

Part 1: Server

```
> ./server 4032
Listening on port: 4032
(range of available ports on skel.ru.is is 4000-4100)
Client connected on server
SYS ls

Makefile      client.dSYM      docker-compose.yml      server.dSYM
P1-TSAM.pdf   client_dir       p1_tsam.tar             server_dir
client        docker-compose.debug.yml  server
```

Server tcpdump

```
> sudo tcpdump -X -i lo0 'tcp port 4032'
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on lo0, link-type NULL (BSD loopback), capture size 262144 bytes
15:58:38.646440 IP localhost.58709 > localhost.vrts-auth-port: Flags [S], seq 2962082445, win 65535, options [mss 16344,nop,wscale 6,nop,nop,TS val 1067584751 ecr 0,sackOK,eol],
length 0
 0x0000: 4500 0040 0000 4000 4006 0000 7f00 0001 E..@..@.....
 0x0010: 7f00 0001 e555 0fc0 b08d ca8d 0000 0000 .....U.Z.....
 0x0020: b002 ffff fe34 0000 0204 3fd8 0103 0306 ....4....7....
 0x0030: 0101 080a 3fa2 0cef 0000 0000 0402 0000 ....7.....
15:58:38.646658 IP localhost.vrts-auth-port > localhost.58709: Flags [S.], seq 2556074712, ack 2962082446, win 65535, options [mss 16344,nop,wscale 6,nop,nop,TS val 2343520100 ecr 1067584751,sackOK,eol], length 0
 0x0000: 4500 0040 0000 4000 4006 0000 7f00 0001 E..@..@.....
 0x0010: 7f00 0001 0fc0 e555 985a 9ad9 b08d ca8e .....U.Z.....
 0x0020: b012 ffff fe34 0000 0204 3fd8 0103 0306 ....4....7....
 0x0030: 0101 080a 8baf 4764 3fa2 0cef 0402 0000 ....Gd7.....
15:58:38.646687 IP localhost.58709 > localhost.vrts-auth-port: Flags [L], ack 1, win 6379, options [nop,nop,TS val 1067584751 ecr 2343520100], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001 E..4..@.....
 0x0010: 7f00 0001 e555 0fc0 b08d ca8e 985a 9ad9 .....U.Z.....
 0x0020: 8010 18eb fe28 0000 0101 080a 3fa2 0cef ....(.....7...
 0x0030: 8baf 4764 .....Gd
15:58:38.646713 IP localhost.vrts-auth-port > localhost.58709: Flags [L.], ack 1, win 6379, options [nop,nop,TS val 2343520100 ecr 1067584751], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001 E..4..@.....
 0x0010: 7f00 0001 0fc0 e555 985a 9ad9 b08d ca8e .....U.Z.....
 0x0020: 8010 18eb fe28 0000 0101 080a 8baf 4764 ....(.....Gd
 0x0030: 3fa2 0cef ?...
15:59:27.473452 IP localhost.58709 > localhost.vrts-auth-port: Flags [P.], seq 1:8, ack 1, win 6379, options [nop,nop,TS val 1067633421 ecr 2343520100], length 7
 0x0000: 4500 003b 0000 4000 4006 0000 7f00 0001 E..j..@.....
 0x0010: 7f00 0001 e555 0fc0 b08d ca8e 985a 9ad9 .....U.Z.....
 0x0020: 8018 18eb fe2f 0000 0101 080a 3fa2 cb0d ....(.....7...
 0x0030: 8baf 4764 5359 5320 6c73 0a .....GdSYS.ls.
15:59:27.473496 IP localhost.vrts-auth-port > localhost.58709: Flags [L.], ack 8, win 6379, options [nop,nop,TS val 2343568770 ecr 1067633421], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001 E..4..@.....
 0x0010: 7f00 0001 0fc0 e555 985a 9ad9 b08d ca95 .....U.Z.....
 0x0020: 8010 18eb fe28 0000 0101 080a 8bb0 0582 ....(.....
 0x0030: 3fa2 cb0d ?...
15:59:27.495129 IP localhost.vrts-auth-port > localhost.58709: Flags [P.], seq 1:31, ack 8, win 6379, options [nop,nop,TS val 2343568790 ecr 1067633421], length 30
 0x0000: 4500 0052 0000 4000 4006 0000 7f00 0001 E..R..@.....
 0x0010: 7f00 0001 0fc0 e555 985a 9ad9 b08d ca95 .....U.Z.....
 0x0020: 8018 18eb fe46 0000 0101 080a 8bb0 0596 ....F.....
 0x0030: 3fa2 cb0d 436f 6d6d 616e 6420 6578 6563 ?...Command.exec
 0x0040: 7574 6564 2073 7563 6365 7373 6675 6c6c uted.successfull
 0x0050: 790a Y.
15:59:27.495233 IP localhost.58709 > localhost.vrts-auth-port: Flags [L.], ack 31, win 6379, options [nop,nop,TS val 1067633441 ecr 2343568790], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001 E..4..@.....
 0x0010: 7f00 0001 e555 0fc0 b08d ca95 985a 9af7 .....U.Z.....
 0x0020: 8010 18eb fe28 0000 0101 080a 3fa2 cb21 ....(.....7..!
 0x0030: 8bb0 0596 ....
```

