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Computer Science

Fall 2024: CSCI 181RT

Real-Time Systems in the Real World

Lecture 12

Thursday, October 3, 2024
Edmunds Hall 105
2:45 PM - 4:00 PM

Professor Jennifer DesCombes

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Agenda

- Go Backs
- Discussion on Reading
- Lab Review
- Use of Semaphores (Part 2)
- Look Ahead
- Assignment
- Action Items

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Go Backs

- General?
- Action Item Status
  - AI240910-2: Find recommended book on computer architecture.
  - AI240924-1: At what point as a development team grows does it make sense to have dedicated software and integration testers?
  - AI240924-2: Is there a limit on the size of an Agile development effort before it becomes less efficient than other development approaches?
  - AI240924-3: Are ‘C’ type Handles (pointer to a pointer) similar in concept to Java Script Handles
  - AI240926-1: Fix the Charts - Provide Missing Information and Add Review (OK to Close?)

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Discussion on Reading

- The Mythical Man Month
  - Chapter 7, 8 & 9: Why Did the Tower of Babel Fail? - Calling the Shot - Ten Pounds in a Five-Pound Sack

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Lab 5 Discussion

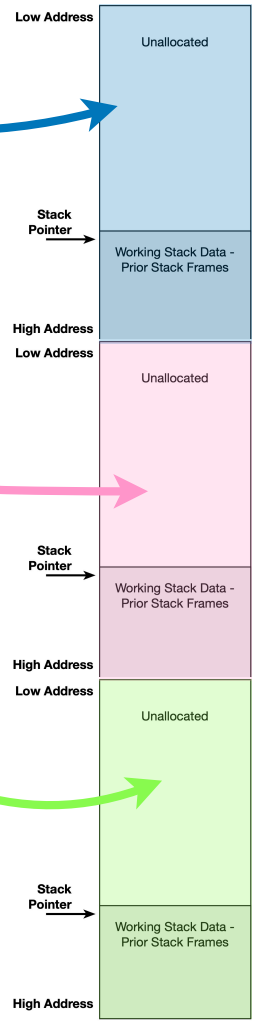
- Debouce Timing and Discrete Sampling
- Functional Divisions of Code
- Tuning of Delays

System With Three Tasks

```
// Serial Port task

#include myOSCalls.h
#include mySerialPort.h

#define true 1

while(true) {

     // Process serial port
     uartChar = readUART( );
     If (uartChar != 0)
     {
        processChar( uartChar );
     }
     myOSSleepms(5);

}
```

```
// Dummy Task
// NOTE: Must be lowest
//   priority task

#include myOSCalls.h
#include myIOAbstraction.h

#define true 1

while(true) {

     // Constantly flash LED
     myIODummyLEDOn( );
     myIODummyLEDOff( );

}
```

```
// Heartbeat task

#include myOSCalls.h
#include myIOAbstraction.h

#define true 1

while(true) {

     // turn on and off
     // heartbeat LED at a
     // half-second rate
     myIOHeartbeatLEDOn();
     myOSSleepms(1000);
     myIOHeartbeatLEDOff();
     myOSSleepms(1000);

}
```



