I2C Driver in Linux

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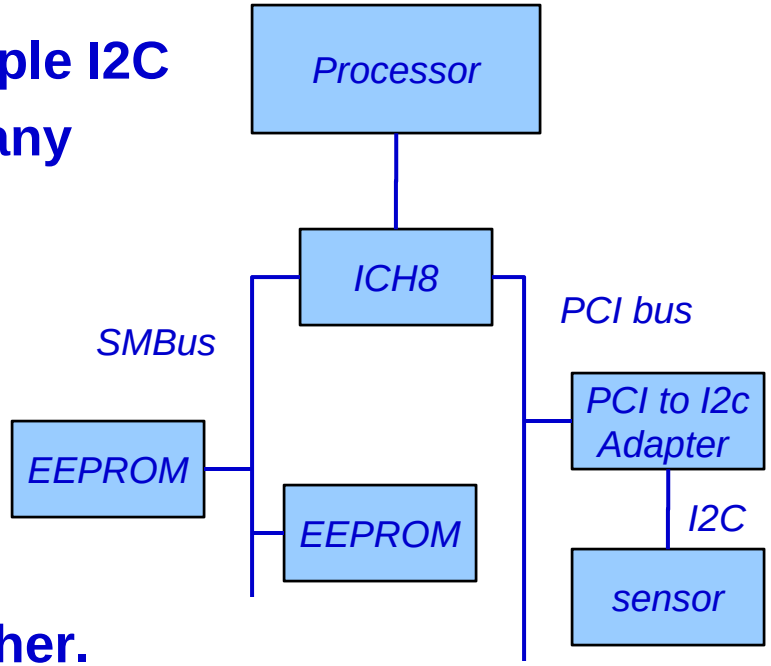
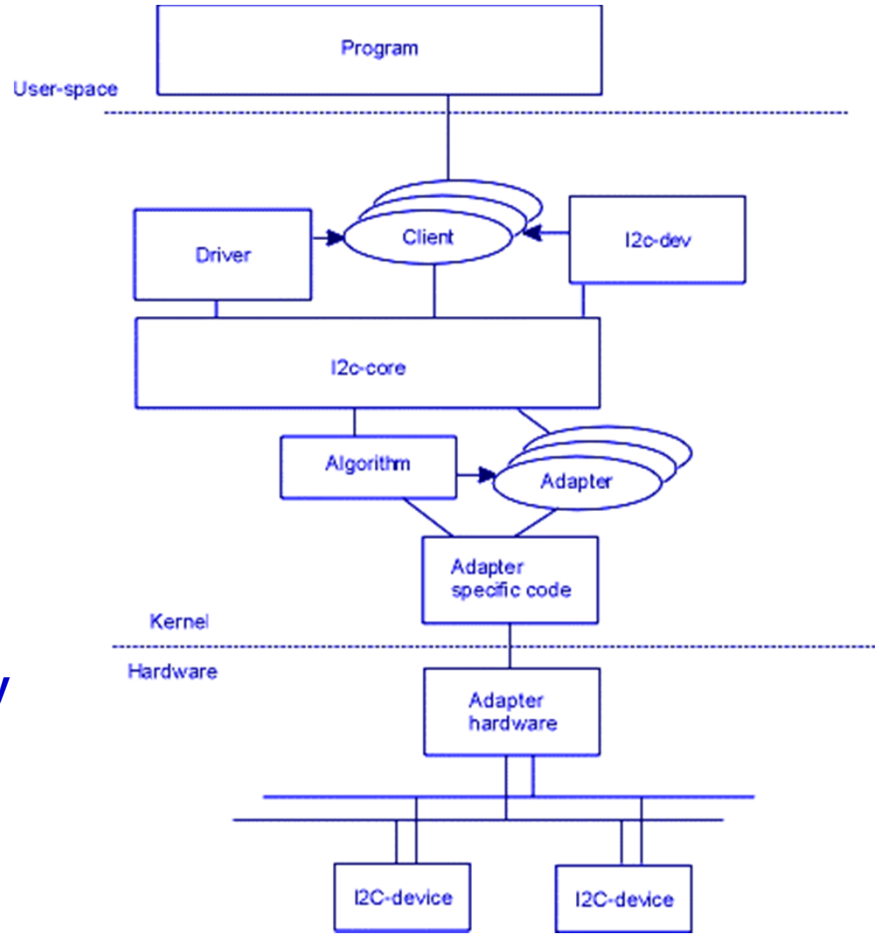
I2C and SMBus in x86

- **In general, a system can have multiple I2C buses via different adapters and many I2C devices**
- **2-wire synchronous serial buses**
  - Master and slave, addressable
- **SMBus module in ICH8**
  - *0000:00:1f.3* [0x400-0x41f]
- **I2C bus and the SMBus are essentially compatible with each other.**
- **Differences:**
  - Timeout (in SMBus, reset interfaces when clock is low forlonger than 35ms))
  - Maximum clock speed: 100MHz(Smbus) but I2C bus has both 400kHz and 3.4MHz versions.
  - Logic level: 1: 3V in I2C and 2.1V in SMBus
  - General call and alert response



