

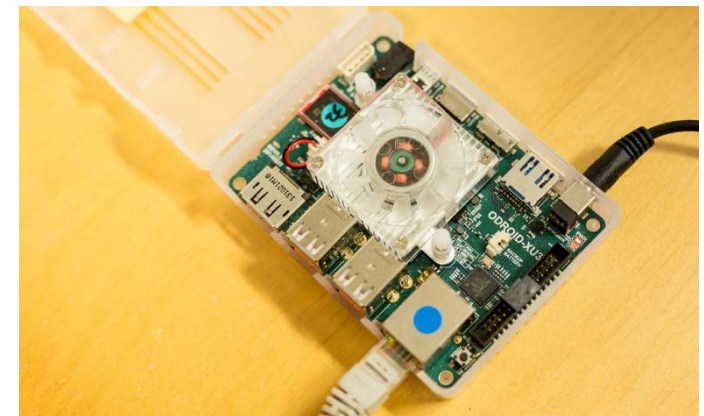
**COLA: Computing on Low-Power Architectures,  
Ferrara, Italy, 25-26 February, 2016**



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## **Climbing Mont Blanc – A Prototype System for Training in Energy Efficient Programming**

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Dept. of Computer and Information Science  
Norwegian University of Science and Technology**



# Outline

- The inspiration
- What is Climbing Mont Blanc (CMB)?
- Early experience
- Future work



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# The inspiration

- Using Exynos SoC from Samsung
  - ARM big.LITTLE + **Mali GPU**
  - Sold in large numbers
    - Samsung Galaxy mobile phones ++
  - Energy efficiency
  - Very challenging programming

GPU family started  
by NTNU-students  
→ Falanx → ARM  
Media Processing  
Division



750 million  
**Mali GPUs**  
sold in 2015!

## MONT-BLANC

<http://www.montblanc-project.eu>

European scalable and power  
efficient HPC platform based on  
low-power embedded technology

Alex Ramirez

Barcelona Supercomputing Center

Technical Coordinator



Now: Filippo



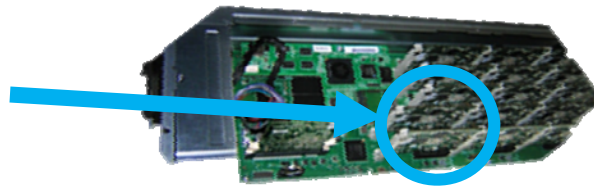
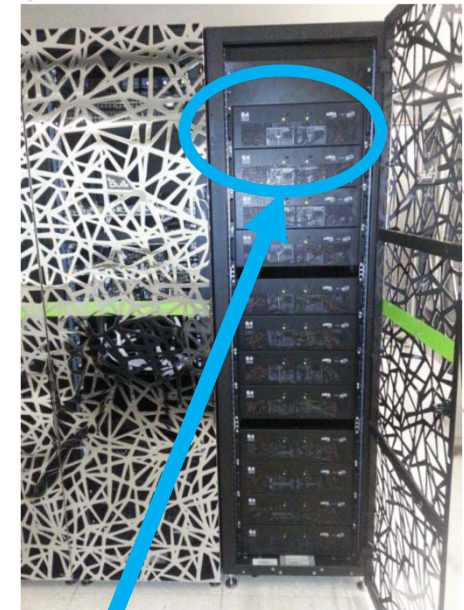
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# MONT-BLANC

26 TFLOPS – 18KW

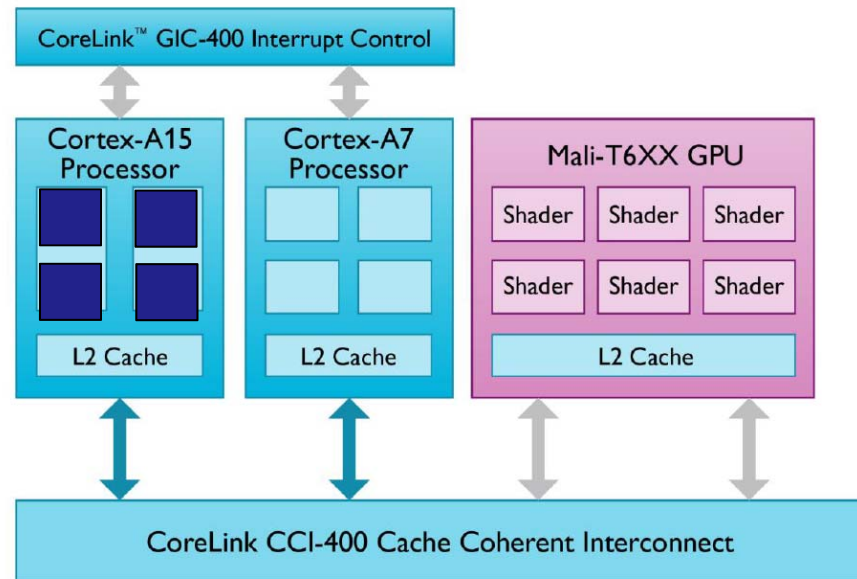
- Prototype
  - Exynos 5 based (32.3GFLOPS – CPU+GPU)
  - One blade: 15 compute cards (30 Cortex A15 + 15 Mali-T604)
  - One chassis: 9 blades (270 Cortex A15 + 135 Mali-T604)
  - Prototype: 6 chassis (1620 CPUs + 810 GPUs)



