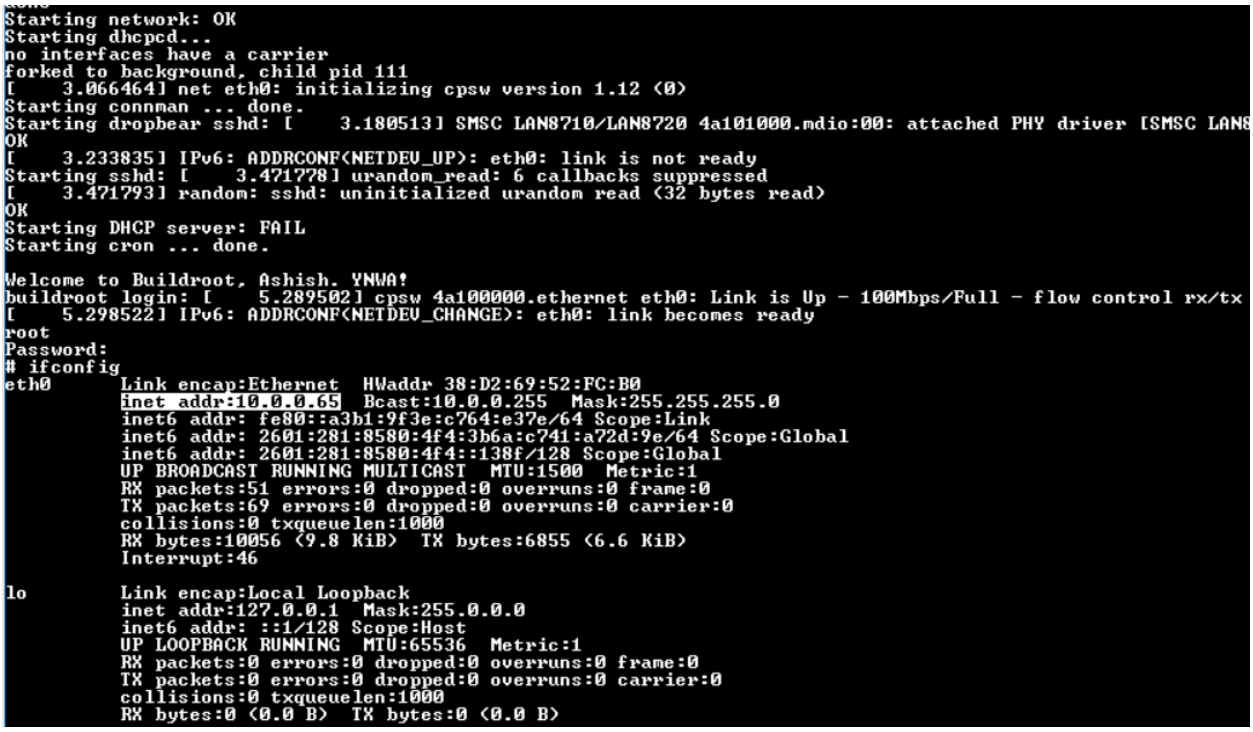
Advanced Embedded Software Development

Homework 3

-Ashish Tak

Question 1

Boot sequence log showing the BBG getting an ethernet address from the network:



SCP copy of a file from host to the BBG to the /usr/bin directory:

```
# cd /usr/bin/
# ls
[                                       mkfifo
[[                                      mkpasswd
ar                                      nl
autossh                                 nohup
awk                                     nproc
basename                                nslookup
bunzip2                                 od
bzcat                                   openvt
chrt                                    passwd
chvt                                    paste
cksum                                   patch
clear                                   pcregrep
cmp                                     pcretest
crontab                                 perf
cut                                     printf
dbclient                                readlink
```

```
ashish@Merseyside:~/Documents/Homework2/Cross-compile-dir$ scp crontest.c root@10.0.0.65:/usr/bin
root@10.0.0.65's password:
crontest.c
```

```
ls
[                                       microcom
[[                                      mkfifo
ar                                      mkpasswd
autossh                                 nl
awk                                     nohup
basename                                nproc
bunzip2                                 nslookup
bzcat                                   od
chrt                                    openvt
chvt                                    passwd
cksum                                   paste
clear                                   patch
cmp                                     pcregrep
crontab                                 pcretest
crontest.c                              perf
cut                                     printf
dbclient                                readlink
```

