

ECEN 5623, Real-Time Embedded Systems:

Exercise #2 – Service Scheduling Feasibility

DUE: As Indicated on Canvas.

Please thoroughly read Chapters 3, 4 & 5 in RTECS with Linux and RTOS

Please see example code provided - <http://mercury.pr.erau.edu/~siewerts/cec450/code/>

Exercise #2 Requirements:

- 1) [5 points] make yourself an account on your Dev Kit. To do this, use the reset button if the system is locked, use your password to login, and then use “sudo adduser”, enter a password, and enter user information as you see fit. Add your new user account as a “sudoer” using “visudo” right below root with the same privileges (if you need help with “vi”, here’s a [quick reference](#) or [reference card](#)– use arrows to position cursor, below root hit Esc, “i” for insert, type username and privileges as above, and when done, Esc, “:”, “wq”). The old [unix vi editor](#) was one of the first full-screen visual editors – it still has the advantage of being found on virtually any Unix system in existence, but is otherwise cryptic – along with [Emacs](#) it is still widely used in IT, by developers and systems engineers, so it’s good to know the basics. If you really don’t like vi or Emacs, your next best bet is “nano” for Unix systems. Do a quick “sudo whoami” to demonstrate success. Logout of Linux and test your login, then logout. Use Alt+Print-Screen to capture your desktop and save as proof you set up your account. Note that you can always get a terminal with Ctrl+Alt+t key combination. If you don’t like the desktop, you can try “GNOME Flashback” and please play around with customizing your account as you wish.
- 2) [10 points] Read the paper "[Architecture of the Space Shuttle Primary Avionics Software System](#)" [also available on Canvas, “shuttle_paper.pdf”], by Gene Carlow and provide an explanation and critique of the frequency executive architecture. What advantages and disadvantages does the frequency executive have compared to the real-time threading and tasking implementation methods for real-time software systems? Please be specific about the advantages and disadvantages and provide at least 3 advantages as well as 3 disadvantages.
- 3) [5 points] Read the paper “Building Safety-Critical Real-Time Systems with Reuseable Cyclic Executives”, available from [http://dx.doi.org/10.1016/S0967-0661\(97\)00088-9](http://dx.doi.org/10.1016/S0967-0661(97)00088-9). In other embedded systems classes you built ISR (Interrupt Service Routine) processing software and polling/control loops to control for example stepper motors – describe the

concept of the Cyclic Executive and how this compares to the Linux POSIX RT threading and RTOS approaches we have discussed.

- 4) [50 points] Download [Feasibility example code](#) and build it on a Jetson, DE1-SoC or TIVA or Virtual Box and execute the code. Compare the tests provided to analysis using Cheddar for the first 4 examples. Now, implement the remaining examples [5 more] that we reviewed in class ([found here](#), and on Canvas). Complete analysis for all three policies using Cheddar (RM, EDF, LLF). In cases where RM fails, but EDF or LLF succeeds, explain why. Cheddar uses both service simulations over the LCM of the periods as well as feasibility analysis based on the RM LUB and scheduling-point/completion-test algorithms, referred to as “Worst Case Analysis”. Does your modified Feasibility code agree with Cheddar analysis in all 5 additional cases? Why or why not?
- 5) [30 points] Provide 3 constraints that are made on the RM LUB derivation and 3 assumptions as documented in the Liu and Layland paper and in Chapter 3 of the text. Finally, list 3 key derivation steps in the RM LUB derivation that you either do not understand or that you would consider “tricky” math. Attempt to describe the rationale for those steps as best you can do based upon reading in Chapter 3 of the text.

Grading Rubric

[5 points] Create account on target board: _____

[10 points] Shuttle PASS paper review:

[3 points] Three advantages _____

[3 points] Three disadvantages _____

[4 points] Overall understanding of paper and key point articulation _____

[5 points] Cyclic Executive paper review:

[3 points] Overall understanding of paper and key point articulation _____

[2 points] Comparison to Linux and RTOS approaches _____

[50 points] Shared CPU system overload – for each provide code, screenshots of code output, including EDF and LLF test output, and Cheddar results screenshots:

[5 pts] Examples 0-3 comparison _____

[5 pts] EDF and LLF code _____

[4 pts] Example #4 code and output for 3 policies _____

[4 pts] Example #5 code and output for 3 policies _____

[4 pts] Example #6 code and output for 3 policies _____

[4 pts] Example #7 code and output for 3 policies _____

[4 pts] Example #8 code and output for 3 policies _____

[4 pts] Example #4 Cheddar confirm _____

[4 pts] Example #5 Cheddar confirm _____

[4 pts] Example #6 Cheddar confirm _____

[4 pts] Example #7 Cheddar confirm _____

[4 pts] Example #8 Cheddar confirm _____

Don't forget to explain why in some cases RM fails, but EDF or LLF succeeds.

[30 points] Shared CPU system overload:

[5 pts] C#1, A#1 _____

[5 pts] C#2, A#2 _____

[5 pts] C#3, A#3 _____

[5 pts] key step #1 _____

[5 pts] key step #2 _____

[5 pts] key step #3 _____

Overall, provide a well-documented professional report of your findings, output, and tests so that it is easy for a colleague (or instructor) to understand what you've done. Include any C/C++ source code you write (or modify) and Makefiles needed to build your code. I will look at your report first, so it must be well written and clearly address each problem providing clear and concise responses to receive credit.

Note: Linux manual pages can be found for all system calls (e.g. `fork()`) on the web at <http://linux.die.net/man/> - e.g. <http://linux.die.net/man/2/fork>

In this class, you'll be expected to consult the Linux manual pages and to do some reading and research on your own, so practice this in each lab and try to answer as many of your own questions as possible, but do come to office hours and ask for help if you get stuck.

Upload all code and your report completed using MS Word or as a PDF to Canvas and include all source code (ideally example output should be integrated into the report directly, but if not, clearly label in the report and by filename if test and example output is not pasted directly into the report). ***Your code must include a Makefile so I can build your solution on Ubuntu VB-Linux or a Jetson. Please zip or tar.gz your solution with your first and last name embedded in the directory name.***