

nexTTeam mpx Module 3

Programmer's Manual

Team Members

Teddy Hale

Jessica Hammersla

Mya Junkin

Philip Wenger

Table of Contents

1. Module 1	
a. commandhandler.h	
i. version	5
ii. help	5
iii. shutdown	5
iv. setTimeWrapper	6
v. setDateWrapper	6
vi. comhand	6
b. date.h	
i. getDate	7
ii. setDate	7
c. polling.h	
i. poll	7
d. time.h	
i. getTime	8
ii. bcdToInt	8
iii. setTime	8
iv. intToBcd	8
2. Module 2	
a. commandhandler.h	
i. createPCBWrapper	9
ii. deletePCBWrapper	9
iii. setPriorityWrapper	10
iv. showPCBWrapper	10
v. blockWrapper	10
vi. unblockWrapper	10
vii. historyWrapper	11
viii. suspendWrapper	11
ix. resumeWrapper	11
b. pcb.h	
i. insertPCB	12
ii. allocatePCB	12
iii. setupPCB	12
iv. removePCB	12
v. setPriority	13
vi. findPCB	13
vii. showPCB	13
viii. showReady	13
ix. showBlocked	14

x.	showAllProcesses	14
xi.	printtOnePCB	14
xii.	block	14
xiii.	unblock	14
xiv.	freePCB	15
xv.	suspend	15
xvi.	resume	15
3.	Module 3	
a.	irq.s	
i.	sys_call_isr	16
b.	context.h	
i.	sys_call	16
c.	r3commands.h	
i.	yield	16
ii.	loadr3	16

Module 1

commandhandler.h

Purpose: Display current version for the MPX project.

Parameters: No parameters.

Preconditions: The user successfully enters the command for version.

Postconditions: The method displays the current version for the project.

Exceptions: No exceptions.

Explanation of Code: The method prints and displays the current version of the program.
void version();

Purpose: Display the name and a detailed description of all possible commands the user can execute.

Parameters: No parameters.

Preconditions: The user successfully enters the command for help.

Postconditions: The name and description for each function that a user can call is displayed.

Exceptions: No exceptions.

Explanation of Code: The method writes the name and a detailed description for every method that the user can call.
void help();

Purpose: Shutdown the MPX and terminate. When shutdown is entered, the user has the option to confirm if the user would like to shutdown.

Parameters: The user will be given a chance to confirm the shutdown. If the user says yes, the program will shutdown. If the user says no, the program will not shutdown and will return for the user to continue entering commands. If the user does not enter yes or no, the program will say that it is not a valid option.

Preconditions: The user will need to successfully enter the command to shutdown.

Postconditions: The program will return to the command handler if the shutdown is not confirmed. It will end program execution if it is confirmed to shutdown.

Exceptions: The program will return to command handler if something other than yes or no is entered in the command handler.

Explanation of Code: The function prints the question asking if the user would like to shutdown. The system then reads in the user input. If the user enters yes, the program will shutdown and return a value of 1. If the user enters not or any other response, the program will not shutdown and return a value of 0.

int shutdown();

Purpose: The method will gather the information needed to be able to set the time in the setTime method.

Parameters: The method asks for the time written as hh:mm:ss that will be sent to setTime.

Preconditions: The user will need to successfully enter the command setTime to start collecting

information needed for setTime.

Postconditions: The collected information in the wrapper will be sent to the setTime method.

Exceptions: If the information entered into the wrapper method is not formatted as hh:mm:ss, then the method will terminate.

Explanation of Code: The prompt to enter the time as hh:mm:ss is displayed. The method then reads in the time entered by the user, first hour, then minute, then second. These variables are then sent to the function setTime to physically set the time.

void setTimeWrapper();

Purpose: The method will gather the information needed to be able to set the time in the setDate method.

Parameters: The method asks for the time written as mm/dd/yy that will be sent to setDate.

Preconditions: The user will need to successfully enter the command setDate to start collecting information needed for setDate.

Postconditions: The collected information in the wrapper will be sent to the setDate method.

Exceptions: If the information entered into the wrapper method is not formatted as mm/dd/yy, then the method will terminate.