# The idea

1. The need for energy-efficiency (Mont Blanc project)
2. Difficult programming
  - Exynos 5422 is **“3-way heterogeneous” with 14 cores**
  - → need for training
3. How to get programmers? ...

Exynos 5422  
has 4x A15



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#	Problem	User	Verdict	Language	Run Time	Submission Date
16096060	763 Fibinary Number...	Ahmad Elsa...	Accepted	JAVA	0.312	2015-09-13 20:52:03
16096059	763 Fibinary Number...	Adria Gar...	Wrong answer	C++	0.000	2015-09-13 20:51:56
16096058	763 Fibinary Number...	Duban Caro...	Time limit exceeded	C++	1.000	2015-09-13 20:51:54
16096057	763 Fibinary Number...	Abdullah Chea...	Wrong answer	C++	0.000	2015-09-13 20:51:52
16096056	763 Fibinary Number...	Mostafa Ga...	Time limit exceeded	C++11	3.000	2015-09-13 20:51:49
16096055	763 Fibinary Number...					2015-09-13 20:51:29
16096054	763 Fibinary Number...					2015-09-13 20:51:23
16096053	11631 Dark road					2015-09-13 20:51:09
16096052	12940 Next Palindromic					2015-09-13 20:51:05
16096051	11321 Sort! Sort!					2015-09-13 20:51:05
16096050	12075 Counting					2015-09-13 20:50:56
16096049	100 The 3n+1 problem					2015-09-13 20:50:24
16096048	12940 Next Palindromic					2015-09-13 20:49:38
16096047	1188 Enigma					2015-09-13 20:49:33
16096046	1296 Last day of the month					2015-09-13 20:49:15
16096045	1296 Last day of the month					2015-09-13 20:49:15
16096044	1296 Last day of the month					2015-09-13 20:49:07
16096043	543 Goldbach's conjecture					2015-09-13 20:49:04
16096042	455 Periodic					2015-09-13 20:48:40
16096041	12959 Strategy Game	Carlos Men...	Accepted	C++	0.019	2015-09-13 20:48:09

## UVA Online:

(Universidad de Valladolid, Spain)

\* 16 million submissions so far

\* 9 submi

Current UTC (or GMT)-time: 2015-11-16 09:31:56

## Live rankings at UVa Online Judge

Only new AC or cpu time improved

RANKING (UTC)	SUBMISSIONS	RANKING	SUBMISSIONS
<a href="#">Actual hour</a>	144	<a href="#">Last 60 minutes</a>	233
		<a href="#">Last 4 hours</a>	4164
		<a href="#">Last 7 days</a>	32567
		<a href="#">Last 30.44 days</a>	162868
		<a href="#">Last 65.24 days</a>	1875532
		<a href="#">Overall</a>	16316519

