An analysis of the performance and benefit of execution of the Open Porous Media (OPM) Reservoir Simulator in the Cloud

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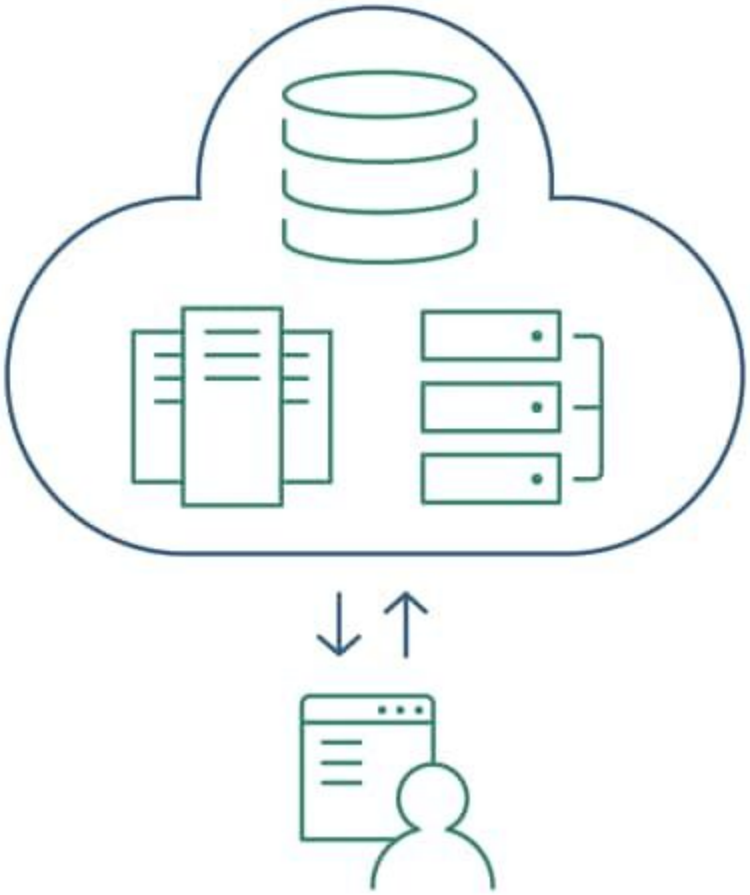
Summary

- Context and Motivations
- Experimentation and Results
- Conclusion
- Future Work