Question 2

Host debugging session using the “manual” configuration command method:

```
ashish@Merseyside:~/Documents/Homework2/Cross-compile-dir$ arm-linux-gdb file_io
GNU gdb (GDB) 8.1.1
Copyright (C) 2018 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=x86_64-pc-linux-gnu --target=arm-buildroot-linux-uclibcgnueabihf".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from file_io...done.
(gdb) target extended-remote 10.0.0.65:10000
Remote debugging using 10.0.0.65:10000
(gdb) remote put file_io /file_io
Successfully sent file "file_io".
(gdb) set remote exec-file file_io
(gdb) break main
Breakpoint 1 at 0x106f4: file file_io.c, line 8.
(gdb) break file_io.c:20
Breakpoint 2 at 0x1078c: file file_io.c, line 20.
```

```
Breakpoint 1 at 0x106f4: file file_io.c, line 8.
(gdb) break file_io.c:20
Breakpoint 2 at 0x1078c: file file_io.c, line 20.
(gdb) r
Starting program: /home/ashish/Documents/Homework2/Cross-compile-dir/file_io
Reading /lib/ld-uClibc.so.0 from remote target...
warning: File transfers from remote targets can be slow. Use "set sysroot" to access files locally instead.
Reading /lib/ld-uClibc.so.0 from remote target...
Reading /lib//libc.so.0 from remote target...

Breakpoint 1, main () at file_io.c:8
8               printf("\nYou'll Never Walk Alone");
(gdb) n
15              fp= fopen("output.txt", "w");
(gdb) n
17              fputc( 'A', fp );
(gdb) c
Continuing.

Breakpoint 2, main () at file_io.c:21
21              fp= fopen("output.txt", "a");
(gdb) n
23              char *str= (char *)malloc(sizeof(char)*50);
(gdb) c
Continuing.
[Inferior 1 (process 824) exited normally]
```

Console printout from the BBG output:

```
# gdbserver --multi :10000
Listening on port 10000
Remote debugging from host 10.0.0.163
Process /file_io created; pid = 824

You'll Never Walk Alone
Enter a string:Tak

Received character: A
Received string: Tak

Child exited with status 0
[  176.088356] random: crng init done
```

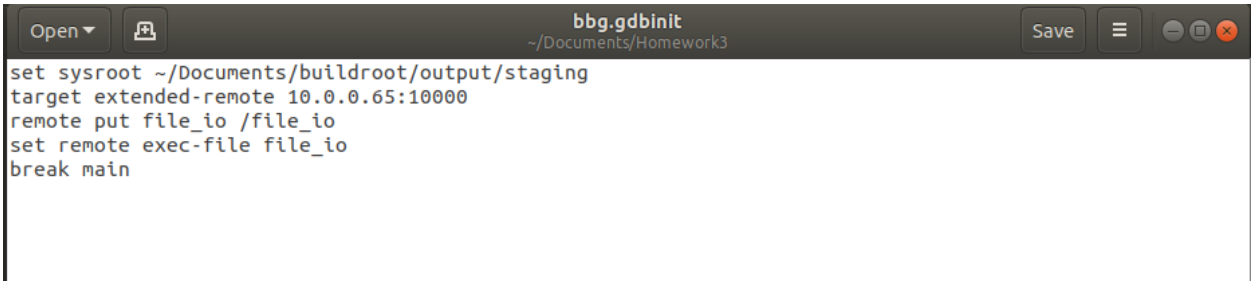
Using a host initialization file (bbg.gdbinit file on github):

```
ashish@Merseyside:~/Documents/Homework2/Cross-compile-dir$ arm-linux-gdb file_io -x ~/Documents/Homew
ork3/bbg.gdbinit
GNU gdb (GDB) 8.1.1
Copyright (C) 2018 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=x86_64-pc-linux-gnu --target=arm-buildroot-linux-uclibcgnueabihf".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from file_io...done.
Breakpoint 1 at 0x106f4: file file_io.c, line 8.
(gdb) break file  ^CQuit
(gdb) break file_io.c:24
Breakpoint 2 at 0x107b4: file file_io.c, line 24.
(gdb) r
Starting program: /home/ashish/Documents/Homework2/Cross-compile-dir/file_io

Breakpoint 1, main () at file_io.c:8
8               printf("\nYou'll Never Walk Alone");
(gdb) n
15              fp= fopen("output.txt", "w");
(gdb) c
Continuing.

Breakpoint 2, main () at file_io.c:25
25              printf("\nEnter a string:");
(gdb) n
26              scanf("%s",str);
(gdb) n
28              fputs(str, fp);
(gdb) n
30              fflush(fp);
(gdb) c
Continuing.
[Inferior 1 (process 906) exited normally]
(gdb) quit
```

Contents of .gdbinit file:



Question 3

Github link: https://github.com/asta0463/APES/tree/master/HW3

Module Insertion #1:

```
# insmod timermodule.ko Username="Ashish" period=1000
[ 1944.508226] Timer Module Init
# [ 1945.528203] User name: Ashish
[ 1945.528263] Iteration # 1
[ 1946.567749] User name: Ashish
[ 1946.570514] Iteration # 2
[ 1947.607745] User name: Ashish
[ 1947.610518] Iteration # 3
[ 1948.647752] User name: Ashish
[ 1948.650515] Iteration # 4
[ 1949.687738] User name: Ashish
[ 1949.690504] Iteration # 5
[ 1950.727743] User name: Ashish
[ 1950.730520] Iteration # 6
[ 1951.767772] User name: Ashish
[ 1951.770547] Iteration # 7
[ 1952.807757] User name: Ashish
[ 1952.810524] Iteration # 8
[ 1953.847742] User name: Ashish
[ 1953.850520] Iteration # 9
```

```
# lsmod | grep timermod
timermodule            16384  0
# modinfo timermodule.ko
filename:       /timermod/timermodule.ko
license:        GPL
author:         Ashish Tak
description:    Basic Timer module
srcversion:     41B8AA7124F6712643B8354
depends:
name:           timermodule
vermagic:       4.14.40 SMP mod_unload modversions ARMv6 p2v8
parm:           Username:charp
parm:           period:uint
```

```
# rmmod timermodule
[ 1954.890508] Iteration # 10
[ 2099.069437] Timer Module Exit
```

Module Insertion #2:

```
# insmod timermodule.ko Username="Taks" period=3000
[ 2164.951702] Timer Module Init
# [ 2168.008192] User name: Taks
[ 2168.008252] Iteration # 1
[ 2171.047775] User name: Taks
[ 2171.050551] Iteration # 2
[ 2174.087782] User name: Taks
[ 2174.090551] Iteration # 3
[ 2177.127743] User name: Taks
[ 2177.130514] Iteration # 4
[ 2180.167745] User name: Taks
[ 2180.170510] Iteration # 5
[ 2183.207740] User name: Taks
[ 2183.210512] Iteration # 6
[ 2186.247743] User name: Taks
[ 2186.250518] Iteration # 7
[ 2189.287735] User name: Taks
[ 2189.290502] Iteration # 8
[ 2192.327749] User name: Taks
[ 2192.330520] Iteration # 9
```

```
# lsmod | grep timermod
timermodule            16384  0
# modinfo timermodule.ko
filename:       /timermod/timermodule.ko
license:        GPL
author:         Ashish Tak
description:    Basic Timer module
srcversion:     41B8AA7124F6712643B8354
depends:
name:           timermodule
vermagic:       4.14.40 SMP mod_unload modversions ARMv6 p2v8
parm:           Username:charp
parm:           period:uint
```

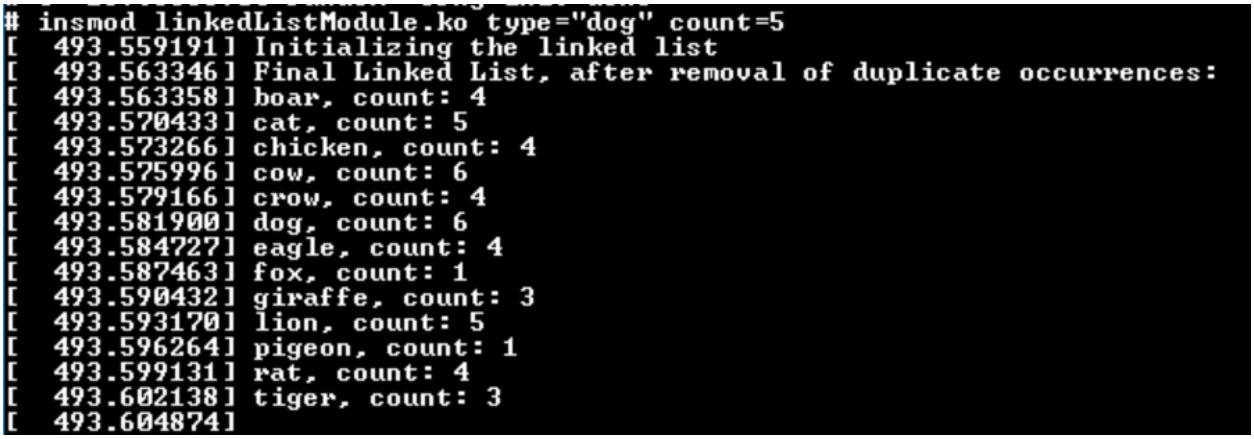
```
# rmmod timermodule
[ 2195.370566] Iteration # 10
[ 2353.101400] Timer Module Exit
```