## Peking University Online Judge:

\* Close to 15 million submissions so far

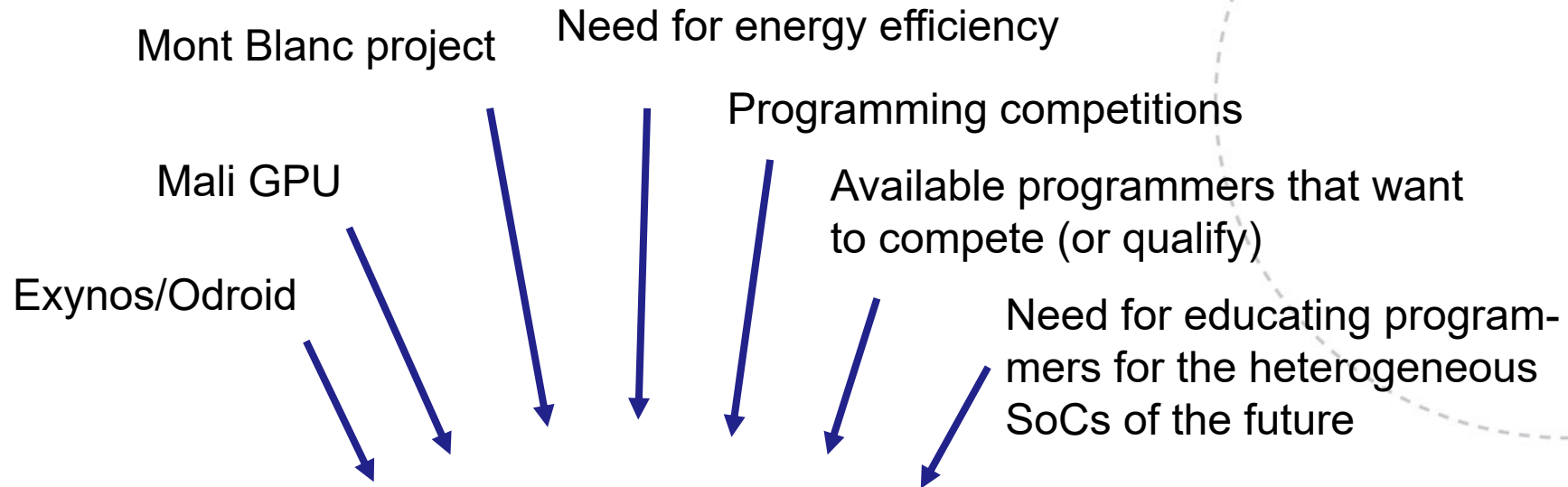
\*  $\approx 3000$  per day

# The force (Background)

- UVA Online (Spain) (16 million submissions)
- PKU (Peking University) (14 million)
- **KATTIS (KTH, Sweden)**
- Jutge.org
- TopCoder
- Sphere Online Judge
- HackerRank
- CodeChef
- LeetCode
- Timus Online Judge
- A2 Online Judge
- URI Online Judge



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<https://climb.idi.ntnu.no/>

**Public Problems**

Problem ID	Name	Go To Problem
1	The shortest path problem	Go To Problem
2	The traveling salesman problem	Go To Problem
3	The vertex cover problem	Go To Problem
4	Hello World	Go To Problem
5	Sorting Algorithms	Go To Problem
6	Battleship	Go To Problem
7	Bottles	Go To Problem

**Public Groups**

Group ID	Name	#Members	Go To Group
2	IDI Open training	3	Go To Group
1	TDT4125	2	Go To Group

**TDT4200\_h2015 Highscore (time)**

User	Time (s)	Energy (j)	EDP (js)	Filename
Yulongb	1.53	7.37	11.27	vectorized_v7
Bartiver	2.03	6.95	14.10	PS6_LF_v1
Sindresf	2.15	7.61	16.37	climb_ps6_vec_4made1_ss
Havarbar	2.19	8.47	18.54	havarbar_ps6_v6
Arntul	2.20	8.02	17.64	CMB_simpleVec_v4
Floriamd	2.23	7.65	17.06	cmb_code_v2
Jonandme	2.23	7.26	16.19	jonandme_code_ps6_v6
Runeerle	2.24	7.64	17.11	basicVector
Jonaswai	2.24	7.90	17.70	jonaswai_code_ps6_v2
Jabirali	2.29	8.00	18.31	babacode
Einarnyb	2.41	9.17	22.11	ImprovedBaba
Richarji	2.95	9.83	28.99	k_v4