Explanation of Code: The prompt to enter the time as mm/dd/yy is displayed. The method then reads in the time entered by the user, first month, then day, then year. These variables are then sent to the function setDate to physically set the date.

void setDateWrapper();

Purpose: The command reads in methods entered by the user and transfers control to the necessary method.

Parameters: There is a buffer that reads in the input from the user for what method to send the information to.

Preconditions: The MPX project must be successfully started.

Postconditions: The command handler transfers control to the method needed by the user.

Exceptions: If none of the possible commands are entered by the user, an error message is displayed.

Explanation of Code: A pointer to each method that a user can call is created. The welcome menu is displayed, asking for the user to enter an available command. The available commands are then displayed. The method then reads in the command entered by the user. The entered command is then entered into history. If the user enters shutdown, the command handler will handle if the user confirms that they want to quit. If a different valid command is entered, the pointer to the correct method is called. If the user enters a not valid command, a message saying there is no matching command is displayed.

int comhand();

date.h

Purpose: The method will retrieve the system date.

Parameters: The method works with the month, day, and year registers to get the date.

Preconditions: getdate needs to be entered by the user.

Postconditions: The method will display the system date.

Exceptions: No exceptions.

Explanation of Code: The month is retrieved from register 78, the day from register 77, and the year from register 79. The values from the registers are converted from BCD to integers, and then from integers to ASCII. The date is then displayed to the user.

void getdate();

Purpose: The method sets a new value for the month, day, and year.

Parameters: The month, day and year values entered by the user are sent to setDate.

Preconditions: The information entered into setDateWrapper needs to be entered in the correct format to send the information to setDate.

Postconditions: The new date is set and a success message is displayed to the user.

Exceptions: If any of the month, day, or year values are not valid, the method will display an error message and not set the date.

Explanation of Code: The method accepts the month, day, and year entered by the user in the setDateWrapper. If any of the values are not valid dates, an error will be displayed. If there are no errors, the three integers are converted to BCD. Once they are converted, the year is set to register 79, the month is set to register 78, and the day is set to register 77. If successfully set, a success message is displayed.

void setDate(int month, int day, int year);

polling.h

Purpose: The polling method collects the user input from the keyboard.

Parameters: A buffer reads in the input from the keyboard. A count of how many characters are in the buffer is kept track of.

Preconditions: The MPX program needs to be started.

Postconditions: The character entered will be processed by the method, and the character will be printed if necessary.

Exceptions: Some characters, such as enter, are only processed and are not displayed.

Explanation of Code: The buffer reads in the input from the user keyboard. If a character or number is entered, the character or number is displayed. If backspace is entered, the previous character is removed. If the delete is entered, the next character is removed. If enter is pressed, the line is accepted and a new line is started.

*int poll(char * buffer, int * count);*

time.h

Purpose: The method will retrieve the system time.

Parameters: The method works with the hour, minute and second registers to get the time.

Preconditions: gettime needs to be entered by the user.

Postconditions: The method will display the system time.

Exceptions: No exceptions.

Explanation of Code: The hour is retrieved from register 74, the minute from register 72, and the second from register 70. The values from the registers are converted from BCD to integers, and then from integers to ASCII. The time is then displayed to the user.

```
void gettime();
```

Purpose: The method converts a BCD to an integer.

Parameters: The method takes in an unsigned char that will be turned into an integer.

Preconditions: An unsigned char is sent to the method.

Postconditions: The unsigned char is converted to an integer and the integer is returned.

Exceptions: No exceptions.

Explanation of Code: The tens digits of the unsigned char value is and-ed with 0xF0, and then is multiplied by ten. The ones digit is then and-ed with 0x0F and is added to the previously found tens digit. The integer is then returned.

```
int bcdToInt(unsigned char value);
```

Purpose: The method sets a new value for the hour, minute, and second.

Parameters: The hour, minute, and second values entered by the user are sent to setTime.

Preconditions: The information entered into setTimeWrapper needs to be entered in the correct format to send the information to setTime.

Postconditions: The new time is set and a success message is displayed to the user.

Exceptions: If any of the hour, minute, or second values are not valid, the method will display an error message and not set the time.

