

Report for Project 1

COMP 7500 Advanced Operating systems

By using Oracle VM VirtualBox, I installed CentOS7 to work on project 1 but after finishing the project I couldn't transfer the files from virtual machine to host machine. Upon referring Piazza, the instructor mentioned we could use CentOS9, so I completed my project using CentOS9.

All the commands below work in root only. By using script command to create a typescript, I created a typescript (update.script) to log to check if the packages are updated. Here is the result: -

```
Script started on 2023-01-20 12:38:41-06:00 [TERM="xterm-256color" TTY="/dev/pts/0" COLUMNS="80" LINES="24"]
[?]777;notify;command completed;[?]777;precmd;[?]0;centos@localhost:/home/centos@[?]7;file:///localhost/home/centos@[?]2004h[root@localhost centos]# yum -y update
[?]2004l
[?]777;prexec@CentOS Stream 9 - Ba [=== ] --- B/s | 0 B --:-- ETA
CentOS Stream 9 - Ba [=== ] --- B/s | 0 B --:-- ETA
CentOS Stream 9 - Ba [=== ] --- B/s | 0 B --:-- ETA
CentOS Stream 9 - Ba 12% [== ] 2.4 MB/s | 750 kB 00:02 ETA
CentOS Stream 9 - Ba 88% [=====] 3.2 MB/s | 5.4 MB 00:00 ETA
CentOS Stream 9 - BaseOS [=====] 3.8 MB/s | 6.0 MB 00:01
CentOS Stream 9 - Ap [=== ] --- B/s | 0 B --:-- ETA
CentOS Stream 9 - Ap 59% [=====] 8.6 kB/s | 2.6 kB 00:00 ETA
CentOS Stream 9 - Ap 3% [- ] 120 kB/s | 565 kB 02:10 ETA
CentOS Stream 9 - Ap 34% [=====] 1.1 MB/s | 5.4 MB 00:09 ETA
CentOS Stream 9 - Ap 69% [=====] 2.2 MB/s | 11 MB 00:02 ETA
CentOS Stream 9 - AppStream [=====] 10 MB/s | 16 MB 00:01
CentOS Stream 9 - Ex [=== ] --- B/s | 0 B --:-- ETA
CentOS Stream 9 - Ex100% [=====] 26 kB/s | 8.4 kB 00:00 ETA
CentOS Stream 9 - Ex 0% [ ] 26 kB/s | 0 B 00:00 ETA
CentOS Stream 9 - Extras packages 14 kB/s | 10 kB 00:00
Dependencies resolved.
Nothing to do.
Complete!
[?]777;notify;command completed;yum -y update@[?]777;precmd@[?]0;centos@localhost:/home/centos@[?]7;file:///localhost/home/centos@[?]2004h[root@localhost centos]# exit
[?]2004l
[?]777;prexec@exit

Script done on 2023-01-20 12:39:14-06:00 [COMMAND_EXIT_CODE="0"]
```

Using script, I created a typescript (packages.script) to log all the packages that we need to install for the project. The installed packages are:-

```
yum -y install gcc
yum -y install gcc-c++
yum -y install vim-enhanced
yum -y install emacs
yum -y install gdb
yum -y install ethtool
yum -y install pciutils
yum -y install file
```

