**C++线程池原理及创建**

      本文给出了一个通用的线程池框架，该框架将与线程执行相关的任务进行了高层次的抽象，使之与具体的执行任务无关。另外该线程池具有动态伸缩性，它能根据执行任务的轻重自动调整线程池中线程的数量。文章的最后，我们给出一个简单示例程序，通过该示例程序，我们会发现，通过该线程池框架执行多线程任务是多么的简单。

**为什么需要线程池**   
      目前的大多数网络服务器，包括Web服务器、Email服务器以及数据库服务器等都具有一个共同点，就是单位时间内必须处理数目巨大的连接请求，但处理时间却相对较短。   
传统多线程方案中我们采用的服务器模型则是一旦接受到请求之后，即创建一个新的线程，由该线程执行任务。任务执行完毕后，线程退出，这就是是“即时创建，即时销毁”的策略。尽管与创建进程相比，创建线程的时间已经大大的缩短，但是如果提交给线程的任务是执行时间较短，而且执行次数极其频繁，那么服务器将处于不停的创建线程，销毁线程的状态。

我们将传统方案中的线程执行过程分为三个过程：T1、T2、T3。

T1：线程创建时间   
T2：线程执行时间，包括线程的同步等时间   
T3：线程销毁时间

那么我们可以看出，线程本身的开销所占的比例为(T1+T3) / (T1+T2+T3)。如果线程执行的时间很短的话，这比开销可能占到20%-50%左右。如果任务执行时间很频繁的话，这笔开销将是不可忽略的。

      除此之外，线程池能够减少创建的线程个数。通常线程池所允许的并发线程是有上界的，如果同时需要并发的线程数超过上界，那么一部分线程将会等待。而传统方案中，如果同时请求数目为2000，那么最坏情况下，系统可能需要产生2000个线程。尽管这不是一个很大的数目，但是也有部分机器可能达不到这种要求。

      因此线程池的出现正是着眼于减少线程池本身带来的开销。线程池采用预创建的技术，在应用程序启动之后，将立即创建一定数量的线程(N1)，放入空闲队列中。这些线程都是处于阻塞（Suspended）状态，不消耗CPU，但占用较小的内存空间。当任务到来后，缓冲池选择一个空闲线程，把任务传入此线程中运行。当N1个线程都在处理任务后，缓冲池自动创建一定数量的新线程，用于处理更多的任务。在任务执行完毕后线程也不退出，而是继续保持在池中等待下一次的任务。当系统比较空闲时，大部分线程都一直处于暂停状态，线程池自动销毁一部分线程，回收系统资源。   
      基于这种预创建技术，线程池将线程创建和销毁本身所带来的开销分摊到了各个具体的任务上，执行次数越多，每个任务所分担到的线程本身开销则越小，不过我们另外可能需要考虑进去线程之间同步所带来的开销。

**构建线程池框架**

一般线程池都必须具备下面几个组成部分：   
线程池管理器:用于创建并管理线程池   
工作线程: 线程池中实际执行的线程   
任务接口: 尽管线程池大多数情况下是用来支持网络服务器，但是我们将线程执行的任务抽象出来，形成任务接口，从而使得线程池与具体的任务无关。   
任务队列:线程池的概念具体到实现则可能是队列，链表之类的数据结构，其中保存执行线程。

我们实现的通用线程池框架由五个重要部分组成CThreadManage，CThreadPool，CThread，CJob，CWorkerThread，除此之外框架中还包括线程同步使用的类CThreadMutex和CCondition。   
CJob是所有的任务的基类，其提供一个接口Run，所有的任务类都必须从该类继承，同时实现Run方法。该方法中实现具体的任务逻辑。   
CThread是Linux中线程的包装，其封装了Linux线程最经常使用的属性和方法，它也是一个抽象类，是所有线程类的基类，具有一个接口Run。   
CWorkerThread是实际被调度和执行的线程类，其从CThread继承而来，实现了CThread中的Run方法。   
CThreadPool是线程池类，其负责保存线程，释放线程以及调度线程。   
CThreadManage是线程池与用户的直接接口，其屏蔽了内部的具体实现。   
CThreadMutex用于线程之间的互斥。   
CCondition则是条件变量的封装，用于线程之间的同步。

线程池的时序很简单。CThreadManage直接跟客户端打交道，其接收需要创建的线程初始个数，并接收客户端提交的任务。这儿的任务是具体的非抽象的任务。CThreadManage的内部实际上调用的都是CThreadPool的相关操作。CThreadPool创建具体的线程，并把客户端提交的任务分发给CWorkerThread，CWorkerThread实际执行具体的任务。

**理解系统组件**

下面我们分开来了解系统中的各个组件。   
CThreadManage   
CThreadManage的功能非常简单，其提供最简单的方法，其类定义如下：

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1 class CThreadManage

2 {

3 private:

4 CThreadPool\* m\_Pool;

5 int m\_NumOfThread;

6 protected:

7 public:

8 void SetParallelNum(int num);

9 CThreadManage();

10 CThreadManage(int num);

11 virtual ~CThreadManage();

12

13 void Run(CJob\* job,void\* jobdata);

14 void TerminateAll(void);

15 };

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其中m\_Pool指向实际的线程池；m\_NumOfThread是初始创建时候允许创建的并发的线程个数。另外Run和TerminateAll方法也非常简单，只是简单的调用CThreadPool的一些相关方法而已。其具体的实现如下:

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1 CThreadManage::CThreadManage(){

2 m\_NumOfThread = 10;

3 m\_Pool = new CThreadPool(m\_NumOfThread);

4 }

5 CThreadManage::CThreadManage(int num){

6 m\_NumOfThread = num;

7 m\_Pool = new CThreadPool(m\_NumOfThread);

8 }

9 CThreadManage::~CThreadManage(){

10 if(NULL != m\_Pool)

11 delete m\_Pool;

12 }

13 void CThreadManage::SetParallelNum(int num){

14 m\_NumOfThread = num;

15 }

16 void CThreadManage::Run(CJob\* job,void\* jobdata){

17 m\_Pool->Run(job,jobdata);

18 }

19 void CThreadManage::TerminateAll(void){

20 m\_Pool->TerminateAll();

21 }

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CThread   
CThread 类实现了对Linux中线程操作的封装，它是所有线程的基类，也是一个抽象类，提供了一个抽象接口Run，所有的CThread都必须实现该Run方法。CThread的定义如下所示：

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1 class CThread

2 {

3 private:

4 int m\_ErrCode;

5 Semaphore m\_ThreadSemaphore; //the inner semaphore, which is used to realize

6 unsigned long m\_ThreadID;

7 bool m\_Detach; //The thread is detached

8 bool m\_CreateSuspended; //if suspend after creating

9 char\* m\_ThreadName;

10 ThreadState m\_ThreadState; //the state of the thread

11 protected:

12 void SetErrcode(int errcode){m\_ErrCode = errcode;}

13 static void\* ThreadFunction(void\*);

