Chapter 1.4: System Programing

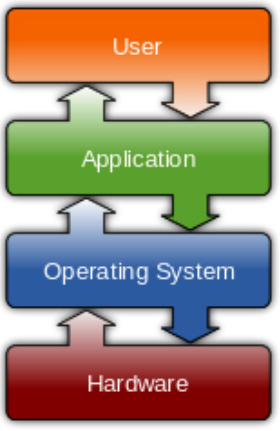
GV: Nguyễn Thị Thanh Vân

Outline

- Introduction
- System Programs
- System Programming

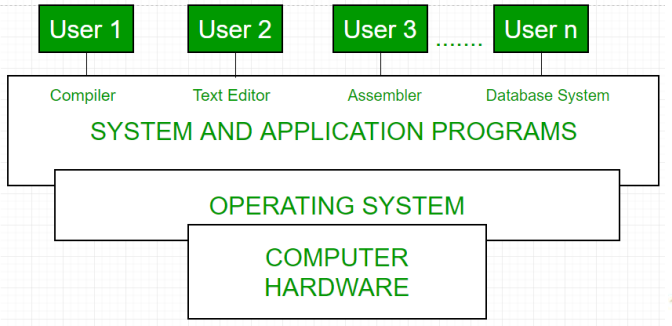
Introduction

- Operation System



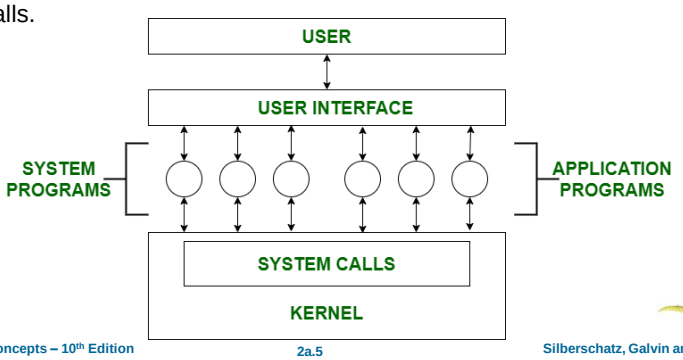
Introduction

- **System Programming** can be defined as the act of building Systems Software using System Programming Languages.
- According to Computer Hierarchy:
  - one which comes at last is Hardware
  - then it is Operating System, System Programs,
  - and finally Application Programs.



System Programs

- System Programs - component of the OS, lies between the user interface (UI) and system calls.
  - Help Program Development and Execution can be done conveniently
  - Some of the System Programs are simply user interfaces, others are complex.
  - It traditionally lies between the user interface and system calls.
  - the user can only view up-to-the System Programs he can't see System Calls.



System Program types

- **File Management –** defined as the process of manipulating files in the computer system, its management includes the process of creating, modifying and deleting files
- **Status Information –**
  Information like date, time amount of available memory, or disk space is asked by some users.
- **File Modification –**
  For Files stored on disks or other storage devices, we used different types of editors. For searching contents of files or perform transformations of files we use special commands.
- **Programming-Language support –**
  Compilers, Assemblers, Debuggers, and interpreters are already provided to users. It provides all support to users.
- **Program Loading and Execution –**
  after Assembling and compilation, program must be loaded into memory for execution. Loaders, relocatable loaders, linkage editors, and Overlay loaders are provided by the system.
- **Communications –**
  Virtual connections among processes, users, and computer systems are provided by programs. Users can send messages to another user on their screen, User can use email, web, remote login, the transformation of files from one user to another.

