

CSE 438: Embedded Systems Programming

Shared Message Queues in User and Kernel Space

Report

Project 1

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PROJECT DESCRIPTION

The assignment is to implement shared queues in user level. The queue implemented is of finite length and exhibits the circular buffer property. There are four periodic threads, two aperiodic threads and one receiver thread that can access the shared queue. So basically this is a multi-threaded program.

The main concentration in this project is to implement safe threads and calculate the number of messages received at the receiver thread and the number of messages dropped.

Here we calculate the queuing time that is the elapsing time between the time when the message was enqueued and dequeued from the data queue.

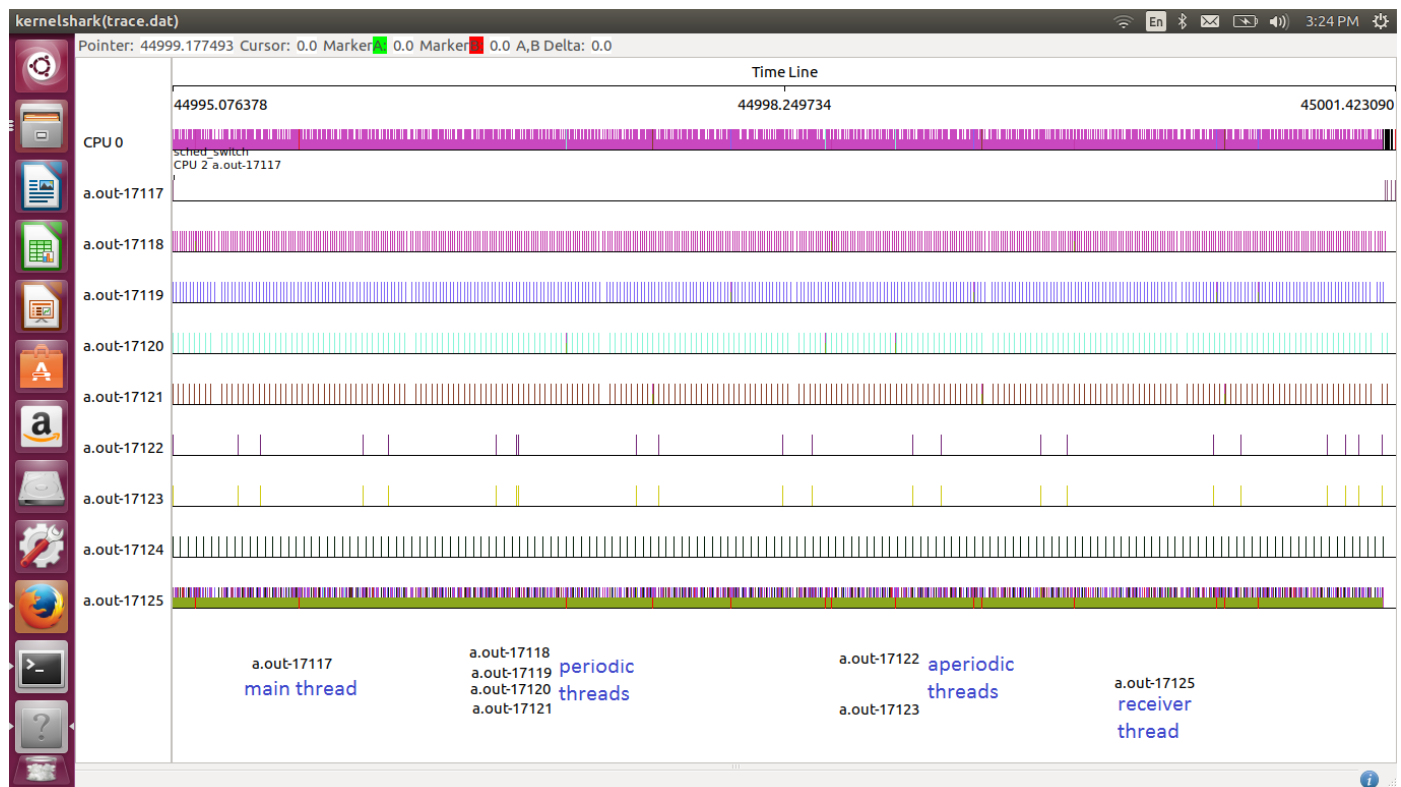
The periodic threads are assigned with different priorities and the aperiodic threads being assigned with the higher priority.

