



ANALYSIS OF ENERGY CONSUMPTION AND PERFORMANCE OF I/O OPERATIONS IN LOW-POWER ARCHITECTURES

Pablo J. Pavan, Ricardo K. Lorenzoni, Jean L. Bez,
Edson L. Padoin, Francieli Z. Boito, Philippe O. A.
Navaux, Jean-François Méhaut

WSPPD -2016 — September of 2016

SUMMARY

1. Introduction
2. Goal
3. Methodology
4. Results Analysis
5. Conclusion and Future Work

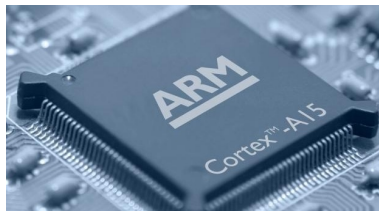
1. Introduction
2. Goal
3. Methodology
4. Results Analysis
5. Conclusion and Future Work

- **Energy consumption** is a major limitation in the construction **Exascale Systems**
 - DARPA limits the consumption to **20 MWatt**
- The processors represent a **significant percentage** of the power demand of HPC systems
- **File systems** also have an impact on power demand

P. Kogge, K. Bergman, S. Borkar, D. Campbell, W. Carson, W. Dally, M. Denneau, P. Franzon, W. Harrod, K. Hill

"Exascale computing study: Technology challenges in achieving exascale systems" 2008.

- Some research efforts point that using **ARM processors** could be an alternative to achieve **exascale**
- ARM processors focus on **low energy consumption** but yet present good **energy efficiency** results

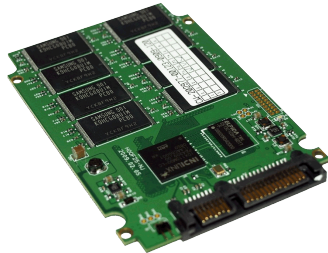


M. Valero, "Towards exaflop supercomputers"
Conference Center of the University of Patras - (HPC-net), 2011.

B. Smith. "ARM and Intel battle over the mobile chip's future" Computer, 2008

- **Features**

- No Moving Parts
- Speed
- Reliability
- Wear leveling
- **Energy Efficiency**



Agrawal, Nitin, et al. "Design Tradeoffs for SSD Performance." USENIX Annual Technical Conference. 2008.

Seo, Euseong, Seon-Yeong Park, and Bhuvan Urgaonkar

"Empirical Analysis on Energy Efficiency of Flash-based SSDs." HotPower. 2008.

2

GOAL

ANALYSIS OF ENERGY
CONSUMPTION AND
PERFORMANCE OF I/O
OPERATIONS IN LOW-POWER
ARCHITECTURES

1. Introduction
2. Goal
3. Methodology
4. Results Analysis
5. Conclusion and Future Work

To analyze the viability of using ARM in
Storage Servers in HPC

1. Introduction
2. Goal
3. Methodology
4. Results Analysis
5. Conclusion and Future Work

Equipments

	PC	MPSoC
Processor	Intel Core2Duo	ARM Cortex A7
Model Processor	E8400	AllWinnerTech SoC A20
Frequency Clock	3.0GHz	960MHz
Number of Processor	1	1
Cores/Processor (#)	2	2
TDP of Processor (W)	65	0,25
Memory (GB)	6 (DDR2)	2 (LP DDR3)

Equipments Storage Devices

	Type	manufacturer	Capacity (GB)	RPM	Manufacturer Specifications	
					Voltage (VDC)	Current (A)
HDD1	HDD	Western Digital	160	5400	5	0,55
HDD2	HDD	Seagate	500	7200	5	0,45
SSD1	SSD	Samsung	240	-	5	0,50
SSD2	SSD	Kingston	120	-	5	1,00

- IOzone¹
 - File Size
 - 2 GB
 - Accesses
 - Read
 - Write
 - Random Read
 - Random Write
 - Buffer Cache
 - On
 - Off
 - Requisitions
 - 32 KB
 - 4 MB

128 experiments repeated 10 times

¹<http://www.iozone.org/>

- Power metering equipment
 - **Dranetz PP-4300** which measures voltage and alternating current(AC) of entire equipment

