D5.1

Benchmark service providers

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A- ENERGETIC project summary

The EU roadmap towards a climate-neutral economy by 2050 sets ambitious decarbonation targets that shall be achieved by a massive deployment of renewable energy sources. Energy storage improves grid flexibility and allows higher penetration levels of renewable energy sources to create a decarbonized and more electrified society by means of leveraging second-life batteries. Battery management plays an essential role by ensuring an efficient and safe battery operation. However, current Battery Management Systems (BMS) typically rely on semi-empirical battery models (such as equivalent-circuit models) and on a limited amount of measured data.

ENERGETIC is a European consortium set to provide new standards in electric vehicle battery pack management. It includes development of predictive maintenance system (thermal management, Remaining Useful Life (RUL) and Safe operating Area (SoA)), second file optimization and fleet management system.

Therefore, the ENERGETIC project aims to develop the next generation of BMS for optimizing batteries 'systems utilization in its entire life path, being the first (transport) and second life (stationary) in a path towards operations that are safer, powerful, and more reliable. The ENERGETIC project contributes to the field of translational enhanced sensing technologies, exploiting multiple Artificial Intelligence models, supported by Edge and Cloud computing.

ENERGETIC's vision not only encompasses monitoring and prognosis the remaining useful life of a Li-ion battery with a digital twin, but also encompasses diagnosis by scrutinizing the reasons for degradation through investigating the explainable AI models. This involves development of new technologies of sensing, combination and validation of multiphysics and data driven models, information fusion through Artificial Intelligence, Real time testing and smart Digital Twin development.

Based on a solid and interdisciplinary consortium of partners, the ENERGETIC R&D project develops innovative physics and data-based approaches both at the software and hardware levels to ensure an optimized and safe utilization of the battery system during all modes of operation.

B- Work package 5 Objectives

This deliverable is part of Work package 5.1 dedicated to cloud/edge architecture for the ENERGETIC project. The main objectives of WP 5 are:

1) Predictive maintenance system architecture providing accessibility, scalability, availability, security, low latency
2) Multimodal BMS relying on local, Edge, cyber foraging and Cloud computing to optimize confidence and accuracy of predictions for maintenance
3) Recommendations for standard methodology and model definition for battery management and predictive maintenance

C- Deliverable objectives

The goal of this deliverable is to assess Cloud Service Providers (CSP) for the ENERGETIC project. Since this project rely on heavy computation and reliability rather than price, the overall evaluation focus on performance. Nevertheless, a price study is given in Annex 1.

D- Methodology

1) Cloud providers general information gathering

The main issue benchmarking cloud service providers is the accessibility and reliability of data. CSP companies are scattered from tech giant (Amazon, Google, Microsoft, Alibaba) to more confidential ones (Upcloud, Linode…), from generic to niche market. The business also dominated by American tech Giant, followed by Chinese companies[1,2,3,4,5,6].

Preliminary research on publicly available data (internet site and research publication) shows that precise performance and technical data are mainly available for Amazon, Google, Microsoft, Oracle and IBM cloud. Fortunately, Cloud Mercato (Projector - Projector (cloud-mercato.com)), a benchmarking company, provides information based on open-source benchmarking tools for the 28 main cloud providers in the world.

2) Cloud provider selection

Within Projector, the analytic tools of Cloud Mercato, data coming from 28 cloud providers were gathered. The data gathered were the most recent, from Q2 2022. These CSP were split into 4 groups, depending on the critical criteria for the ENERGETIC project. These criteria are:

- ➔ Cybersecurity & European sovereignty
- ➔ Ability to cope with European regulation quickly
- ➔ Company resilience to ensure continuity of long-term services

[1] Aljamal, El-Mousa, et Jubair, « A User Perspective Overview of The Top Infrastructure as a Service and High Performance Computing Cloud Service Providers ».
[2] « Benchmarking Microsoft Azure Virtual Machines for the use of HPC applications | IEEE Conference Publication | IEEE Xplore ».
[3] Barcelona-Pons et García-López, « Benchmarking Parallelism in FaaS Platforms ».
[4] Martins, Araujo, et da Cunha, « Benchmarking Serverless Computing Platforms ».
[5] Kaushik et al., « Cloud Computing and Comparison based on Service and Performance between Amazon AWS, Microsoft Azure, and Google Cloud ».
[6] Avula et Zou, « Performance Evaluation of TPC-C Benchmark on Various Cloud Providers ».

3) Performance data gathering

An analysis of 3 CSP groups is provided. Multiple results of various benchmarking tools were considered:

- ➔ A specification score describing the quality of the hardware/CSP
- ➔ Geekbench scores describing the overall performance of cloud systems. The data are segmented between single and multi-core application. Since we don't know yet the future computation needs for ENERGETIC, the generic results is used for this benchmark
- ➔ Sysbench CPU score dedicated to computation performance
- ➔ Sysbench RAM score dedicated to memory performance
- ➔ CPU steal scored is a quality indicator describing the unavailability of the cloud because of external factors (independent from the application)
- ➔ I/O score that described the speed of the database access supported in the cloud
- ➔ Network bandwidth score is a measurement of the bandwidth between two identical machines in the same datacenter

Geekbench, Sysbench CPU and RAM display score 3 different ways:

- ➔ *General*: the overall results
- ➔ *Compute optimized* scores that focus on heavy computation-needed application performance
- ➔ *Memory optimized* scores that focus on heavy memory-needed application performance

Since the envisaged ENERGETIC applications are computation-heavy, this deliverable focus on *general* performance and *compute optimized* scores.

4) KPI design

We choose to provide Key Performance Indicators (KPI) based on general scores for CSP general performance evaluation as well as computation optimized cloud (more dedicated to ENERGETIC application)

To create these indicators, a normalization of Geekbench, Sysbench RAM, CPU and I/O scores was made.

At the current state of the ENERGETIC project, we don't know if the quality of the I/O on the database is a prevalent factor. So, the results were split to not consider this I/O score.

E- Results and analysis

1) CSP group selection

Cloud Mercato provides data for 28 CSPs located globally (**Table 1**):

Cloud	Entreprise	Pays
3DS	Dassault-Outscale	France
Alibababa	Alibaba	China
AWS	Amazon	USA
CloudFerro	CloudFerro Sp. z o. o	Poland
CloudSigma	CloudSigma	Switzerland
DigitalOcean	DigitalOcean Holdings, Inc.	USA
Exoscale	Exoscale	Switzerland
FugaCloud	FugaCloud	Netherlands
G-Core	G-Core	Austria
Google Cloud	Google Cloud	USA
IBM cloud	IBM cloud	USA
IONOS	United Internet	Germany
Kamatera	Kamatera	USA
Linode	Linode LLC	USA
Microsoft Azure	Microsoft	USA
Nua.ge	OXEVA	France
OVH cloud	OVH	France
Oracle cloud	Oracle	USA
Orange Business	Orange	France
Scaleway	Scaleway	France
T-systems open telekom cloud	T-systems	Germany
Tencent Cloud	Tencent	China
Upcloud	Uopcloud	Finland
Vexxhost	Vexxhost	Canada
Vultr	Vultr	USA
Gridscale	Gridscale	Germany
hopla.cloud	hopla.cloud	France
infomaniak	infomaniak	Switzerland

Table 1: CSP provider by country

As mentioned above, the CSP were split into 4 groups, depending on the critical criteria for the ENERGETIC project.

Group 1 are European big tech companies able to sustain their business activities on a long period following European regulation.

Group 2 are US tech giant able to sustain their activities on a long period with an actual partnership (ex. Google/Thales S3NS service) or planning to do so. Due to their size and business importance, Group 2 CSP are eager to follow European compliance.

Group 3 are smaller European CSP with more uncertainty to sustain a project the size of ENERGETIC for a long period.

Group 4 are non-US, non-European CSP or smaller US CSP. We also include CloudFerro, a Polish CSP, due to the regional instability.

Following these criteria, the 4 groups are (**Table 2**):

Group 1	Group 2	Group 3	Group 4
3DS	AWS	CloudSigma	Alibababa
OVH cloud	Google Cloud	Exoscale	CloudFerro
Orange Business	IBM cloud	FugaCloud	DigitalOcean
	Microsoft Azure	G-Core	Kamatera
	Oracle	IONOS	Linode
		Scaleway	Tencent Cloud
		T-systems	Vexxhost
		Upcloud	Vultr
		Gridscale	
		hopla.cloud	
		infomaniak	

Table 2: CSP 4 groups split

KPI on group 1 and 2 will be discussed in this deliverable. KPIs for group 3 are provided in **Annex 2.**

2) Data analytics

Group 1 & 2 data analytics are provided here, the corresponding graphics are available in **Annex 3**.

a) Specification score.

This general test evaluates the amount of CPU, storage and RAM given by each CSP. This score breaks down into:

- ➔ CPU: 1 point/vCPU
- ➔ RAM: 1 point/GB
- ➔ Storage: 1 point/100GB

For group 1 + 2 the results are given in Table 3:

Cloud service provider	CPU	RAM	Memory	SPEC Score
3DS	16	66	On demand	82
AWS	16	64	On demand	80
Google Cloud	16	64	On demand	80
IBM cloud	16	68	On demand	84
Microsoft Azure	16	64	On demand	80
Oracle	16	58	On demand	74
OVH cloud	16	64	On demand	80
Orange Business	16	64	On demand	80

Table 3: Specification score

All the CSP in group 1&2 provide similar hardware specifications. Since the business model of these CSP scale with the data storage, this specific criterion was not evaluated.

