Assignment 1

Please complete the report and upload the corresponding code.

The files required for submission for this assignment include:

1. Submit `report.pdf` through Blackboard.
2. push `libs/sbi.c` and `kern/libs/stdio.c` to GitLab

How to push code to GitLab, please refer to `blackboard->week2->lab2_en.pdf` or `blackboard->week2->作业提交配置手册.pdf`

1) [20pts] The `make qemu` command refers to a label in the corresponding Makefile, which corresponds to:

```
qemu-system-riscv64 \
    -machine virt \
    -nographic \
    -bios default \
    -device loader,file=bin/ucore.bin,addr=0x80200000
```

Please explain the function of each option in the above command.

2) [20pts] Please explain the function of each line in the following snippet from the `tools/kernel.ld` linker script file. (Refer to: https://sourceware.org/binutils/docs/ld/Scripts.html)

```
SECTIONS
{
    /* Load the kernel at this address: "." means the current address */
    . = BASE_ADDRESS;

    .text : {
        *(.text.kern_entry)
        *(.text .stub .text.* .gnu.linkonce.t.*)
    }

    PROVIDE(etext = .); /* Define the 'etext' symbol to this value */

    .rodata : {
        *(.rodata .rodata.* .gnu.linkonce.r.*)
    }

    /* Adjust the address for the data segment to the next page */
    . = ALIGN(0x1000);
```

3) [10pts] Please explain the parameters and the purpose of the statement `memset(edata, 0, end - edata);` within `kern/init/init.c`. (The relevant code to be read includes `init.c` and `kernel.ld`)

4) [20pts] Please describe how the `cputs()` instruction prints characters through the SBI.

5) [30pts] Programming

Download the code from GitLab: `git clone ssh://git@mirrors.sustech.edu.cn:13389/operating-systems/project/kernel_assignment_12XXXXXX.git` (Replace `12XXXXXX` with your student ID)

According to the description, complete the `sbi_shutdown()` function within the `libs/sbi.c` and the `double_cputs()` function within the `kern/libs/stdio.c`.

Output:

```
root@2e4a29d58f39:/src/git/kernel_legacy_previewsheny# make qemu
riscv64-unknown-elf-objcopy bin/kernel --strip-all -O binary bin/ucore.bin

OpenSBI v0.6
   ____                    _____ ____ _____
  / __ \                  / ____|  _ \_   _|
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        | |
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Platform Name          : QEMU Virt Machine
Platform HART Features : RV64ACDFIMSU
Platform Max HARTs     : 8
Current Hart           : 0
Firmware Base          : 0x80000000
Firmware Size          : 120 KB
Runtime SBI Version    : 0.2

MIDELEG : 0x0000000000000222
MEDELEG : 0x000000000000b109
PMP0    : 0x0000000080000000-0x000000008001ffff (A)
PMP1    : 0x0000000000000000-0xffffffffffffffff (A,R,W,X)
os is loading ...

ooss  iiss  llooaaddiinngg  ......


root@2e4a29d58f39:/src/git/kernel_legacy_previewsheny#
```
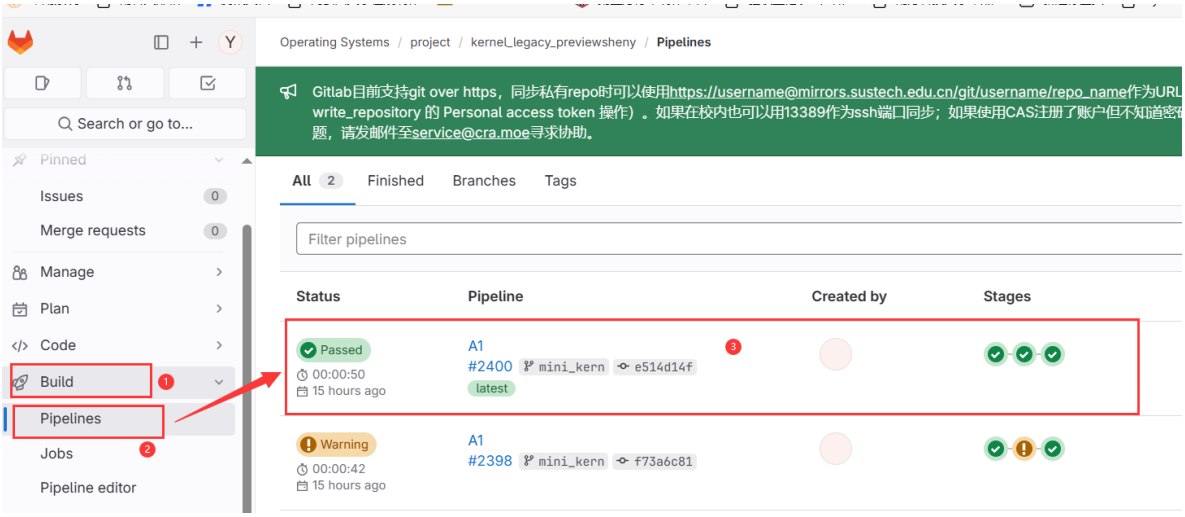

After completion, push both two code files to GitLab for automatic assessment. If the **test does not pass**, you will receive an email notification (which can be disabled through settings if desired). There is no limit on the number of submission attempts, and your assignment score will be based on your last submission.

The assessment results can also be viewed by checking in the following steps, a warning symbol marked as `format-check-job` indicates poor coding style but does not affect the overall score.



(Refer to: https://github.com/riscv-non-isa/riscv-sbi-doc/blob/ed90b26fcc20de16035988aaf21c9e1c2b11447b/src/ext-legacy.adoc)