- Context and Motivations

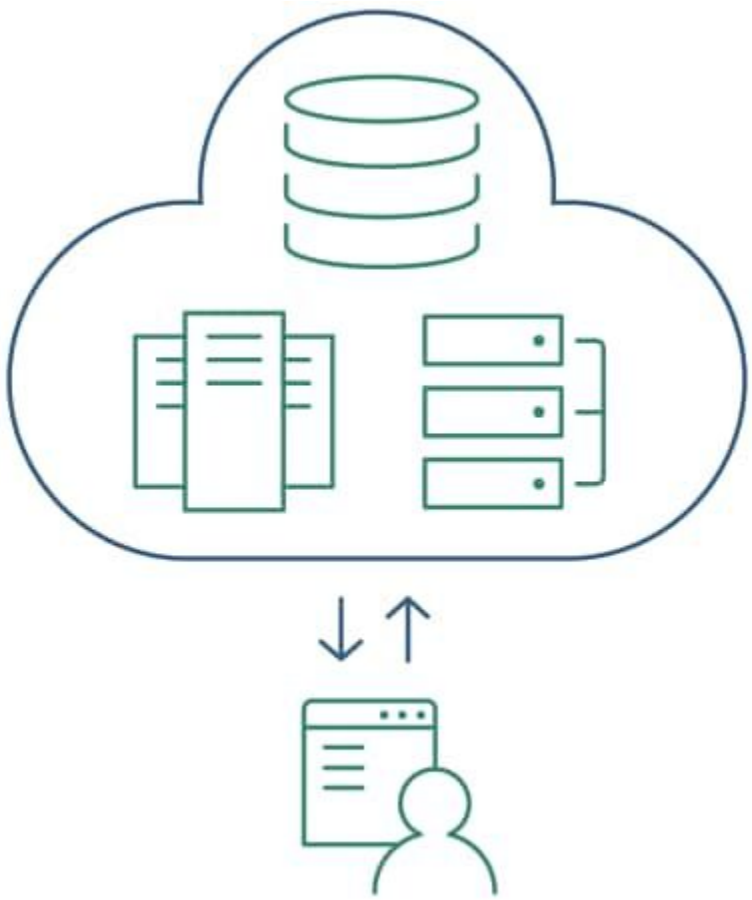
Cloud Computing

- Infrastructure-as-a-Service
- Elasticity of use
- Pay-for-use model
- Format of economies of scale



Cloud Computing Challenge

- It is expected **92%** of workloads to run in the cloud by 2020
- Growing interest in running HPC applications
- … Many jobs running benchmarks to measure Cloud availability for HPC



Cloud Computing Challenge

- The Cloud consumes about **8%** of the energy produced around the world.
- ... And it will grow

What can **we** do?

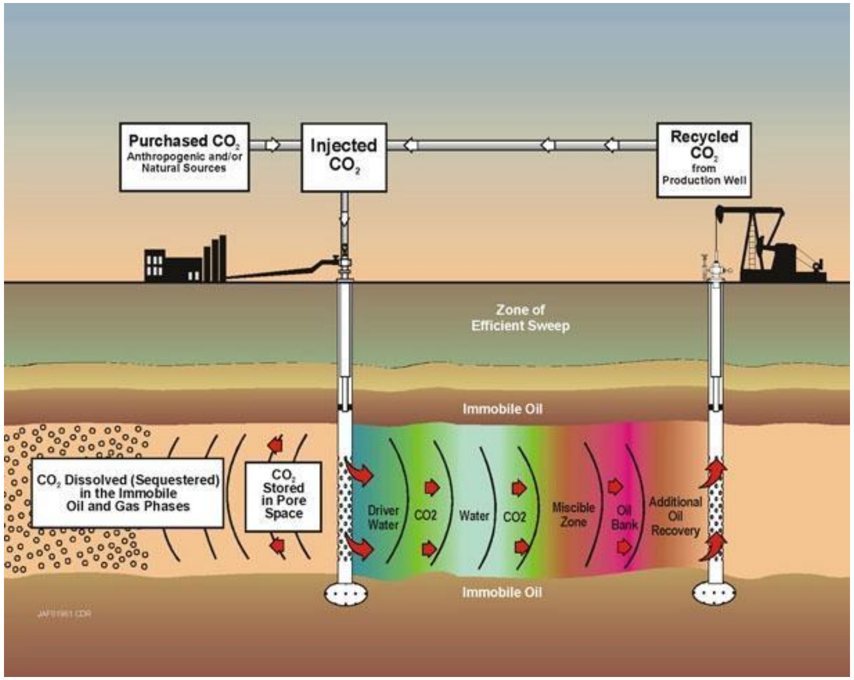
Search for new ways to scale scientific applications in the Cloud taking into account **cost** and **energy consumption**

Our Contribution

- The Suggestion of how best to run an Open Source Reservoir Simulator in the Cloud
- Performance measurement of RS in the Cloud
- Comparison of RS performance on traditional machines of HPC and Virtual Machine in the Cloud

Reasons Why Using Reservoir Simulator

- More and more challenges in this area:
  - Depletion of oil reserves
  - Simulations of CO2 storage
  - The conscious use of aquifers
  - The oil field PRE-SAL



Reasons Why Using OPM

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Community

SINTEF ICT, Statoil, IRIS, etc.

Data

SPE test cases, Norne model, etc.

