

5

5.1

5.1.1

-> -> -> -> ->

5.1.2

5.1.3 pthread_t

PID " PID " tid pthread_t

```
#include <pthread.h>
pthread_t pthread_self(void);
```

pthread_self 1 tid

1 Phtread_txex1.c

```

1#include <pthread.h>
2#include <stdio.h>
3
4int main()
5{
6    pthread_t tid = pthread_self(); //      tid
7    printf("tid = %lu\n", (unsigned long)tid);
8    return 0;
9}

```

POSIX

pthread

gcc

gcc xxx.c -lpthread

MultiThread_Image001

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5.1.4

```

#include <pthread.h>
int pthread_create(pthread_t *thread, const pthread_attr_t *attr, void *(*start_routine) (void
*), void *arg);
    0

```

pthread_create

pthread_t

NULL

void * v

2 Phtread_txex2.c

```

1#include <pthread.h>
2#include <stdio.h>
3#include <unistd.h>
4#include <errno.h>
5
6void *fun(void *arg)
7{
8    printf("pthread_New = %lu\n", (unsigned long)pthread_self()); //      tid
9}
10

```

```

11 int main()
12 {
13
14 pthread_t tid1;
15 int ret = pthread_create( &tid1, NULL, fun, NULL); //
16 if (ret != 0) {
17 perror("pthread_create");
18 return -1;
19 }
20
21 /*tid_main pthread_self ID tid_new pthread_create tid */
22 printf("tid_main = %lu tid_new = %lu \n", (unsigned long)pthread_self(), (unsigned long)tid1);
23
24 /* sleep */
25 sleep(1);
26
27 return 0;
28 }
29

```

MultiThread_Image002

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```

pthread_create pthread_create tid pthread_self
sleep
25

```

MultiThread_Image003

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```

3 2

```

5.1.5

```

pthread_create() void * void * 3

```

3 Phtread_txex3.c

```

1  #include <pthread.h>
2  #include <stdio.h>
3  #include <unistd.h>
4  #include <errno.h>
5
6  void *fun1(void *arg)
7  {
8      printf("s: arg = %d Addr = %p\n", __FUNCTION__, *(int *)arg, arg);
9  }
10
11 void *fun2(void *arg)
12 {
13     printf("s: arg = %d Addr = %p\n", __FUNCTION__, (int)(long)arg, arg);
14 }
15
16 int main()
17 {
18
19     pthread_t tid1, tid2;
20     int a = 50;
21     int ret = pthread_create(&tid1, NULL, fun1, (void *)&a); // a
22     if(ret != 0){
23         perror("pthread_create");
24         return -1;
25     }
27     ret = pthread_create(&tid2, NULL, fun2, (void*)(long)a); // a
28     if(ret != 0){
29         perror("pthread_create");
30         return -1;
31     }
32     sleep(1);
33     printf("s: a = %d Addr = %p\n", __FUNCTION__, a, &a);
34     return 0;
35 }
36

```

MultiThread_Image004

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4 Phtread_txex4.c

```
1 #include <pthread.h>
2 #include <stdio.h>
3 #include <unistd.h>
4 #include <errno.h>
5
6 void *fun1(void *arg)
7 {
8     while(1){
9
10        printf("%s: arg = %d Addr = %p\n", __FUNCTION__, *(int *)arg, arg);
11        sleep(1);
12    }
13 }
14
15 void *fun2(void *arg)
16 {
17     while(1){
18
19        printf("%s: arg = %d Addr = %p\n", __FUNCTION__, (int)(long)arg, arg);
20        sleep(1);
21    }
22 }
23
24 int main()
25 {
26
27     pthread_t tid1, tid2;
28     int a = 50;
29     int ret = pthread_create(&tid1, NULL, fun1, (void *)&a);
30     if(ret != 0){
31         perror("pthread_create");
32         return -1;
33     }
34     sleep(1);
35     ret = pthread_create(&tid2, NULL, fun2, (void *) (long)a);
```

```

36    if(ret != 0){
37        perror("pthread_create");
38        return -1;
39    }
40    while(1){
41        a++;
42        sleep(1);
43        printf("%s: a = %d Add = %p \n", __FUNCTION__, a, &a);
44    }
45    return 0;
46 }
47

```

MultiThread_Image005

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5 Phtread_txex5.c

```

1  #include <pthread.h>
2  #include <stdio.h>
3  #include <unistd.h>
4  #include <string.h>
5  #include <errno.h>
6
7  struct Stu{
8      int Id;
9      char Name[32];
10     float Mark;
11 };
12
13 void *fun1(void *arg)
14 {
15     struct Stu *tmp = (struct Stu *)arg;
16     printf("%s: Id = %d Name = %s Mark = %.2f\n", __FUNCTION__, tmp->Id, tmp->Name, tmp->Mark);
17 }
18
19

