Operating Systems and Networks

Lecture 07:

Introduction to OS-part 5

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Recap

- ❑General recap of all we have learnt!
- ❑CPU, how computer starts? kernel/user mod, system calls, mutlitasking

Last week

- ❑Heap vs stack (what size is a proc stack?)
- ❑proc states and control block
- ❑context switching (just overhead ☹)
- ❑process and thread
- ❑process in linux

Contents

- ❑why do we need threads?
- ❑What is a thread?
- ❑What is multicore(multiprocess)?
- ❑How does it fit into the story.
- ❑Is more core ALWAYS better?
- ❑How are threads implemented?
- ❑End... move to networking

What is a thread?

- ❑program=/=process =/= thread
- ❑consider client’s accessing a server. Design a model for interaction?

Modern OS are multi-threaded, multiple threads operate in the kernel, and each thread performs a specific task:

- ❑managing devices
- ❑managing memory
- ❑interrupt handling.

What is a thread? (continue)

❑program=/=process =/= thread

❑Have you written a multi-threaded program?

main() + gc ...

❑Garbage collection!

❑if GUI many more

thread is a basic unit of CPU utilization

Single threaded process vs. multi-threaded process.

❑Why not multiple processes?

Data can be shared, but execution separated!

What is a thread? (continue)

Similar to process, a thread has

❑ thread ID,

❑program counter

❑register set

❑stack

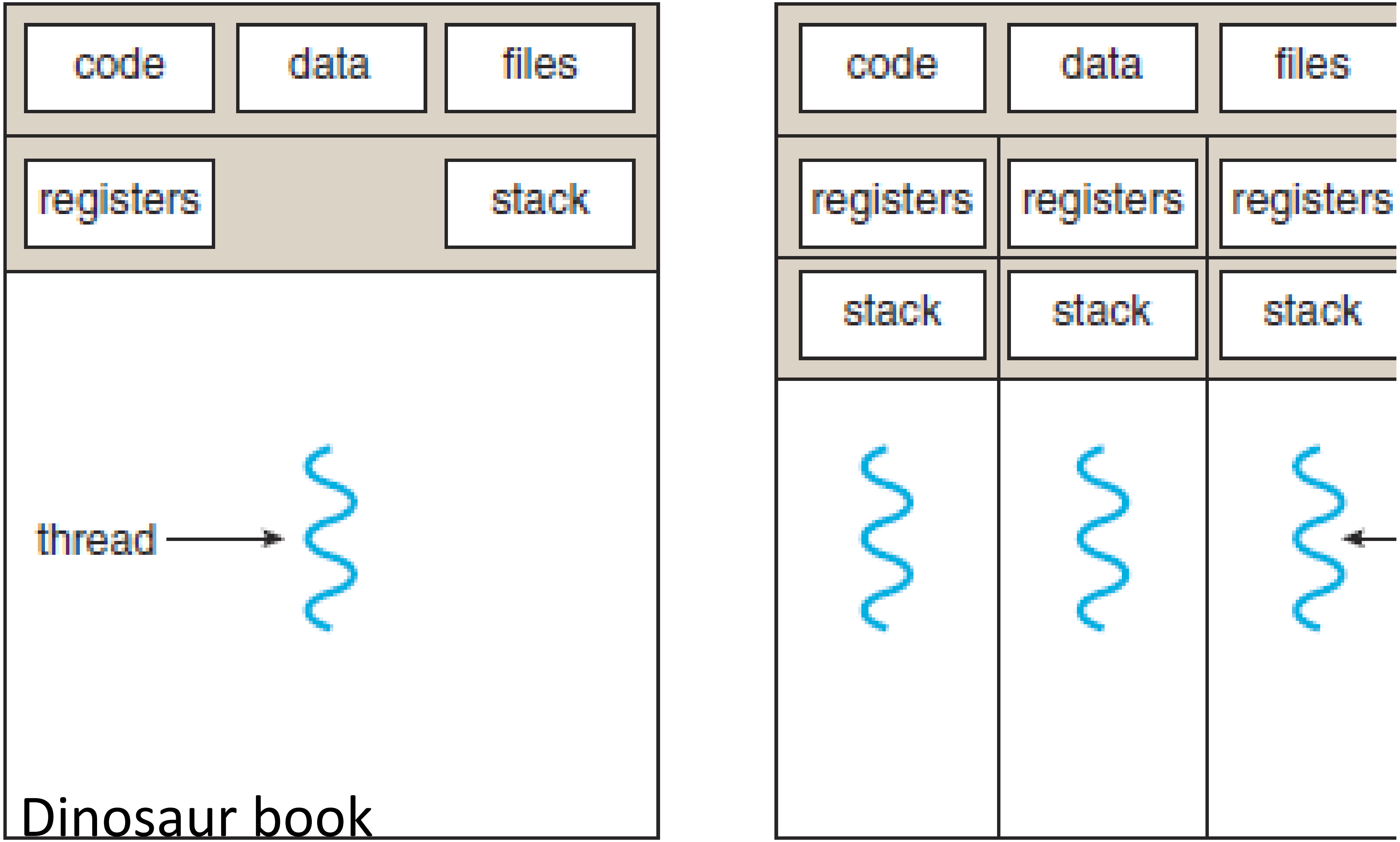
threads belonging to same process share

❑ code section

❑ data section

❑ OS resources, such as open files

single threaded vs multithreaded



Dinosaur book

How to see threads in Linux

- ❑ ps -e -T | grep firefox
- ❑-e all processes
- ❑-T all threads
- ❑Exercise: find out threads for a number of well know processes
- ❑*How many threads are running on your machine?*

Why threads?