System Programming

- Unix
- Windows
- C++

Linux: Command and program

1. Concept
2. Basic commands working with folder
3. System Programming Languages: Assembly, C, Python

9

Command

- Command: - a executable binary or
  - a text file (written in the syntax of the shell.)
- Two command types:
  - Outside command: is a executable file that can be found out its location in the system. Shell created a child process to handle it.
  - Inside command (shell built-in): does not exist as a single file. It is available in the shell and ready to execute (as a keyword), no need to create a child process to handle it.
- **type**: type xxx
  - Outside command: return result: `xxx is /bin/mkdir`
  - Inside command: return result `xxx is a shell builtin`
- Syntax: **command [option] argument**

10

Path

- echo $PATH: the paths that are set before

```
# echo $PATH
/usr/kerberos/sbin:/usr/kerberos/bin...
```

- Absolute path: independence with the current directory of the user and start with /
- The relative path: depends on the current directory of the user and does not start with /

11

Time to execute the command

time: allow us know time to execute 1 command or 1 program in second

```
$ time find / -name tệp -print > result
55.6 real 1.5 user 18.3 sys
```

- real: total real time from press <ENTER> to Shell prompt come back
- user: major time to execute the command
- Sys: time that UNIX kernel use administrate that command

real >= user + sys

12

Basic commands working with folder

1. cd (change directory)
2. pwd (print working directory)
3. ls (list)
4. mkdir (make directory)
5. rmdir (remove directory)
6. basename và dirname

13

Basic commands working with normal files

1. Create file: touch, cat
2. Copy, rename: cp
3. Move, rename: mv
4. list: ls
5. Remove: rm
6. Find file: find
7. Link: ln
8. Compare: cmp (compare), comm, diff , diff3
9. Edit: cat, head, tail, pg, more
10. Display with text/binary: od [tùy chọn]
11. Count: wc
12. size: sum
13. Compress and decompress: pack và gzip
14. Divide: Split
15. cut
16. sort
17. awk

14

Data Flow Management

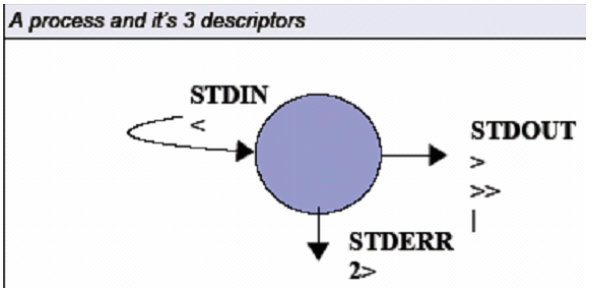
1. UNIX standard I/O
2. Redirecting data streams
3. Connecting pipes
4. Filter

15

UNIX standard I/O

3 standard I/O at terminal (/dev/tty):

Chanel	Num	Name	Devices
Standard Input	0	**stdin**	Keyboard /dev/tty
Standard Output	1	**stdout**	Monitor /dev/tty
Standard Error	2	**stderr**	Monitor /dev/tty



16

Redirecting data flows

- ❖ Redirecting to new file
- Use ">"
- Ex : ls > file1
- ❖ Redirecting to old file
- Use " >>"
- Ex: cat file_2 >> file_1
- ❖ Redirecting from a file
- Use "< "
- Ex: tee < file1

17

pipe

- A shell technique used to concatenate the data streams of several processes
- We can communicate with each other using pipes, for example :

command_1 | command_2 | command_3

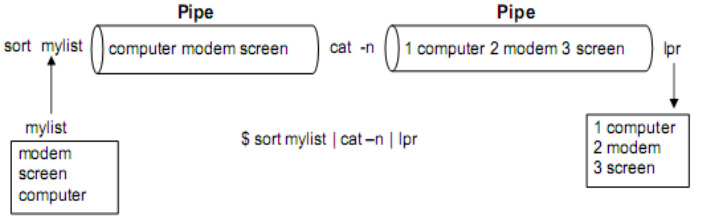
Where:

command_1 need has output,
command_2 is filter
command_3 need has input.

PIPE: each pipe connects two data streams of two adjacent instructions through an intermediate pipe, represented by the BUFER.

