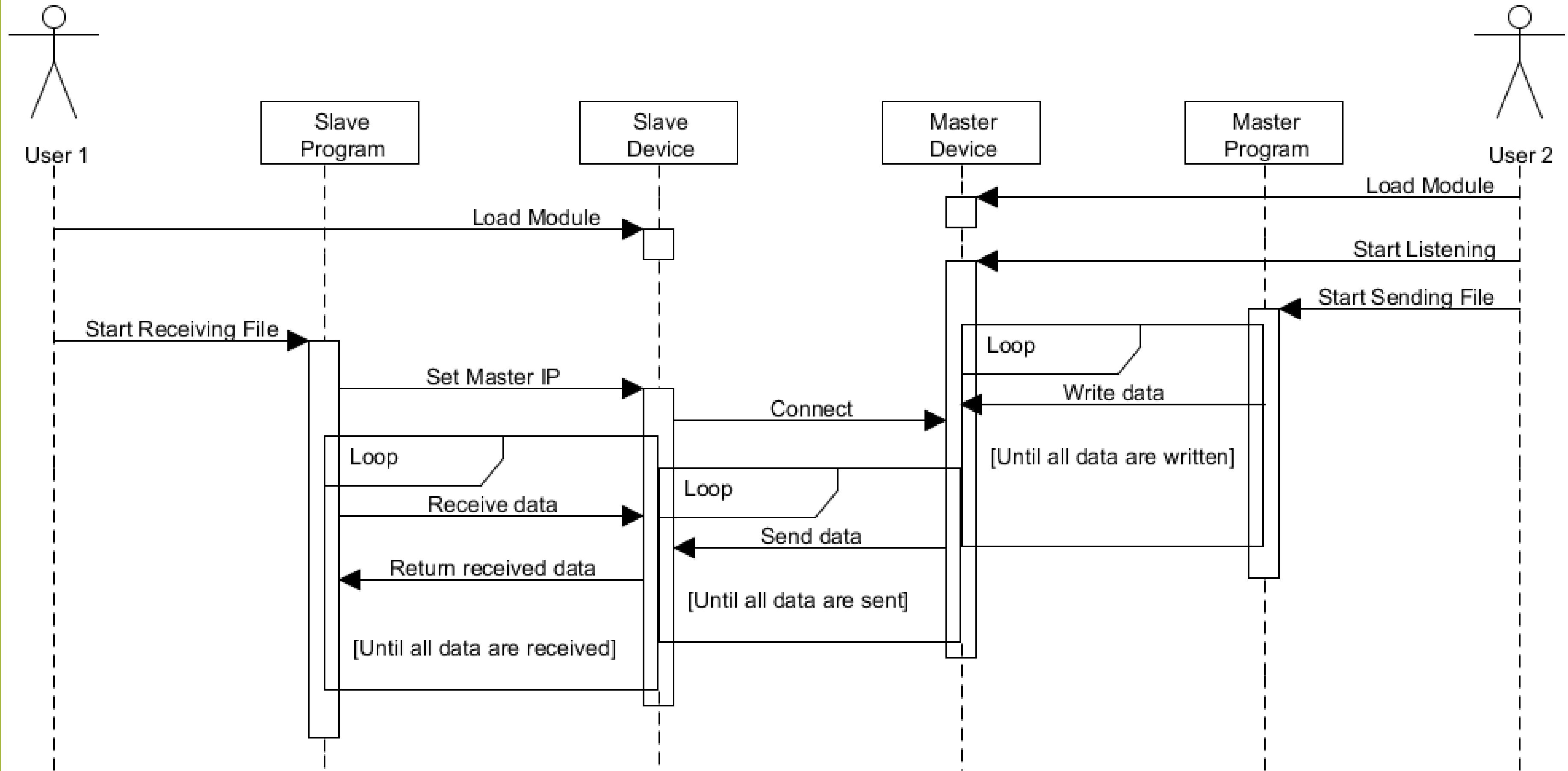
OS2014 PROJECT 2

Supplemental Information

Outline

- Sequence Diagram of Project 2
- Kernel Modules
- Kernel Sockets
- Work Queues
- Synchronization

Sequence Diagram (1/2)



Sequence Diagram (2/2)

- The diagram illustrates one possible situation.
  - The actual sequence might differ from the diagram due to different manipulation.
- Only the following orders are guaranteed.
  - The slave program will be executed only after both device modules have been loaded.
  - The master program will be executed only after the master device module has been loaded.
  - In the slave program, it first set the IP address and then begin reading data from the slave device with blocking I/O.
- Your design should not depend on any particular orders not defined here.

A Mini Example

- In the following slides, we will go through the necessary kernel APIs for this project with a mini example.
- In this example, it create a TCP server and read one line of texts from the client.
  - The data is also cached for reading from user space.
  - Please note that there are some possible race conditions in design.
- All details can be found in the attached example.
  - http://rswiki.csie.org/dokuwiki/_media/courses:102_2:miniex.tar.bz2

Kernel Modules (1/2)

- A character device (cdev) is a device supporting data manipulation in bytes.
- To create a character device, we need to do the following initialization.
  - Requesting a range of device numbers by **alloc_chrdev_region**
  - Initializing a cdev object and specifying the file operations of this device by **cdev_init**
  - Adding the device to the kernel by **cdev_add**
- The device file can be created as follows.
  - Adding a new device class by **class_create**
  - Creating a device file with the specified device number and file name by **device_create**

Kernel Modules (2/2)

- The file operations, such as open, read, write, etc., of the character device is specified by the structure **file_operations**.
  - For example, the function pointer **release** in the structure should point to the function which will be called when the system call close is invoked over the device file in user space.

Kernel Sockets (1/2)

- Kernel sockets have the similar interface as the BSD-style sockets.
- Since it will be blocked when waiting incoming connections, we should put it in a separated thread through work queues.
- In this example, the entry function of the work is **miniex_work_handler**.
  - The incoming connections will be handled in the infinite loop.

Kernel Sockets (2/2)

- You can use **miniex_recv/miniex_send** to receive and send data with a socket.
  - The data buffer must be in kernel space, which means you need to copy the data from/to user space by **copy_from_user/copy_to_user**.

Work Queues

- In the Linux kernel, a work queue is used for deferred works.
  - Each work will be executed asynchronously in a kernel thread.
- A work queue can be created by the function **create_workqueue**.
  - It takes an input parameter specifying the name of this work queue, which can be an arbitrary text string.
- A work can be defined by the macro **DECLARE_WORK**.
- A work can be put in the work queue by the function **queue_work**.
  - It takes two input parameters specifying the work queue and the defined work.

Synchronization

- In the Linux kernel, a wait queue implements a conditional variable.
- A work queue can be defined by the macro **DECLARE_WAIT_QUEUE_HEAD**.
- To wait on a conditional variable, use the function **wait_event_interruptible**.
  - The execution will be blocked until the specified condition evaluates to a true value or some signals occur.
- To wake the tasks wait on a conditional variable, use the function **wake_up_interruptible**.