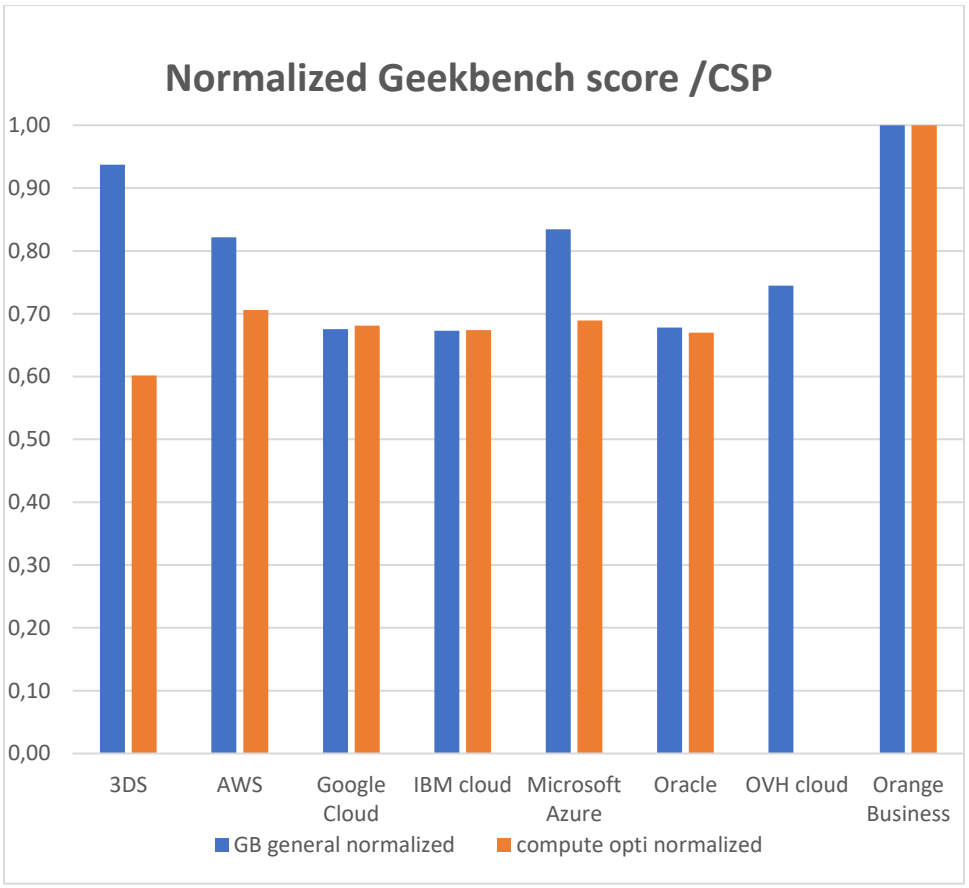
b) Geekbench benchmark.

This benchmark was started with Geekbench 5 which is a standard benchmark able to evaluate system performance. Geekbench provides results for single and multicore system performance.

ENERGETIC is a project with multiple technological bricks working in parallel. So, for this benchmark we focus on multicore system performance. The result is given in Table 4 and Graph 1:

Cloud Provider	GB general	GB general normalized	compute optimized	compute optimized normalized	Memory optimized	memory optimized normalized
3DS	11579	0,94	7292	0,60	11957	1,00
AWS	10172	0,82	8569	0,71	5589	0,47
Google Cloud	8323	0,68	8242	0,68	8193	0,69
IBM cloud	8333	0,67	8179	0,67	7982	0,67
Microsoft Azure	10328	0,83	8371	0,69	10366	0,87
Oracle	8390	0,68	8141	0,67	8278	0,69
OVH cloud	9232	0,74	NA	NA	NA	NA
Orange Business	12366	1,00	12147	1,00	11145	0,93

Table 4: Geekbench score and normalized score for Group 1 CSP



Graph 1: Geekbench bar chart for each CSP: general and compute optimized score.

Due to lack of data, OVH Cloud has no evaluation now. 6 CSPs has similar performance (AWS, Google Cloud, IBM cloud, Microsoft Azure, Oracle and OVH). Orange Business performs better in both general and compute optimized indicators. Despite a good general score 3DS finishes last in the compute optimized tests which is mandatory for the ENERGETIC project.

c- Sysbench CPU benchmark.

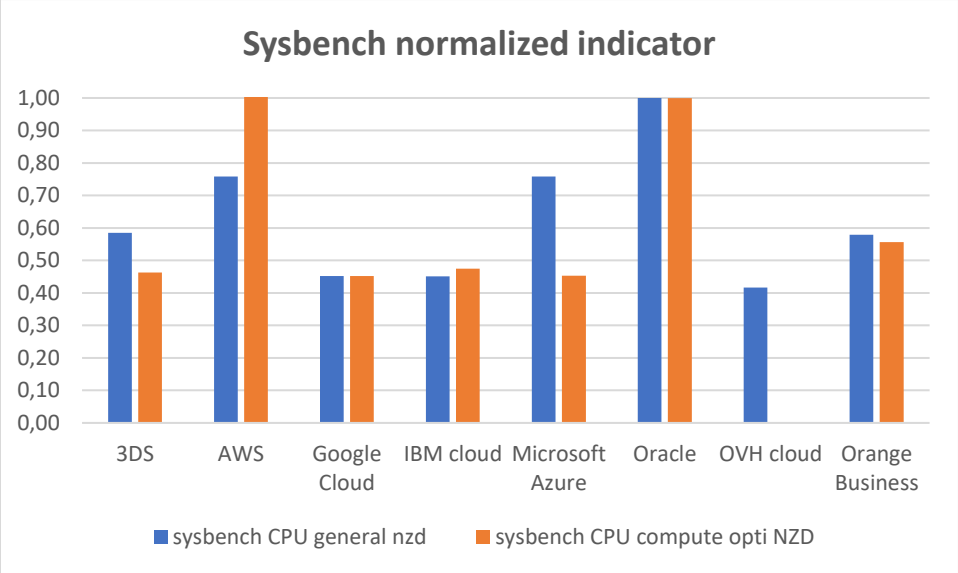
Sysbench is an open-source benchmark tool for heavy calculation. Its purpose is to find the highest prime number in defined amount of time. This test outputs a rate comparable across different virtual machines and being a simple operation, it doesn't involve thread cooperation nor intensive RAM usage.

The testing configuration use a number of thread equal to the CPU number and prime number under 64000.

The results are compiled in Table 5 and normalized data for analysis shown in Graph 2.

Cloud Provider	CPU general	CPU general normalized	CPU compute optimized	CPU compute optimized normalized
3DS	1482,2	0,59	1170,5	0,46
AWS	1919,3	0,76	2721,1	1,07
Google Cloud	1145,1	0,45	1144,2	0,45
IBM cloud	1142,7	0,45	1200,7	0,47
Microsoft Azure	1920,5	0,76	1145,9	0,45
Oracle	2532,5	1,00	2531,4	1,00
OVH cloud	1055	0,42		
Orange Business	1466,1	0,58	1408,8	0,56

Table 5: Sysbench general and compute optimized results for each CSP.



Graph 2: Sysbench bar chart general and compute optimized normalized results for each CSP.

In this benchmark, the results can be clustered in 3 groups:

- ➔ The best group (AWS and Oracle) with particularly good results in compute optimized calculations
- ➔ Orange Business with average results
- ➔ A third group with mild results compared to the top

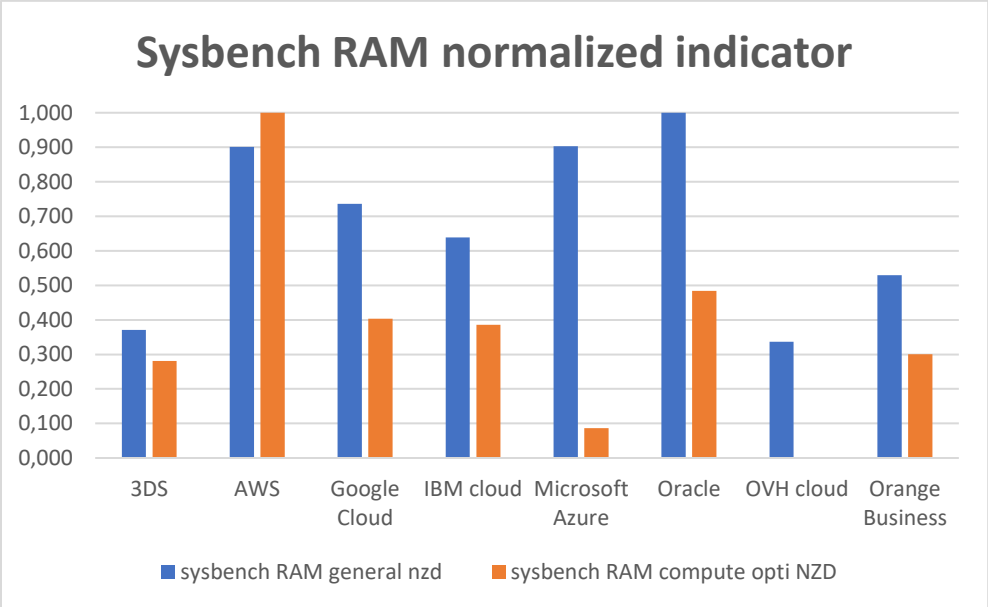
d- Sysbench RAM benchmark.