Explanation of Code: The method accepts the hour, minute, and second entered by the user in the setTimeWrapper. If any of the values are not valid dates, an error will be displayed. If there are no errors, the three integers are converted to BCD. Once they are converted, the hour is set to register 74, the minute is set to register 72, and the second is set to register 70. If successfully set, a success message is displayed.

```
void setTime(int hours, int minutes, int seconds);
```

Purpose: The method converts an integer to a BCD.

Parameters: An integer is accepted by the method.

Preconditions: An integer must be the type of variable sent to the method.

Postconditions: An unsigned char that is a BCD is returned.

Exceptions: No exceptions.

Explanation of Code: The ones digits for the integer is done using mod 10. The integer is then divided by ten. The tens digit is found from the now divided integer using mod 10. The unsigned char is created by shifting the tens digit by four and adding the ones digit. The unsigned char is returned

```
unsigned char intToBcd(int data);
```


Module 2

commandhandler.h

Purpose: The create PCB wrapper collects the information necessary to setup and insert the PCB into the correct queue.

Parameters: The method asks for the name, priority, and class of the PCB to be set up.

Preconditions: The user will need to successfully enter the command to createPCB.

Postconditions: The PCB will be setup and inserted into the correct queue and a message saying it has been successful will be displayed.

Exceptions: If an invalid name, priority, or class is entered, an error message will be displayed and the PCB will not be created.

Explanation of Code: The method asks for a PCB name, and if the name is valid and not previously used, the PCB name will be set. The method then asks for the priority, and if the priority is valid, the PCB priority will be set. The method finally asks for the class, and if the class is valid, the PCB class will be set. The method will then be set up with the values set earlier, and the new PCB will then be inserted into the proper queue. If successful, a success message is displayed. If at any point the method fails, an error message is displayed and the method ends.

void createPCBWrapper();

Purpose: The method will remove a PCB based on the name entered by the user.

Parameters: The method reads in the name entered by the user.

Preconditions: The user will need to enter the command deletePCB.

Postconditions: The PCB entered by the user will be removed from its queue and its memory will be freed.

Exceptions: If there is no PCB with the name entered by the user, then an error message saying that PCB does not exist will be displayed.

Explanation of Code: The method asks for the name of the PCB it wants to delete. If the PCB with that name does not exist, an error message is displayed. If it does exist, then the PCB will be removed. The memory for the found PCB will then be freed. A success message saying the PCB has been successfully deleted is displayed.

void deletePCBWrapper();

Purpose: The method will change the priority for a PCB entered by the user.

Parameters: The method reads in the PCB name and the priority for the new PCB from the user.

Preconditions: The user needs to enter the command setPriority.

Postconditions: The method will send the priority off to setPriority to set the new priority.

Exceptions: If the PCB entered by the user does not exist, an error message is displayed saying there is no PCB with that name. If the new priority number is not valid, an error message is displayed.

Explanation of Code: The method asks for the name of the PCB that the user wants to change the priority of. If the PCB does not exist, an error message is displayed and the method ends. If

the PCB exists, then the method asks for the new priority of the PCB. If the priority entered is not valid, an error is displayed and the method ends. If the priority is valid, the PCB and the new priority are sent to setPriority.

void setPriorityWrapper();

Purpose: The method will collect the info to display one PCB's info.

Parameters: The method reads in the PCB name from the user,

Preconditions: The user must enter the command showPCB.

Postconditions: The PCB name will be sent off to showPCB.

Exceptions: If the name is too long, an error message will be displayed.

Explanation of Code: The method asks for the name of the PCB to be displayed. If the name is valid, the PCB is sent off to showPCB. If the name is not valid, an error message will be displayed.

void showPCBWrapper();

Purpose: The method will collect the info to block a PCB.

Parameters: The method reads in the PCB name from the user,

Preconditions: The user must enter the command block.

Postconditions: The PCB name will be sent off to block.

Exceptions: If the name is too long, an error message will be displayed. If the PCB cannot be found, an error message will be displayed saying the PCB does not exist.

Explanation of Code: The method asks for the name of the PCB to be blocked. If the name is valid and the PCB is found, the PCB is sent off to block. If the name is not valid, an error message will be displayed. If the PCB is not found, an error message will be displayed.

void blockWrapper();

Purpose: The method will collect the info to unblock a PCB.

