Complex Lab – Operating Systems

Introduction

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Organisation

- Website (e.g. source repository):
  https://tu-dresden.de/ing/informatik/sya/professur-fuer-betriebssysteme/studium/praktika-seminare/komplexpraktikum-mikrokernbasierte-betriebssysteme
- Mailinglist: kpr2021@os.inf.tu-dresden.de
  Subscribe at https://os.inf.tu-dresden.de/mailman/listinfo/kpr2021
- Repository: https://os.inf.tu-dresden.de/repo/git/kpr.git
- Send Code to: martin.kuettler@os.inf.tu-dresden.de

Organisation – Dates

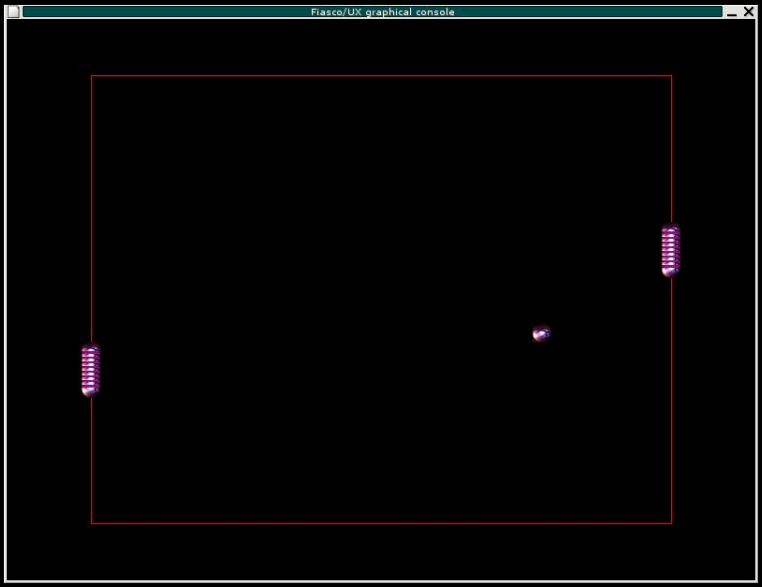
19.10.21	Introduction
31.10.21	1st Assignment due
02.11.21	Sessions & Memory
tbd	Graphical Console
tbd	Keyboard Driver
31.03.22	Final Assignment due

Requirements

- Basic OS knowledge: threads, processes, virtual memory, drivers, ...
- Experience with Linux: editor, shell, development (make, gcc)
- Experience with C/C++

Goal of this course

Multi-user Pong game



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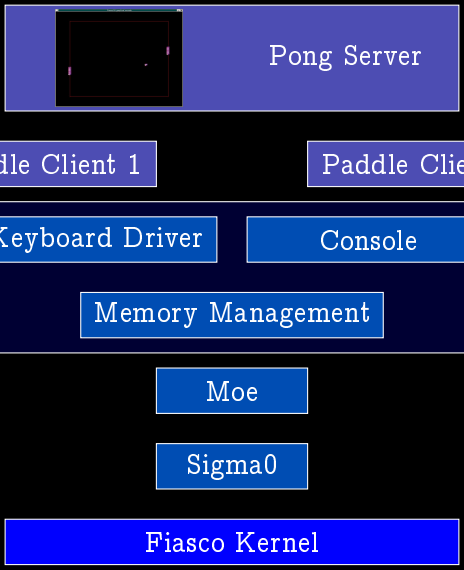

Required Software

- A Linux system (preferably Debian/Ubuntu)
- qemu
- build-essentials: gcc (<= 10?), g++, make
- gcc-multilib, g++-multilib
- device-tree-compiler
- git

The Repository

`doc/source/` documentation

`obj/l4/$ARCH/` build directory

`src/fiasco` Fiasco kernel sources

`src/l4/pkg/` sources for all userspace packages

`src/l4/conf/` boot configuration

To build everything in the beginning:

```
$ make setup
$ make [-j X]
```

Add the following to src/l4/Makeconf.local and the first two lines to src/kernel/fiasco/src/Makeconf.local if you want to use a non-default compiler.

```
CC=gcc-<version>
CXX=g++-<version>
OBJ_BASE=<full-path-to-build-dir>
```