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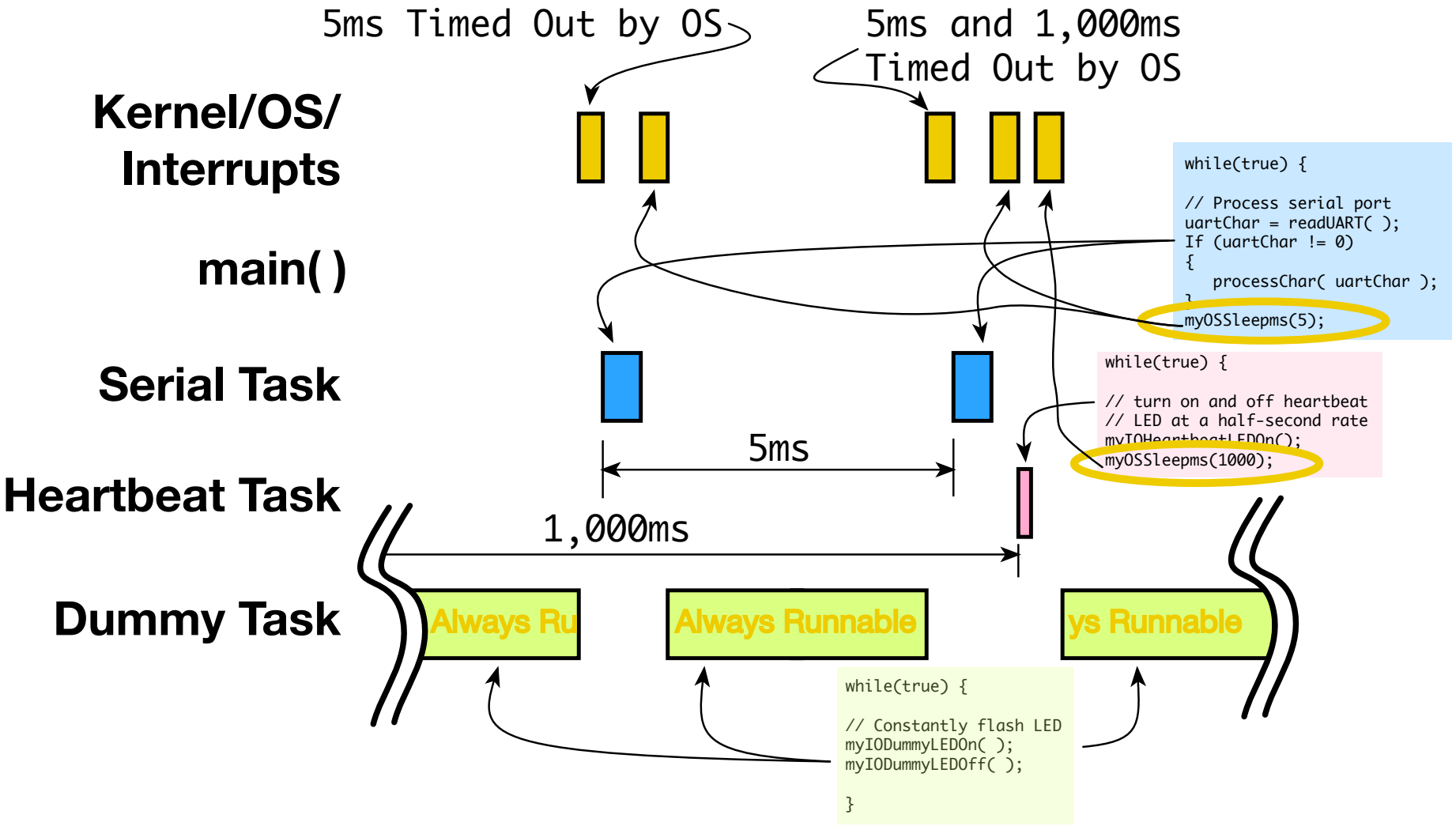
"Just the Two of Us" - Heartbeat Task Executes



Task Structure Review

- Synchronization of Tasks
- Protection of Shared Devices/Services
- Controlled Processing of Input Data
- Protection of Non-reentrant Code
- Guarantee Completion of Specific Operations

Use of Semaphores

- Semaphore Functions in Different RTOS

RTOS	P-Action	V-Action
POSIX	int **sem_wait**(sem_t *sem);	int **sem_post**(sem_t *sem);
FreeRTOS	pdStatus **xSemaphoreTake**(SemaphoreHandle_t xSemaphore, TickType_t xTicksToWait);	pdStatus **xSemaphoreGive**(SemaphoreHandle_t xSemaphore);
VxWorks	STATUS **semTake**(SEM_ID semId, int timeout);	STATUS **semGive**(SEM_ID semId);