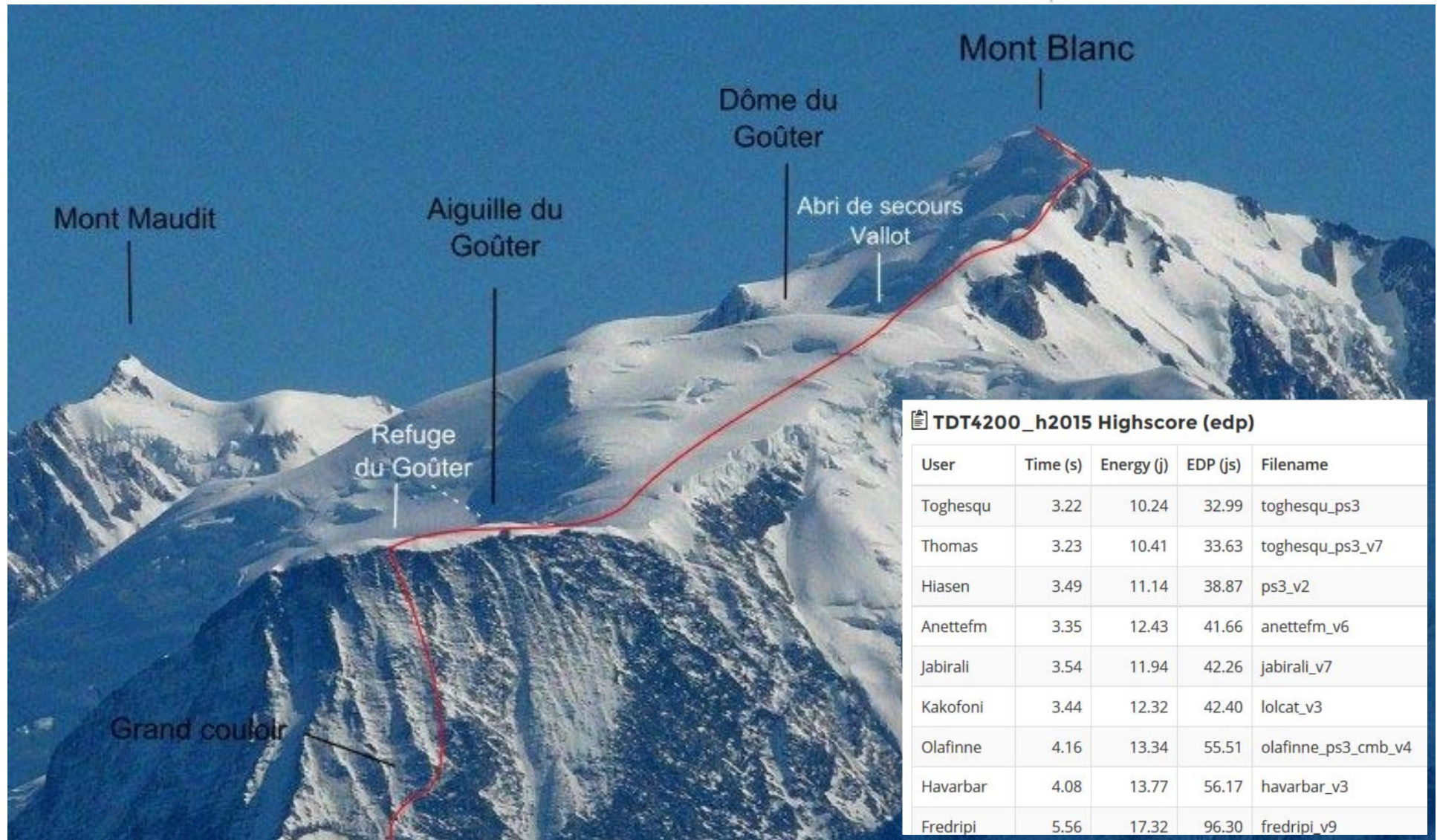


# CMB SHORT INTRO



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# CMB - the name



📄 TDT4200\_h2015 Highscore (edp)

User	Time (s)	Energy (j)	EDP (js)	Filename
Toghesqu	3.22	10.24	32.99	toghesqu_ps3
Thomas	3.23	10.41	33.63	toghesqu_ps3_v7
Hiasen	3.49	11.14	38.87	ps3_v2
Anettefm	3.35	12.43	41.66	anettefm_v6
Jabirali	3.54	11.94	42.26	jabirali_v7
Kakofoni	3.44	12.32	42.40	lolcat_v3
Olafinne	4.16	13.34	55.51	olafinne_ps3_cmb_v4
Havarbar	4.08	13.77	56.17	havarbar_v3
Fredripi	5.56	17.32	96.30	fredripi_v9

# CMB select group or problem

The screenshot shows the homepage of the Climbing Mont Blanc (CMB) website. The browser address bar displays <https://climb.idi.ntnu.no/#/>. The website header includes the logo "Climbing Mont Blanc" and navigation links for "Home" and "How To". On the right side of the header, there are links for "Login" and "Sign up".

The main content area is titled "HOME PAGE" and is divided into two sections:

- Public Problems:** A table listing seven problems, each with a "Go To Problem" button.
- Public Groups:** A table listing two groups, each with a "Go To Group" button.

