Module Programming

By : Amir Hossein Payberah

payberah@yahoo.com
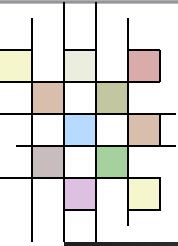
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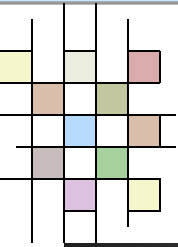
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User Space and Kernel Space

- The User Space is the space in memory where user processes run.

- The Kernel Space is the space in memory where all kernel services are provided via kernel processes.
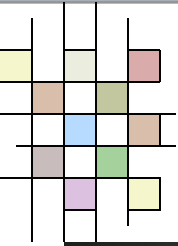
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Kernel Modules Versus Applications

- Application
  - an application performs a single task from beginning to end.
  - A module runs in user space.
- Module
  - module registers itself in order to serve future requests, and its "main" function terminates immediately.
  - A module runs in kernel space.
  - The role of a module is to extend kernel functionality.
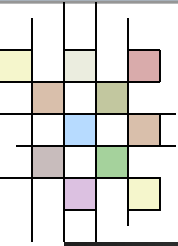
Hello World …

```
#define __KERNEL__
#define MODULE
#include <linux/module.h>
int init_module(void)
{
    printk("<1>Hello, world …\n");
    return 0;
}
void cleanup_module(void)
{
    printk("<1>Goodbye cruel world\n");
}
```

Two Important ...

- __KERNEL__
  - It is used before we include any headers.
  - much of the kernel-specific content in the kernel headers is unavailable without this symbol.
- MODULE
  - the MODULE symbol is always defined in kernel modules.
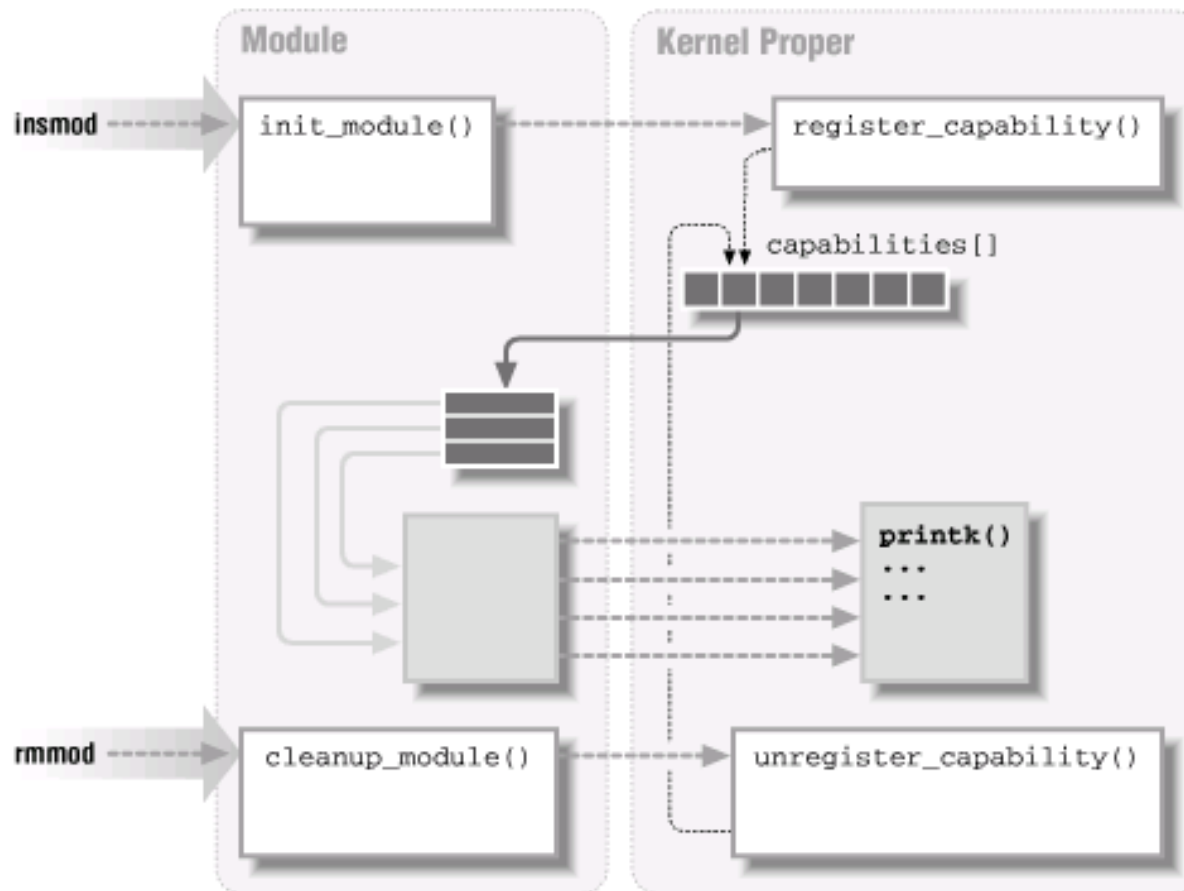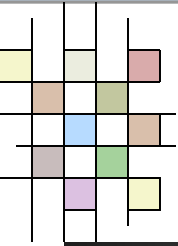
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Compile and Install Modules