OPEN

Source Code

www.github.com/OPM/

License

General Public License (GPL 3.0)

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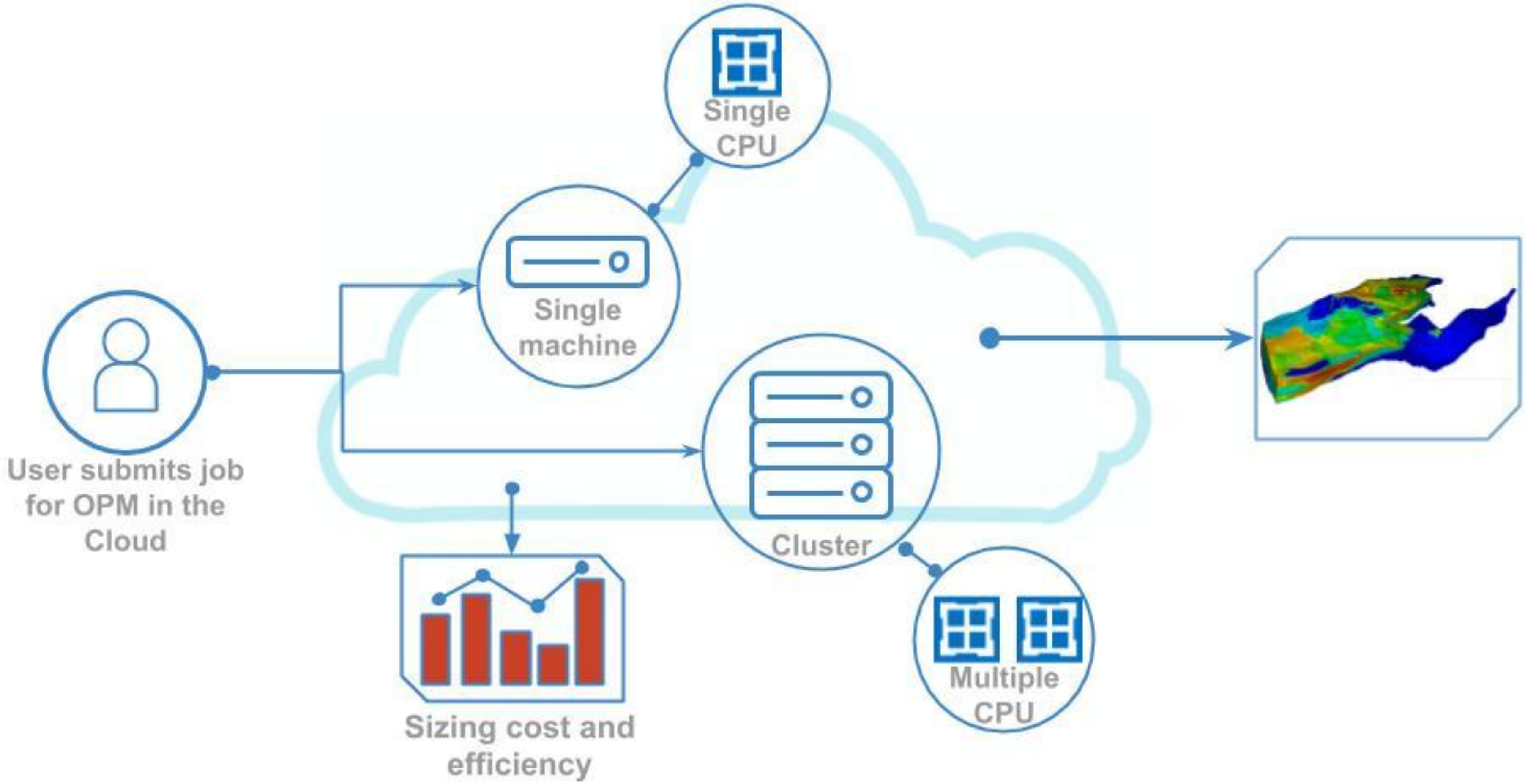
- Experimentation and Results