```

```

20int main()
21{
22
23pthread_t tid1,tid2;
24struct Stu stu;
25stu.Id = 10000;
26strcpy( stu. Name," ZhangSan");
27stu.Mark = 94. 6;
28
29int ret = pthread_create( &tid1, NULL, fun1, ( void *) &stu);
30if( ret != 0){
31perror("pthread_create");
32return -1;
33}
34printf("%s: Id = %d Name = %s Mark = %. 2f\n", __FUNCTION__, stu. Id, stu. Name, stu. Mark);
35sleep(1);
36return 0;
37}
38

```

MultiThread_Image006

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5.1.6

pthread_exit

pthread_cancel

```

#include <pthread.h>
void pthread_exit(void *retval);

```

void*

NULL

```

#include <pthread.h>
int pthread_join(pthread_t thread, void **retval);
0

```

tid


```

#define _GNU_SOURCE
#include <pthread.h>
int pthread_tryjoin_np(pthread_t thread, void **retval);
    0

```

0 pthread_join

```

#include <pthread.h>
int pthread_cancel(pthread_t thread);
    0

```

tid	tid	0
	API	API

6 Phtread_txex6.c

```

1  #include <pthread.h>
2  #include <stdio.h>
3  #include <unistd.h>
4  #include <errno.h>
5
6  void *fun1(void *arg)
7  {
8      static int tmp = 0; // static pthread_join
9      //int tmp = 0;
10     tmp = *(int *)arg;
11     tmp+=100;
12     printf("%s: Addr = %p tmp = %d\n", __FUNCTION__, &tmp, tmp);
13     pthread_exit((void *)&tmp); // tmp void*
14 }
15
16
17 int main()
18 {
19
20     pthread_t tid1;
21     int a = 50;
22     void *Tmp = NULL; // pthread_join void**
23     int ret = pthread_create(&tid1, NULL, fun1, (void *)&a);

```

```

24    if(ret != 0){
25        perror("pthread_create");
26        return -1;
27    }
28    pthread_join(tid1, &Tmp);
29    printf("%s: Addr = %p Val = %d\n", __FUNCTION__, Tmp, *(int *) Tmp);
30    return 0;
31 }
32

```

MultiThread_Image007

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23

100

void*

pthread_join

slee

7 Phtread_txex7.c

```

1  #define _GNU_SOURCE
2  #include <pthread.h>
3  #include <stdio.h>
4  #include <unistd.h>
5  #include <errno.h>
6
7  void *fun(void *arg)
8  {
9      printf("Pthread: %d Come !\n", (int)(long) arg+1);
10     pthread_exit(arg);
11 }
12
13
14 int main()
15 {
16     int ret, i, flag = 0;
17     void *Tmp = NULL;
18     pthread_t tid[3];
19     for(i = 0; i < 3; i++){
20         ret = pthread_create(&tid[i], NULL, fun, (void*)(long)i);
21         if(ret != 0){
22             perror("pthread_create");

```

```

23    return -1;
24}
25
26while(1){//          3
27    for(i = 0; i < 3; i++){
28        if(pthread_tryjoin_np(tid[i], &Tmp) == 0){
29            printf("Pthread : %d exit ! \n", (int)(long)Tmp+1);
30            flag++;
31        }
32    }
33    if(flag >= 3) break;
34}
35return 0;
36
37

```

MultiThread_Image008

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7

6

pthread_tryjoin_np

8 Phtread_txex8.c

```

1  #define _GNU_SOURCE
2  #include <pthread.h>
3  #include <stdio.h>
4  #include <unistd.h>
5  #include <errno.h>
6
7  void *fun1(void *arg)
8  {
9      printf("Pthread:1 come! \n");
10     while(1){
11         sleep(1);
12     }
13 }
14
15 void *fun2(void *arg)

```

```

16{
17    printf("Pthread: 2 come! \n");
18    pthread_cancel((pthread_t )(long) arg); //    1
19    pthread_exit(NULL);
20}
21
22int main()
23{
24    int ret, i, flag = 0;
25    void *Tmp = NULL;
26    pthread_t tid[ 2];
27    ret = pthread_create( &tid[ 0], NULL, fun1, NULL);
28    if( ret != 0){
29        perror("pthread_create");
30        return -1;
31    }
32    sleep(1);
33    ret = pthread_create( &tid[ 1], NULL, fun2, ( void *) tid[ 0]); //    1
34    if( ret != 0){
35        perror("pthread_create");
36        return -1;
37    }
38    while(1){ //    2
39        for( i = 0; i <2; i++){
40            if( pthread_tryjoin_np( tid[ i], NULL) == 0){
41                printf("Pthread :  %d exit ! \n", i+1);
42                flag++;
43            }
44        }
45        if( flag >= 2) break;
46    }
47    return 0;
48}
49

