

Approach a):

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liminrui@ubuntu:~/hw2/a$ make
make -C /lib/modules/5.13.0-28-generic/build M=/home/liminrui/hw2/a modules
make[1]: Entering directory '/usr/src/linux-headers-5.13.0-28-generic'
CC [M] /home/liminrui/hw2/a/sample.o
MODPOST /home/liminrui/hw2/a/Module.symvers
CC [M] /home/liminrui/hw2/a/sample.mod.o
LD [M] /home/liminrui/hw2/a/sample.ko
BTF [M] /home/liminrui/hw2/a/sample.ko
Skipping BTF generation for /home/liminrui/hw2/a/sample.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-5.13.0-28-generic'
liminrui@ubuntu:~/hw2/a$ sudo insmod sample.ko
[sudo] password for liminrui:
liminrui@ubuntu:~/hw2/a$ sudo rmmod sample
liminrui@ubuntu:~/hw2/a$
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[ 140.524384] Bluetooth: RFCOMM ver 1.11
[ 158.977620] rfkill: input handler disabled
[ 164.493635] audit: type=1400 audit(1644467704.462:38): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=12 capname="net admin"
[ 164.498996] audit: type=1400 audit(1644467704.470:39): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=38 capname="perfmon"
[ 164.899570] audit: type=1400 audit(1644467704.870:40): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=4 capname="fsetid"
[ 196.776766] input: VMware DnD UInput pointer as /devices/virtual/input/input6
[ 197.604210] audit: type=1326 audit(1644467737.539:41): auid=1000 uid=1000 gid=1000 ses=3 subj=snap.snap-store.ubuntu-software pid=19
00 comm="snap-store" exe="/snap/snap-store/558/usr/bin/snap-store" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fcd8895e89d code=0x50
000
[ 212.880879] audit: type=1107 audit(1644467752.742:42): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.DBus.Proper
ties" member="GetAll" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 212.887813] audit: type=1107 audit(1644467752.750:43): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.PolicyKit1
.Authority" member="CheckAuthorization" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label
="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 213.077479] audit: type=1107 audit(1644467752.937:44): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.DBus.Proper
ties" member="GetAll" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 213.084226] audit: type=1107 audit(1644467752.949:45): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.PolicyKit1
.Authority" member="CheckAuthorization" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label
="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 215.079793] audit: type=1400 audit(1644467754.936:46): apparmor="DENIED" operation="open" profile="snap.snap-store.ubuntu-software"
name="/etc/PackageKit/Vendor.conf" pid=1900 comm="snap-store" requested_mask="r" denied_mask="r" fsuid=1000 ouid=0
[ 296.403825] audit: type=1326 audit(1644467836.314:47): auid=1000 uid=1000 gid=1000 ses=3 subj=snap.snap-store.ubuntu-software pid=19
00 comm="snap-store" exe="/snap/snap-store/558/usr/bin/snap-store" sig=0 arch=c000003e syscall=93 compat=0 ip=0x7fcd889554fb code=0x500
00
[ 384.016041] sample: loading out-of-tree module taints kernel.
[ 384.022348] sample: module verification failed: signature and/or required key missing - tainting kernel
[ 384.031440] Hello world 17179952436
[ 390.412911] Goodbye cruel world 6384
liminrui@ubuntu:~/hw2/a$
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Approach b):

```
liminrui@ubuntu:~/hw2/b$ make
make -C /lib/modules/5.13.0-28-generic/build M=/home/liminrui/hw2/b modules
make[1]: Entering directory '/usr/src/linux-headers-5.13.0-28-generic'
CC [M] /home/liminrui/hw2/b/sample_ktime.o
MODPOST /home/liminrui/hw2/b/Module.symvers
CC [M] /home/liminrui/hw2/b/sample_ktime.mod.o
LD [M] /home/liminrui/hw2/b/sample_ktime.ko
BTF [M] /home/liminrui/hw2/b/sample_ktime.ko
Skipping BTF generation for /home/liminrui/hw2/b/sample_ktime.ko due to unavailability of vmlinux
make[1]: Leaving directory '/usr/src/linux-headers-5.13.0-28-generic'
liminrui@ubuntu:~/hw2/b$ sudo insmod sample_ktime.ko
liminrui@ubuntu:~/hw2/b$ sudo rmmod sample_ktime
liminrui@ubuntu:~/hw2/b$
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[ 164.493635] audit: type=1400 audit(1644467704.462:38): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=12 capname="net admin"
[ 164.498996] audit: type=1400 audit(1644467704.470:39): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=38 capname="perfmon"
[ 164.899570] audit: type=1400 audit(1644467704.870:40): apparmor="DENIED" operation="capable" profile="/snap/core/12603/usr/lib/snapd
/snap-confine" pid=1900 comm="snap-confine" capability=4 capname="fsetid"
[ 196.776766] input: VMware DnD UInput pointer as /devices/virtual/input/input6
[ 197.604210] audit: type=1326 audit(1644467737.539:41): auid=1000 uid=1000 gid=1000 ses=3 subj=snap.snap-store.ubuntu-software pid=19
00 comm="snap-store" exe="/snap/snap-store/558/usr/bin/snap-store" sig=0 arch=c000003e syscall=314 compat=0 ip=0x7fcd8895e89d code=0x50
000
[ 212.880879] audit: type=1107 audit(1644467752.742:42): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.DBus.Proper
ties" member="GetAll" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 212.887813] audit: type=1107 audit(1644467752.750:43): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.PolicyKit1.
Authority" member="CheckAuthorization" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label
="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 213.077479] audit: type=1107 audit(1644467752.937:44): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.DBus.Proper
ties" member="GetAll" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 213.084226] audit: type=1107 audit(1644467752.949:45): pid=795 uid=103 auid=4294967295 ses=4294967295 subj=unconfined msg='apparmor=
"DENIED" operation="dbus_method_call" bus="system" path="/org/freedesktop/PolicyKit1/Authority" interface="org.freedesktop.PolicyKit1.
Authority" member="CheckAuthorization" mask="send" name=":1.8" pid=1900 label="snap.snap-store.ubuntu-software" peer_pid=809 peer_label
="unconfined"
exe="/usr/bin/dbus-daemon" sauid=103 hostname=? addr=? terminal=?'
[ 215.079793] audit: type=1400 audit(1644467754.936:46): apparmor="DENIED" operation="open" profile="snap.snap-store.ubuntu-software"
name="/etc/PackageKit/Vendor.conf" pid=1900 comm="snap-store" requested_mask="r" denied_mask="r" fsuid=1000 ouid=0
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00
[ 384.016041] sample: loading out-of-tree module taints kernel.
[ 384.022348] sample: module verification failed: signature and/or required key missing - tainting kernel
[ 384.031440] Hello world 17179952436
[ 390.412911] Goodbye cruel world 6384
[ 486.728614] Hello world 486754
[ 493.347196] Goodbye cruel world 6585
liminrui@ubuntu:~/hw2/b$
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