Sysbench RAM is a part of the Sysbench suite. It is designed to stress volatile memory in write/read access and report performance in MB/s.

The test configuration was operated with 1KB data block, a number of thread equal to the CPU and read then write access.

Cloud Provider	General	General normalized	Compute optimized	Compute optimized normalized
3DS	15055	0,371	20148	0,282
AWS	36525	0,901	71564	1,000
Google Cloud	29866	0,737	28854	0,403
IBM cloud	25889	0,638	27619	0,386
Microsoft Azure	36603	0,903	6209	0,087
Oracle	40548	1,000	34666	0,484
OVH cloud	13666	0,337		0,000
Orange Business	21463	0,529	21479	0,300

Table 6: Sysbench RAM general and compute results and normalized results for each group 1 CSP.



Graph 3: Sysbench RAM barcharts general and compute results and normalized results for each group 1 CSP.

The results are heavily segmented. AWS dominates the CSP tested in both general and compute optimized configurations. The other CSP have sparse or mild results in this benchmark.

e- CPU steal beanchmark.

CPU steal is a value representing the amount of time a CPU couldn't perform due to external factors (maintenance, hypervisor tasks). The results are given in Table 7 for each different offer for each group 1 CSP.

Clous Service Provider	Configuration	max	mean
3DS Outscale	c5.4xlarge	43.1	12.3
3DS Outscale	m5.4xlarge	0.0	0.0
3DS Outscale	r4.4xlarge	0.0	0.0
Amazon Web Services	c6a.4xlarge	0.0	0.0
Amazon Web Services	m6i.4xlarge	0.0	0.0
Amazon Web Services	r5a.4xlarge	0.0	0.0
Google Cloud	Custom N2 16 vCPU 128GB Intel Cascade Lake	0.0	0.0
Google Cloud	Custom N2 16 vCPU 256GB Ext Intel Cascade Lake	0.0	0.0
Google Cloud	Custom N2 16 vCPU 32GB Intel Cascade Lake	0.0	0.0
Google Cloud	n2-standard-16 Intel Cascade Lake	0.0	0.0
IBM Cloud	bx2-16x64	0.2	0.1
IBM Cloud	cx2-16x32	0.2	0.1
IBM Cloud	mx2-16x128	0.9	0.3
IBM Cloud	vx2d-16x224	0.1	0.0
Microsoft Azure	Standard_D16s_v5	0.0	0.0
Microsoft Azure	Standard_E16s_v5	0.0	0.0
Microsoft Azure	Standard_F16s_v2	0.0	0.0
OVHcloud	B2-60	0.3	0.1
OVHcloud	R2-240	0.1	0.0
Oracle Cloud	VM.Standard.E4.Flex.8-128	3.2	1.2
Oracle Cloud	VM.Standard.E4.Flex.8-256	3.8	1.1
Oracle Cloud	VM.Standard.E4.Flex.8-32	32.2	7.0
Oracle Cloud	VM.Standard.E4.Flex.8-64	4.5	1.2
Orange Business	c6.4xlarge.2	0.0	0.0
Orange Business	m6.4xlarge.8	0.0	0.0
Orange Business	s6.4xlarge.4	0.0	0.0

Table 7: CPU Steal value for the different offer of Groupe 1 CSP. (in red, the worst case)

The results are clustered in 2 groups. Orange, Microsoft, Google and Amazon perform perfectly with no unavailability of their cloud during the test. The others CSP have light issue (OVH, IBM) or heavy issues maintaining a continuity of service (Oracle and 3DS).

f- Block Storage I/O per seconds.

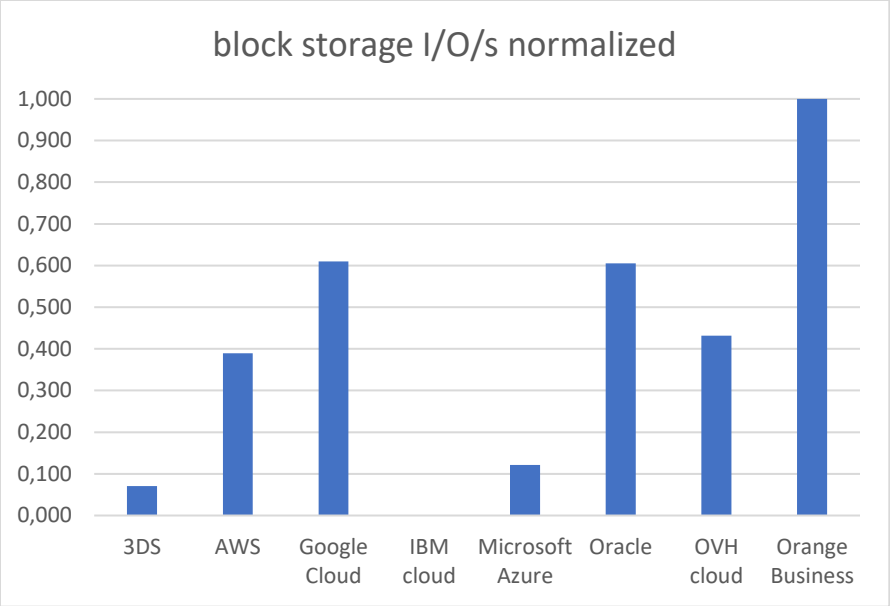
This benchmark gives us a good evaluation of the database speed for an intensive task. The tests were performed with the following configuration:

- 4KB blocks
- Random access
- Read then Write
- Direct access to device without filesystems
- libaio engine

The results are given in Table 8 and Graph 4.

Cloud Provider	block storage I/O/s	block storage I/O/s normalized
3DS	3006	0,071
AWS	16532	0,389
Google Cloud	25899	0,610
IBM cloud		0,000
Microsoft Azure	5149	0,121
Oracle	25717	0,606
OVH cloud	18339	0,432
Orange Business	42472	1,000

Table 8: Block Storage I/O/s results and normalized results.



Graph 5: Block Storage barcharts I/O/s results and normalized results.

In this benchmark, Orange performs far better than the other CSP. Azure and 3DS have the worst results among this group. (Note: IBM was not evaluated).

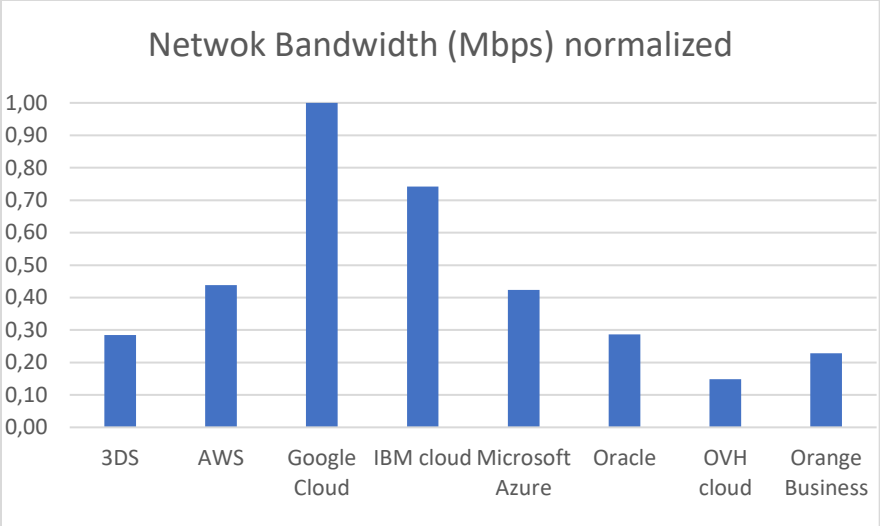
g- Network bandwidth.

This benchmark gives us a measurement of communication between virtual machine within a datacenter. This KPI is quite relevant for the parallel yet intricate ENERGETIC technological bricks.

Local bandwidth between two identical machines in the same datacenter were measured. The tool used here is Iperf 3 with TCP mode and a number of thread equal to CPU. The results are given in **Table 9** and **Graph 6**.

Cloud Provider	Netwok Bandwidth (Mbps)	Netwok Bandwidth (Mbps) normalized
3DS	7666	0,28
AWS	11837	0,44
Google Cloud	26976	1,00
IBM cloud	20008	0,74
Microsoft Azure	11423	0,42
Oracle	7716	0,29
OVH cloud	4016	0,15
Orange Business	6159	0,23

Table 9: Network bandwidth benchmark for Group 1&2 CSPs.



Graph 6: Network bandwidth normalized results barchart for Group 1&2 CSPs.

F- Meta-analysis

We use 7 different indicators from different benchmark tools. To give a general and more concise overview, 4 meta-indicators were created.

For these meta-indicators, SpecScore is not considered due to the homogeneity of results for all CSPs.

CPU Steal is also excluded and discussed separately.

General results and computation optimized cloud service results were analyzed by adding the normalized results of Geekbench, Sysbench RAM & CPU and bandwidth results.