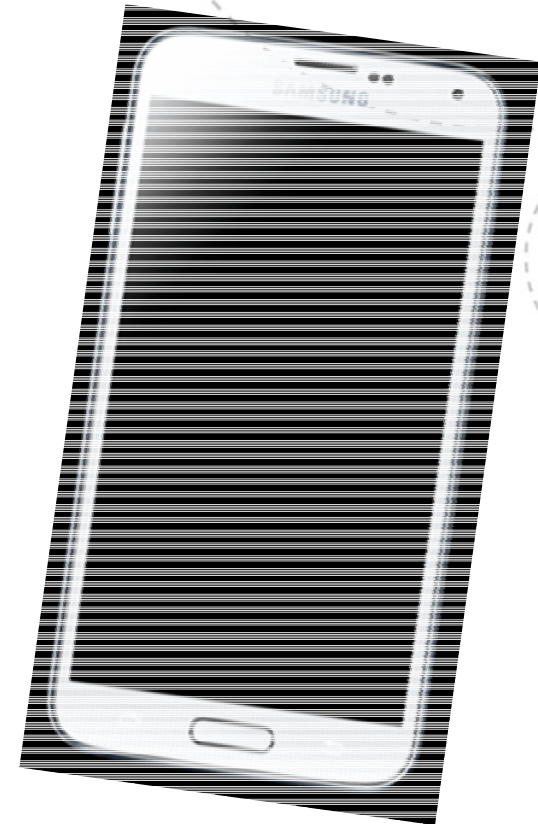
Problem ID	Name	Action
1	The shortest path problem	<a href="#">Go To Problem</a>
2	The traveling salesman problem	<a href="#">Go To Problem</a>
3	The vertex cover problem	<a href="#">Go To Problem</a>
4	Hello World	<a href="#">Go To Problem</a>
5	Sorting Algorithms	<a href="#">Go To Problem</a>
6	Battleship	<a href="#">Go To Problem</a>
7	Bottles	<a href="#">Go To Problem</a>

Group ID	Name	#Members	Action
2	IDI Open training	3	<a href="#">Go To Group</a>
1	TDT4125	2	<a href="#">Go To Group</a>