```

MultiThread_Image009

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5.2

5.2.1

“ ”

1

2

“ ”

9 Phtread_txex9.c

```
1 #define _GNU_SOURCE
2 #include <pthread.h>
3 #include <stdio.h>
4 #include <unistd.h>
5 #include <errno.h>
6
7
8 int Num = 0;
9
10 void *fun1(void *arg)
11 {
12     while(Num < 3){
13         Num++;
14         printf("%s: Num = %d\n", __FUNCTION__, Num);
15         sleep(1);
16     }
17     pthread_exit(NULL);
18 }
19
20 void *fun2(void *arg)
21 {
22     while(Num > -3){
23         Num--;
24         printf("%s: Num = %d\n", __FUNCTION__, Num);
25         sleep(1);
26     }
27     pthread_exit(NULL);
28 }
29
```

```

30 int main()
31 {
32     int ret;
33     pthread_t tid1, tid2;
34     ret = pthread_create(&tid1, NULL, fun1, NULL);
35     if (ret != 0) {
36         perror("pthread_create");
37         return -1;
38     }
39     ret = pthread_create(&tid2, NULL, fun2, NULL);
40     if (ret != 0) {
41         perror("pthread_create");
42         return -1;
43     }
44     pthread_join(tid1, NULL);
45     pthread_join(tid2, NULL);
46     return 0;
47 }
48

```

MultiThread_Image010

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pthread

5.2.2 API

```

#include <pthread.h>

int pthread_mutex_init(pthread_mutex_t *mutex,
const pthread_mutexattr_t *restrict attr);

0

```

pthread_mutex_t

pthread_mutex_t mutex = PTHREAD_MUTEX_INITIALIZER;

```

/
#include <pthread.h>

```

```
int pthread_mutex_lock(pthread_mutex_t *mutex);
int pthread_mutex_unlock(pthread_mutex_t *mutex);
```

lock	unlock	pthread_mutex_t	0	lock
	lock	unlock		pthread_cancel

```
#include <pthread.h>
int pthread_mutex_trylock(pthread_mutex_t *mutex);
0
```

```
#include <pthread.h>
int pthread_mutex_destory(pthread_mutex_t *mutex);
0
```

0

10 Phtread_txex10.c

```
1 #define _GNU_SOURCE
2 #include <pthread.h>
3 #include <stdio.h>
4 #include <unistd.h>
5 #include <errno.h>
6
7 pthread_mutex_t mutex; //
8
9 int Num = 0; //
10
11 void *fun1(void *arg)
12 {
13     pthread_mutex_lock(&mutex); //
14     while(Num < 3){
15         Num++;
16         printf("%s: Num = %d\n", __FUNCTION__, Num);
17         sleep(1);
18     }
19     pthread_mutex_unlock(&mutex); //
```

```

20 pthread_exit(NULL); // pthread_join
21
22
23 void *fun2( void *arg)
24 {
25 pthread_mutex_lock( &mutex); //
26 while( Num > -3){
27 Num--;
28 printf("s: Num = %d\n", __FUNCTION__, Num);
29 sleep(1);
30 }
31 pthread_mutex_unlock( &mutex); //
32 pthread_exit(NULL); // pthread_join
33
34
35 int main()
36 {
37 int ret;
38 pthread_t tid1, tid2;
39 ret = pthread_mutex_init( &mutex, NULL); //
40 if( ret != 0){
41 perror("pthread_mutex_init");
42 return -1;
43 }
44 ret = pthread_create( &tid1, NULL, fun1, NULL); // 1
45 if( ret != 0){
46 perror("pthread_create");
47 return -1;
48 }
49 ret = pthread_create( &tid2, NULL, fun2, NULL); // 2
50 if( ret != 0){
51 perror("pthread_create");
52 return -1;
53 }
54 pthread_join( tid1, NULL); // 1
55 pthread_join( tid2, NULL); // 2
56 pthread_mutex_destroy( &mutex); //
57 return 0;
58
59