The I/O score has a great impact on these indicators, so the meta-analysis focused on results with and without this specific score, following Table 10.

	General	Computation optimized
With I/O score	KPI 1	KPI 2
Without I/O score	KPI 3	KPI 4

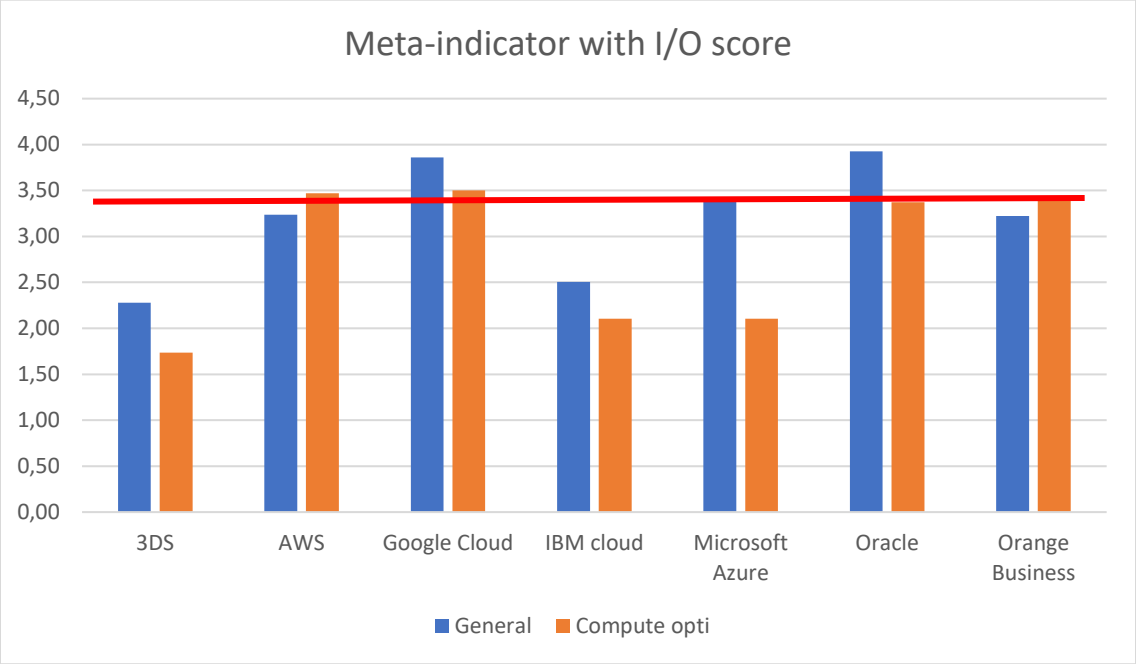
Table 10: Definition of meta-indicator.

Due to the lack of many benchmark data, OVH cloud is excluded from this analysis.

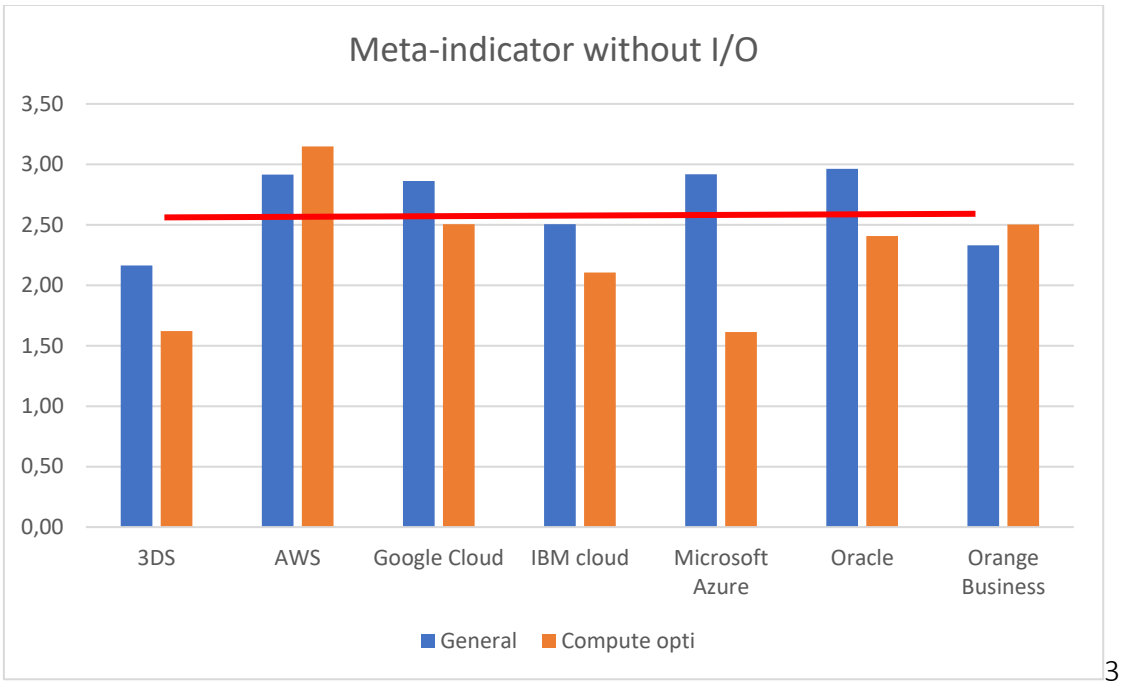
The meta-indicators are given for each other CSP in the Table 11 and Graph 6 & 7 for easier comparison.

	Meta-KPI avec I/O/sec		Meta-KPI sans I/O/sec	
Cloud Provider	**General (KPI 1)**	**Compute opti (KPI 2)**	**General (KPI 3)**	**Compute opti (KPI 4)**
3DS	2,28	1,74	2,16	1,62
AWS	3,24	3,47	2,92	3,15
Google Cloud	3,86	3,50	2,86	2,50
IBM cloud	2,50	2,10	2,50	2,10
Microsoft Azure	3,41	2,11	2,92	1,61
Oracle	3,93	3,37	2,96	2,41
Orange Business	3,22	3,39	2,33	2,50

Table 11. Meta-indicator calculation (Group 1 CSP in green)



Graph 6. Bar chart meta-indicator (I/O score included).



Graph 7. Bar chart meta-indicator (I/O Score excluded).

A group of 4 CSPs that performs better emerges from the analysis of these meta-indicators: AWS, Google Cloud, Oracle and Orange (red bar). Within these 4 CSPs, Oracle must be excluded due to the poor CPU Steal score describing the availability of their cloud which is not compatible with a project such as ENERGETIC.

G- Recommendations.

Primary recommendation.

Group 1 is the CSP cluster that fulfills cybersecurity and European compliance with anticipated business stability. In this group, Orange Business performs the best and, among group 1&2, has an overall good performance, just behind AWS and Google.

It has to be noted that Capgemini is an Orange Cloud Business partner as well as the other big companies like Google or Microsoft. As Capgemini is involved in the Orange Business Cloud development, implementation of technological bricks will be easier.

Secondary recommendation.

We are aware that the Capgemini/Orange partnerships could cause a risk of conflict of interests despite the clear and reproductible methodology used to evaluate the different CSP.

In that case, we recommend using Google Cloud service which perform the best in the Group 2, especially with compute heavy calculation (if it's a one way of communication). If it's two ways of

communication we recommend using Azure or AWS. The cybersecurity and sovereignty problems can be solved by using the Google x Thalès S3NS solution. S3NS is a joint company in which Google provide cloud possibility within Thalès well-known cybersecurity capacities.

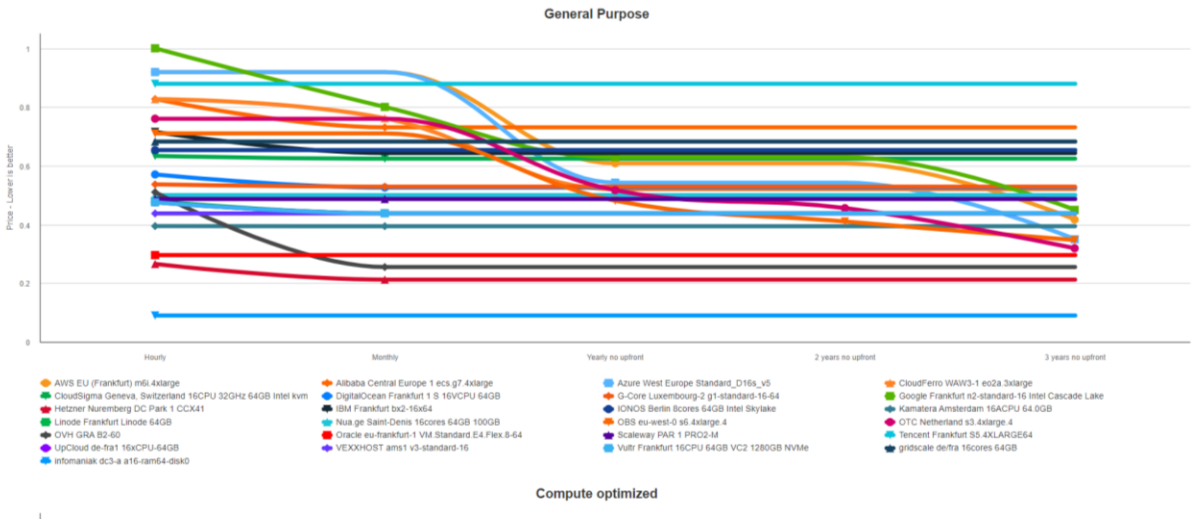
Cautions.

