Green Computing: Managing Power Consumption in Parallel Applications

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2016: 3% of the global electricity (more than Italy or United Kingdom) Cost of the **energy** overcomes cost of the hardware



Trade power for performance (and viceversa)

Different **algorithms** (heuristics, machine learning, etc...)



Applications

Application Interaction https://github.com/DanieleDeSensi/riff

Self-Adaptive and Power-Aware Runtime https://github.com/DanieleDeSensi/nornir

Hardware Interaction https://github.com/DanieleDeSensi/mammut







USE CASES

39.500

62.748

1.570

440

070

01.230 NIA 61.8175 82.230 22.550 30.400 200 200 NIA 16.370 NIA 0 NIA 0 16.310 600 3400 38.900 16.380 NIA 40.710 NIA NA NIA 6.080 12000 Tools Help NIA 🛅 🖓 🙀 🏷 🕨 🚍 🤤 ヤ 🖸 🖉 🙆 🙆 🙆 4 0 NIA I Menitor 0 17 200 10 Layered Summary Honitor Dashboas Application 0.00% Active Flows: 111 = 10^p Padata 1.512 · Utilization: 129 . UDP Packets 0 Current Flower 379 Total Packets: 2,356 6.7 · Total Butes: E-entral 2 0 Hosts: 521.32×B TCP Retrest 22 * 15865. -46 Events: 1.717 * Events: Top IP Hosts Top MAC Hosts 43.86% CEIGAIARIEH/RCE7 55,57% 10.10.45.122 00:01:24:73:4440 61.4.185.35 ■ ########### 112.95.240.85 Humeir09:8CP9 10.10.45.255 90/PEIA6/0A/8022 58,251,61,362 00:14:22:46:70A3 123.138.238.88 01:80:C2:00:00:00 24,125,71.19 # 00:17:16:27:84D6 ■ 221.176.31.1 C100.5E.7F.PEFA 3.47% 10.10.45.225 00:00:56/75:0586 10.10.65.121 4.17% 23.76% 5.55% 4.93% 43,82% E Honitor Utilization Trend · Graph - Packet Size Distribution 1,200 0.54 0.12 1.005 40.40% 0.50 800 25,85% 0.08 600 0.06 10.704 11.58% à à 0.0 1.32% 0.89% Duration: 0 4 0.9/8/6 1 0/8/6 1/12/2010 09:19:47 Packets: 2,356 For Help, press F 11

THESIS #1 - MOBILE APPLICATIONS



Batch vs **interactive** applications



THESIS #1 - MOBILE APPLICATIONS



Heterogeneous hardware



THESIS #1 - MOBILE APPLICATIONS

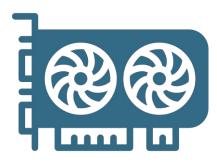


Heterogeneous hardware

Validation on **hardware** used by Samsung devices

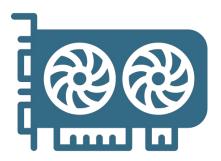


THESIS #2 - GPUs



Analysis on how to **tune** power/performance

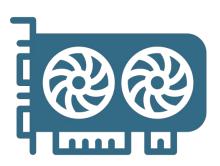
THESIS #2 - GPUs



Analysis on how to **tune** power/performance

Widely used for training **Deep Neural Networks**

THESIS #2 - GPUs

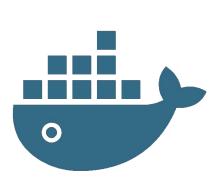


Analysis on how to **tune** power/performance

Widely used for training **Deep Neural Networks**

Key technology in top **supercomputers**

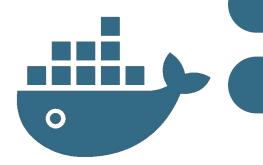
THESIS #3 - CONTAINERS



Naturally allows **resources control**

THESIS #3 - CONTAINERS





Coordination of different instances

THESIS #3 - CONTAINERS



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Coordination of different instances

Multi-Agent Reinforcement Learning

REFERENCES

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[Thesis #3] A. Asnaghi, M. Ferroni, M.D. Santambrogio (2016)

DockerCap: A Software-Level Power Capping Orchestrator for Docker Containers

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