Parallel programming

Introduction

Libor Bukata a Jan Dvořák

FAKULTA
ELEKTROTECHNICKÁ
ČVUT V PRAZE

Instruktors

- Libor Bukata

- Jan Dvořák

Web sites

- https://cw.fel.cvut.cz/wiki/courses/b4m35pag/start

[[courses:b4m35pag:start]]

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Paralelní algoritmy (B4M35PAG)

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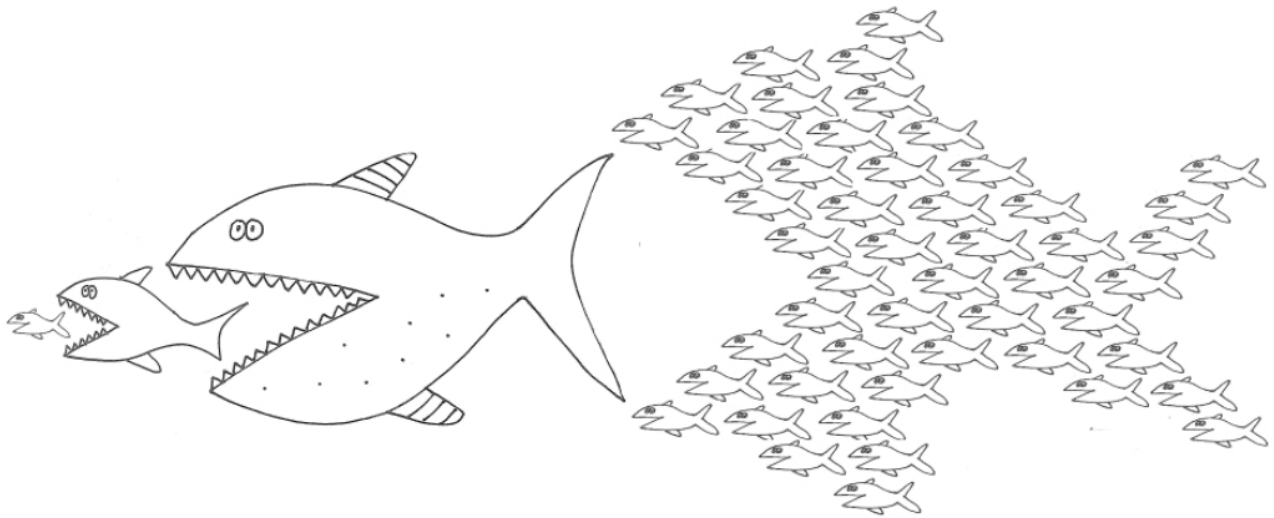
  - Literatura

Přednášející: Přemysl Šůcha

Cvičící: Jan Dvořák a Libor Bukata

Rychlé odkazy: Paralelní algoritmy - cvičení, Upload system, Diskusní Fórum, Kde najdete místnosti, Rozvrh předmětu, Časový plán akademického roku.

Proč paralelní algoritmy?



Novinky

Vítáme Vás na stránkách nového předmětu věnovaného paralelním algoritmům. Věříme, že předmět bude pro Vás přínosem.

Academic calendar

04.10.	Introduction to Parallel programming
11.10.	Pthreads
18.10.	C++11 threads
25.10.	1. individual lab assignment (ILA), semestral work assignment
01.11.	Basics of OpenMP
08.11.	Advanced statements in OpenMP
15.11.	2. ILA, **deadline for submission** of **1. ILA**
22.11.	*Consultation of the semestral work*
29.11.	OpenMPI
06.12.	3. ILA, **deadline for submission** of **2. ILA**
13.12.	*Consultation of the semestral work*
20.12.	**Presentation** of results from **semestral work**
27.12.	**Deadline for submission** of **3. ILA**
03.12.	*Reserve*

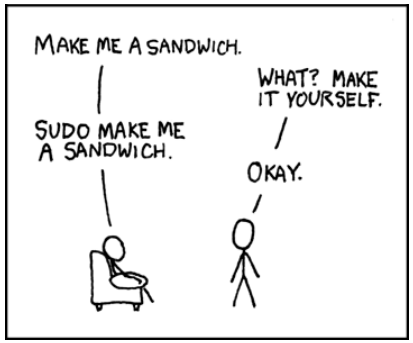
What is the aim of this lab?