Question 4

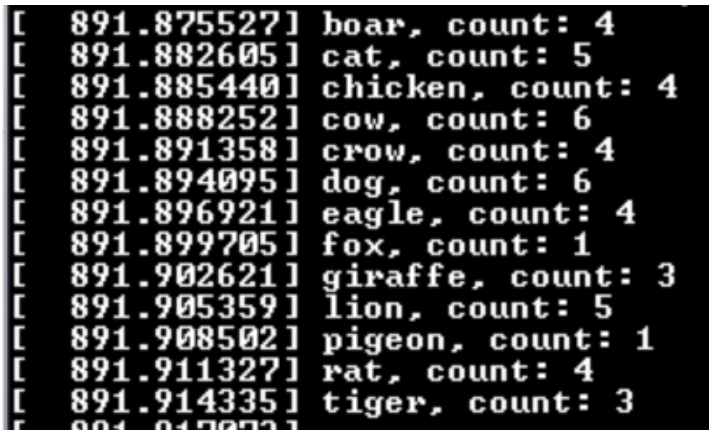
- Data structure used: Linked List

- Entries in the seed array:
  {"fox", "dog", "cat", "rat", "cat", "tiger", "lion", "lion", "dog", "dog",
"chicken", "giraffe", "boar", "chicken", "eagle", "rat", "chicken", "boar", "boar", "giraffe",
"cat", "cat", "crow", "dog", "eagle", "eagle", "boar", "cow", "cow", "cat",
"crow", "cow", "chicken", "dog", "rat", "tiger", "lion", "lion", "tiger", "cow",
"pigeon", "rat", "giraffe", "cow", "crow", "cow", "lion", "dog", "crow", "eagle"};

- Removal of duplicate occurrences (and parallel sorting):



- Sets of processed data:
  - Set 1
    - Unique ecosystem:



- Ecosystem size and amount of memory allocated:

```
[  891.917073] Total no. of nodes: 13
[  891.920036]
[  891.920036] Size in memory: 208 bytes
[  891.926669]
```

- Set 2
  - Criteria 1: No filter (size and elements same as earlier scenario)

```
[ 1434.964905] Without any filter:
[ 1434.976671] boar, count: 4
[ 1434.976680] cat, count: 5
[ 1434.979550] chicken, count: 4
[ 1434.982281] cow, count: 6
[ 1434.985377] crow, count: 4
[ 1434.988160] dog, count: 6
[ 1434.990990] eagle, count: 4
[ 1434.993726] fox, count: 1
[ 1434.996640] giraffe, count: 3
[ 1434.999423] lion, count: 5
[ 1435.002526] pigeon, count: 1
[ 1435.005353] rat, count: 4
[ 1435.008409] tiger, count: 3
```

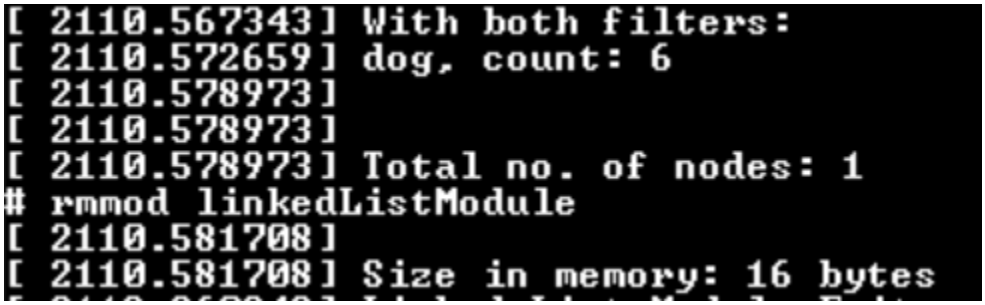
  - Criteria 2: type=”dog”

```
[ 1435.011146] With the type/species filter:
[ 1435.014064] dog, count: 6
[ 1435.021381]
[ 1435.021381]
[ 1435.021381] Total no. of nodes: 1
[ 1435.024120]
[ 1435.024120] Size in memory: 16 bytes
```

  - Criteria 3: count>=5

```
[ 2110.537472] With the count filter:
[ 2110.542790] cat, count: 5
[ 2110.549706] cow, count: 6
[ 2110.552445] dog, count: 6
[ 2110.555180] lion, count: 5
[ 2110.557974]
[ 2110.557974]
[ 2110.557974] Total no. of nodes: 4
[ 2110.560798]
[ 2110.560798] Size in memory: 64 bytes
```

- Criteria 4: type=”dog” and count>=5



- Amount of time to insert the module:

420717-416313 = <u>4404 uS</u>