Here the mouse clicks are considered to be the aperiodic threads. A single click on the left or the right button of the mouse should enqueue the message into the shared queue. A double click on the left button of the mouse should terminate the entire process by dequeuing all the messages in both the data queues and display the total number of message received , dropped , the average enqueueing time and the standard deviation of the enqueueing time .

We have used the kernel shark tool to analyze the scheduling of pthreads, both periodic and aperiodic in the system.

Here the affinity of the process is set to a particular core in a multi core system.

The time stamp counter, a precise counter is used to calculate the queueing time in this project.



The first thread a.out-17117 is main thread which remains idle most times . Its just required to invoke the other threads.

The next 4 threads are periodic threads which are used to enqueue at regular intervals.

The next 2 threads are a periodic threads which are executed on click of mouse button.

The last thread is the receiving thread which remains busy most of the time.

The overlapping threads (i.e periodic & aperiodic) hasn't occurred.

```
asu@ubuntu: ~/Documents/queueimp.h/final
SOURCE_ID: 0    DESTINATION_ID: 0    MSG_ID: 237
The random number generated is : 13.000000
Aproximated value of PI = 3.1415926343385627
SENDING MESSAGE_ID IS : 237
The initail time of enqueueing of MSG_ID: 237 is : 98291925058351
Function sq_write is called successfully
=====
SOURCE_ID: 3    DESTINATION_ID: 1    MSG_ID: 238
The random number generated is : 44.000000
Aproximated value of PI = 3.1415926535897940
SENDING MESSAGE_ID IS : 238
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 0    DESTINATION_ID: 0    MSG_ID: 239
The random number generated is : 24.000000
Aproximated value of PI = 3.1415926535897891
SENDING MESSAGE_ID IS : 239
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 4    DESTINATION_ID: 1    MSG_ID: 240
The random number generated is : 42.000000
Aproximated value of PI = 3.1415926535897940
SENDING MESSAGE_ID IS : 240
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 0    DESTINATION_ID: 0    MSG_ID: 241
The random number generated is : 16.000000
Aproximated value of PI = 3.1415926532889928
SENDING MESSAGE_ID IS : 241
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 1    DESTINATION_ID: 0    MSG_ID: 242
The random number generated is : 20.000000
Aproximated value of PI = 3.1415926535886185
SENDING MESSAGE_ID IS : 242
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 3    DESTINATION_ID: 1    MSG_ID: 243
The random number generated is : 18.000000
Aproximated value of PI = 3.1415926535709935
SENDING MESSAGE_ID IS : 243
Operation failed!!!! Since Queue is Full...
=====
=====
The received multiplier is : 40
Message at receiver with source_id:4, destination id=1, msgid =78, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q2 IS BEING DE-QUEUED
The no. of message received is : 30
The accumulated queueing time of msg:78 is 1687.987427 MILLI SECONDS
=====
SOURCE_ID: 0    DESTINATION_ID: 0    MSG_ID: 244
The random number generated is : 35.000000
Aproximated value of PI = 3.1415926535897940
SENDING MESSAGE_ID IS : 244
Operation failed!!!! Since Queue is Full...
```

The enqueueing thread & receiving thread is displayed in the above screen shot.

```
=====
SOURCE_ID: 1  DESTINATION_ID: 0  MSG_ID: 233
The random number generated is : 11.000000
Aproximated value of PI = 3.1415923455701176
SENDING MESSAGE_ID IS : 233
Operation failed!!!! Since Queue is Full...
=====
SOURCE_ID: 4  DESTINATION_ID: 1  MSG_ID: 234
The random number generated is : 14.000000
Aproximated value of PI = 3.1415926487769852
SENDING MESSAGE_ID IS : 234
Operation failed!!!! Since Queue is Full...
=====
left click 4.342000 c= 1 d=1
SOURCE_ID: 2  DESTINATION_ID: 0  MSG_ID: 235
The random number generated is : 19.000000
Aproximated value of PI = 3.1415926535850933
SENDING MESSAGE_ID IS : 235
Operation failed!!!! Since Queue is Full...
=====
left click 4.342000 c= 1 d=1
SOURCE_ID: 2  DESTINATION_ID: 0  MSG_ID: 236
The random number generated is : 15.000000
Aproximated value of PI = 3.1415926523865907
SENDING MESSAGE_ID IS : 236
Operation failed!!!! Since Queue is Full...
=====
The received multiplier is : 40
Message at receiver with source id:0, destination id=0, msgid =69, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q1 IS BEING DE-QUEUED
The no. of message received is : 29
The accumulated queueing time of msg:69 is 1687.888062 MILLI SECONDS
=====
SOURCE_ID: 0  DESTINATION_ID: 0  MSG_ID: 237
```