- To get the feel for parallel programming
  1) Understand what makes the parallelisation **complicated**
  2) Which **problems** can occur during the paralellisation
  3) What can be a **bottleneck**
  4) How to think about **algorithms** from the paralellsation point of view

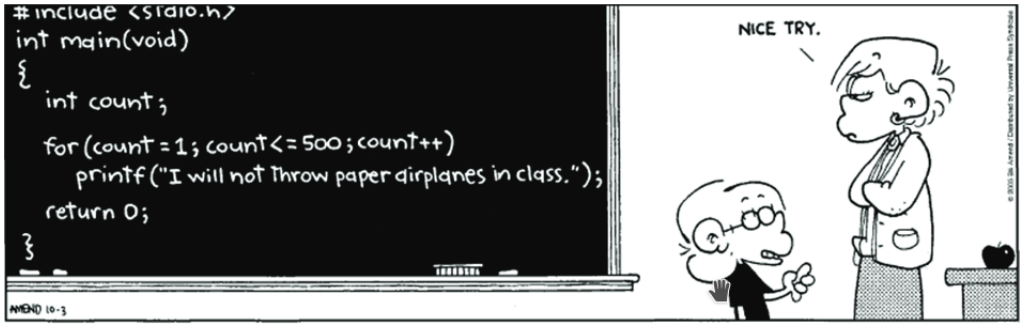
- To get basic skills in common parallel programming frameworks
  1) for Multicore processors – Pthreads, C++11 threads, OpenMP
  2) for Computer clusters – OpenMPI

What this course requires?

- Basic skills with Linux – shell, ssh, etc.



- Knowledge of C and C++ language

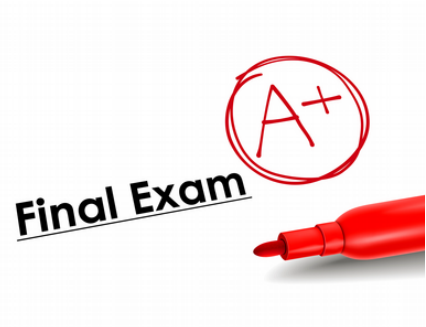


- Analytical thinking and opened mind

How will we evaluate you?

- Labs
  - Each Individual Lab Assignment – **7 points**
  - Semestral work – **14 points**
- Lectures
  - Teoretical test (optional) – **10 points**
- Final Exam
  - Written exam – **45 points**
  - Oral exam – **10 points**

- **Pass criteria:**
  - **Assignment:** Everything submitted + at least 25 points
  - **Exam:** At least 25 points from written exam



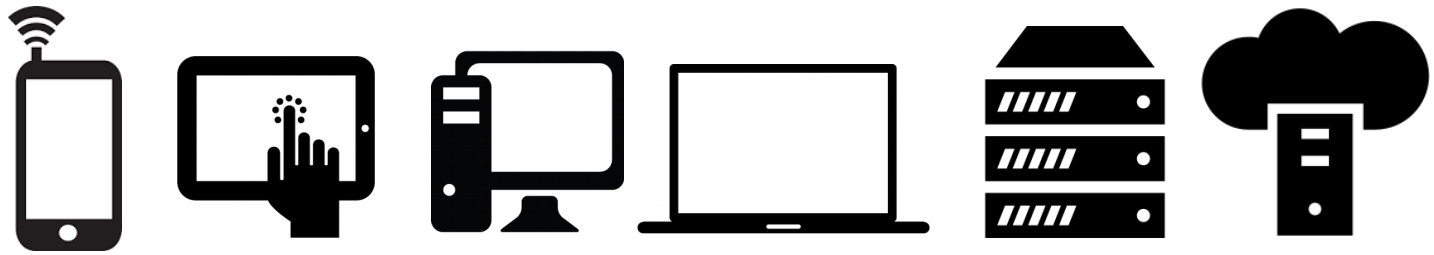
Parallel programing – the first cut

No questions?

Let's start with our business!

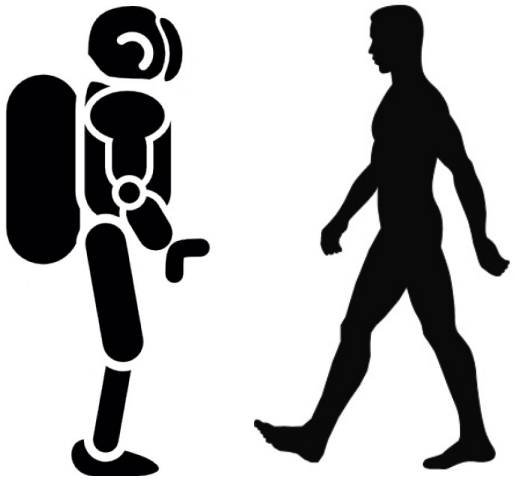
Why should you care about it?