Operation: command_i ==> BUFER ==> command_j

Ex:



18

Filtering

1. tr (replace)

tr string_1 string_2

2. fgrep
3. grep
4. egrep

grep [option] PATTERN FILE

“string" PATTERN is regular expression

19

Regular expression

- ^c: rows begin with “c” (char, string)
  grep ‘^Begin’. .
- c$: rows end with “c”
  grep ‘End$’
- \<c: rows contain words begin with “c” (char, string)
  grep ‘\<Be’
- c\>: rows contain words end with “c” (char, string)

20

Wildcards

- .: any ASCII character, except <RETURN>:

grep ‘ .*’ file => all rows in “file", including blank lines.

- [ ]: an ASCII character in square brackets, but needs to be enclosed between quotes like: [^xyzt]
- -: two ASCII characters inside square brackets, for example [b-y], represents a character in the range, but also needs to be enclosed in quotes like '[b-y]'.
- \: remove the special meaning of the character following it and return the original meaning.
- ^: exception

Ex: an expression like [^xyzt] represents a character other than x, y, z, t

Shell programming

- Variable: $0, $1, $2…; $#, $*, $@
  - Input to variable: var=value
  - Get value: $var
  - Output variable: echo $var
- Check condition:

```
    [ <condition> ]
Or test <condition>
Number: -lt, -gt, -eq
```

- Run script:

```
chmod +x <filename>
./<filename>
```

- Function:

```
try_func() {
     echo <gtri> #return stdout
     return <gtri>
     }
# Call function
x=$(try_func)
```

- Structures:…

Structures

```
if condition
then
     statements
else
     statements
fi
```

```
if condition1
then
     statements
elif condition2; then
     statements
else
     statements
fi
```

```
for variable in values
do
     statements
done
```

```
while codition
do
      statements
done
```

```
until codition
do
   statements
done
```

```
case mau in
     mau1)
        statements;;
     mau2)
        statements;;
     *)
        statements ;;
esac
```

Ex, run script

```
$ for file in *
  > do
  > if grep -l 'Hello' $file
  > then
  > more $file
  > fi
  > done
```

NO

```
Cat > vidu1.sh
#! /bin/sh
for file in *
do
   if grep -l 'Hello' $file
   then
     more $file
   fi
done
exit 0
```

Ex

Define Max_2num(), then find Max of N intergers

```
max_2num()
{
if [ $1 -gt $2 ]
then
    m=$1
else
    m=$2
fi
echo $m
return $m
}
```

```
#Main
max=$1
for i in $*
do
  max=$(max_2num $max $i)
done
echo "Max $# so: $max"
exit 0
```

Array

- array=(zero one two three four)

echo ${array[0]} or echo ${array:0} # zero
echo ${array:1} # ero
echo ${array[2]:1:2] # wo
echo ${array[@]} # one two three four five
echo ${array[@]:1} # two three four five
echo ${array[@]:1:2} # two three
echo ${#array[0]} # 4 = length of “zero”
echo ${#array[@]} # 6 = number of elements in arr

```
echo "input n"
read n
for (( i=1; i <= $n; i++ ))
do
     echo -n "the $i"
     read a[i]
done
echo "array is: ${a[@]}"
Dc=0
Dl=0
T=0
```

```
for (( i=1; i <= $n; i++ ))
do
   if [ `expr ${a[i]} % 2` -eq 0 ]
   then
         Dc=`expr $Dc + 1`
   else
         Dl=`expr $Dl + 1`
   fi
   T=`expr $T + ${a[i]}`
done
echo "$Dc odd. $Dl evev. Sum is $T"
exit 0
```

String

stringZ=abcABC123ABCabc

- ${#string} hoặc expr: length of string

echo ${#stringZ} # 15

- expr index $string $substring: position of substring

echo `expr index "$stringZ" C12` # 6

- ${string:position:length}: get substring (from left of right)

echo ${stringZ:0} # abcABC123ABCabc
echo ${stringZ:7:3} # 23A
echo ${stringZ:(-4)} or echo ${stringZ: -4} # Cabc

- ${string#substring}: delete shortest substring
- ${string##substring}: delete longest substring

Lab No.4. Simple shell programs

- No.4.
  - number is even or odd
  - year is leap year or not
  - find the factorial of a number
  - swap the two integers
- Others:
  - Print the prime numbers in any sequence of numbers passed in from the command line (using a function check 1 number is prime or not)
  - Write a function to find the greatest common divisor of two numbers, then use the function you just wrote to find the UCLN of an array.
  - Input an array and sort the array ascending.
  - Check increment, decrement, symmetric arrays.
  - Input 1 array. Remove the odd elements in the array, Then print the remaining array

Linux file system calls

- **Basic file functions**: Linux has many system calls to handle file, the table below shows some of common system calls.