14 public:

15 CThread();

16 CThread(bool createsuspended,bool detach);

17 virtual ~CThread();

18 virtual void Run(void) = 0;

19 void SetThreadState(ThreadState state){m\_ThreadState = state;}

20

21 bool Terminate(void); //Terminate the thread

22 bool Start(void); //Start to execute the thread

23 void Exit(void);

24 bool Wakeup(void);

25

26 ThreadState GetThreadState(void){return m\_ThreadState;}

27 int GetLastError(void){return m\_ErrCode;}

28 void SetThreadName(char\* thrname){strcpy(m\_ThreadName,thrname);}

29 char\* GetThreadName(void){return m\_ThreadName;}

30 int GetThreadID(void){return m\_ThreadID;}

31

32 bool SetPriority(int priority);

33 int GetPriority(void);

34 int GetConcurrency(void);

35 void SetConcurrency(int num);

36 bool Detach(void);

37 bool Join(void);

38 bool Yield(void);

39 int Self(void);

40 };

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线程的状态可以分为四种，空闲、忙碌、挂起、终止(包括正常退出和非正常退出)。由于目前Linux线程库不支持挂起操作，因此，我们的此处的挂起操作类似于暂停。如果线程创建后不想立即执行任务，那么我们可以将其“暂停”，如果需要运行，则唤醒。有一点必须注意的是，一旦线程开始执行任务，将不能被挂起，其将一直执行任务至完毕。   
线程类的相关操作均十分简单。线程的执行入口是从Start()函数开始，其将调用函数ThreadFunction，ThreadFunction再调用实际的Run函数，执行实际的任务。

CThreadPool   
CThreadPool是线程的承载容器，一般可以将其实现为堆栈、单向队列或者双向队列。在我们的系统中我们使用STL Vector对线程进行保存。CThreadPool的实现代码如下：

[复制代码](javascript:void(0);)

1 class CThreadPool

2 {

3 friend class CWorkerThread;

4 private:

5 unsigned int m\_MaxNum; //the max thread num that can create at the same time

6 unsigned int m\_AvailLow; //The min num of idle thread that shoule kept

7 unsigned int m\_AvailHigh; //The max num of idle thread that kept at the same time

8 unsigned int m\_AvailNum; //the normal thread num of idle num;

9 unsigned int m\_InitNum; //Normal thread num;

10 protected:

11 CWorkerThread\* GetIdleThread(void);

12

13 void AppendToIdleList(CWorkerThread\* jobthread);

14 void MoveToBusyList(CWorkerThread\* idlethread);

15 void MoveToIdleList(CWorkerThread\* busythread);

16

17 void DeleteIdleThread(int num);

18 void CreateIdleThread(int num);

19 public:

20 CThreadMutex m\_BusyMutex; //when visit busy list,use m\_BusyMutex to lock and unlock

21 CThreadMutex m\_IdleMutex; //when visit idle list,use m\_IdleMutex to lock and unlock

22 CThreadMutex m\_JobMutex; //when visit job list,use m\_JobMutex to lock and unlock

23 CThreadMutex m\_VarMutex;

24

25 CCondition m\_BusyCond; //m\_BusyCond is used to sync busy thread list

26 CCondition m\_IdleCond; //m\_IdleCond is used to sync idle thread list

27 CCondition m\_IdleJobCond; //m\_JobCond is used to sync job list

28 CCondition m\_MaxNumCond;

29

30 vector<CWorkerThread\*> m\_ThreadList;

31 vector<CWorkerThread\*> m\_BusyList; //Thread List

32 vector<CWorkerThread\*> m\_IdleList; //Idle List

33

34 CThreadPool();

35 CThreadPool(int initnum);

36 virtual ~CThreadPool();

37

38 void SetMaxNum(int maxnum){m\_MaxNum = maxnum;}

39 int GetMaxNum(void){return m\_MaxNum;}

40 void SetAvailLowNum(int minnum){m\_AvailLow = minnum;}

41 int GetAvailLowNum(void){return m\_AvailLow;}

42 void SetAvailHighNum(int highnum){m\_AvailHigh = highnum;}

43 int GetAvailHighNum(void){return m\_AvailHigh;}

44 int GetActualAvailNum(void){return m\_AvailNum;}

45 int GetAllNum(void){return m\_ThreadList.size();}

46 int GetBusyNum(void){return m\_BusyList.size();}

47 void SetInitNum(int initnum){m\_InitNum = initnum;}

48 int GetInitNum(void){return m\_InitNum;}

49

50 void TerminateAll(void);

51 void Run(CJob\* job,void\* jobdata);

52 };

53 CThreadPool::CThreadPool()

54 {

55 m\_MaxNum = 50;

56 m\_AvailLow = 5;

57 m\_InitNum=m\_AvailNum = 10 ;

58 m\_AvailHigh = 20;

59

60 m\_BusyList.clear();

61 m\_IdleList.clear();

62 for(int i=0;i<m\_InitNum;i++){

63 CWorkerThread\* thr = new CWorkerThread();

64 thr->SetThreadPool(this); //将创建的CworkerThread放到CThreadPool中

65 AppendToIdleList(thr);

66 thr->Start(); // Start()在基类Cthread中实现

67 }

68 }

69

70 CThreadPool::CThreadPool(int initnum)

71 {

72 assert(initnum>0 && initnum<=30);

73 m\_MaxNum = 30;

74 m\_AvailLow = initnum-10>0?initnum-10:3;

75 m\_InitNum=m\_AvailNum = initnum ;

76 m\_AvailHigh = initnum+10;

77

78 m\_BusyList.clear();

79 m\_IdleList.clear();

80 for(int i=0;i<m\_InitNum;i++){

81 CWorkerThread\* thr = new CWorkerThread();

82 AppendToIdleList(thr);

83 thr->SetThreadPool(this);

84 thr->Start(); //begin the thread,the thread wait for job

85 }

86 }

87

88 CThreadPool::~CThreadPool()

89 {

90 TerminateAll();

91 }

92

93 void CThreadPool::TerminateAll()

94 {

95 for(int i=0;i < m\_ThreadList.size();i++) {

96 CWorkerThread\* thr = m\_ThreadList[i];

97 thr->Join();

98 }

99 return;

100 }

101

102 CWorkerThread\* CThreadPool::GetIdleThread(void)

103 {

104 while(m\_IdleList.size() ==0 )

105 m\_IdleCond.Wait();

106

107 m\_IdleMutex.Lock();

108 if(m\_IdleList.size() > 0 )

109 {

110 CWorkerThread\* thr = (CWorkerThread\*)m\_IdleList.front();

111 printf("Get Idle thread %dn",thr->GetThreadID());

112 m\_IdleMutex.Unlock();

113 return thr;

114 }

115 m\_IdleMutex.Unlock();

116

117 return NULL;