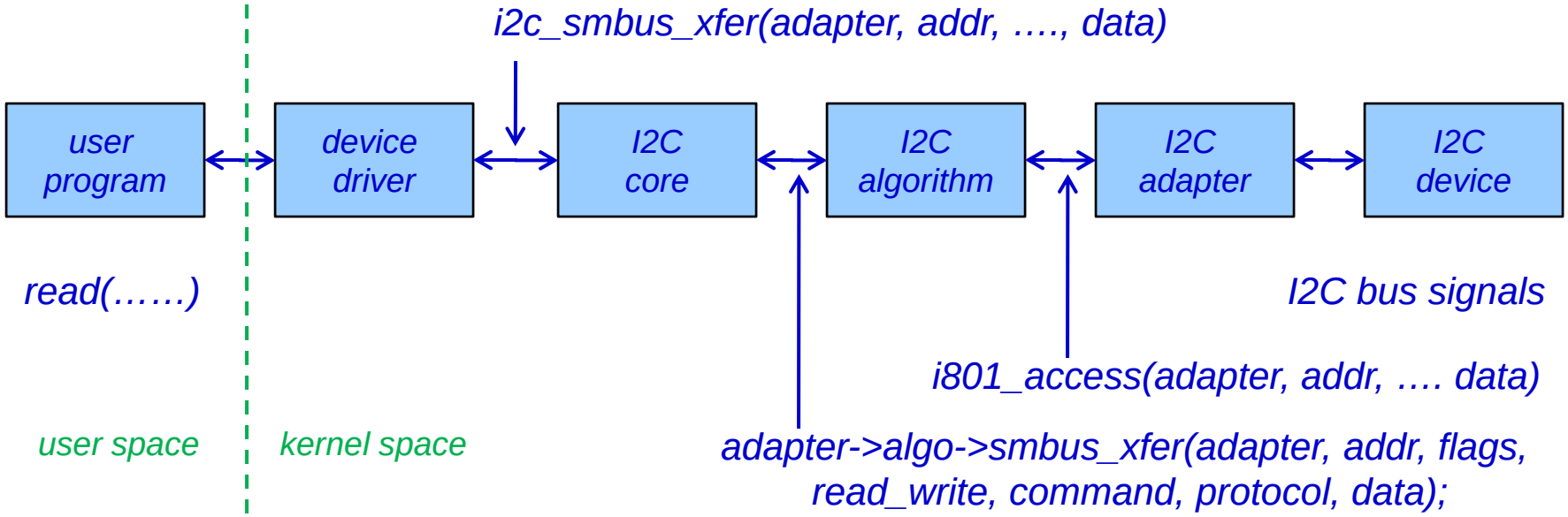
I2C Drivers in Linux

- A driver for I2C bus
  - adapter and algorithm drivers
  - manages I2C bus transactions
- Drivers for I2C devices
- A client has the device's I2C bus address and a pointer to a driver which is attached with an adapter
- When a user program issues a file operation that needs an I2C transaction
  - i2C_transfer (i2C-core.c) to invoke adap_algo_master_xfer
  - command or data is in an msg array
  - the adapter issues reads/writes to hardware I/O addresses.
- Other operations (except I2C bus transaction) are handler by the drivers



(https://i2c.wiki.kernel.org/index.php/Driver_Architecture)

Example of Accessing I2C/SMBus Devices




```
// for each i2c device
struct i2c_client {
    unsigned short  flags;
    unsigned short  addr;
    char  name[I2C_NAME_SIZE];
    struct i2c_adapter *  adapter;
    struct i2c_driver *  driver;
    struct device  dev;
     int  irq;
    struct list_head  list;
    struct completion  released;
    };
```

Example of I2C Devices

- **Two Wii nunchuck devices**
  - one is connected to ICH8 SMBus
  - one is connected to I2C adapter on PCI bus
- **2 instances of I2C_client**
  - different I2C device names
  - different adapters
  - Use the same device driver
  - same I2C slave address 0x52
- **When read from the nunchucks**
  - Same I2C signals on both buses, e.g. start, addr, R/W, ack …..
  - Different commands are sent to the different adapters (ICH8 SMBus module and PCI I2C adapter)
  - Driver makes the same call to

    i2c_smbus_xfer of *i2c.core* and then *adapter->algo->smbus_xfer*

User Space Access to I2C Devices

- **Basically, a device driver to control I2C adapters**
  - Send and receive raw data to and from I2C buses
- **An I2C device driver can process the raw data and present data according to device model**
  - A nunchuck device driver measures the speed of joystick movement instead of reporting joystick position.
- **I2C-dev – loadable module**
  - Major number: 89
  - Minor number: defined for each adapter
  - i2c_dev represents an i2c_adapter, an I2C or SMBus master, not a slave (i2c_client) – called */dev/i2c-0, /dev/i2c-1, /dev/i2c-2,* etc.

```
struct i2c_dev {
        struct list_head    list;
        struct i2c_adapter    *adap;
        struct device    *dev;          };
```

How to Use I2C-dev

- **Load i2c-dev module**
- **Create an i-node for the device**

  % mknod /dev/i2c-0 c 89 0
- **Include i2c-dev.h where i2c-dev interface is defined**

```
#define ADDRESS 0x38
int fd;
fd = open( "/dev/i2c-0", O_RDWR );          // open a device file
ioctl( fd, I2C_SLAVE, ADDRESS );            // set up the slave address
```

- Using read() and write) for an entire I2C transaction takes place (i.e. start bit, address, data, stop).
- Using the wrapper functions that i2c-dev.h provides.
- SMBus commands

  i2c_smbus_write_byte_data() → *i2c_smbus_acces*

  → *ioctl(file,I2C_SMBUS,&args)*

  → *S _ Addr _ Wr _ [A] _ Comm _ [A] _ Data _ [A] _ P*