Parameters: The method reads in the PCB name from the user,

Preconditions: The user must enter the command unblock.

Postconditions: The PCB name will be sent off to unblock.

Exceptions: If the name is too long, an error message will be displayed. If the PCB cannot be found, an error message will be displayed saying the PCB does not exist.

Explanation of Code: The method asks for the name of the PCB to be unblocked. If the name is valid and the PCB is found, the PCB is sent off to unblock. If the name is not valid, an error message will be displayed. If the PCB is not found, an error message will be displayed.

void unblockWrapper();

Purpose: The method prints the history of commands entered by the user.

Parameters: The method uses the thisHistory array to see previously entered commands.

Preconditions: The user needs to enter the command history.

Postconditions: The previous ten entered user commands are displayed.

Exceptions: No exceptions.

Explanation of Code: The method cycles through the last ten commands entered. The method

entered at the current index is printed. The index is incremented, and the next method in the history array is displayed. This continues for ten times, as long as the value at the index is not null. If the index is at 10, and ten commands have not been printed yet, the index is set back to zero.

void historyWrapper();

Purpose: The method will collect the info to suspend a PCB.

Parameters: The method reads in the PCB name from the user,

Preconditions: The user must enter the command suspend.

Postconditions: The PCB name will be sent off to suspend.

Exceptions: If the name is too long, an error message will be displayed. If the PCB cannot be found, an error message will be displayed saying the PCB does not exist.

Explanation of Code: The method asks for the name of the PCB to be suspended. If the name is valid and the PCB is found, the PCB is sent off to suspend. If the name is not valid, an error message will be displayed. If the PCB is not found, an error message will be displayed.

void suspendWrapper();

Purpose: The method will collect the info to resume a PCB.

Parameters: The method reads in the PCB name from the user,

Preconditions: The user must enter the command resume.

Postconditions: The PCB name will be sent off to resume.

Exceptions: If the name is too long, an error message will be displayed. If the PCB cannot be found, an error message will be displayed saying the PCB does not exist.

Explanation of Code: The method asks for the name of the PCB to be resumed. If the name is valid and the PCB is found, the PCB is sent off to resume. If the name is not valid, an error message will be displayed. If the PCB is not found, an error message will be displayed.

void resumeWrapper();

pcb.h

Purpose: The method will insert the PCB into the correct queue.

Parameters: The method accepts a PCB.

Preconditions: The PCB needs to have a state and have whether it is suspended or not.

Postconditions: The PCB will be inserted into the correct queue.

Exceptions: No exceptions.

Explanation of Code: A PCB can be inserted into one of four queue based off the state and if it is suspended. If it is in the ready state, regardless if it is suspended or not, the method the PCB gets inserted is the same. If the queue is empty, the PCB is set to the head and the tail, and the next and previous are set to null, and increase the count.. If the queue is not empty, if the priority of the PCB is less than the head's priority, set the head's previous to the PCB, the PCB's next to the head, the PCB to the head, and increase the count. If the PCB's priority is less than the current PCB's priority, set the PCB's the current previous's next to PCB, the current's previous to PCB, the PCB's next to current, and the previous to the current's previous. Set the

current to current's next, and continue checking until at the tail. If you get all the way to the tail, set the PCB's previous as the tail, the tail's next as the PCB, the PCB's next as null, set the PCB to the tail, and increment the count. If the PCB is blocked, regardless if it is suspended or not, set the tail's next to PCB, the PCB's previous to the tail, the PCB's next to null, and set the tail to the PCB.

```
void insertPCB(pcb* Pcb);
```

Purpose: The method will allocate memory for the PCB.

Parameters: The method uses the size of the struct PCB.

Preconditions: The user must select to create a PCB and enter the information correctly.

Postconditions: The method return's an allocated memory block for a PCB.

Exceptions: No exceptions.

Explanation of Code: The method uses `sys_alloc_mem` to allocate memory for a PCB using the size of the struct for a PCB.

```
pcb* allocatePCB();
```

Purpose: This method sets up a PCB and sets the attribute values.

Parameters: The method takes in the PCB name, the class code, and the priority code.

Preconditions: The user must select to create a PCB and enter the information correctly.

Postconditions: The method returns a setup PCB.