The data used in this deliverable are Q2 2022 data. With the 4 years duration of the ENERGETIC project, it seems coherent to make another benchmark by 2027 to assess Cloud Service Provider. At that moment, the calculation/memory needs for the ENERGETIC technological bricks will be known and help us tailored the best cloud architecture for this project.

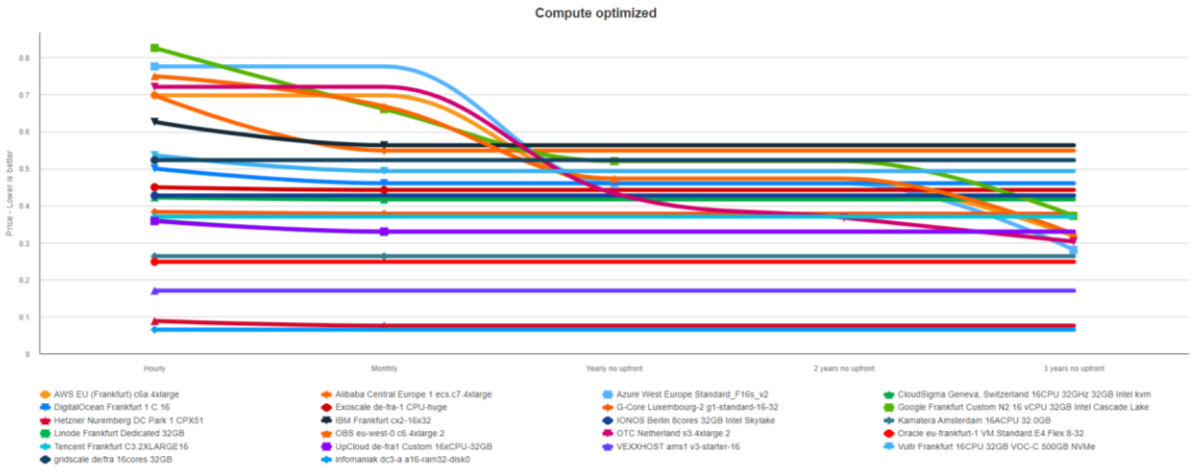
Annexes

Annex 1. Pricing study among 28 CSPs

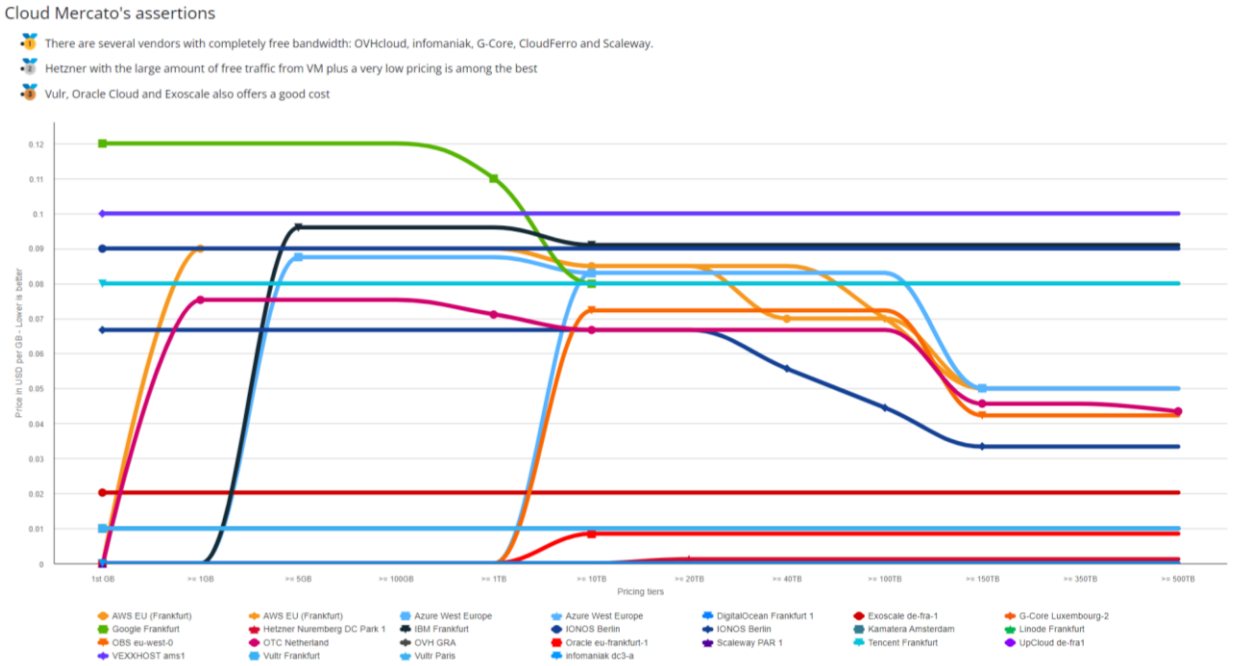
General Instance pricing.



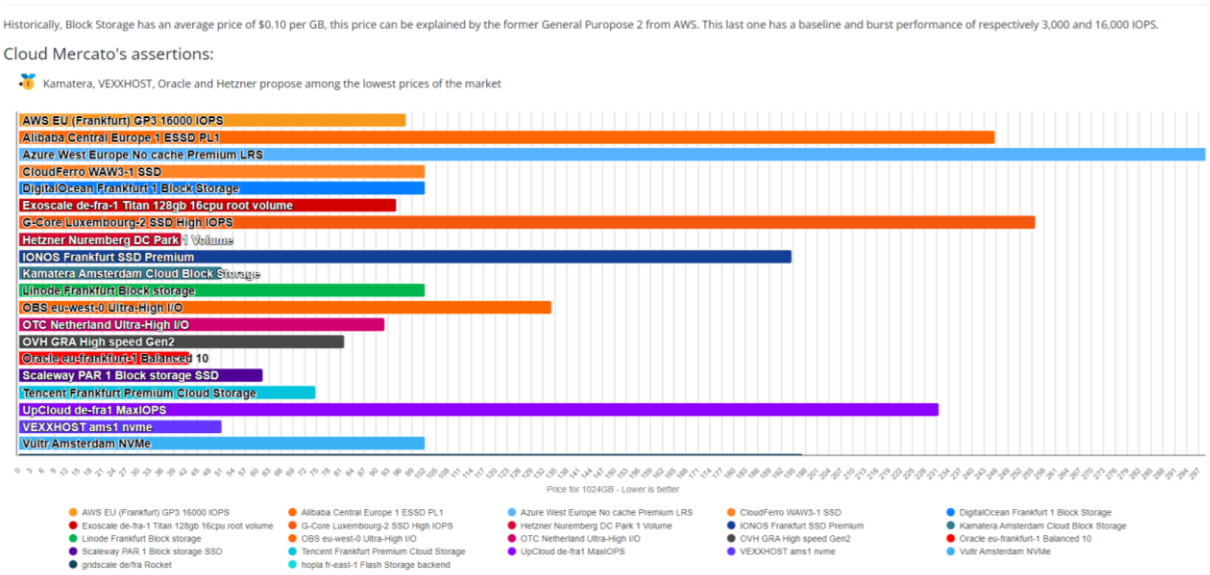
Compute optimized Instance pricing.



Network Pricing.



Block Storage Pricing.



Annex 2. Group 3 data and meta indicators.

Geekbench Benchmark.

	Geekbench					
Cloud Provider	GB general	GB general normalized	compute opti	compute opti normalized	GB memory opti	memory opti normallized
CloudSigma	8,20	0,35	8,98	0,40	NA	0,00
Exoscale	NA	0,00	22,40	1,00	13,37	0,68
FugaCloud	12,75	0,54	NA	0,00	NA	0,00
G-Core	19,36	0,83	21,25	0,95	16,11	0,82
IONOS	14,81	0,63	16,96	0,76	12,54	0,64
Scaleway	22,86	0,98	NA	0,00	NA	0,00
T-systems open telekom cloud	23,41	1,00	22,24	0,99	19,66	1,00
Upcloud	17,20	0,73	16,76	0,75	15,96	0,81
Gridscale	17,40	0,74	20,73	0,93	13,61	0,69
hopla.cloud	15,97	0,68	NA	0,00	NA	0,00
infomaniak	18,91	0,81	15,70	0,70	NA	0,00

