```c
#include "_kernelCore.h"
#include "osDefs.h"

//global variables
extern threadStruct threadCollection[MAX_THREADS];
extern int numThreads;
int threadCurr = 0;
extern int idleIndex;
bool leaveIdle = false;


//set priority of the PendSV interrupt
void kernelInit(void){
  //PendSV priority
  SHPR3 |= 0xFE << 16;
  SHPR3 |= 0xFFU << 24; //SysTick priority

  SHPR2 |= 0xFDU << 24; //SVC priority
}

//start running the kernel, i.e. the OS
bool osKernelStart(){
  threadCurr = 0;
  if(numThreads > 0)
  {
    __set_CONTROL(1<<1); //enter threading
    __set_PSP((uint32_t) threadCollection[threadCurr].TSP); //set PSP to the first thread address

    osLoadFirst(); //begin running threads
  }

  return false; //once called, function should not end unless something went wrong in OS
}

//start running the first thread, which will lead into context switching between all the threads
void osLoadFirst(){
  if(numThreads < 1){
    threadCurr = idleIndex;
  }

    ICSR |= 1<<28;
    __asm("isb");
}

//called when a non-periodic thread is set to sleep, starts task switching process
void osSleep(int sleepTime){
  threadCollection[threadCurr].status = SLEEPING;
  threadCollection[threadCurr].timer = sleepTime;

  printf("Thread yielded from osSleep.\n");
  __ASM("SVC #0");
}

//called when a thread yields, starts task switching process
void osYield(void){
  printf("Thread yielded from osYield.\n");
  __ASM("SVC #0");
}

//determine next available thread to switch to
void scheduler(void){
  bool isFound = false;
  int shortestDeadIndex = 0;

  if(numThreads > 0){
    for (int i = 0; i < numThreads; i++)
    {
      printf("Time on thread %d: %d, Status: %d\n", i+1, threadCollection[i].timer,
threadCollection[i].status);

      //look for the earliest deadline among waiting tasks
      if(threadCollection[i].status == WAITING){
```

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72          if(isFound == false){ //at least one waiting task found
73            isFound = true;
74            shortestDeadIndex = i;
75
76          }
77          if(isFound == true){ //find earlier deadlines than the one found
78            if(threadCollection[i].timer < threadCollection[shortestDeadIndex].timer){ //if there's a
    tie, stick with the thread of the lower index
79              shortestDeadIndex = i;
80            }
81          }
82        }
83      }
84    }
85
86    //if no threads are waiting, use idle thread
87    if(isFound != true){
88      printf("all the people of the world are asleep\n");
89      threadCurr = idleIndex;
90    }
91    else{
92      threadCurr = shortestDeadIndex;
93      printf("Trying thread %d\n", threadCurr+1);
94    }
95  }
96
97  void SysTick_Handler(void){
98    bool preEmptTask = false;
99
100   for(int i = 0; i < numThreads; i++)
101   {
102     --threadCollection[i].timer; //decrement all timers: deadlines and sleep timers
103
104     if(threadCollection[i].timer <= 0) //i is within numThreads range, therefore does not include the
    idleThread
105     {
106       //thread failed to meet its deadline. user's fault for designing poor threads
107       if(threadCollection[i].status == WAITING){
108         printf("Deadline of thread %d missed -- system failed.\n", i+1);
109       }
110
111       //check wake-up status if sleeping
112       if(threadCollection[i].status == SLEEPING)
113       {
114         printf("Waking up thread %d\n", i+1);
115
116         if(threadCurr == idleIndex){
117             leaveIdle = true;
118         }
119         threadCollection[i].status = WAITING;
120         threadCollection[i].timer = threadCollection[i].deadline;
121
122         //if the thread that has woken up has an earlier deadline than the running task, or has a tied
    deadline
123           //if tied, choose the thread with the lower index
124         if (threadCollection[i].timer < threadCollection[threadCurr].timer ||
    (threadCollection[i].timer == threadCollection[threadCurr].timer && i < threadCurr)){
125           preEmptTask = true;
126         }
127       }
128     }
129   }
130
131   //leave current thread if preempted by another thread with a earlier deadline, have been signalled to
    leave the idle thread, or if the running thread's timer goes to zero
132   if(preEmptTask == true || leaveIdle == true || threadCollection[threadCurr].timer <= 0)
133   {
134     printf("Thread yielded from SysTick.\n");
135
136     threadCollection[threadCurr].TSP = (uint32_t*)(__get_PSP()-8*4); //decrement PSP only 8 locations
    lower, since the hardware registers remain on the stack
137
```

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138       if(preEmptTask != true){ //leaveIdle or timer = 0. don't reset the deadline if pre-empted
139         //set to sleep if periodic
140         if(threadCollection[threadCurr].period != 0){
141           threadCollection[threadCurr].status = SLEEPING;
142           threadCollection[threadCurr].timer = threadCollection[threadCurr].period;
143         }
144         else{
145           threadCollection[threadCurr].status = WAITING;
146           threadCollection[threadCurr].timer = threadCollection[threadCurr].deadline;
147         }
148       }
149       else{
150         threadCollection[threadCurr].status = WAITING;
151         preEmptTask = false; //reset bool
152       }
153
154       //reset leaveIdle flag
155       if(leaveIdle == true){
156         leaveIdle = false;
157       }
158
159       scheduler();
160
161       ICSR |= 1<<28;
162       __asm("isb");
163     }
164   }
165
166   void SVC_Handler_Main(uint32_t *svc_args)
167   {
168     char call = ((char*)svc_args[6])[-2];
169
170     if(call == 0) //code for a thread that has yielded/yielded by osSleep()
171     {
172       //move TSP of the running thread 8 memory locations lower, so that next time the thread loads the
    16 context registers, we end at the same PSP
173       threadCollection[threadCurr].TSP = (uint32_t*)(__get_PSP()-8*4);
174       //in the case of a periodic thread that yields
175       if(threadCollection[threadCurr].period != 0){
176         threadCollection[threadCurr].status = SLEEPING;
177         threadCollection[threadCurr].timer = threadCollection[threadCurr].period;
178       }
179       //if not periodic and if not yielded by osSleep
180       else if(threadCollection[threadCurr].status != SLEEPING){
181         threadCollection[threadCurr].status = WAITING;
182         threadCollection[threadCurr].timer = threadCollection[threadCurr].deadline;
183       }
184
185       scheduler();
186
187       ICSR |= 1<<28;
188       __asm("isb");
189     }
190   }
191
192
193   int task_switch(void){
194     //set PSP to the thread we want to start running
195     __set_PSP((uint32_t)threadCollection[threadCurr].TSP);
196     threadCollection[threadCurr].status = ACTIVE;
197
198     if (threadCurr == idleIndex ){
199       printf("Running idle thread \n");
200     }
201     return 0;
202   }
203
204
205
```