118 }

119

120 //add an idle thread to idle list

121 void CThreadPool::AppendToIdleList(CWorkerThread\* jobthread)

122 {

123 m\_IdleMutex.Lock();

124 m\_IdleList.push\_back(jobthread);

125 m\_ThreadList.push\_back(jobthread);

126 m\_IdleMutex.Unlock();

127 }

128

129 //move and idle thread to busy thread

130 void CThreadPool::MoveToBusyList(CWorkerThread\* idlethread)

131 {

132 m\_BusyMutex.Lock();

133 m\_BusyList.push\_back(idlethread);

134 m\_AvailNum--;

135 m\_BusyMutex.Unlock();

136

137 m\_IdleMutex.Lock();

138 vector<CWorkerThread\*>::iterator pos;

139 pos = find(m\_IdleList.begin(),m\_IdleList.end(),idlethread);

140 if(pos !=m\_IdleList.end())

141 m\_IdleList.erase(pos);

142 m\_IdleMutex.Unlock();

143 }

144

145 void CThreadPool::MoveToIdleList(CWorkerThread\* busythread)

146 {

147 m\_IdleMutex.Lock();

148 m\_IdleList.push\_back(busythread);

149 m\_AvailNum++;

150 m\_IdleMutex.Unlock();

151

152 m\_BusyMutex.Lock();

153 vector<CWorkerThread\*>::iterator pos;

154 pos = find(m\_BusyList.begin(),m\_BusyList.end(),busythread);

155 if(pos!=m\_BusyList.end())

156 m\_BusyList.erase(pos);

157 m\_BusyMutex.Unlock();

158

159 m\_IdleCond.Signal();

160 m\_MaxNumCond.Signal();

161 }

162

163 //create num idle thread and put them to idlelist

164 void CThreadPool::CreateIdleThread(int num)

165 {

166 for(int i=0;i<num;i++){

167 CWorkerThread\* thr = new CWorkerThread();

168 thr->SetThreadPool(this);

169 AppendToIdleList(thr);

170 m\_VarMutex.Lock();

171 m\_AvailNum++;

172 m\_VarMutex.Unlock();

173 thr->Start(); //begin the thread,the thread wait for job

174 }

175 }

176

177 void CThreadPool::DeleteIdleThread(int num)

178 {

179 printf("Enter into CThreadPool::DeleteIdleThreadn");

180 m\_IdleMutex.Lock();

181 printf("Delete Num is %dn",num);

182 for(int i=0;i<num;i++){

183 CWorkerThread\* thr;

184 if(m\_IdleList.size() > 0 ){

185 thr = (CWorkerThread\*)m\_IdleList.front();

186 printf("Get Idle thread %dn",thr->GetThreadID());

187 }

188

189 vector<CWorkerThread\*>::iterator pos;

190 pos = find(m\_IdleList.begin(),m\_IdleList.end(),thr);

191 if(pos!=m\_IdleList.end())

192 m\_IdleList.erase(pos);

193 m\_AvailNum--;

194 printf("The idle thread available num:%d n",m\_AvailNum);

195 printf("The idlelist num:%d n",m\_IdleList.size());

196 }

197 m\_IdleMutex.Unlock();

198 }

199 void CThreadPool::Run(CJob\* job,void\* jobdata)

200 {

201 assert(job!=NULL);

202

203 //if the busy thread num adds to m\_MaxNum,so we should wait

204 if(GetBusyNum() == m\_MaxNum)

205 m\_MaxNumCond.Wait();

206

207 if(m\_IdleList.size()<m\_AvailLow)

208 {

209 if(GetAllNum()+m\_InitNum-m\_IdleList.size() < m\_MaxNum )

210 CreateIdleThread(m\_InitNum-m\_IdleList.size());

211 else

212 CreateIdleThread(m\_MaxNum-GetAllNum());

213 }

214

215 CWorkerThread\* idlethr = GetIdleThread();

216 if(idlethr !=NULL)

217 {

218 idlethr->m\_WorkMutex.Lock();

219 MoveToBusyList(idlethr);

220 idlethr->SetThreadPool(this);

221 job->SetWorkThread(idlethr);

222 printf("Job is set to thread %d n",idlethr->GetThreadID());

223 idlethr->SetJob(job,jobdata);

224 }

225 }

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在CThreadPool中存在两个链表，一个是空闲链表，一个是忙碌链表。Idle链表中存放所有的空闲进程，当线程执行任务时候，其状态变为忙碌状态，同时从空闲链表中删除，并移至忙碌链表中。在CThreadPool的构造函数中，我们将执行下面的代码:

[复制代码](javascript:void(0);)

1 for(int i=0;i<m\_InitNum;i++)

2 {

3 CWorkerThread\* thr = new CWorkerThread();

4 AppendToIdleList(thr);

5 thr->SetThreadPool(this);

6 thr->Start(); //begin the thread,the thread wait for job

7 }

[复制代码](javascript:void(0);)

在该代码中，我们将创建m\_InitNum个线程，创建之后即调用AppendToIdleList放入Idle链表中，由于目前没有任务分发给这些线程，因此线程执行Start后将自己挂起。   
事实上，线程池中容纳的线程数目并不是一成不变的，其会根据执行负载进行自动伸缩。为此在CThreadPool中设定四个变量：   
m\_InitNum：处世创建时线程池中的线程的个数。   
m\_MaxNum:当前线程池中所允许并发存在的线程的最大数目。   
m\_AvailLow:当前线程池中所允许存在的空闲线程的最小数目，如果空闲数目低于该值，表明负载可能过重，此时有必要增加空闲线程池的数目。实现中我们总是将线程调整为m\_InitNum个。   
m\_AvailHigh：当前线程池中所允许的空闲的线程的最大数目，如果空闲数目高于该值，表明当前负载可能较轻，此时将删除多余的空闲线程，删除后调整数也为m\_InitNum个。   
m\_AvailNum：目前线程池中实际存在的线程的个数，其值介于m\_AvailHigh和m\_AvailLow之间。如果线程的个数始终维持在m\_AvailLow和m\_AvailHigh之间，则线程既不需要创建，也不需要删除，保持平衡状态。因此如何设定m\_AvailLow和m\_AvailHigh的值，使得线程池最大可能的保持平衡态，是线程池设计必须考虑的问题。   
线程池在接收到新的任务之后，线程池首先要检查是否有足够的空闲池可用。检查分为三个步骤：   
      (1)检查当前处于忙碌状态的线程是否达到了设定的最大值m\_MaxNum，如果达到了，表明目前没有空闲线程可用，而且也不能创建新的线程，因此必须等待直到有线程执行完毕返回到空闲队列中。   
      (2)如果当前的空闲线程数目小于我们设定的最小的空闲数目m\_AvailLow，则我们必须创建新的线程，默认情况下，创建后的线程数目应该为m\_InitNum，因此创建的线程数目应该为( 当前空闲线程数与m\_InitNum);