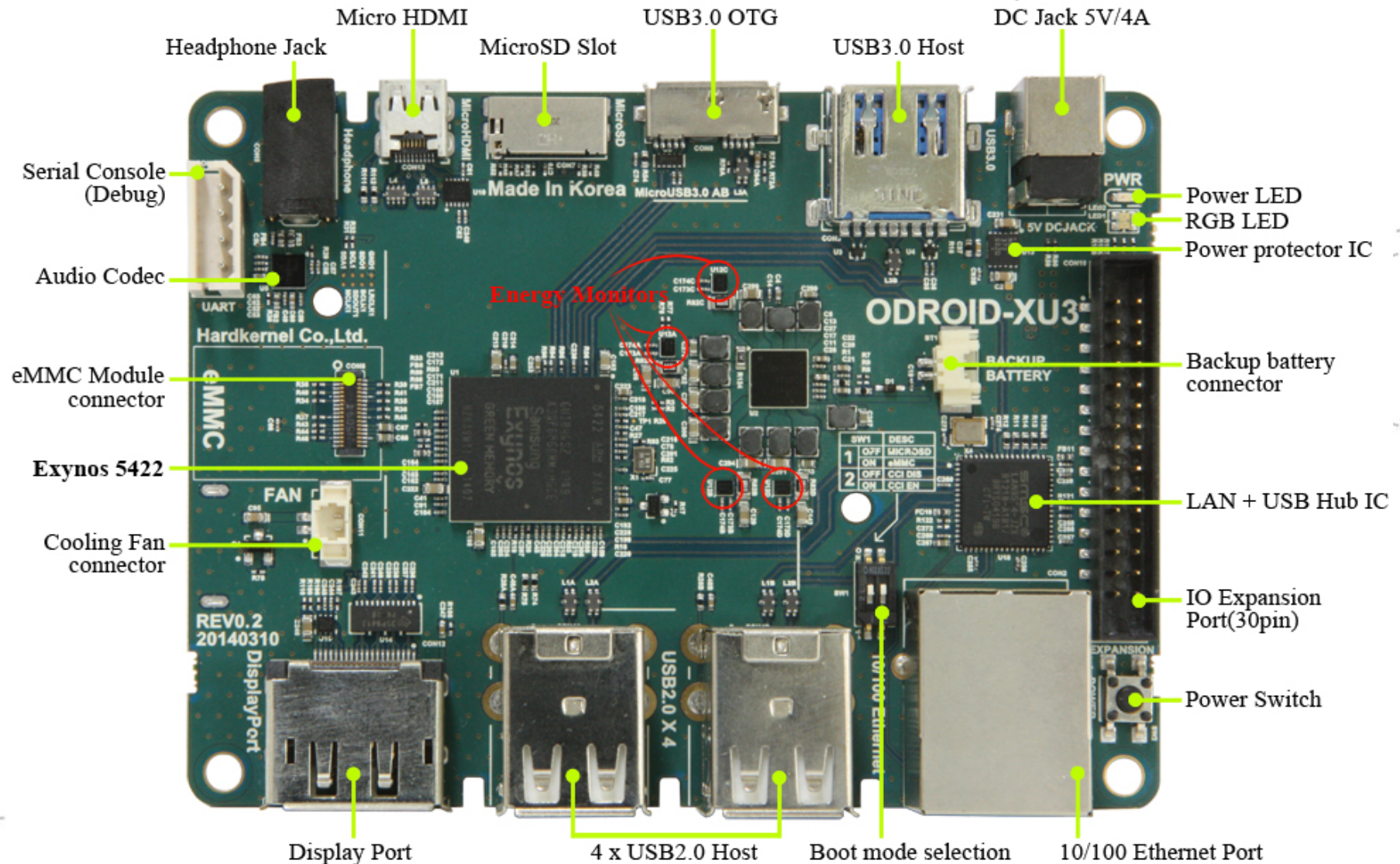
# Odroid XU-3

- Odroid board from hardkernel.com
  - Full details at [http://www.hardkernel.com/main/products/prdt\\_info.php?g\\_code=G140448267127](http://www.hardkernel.com/main/products/prdt_info.php?g_code=G140448267127)
- Samsung Exynos 5422
  - Cortex™-A15 2.0Ghz quad core & Cortex™-A7 quad core CPUs
  - Mali-T628 MP6 533 MHz
  - ubuntu or android



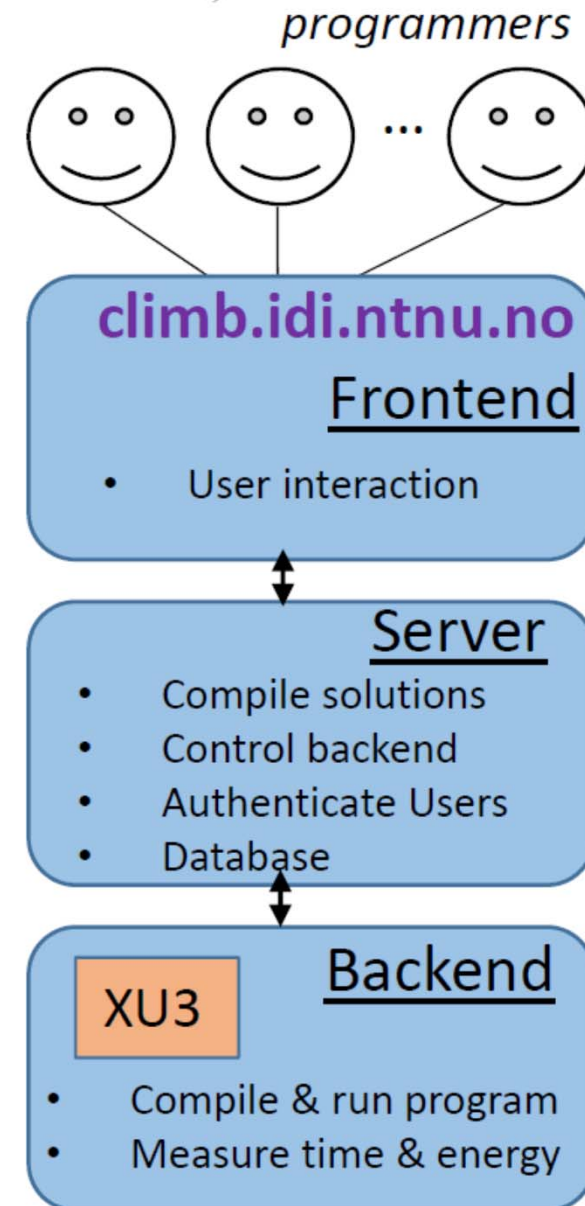
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# Odroid XU-3



# CMB technical overview

- Currently
  - C, C++, OpenCL
  - Pthreads, OpenMP 4.0
- Coming (?)
  - OmpSs
  - Java, python, Haskell?
  - MPI
- More info
  - Workshop paper at [arXiv:1511.02240](https://arxiv.org/abs/1511.02240)