Functions	Description	Returns
open	Open a file	If success, return a file descriptor, otherwise, return -1
close	Close a file	Return 0 on success, otherwise, return -1
read	read data from a file	On success, return the number of bytes that been read, otherwise return -1
write	write data to a file	On success, the number of bytes written is returned, otherwise, return -1
lseek	seek to a specified position in file	Upon successful completion, return the resulting offset location as measured in bytes from the beginning of the file, otherwise, return -1

- C can call above functions
- Write C using the following system calls: close, open, read, write
  - simulation of the Linux cp command
    - buffer is used to transfer data from the source file to destination file.

Linux file system calls

- Directory
  - Note that **DIR** structure is an internal structure used by ***readdir, closedir*** to maintain information about the directory being read.
  - The **dirent** structure contains the inode number and the name. This information is collected into a file called dirent.h.

Function	Description	Returns
mkdir(const char * pathname, mode)	Create a dirctory	0 if OK, -1 on error
rmdir(const char * pathname)	Delete a directory	0 if OK, -1 on error
opendir(const char * pathname)	Open a directory	Pointer of DIR if OK, NULL on error
readdir(DIR * dp)	Read a directory	Pointer of dirent if OK, NULL at the end of directory or error
closedir(DIR * dp)	Close a directory	0 if OK, -1 on error

- Write C using the following system calls: close, opendir, readdir.
  - Ex: simulates command ls to list all the file in the current directory.

C - Functions in File Operations

- C File I/O: There are types and functions in the library stdio.h that are used for file I/O. Reading from or writing to a file in C requires 3 basic steps:
  - Open the file.
  - Do all the reading or writing.
  - Close the file
- For files you want to read or write, you need a file pointer: FILE *fp;
  - FILE is some kind of structure that contains all the information necessary to control the file
- Open File -- **fopen(const char filename, const char mode)**
  - will initialize an object of the type FILE
- Close File -- **fclose(FILE *fp**)
  - When done with a file, it must be closed

C - Functions in File Operations

- Text I/O Functions

Mode	Description
feof	detects end-of-file marker in a file
fscanf	reads formatted input from a file
fprintf	prints formatted output to a file
fgets	reads a string from a file
fputs	prints a string to a file
fgetc	reads a character from a file
fputc	prints a character to a file

- Ex: fgetc_cp.c use fputc(int char, FILE *stream) writes a character (an unsigned char) specified by the argument char to the specified stream and advances the position indicator for the stream.
  - Similarly, fgetc(FILE *stream) reads a character from the specified stread and advances the position indicator for the stream

C - Functions in File Operations

- Binary I/O Functions
  - When the files are binary, the previous functions will not work.
  - For reading from and writing to a file on the disk respectively in case of binary files, use:

fread(void *buffer, size, number, FILE *stream);

fwrite(void *buffer, size, number, FILE *stream);

    - "buffer“: a pointer to buffer used for reading/writing the data,
    - "void“: a pointer that can be used for any type variable.
    - "size“: size of the objects to be read/written (ex, sizeof(char))
    - "number" : number of objects to be read/written,
    - "stream“: the file pointer or stream which the data is to be read from/written to.
  - If success, fread/fwrite return the number of items read or written. This number equals the number of bytes transferred only when size is 1. If fail, a lesser number of bytes is returned.

Practice

- Ex No. 2,3 – file OS-LAB.pdf
  - Write C Programs using the following system calls of UNIX operating system close, opendir, readdir.
  - C programs to simulate UNIX commands like cp, ls, grep.

End of Chapter 1.4