

# CS342301 2023 MP2 – Multi-Programming

Deadline: 2023/03/27 23:59

## ★ Goal

1. Understand how memory management works in NachOS
2. Understand how to implement page table mechanism

## ★ Assignment

### ○ Trace code

- Starting from “threads/kernel.cc **Kernel::ExecAll()**”, “threads/thread.cc **thread::Sleep()**” until “machine/mipsim.cc **Machine::Run()**” is called for executing the first instruction from the user program.
  - You need to explain at least the function mentioned below in the report.
- 1-1. threads/thread.cc

```
Thread::Sleep()
Thread::StackAllocate()
Thread::Finish()
Thread::Fork()
```

1-2. userprog/addrspace.cc

```
AddrSpace::AddrSpace()
AddrSpace::Execute()
AddrSpace::Load()
```

1-3. threads/kernel.cc

```
Kernel::Kernel()
Kernel::ExecAll()
Kernel::Exec()
Kernel::ForkExecute()
```

1-4. threads/scheduler.cc

```
Scheduler::ReadyToRun()
Scheduler::Run()
```

- Implement page table in NachOS

2-1. Working item: Modify its memory management code to make NachOS support multiprogramming.

2-2. Verification:

- Wrong results without multiprogramming

```
[ta@lsalab ~/2020/riya/MP2_test/code/test]$ ../build.linux/nachos -e consoleIO_test1 -e consoleIO_test2
consoleIO_test1
consoleIO_test2
9
16
15
18
19
1return value:0
7
return value:0
```

- Correct results with multiprogramming

```
[ta@lsalab ~/2020/riya/MP2_sol/code/test]$ ../build.linux/nachos -e consoleIO_test1 -e consoleIO_test2
consoleIO_test1
consoleIO_test2
9
8
7
6
1return value:0
5
16
17
18
19
return value:0
```

- Correctly handle the exception about insufficient memory (Details in 2-3 requirement)

```
[ta@localhost test]$ ../build.linux/nachos -e consoleIO_test1 -e consoleIO_test4
consoleIO_test1
consoleIO_test4
9Unexpected user mode exception 8
Assertion failed: line 201 file ../userprog/exception.cc
Aborted
```

2-3. Requirement:

- Be careful that program size might exceeds a pagesize
- You must put the data structure recording used physical memory in **kernel.h** / **kernel.cc**
- You must set up “valid, readOnly, use, and dirty” field for your page table, which is defined under “**TranslationEntry class**” in translate.h

- You must call ExceptionHandler to handle the exception when there is insufficient memory for a thread. (i.e. MemoryLimitException).

Since there is no MemoryLimitException in ExceptionType class, you need to add it in machine.h and place it right before **NumExceptionTypes**. **(0 points for using existing exception type or placing it in the wrong index.)**

- When loading a program into memory, you can just **load a page at a time**, and repeatedly load until the whole program finishes loading. That is, you cannot simply modify the source code (executable->ReadAt() in AddrSpace::Load()) by the correct physical address.
- When the thread is finished, make sure to release the address space and restore physical page status.

2-4. Hint: The following files “may” be modified...

- **userprog/addrspace.\***

- **threads/kernel.\***
- **machine/machine.h**

#### ○ Report

- Cover page, including studentID, teamID.
  - Explain your implementation.
  - Explain how NachOS creates a thread (process), load it into memory and place it into the scheduling queue as requested in the **Trace code** part.
- Your explanation on the functions along the code path should at least cover answer for the questions below:

- How does Nachos allocate the memory space for a new thread(process)?
- How does Nachos initialize the memory content of a thread(process), including loading the user binary code in the memory?
- How does Nachos create and manage the page table?
- How does Nachos translate addresses?
- How Nachos initializes the machine status (registers, etc) before running a thread(process)
- Which object in Nachos acts the role of process control block
- When and how does a thread get added into the ReadyToRun queue of Nachos CPU scheduler?

#### ★ Instructions

1. Copy your code for MP1 to a new folder

```
$ cp -r /home/os2023/share/NachOS-4.0_MP2 NachOS-4.0_MP2
```

2. Copy test file

```
$ cp /home/os2023/share/consoleIO_test* NachOS-4.0_MP2/code/test/
```

3. Compile / Rebuild NachOS

```
$ cd NachOS-4.0_MP2/code/build.linux
```

```
$ make clean
```

```
$ make
```

4. Test your program

```
$ cd NachOS-4.0_MP2/code/test
```

```
$ ../build.linux/nachos -e consoleIO_test1 -e consoleIO_test2
```

#### ★ Grading

1. Implementation correctness – 60%

- (a) Execute “../build.linux/nachos -e consoleIO\_test1 -e consoleIO\_test2” correctly
- (b) There will be **hidden test cases** to test the requirements. Make sure your code meets all the requirements.
- (c) You **DO NOT need to upload NachOS code to eeclass**, and just put your code to the folder named “NachOS-4.0\_MP2” in your home directory.
- (d) Your working directory will be copied for validation after the deadline.

2. Report – 15%

- (a) Upload to eeclass with the filename **MP2\_report\_[StudentID].pdf** (E.g. MP2\_report\_111062584.pdf)

3. Demo – 25%

- (a) We will ask several questions about your codes.
- (b) Demos will take place on our server, so you are responsible to make sure your code works on our server.

4. TAs won't help you recover from file loss or misedited. Please make sure you backup your code. You can use git or simply make a copy in your local.
5. **Late submissions will not be accepted.** Refer to the course syllabus for detailed homework rules and policies.
6. **Plagiarism**
  - (a) **NEVER SHOW YOUR CODE** to others.
  - (b) If the codes are similar to other people (**including your upperclassman**) and you can't answer questions properly during the demo, you will be identified as plagiarism.