Methodology



Cloud vs local machine

- Machine Comparison:
  - 2 similar machines
  - Same computational environment
  - Even simulation parameters

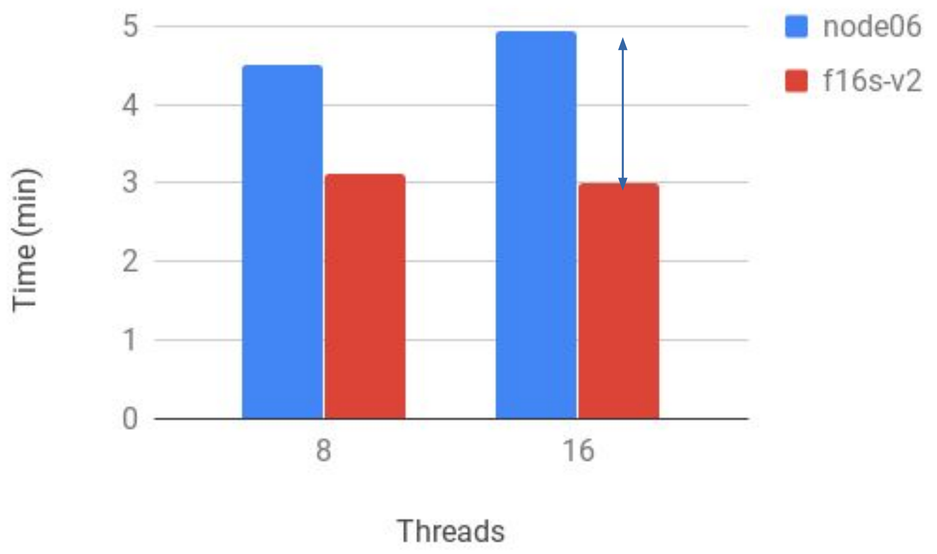
Machine	CPU	RAM	Storage	Payment for use
Local machine - node06	Xeon E5-2630 v2 2.60GHz	32 GB	2 TB	?
Azure - F16s - v2	Xeon Platinum 8168 2,7 GHz	32 GB	128 GB	2,258

Cloud vs local machine

HPC Machine Price - node06			
	Unit	Unit price	Total
Xeon E5-2630 2.60GHz	2	2024,25	4048,5
Memory 32 GB	4	370,3	1481,2
Motherboard	1	2279,2	2279,2
Cooler	2	193,2	386,4
HD 2TB	1	424,15	424,15
Power Source	1	744	744
Cabinet	1	679,15	679,15
			10042,6

Annual consumption - local machine		
Kwh/month	R$/month	R$/year
460,66	211,76	2541,16