Skel ncst

```
[lokih@skel ~]$ nc 127.0.0.1 4032
SYS ls
Command executed successfully
```

Part 2

Server

```
> ./server 4032
Listening on port: 4032
      (range of available ports on skel.ru.is is 4000-4100)
Client connected on server
SYS ls
D1
Dockerfile      Makefile      client      client.dSYM      p1_tsam.tar      server.cpp
P1-TSAM.pdf     client.cpp     docker-compose.yml      server
```

Server tcpdump

```
[listening on lo0, link-type NULL (BSD loopback), capture size 262144 bytes
11:13:53.371876 IP localhost.59060 > localhost.vrts-auth-port: Flags [S], seq 1881287162, win 65535, length 0
Name: tcpdump (tcpdump)
Profile: Default
Command: login
4,nop,wscale 6,nop,nop,TS val 3055582033 ecr 0,sackOK,eol],
length 0
0x0000: 4500 0040 0000 4000 4006 0000 7f00 0001  E..@..@.....
0x0010: 7f00 0001 e6b4 0fc0 7022 29fa 0000 0000  .....p".....
0x0020: b002 ffff fe34 0000 0204 3fd8 0103 0306  ....4...7.....
0x0030: 0101 080a b620 7b51 0000 0000 0402 0000  .....{0.....
11:13:53.372049 IP localhost.vrts-auth-port > localhost.59060: Flags [S.], seq 922574556, ack 1881287163, win 65535, options [mss 16344,nop,wscale 6,nop,nop,TS val 812190903 ecr 3055582033,sackOK,eol], length 0
0x0000: 4500 0040 0000 4000 4006 0000 7f00 0001  E..@..@.....
0x0010: 7f00 0001 0fc0 e6b4 36fd 5edc 7022 29fb  .....6.^p".....
0x0020: b012 ffff fe34 0000 0204 3fd8 0103 0306  ....4...7.....
0x0030: 0101 080a 3069 0cb7 b620 7b51 0402 0000  ....01....{0....
11:13:53.372068 IP localhost.59060 > localhost.vrts-auth-port: Flags [S.], ack 1, win 6379, options [nop,nop,TS val 3055582033 ecr 812190903], length 0
0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.....
0x0010: 7f00 0001 e6b4 0fc0 7022 29fb 36fd 5edd  .....p".....6.^
0x0020: 8010 18eb fe28 0000 0101 080a b620 7b51  ....{.....{0....
0x0030: 3069 0cb7 01..
11:13:53.372082 IP localhost.vrts-auth-port > localhost.59060: Flags [S.], ack 1, win 6379, options [nop,nop,TS val 812190903 ecr 3055582033], length 0
0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.....
0x0010: 7f00 0001 0fc0 e6b4 36fd 5edd 7022 29fb  .....6.^p".....
0x0020: 8010 18eb fe28 0000 0101 080a 3069 0cb7  ....{.....01..
0x0030: b620 7b51 ..{Q
11:13:58.455123 IP localhost.59060 > localhost.vrts-auth-port: Flags [P.], seq 1:33, ack 1, win 6379, options [nop,nop,TS val 3055587089 ecr 812190903], length 32
0x0000: 4500 0054 0000 4000 4006 0000 7f00 0001  E..T..@.....
0x0010: 7f00 0001 e6b4 0fc0 7022 29fb 36fd 5edd  .....p".....6.^
0x0020: 8018 18eb fe48 0000 0101 080a b620 8f11  ....H.....
0x0030: 3069 0cb7 5359 5320 6c73 0000 b090 789e  01..SYS.ls....x
0x0040: fc7f 0000 0000 0000 0000 0000 0000 0000  .....
0x0050: 0000 0000 ....
11:13:58.455149 IP localhost.vrts-auth-port > localhost.59060: Flags [S.], ack 33, win 6379, options [nop,nop,TS val 812195959 ecr 3055587089], length 0
0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.....
0x0010: 7f00 0001 0fc0 e6b4 36fd 5edd 7022 2a1b  .....6.^p".....
0x0020: 8010 18eb fe28 0000 0101 080a 3069 2077  ....{.....01..w
0x0030: b620 8f11 ....
11:13:58.465275 IP localhost.vrts-auth-port > localhost.59060: Flags [P.], seq 1:31, ack 33, win 6379, options [nop,nop,TS val 812195969 ecr 3055587089], length 30
0x0000: 4500 0052 0000 4000 4006 0000 7f00 0001  E..R..@.....
0x0010: 7f00 0001 0fc0 e6b4 36fd 5edd 7022 2a1b  .....6.^p".....
0x0020: 8018 18eb fe46 0000 0101 080a 3069 2081  ....F.....01..
0x0030: b620 8f11 436f 6d6d 616e 6420 6578 6563  ....Command.exec
0x0040: 7574 6564 2073 7563 6365 7373 6675 6c6c  uted.successfull
0x0050: 790a y.
11:13:58.465305 IP localhost.59060 > localhost.vrts-auth-port: Flags [S.], ack 31, win 6379, options [nop,nop,TS val 3055587099 ecr 812195969], length 0
0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.....
0x0010: 7f00 0001 e6b4 0fc0 7022 2a1b 36fd 5efb  .....p".....6.^
0x0020: 8010 18eb fe28 0000 0101 080a b620 8f1b  ....{.....
0x0030: 3069 2081 01..
```

Skel client

```
[lokih@skel ~]$ ./client localhost
SYS ls
Command executed successfully
```

Part 3

Server ls -l

```
> ./server 4032
Listening on port: 4032
      (range of available ports on skel.ru.is is 4000-4100)
Client connected on server
SYS ls -l
total 1152
-rw-r--r--  1 alexandra  staff      160 Aug 28 11:34 Dockerfile
-rw-r--r--  1 alexandra  staff      212 Aug 27 18:02 Makefile
-rw-r--r--@ 1 alexandra  staff 161725 Aug 24 22:07 P1-TSAM.pdf
-rwxr-xr-x  1 alexandra  staff   72307 Aug 28 12:41 client
-rw-r--r--  1 alexandra  staff   1274 Aug 28 12:41 client.cpp
drwxr-xr-x  2 alexandra  staff     64 Aug 28 12:42 client.dSYM
-rw-r--r--@ 1 alexandra  staff   61440 Aug 24 22:07 p1_tsam.tar
-rwxr-xr-x  1 alexandra  staff 259475 Aug 28 12:36 server
-rw-r--r--  1 alexandra  staff   9669 Aug 28 12:43 server.cpp
-rw-r--r--  1 alexandra  staff    641 Aug 28 12:43 temp_cmd_file.txt
```