Here's the snippet of the log: -

```

Script started on 2023-01-20 12:44:22-06:00 [TERM="xterm-256color" TTY="/dev/pts/0" COLUMNS="80" LINES="24"]
[?]777;notify;Command completed;exit[?]777;precmd[?]0;centos@localhost:/home/centos[?]7;file:///localhost/home/centos[?]720041[root@localhost centos]# yum -y install gcc
[?]20041
[?]777;preexec[?]Last metadata expiration check: 0:05:36 ago on Fri 20 Jan 2023 12:38:57 PM CST.
Dependencies resolved.
=====
Package                Architecture Version      Repository    Size
=====
Installing:
[?]1m[?]32mgcc          [?]([?]([?]m x86_64 11.3.1-4.3.el9 appstream    32 M
Installing dependencies:
[?]1m[?]32mglibc-devel  [?]([?]([?]m x86_64 2.34-54.el9  appstream    49 k
[?]1m[?]32mglibc-headers [?]([?]([?]m x86_64 2.34-54.el9  appstream    550 k
[?]1m[?]32mkernel-headers [?]([?]([?]m x86_64 5.14.0-234.el9 appstream    4.6 M
[?]1m[?]32mlibxcrypt-devel [?]([?]([?]m x86_64 4.4.18-3.el9 appstream     29 k
[?]1m[?]32mmake          [?]([?]([?]m x86_64 1:4.3-7.el9  baseos       538 k
Transaction Summary
=====
Install 6 Packages

Total download size: 38 M
Installed size: 94 M
Downloading Packages:
=====
[?]=== [?]--- B/s [?]0 B [?]---:-- ETA
[?]=== [?]--- B/s [?]0 B [?]---:-- ETA
(1/6): make-4.3-7.el 0% [?]--- B/s [?]0 B [?]---:-- ETA
(1/6): glibc-devel-2.34-54.el9.x86_64.rpm 189 kB/s [?]49 kB 00:00
(2-3/6): gcc-11.3.1- 0% [?]551 kB/s [?]142 kB 01:10 ETA
(2/6): glibc-headers-2.34-54.el9.x86_64.rpm 1.8 MB/s [?]550 kB 00:00
(3-4/6): make-4.3-7. 11% [?]1.3 MB/s [?]4.2 MB 00:25 ETA
(3-5/6): gcc-11.3.1- 26% [?]2.4 MB/s [?]18 MB 00:11 ETA
(3/6): make-4.3-7.el9.x86_64.rpm 556 kB/s [?]538 kB 00:00
(4-5/6): gcc-11.3.1- 32% [?]2.8 MB/s [?]12 MB 00:09 ETA
(4/6): libxcrypt-devel-4.4.18-3.el9.x86_64.rpm 144 kB/s [?]29 kB 00:00
(5-6/6): gcc-11.3.1- 44% [?]3.6 MB/s [?]17 MB 00:05 ETA
(5-6/6): kernel-head 59% [?]4.6 MB/s [?]23 MB 00:03 ETA
(5-6/6): kernel-head 75% [?]5.5 MB/s [?]29 MB 00:01 ETA
(5-6/6): kernel-head 92% [?]6.4 MB/s [?]35 MB 00:00 ETA

```

Also scripted(system.script) information about CPU frequency, cache size, memory size, the list of PCI devices, hard drive, network MAC address and link speed, and the devices generating interrupts by using the commands: -

```

more /proc/cpuinfo
more /proc/meminfo
/sbin/lspci
/sbin/ethtool eth0
/sbin/ifconfig eth0
more /proc/interrupts

```

Here is the snap of the script: -

```

Script started on 2023-01-20 12:48:35-06:00 [TERM="xterm-256color" TTY="/dev/pts/0" COLUMNS="80" LINES="24"]
[?]777;notify;Command completed;exit[?]777;precmd[?]0;centos@localhost:/home/centos[?]7;file:///localhost/home/centos[?]720041[root@localhost centos]# more /proc/cpuinfo
[?]20041
[?]777;preexec[?]processor      : 0
vendor_id   : AuthenticAMD
cpu family  : 25
model       : 80
model name  : AMD Ryzen 5 5600H with Radeon Graphics
stepping    : 0
microcode   : 0xffffffff
cpu MHz     : 3293.726
cache size  : 512 KB
physical id : 0
siblings    : 3
core id     : 0
cpu cores   : 3
apicid      : 0
initial apicid : 0
fpu         : yes
fpu_exception : yes
cpuid level : 13
wp          : yes
flags       : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov
pat pse36 clflush mmx fxsr sse sse2 ht syscall nx mmxext fxsr_opt rdtscp lm
qnt_tsc rep_good nopl nonstop_tsc cpuid extd_apicid tsc_known_freq pni pclmulqdq
q_sse3 cx16 sse4_1 sse4_2 movbe popcnt aes rdrand hypervisor lahf_lm cmp_legacy
[?]7m-More- [?]27m
cr0 legacy_bsm sse4a misalignsse 3dnowprefetch vmcall fsgsbase bmi1 bmi2 invpc
id rdseed clflushopt arat
bugs        : fxsavleak sysret_ss_attrs null_seg spectre_v1 spectre_v2
bogomips    : 6587.45
TLB size    : 2560 4K pages
clflush size : 64
cache alignment : 64
address sizes : 48 bits physical, 48 bits virtual
power management:

processor    : 1
vendor_id    : AuthenticAMD