- Code Snippets Not Complete
- Color Highlights Show Semaphore Control

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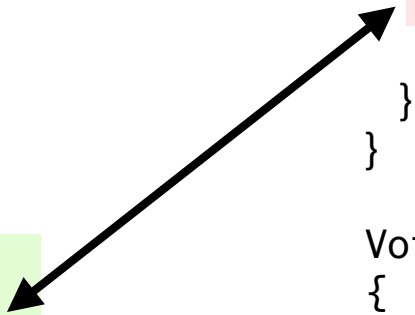
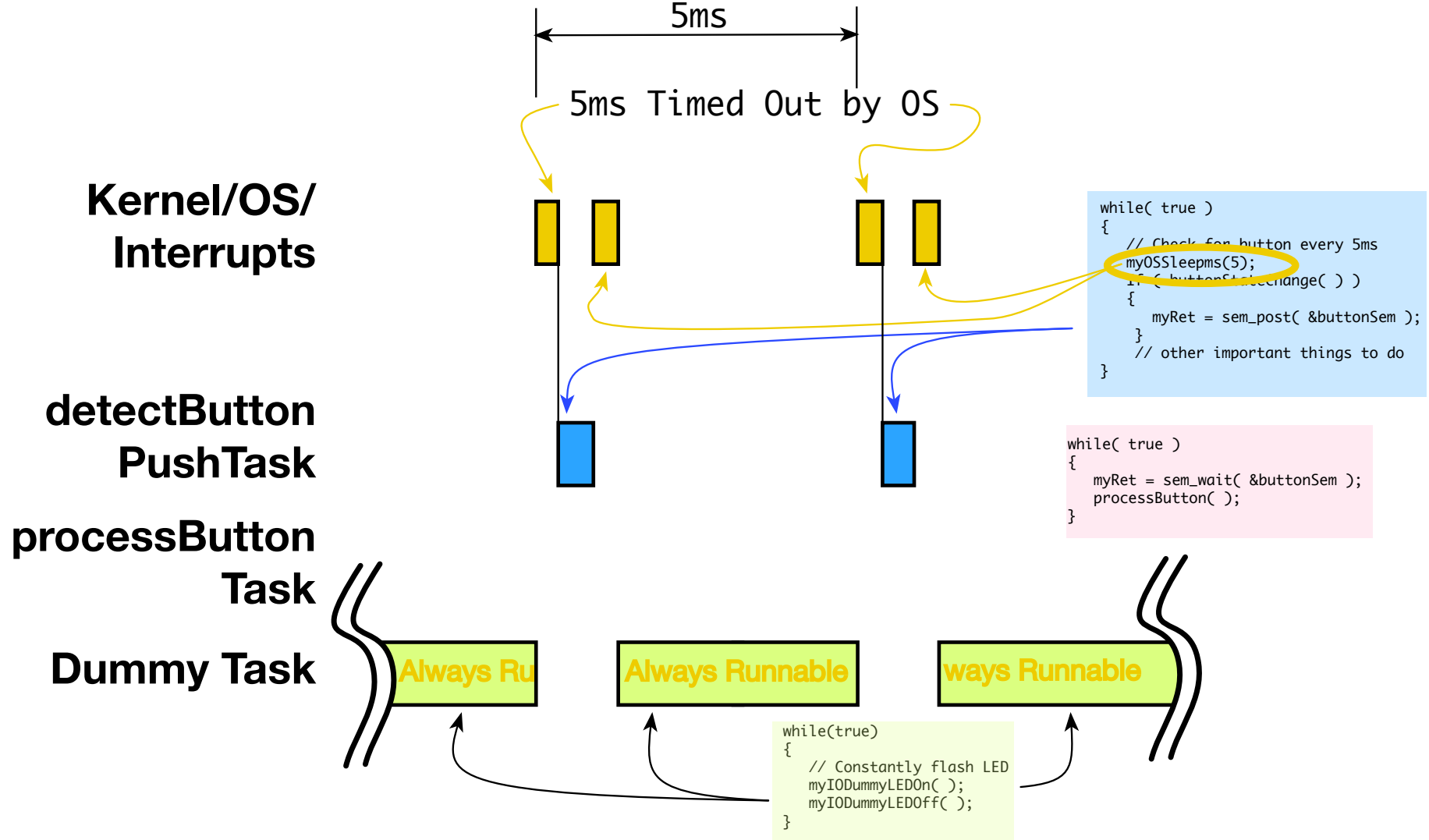
Use of Semaphores - Task Synchronization

```
sem_t buttonSem;
bool buttonStateChange( void );
void processButton( void );

// High Priority Task
void detectButtonPushTask (void)
{
   int myRet;
   while( true )
   {
      // Check for button every 5ms
       myOSSleepms(5);
      If ( buttonStateChange( ) )
      {
        myRet = sem_post( &buttonSem );
      }
      // other important things to do
   }
}
```