# EARLY EXPERIENCE



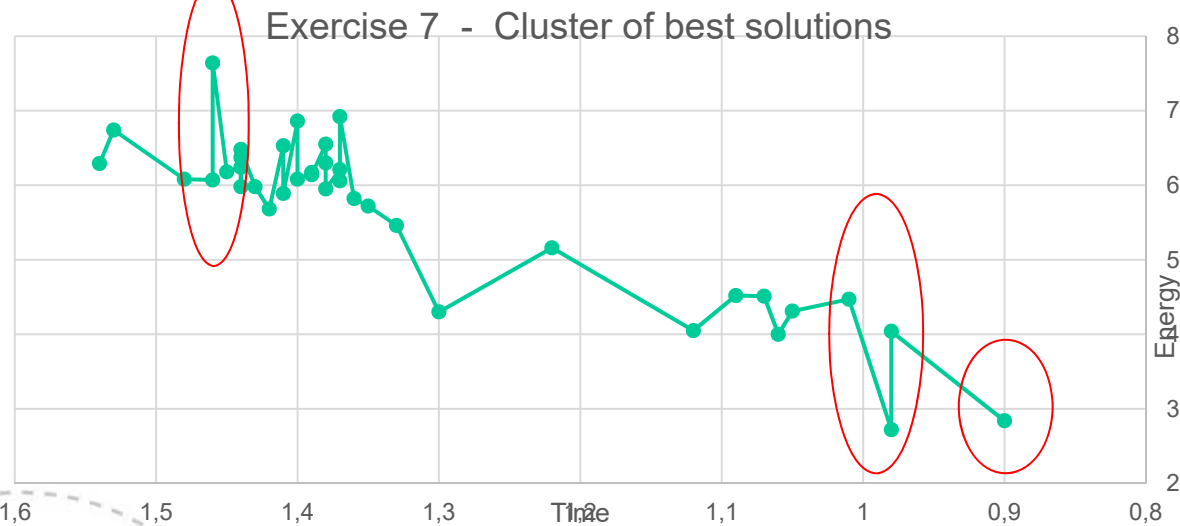
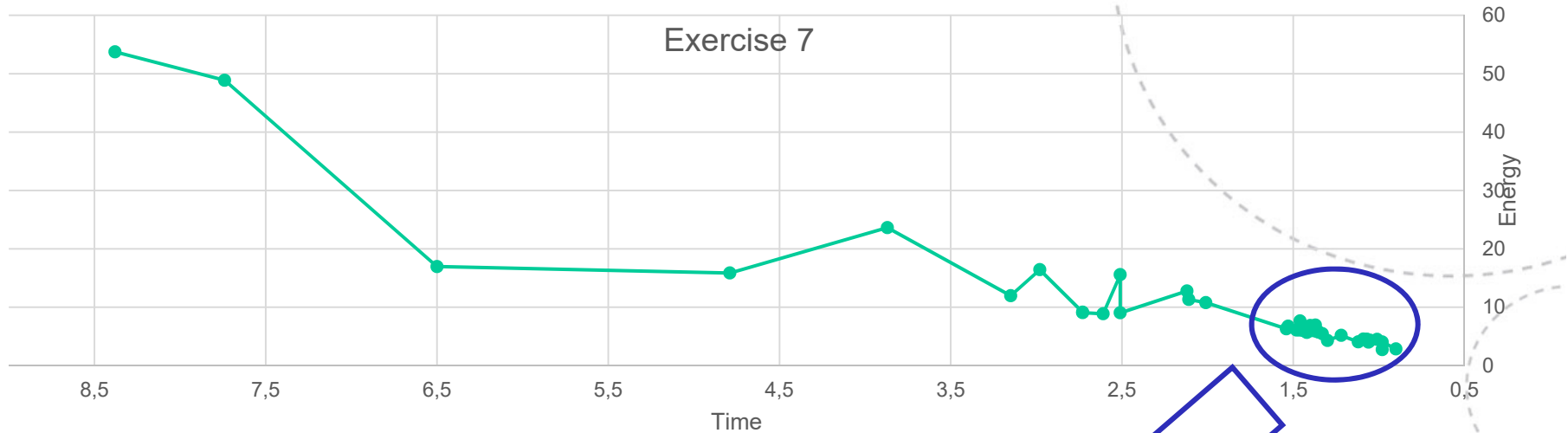
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# CMB - VERY early experience

- 5 programming exercises in a course on parallel computing
  - Autumn 2015, approx. 65 students
  - CMB as one of three experimental platforms
  - Students also used
    - desktops w/NVIDIA-GPU
    - Supercomputer Vilje, 22000+ cores