(3)但是有一种特殊情况必须考虑，就是现有的线程总数加上创建后的线程数可能超过m\_MaxNum，因此我们必须对线程的创建区别对待。

1 if(GetAllNum()+m\_InitNum-m\_IdleList.size() < m\_MaxNum )

2 CreateIdleThread(m\_InitNum-m\_IdleList.size());

3 else

4 CreateIdleThread(m\_MaxNum-GetAllNum());

如果创建后总数不超过m\_MaxNum，则创建后的线程为m\_InitNum；如果超过了，则只创建( m\_MaxNum-当前线程总数 )个。   
      (3)调用GetIdleThread方法查找空闲线程。如果当前没有空闲线程，则挂起；否则将任务指派给该线程，同时将其移入忙碌队列。   
当线程执行完毕后，其会调用MoveToIdleList方法移入空闲链表中，其中还调用m\_IdleCond.Signal()方法，唤醒GetIdleThread()中可能阻塞的线程。

CWorkerThread   
CWorkerThread是CThread的派生类，是事实上的工作线程。在CThreadPool的构造函数中，我们创建了一定数量的CWorkerThread。一旦这些线程创建完毕，我们将调用Start()启动该线程。Start方法最终会调用Run方法。Run方法是个无限循环的过程。在没有接受到实际的任务的时候，m\_Job为NULL，此时线程将调用Wait方法进行等待，从而处于挂起状态。一旦线程池将具体的任务分发给该线程，其将被唤醒，从而通知线程从挂起的地方继续执行。CWorkerThread的完整定义如下:

[复制代码](javascript:void(0);)

1 class CWorkerThread:public CThread

2 {

3 private:

4 CThreadPool\* m\_ThreadPool;

5 CJob\* m\_Job;

6 void\* m\_JobData;

7

8 CThreadMutex m\_VarMutex;

9 bool m\_IsEnd;

10 protected:

11 public:

12 CCondition m\_JobCond;

13 CThreadMutex m\_WorkMutex;

14 CWorkerThread();

15 virtual ~CWorkerThread();

16 void Run();

17 void SetJob(CJob\* job,void\* jobdata);

18 CJob\* GetJob(void){return m\_Job;}

19 void SetThreadPool(CThreadPool\* thrpool);

20 CThreadPool\* GetThreadPool(void){return m\_ThreadPool;}

21 };

22 CWorkerThread::CWorkerThread()

23 {

24 m\_Job = NULL;

25 m\_JobData = NULL;

26 m\_ThreadPool = NULL;

27 m\_IsEnd = false;

28 }

29 CWorkerThread::~CWorkerThread()

30 {

31 if(NULL != m\_Job)

32 delete m\_Job;

33 if(m\_ThreadPool != NULL)

34 delete m\_ThreadPool;

35 }

36

37 void CWorkerThread::Run()

38 {

39 SetThreadState(THREAD\_RUNNING);

40 for(;;)

41 {

42 while(m\_Job == NULL)

43 m\_JobCond.Wait();

44

45 m\_Job->Run(m\_JobData);

46 m\_Job->SetWorkThread(NULL);

47 m\_Job = NULL;

48 m\_ThreadPool->MoveToIdleList(this);

49 if(m\_ThreadPool->m\_IdleList.size() > m\_ThreadPool->GetAvailHighNum())

50 {

51 m\_ThreadPool->DeleteIdleThread(m\_ThreadPool->m\_IdleList.size()- m\_ThreadPool->GetInitNum());

53 }

54 m\_WorkMutex.Unlock();

55 }

56 }

57 void CWorkerThread::SetJob(CJob\* job,void\* jobdata)

58 {

59 m\_VarMutex.Lock();

60 m\_Job = job;

61 m\_JobData = jobdata;

62 job->SetWorkThread(this);

63 m\_VarMutex.Unlock();

64 m\_JobCond.Signal();

65 }

66 void CWorkerThread::SetThreadPool(CThreadPool\* thrpool)

67 {

68 m\_VarMutex.Lock();

69 m\_ThreadPool = thrpool;

70 m\_VarMutex.Unlock();

71 }

[复制代码](javascript:void(0);)

      当线程执行任务之前首先必须判断空闲线程的数目是否低于m\_AvailLow，如果低于，则必须创建足够的空闲线程，使其数目达到m\_InitNum个，然后将调用MoveToBusyList()移出空闲队列，移入忙碌队列。当任务执行完毕后，其又调用MoveToIdleList()移出忙碌队列，移入空闲队列，等待新的任务。   
      除了Run方法之外，CWorkerThread中另外一个重要的方法就是SetJob，该方法将实际的任务赋值给线程。当没有任何执行任务即m\_Job为NULL的时候，线程将调用m\_JobCond.Wait进行等待。一旦Job被赋值给线程，其将调用m\_JobCond.Signal方法唤醒该线程。由于m\_JobCond属于线程内部的变量，每个线程都维持一个m\_JobCond，只有得到任务的线程才被唤醒，没有得到任务的将继续等待。无论一个线程何时被唤醒，其都将从等待的地方继续执行m\_Job->Run(m\_JobData)，这是线程执行实际任务的地方。   
      在线程执行给定Job期间，我们必须防止另外一个Job又赋给该线程，因此在赋值之前，通过m\_VarMutex进行锁定， Job执行期间，其于的Job将不能关联到该线程；任务执行完毕，我们调用m\_VarMutex.Unlock()进行解锁，此时，线程又可以接受新的执行任务。   
在线程执行任务结束后返回空闲队列前，我们还需要判断当前空闲队列中的线程是否高于m\_AvailHigh个。如果超过m\_AvailHigh，则必须从其中删除(m\_ThreadPool->m\_IdleList.size()-m\_ThreadPool->GetInitNum())个线程，使线程数目保持在m\_InitNum个。

CJob   
CJob类相对简单，其封装了任务的基本的属性和方法，其中最重要的是Run方法，代码如下：

[复制代码](javascript:void(0);)

1 class CJob

2 {

3 private:

4 int m\_JobNo; //The num was assigned to the job

5 char\* m\_JobName; //The job name

6 CThread \*m\_pWorkThread; //The thread associated with the job

7 public:

8 CJob( void );

9 virtual ~CJob();

10

11 int GetJobNo(void) const { return m\_JobNo; }

12 void SetJobNo(int jobno){ m\_JobNo = jobno;}

13 char\* GetJobName(void) const { return m\_JobName; }

14 void SetJobName(char\* jobname);

15 CThread \*GetWorkThread(void){ return m\_pWorkThread; }

16 void SetWorkThread ( CThread \*pWorkThread ){

17 m\_pWorkThread = pWorkThread;

18 }

19 virtual void Run ( void \*ptr ) = 0;

20 };

21 CJob::CJob(void)

22 :m\_pWorkThread(NULL)

23 ,m\_JobNo(0)

24 ,m\_JobName(NULL)