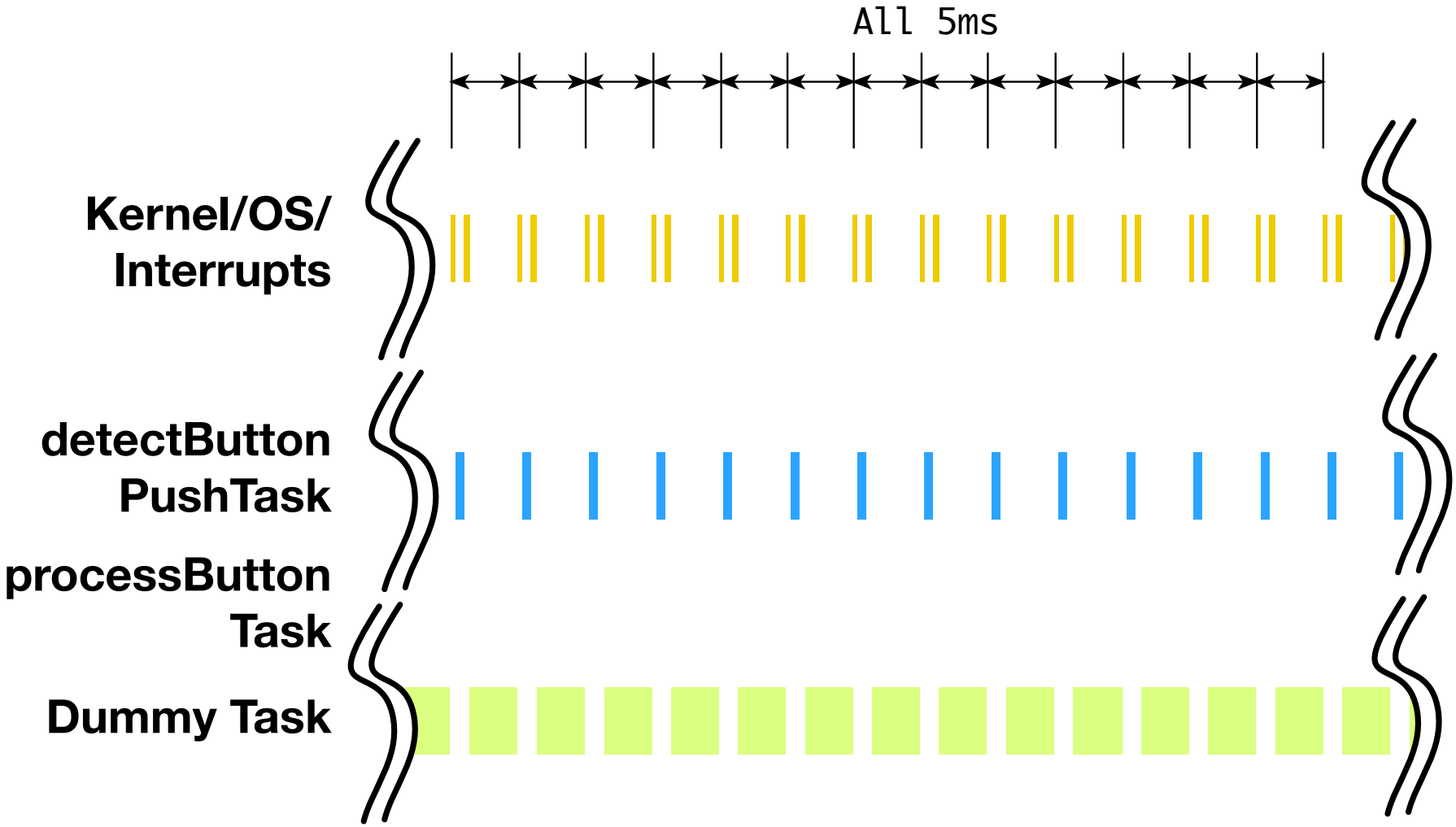


```
// Lower Priority Task
void processButtonTask (void)
{
   int myRet;
   while( true )
   {
      myRet = sem_wait( &buttonSem );
      processButton( );
   }
}

Void dummyTask( void )
{
    while(true)
    {
        // Constantly flash LED
        myIODummyLEDOn( );
        myIODummyLEDOff( );
    }
}
```