Exceptions: No exceptions.

Explanation of Code: The method calls to allocate memory for the PCB. The PCB's name, priority, state, suspended, and class code are set. The newly setup PCB is returned.

```
pcb* setupPCB(char *name, int classCode, int priorityCode);
```

Purpose: This method removes a PCB from a queue.

Parameters: The method accepts a PCB.

Preconditions: The user must enter to delete a PCB and enter valid values into delete PCB.

Postconditions: The method will remove the PCB. The method returns -1 if there was an error and 0 if the remove was successful.

Exceptions: No exceptions.

Explanation of Code: The method looks at the state and the suspended state of the PCB to see what queue it is in. If the PCB is the head of any of the queues, the head is set to the head's next. If the PCB is the tail, the tail is set to the tail's previous. If the PCB is in the middle of the list, set the PCB's previous next to the PCB's next and the PCB's next previous to the PCB's previous to remove the PCB from the queue. Return 0 if the PCB was removed and -1 if a PCB was not successfully removed.

```
int removePCB(pcb* process);
```

Purpose: The method changes the priority for a PCB.

Parameters: The method accepts the PCB and the priority number to change the PCB to.

Preconditions: The user must have successfully entered the information in the wrapper for it to be sent to `setPriority`.

Postconditions: The PCB with the new priority is reinserted into the correct queue.

Exceptions: No exceptions.

Explanation of Code: The method changes the priority number for the PCB. It removes the PCB from the current queue and reinserts it into its correct place based off the new priority number. A success message is printed to the user.

```
void setPriority(char *name, int priorityNum);
```

Purpose: The method will find a PCB based off the PCB name.

Parameters: The method accepts a name to search for.

Preconditions: The name for the PCB must be less than eight characters.

Postconditions: The method will return a PCB if found. If the PCB is not found, then the method will return null.

Exceptions: No exceptions.

Explanation of Code: The method loops through each entry in the four queues. If the name accepted by the method matches the name of a PCB in the queue, the PCB is returned. If no PCB with the name is found, null is returned.

```
pcb* findPCB(char *PcbName);
```

Purpose: The method will display a PCB with the name accepted by the process.

Parameters: The method accepts a character array with the name for the PCB.

Preconditions: The name must be no more than eight characters.

Postconditions: The method prints the PCB.

Exceptions: If the PCB is not found, then an error message saying there is no PCB with that name is printed.

Explanation of Code: The method calls findPCB for the name entered. If the PCB is found, the method calls printOnePCB to print the PCB. If the PCB is not found, an error message is printed.

```
void showPCB(char *name);
```

Purpose: The method shows all ready processes.

Parameters: No parameters.

Preconditions: The method showReady must be entered by the user.

Postconditions: All ready processes will be displayed.

Exceptions: No exceptions.

Explanation of Code: The method first prints the ready queue. Starting at the head, the method printOnePCB is called for the current PCB. The PCB moves to the next PCB. As long as current is not null, the loop will continue. The same process is then done for the suspend ready queue. In the end, all ready processes are displayed.

```
void showReady();
```

Purpose: The method shows all blocked processes.

Parameters: No parameters.

Preconditions: The method showBlocked must be entered by the user.

Postconditions: All blocked processes will be displayed.

Exceptions: No exceptions.

Explanation of Code: The method first prints the blocked queue. Starting at the head, the method printOnePCB is called for the current PCB. The PCB moves to the next PCB. As long as current is not null, the loop will continue. The same process is then done for the suspended blocked queue. In the end, all ready processes are displayed.

void showBlocked();

Purpose: The method shows all processes.

Parameters: No parameters.

Preconditions: The user must enter the command showAllProcesses.

Postconditions: The method displays all processes.

Exceptions: No exceptions.

Explanation of Code: The method calls showReady to show all ready processes. The method then calls showBlocked to show all blocked processes.

void showAllProcesses();

Purpose: The method prints all the attributes for one PCB.

Parameters: The method accepts a PCB.

Preconditions: The PCB to be displayed must already be created.

Postconditions: The PCB and its attributes will be displayed.

Exceptions: No exceptions.