Skel client ls -l

```
[lokih@skel ~]$ ./client localhost
SYS ls -l
total 1144
-rw-r--r--  1 alexandra  staff      160 Aug 28 11:34 Dockerfile
-rw-r--r--  1 alexandra  staff      212 Aug 27 18:02 Makefile
-rw-r--r--@ 1 alexandra  staff 161725 Aug 24 22:07 P1-TSAM.pdf
-rwxr-xr-x  1 alexandra  staff   72307 Aug 28 12:41 client
-rw-r--r--  1 alexandra  staff   1274 Aug 28 12:41 client.cpp
drwxr-xr-x  2 alexandra  staff     64 Aug 28 12:42 client.dSYM
-rw-r--r--@ 1 alexandra  staff   61440 Aug 24 22:07 p1_tsam.tar
-rwxr-xr-x  1 alexandra  staff 259475 Aug 28 12:36 server
-rw-r--r--  1 alexandra  staff   9669 Aug 28 12:43 server.cpp
-rw-r--r--  1 alexandra  staff     0 Aug 28 12:43 temp_cmd_file.txt
```

Skel client cat Makefile

```
SYS cat Makefile
TARGET=client server
PP=g++
CFLAGS= -Wall -g -std=c++11
normal: $(TARGET)
client: client.cpp
        $(PP) $(CFLAGS) client.cpp -o client
server: server.cpp
        $(PP) $(CFLAGS) server.cpp -o server
clean:
        $(RM) $(TARGET)
```