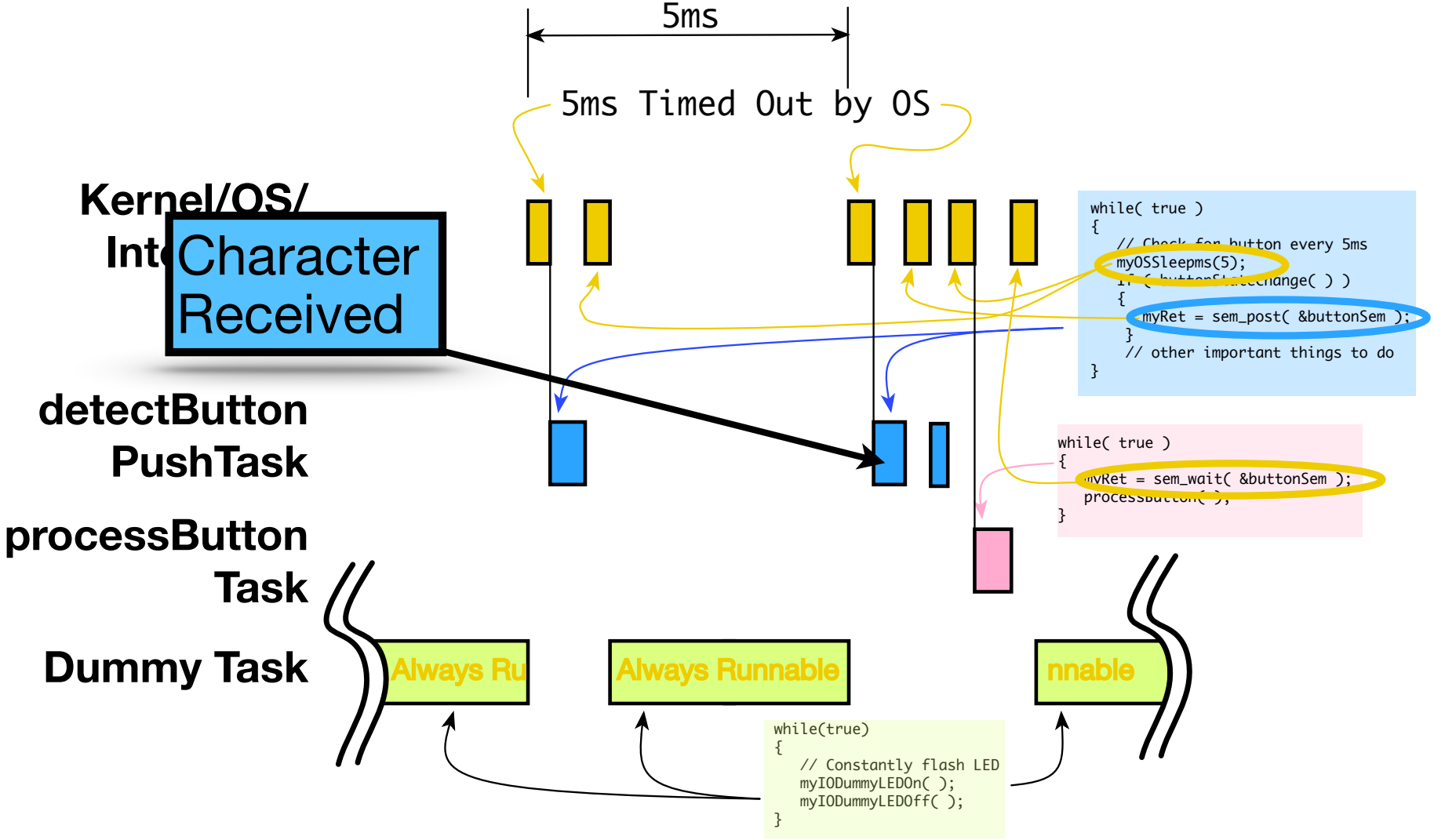
Use of Semaphores - Task Synchronization



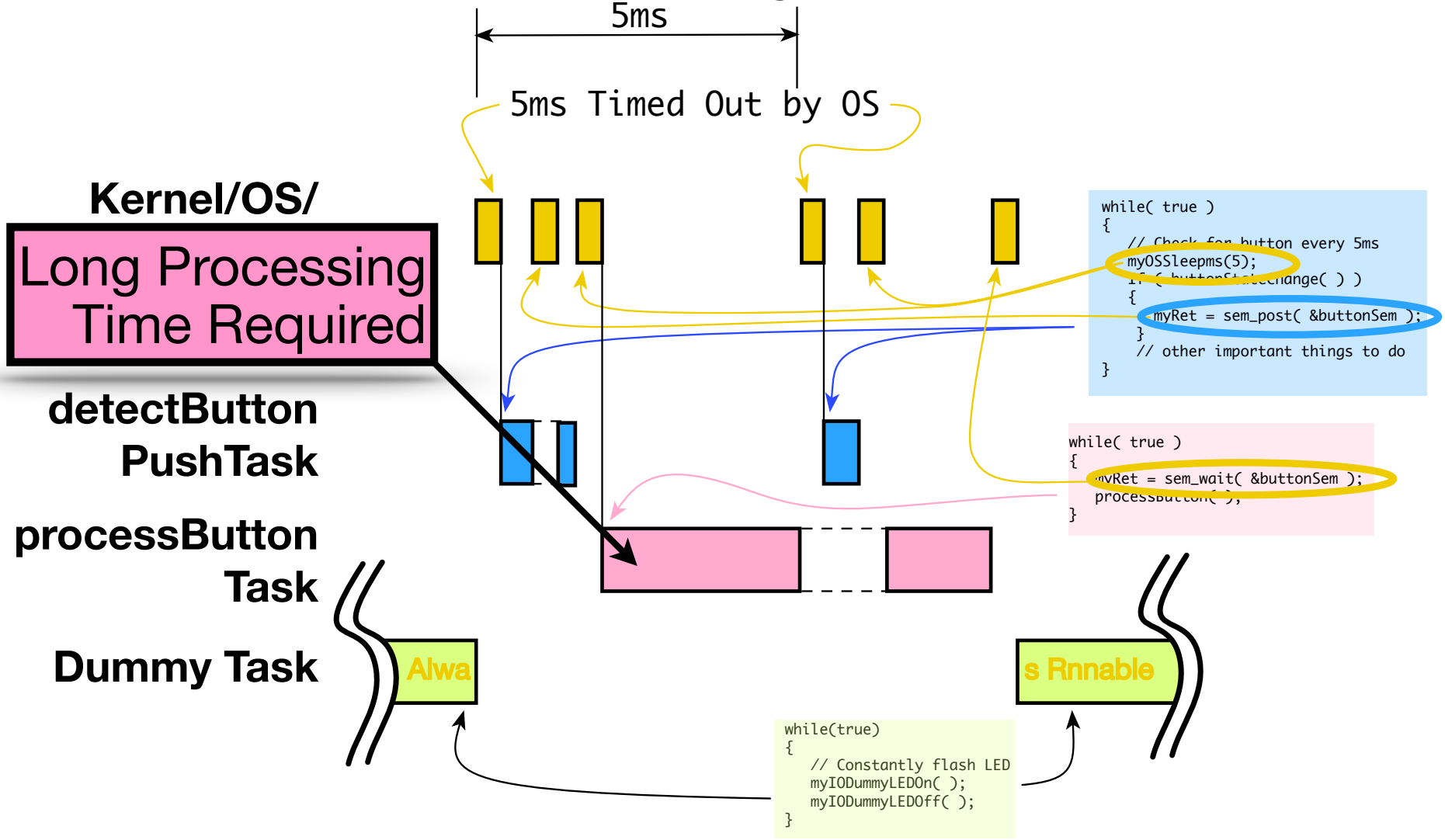
Use of Semaphores - Task Synchronization