25 {

26 }

27 CJob::~CJob(){

28 if(NULL != m\_JobName)

29 free(m\_JobName);

30 }

31 void CJob::SetJobName(char\* jobname)

32 {

33 if(NULL !=m\_JobName) {

34 free(m\_JobName);

35 m\_JobName = NULL;

36 }

37 if(NULL !=jobname) {

38 m\_JobName = (char\*)malloc(strlen(jobname)+1);

39 strcpy(m\_JobName,jobname);

40 }

41 }

[复制代码](javascript:void(0);)

线程池使用示例   
至此我们给出了一个简单的与具体任务无关的线程池框架。使用该框架非常的简单，我们所需要的做的就是派生CJob类，将需要完成的任务实现在Run方法中。然后将该Job交由CThreadManage去执行。下面我们给出一个简单的示例程序

[复制代码](javascript:void(0);)

1 class CXJob:public CJob

2 {

3 public:

4 CXJob(){i=0;}

5 ~CXJob(){}

6 void Run(void\* jobdata) {

7 printf("The Job comes from CXJOB\n");

8 sleep(2);

9 }

10 };

11

12 class CYJob:public CJob

13 {

14 public:

15 CYJob(){i=0;}

16 ~CYJob(){}

17 void Run(void\* jobdata) {

18 printf("The Job comes from CYJob\n");

19 }

20 };

21

22 main()

23 {

24 CThreadManage\* manage = new CThreadManage(10);

25 for(int i=0;i<40;i++)

26 {

27 CXJob\* job = new CXJob();

28 manage->Run(job,NULL);

29 }

30 sleep(2);

31 CYJob\* job = new CYJob();

32 manage->Run(job,NULL);

33 manage->TerminateAll();

34 }

[复制代码](javascript:void(0);)

CXJob和CYJob都是从Job类继承而来，其都实现了Run接口。CXJob只是简单的打印一句”The Job comes from CXJob”，CYJob也只打印”The Job comes from CYJob”，然后均休眠2秒钟。在主程序中我们初始创建10个工作线程。然后分别执行40次CXJob和一次CYJob。

**线程池使用后记**

线程池适合场合:  
事实上，线程池并不是万能的。它有其特定的使用场合。线程池致力于减少线程本身的开销对应用所产生的影响，这是有前提的，前提就是线程本身开销与线程执行任务相比不可忽略。如果线程本身的开销相对于线程任务执行开销而言是可以忽略不计的，那么此时线程池所带来的好处是不明显的，比如对于FTP服务器以及Telnet服务器，通常传送文件的时间较长，开销较大，那么此时，我们采用线程池未必是理想的方法，我们可以选择“即时创建，即时销毁”的策略。   
总之线程池通常适合下面的几个场合：   
(1) 单位时间内处理任务频繁而且任务处理时间短   
(2) 对实时性要求较高。如果接受到任务后在创建线程，可能满足不了实时要求，因此必须采用线程池进行预创建。   
(3) 必须经常面对高突发性事件，比如Web服务器，如果有足球转播，则服务器将产生巨大的冲击。此时如果采取传统方法，则必须不停的大量产生线程，销毁线程。此时采用动态线程池可以避免这种情况的发生。

**结束语**   
本文给出了一个简单的通用的与任务无关的线程池的实现，通过该线程池能够极大的简化Linux下多线程的开发工作。该线程池的进一步完善开发工作还在进行中，希望能够得到你的建议和支持。   
参考资料   
http://www-900.ibm.com/developerWorks/cn/java/j-jtp0730/index.shtml   
POSIX多线程程序设计，David R.Butenhof 译者：于磊 曾刚，中国电力出版社   
C++面向对象多线程编程，CAMERON HUGHES等著 周良忠译，人民邮电出版社   
Java Pro,结合线程和分析器池,Edy Yu

测试程序，目前可以跑通

#include <stdio.h>

#include <stdlib.h>

#include <vector>

#include <algorithm>

#include <assert.h>

#include <Windows.h>

#include <functional>

#include <process.h>

using namespace std;

class CThread;

//锁的基类

class CLockObject

{

public:

virtual BOOL Lock() = 0;

virtual BOOL UnLock() = 0;

};

//任务基类，所有要执行的任务都继承这个类

class CJob

{

private:

int m\_JobNo;//任务ID 用来调试是否绑定特定线程

char\* m\_JobName; //任务名字，用来调试是否绑定特定线程

CThread\* m\_pWorkThread; //The thread associated with the job

public:

CJob();

virtual ~CJob();

CThread \*GetWorkThread(void); //获取工作线程

void SetWorkThread(CThread\* pWorkThread);//设置工作线程

virtual void Execute(void\* ptr) = 0; //执行函数

int GetJobNo(void) const { return m\_JobNo; }

void SetJobNo(int jobno){ m\_JobNo = jobno;}

char\* GetJobName(void) const { return m\_JobName; }

void SetJobName(char\* jobname);

};

void CJob::SetJobName(char\* jobname)

{

if(NULL !=m\_JobName)

{

free(m\_JobName);

m\_JobName = NULL;

}

if(NULL !=jobname)

{

m\_JobName = (char\*)malloc(strlen(jobname)+1);

strcpy(m\_JobName,jobname);

}

}

CThread\* CJob::GetWorkThread(void)

{

return m\_pWorkThread;

}

void CJob::SetWorkThread(CThread \*pWorkThread)

{

m\_pWorkThread = pWorkThread;

}

CJob::CJob(void) :m\_pWorkThread(NULL),m\_JobName(NULL), m\_JobNo(0)

{

}

CJob::~CJob()

{

if (NULL != m\_JobName)

{

free(m\_JobName);

m\_JobName = NULL;

}

}

//线程状态

typedef enum \_ThreadState

{

THREAD\_RUNNING = 0x0, //运行

THREAD\_IDLE = 0x1,//空闲

THREAD\_EXIT = 0X2,//退出

}ThreadState;

//线程基类

class CThread

{

private:

int m\_ErrorCode; //错误码

unsigned long m\_ThreadID; //线程ID

char\* m\_ThreadName; //线程名字

ThreadState m\_ThreadState; //线程状态

HANDLE m\_hthreadHandle; //线程句柄

bool m\_IsExit;//是否退出

protected:

static unsigned \_\_stdcall ThreadFunction(void\*); //start调用此函数，此函数再调用run函数，执行实际的任务

public:

CThread();

virtual ~CThread();

virtual void Run() = 0;

//设置线程状态

void SetThreadState(ThreadState state);

//获取线程状态

ThreadState GetThreadState();

//Start to execute the thread

bool Start();

//获取线程ID

int GetThreadID(void);

//设置错误码

void SetErrorCode(int errorCode);

//获取错误码

int GetLastError(void);

//设置线程名字

void SetThreadName(char\* threadName);

//获取线程名字

char\* GetThreadName();

//设置线程优先级

bool SetPriority(int priority);

//获取线程优先级

int GetPriority(void);

bool Terminate(void);

