Supporting User Programs

Phase 2 of Nachos Project

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ACM Honored Class 06
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Outline

1. Knowledge
2. Tasks
3. Selected Topics

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`nachos.machine.FileSystem` and `nachos.machine.OpenFile`

- basic interfaces for file system
- *Abstract Factory* pattern

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`nachos.userprog.UserProcess`

- contains local algorithm and data for a process
  - page tables, file tables, etc.
- much work need to do here

Code Overview

Booting

- a kernel thread does the initialization
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Launching a Process

- load binary code from file
- run instructions on `Processor`

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Address Translation

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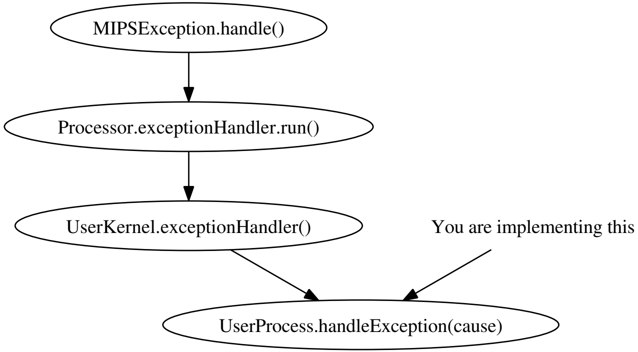
Context Switch

- `UThread.saveState()` is called before context switches
- `UThread.restoreState()` is called after context switches

Code Overview

When exception occurs

- exception handler in `UserKernel` is invoked



MIPSException.handle()

Processor.exceptionHandler.run()

UserKernel.exceptionHandler()

You are implementing this

UserProcess.handleException(cause)

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Task 1

Implement syscalls for file management.

- `creat`, `open`, `read`, `write`, `close`, `unlink`
- see **syscall.h** for details

Make use of `nachos.machine.StubFileSystem` .

- it's a wrapper of your real file system
- through `StubFileSystem` , you can access files in the "test" directory by the `OpenFile` interface

Task 2

Implement simple paging using page table.
Modify `UserProcess.readVirtualMemory()` and `UserProcess.writeVirtualMemory()` .

- they are widely used & important method
- they are used to copy data between kernel and user's virtual address space
- better to make their code independent with address translation

Task 3

Implement syscalls for process management.

- `exec`, `join`, `exit`
- see **syscall.h** for details

Bullet-proof all the syscalls.

- i.e. there should be *nothing* a user program can do to crash the operating system

Task 3

Take `join` as an example:

`handleJoin(int pid, int addrStatus)`

1. check whether *pid* is a child of `currentProcess`
2. call `join` on the child's `KThread` object
3. check whether the child exited normally
4. get the return value of the child
5. write the return value to memory address *addrStatus*
6. do some cleanings
7. return a value

Task 4

Implement a lottery scheduler.

- if you did make a good design before implementing `PriorityScheduler` , this will be very easy

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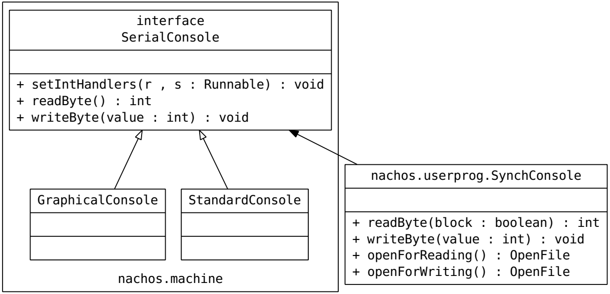
Consoles



interface
SerialConsole

```
+ setIntHandlers(r , s : Runnable) : void
+ readByte() : int
+ writeByte(value : int) : void
```