3

METHODOLOGY METRICS

- Power (Watt)
- Time (second)
- Energy (Joule)

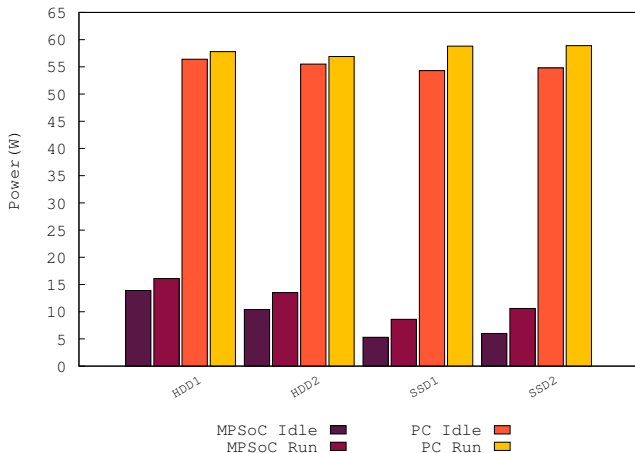
1. Introduction
2. Goal
3. Methodology
- 4. Results Analysis**
5. Conclusion and Future Work

Average **power**(W) of the equipments during testing

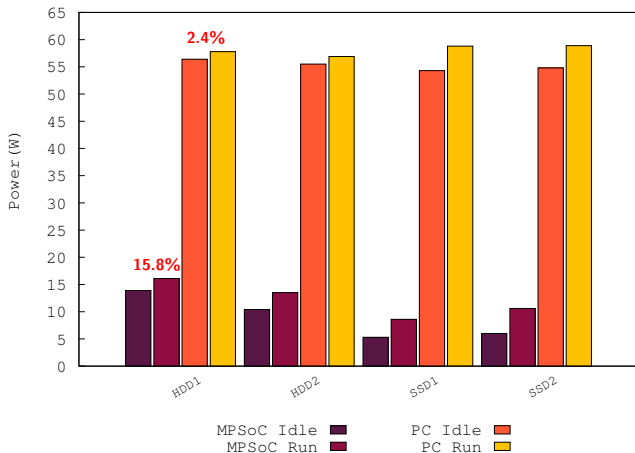
Equipment	Request	Cache	HDD1	HDD2	SSD1	SSD2
PC	32KB	off	60	56	59	59
PC	32KB	on	59	57	64	69
PC	4096KB	off	58	57	58	57
PC	4096KB	on	60	59	66	65
MPSoC	32KB	off	15	12	8	10
MPSoC	32KB	on	16	12	9	11
MPSoC	4096KB	off	16	13	8	10
MPSoC	4096KB	on	17	14	9	11

