Activity Two

Kernel Modules with eSDKs

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Kernel modules with eSDKs – Overview

- **The Extensible SDK (eSDK) is a portable and standalone development environment , basically an SDK with an added bitbake executive via devtool.**
- **The “devtool” is a collection of tools to help development, in particular user space development.**
- **We can use devtool to manage a new kernel module:**
  - Like normal applications is possible to import and create a wrapper recipe to manage the kernel module with eSDKs.

Kernel modules with eSDKs – Compiling a kernel module

- **We have two choices**
- **Out of the kernel tree**
  - When the code is in a different directory outside of the kernel source tree
- **Inside the kernel tree**
  - When the code is managed by a KConfig and a Makefile into a kernel directory

Kernel modules with eSDKs – Pro and Cons of a module outside the kernel tree

- **When the code is outside of the kernel source tree in a different directory**
- **Advantages**
  - Might be easier to handle modifications than modify it into the kernel itself
- **Drawbacks**
  - Not integrated to the kernel configuration/compilation process
  - Needs to be built separately
  - The driver cannot be built statically

Kernel modules with eSDKs – Pro and Cons of a module inside the kernel tree

- **When the code is inside the same directory tree of the kernel sources**
- **Advantages**
  - Well integrated into the kernel configuration and compilation process
  - The driver can be built statically if needed
- **Drawbacks**
  - Bigger kernel size
  - Slower boot time

Kernel modules with eSDKs – The source code

```
#include <linux/module.h>
#include <linux/kernel.h>

static int __init hello_init(void)
{
    printk("When half way through the journey of our life\n");
    return 0;
}

static void __exit hello_exit(void)
{
    printk("I found that I was in a gloomy wood\n");
}

module_init(hello_init);
module_exit(hello_exit);

MODULE_LICENSE("GPL");
MODULE_DESCRIPTION("Greeting module from the Divine Comedy");
MODULE_AUTHOR("Dante Alighieri");
```

Kernel modules with eSDKs – The Makefile

```
obj-m += hellokernel.o

SRC := $(shell pwd)

all:
	$(MAKE) -C $(KERNEL_SRC) M=$(SRC) modules

modules_install:
	$(MAKE) -C $(KERNEL_SRC) M=$(SRC) modules_install
```

- ***KERNEL_SRC*** *is the location of the kernel sources.*
- *This variable is set to the value of the STAGING_KERNEL_DIR within the module class (module.bbclass)*

- *Sources available on https://github.com/koansoftware/simplest-kernel-module.git*

Kernel modules with eSDKs – Devtool setup

- **Start a new Shell!** Otherwise, the existing bitbake environment can cause unexpected results
- Here is how the eSDK was prepared for this class account:

< DO NOT ENTER THE FOLLOWING COMMANDS : ALREADY EXECUTED >

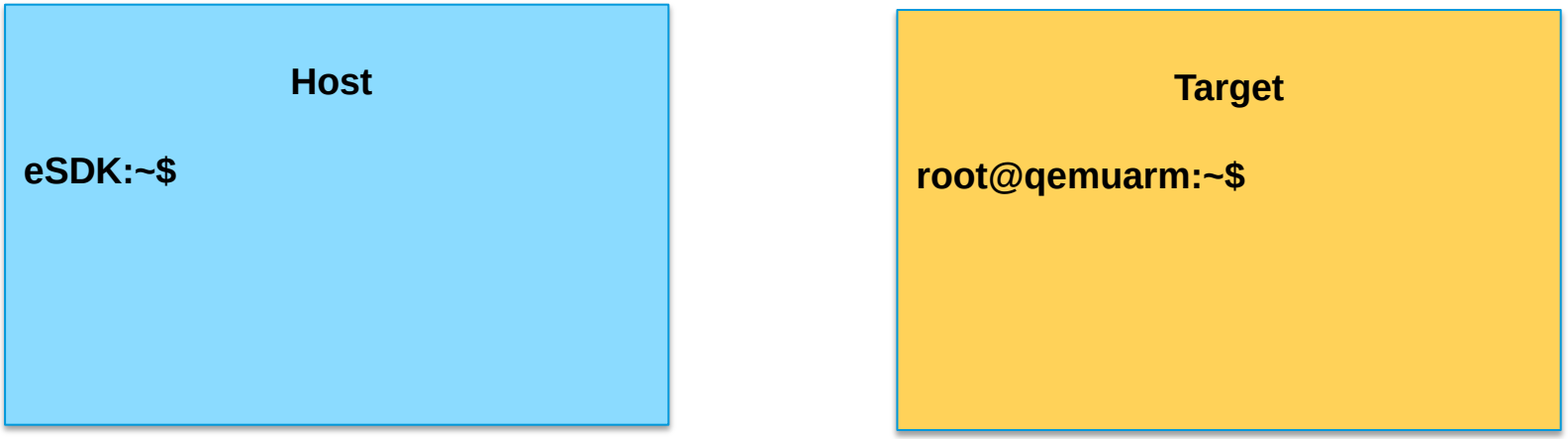
```
$ bitbake core-image-base -c populate_sdk_ext
$ cd /scratch/working/build-qemuarm/tmp/deploy/sdk/
$ ./poky-glibc-x86_64-core-image-base-armv5e-toolchain-ext-2.4.sh \
       -d /scratch/sdk/qemuarm -y
$ cd /scratch/sdk/qemuarm
$ . environment-setup-armv5e-poky-linux-gnueabi
$ devtool modify virtual/kernel
$
```