Explanation of Code: The method prints out all the attributes for a PCB. It displays the name, class, state, suspended state, and the priority for the PCB. Titles are in front of each attribute to make it clear what attribute is being displayed.

void printOnePCB(pcb Pcb);*

Purpose: The method will change the state of a PCB to block a PCB.

Parameters: The method accepts a PCB.

Preconditions: The user must enter the command block.

Postconditions: The PCB will be set to the state block.

Exceptions: No exceptions.

Explanation of Code: The method removes the PCB. The state is set to blocked. The newly unblocked PCB is then inserted using insertPCB. A success message is then displayed.

void block(pcb PCB);*

Purpose: The method will change the state of a PCB to ready.

Parameters: The method accepts a PCB.

Preconditions: The user must enter the command unblock.

Postconditions: The PCB will be set to the state ready.

Exceptions: No exceptions.

Explanation of Code: The method removes the PCB. The state is set to ready. The newly blocked PCB is then inserted using insertPCB. A success message is then displayed.

void unblock(pcb PCB);*

Purpose: The method frees all memory associated with a PCB.

Parameters: The method accepts a PCB.

Preconditions: The user must enter to delete a PCB.

Postconditions: All memory for the PCB will be freed. The integer 0 is returned.

Exceptions: No exceptions.

Explanation of Code: The method frees all PCB attributes using `sys_free_mem`: name, priority, state, suspended state, class, next PCB, previous PCB, stack top, and stack base. The PCB is then freed using `sys_free_mem`.

int freePCB(pcb PCB);*

Purpose: The method will change the suspended state of a PCB to suspend.

Parameters: The method accepts a PCB.

Preconditions: The user must enter the command suspend.

Postconditions: The PCB will be set to the suspended state suspend.

Exceptions: No exceptions.

Explanation of Code: The method removes the PCB. The state is the set to suspend. The newly suspended PCB is then inserted using `insertPCB`. A success message is then displayed.

void suspend(pcb PCB);*

Purpose: The method will change the suspended state of a PCB to not suspended.

Parameters: The method accepts a PCB.

Preconditions: The user must enter the command resume.

Postconditions: The PCB will be set to the suspended state not suspended.

Exceptions: No exceptions.

Explanation of Code: The method removes the PCB. The state is the set to not suspended. The newly not suspended PCB is then inserted using `insertPCB`. A success message is then displayed.

void resume(pcb PCB);*

Module 3

irq.s

Purpose: The method will complete the interrupt service routine when an interrupt is called.

Parameters: No parameters.

Preconditions: An interrupt must be alerted.

Postconditions: The interrupt will be handled and will return from the interrupt.

Exceptions: No exceptions.

Explanation of Code: The method pushes general purpose registers to the stack, and then pushes segment registers. The register that points to the top of the stack is pushed. `Sys_call` is

then called, and the value returned from the call is used to set the stack pointed. The segment register and general purpose registers are pop, and then the method returns from the interrupt.

sys_call_isr

context.h

Purpose: The method will handle when the op code is idle and when it should exit

Parameters: The method takes in the current registers.

Preconditions: sys_call is called from sys_call_isr

Postconditions: The current operating process's stack top is returned.

Exceptions: If the current PCB is null, then the current is returned.

Explanation of Code: The method takes in the current register values. If the cop is null, then the current context is set to the registers. Else, if the op code is exit, then the PCB is removed and freed. If the op code is idle, then the cop is reinserted into the proper queue. If the current PCB is not null, meaning the ready queue has something in it, then the PCB is removed and the top of the cop is returned. Else, the current context is returned.

u32int sys_call(context *registers);*

r3commands.h

Purpose: The method cause the command handler to yield to other processes.

Parameters: No parameters.

Preconditions: A process must be in the ready queue.

Postconditions: The command handler will yield to another process.

Exceptions: No exceptions.

Explanation of Code: The one line of code causes the command handler to yield to other processes if any are in the ready queue.

void yield();

Purpose: The method will load in the five processes from procsr3.c

Parameters: No parameters.

Preconditions: The user must enter loadr3.

Postconditions: The three processes will be loaded and processed.

Exceptions: No exceptions.

Explanation of Code: For the five different processes, the method sets up the PCB. The context for the process is then set to the top of the PCB's stack. The context's registers are set to the needed values.

void loadr3();