Difference: **8 times**

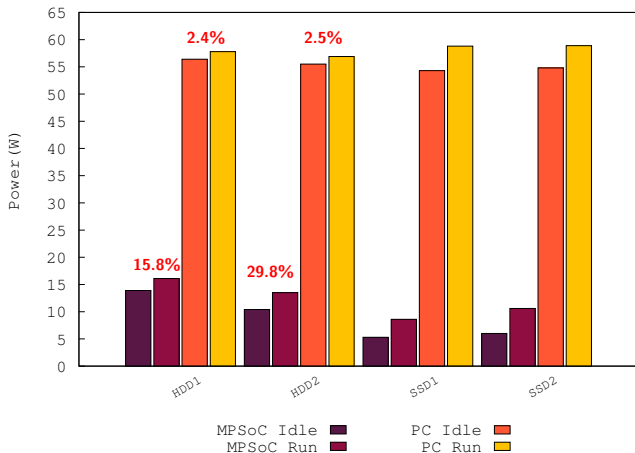
Power demand increase



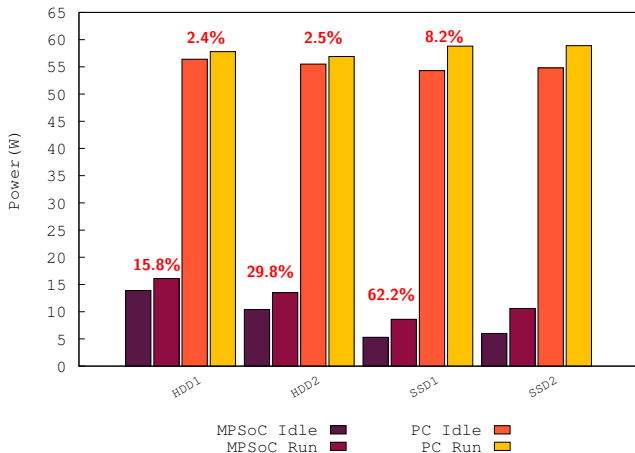
Power demand increase



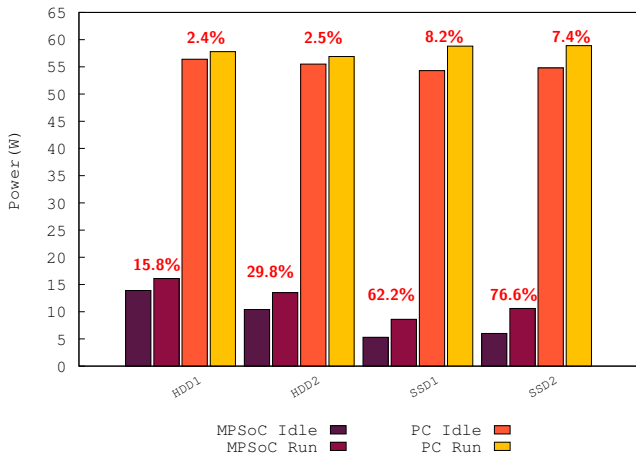
Power demand increase



Power demand increase



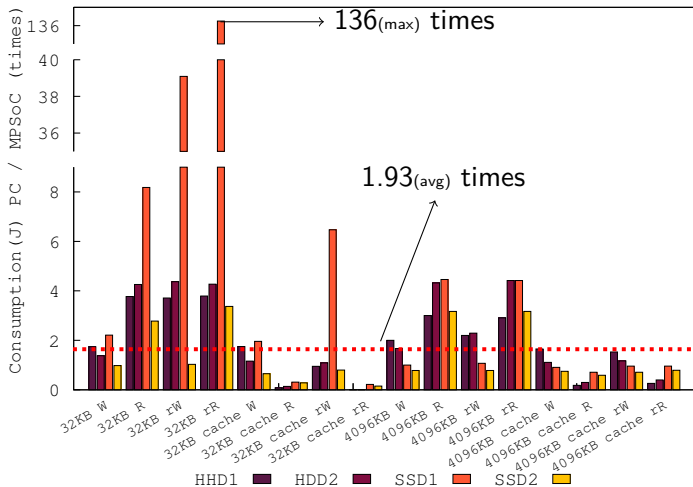
Power demand increase



Average **times**(s) of the equipment during testing

Equipment	Request	Cache	HDD1	HDD2	SSD1	SSD2
PC	32KB	off	253	237	221	16
PC	32KB	on	17	18	16	3
PC	4096KB	off	36	28	8	8
PC	4096KB	on	13	8	4	4
MPSoC	32KB	off	275	252	44	58
MPSoC	32KB	on	101	104	33	34
MPSoC	4096KB	off	51	43	34	36
MPSoC	4096KB	on	37	36	32	32

Difference: 68 times



4

RESULTS ANALYSIS ENERGY

ANALYSIS OF ENERGY
CONSUMPTION AND
PERFORMANCE OF I/O
OPERATIONS IN LOW-POWER
ARCHITECTURES

Why does it happen?

Why does it happen?

MPSoC the power is 6.7 times lower

1. Introduction
2. Goal
3. Methodology
4. Results Analysis
5. Conclusion and Future Work

- Thinking power: the use of MPSoC have a power demand of 8 times lower
- Thinking time: the use of PC would have a better access time 68 times
- For sequential or random reads, a single MPSoC + SSD1 server could replace the PC + HDD configuration, requiring 0.85 times less power

- Use other configuration of **storage devices**
- Evaluate **parallel environments** where multiple **low-power** servers offer **storage**

Pablo J. Pavan, Ricardo K. Lorenzoni, Jean L. Bez, Edson L. Padoin, Francieli Z. Boito, Philippe O. A. Navaux, Jean-François Méhaut

Thanks!