- Compile
  - **root#** gcc -c hello.c
- Install
  - **root#** insmod ./hello.o
- Uninstall
  - **root#** rmmod hello
- List Modules
  - **root#** lsmod

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Linking a module to the kernel

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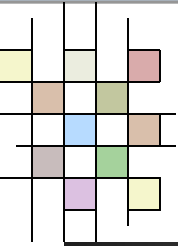University

Usage Count

- MOD_INC_USE_COUNT
  - Increments the count for the current module.

- MOD_DEC_USE_COUNT
  - Decrements the count.

- MOD_IN_USE
  - Evaluates to true if the count is not zero.
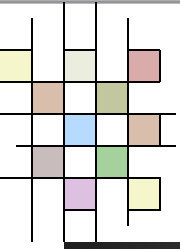
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Memory Allocation

- Static
  - char buf[100];
- kmalloc and kfree_s
  - void kmalloc (size_t size, int priority);
  - void kfree_s (void *ptr, int size);
- vmalloc and vfree
  - void *vmalloc (unsigned long size);
  - void vfree (void *ptr);

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Print the Data

- console_print
  - console_print (char *str);
- printk
  - It is like printf.
  - It sends to /var/log/messages

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Module Configuration Parameters

```
int num = 0;
MODULE_PARM (num, "i");

char *str;
MODULE_PARM (str, "s");

int array[4];
MODULE_PARM (array, "2-4i");
```

Copy Data between User Space and Kernel Space

- User Space -> Kernel Space
  - unsigned long __copy_from_user (void *to, const void *from, unsigned long count);
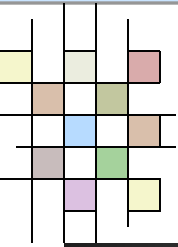 - get_user (char *kbuf, char *ubuf);
- Kernel Space -> User Space
  - unsigned long __copy_to_user (void *to, const void *from, unsigned long count);
  - put_user (char *kbuf, char *ubuf);

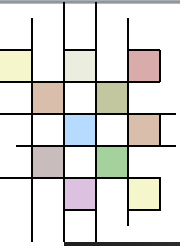Tehran

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Symbol Table

- insmod resolves undefined symbols (functions and variables) against the table of public kernel symbols.

- The table contains the addresses of global kernel items (functions and variables) that are needed to implement modularized drivers.

- The public symbol table can be read in text form from the file /proc/ksyms.
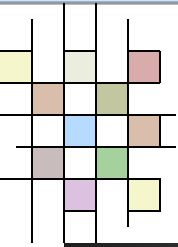
Symbol Table (Cont.)

- EXPORT_NO_SYMBOLS;
  - If your module exports no symbols at all.
- EXPORT_SYMBOL (name);
- EXPORT_SYMBOL_NOVERS (name);

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Question?

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