GraphicalConsole

StandardConsole

nachos.machine

nachos.userprog.SynchConsole

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+ readByte(block : boolean) : int
+ writeByte(value : int) : void
+ openForReading() : OpenFile
+ openForWriting() : OpenFile
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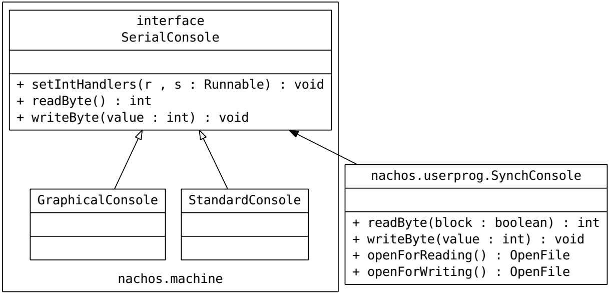
Consoles



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+ openForReading() : OpenFile
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- Make use of `openForReading()` and `openForWriting()` to provide standard input/output to user program.
- Consider whether your readings need to be blocked or not.

Consoles

A difference between nachos console and your real console:

- by default, your real console program will buffer your input until a line break
- for `*nix` users who want to simulate more accurately:

```
#!/bin/sh

onexit () {
  stty $OLDSTTYSTATE
}

OLDSTTYSTATE=`stty -g`
trap onexit 0
stty -icanon min 1 -echo
java -cp bin nachos.machine.Machine $*
```

Debugging

Use debug flags properly will help a lot in debugging.

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Use `GraphicalConsole` to seperate standard input/output from debug output.

Cross Compiling

First, edit your `Makefile` to make it work properly

- tell it where is your cross compiler
    - i.e. `ARCHDIR= "../mips-x86.linux-xgcc"`

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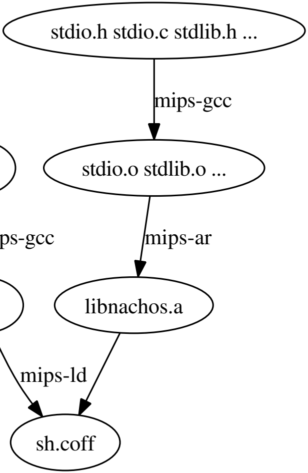

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Need libraries to support tiger programs.

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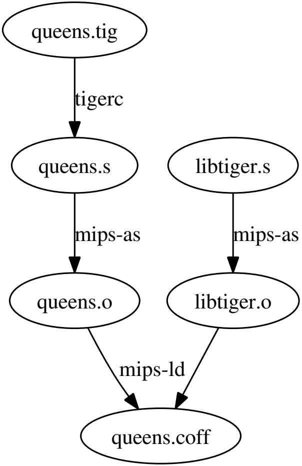
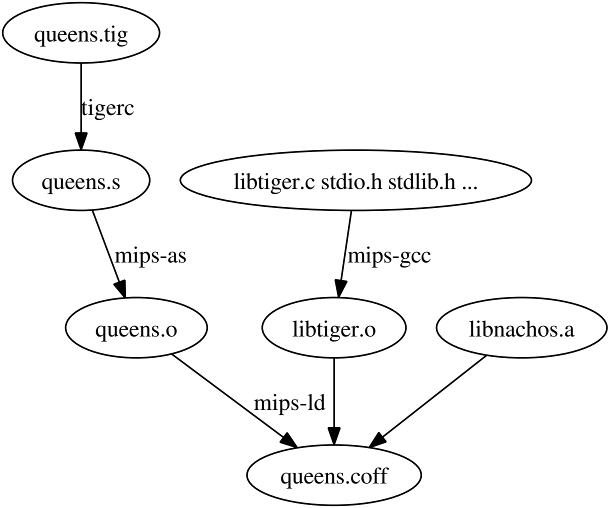


Integrating with Tiger Compiler

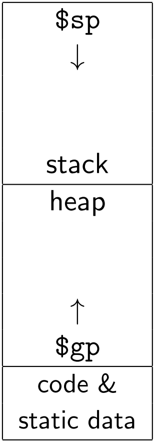
Approach 2:



Integrating with Tiger Compiler

Tiger programs need dynamic memory allocation.

- we can use $gp to allocate memory
- give $gp a initial value in `UserProcess.initRegisters()`
- write memory allocation programs in your library, for example:
  - `move $2, $28`
  - `addu $28, $4`
  - Think: will this code work?



$sp

↓

stack

heap

↑

$gp

code & static data

Q & A