Build Infrastructure

simple Makefile:

```
PKGDIR ?=     ../..
L4DIR  ?=     $(PKGDIR)/../..

SRC_C   =     main.c
SRC_CC  =     file.cc

TARGET  =     my_program
REQUIRED_LIBS =

include $(L4DIR)/mk/prog.mk
```

Generate template Makefiles and file structure:

```
kpr/src/l4/pkg$ mkdir my_pkg
kpr/src/l4/pkg$ cd my_pkg
kpr/src/l4/pkg/my_pkg$ ../../mk/tmpl/inst
```

Headers

Package headers are in:

```
kpr/src/l4/pkg/my_pkg/include/my_header.h
```

They are installed to

```
kpr/obj/l4/$ARCH/include/l4/my_pkg/my_header.h
```

Compiling

Compiling stuff

```
# build everything (e.g. in the beginning)
kpr$ make [-j X]
# build single pkg from build dir
kpr/obj/l4/amd64/pkg/my_pkg$ make
# build single pkg from source dir
kpr/src/l4/pkg/my_pkg$ make [O=<BUILDDIR>]
```

Run:

```
kpr/obj/l4/amd64$ make qemu [E=<entry>]
```

Qemu

Qemu configuration in `kpr/obj/l4/amd64/Makeconf.local`

- MODULE_SEARCH_PATH: Where binaries, config files, etc. are
- QEMU_OPTIONS: command line parameters

Boot configurations in `kpr/src/l4/conf/modules.list`

entry name

kernel fiasco <parameters>

roottask moe <program/startup script>

module modules to load (one per module-line)

IPC overview

- External resources are accessed through capabilities.
- Applications have a namespace containing capabilitites.
- Some magically appear at startup, others can be added in startup script.
- Communication requires capability to an IPC gate.

Lua

Example Ned config scripts can be found in

- src/l4/conf/examples
- src/l4/pkg/l4re-core/ned/doc/
- src/l4/pkg/examples/clntsrv

General idea for our simple usecase:

- Programs are started with `L4.default_loader.start`
- They take capabilities to channels (aka IPC gates) that are created with `L4.default_loader.new_channel`
- Programs can get a client or a server (`:svr()`) capability

IPC

In the program, these capabilities can be used to send and receive messages.
Server side:

- Register Server object (that implements handler) with the named cap.
- Run server loop
- Handle requests

Client side:

- Query IPC gate capability at name service.
- Invoke cap with arguments.

Sending data works with the UTCB (lecture). We use a high-level interface on top.

IPC interface

- Define a class that inherits from `L4::Kobject_t` that has a member function for each message type.

```
struct MyClass : public
    L4::Kobject_t<MyClass, L4::Kobject, MY_PROTO_NUM>
{
  L4_INLINE_RPC(int, foo, (int arg1, int arg2));
  typedef L4::Typeid::Rpcs<foo_t> Rcps;
};
```

- Functions return error code.
- All functions are listed in type Rcps.

IPC interface

- The server implements a class inheriting `L4::Epiface` that implements the methods.
- Types are converted between interface and implementation; special types for inout/out parameters, capabilities, arrays, etc. are available.
- If you need to send caps, the `L4::Kobject_t` needs a fourth template argument of type `L4::Type_info::Demand_t<NUM>`, with NUM being the maximum number of caps per call.
- See src/l4/pkg/examples/clntsrv for a example.
- See documentation doc/source/html/index.html (specifically e.g. doc/source/html/l4_cxx_ipc_iface.html)
- The source is the ultimate documentation (and it includes all the normal documentation).
- When you have questions, use the mailing list (kpr2021) or send me an email directly.

Assignment 1

- Download the repo, set it up and compile everything.
- Try it in Qemu, make sure that hello-cfg works.
- Build a client-server version of hello: The client should send a string to the server via ipc.
- As a second step, also consider large strings.
- Deadline on 31.10.21.

Next meeting

We “meet” next on 02.11.21, where we start the real project. A link will follow.