```

Using vim editor, created a c program (project1.c) which takes 10 numbers from the user and calculates the average of the square root of the array.

```
#include<stdio.h>
#include<math.h>
int main()
{
    /* Function to take ten numbers from user and sum the square roots of the numbers and find the average of the square roots */
    int array[10];
    int max=10;
    double sum=0;
    double avg;
    int i;
    printf("\n Enter the 10 numbers:\n");
    for ( i=0;i<max;i++)
    {
        scanf("%d", &array[i]);
    }
    for(i=0;i<max;i++)
    {
        sum+=sqrt(array[i]);
    }
    avg=sum/10.0;
    printf("\n The average of the sum of the square roots =%f\n ", avg);
    return 0;
}
```

Further used gcc from GNU collection to compile and execute the c program which is logged in exec.script. Used ldd project1 command to get familiar with the libraries used for program execution which is logged in lib.script

```
Script started on 2023-01-20 13:00:40-06:00 [TERM="xterm-256color" TTY="/dev/pts/0" COLUMNS="80" LINES="24"]
[~]777;notify;command completed;exit[~]777;precmd[~]0;centos@localhost:/home/centos[~]7;file:///localhost/home/centos[~][?]2004h[root@localhost centos]# ldd p r o j e c t 1
[?]2004l
[~]777;prexec[~] linux-vdso.so.1 (0x00007ffdb65fe000)
libm.so.6 => /lib64/libm.so.6 (0x00007f4f27680000)
libc.so.6 => /lib64/libc.so.6 (0x00007f4f27400000)
/lib64/ld-linux-x86-64.so.2 (0x00007f4f27767000)
[~]777;notify;command completed;ldd project1[~]777;precmd[~]0;centos@localhost:/home/centos[~]7;file:///localhost/home/centos[~][?]2004h[root@localhost centos]# exit
[?]2004l
[~]777;prexec[~]\exit
Script done on 2023-01-20 13:00:55-06:00 [COMMAND_EXIT_CODE="0"]
```

To familiarize with GNU gdb debugger, I created a. gdbinit file with the following content.

```
Set auto-load safe-path /
file simple
break main
break sqrt
info registers
```

GDB provides the 'set auto-load safe-path' setting to list directories trusted for loading files not explicitly requested by user. Each directory can also be a shell wildcard pattern. Without this command warnings would be generated by the debugger. Debugged the program and used run, step, next and continue. The debugging process is logged in a script (gdb.script). Here is a

snapshot of the script: -

```
For more information about this security protection see the
"Auto-loading safe path" section in the GDB manual.  E.g., run from the shell:
[m@?2004h--Type <RET> for more, q to quit, c to continue without paging--c
[m]?2004l
    info "(gdb)Auto-loading safe path"
[m]?2004h(gdb) file pro ject1
[m]?2004l
Reading symbols from [m]?32mproject1[m]...
[m]?2004h(gdb) start
[m]?2004l
Temporary breakpoint 1 at [m]?34m0x40115e[m]: file [m]?32mproject1.c[m], line 7.
Starting program: /home/centos/project1
[thread debugging using libthread_db enabled]
Using host libthread_db library "[m]?32m/lib64/libthread_db.so.1[m]".

Temporary breakpoint 1, [m]?33mmain[m] () at [m]?32mproject1.c[m]:7
7      [m]?32mint[m] max[m]?31m=[m]?m[m]?35m100[m]?m[m]?31m;[m]
[m]?2004hMissing separate debuginfos, use: dnf debuginfo-install glibc-2.34-54.el9.x86_64
[m]?2004l
[m]?2004h(gdb) next
[m]?2004l
8      [m]?32mdouble[m] sum[m]?31m=[m]?m[m]?35m0[m]?m[m]?31m;[m]
[m]?2004h[m]?2004l
[m]?2004h(gdb) step
[m]?2004l
11     [m]?01printf[m]?31m([m]?m[m]?31m"[m]?m[m]?35m\n[m]?m[m]?31m Enter the 10 numbers:[m]?m[m]?35m\n[m]?m[m]?31m"[m]?m[m]?31m);[m]
[m]?2004h[m]?2004l
[m]?2004h(gdb) continue
[m]?2004l
Continuing.

Enter the 10 numbers:
1
2
3
4
5
6
7
^
```