HANDLE GetThreadHandle();

void SetThreadHandle(HANDLE hdl);

void SetExitFlag(bool bExit);

bool GetExitFlag();

bool NeedExit();

};

bool CThread::NeedExit()

{

return m\_IsExit;

}

void CThread::SetExitFlag(bool bExit)

{

m\_IsExit = bExit;

}

bool CThread::GetExitFlag()

{

return m\_IsExit;

}

bool CThread::Terminate(void)

{

\_endthreadex(0);

return TRUE;

}

HANDLE CThread::GetThreadHandle()

{

return m\_hthreadHandle;

}

void CThread::SetThreadHandle(HANDLE hdl)

{

m\_hthreadHandle = hdl;

}

void CThread::SetErrorCode(int errorCode)

{

m\_ErrorCode = errorCode;

}

int CThread::GetLastError(void)

{

return m\_ErrorCode;

}

CThread::CThread()

{

m\_IsExit = FALSE;

}

CThread::~CThread()

{

}

void CThread::SetThreadState(ThreadState state)

{

m\_ThreadState = state;

}

ThreadState CThread::GetThreadState()

{

return m\_ThreadState;

}

//Start to execute the thread

bool CThread::Start()

{

unsigned threadID;

HANDLE hThread = (HANDLE)\_beginthreadex(NULL, 0, ThreadFunction, this, 0, &threadID);

this->m\_ThreadID = threadID;

this->SetThreadHandle(hThread);

return true;

}

unsigned \_\_stdcall CThread::ThreadFunction(void\* pArg)

{

CThread\* pThread = (CThread\*)pArg;

pThread->Run();

return TRUE;

}

int CThread::GetThreadID(void)

{

return m\_ThreadID;

}

void CThread::SetThreadName(char\* threadName)

{

strncpy(m\_ThreadName, threadName, strlen(threadName));

}

char\* CThread::GetThreadName()

{

return m\_ThreadName;

}

//线程互斥锁

class CThreadMutex: public CLockObject

{

private:

CRITICAL\_SECTION m\_CritSec;//临界区

public:

CThreadMutex();

~CThreadMutex();

BOOL Lock();//加锁，阻塞式

BOOL UnLock();//解锁

BOOL TryLock();//加锁，非阻塞式

};

CThreadMutex::CThreadMutex()

{

#if (\_WIN32\_WINNT >= 0x0403)

//使用 InitializeCriticalSectionAndSpinCount 可以提高性能

::InitializeCriticalSectionAndSpinCount(&m\_CritSec,4000);

#else

::InitializeCriticalSection(&m\_CritSec);

#endif

}

CThreadMutex::~CThreadMutex()

{

::DeleteCriticalSection(&m\_CritSec);

}

BOOL CThreadMutex::Lock()

{

::EnterCriticalSection(&m\_CritSec);

return TRUE;

}

BOOL CThreadMutex::UnLock()

{

::LeaveCriticalSection(&m\_CritSec);

return TRUE;

}

BOOL CThreadMutex::TryLock()

{

BOOL bRet = TryEnterCriticalSection(&m\_CritSec);

return bRet;

}

//条件变量

class CThreadCondition

{

private:

HANDLE m\_phEvent; //句柄

public:

CThreadCondition();

~CThreadCondition();

void Wait();

void Signal();

};

CThreadCondition::CThreadCondition()

{

//第二个参数 bManualReset FALSE the system automatically resets the state to nonsignaled

//If this parameter is TRUE, the function creates a manual-reset event object

//第三个参数 bInitialState FALSE it is nonsignaled

m\_phEvent = ::CreateEvent(NULL, TRUE, FALSE, NULL);

}

CThreadCondition::~CThreadCondition()

{

if (NULL != m\_phEvent)

{

::CloseHandle((m\_phEvent));

}

}

void CThreadCondition::Wait()

{

//If dwMilliseconds is INFINITE, the function will return only when the object is signaled.

WaitForSingleObject(m\_phEvent, INFINITE);

ResetEvent(m\_phEvent);

}

void CThreadCondition::Signal()

{

//Sets the specified event object to the signaled state

SetEvent(m\_phEvent);

}

//线程池类，主要负责调度线程，创建线程，删除线程

class CThreadPool

{

friend class CWorkerThread;

private:

unsigned int m\_nMaxNum; //当前线程池中所允许并发存在的线程的最大数目

unsigned int m\_nAvailLow; //当前线程池中所允许存在的空闲线程的最小数目

//如果空闲数目低于该值，表明负载可能过重，此时有必要增加空闲线程池的数目

//实现中我们总是将线程调整为m\_InitNum个

unsigned int m\_nAvailHigh;//当前线程池中所允许的空闲的线程的最大数目，

//如果空闲数目高于该值，表明当前负载可能较轻，此时将删除多余的空闲线程，删除后调整数也为m\_InitNum个

unsigned int m\_nCurIdleThreadsNum;//当前线程池中实际存在的线程的个数，其值介于m\_nAvailHigh和m\_nAvailLow之间

//如果线程的个数始终维持在m\_nAvailLow和m\_nAvailHigh之间，则线程既不需要创建，也不需要删除，保持平衡状态

unsigned int m\_nInitThreadsNum;//初始创建时线程池中的线程的个数

protected:

CWorkerThread\* GetIdleThread(void);//获取空闲线程

void AppendToIdleList(CWorkerThread\* jobthread);//线程加入空闲队列

void MoveToBusyList(CWorkerThread\* idlethread);//线程加入忙碌队列

void MoveToIdleList(CWorkerThread\* busythread);//线程加入空闲队列

void DeleteIdleThread(int num); //删除空闲线程

void CreateIdleThread(int num); //创建空闲线程

public:

CThreadMutex m\_BusyMutex;//when visit busy list,use m\_BusyMutex to Lock and unlock

CThreadMutex m\_IdleMutex;//when visit idle list,use m\_IdleMutex to Lock and unlock

CThreadMutex m\_ThreadNumMutex;//变量锁， 目前用在m\_nCurIdleThreadsNum修改上面

CThreadCondition m\_BusyCond; //m\_BusyCond is used to sync busy thread list

CThreadCondition m\_IdleCond; //m\_IdleCond is used to sync idle thread list

CThreadCondition m\_MaxNumCond;//m\_MaxNumCond is used to sync m\_nCurIdleThreadsNum

vector<CWorkerThread\*> m\_vecAllThreads;//所有创建出来的线程集合

vector<CWorkerThread\*> m\_vecBusyThreads;//忙碌线程队列，随着负载的多少会改变

vector<CWorkerThread\*> m\_vecIdleThreads;//空闲线程队列,随着负的多少会改变

public:

void SetMaxNum(int maxnum){m\_nMaxNum = maxnum;} //设置线程池运行的最大线程数

int GetMaxNum(void){return m\_nMaxNum;}

void SetAvailLowNum(int minnum){m\_nAvailLow = minnum;} //设置最少空闲线程数

int GetAvailLowNum(void){return m\_nAvailLow;}

void SetAvailHighNum(int highnum){m\_nAvailHigh = highnum;} //设置最多空闲线程数

int GetAvailHighNum(void){return m\_nAvailHigh;}

int GetCurIdleThreadsNum(void){return m\_nCurIdleThreadsNum;} //获取当前空闲线程个数

int GetAllThreadsNum(void){return m\_vecAllThreads.size();} //获取所有线程个数

int GetBusyThreadsNum(void){return m\_vecBusyThreads.size();} //获取忙碌空闲线程个数

void SetInitNum(int initnum){m\_nInitThreadsNum = initnum;}

int GetInitNum(void){return m\_nInitThreadsNum;}

CThreadPool();