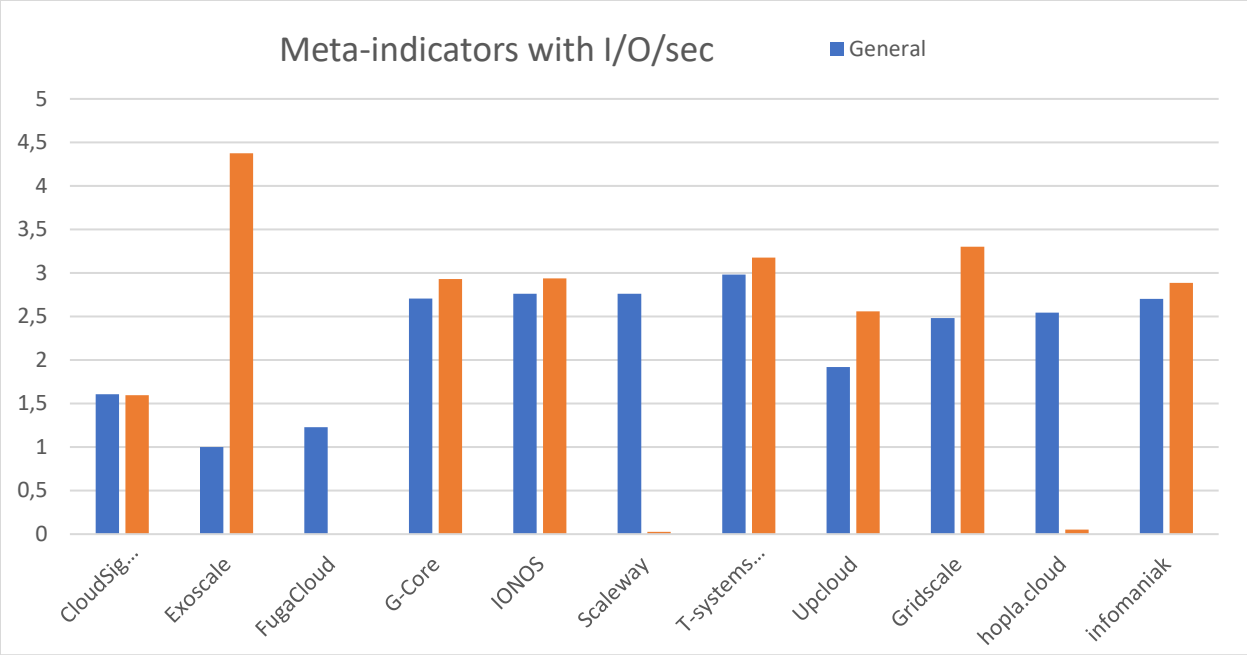
Sysbench CPU & RAM benchmark.

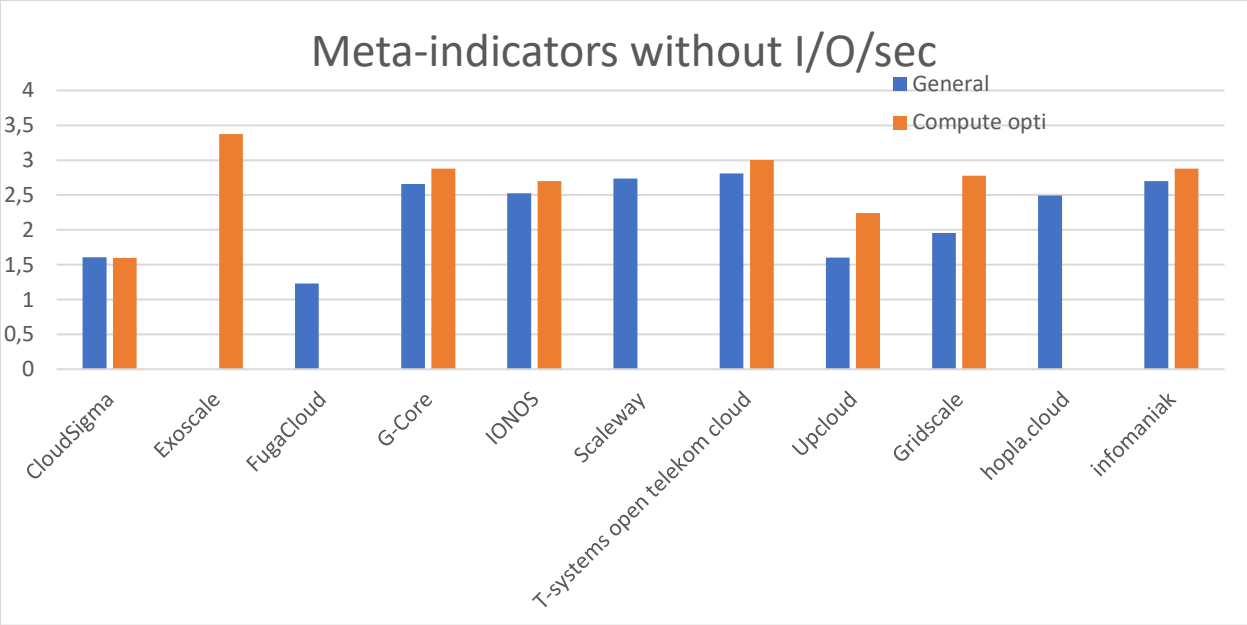
	Sysbench											
Cloud Provider	Sysbench CPU general	sysbench CPU general nzd	sysbench CPU compute opti	sysbench CPUcompute opti nzd	sysbench CPU memory opti	sysbench CPU memory opti nzd	sysbench RAM gen	sysbench RAM gen nzd	sysbench RAM compute opti	sysbench RAM compute opti nzd	sysbench RAM mem opti	sysbench RAM mem opti ned
CloudSigma	2,36	0,12	7,11	0,39		0,00	6,86	0,47	8,48	0,53		0,00
Exoscale		0,00	14,06	0,78	10,58	0,59		0,00	9,54	0,60	12,05	0,65
FugaCloud	3,49	0,18		0,00		0,00	7,37	0,50		0,00		0,00
G-Core	4,57	0,24	13,21	0,73	11,98	0,67	11,28	0,77	14,29	0,89	18,27	0,98
IONOS	3,99	0,21	11,71	0,65	10,50	0,58	14,70	1,00	16,03	1,00	15,77	0,85
Scaleway	19,09	1,00		0,00		0,00	5,93	0,40		0,00		0,00
T-systems open telekom cloud	5,29	0,28	13,86	0,77	13,08	0,73	11,50	0,78	14,75	0,92	18,63	1,00
Upcloud	6,88	0,36	18,01	1,00	17,97	1,00	5,82	0,40	7,14	0,45	10,18	0,55
Gridscale	4,92	0,26	16,15	0,90	12,59	0,70	7,98	0,54	10,97	0,68	12,54	0,67
hopla.cloud	3,86	0,20		0,00		0,00	9,39	0,64		0,00		0,00
infomaniak	5,91	0,31	12,85	0,71		0,00	8,53	0,58	11,17	0,70		0,00

I/O and Bandwidth (BW) benchmarks.

Cloud Provider	I/O/seconds	I/O/seconds nzd	Bandwidth gen	Bandwidth gen nzd	BW compute opti	BW compute opti nzd	BW memory opti	BW memory opti
CloudSigma	NA	NA	10,18	0,67	5,02	0,27	NA	NA
Exoscale	22,06	1,00	NA	NA	18,44	1,00	9,34	0,50
FugaCloud	NA	NA	NA	NA	NA	NA	NA	NA
G-Core	1,08	0,05	12,59	0,82	5,65	0,31	5,62	0,30
IONOS	5,23	0,24	10,46	0,68	5,40	0,29	5,62	0,30
Scaleway	0,57	0,03	5,44	0,36	NA	NA	NA	NA
T-systems open telekom cloud	3,87	0,18	11,43	0,75	5,88	0,32	18,78	1,00
Upcloud	7,03	0,32	1,67	0,11	0,85	0,05	0,88	0,05
Gridscale	11,64	0,53	6,27	0,41	4,97	0,27	5,29	0,28
hopla.cloud	1,16	0,05	14,80	0,97	NA	NA	NA	NA
infomaniak	0,13	0,01	15,28	1,00	14,18	0,77	NA	NA