- Parallel computing is a dominant player in scientific and cluster computing. Why?
  - Moore law is reaching its limits
    - Increase in transistor density is limited
    - Memory access time has not been reduced at a rate comparable with processing speed
- How to get out of this trap?
  - Most promising approach is to have multiple cores on a single processor.
  - Parallel computing can be found at many devices today:



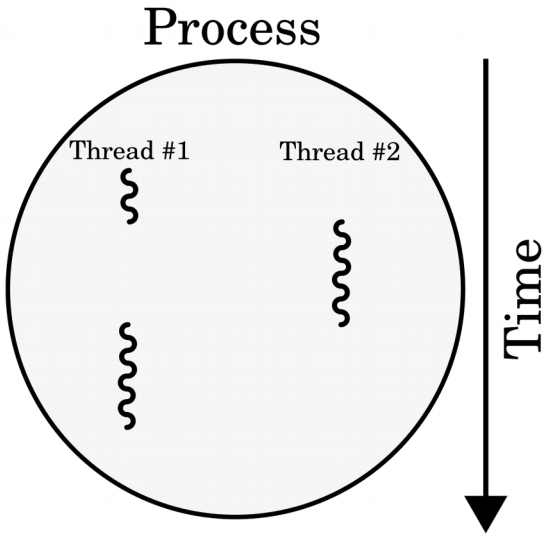
Ok; However, It should be task for compiler and not for me!!!

- Yes, compiler can help you, but without your guidance, it is not able pass all the way to the successful result.
  - Parallel programs often look very different than sequential ones.
  - An efficient parallel implementation of a serial program may not be obtained by simply parallelizing each step.
  - Rather, the best parallelization may be obtained by stepping back and devising an entirely new algorithm.



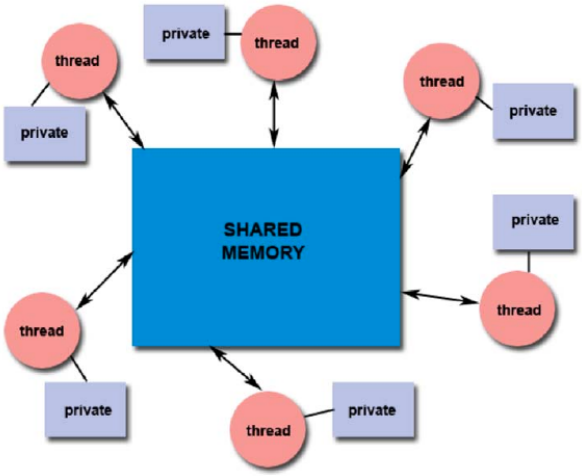
Basics of Parallel programming theory Terms

- Program
  - Collection of instructions designed to perform a group of coordinated functions
- Process
  - Instance of a program that is being executed.
  - Multiple processes are typically independent
  - It has its own memory space.
- Thread
  - Sequence of instructions that is managed independently by system scheduler.
  - Subset of process
  - Multiple threads within process share the memory space.
- Task
  - Unit of execution

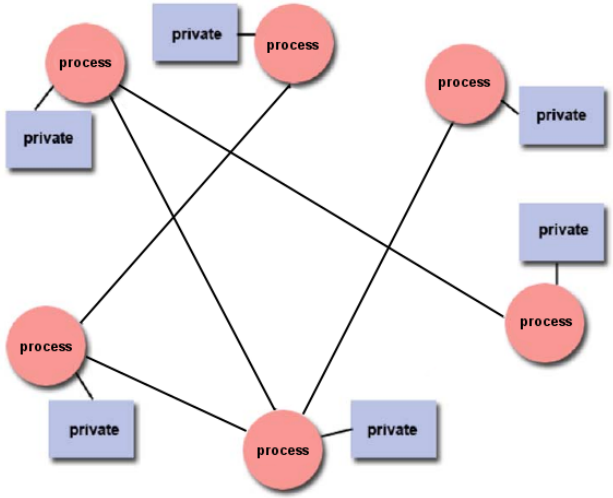


Basics of Parallel programming theory
Memory architectures

- **Shared memory**
  - All functional units share the common memory space.
  - When a functional unit share the value in the common memory space another functional unit can access this value.