~CThreadPool();

CThreadPool(int initnum);

void TerminateAll();

void Run(CJob\* job,void\* jobdata);

};

//真正的工作线程，执行操作的线程

class CWorkerThread : public CThread

{

private:

CThreadPool\* m\_pThreadPool;//线程池

CJob\* m\_pJob;//任务

void\* m\_pJobData;//任务参数

CThreadMutex m\_VarMutex;//

public:

CThreadCondition m\_JobAddCond; //有新的任务时触发条件变量,每个线程一个条件变量，可以指定线程去执行任务

CThreadMutex m\_WorkMutex;//

CWorkerThread();

virtual ~CWorkerThread();

void Run();

void AddNewJob(CJob\* job,void\* jobdata);

CJob\* GetJob(void){return m\_pJob;}

void SetThreadPool(CThreadPool\* thrpool);

CThreadPool\* GetThreadPool(void){return m\_pThreadPool;}

void Terminate(void);

};

void CWorkerThread::Terminate(void)

{

//工作线程再处理任务结束才会解锁，这个时候再去退出线程，避免打断线程处理任务。

m\_WorkMutex.Lock();

SetExitFlag(TRUE);

//工作为假 代表要求线程退出

m\_pJob = NULL;

m\_pJobData = NULL;

printf("thread [%d] ready to exit\n", GetThreadID());

m\_JobAddCond.Signal();

m\_WorkMutex.UnLock();

WaitForSingleObject(GetThreadHandle(), INFINITE);

CloseHandle(GetThreadHandle());

}

CWorkerThread::CWorkerThread()

{

m\_pJobData = NULL;

m\_pJob = NULL;

m\_pThreadPool = NULL;

}

CWorkerThread::~CWorkerThread()

{

if (NULL != m\_pJob) {delete m\_pJob; m\_pJob = NULL;}

if (NULL != m\_pThreadPool) {delete m\_pThreadPool; m\_pThreadPool = NULL;}

}

void CWorkerThread::Run()

{

printf("Enter CWorkerThread::Run\n");

SetThreadState(THREAD\_RUNNING);

for(;;)

{

//当前线程不退出才需要等待任务的到来

while ((NULL == m\_pJob) && !NeedExit())

{

printf("thread [%d] wait for job \n", GetThreadID());

m\_JobAddCond.Wait();

}

if (NULL == m\_pJob)

{

printf("thread [%d] exitFlag [%d]\n", GetThreadID(), NeedExit());

if (NeedExit())

{

break;//不再等待任务，退出线程

}

else

{

//任务为NULL 但不是线程退出，跳过这个任务

printf("m\_pJob [%p] exitFlag [%d]\n", m\_pJob, NeedExit());

continue;

}

}

m\_WorkMutex.Lock();

printf("thread [%d] accept the job [%d]\n", GetThreadID(), m\_pJob->GetJobNo());

//真正执行任务的地方

m\_pJob->Execute(m\_pJobData);

m\_pJob->SetWorkThread(NULL);

m\_pJob = NULL;

m\_pJobData = NULL;

m\_pThreadPool->MoveToIdleList(this);

SetThreadState(THREAD\_IDLE);

if(m\_pThreadPool->m\_vecIdleThreads.size() > m\_pThreadPool->GetAvailHighNum())

{

m\_pThreadPool->DeleteIdleThread(m\_pThreadPool->m\_vecIdleThreads.size() - m\_pThreadPool->GetInitNum());

}

m\_WorkMutex.UnLock();

}

printf("thread [%d] exit\n", GetThreadID());

}

void CWorkerThread::AddNewJob(CJob\* pJob,void\* jobdata)

{

assert(NULL != pJob);

m\_VarMutex.Lock();

m\_pJob = pJob;

m\_pJobData = jobdata;

pJob->SetWorkThread(this);

m\_VarMutex.UnLock();

printf("job [%d] add to the pool\n",m\_pJob->GetJobNo());

m\_JobAddCond.Signal();

}

void CWorkerThread::SetThreadPool(CThreadPool\* thrpool)

{

m\_VarMutex.Lock();

m\_pThreadPool = thrpool;

m\_VarMutex.UnLock();

}

CThreadPool::CThreadPool()

{

m\_nMaxNum = 50;

m\_nAvailLow = 5;

m\_nInitThreadsNum = 10;

m\_nCurIdleThreadsNum = 10;

m\_nAvailHigh = 20;

m\_vecBusyThreads.clear();

m\_vecIdleThreads.clear();

int i;

for (i=0; i<m\_nInitThreadsNum; ++i)

{

CWorkerThread\* pNewWorkThread = new CWorkerThread;

pNewWorkThread->SetThreadPool(this);

AppendToIdleList(pNewWorkThread);

pNewWorkThread->Start();

}

}

CThreadPool::CThreadPool(int initnum)

{

m\_nMaxNum = 30;

m\_nAvailLow = (initnum-10>0)?(initnum-10):3;

m\_nInitThreadsNum = m\_nCurIdleThreadsNum = initnum ;

m\_nAvailHigh = initnum+10;

m\_vecAllThreads.clear();

m\_vecBusyThreads.clear();

m\_vecIdleThreads.clear();

int i;

for (i=0; i<m\_nInitThreadsNum; ++i)

{

CWorkerThread\* pNewWorkThread = new CWorkerThread;

pNewWorkThread->SetThreadPool(this);

AppendToIdleList(pNewWorkThread);

pNewWorkThread->Start();

}

printf("CThreadPool::CThreadPool: Create Thread [%d] success\n", m\_nInitThreadsNum);

}

CThreadPool::~CThreadPool()

{

TerminateAll();

}

void CThreadPool::TerminateAll()

{

int i;

for (i=0; i<m\_vecAllThreads.size(); ++i)

{

CWorkerThread\* pWorkThread = m\_vecAllThreads[i];

pWorkThread->Terminate();

}

}

//获取空闲的线程

CWorkerThread\* CThreadPool::GetIdleThread(void)

{

while (0 == m\_vecIdleThreads.size())

{

printf("no idle threads, must wait\n");

m\_IdleCond.Wait();