Use of Semaphores - Task Synchronization



Use of Semaphores - Task Synchronization



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Use of Semaphores - Use of Shared Devices/Services

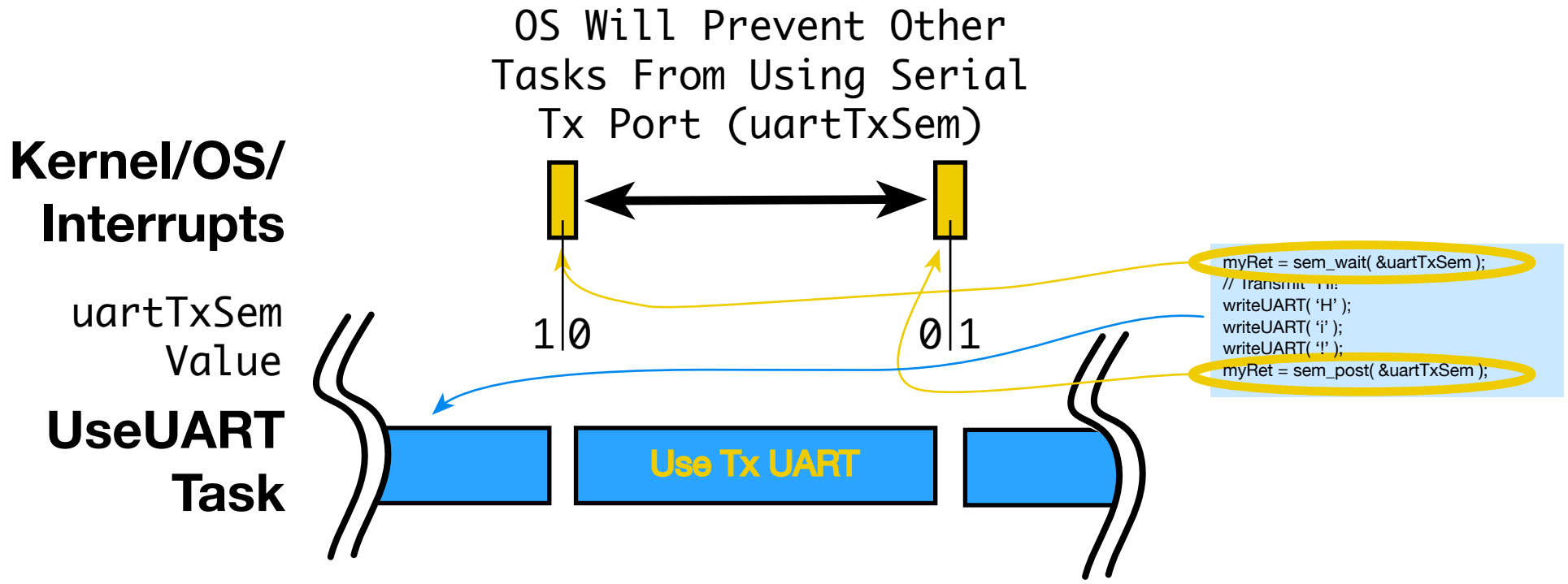
```
sem_t uartTxSem;
char uartChar;
void writeUART( char );

.
.
.
   int myRet;
   myRet = sem_wait( &uartTxSem );
   // Transmit “Hi!”
   writeUART( ‘H’ );
   writeUART( ‘i’ );
   writeUART( ‘!’ );
   myRet = sem_post( &uartTxSem );
.
.
.
```

If the UART is available, execution will continue.