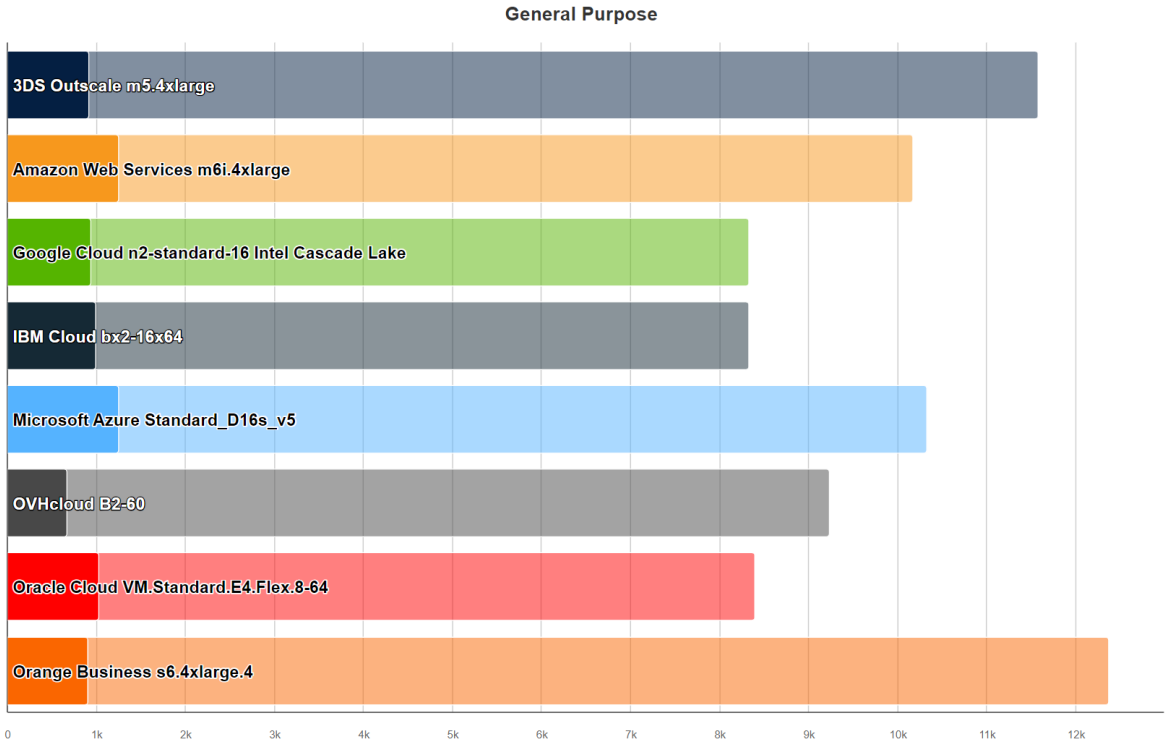
	Meta-KPI with I/O/sec			Meta-KPI without I/O/sec	
Cloud Provider	**General**	**Compute opti**	**Memory opti**	**General**	**Compute opti**
CloudSigma	1,61	1,597	0,00	1,61	1,60
Exoscale	1,00	4,376	3,41	0,00	3,38
FugaCloud	1,23	0,000	0,00	1,23	0,00
G-Core	2,71	2,929	2,81	2,66	2,88
IONOS	2,76	2,937	2,60	2,53	2,70
Scaleway	2,76	0,026	0,03	2,74	0,00
T-systems open telekom cloud	2,98	3,177	3,90	2,81	3,00
Upcloud	1,92	2,558	2,72	1,60	2,24
Gridscale	2,48	3,304	2,88	1,95	2,78
hopla.cloud	2,54	0,053	0,05	2,49	0,00
infomaniak	2,70	2,886	0,01	2,70	2,88

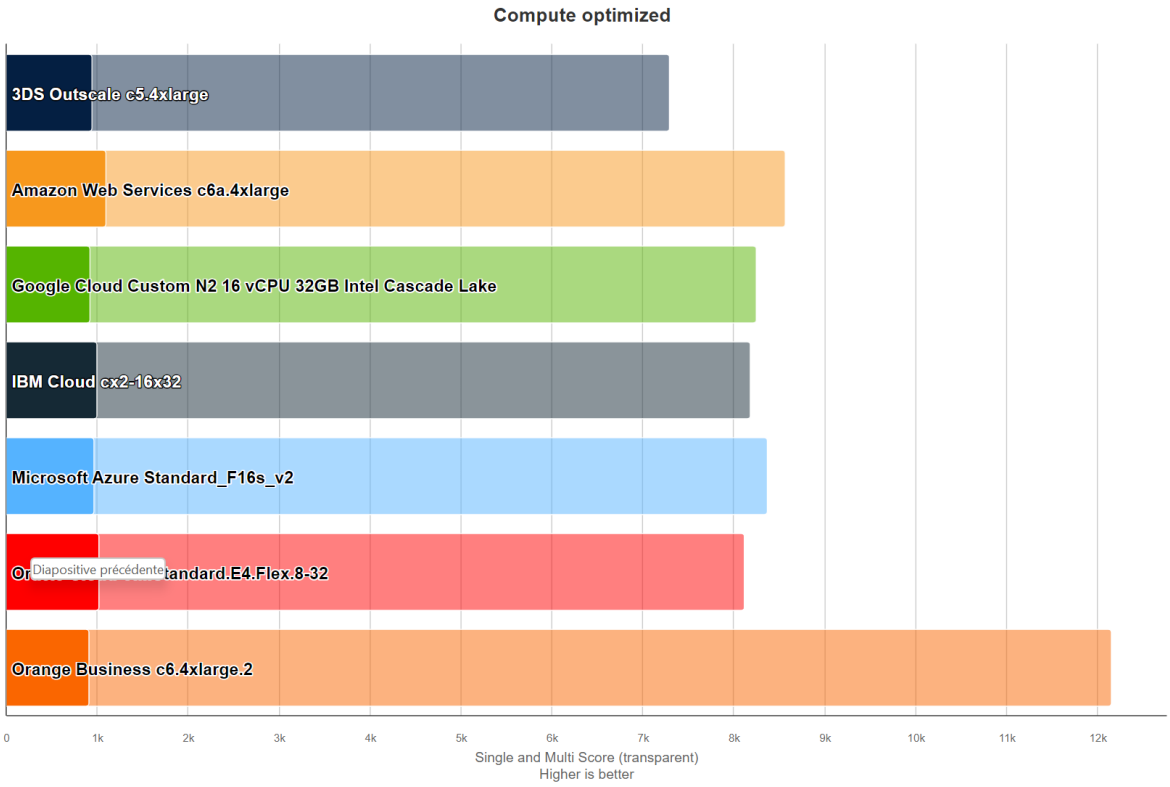

Meta-indicators with I/O/sec
General
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
CloudSig...
Exoscale
FugaCloud
G-Core
IONOS
Scaleway
T-systems...
Upcloud
Gridscale
hopla.cloud
infomaniak


Meta-indicators without I/O/sec
General
Compute opti
4
3,5
3
2,5
2
1,5
1
0,5
0
CloudSigma
Exoscale
FugaCloud
G-Core
IONOS
Scaleway
T-systems open telekom cloud
Upcloud
Gridscale
hopla.cloud
infomaniak

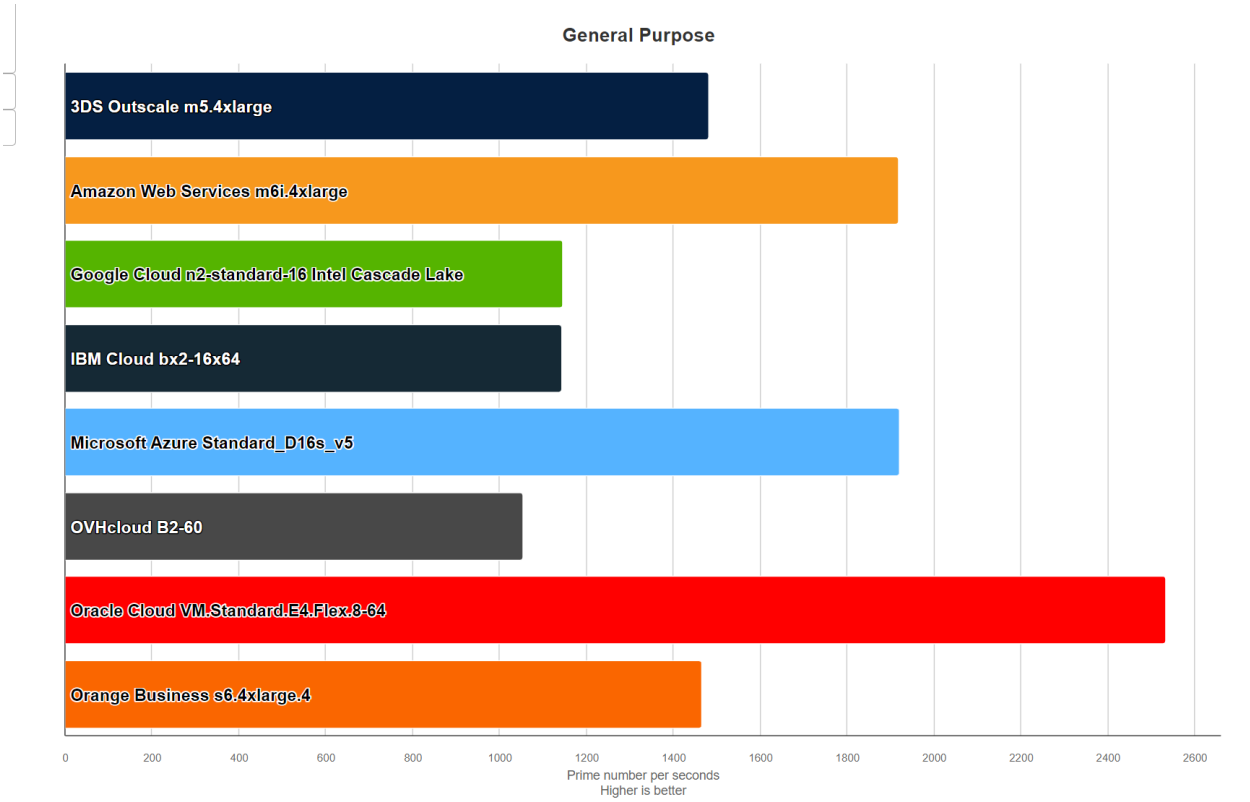
Annex 3. Correspond graphs for group 1+2