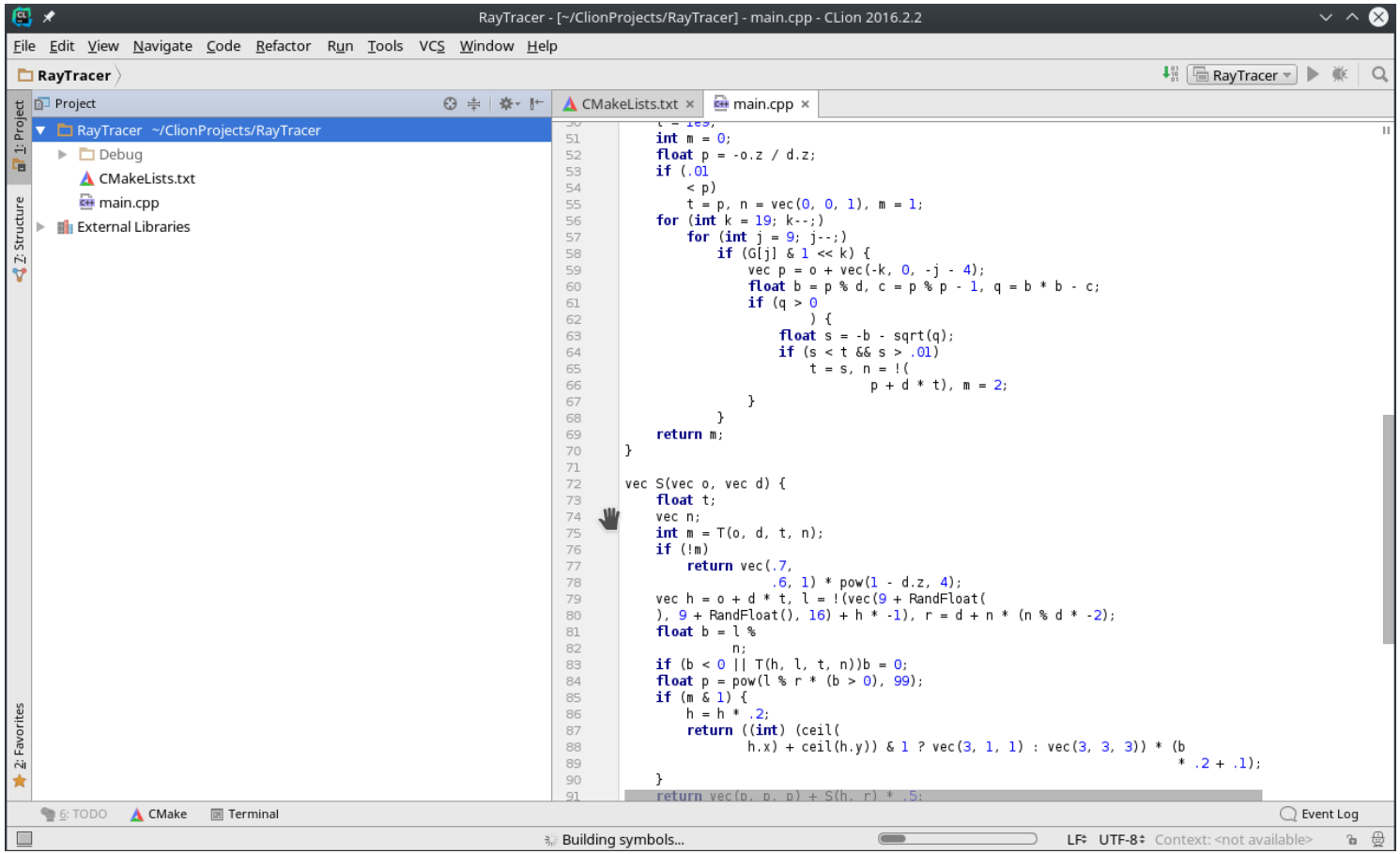
- **Distributed memory**
  - Each functional unit has its own private memory space.
  - When two or more units need to share a value, they have to exchange this value by a message transmitted through the network.



That was theory and now something practical!