If the UART is busy, execution will be suspended (waiting) until UART is available. Code will resume execution when UART is no longer being used by other code/task.

Let the system/tasks know that the UART is now available

Use of Semaphores - Use of Shared Devices/Services



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Use of Semaphores - Use of Shared Devices/Services

- Multiple Tasks, Both Using the Tx Serial Port (writeUART)

```
// High Priority Serial Task
void hpsTask (void)
{
   int myRet;
   while( true )
   {
      // Process every 5ms
      myOSSleepms(5);
      doImportantStuff();
      myRet = sem_wait( &uartTxSem )
      // Transmit “Hi!”
      writeUART( ‘H’ );
      writeUART( ‘i’ );
      writeUART( ‘!’ );
      myRet = sem_post( &uartTxSem );
   }
```

```
// Low Priority Serial Task
void lpsTask (void)
{
   int myRet;
   while( true )
   {
      doLessImportantStuff();
      myRet = sem_wait( &uartTxSem );
      // Transmit “OK”
      writeUART( ‘O’ );
      writeUART( ‘K’ )
      myRet = sem_post( &uartTxSem );
   }
```

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Use of Semaphores - Use of Shared Devices/Services

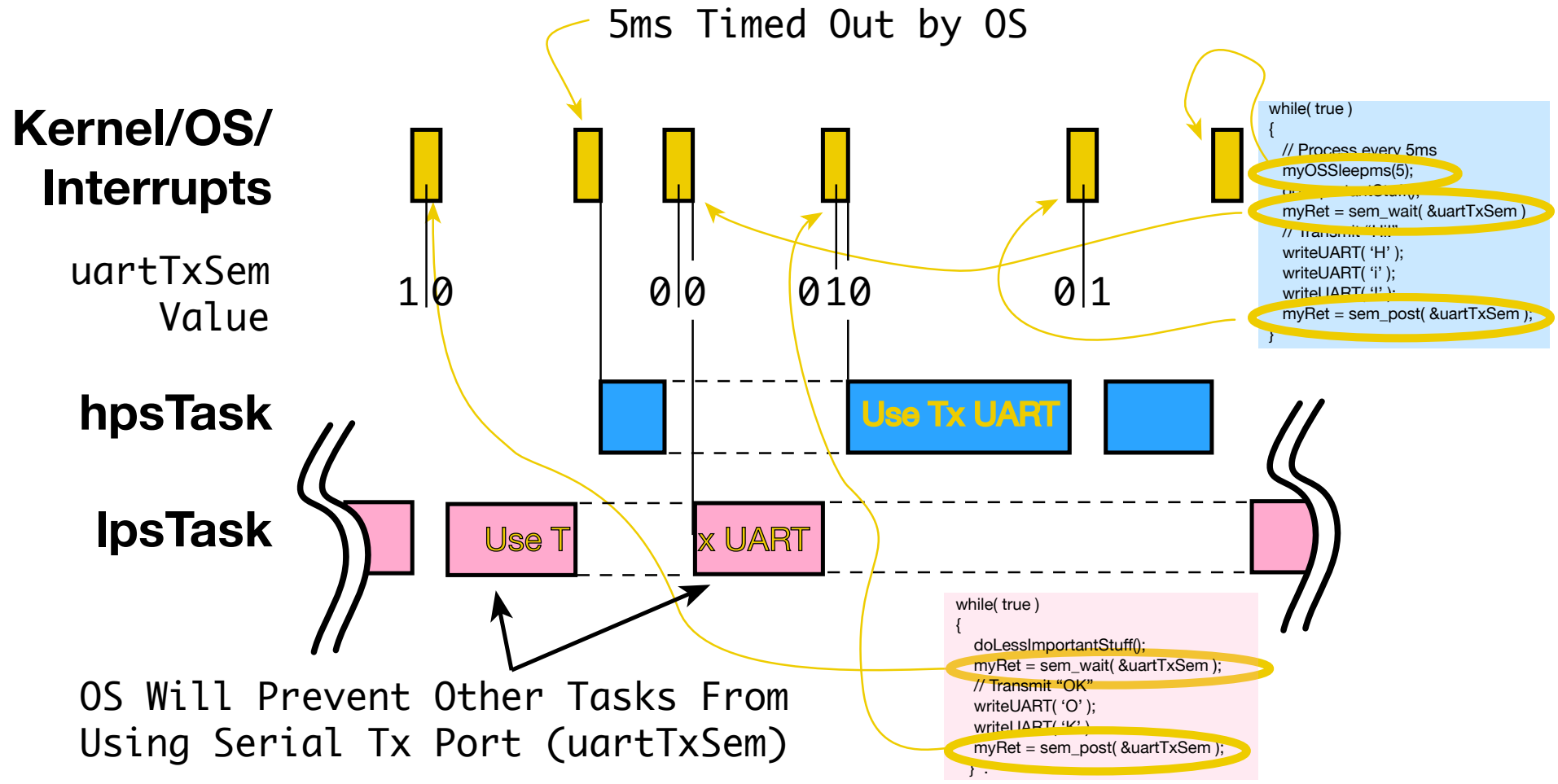
```
// High Priority Serial Task
void hpsTask (void)
{
   int myRet;
   while( true )
   {
      // Process every 5ms
      myOSSleepms(5);
      doImportantStuff();
      myRet = sem_wait( &uartTxSem );
      // Transmit "Hi!"
      writeUART( 'H' );
      writeUART( 'i' );
      writeUART( '!' );
      myRet = sem_post( &uartTxSem );
   }
```