- **This installed the eSDK into:**

  /scratch/sdk/qemuarm

Kernel modules with eSDKs – Overview

- Starting from now we are using the **eSDK** and not the project
- During this exercise we using two different machines
  - The **HOST** containing the eSDK (providing devtool)
  - The **TARGET** running the final qemuarm image



Kernel modules with eSDKs – Globalsetup

- **Open two terminal windows and setup the eSDK environment in each one**

```
$ cd /scratch/sdk/qemuarm
$ bash                                                    # safe shell
$ source  environment-setup-armv5e-poky-linux-gnueabi
...
SDK environment now set up;
additionally you may now run devtool to perform development tasks.
Run devtool --help for further details.
$
```

Kernel modules with eSDKs – build the target image

- After you have setup the eSDK environment, build an image

```
$ devtool build-image
```

- **This will create a new image into:**

  /scratch/sdk/qemuarm/tmp/deploy/images/qemuarm

Kernel modules with eSDKs – build the target image

- Run the image to check if everything is OK
- This will run the QEMU machine in the TARGET shell you were using
- Login using user**: root** (no password required)

```
$ runqemu qemuarm nographic
```

Kernel modules with eSDKs – Hooking a new module into the build

- **Run the devtool to add a new recipe** (on the HOST side)

```
$ devtool add --version 1.0 simplestmodule \
      /scratch/src/kmod/simplest-kernel-module/
```

  - This generates a minimal recipe in the workspace layer
  - This adds EXTERNALSRC in an workspace/appends/simplestmodule_git.bbappend file that points to the sources
  - In other words, the source tree stays where it is, devtool just creates a wrapper recipe that points to it

- ***Note: this does not add your image to the original build engineer's image, which requires changing the platform project's conf/local.conf***

After the add

Workspace layer layout

```
$ tree /scratch/sdk/qemuarm/workspace/

/scratch/sdk/qemuarm/workspace/
├── appends
│   └── simplestmodule_git.bbappend
├── conf
│   └── layer.conf
├── README
└── recipes
    └── simplestmodule
        └── simplestmodule_git.bb
```

Kernel modules with eSDKs – Build the Module

- **Build the new recipe** (on the HOST side)

```
$ devtool build simplestmodule
```

*This will create the **simplestmodule.ko** kernel module*

This downloads the kernel sources (already downloaded for you):
linux-yocto-4.12.12+gitAUTOINC+eda4d18ce4_67b62d8d7b-r0 do_fetch

Kernel modules with eSDKs – Deploy the Module

- ***Get the target's IP address from the target serial console***

  root@qemuarm:~# ifconfig

- **In the eSDK** (HOST) **shell, deploy the output**
  (*the target's ip address may change)*

```
$ devtool deploy-target -s simplestmodule root@192.168.7.2
```

- *NOTE: the '-s' option will note any ssh keygen issues, allowing you to (for example) remove/add this IP address to the known hosts table*

Kernel modules with eSDKs – Deploy Details

- **In the target** (qemuarm)**, observe the result of deployment**

```
devtool_deploy.list                    100%   108        0.1KB/s  00:00
devtool_deploy.sh                      100%  1017        1.0KB/s  00:00
./
./lib/
./lib/modules/
./lib/modules/4.12.12-yocto-standard/
./lib/modules/4.12.12-yocto-standard/extra/
./lib/modules/4.12.12-yocto-standard/extra/hellokernel.ko
./usr/
./usr/include/
./usr/include/simplestmodule/
./usr/include/simplestmodule/Module.symvers
./etc/
./etc/modprobe.d/
./etc/modules-load.d/

NOTE: Successfully deployed
/scratch/sdk/qemuarm/tmp/work/qemuarm-poky-linux-gnueabi/simplestmodule/
```

Kernel modules with eSDKs – Load the Module

- **In the target (qemuarm), load the module and observe the results**

```
root@qemuarm:~# depmod -a


root@qemuarm:~# modprobe hellokernel
[ 874.941880] hellokernel: loading out-of-tree module taints kernel.
[ 874.960165] When half way through the journey of our life


root@qemuarm:~# lsmod
Module                  Size  Used by
hellokernel              929  0
nfsd                  271348  11
```

Kernel modules with eSDKs – Unload the Module

- **In the target** (qemuarm)**, unload the module**

```
root@qemuarm:~# modprobe -r hellokernel
[ 36.005902] I found that I was in a gloomy wood

root@qemuarm:~# lsmod
Module                  Size  Used by
nfsd                  271348  11
```

Kernel modules with eSDKs – automatic load of the module at boot

- **In the target** (qemuarm)**, edit the file below and add a new line containing the module name 'hellokernel'**

```
root@qemuarm:~# vi /etc/modules-load.d/hello.conf

< insert the following line and save >

hellokernel
```

- **Then reboot the Qemu machine and verify**

```
root@qemuarm:~# reboot
```

Questions