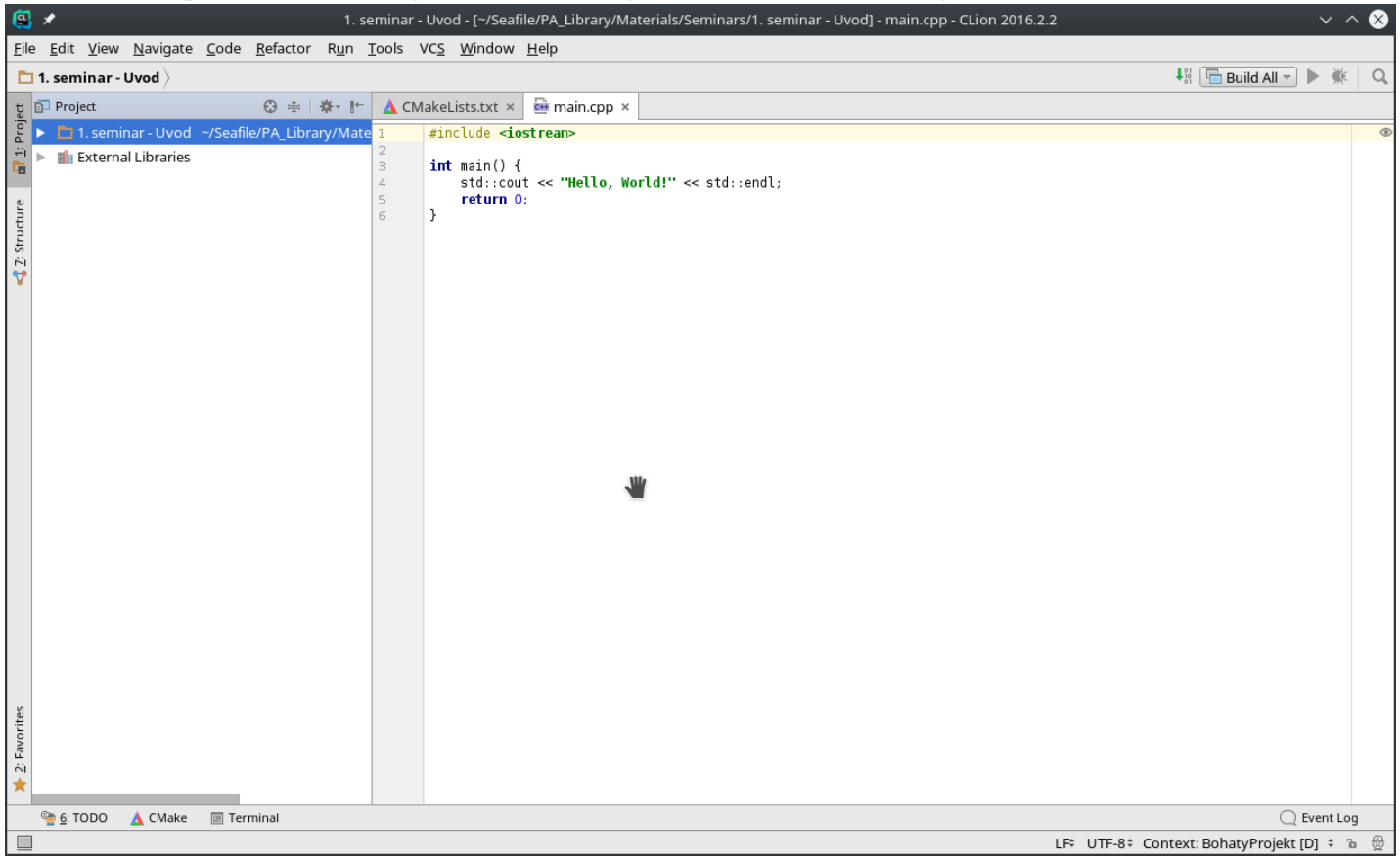
Clion IDE

- Licence server - https://turnkey.felk.cvut.cz/



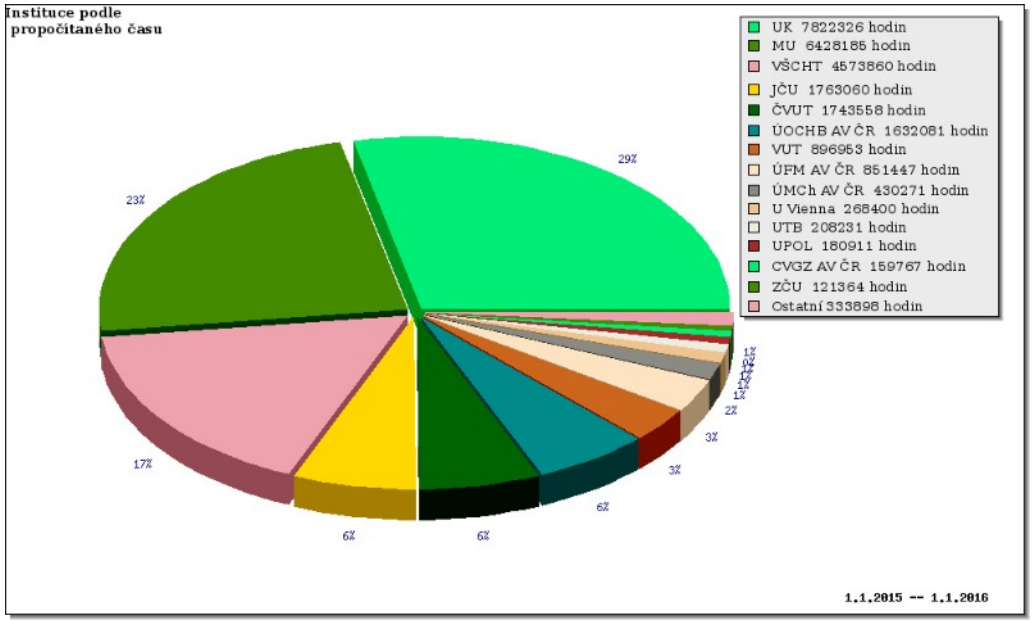
Hello world for free

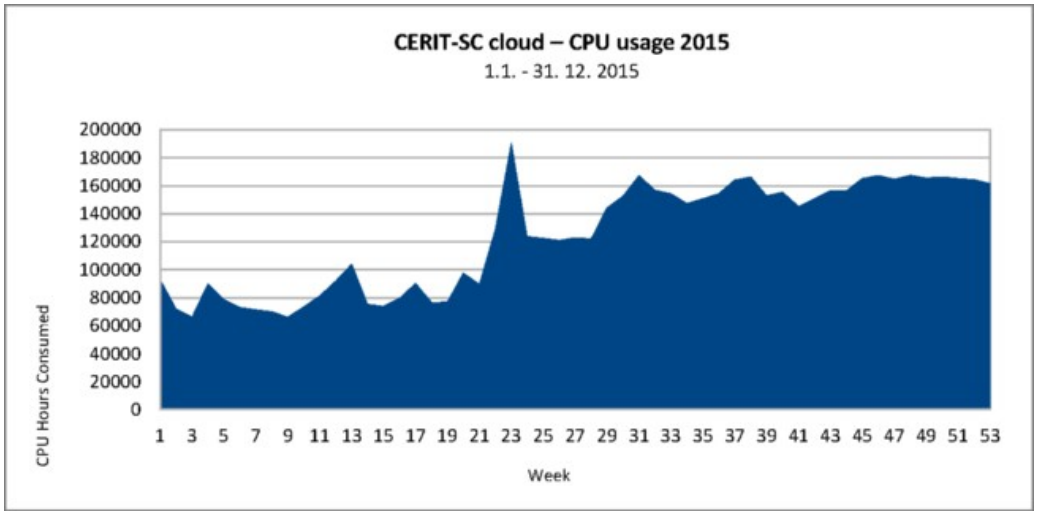
- Live example and walk-through
  - Create project, Build code, Run code, Debug code,
  - Code profiling – valgrind, callgrind



Metacentrum system

- operates and manages **distributed computing** infrastructure consisting of computing and storage resources owned by **CESNET**
- MetaCentrum membership is free for researchers and students of academic institutions in the Czech Republic





MetaCentrum – Sign up

- How to sign up

Metacentrum – How to run code?

- Example of the execution of a program
  - qsub
  - module
  - $SCRATCHDIR
  - $PSB_O_WORKDIR
- Running jobs in MetaCentrum
  - https://wiki.metacentrum.cz/wiki/Running_jobs_in_scheduler
- Detailed description of the scheduling system
  - https://wiki.metacentrum.cz/wiki/Scheduling_system_-_detailed_description
- Application modules
  - https://wiki.metacentrum.cz/wiki/Application_modules

That was nice, wasn't it?

Thank you for your attention...