Annual Price - machine F16s - v2		
R$/h	R$/month	R$/year
2,26	1625,76	19509,12



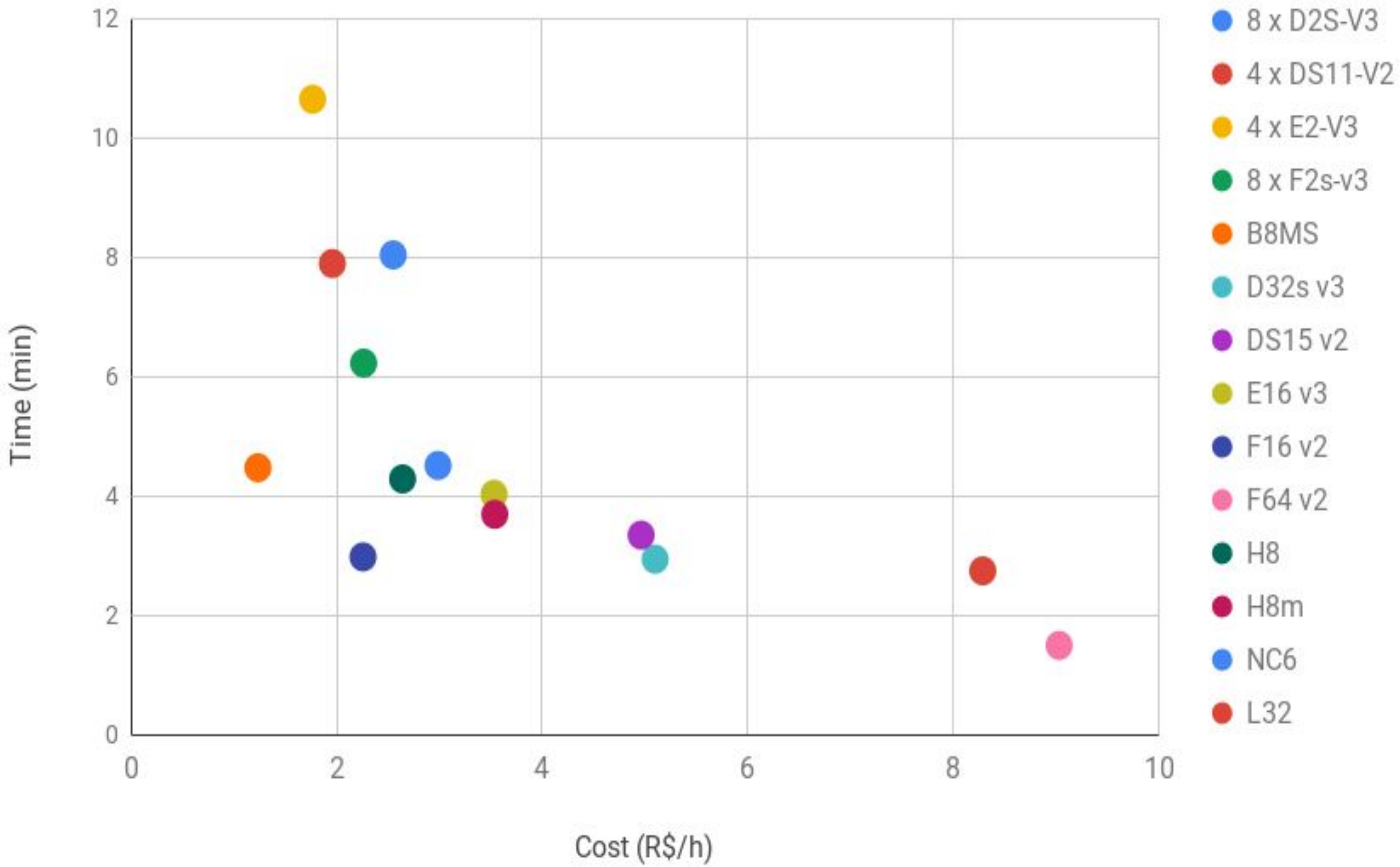
Machine in the Cloud

Machine	CPU	RAM	Storage	Payment for use
A8-v2	Xeon E5-2673 v4 2.30GHz	16 GB	80 GB	1,106
A8m-v2	Xeon E5-2673 v4 2.30GHz	64 GB	80 GB	1,451
B8ms	Xeon E5-2673 v4 2.30GHz	32 GB	64 GB	1,236
D32s-v3	Xeon E5-2673 v3 2.4GHz (Haswell)	128 GB	64 GB	1,236
Ds15-v2	Xeon E5-2673 v3 2.4GHz (Haswell)	140 GB	280 GB	4,964
E16-v3	Core i7-5820K (Haswell) 3.30GHz	16 GB	400 GB	3,533
F16s - v2	Xeon Platinum 8168 2,7 GHz	32 GB	128 GB	2,258
F64s - v2	Core i7-5820K (Haswell) 3.30GHz	128 GB	512 GB	9,031
H8	Core i7-5820K (Haswell) 3.30GHz	56 GB	1 GB	2,643
H8m	Core i7-5820K (Haswell) 3.30GHz	112 GB	1 GB	3,54
L32	Core i7-5820K (Haswell) 3.30GHz	256 GB	5630 GB	8,287
NC6	Core i7-5820K (Haswell) 3.30GHz	56 GB	340 GB	2,988
Cluster D2S-v3	8 x Xeon E5-2673 v4 2.30GHz	64 GB	16 GB	2,552
Cluster DS11 v2	4 x Xeon E5-2673 v3 2.4GHz (Haswell)	84 GB	28 GB	1,98
Cluster E2 - v3	4 x Xeon E5-2673 v4 2.30GHz	84 GB	50 GB	1,768
Cluster F2S v2	8 x Xeon E5-2673 v3 2.4GHz (Haswell)	256 GB	16 GB	2,264