Server tcpdump ls -l

```
listening on lo0, link-type NULL (BSD loopback), capture size 262144 bytes
12:43:57.348183 IP localhost.64011 > localhost.vrts-auth-port: Flags [P.], seq 4212935753:4212935785, ack 3548072063, win 6379, options [nop,nop,TS val 3725561387 ecr 166747267], length 32
 0x0000: 4500 0054 0000 4000 4006 0000 7f00 0001  E..T..@.@.....
 0x0010: 7f00 0001 fa0b 0fc0 fb1c 4c49 d37b 487f  .....LI.(H.
 0x0020: 8018 18eb fe48 0000 0101 080a de0f 8e2b  ....H.....+
 0x0030: 09f0 5c83 5359 5320 6c73 202d 6c00 86a6  ..\SYS.ls.-L...
 0x0040: fc7f 0000 0000 0000 0000 0000 0000 0000  .....
 0x0050: 0000 0000  ....
12:43:57.349277 IP localhost.vrts-auth-port > localhost.64011: Flags [..], ack 32, win 6379, options [nop,nop,TS val 166758782 ecr 3725561387], length 0
 0x0000: 4500 0054 0000 4000 4006 0000 7f00 0001  E..4..@.@.....
 0x0010: 7f00 0001 0fc0 fa0b d37b 487f fb1c 4c69  .....(H...Li
 0x0020: 8010 18eb fe28 0000 0101 080a 09f0 897e  ....(.....~
 0x0030: de0f 8e2b  ....
12:43:57.367424 IP localhost.vrts-auth-port > localhost.64011: Flags [P.], seq 1:642, ack 32, win 6379, options [nop,nop,TS val 166758801 ecr 3725561387], length 641
 0x0000: 4500 02b5 0000 4000 4006 0000 7f00 0001  E....@.@.....
 0x0010: 7f00 0001 0fc0 fa0b d37b 487f fb1c 4c69  .....(H...Li
 0x0020: 8018 18eb 00aa 0000 0101 080a 09f0 8991  .....
 0x0030: de0f 8e2b 746f 7461 6c20 3131 3434 0a2d  ....total.1144.-
 0x0040: 7277 2d72 2d2d 722d 2d20 2031 2061 6c65  nv-r-r-r-..1.a
 0x0050: 7861 6e64 7261 2020 7374 6166 6620 2020  xandra..staff...
 0x0060: 2020 3136 3020 4175 6720 3238 2031 313a  ..160.Aug.28.11:
 0x0070: 3334 2044 6f63 6b65 7266 696c 650a 2d72  34.Dockefile,-r
 0x0080: 772d 722d 2d72 2d2d 2020 3120 616c 6578  w-r-r-r-..1.alex
 0x0090: 6166 6472 6120 2073 7461 6666 2020 2020  andra..staff....
 0x00a0: 2032 3132 2041 7567 2032 3720 3138 3a30  .212.Aug.27.18:0
 0x00b0: 3220 4d61 6b65 6669 6c65 0a2d 7277 2d72  2.Makefile,-nw-r
 0x00c0: 2d2d 722d 2d40 2031 2061 6c65 7861 6e64  -r-@.1.alexand
 0x00d0: 7261 2020 7374 6166 6620 2031 3631 3732  ra..staff...16172
 0x00e0: 3520 4175 6720 3234 2032 323a 3037 2050  5.Aug.24.22:07.P
 0x00f0: 312d 5453 414d 2e70 6466 0a2d 7277 7872  1-TSAM.pdf,-nw-r