# Submitted solutions to Exercise 7



Energy used  
vs. shorter  
execution time

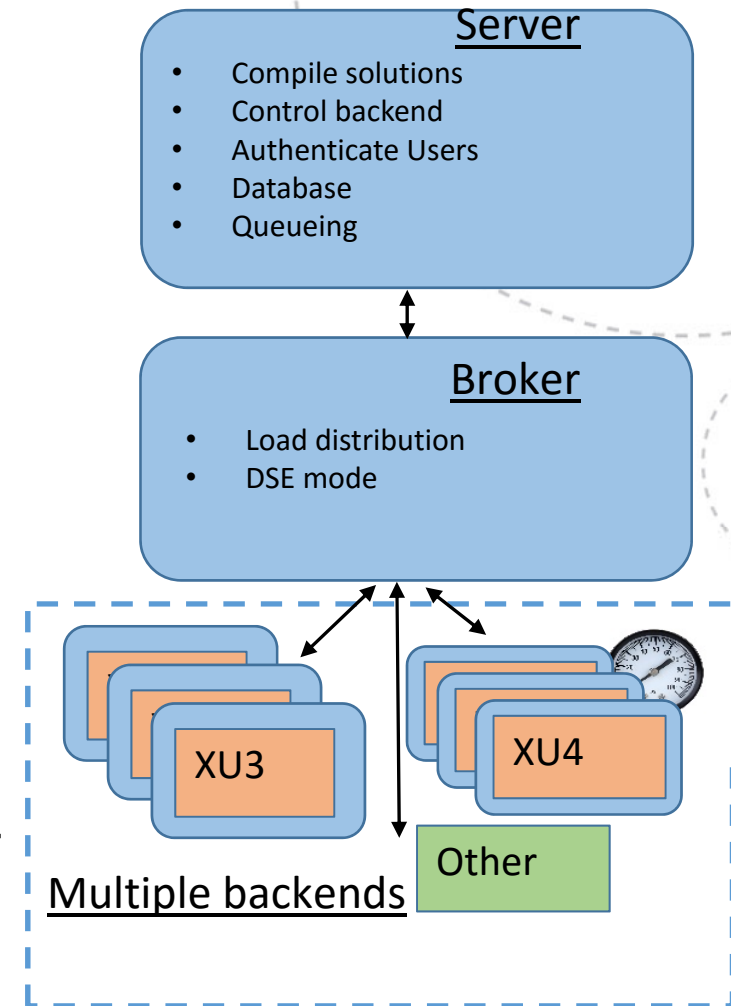


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# Future work

- Spring 2016
  - Optional use in C++ course with 800+ students
  - Improved functionality & capacity
    - Dispatcher/Broker
    - DSE mode
  - More languages
- Sabbatical autumn 2016
  - Developing more problems
    - Parallel programming
- More tests in C++-course spring 2017
- More platforms
  - Newer Odroid-boards? / Exynos?
  - Kirin from Hi-Silicon (Huawei)?



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# Potential models for collaboration

- Application cases/kernels → define problem (now, easy)
  - Precise problem specification
  - Small data set (input, correct output)
  - “Big” data set (Correct output not visible, to avoid cheating)
  - Checker.cpp
    - Checking byte by byte is often not what you want
    - Floating-point operations, approximation problems
  - Optional user-defined “goodness”-parameter
- System development
  - GUI?, statistics?, ...
- Best practice, build experience, textbook? (long term)
- “Stay tuned” at <https://www.ntnu.edu/idi/card/cmb>



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# QUESTIONS?

Read more:

arXiv:1511.02240

Vacant position: 30 months (+?) at ARM Norway, 60% at NTNU

<https://www.hipeac.net/jobs/9025/teaching-and-research-position-at-the-arm-card-lab/>

- Systems SW with energy-efficiency
- HW/SW interface, GPU
- Post.doc level
- Application deadline 31 March

Contact: [Lasse.Natvig@idi.ntnu.no](mailto:Lasse.Natvig@idi.ntnu.no)



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# Demo ...

Writing course r... Skrive emnerap... Run - Admin Climbing Mont ... Overview - Goo... Computing on L...


https://climb.idi.ntnu.no/#/group/7

HiKey kirin

Climbing Mont Blanc Home How To Login Sign up

PUBLIC GROUP

Login to join group.

 COLA workshop 2016

Demonstration group for the COLA workshop (Computing on Low-power Architectures Workshop) in Ferrara, Italy, 25-26th February, 2016.

**Problems**

Problem ID	Name	State	
33	Hello Italy		<a href="#">Go To Problem</a>
34	Text search		<a href="#">Go To Problem</a>
5	Sorting Algorithms		<a href="#">Go To Problem</a>