Machine Comparison

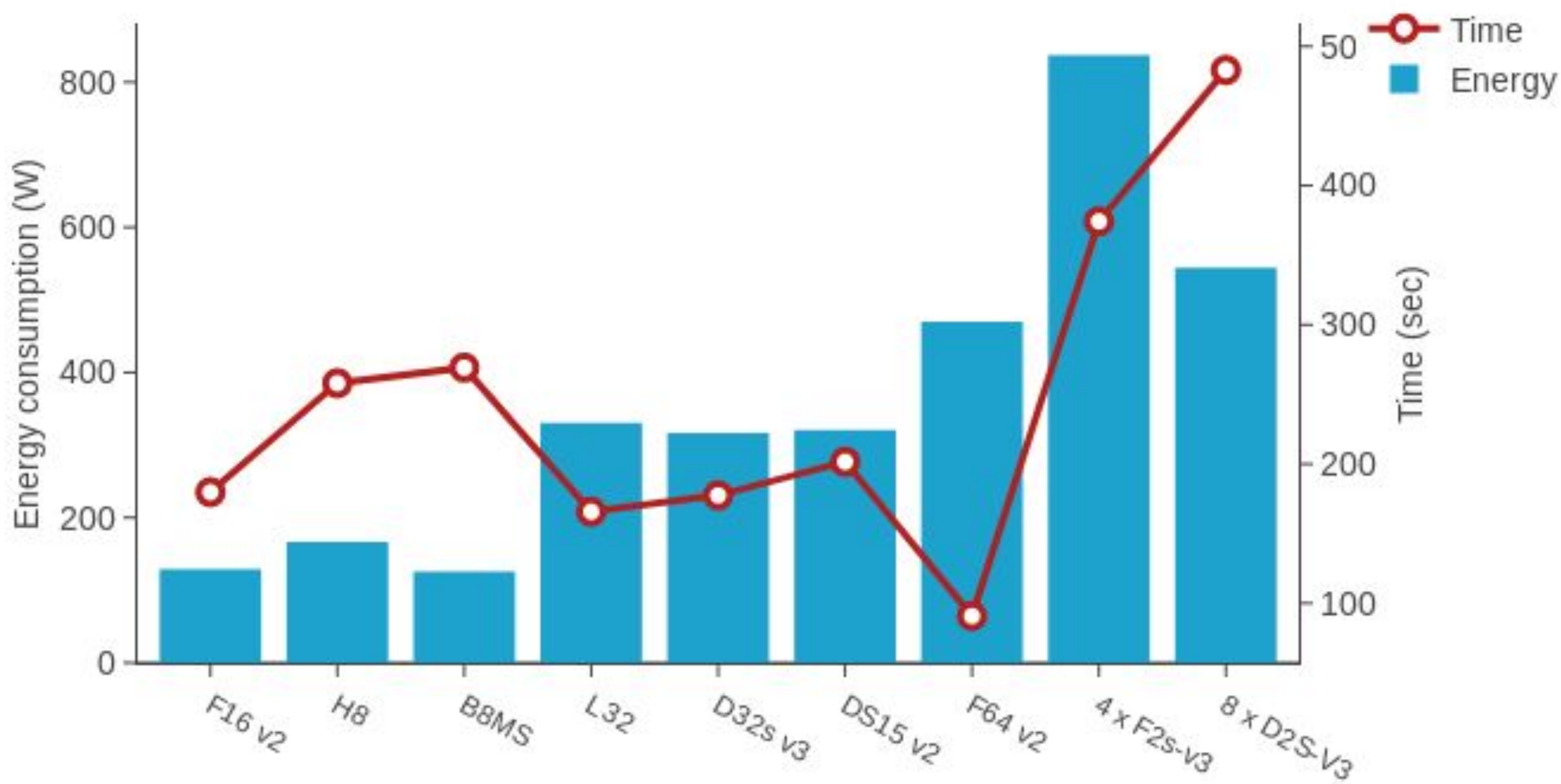
- 16 different virtual machines on Azure
- Same computational environment
- Even simulation parameters