}

m\_IdleMutex.Lock();

if (0 < m\_vecIdleThreads.size())

{

CWorkerThread\* pIdleThread = (CWorkerThread\*)m\_vecIdleThreads.front();

printf("get idle thread %d \n", pIdleThread->GetThreadID());

m\_IdleMutex.UnLock();

return pIdleThread;

}

m\_IdleMutex.UnLock();

printf("warning: no idle threads return\n");

return NULL;

}

//add an idle thread to idle list

void CThreadPool::AppendToIdleList(CWorkerThread\* jobthread)

{

m\_IdleMutex.Lock();

m\_vecIdleThreads.push\_back(jobthread);

m\_vecAllThreads.push\_back(jobthread);

m\_IdleMutex.UnLock();

}

//move and idle thread to busy thread

void CThreadPool::MoveToBusyList(CWorkerThread\* idlethread)

{

m\_BusyMutex.Lock();

m\_vecBusyThreads.push\_back(idlethread);

m\_nCurIdleThreadsNum--;

m\_BusyMutex.UnLock();

m\_IdleMutex.Lock();

vector<CWorkerThread\*>::iterator pos;

pos = find(m\_vecIdleThreads.begin(),m\_vecIdleThreads.end(),idlethread);

if(pos != m\_vecIdleThreads.end())

{

m\_vecIdleThreads.erase(pos);

}

m\_IdleMutex.UnLock();

}

void CThreadPool::MoveToIdleList(CWorkerThread\* busythread)

{

m\_IdleMutex.Lock();

m\_vecIdleThreads.push\_back(busythread);

m\_nCurIdleThreadsNum++;

m\_IdleMutex.UnLock();

m\_BusyMutex.Lock();

vector<CWorkerThread\*>::iterator pos;

pos = find(m\_vecBusyThreads.begin(),m\_vecBusyThreads.end(),busythread);

if(pos!=m\_vecBusyThreads.end())

m\_vecBusyThreads.erase(pos);

m\_BusyMutex.UnLock();

m\_IdleCond.Signal();

m\_MaxNumCond.Signal();

}

//create num idle thread and put them to idlelist

void CThreadPool::CreateIdleThread(int num)

{

int i;

for (i=0;i<num;i++)

{

CWorkerThread\* pWorkThread = new CWorkerThread();

pWorkThread->SetThreadPool(this);

AppendToIdleList(pWorkThread);

m\_ThreadNumMutex.Lock();

m\_nCurIdleThreadsNum++;

m\_ThreadNumMutex.UnLock();

pWorkThread->Start();//begin the thread,the thread wait for job

}

}

void CThreadPool::DeleteIdleThread(int num)

{

printf("Enter into CThreadPool::DeleteIdleThread\n");

m\_IdleMutex.Lock();

printf("Delete Num is %dn",num);

int i;

for(i=0;i<num;i++)

{

CWorkerThread\* thr;

if(m\_vecIdleThreads.size() > 0 )

{

thr = (CWorkerThread\*)m\_vecIdleThreads.front();

printf("Get Idle thread %dn",thr->GetThreadID());

}

else

{

printf("no idle thread, no need to delete thread\n");

break;

}

vector<CWorkerThread\*>::iterator pos;

pos = find(m\_vecIdleThreads.begin(),m\_vecIdleThreads.end(),thr);

if(pos!=m\_vecIdleThreads.end())

m\_vecIdleThreads.erase(pos);

m\_nCurIdleThreadsNum--;

printf("The idle thread available num:%d n",m\_nCurIdleThreadsNum);

printf("The idlelist num:%d n",m\_vecIdleThreads.size());

}

m\_IdleMutex.UnLock();

}

void CThreadPool::Run(CJob\* job, void\* jobdata)

{

assert(NULL != job);

//if the busy thread num adds to m\_nMaxNum,so we should wait

if(m\_nMaxNum <= GetBusyThreadsNum())

{

printf("busy threads beyond the max threads number in the pool, must wait for idle threads\n");

m\_MaxNumCond.Wait();

}

//负载过重，空闲线程少，需要创建新的线程, 使其数目达到m\_InitNum

if(m\_vecIdleThreads.size() < m\_nAvailLow)

{

if(GetAllThreadsNum()+m\_nInitThreadsNum-m\_vecIdleThreads.size() < m\_nMaxNum )

{

//当前有m\_vecIdleThreads.size()空闲线程， 另外再创建m\_nInitThreadsNum - m\_vecIdleThreads.size()， 当前总的空闲线程为m\_nInitThreadsNum

CreateIdleThread(m\_nInitThreadsNum - m\_vecIdleThreads.size());

}

else

{

CreateIdleThread(m\_nMaxNum - GetAllThreadsNum());

}

}

CWorkerThread\* pWorkthread = GetIdleThread();

if(NULL != pWorkthread)

{

pWorkthread->m\_WorkMutex.Lock();

MoveToBusyList(pWorkthread);

pWorkthread->SetThreadPool(this);

job->SetWorkThread(pWorkthread);

printf("Job [%d] bind to thread [%d] \n", job->GetJobNo(), pWorkthread->GetThreadID());

pWorkthread->AddNewJob(job, jobdata);

pWorkthread->m\_WorkMutex.UnLock();

}

else

{

printf("impossible to going here\n");

}

}

//线程管理类

class CThreadManage

{

public:

CThreadManage();

CThreadManage(int num);

virtual ~CThreadManage();

void Run(CJob\* pjob, void\* pJobData);//运行任务

void TerminateAll(); //停止所有的线程

private:

int m\_nNumOfThread; //初始时允许创建的最大的线程个数

CThreadPool\* m\_pPool;//实际的线程池

};

CThreadManage::CThreadManage()

{

m\_nNumOfThread = 10;

m\_pPool = new CThreadPool(m\_nNumOfThread);

}

CThreadManage::CThreadManage(int num)

{

m\_nNumOfThread = num;

m\_pPool = new CThreadPool(m\_nNumOfThread);

}

CThreadManage::~CThreadManage()

{

if (NULL != m\_pPool)

{

delete m\_pPool;

m\_pPool = NULL;

}

}

void CThreadManage::Run(CJob\* pjob, void\* pJobData)

{

m\_pPool->Run(pjob, pJobData);

}

void CThreadManage::TerminateAll()

{

m\_pPool->TerminateAll();

}

class myjob : public CJob

{

public:

myjob(){}

myjob(int i){SetJobNo(i);}

~myjob(){}

void Execute(void\* jobdata) {

printf("The Job comes from CXJOB\n");

::Sleep(2);

}

};

#if 0

int main()

{

CThreadManage\* manage = new CThreadManage(50);

for(int i=0;i<1000;i++)

{

myjob\* job = new myjob(i);

manage->Run(job, NULL);

}

::Sleep(2);

myjob\* job = new myjob();

manage->Run(job, NULL);

manage->TerminateAll();

return 0;

}

#endif