Left click event has initiated an aperiodic thread.

```
left click 4.519000 c= 2 d=0
Double click detected
Double click detected...oops

=====
Message at receiver with source_id:3, destination id=1, msgid =110, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q2 IS BEING DE-QUEUED
The accumulated queueing time of msg:110 is 1641.847168 MILLI SECONDS
The no. of message received is : 34

=====
Message at receiver with source_id:0, destination id=0, msgid =119, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q1 IS BEING DE-QUEUED
The accumulated queueing time of msg:119 is 1554.819458 MILLI SECONDS
The no. of message received is : 35

=====
Message at receiver with source_id:3, destination id=1, msgid =129, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q2 IS BEING DE-QUEUED
The accumulated queueing time of msg:129 is 1452.888916 MILLI SECONDS
The no. of message received is : 36

=====
Message at receiver with source_id:0, destination id=0, msgid =136, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q1 IS BEING DE-QUEUED
The accumulated queueing time of msg:136 is 1376.472168 MILLI SECONDS
The no. of message received is : 37

=====
Message at receiver with source_id:3, destination id=1, msgid =144, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q2 IS BEING DE-QUEUED
The accumulated queueing time of msg:144 is 1300.055786 MILLI SECONDS
The no. of message received is : 38

=====
Message at receiver with source_id:0, destination id=0, msgid =153, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q1 IS BEING DE-QUEUED
The accumulated queueing time of msg:153 is 1198.200806 MILLI SECONDS
The no. of message received is : 39

=====
Message at receiver with source_id:3, destination id=1, msgid =162, PI VALUE:3.141593
FUNCTION SQ_READ CALLED SUCCESSFULLY
BUS_IN_Q2 IS BEING DE-QUEUED
```

Double click event has been invoked by mouse which marks the end . This eventually dequeues both the data queues which is displayed

```
Therefore the total number of messages received at the reciver thread is :53,,,,,the average is : 17914.273804,,,,and the standard deviation ts : 44666.177626
FUNCTION SQ_DELETE CALLED SUCCESSFULLY
FUNCTION SQ_DELETE CALLED SUCCESSFULLY
Kernel buffer statistics:
Note: 'entries' are the entries left in the kernel ring buffer and are not
      recorded in the trace data. They should all be zero.

CPU: 0
entries: 0
overrun: 0
commit overrun: 0
bytes: 612
oldest event ts: 27300.479475
now ts: 27300.493246
dropped events: 0
read events: 2528

CPU: 1
entries: 0
overrun: 0
commit overrun: 0
bytes: 3944
oldest event ts: 27300.414108
now ts: 27300.493254
dropped events: 0
read events: 897

CPU: 2
entries: 0
overrun: 0
commit overrun: 0
bytes: 1156
oldest event ts: 27300.486415
now ts: 27300.493259
dropped events: 0
read events: 2176

CPU: 3
entries: 0
overrun: 0
commit overrun: 0
bytes: 4012
oldest event ts: 27300.452138
now ts: 27300.493264
dropped events: 0
read events: 2278

CPU0 data recorded at offset=0x417000
176128 bytes in size
CPU1 data recorded at offset=0x442000
61440 bytes in size
CPU2 data recorded at offset=0x451000
151552 bytes in size
CPU3 data recorded at offset=0x476000
155648 bytes in size
asu@ubuntu:~/Documents/queueinp.h/final$
```

The average Queueing time ,Standard deviation & number of messages received is displayed at the end of program .

Please follow the next set of instruction from read me file.