Cost vs Time



12
10
8
6
4
2
0
Time (min)
0
2
4
6
8
10
Cost (R$/h)
8 x D2S-V3
4 x DS11-V2
4 x E2-V3
8 x F2s-v3
B8MS
D32s v3
DS15 v2
E16 v3
F16 v2
F64 v2
H8
H8m
NC6
L32

Energy consumption



- Conclusion

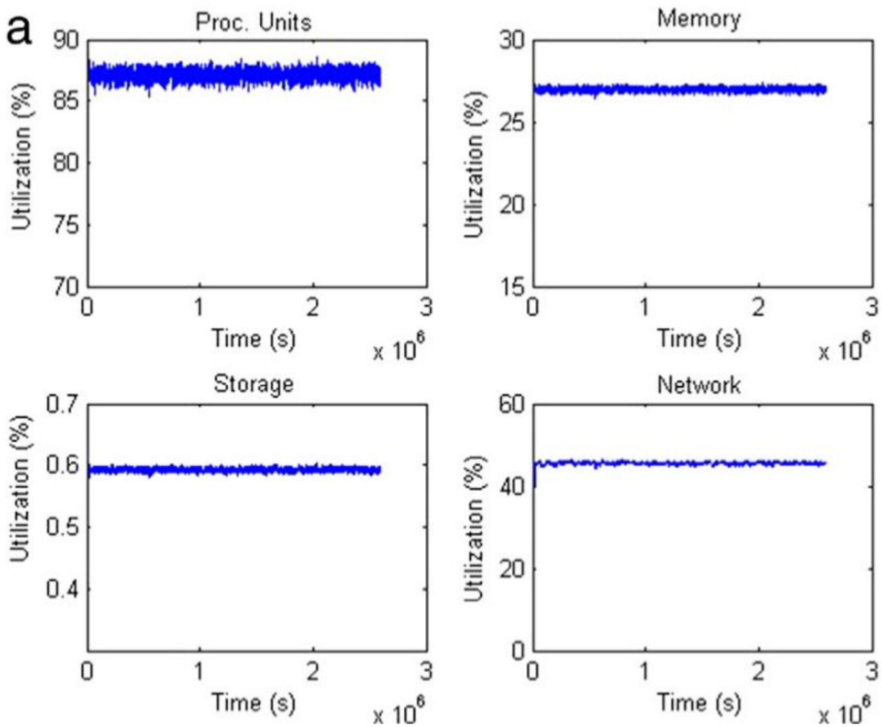
Conclusion

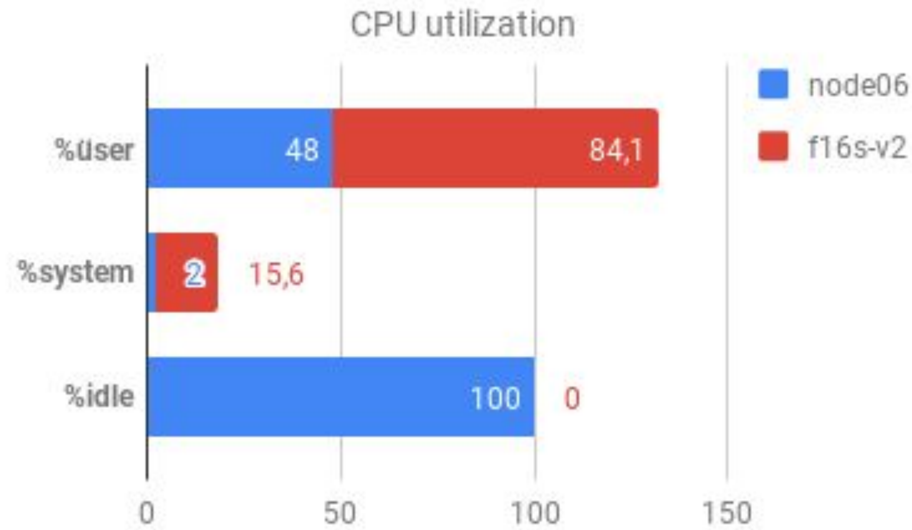
- Best time in the Cloud
- Low cost of simulations using the Cloud
