPC_SET */
      ushort              * array;    /* array for GETALL & SETALL */
      struct seminfo    *   __buf;    /* buffer for IPC_INFO */
      void              *   __pad;
}
```

Semaphore Example (1)

```
int semop ( int semid, struct sembuf *sops, unsigned nsops);

semid = semget(key, 2,  IPC_CREATE);

struct sembuf lock[] = { {0, -1, SEM_UNDO}, {1, -1, SEM_UNDO} };
struct sembuf unlock[] = { {0, +1, SEM_UNDO}, {1, +1, SEM_UNDO} };
```

```
semop(semid, &lock[0], 1);      ⇐ sops  sem_num = 0
// dec 1st semaphore                    sem_op  = -1
                                        sem_flg = SEM_UNDO

semop(semid, &lock[1], 1);      ⇐ sops  sem_num = 1
// dec 2nd semaphore                    sem_op  = -1
                                        sem_flg = SEM_UNDO

semop(semid, &unlock[0], 1);    ⇐ sops  sem_num = 0
// inc 1st semaphore                    sem_op  = +1
                                        sem_flg = SEM_UNDO

semop(semid, &unlock[1], 1);    ⇐ sops  sem_num = 1
// inc 2nd semaphore                    sem_op  = +1
                                        sem_flg = SEM_UNDO
```

semget()

```
int semget ( key_t key, int nsems, int semflg );
```

returns semaphore set identifier (sid) on success
semaphore set – array of semaphores

key – the return value of ftok()

nsems - the **number** of semaphores in a semaphore set *(array)*

semflg

IPC_CREAT	Create the semaphore set if it doesn't already exist
IPC_CREAT | IPC_EXCL	Fails if semaphore set already exists.

```
sid = semget( mykey, 2, IPC_CREAT | 0660 )
```

semop() - (1)

```
int semop ( int semid, struct sembuf *sops, unsigned nsops);
```

semid	- the return value of semget()
sops	- a pointer to an array of operations to be performed on the semaphore set
nsops	- the number of operations in that array.

```
struct sembuf {
  ushort  sem_num;    // semaphore index in array (sem set)
                      // The index of the semaphore you wish to deal with
  short   sem_op;     // semaphore operation (eg inc, dec)
                      // The operation to perform (positive, negative, or zero)
  short   sem_flg;    // operation flags
};
```

sops example

```
sem_num = 0
sem_op  = -1
sem_flg = SEM_UNDO
```

semop() - (2)

```
int semop ( int semid, struct sembuf *sops, unsigned nsops);
```

```
struct sembuf {
  ushort  sem_num;
  short    sem_op;
  short    sem_flg;
};
```

negative sem_op – lock
is added to the semaphore.
the calling process sleeps until the requested amount of resources are available (val > 0) in the semaphore

positive sem_op – unlock
is added to the semaphore.
returning resources back to the semaphore set

zero sem_op
the calling process will sleep() until the semaphore's value is 0.
waiting for a semaphore to reach 100% utilization

semop() - (3)

int semop (int semid, struct sembuf *sops, unsigned nsops);

nsops - the number of operations in that array.

SEM_UNDO : automatically undone when the process terminates

IPC_NOWAIT : If IPC_NOWAIT is not specified,
then the calling process sleeps
until the requested amount of resources
are available in the semaphore
(another process has released some).

semop() - (4)

```
int semop ( int semid, struct sembuf *sops, unsigned nsops);
```

```
struct sembuf sem_lock = { 0, -1, IPC_NOWAIT };
```
a value of ``-1" will be added to semaphore number 0 in the semaphore set.

```
semop(sid, &sem_lock, 1);
```

```
struct sembuf sem_unlock = { 0, 1, IPC_NOWAIT };
```
a value of ``1" will be added to semaphore number 0 in the semaphore set.

```
semop(sid, &sem_unlock, 1);
```

```
struct sembuf {
  ushort  sem_num;
  short   sem_op;
  short   sem_flg;
};
```

semctl() - (1)

```
int semctl ( int semid, int semnum, int cmd, union semun arg );

        /* arg for semctl system calls. */
        union semun {
                int val;                        /* value for SETVAL */
                struct semid_ds *buf;           /* buffer for IPC_STAT & IPC_SET */
                ushort *array;                  /* array for GETALL & SETALL */
                struct seminfo *__buf;          /* buffer for IPC_INFO */
                void *__pad;
        };
```

IPC_STAT	**GETPID**	**GETALL**
IPC_SET	**GETNCNT**	**GETVAL**
IPC_RMID	**GETZCNT**	
		SETALL
		SETVAL

semctl() - (2)

int semctl (int semid, int semnum, int cmd, union semun arg);

IPC_STAT Retrieves the semid_ds structure for a set, and stores it in the address of the buf argument in the semun union.

IPC_SET Sets the value of the ipc_perm member of the semid_ds structure for a set. Takes the values from the buf argument of the semun union.

IPC_RMID Removes the set from the kernel.

GETALL Used to obtain the values of all semaphores in a set. The integer values are stored in an *array* of unsigned short integers pointed to by the array member of the union.

GETNCNT Returns the number of processes currently waiting for resources.

GETPID Returns the PID of the process which performed the last semop call.

GETVAL Returns the value of a single semaphore within the set.

GETZCNT Returns the number of processes currently waiting for 100% resource utilization.

SETALL Sets all semaphore values with a set to the matching values contained in the *array member* of the union.

SETVAL Sets the value of an individual semaphore within the set to the val member of the union.

semctl() - semid_ds