Semaphores control access. All calls use uartTxSem - OS prevents multiple access to UART (hardware device).

```
// Low Priority Serial Task
void lpsTask (void)
{
   int myRet;
   while( true )
   {
      doLessImportantStuff();
      myRet = sem_wait( &uartTxSem );
      // Transmit "OK"
      writeUART( 'O' );
      writeUART( 'K' );
      myRet = sem_post( &uartTxSem );
   }
```

Two Tasks (hpsTask and lpsTask) both use Tx Serial Port.

Use of Semaphores - Use of Shared Devices/Services



Look Ahead

- Review of Reading
- More Semaphore and Task Control (Part 3)
- Insights Into Lab 6

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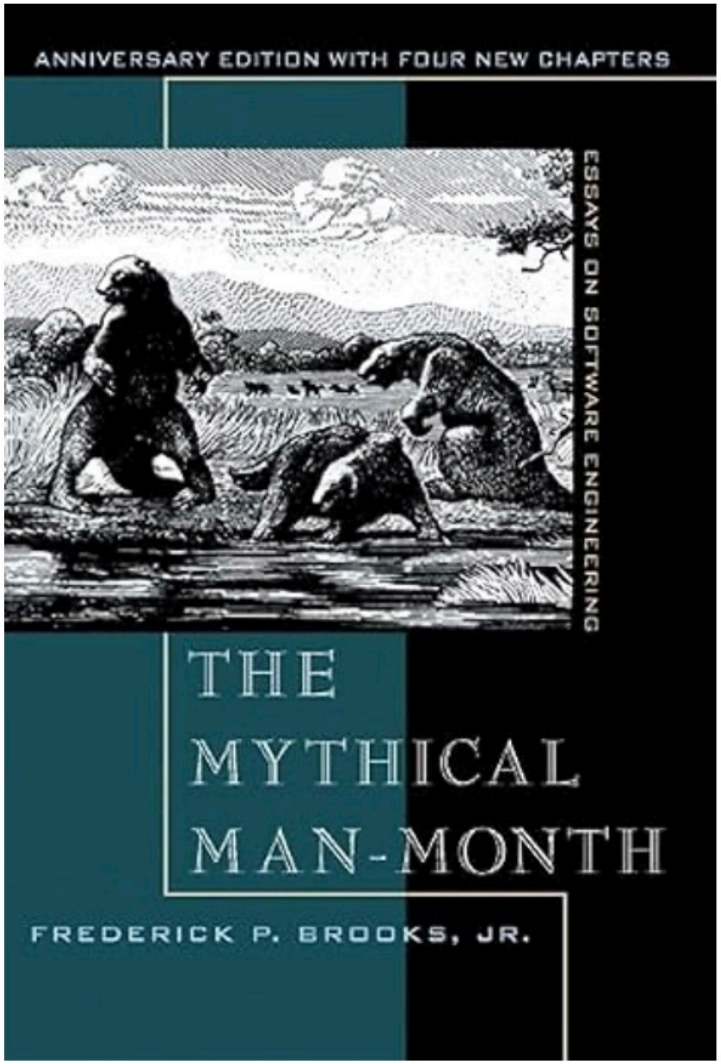
Assignment - Readings

- The Mythical Man Month
  - Chapter 10, 11 & 12: The Documentary Hypothesis, Pan to Throw One Away, Sharp Tools
  - Send Me Discussion Topics by 10:00 AM on Tuesday, Oct. 8, 2024.



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Action Items and Discussion

AI#:	Owner	Slide #	Document	Action