 0x0100: 2d78 722d 7820 2031 2061 6c65 7861 6e64  -xr-x..1.alexand
 0x0110: 7261 2020 7374 6166 6620 2020 3732 3330  ra..staff...7230
 0x0120: 3720 4175 6720 3238 2031 323a 3431 2063  7.Aug.28.12:41.c
 0x0130: 6c69 656e 740a 2d72 772d 722d 2d72 2d2d  lient.-nw-r-r-
 0x0140: 2020 3120 616c 6578 6166 6472 6120 2073  ..1.alexandra..s
 0x0150: 7461 6666 2020 2020 3132 3734 2041 7567  taff....1274.Aug
 0x0160: 2032 3820 3132 3a34 3120 636c 6965 6e74  .28.12:41.client
 0x0170: 2e63 7070 0a64 7277 7872 2d78 722d 7820  .cpp.dnw-r-xr-x.
 0x0180: 2032 2061 6c65 7861 6e64 7261 2020 7374  2.alexandra..st
 0x0190: 6166 6620 2020 2020 2036 3420 4175 6720  aff.....64.Aug.
 0x01a0: 3238 2031 323a 3432 2063 6c69 656e 742e  28.12:42.client.
 0x01b0: 6453 594d 0a2d 7277 2d72 2d2d 722d 2d40  dSYM.-nw-r-r-@
 0x01c0: 2031 2061 6c65 7861 6e64 7261 2020 7374  ..1.alexandra..st
 0x01d0: 6166 6620 2020 3631 3434 3020 4175 6720  aff...61440.Aug.
 0x01e0: 3234 2032 323a 3037 2070 315f 7473 616d  24.22:07,p1_tsam
 0x01f0: 2e74 6172 0a2d 7277 7872 2d78 722d 7820  .tar.-nw-r-r-x.
 0x0200: 2031 2061 6c65 7861 6e64 7261 2020 7374  ..1.alexandra..st
 0x0210: 6166 6620 2032 3539 3437 3520 4175 6720  aff..259475.Aug.
 0x0220: 3238 2031 323a 3336 2073 6572 7665 720a  28.12:36.server.
 0x0230: 2d72 772d 722d 2d72 2d2d 2020 3120 616c  -nw-r-r-r-..1.al
 0x0240: 6578 6166 6472 6120 2073 7461 6666 2020  exandra..staff..
 0x0250: 2020 3936 3639 2041 7567 2032 3820 3132  ..9669.Aug.28.12
 0x0260: 3a34 3320 7365 7276 6572 2e63 7070 0a2d  :43.server.cpp.-
 0x0270: 7277 2d72 2d2d 722d 2d20 2031 2061 6c65  nw-r-r-r-..1.a
 0x0280: 7861 6e64 7261 2020 7374 6166 6620 2020  xandra..staff...
 0x0290: 2020 2020 3020 4175 6720 3238 2031 323a  ....0.Aug.28.12:
 0x02a0: 3433 2074 656d 705f 636d 645f 6669 6c65  43.temp_cmd_file
 0x02b0: 2e74 7874 0a  .txt.
12:43:57.367486 IP localhost.64011 > localhost.vrts-auth-port: Flags [..], ack 642, win 6369, options [nop,nop,TS val 3725561406 ecr 166758801], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.@.....
 0x0010: 7f00 0001 fa0b 0fc0 fb1c 4c69 d37b 4b00  .....LI.(K.
 0x0020: 8010 18e1 fe28 0000 0101 080a de0f 8e3e  ....(.....>
 0x0030: 09f0 8991  ....
```