❑Responsiveness

a time consuming operation or lengthy process not blocking the whole process

Single threaded GUI may block the usage

❑Resource sharing

Processes: shared memory and message passing (program writes code for them)

threads share the memory and the resources of the process to which they belong by default.

Why threads? (continue)

❑Economy.

Allocating memory and resources for process and context switching is computationally costly

threads share the resources of the process; more economical to create and context-switch threads.

[in some cases creating a process is about thirty times costlier and switching context is five times slower]

❑Scalability

multicore allows shared processing, so multi-threading is much faster than muli-processing

multi process, multicore and all that

- ❑multiprocess: many CPU chip

Symmetric and asymmetric design

- ❑multicore: single CPU chip has multiple computing core (register, cache…)

- faster communication (as no inter process communication)
- significantly less energy consumed

Be aware: people use two phrases interchangeably!

- ❑blade server (data centre and Cloud):

processor process, I/O boards, and networking cards are placed in the same chassis

multicore

- ❑single core one thread executing at at time, two cores two threads…
- ❑Single core illusion of parallelism (by fast switching) , multiple core true parallelism
- ❑in single core task run concurrently not parallel

Amdahl’s law

❑if I add core will I always make execution faster?

speed up $\leq \frac{1}{S+\frac{1-s}{N}}$

❑ s percentage of portion that are serial

❑N number of processing cores

what happens if N becomes large (N → ∞)….

throwing in more core is not going to solve the problem always!

You may need to change the program!

Threads an operating system

❑user level threads

❑kernel level threads (managed by kernel support)

What is the relationship between the two groups:

❑many-to-one model

❑one-to-one model

❑many-to-manymodel.

many to one

❑multiple user-level threads to one kernel thread

❑Thread management is done in user space so it is efficient

Not used widely any more:

Only one thread can access kernel at a time

❑All involving process block if a thread makes a blocking system call

❑multiple threads are unable to run in parallel on multicore systems.

one-to-one

- ❑linux and window use this
- ❑Each user thread is mapped to a kernel thread
- ❑When a thread makes blocking system call, another thread can run.
- ❑multiple threads can run in multiprocessors.
- ❑But resource hungry and burden on performance
- ❑Upper bound on the number of threads
- ❑What is the maximum number of threads allowed on my machine?

```
cat /proc/sys/kernel/threads-max
```

many-to-many model

- ❑many user-level threads are handled by multiple kernel threads.
- ❑Developer can create as many user thread
- ❑kernel can schedule one thread create maximum concurrent user threads is bounded by number of kernel threads
- ❑when threads run in parallel on a multiprocessor there is advantage
- ❑when one thread performs a blocking system call, the kernel can schedule another thread for execution.

How to program threads?

thread library: API for creating and managing threads.

1. A library entirely in user space with no kernel support i.e. a local function call in user space and not a system call.
2. a kernel-level library supported directly by the operating system, i.e. code and data structures for in kernel space.

❑Invoking a function in the API for the library typically results in a system call to the kernel.

How to program threads? (continue)

main thread libraries:

1. Windows (uses kernel level library on Windows)
2. POSIX Pthreads (both user and kernel level)

posix? [

(Portable Operating System Interface)

family of standards by IEEE, ensure compatibility

Unix like, but microsoft supports some parts, why?]

cygwin posix compliant

3. Java threads: implemented using a thread library available on the host system[windows or pthread]

❑Java threads are object: implement runnable or extend thread…

communication and networking

❑End of preliminaries of OS

Be aware:

❑lots left to learn

❑similarities/differences between OS

❑some topics important and we did not study: (memory access, registry/hive,…)

❑Communicating processes (on a machine and across)

❑ You know one method for processes to communicate???

pipe |

- ❑ command1 |command2 (both in window and linux | dir |more)
- ❑ pipes allow to process to communicate
- ❑ but how?
- ❑ a temporary file is generated on disk
- ❑ command1 writes into it and command2 reads?
- ❑ but how?
- ❑ standard input, standard output and standard error. (next lecture)
- ❑ ordinary pipe (anonymous pipe in Windows)
- ❑ named pipe (mkfifo) we dont study this.
- ❑

Summary

- ❑Motivated and studied the reason for threads
- ❑threads are units of computation
- ❑multicore is better for threads
- ❑sequential part of core dictates how many core can be useful… need to change code to benefit from manycore
- ❑everything in linux is treated as files even pipe
- ❑further mystery!