```
/* One semid data structure for each set of semaphores in the system. */
struct semid_ds {
   struct ipc_perm   sem_perm;        /* permissions .. see ipc.h */
   time_t            sem_otime;       /* last semop time */
   time_t            sem_ctime;       /* last change time */
   struct sem        *sem_base;       /* ptr to first semaphore in array */
   struct wait_queue *eventn;
   struct wait_queue *eventz;
   struct sem_undo   *undo;            /* undo requests on this array */
   ushort            sem_nsems;        /* no. of semaphores in array */
};
```

sem_perm This is an instance of the ipc_perm structure, which holds the permission information for the semaphore set, including the access permissions, and information about the creator of the set (uid, etc).

sem_otime Time of the last semop() operation (more on this in a moment)

sem_ctime Time of the last change to this structure (mode change, etc)

sem_base Pointer to the first semaphore in the array (see next structure)

sem_undo Number of undo requests in this array

sem_nsems Number of semaphores in the semaphore set (the array)

semctl() - IPC_STAT, IPC_SET

```
int semctl ( int semid, int semnum, int cmd, union semun arg );
```

IPC_STAT Retrieves the semid_ds structure for a set, and stores it in the address of the buf argument in the semun union.

IPC_SET Sets the value of the ipc_perm member of the semid_ds structure for a set. Takes the values from the buf argument of the semun union.

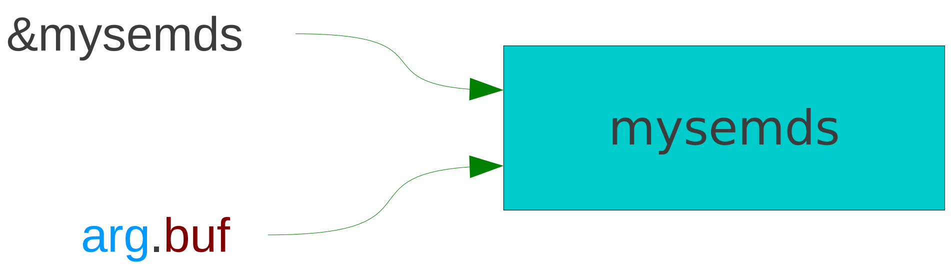
```
union semun {
        int                      val;
        struct semid_ds        * buf;
        ushort                 * array;
        struct seminfo        * __buf;
        void                  * __pad;
}
```

```
struct semid_ds mysemds;            // allocate ds in memory

union semun arg;
arg.buf = &mysemds;                 // buf must point to an allocated ds

semctl(semid, 0, IPC_STAT, arg);


semctl(semid, 0, IPC_SET, arg);
```



semctl() - SETVAL, SETALL

```
int semctl ( int semid, int semnum, int cmd, union semun arg );
```

SETVAL Sets the value of an individual semaphore within the set to the val member of the union.

SETALL Sets all semaphore values with a set to the matching values contained in the *array member* of the union.

```
union semun {
    int                    val;
    struct semid_ds *      buf;
    ushort               * array;
    struct seminfo   *     __buf;
    void             *     __pad;
}
```

```
union semun arg;

arg.val = 5;
semctl(semid, 1, SETVAL, arg);

unsigned short val = {3, 5, 6};
arg.array = val;
semctl(semid, 0, SETALL, arg);
```

semctl() - GETVAL, GETALL

```
int semctl ( int semid, int semnum, int cmd, union semun arg );
```

GETVAL Returns the value of a single semaphore within the set.

GETALL Used to obtain the values of all semaphores in a set. The integer values are stored in an *array* of unsigned short integers pointed to by the array member of the union.

```
union semun {
        int                     val;
        struct semid_ds  * buf;
        ushort                * array;
        struct seminfo   *  __buf;
        void                   *  __pad;
}
```

```
usigned short val;

val = semctl(semid, 1, GETVAL, 0);

union semun arg;
unsigned short semarr[3];
arg.array = semarr;

semctl(semid, 0, GETALL, arg);
```

Reference

References

[1] http://en.wikipedia.org/
[2] http://www.tldp.org/LDP/lpg/node46.html