Server tcpdump cat Makefile

```
listening on lo0, link-type NULL (BSD loopback), capture size 262144 bytes
12:46:20.024801 IP localhost.64011 > localhost.vrts-auth-port: Flags [P.], seq 4212935785:4212935817, ack 3548072704, win 6369, options [nop,nop,TS val 3725703558 ecr 166758801],
length 32
 0x0000: 4500 0054 0000 4000 4006 0000 7f00 0001  E..T..@.@.....
 0x0010: 7f00 0001 fa0b 0fc0 fb1c 4c69 d37b 4b00  .....Li.{K.
 0x0020: 8018 18e1 fe48 0000 0101 080a de11 b986  ....H.....
 0x0030: 09f0 8991 5359 5320 6361 7420 4d61 6b65  ....SYS.cat.Make
 0x0040: 6669 6c65 0000 0000 0000 0000 0100 0000  file.....
 0x0050: 0000 0000  ....
12:46:20.024856 IP localhost.vrts-auth-port > localhost.64011: Flags [L], ack 32, win 6378, options [nop,nop,TS val 166900953 ecr 3725703558], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.@.....
 0x0010: 7f00 0001 0fc0 fa0b d37b 4b00 fb1c 4c89  .....{K...L.
 0x0020: 8010 18ea fe28 0000 0101 080a 09f2 b4d9  ....{.....
 0x0030: de11 b986  ....
12:46:20.038957 IP localhost.vrts-auth-port > localhost.64011: Flags [P.], seq 1:213, ack 32, win 6378, options [nop,nop,TS val 166900967 ecr 3725703558], length 212
 0x0000: 4500 0108 0000 4000 4006 0000 7f00 0001  E.....@.@.....
 0x0010: 7f00 0001 0fc0 fa0b d37b 4b00 fb1c 4c89  .....{K...L.
 0x0020: 8018 18ea fefc 0000 0101 080a 09f2 b4e7  ....{.....
 0x0030: de11 b986 5441 5247 4554 3d63 6c69 656e  ....TARGETclien
 0x0040: 7420 7365 7276 6572 200a 5050 3d67 2b2b  t.server..PP=g++
 0x0050: 0a43 464c 4147 533a 202d 5761 6c6c 202d  .CFLAGS=-Wall,-
 0x0060: 6720 2d73 7464 3d63 2b2b 3131 0a6e 6f72  g.-std=c++11.nor
 0x0070: 6d61 6c3a 2024 2854 4152 4745 5429 0a63  mal..$(TARGET).c
 0x0080: 6c69 656e 743a 2063 6c69 656e 742e 6370  lient..client.cp
 0x0090: 700a 0924 2850 5029 2024 2843 464c 4147  p..$(PP).$(CFLAG
 0x00a0: 5329 2063 6c69 656e 742e 6370 7020 2d6f  S).client.cpp.-o
 0x00b0: 2063 6c69 656e 740a 7365 7276 6572 3a20  .client.server:.
 0x00c0: 7365 7276 6572 2e63 7070 0a09 2428 5050  server.cpp..$(PP
 0x00d0: 2920 2428 4346 4c41 4753 2920 7365 7276  ).$(CFLAGS).serv
 0x00e0: 6572 2e63 7070 202d 6f20 7365 7276 6572  er.cpp.-o.server
 0x00f0: 0a63 6c65 616e 3a0a 0924 2852 4d29 2024  .clean..$(RM).$
 0x0100: 2854 4152 4745 5429  (TARGET)
12:46:20.039002 IP localhost.64011 > localhost.vrts-auth-port: Flags [L.], ack 213, win 6366, options [nop,nop,TS val 3725703572 ecr 166900967], length 0
 0x0000: 4500 0034 0000 4000 4006 0000 7f00 0001  E..4..@.@.....
 0x0010: 7f00 0001 fa0b 0fc0 fb1c 4c89 d37b 4bd4  .....{K...L..
 0x0020: 8010 18de fe28 0000 0101 080a de11 b994  ....{.....
 0x0030: 09f2 b4e7  ....
```