- OPM simulator makes little use of energy
- Better time with less energy machines

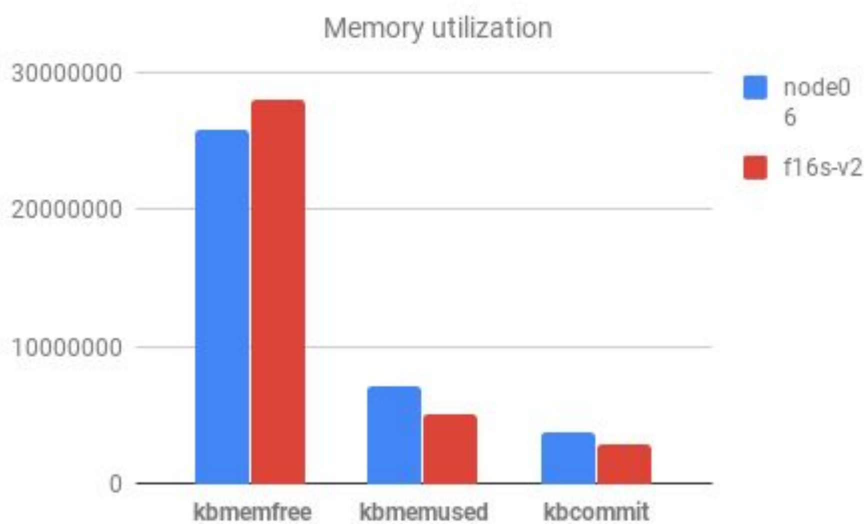
- Research proposal

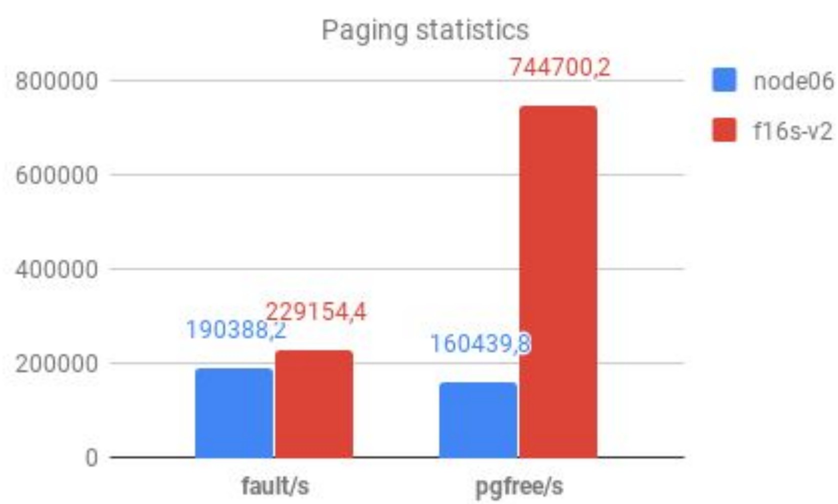
Search interest

Use system metrics to measure system performance for **inside** that helps **reduce energy consumption**









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Thank you!
Questions?