```


MultiThread_Image011

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while

5.2.3

sleep

11

11 Phtread_txex11.c

```
1 #define _GNU_SOURCE
2 #include <pthread.h>
3 #include <stdio.h>
4 #include <unistd.h>
5 #include <errno.h>
6
7 void *fun1(void *arg)
8 {
9     printf("%s: Pthread Come! \n", __FUNCTION__);
10    pthread_exit(NULL);
11}
12
13void *fun2(void *arg)
14{
15    printf("%s: Pthread Come! \n", __FUNCTION__);
16    pthread_exit(NULL);
17}
18
19void *fun3(void *arg)
20{
21    printf("%s: Pthread Come! \n", __FUNCTION__);
22    pthread_exit(NULL);
23}
24
25int main()
26{
```

```

27    int ret;
28    pthread_t tid1, tid2, tid3;
29    ret = pthread_create( &tid1, NULL, fun1, NULL);
30    if( ret != 0){
31        perror("pthread_create");
32        return -1;
33    }
34    ret = pthread_create( &tid2, NULL, fun2, NULL);
35    if( ret != 0){
36        perror("pthread_create");
37        return -1;
38    }
39    ret = pthread_create( &tid3, NULL, fun3, NULL);
40    if( ret != 0){
41        perror("pthread_create");
42        return -1;
43    }
44    pthread_join( tid1, NULL);
45    pthread_join( tid2, NULL);
46    pthread_join( tid3, NULL);
47    return 0;
48 }
49

```

MultiThread_Image012

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5.2.4 API

```

#include <semaphore.h>
int sem_init(sem_t *sem, int pshared, unsigned int value);
    0

```

sem_t

0

0

1

```

PV
#include <pthread.h>
int sem_wait(sem_t *sem);
int sem_post(sem_t *sem);
0

```

```

sem_wait                                "sem-1"    "sem-1"

sem_post                                "sem+1"

2          PV

```

```

#include <pthread.h>
int sem_trywait(sem_t *sem);
0

```

sem_wait

```

#include <pthread.h>
int sem_destory(sem_t *sem);
0

```

12 Phtread_txex12.c

```

1 #define _GNU_SOURCE
2 #include <pthread.h>
3 #include <stdio.h>
4 #include <unistd.h>
5 #include <errno.h>
6 #include <semaphore.h>
7
8 sem_t sem1, sem2, sem3; //
9
10 void *fun1(void *arg)
11 {
12     sem_wait(&sem1); // sem1          sem1-1
13     printf("%s: Pthread Come! \n", __FUNCTION__);
14     sem_post(&sem2); // sem2

```

```

15 pthread_exit(NULL);
16
17
18 void *fun2( void *arg)
19 {
20     sem_wait( &sem2); // sem2          14          sem2-1
21     printf( "%s: Pthread Come! \n", __FUNCTION__ );
22     sem_post( &sem3); // sem3
23     pthread_exit(NULL);
24 }
25
26 void *fun3( void *arg)
27 {
28     sem_wait( &sem3); // sem3          22          sem3-1
29     printf( "%s: Pthread Come! \n", __FUNCTION__ );
30     sem_post( &sem1); // sem1
31     pthread_exit(NULL);
32 }
33
34 int main()
35 {
36     int ret;
37     pthread_t tid1, tid2, tid3;
38     ret = sem_init( &sem1, 0, 1); // 1
39     if( ret < 0){
40         perror( "sem_init");
41         return -1;
42     }
43     ret = sem_init( &sem2, 0, 0); // 2
44     if( ret < 0){
45         perror( "sem_init");
46         return -1;
47     }
48     ret = sem_init( &sem3, 0, 0); // 3
49     if( ret < 0){
50         perror( "sem_init");
51         return -1;
52     }
53     ret = pthread_create( &tid1, NULL, fun1, NULL); // 1
54     if( ret != 0){
55         perror( "pthread_create");

```

```

56    return -1;
57}
58ret = pthread_create( &tid2, NULL, fun2, NULL); // 2
59if (ret != 0) {
60    perror("pthread_create");
61    return -1;
62}
63ret = pthread_create( &tid3, NULL, fun3, NULL); // 3
64if (ret != 0) {
65    perror("pthread_create");
66    return -1;
67}
68/* */
69pthread_join( tid1, NULL);
70pthread_join( tid2, NULL);
71pthread_join( tid3, NULL);
72
73/* */
74sem_destroy( &sem1);
75sem_destroy( &sem2);
76sem_destroy( &sem3);
77
78return 0;
79}
80

```

MultiThread_Image013

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			1	sem_wait	sem_pos
38	1	43 48	2 3		sem_wait

5.3

MultiThread_Image014

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MultiThread_Image015

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PV

MultiThread_Image016

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