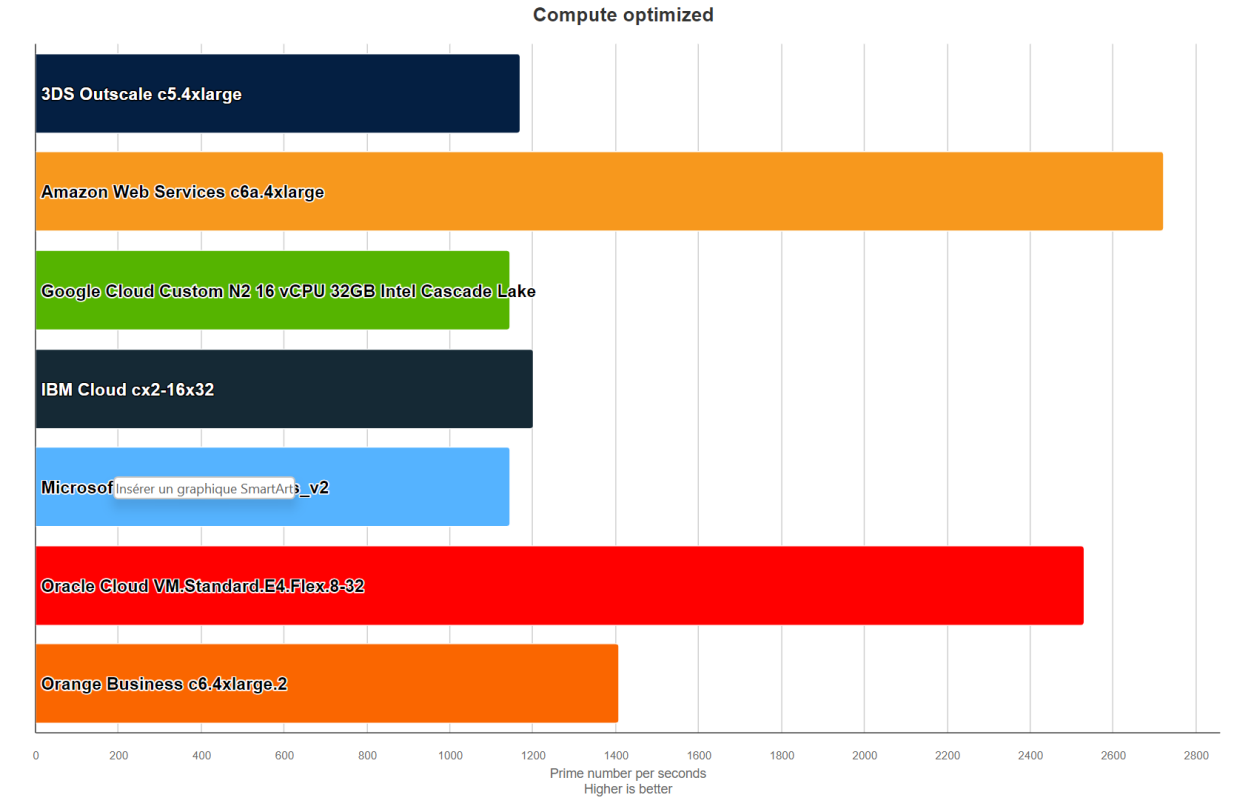
Geekbench.



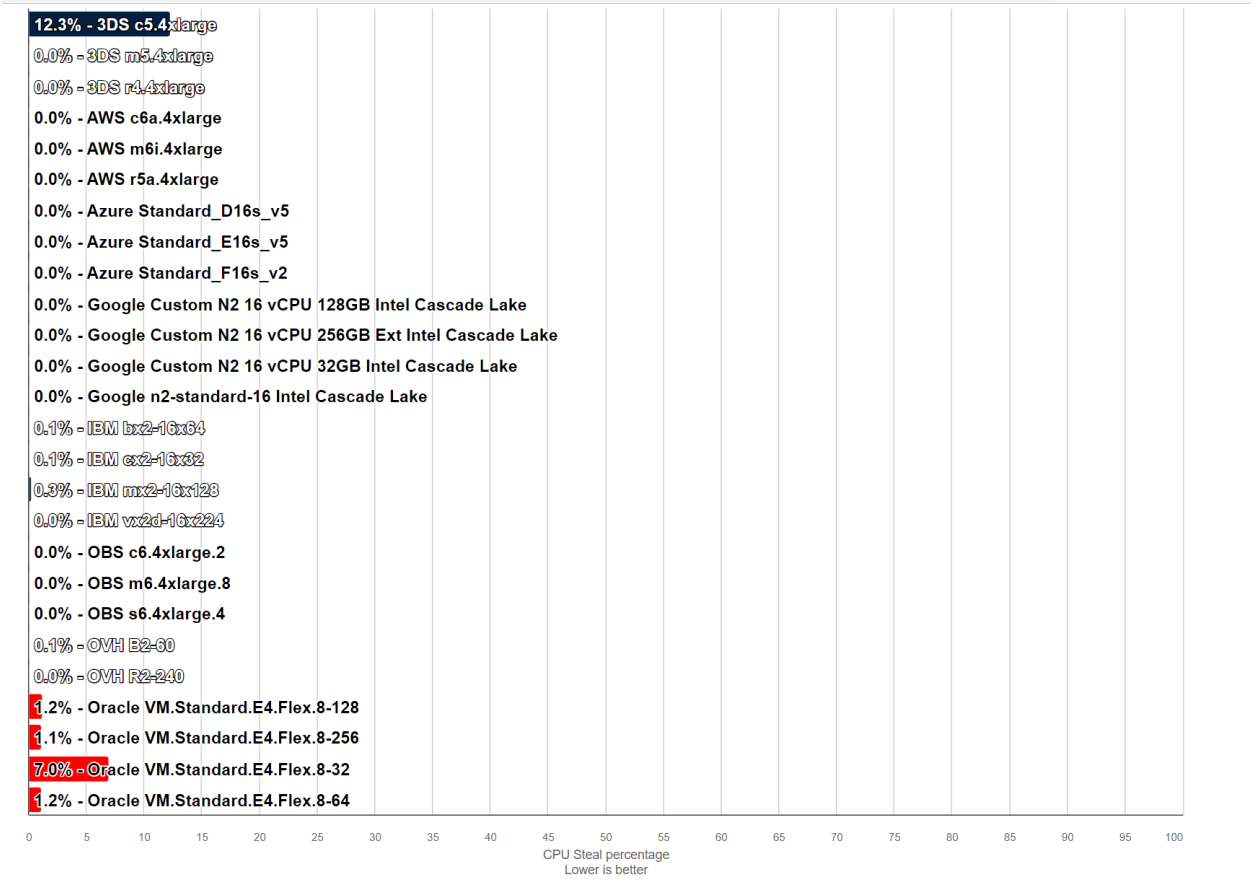


Sysbench CPU benchmark.

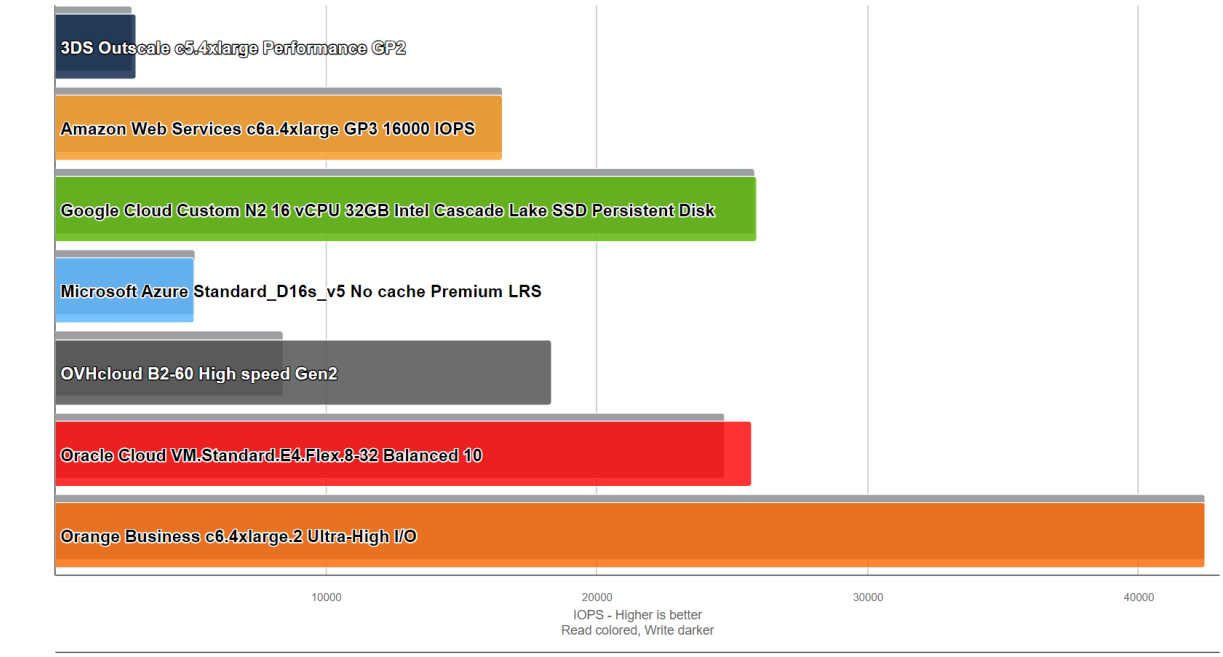




CPU Steal benchmark



I/O/sec benchmark.



Bandwidth benchmark.