



LEONARDO

EuroHPC Leonardo Consortium

EWHPC 2020 - Mirko Cestari

CINECA



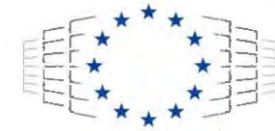
REPUBLIKA SLOVENIJA
REPUBLIC OF SLOVENIA
Ministrstvo za izobraževanje, znanost in šport
Ministry of education, science and sport
Masarykova cesta 16, SI - 1000 Ljubljana

Joint effort process



EuroHPC JU

- conducting the Procurement process



EuroHPC
Joint Undertaking

CINECA

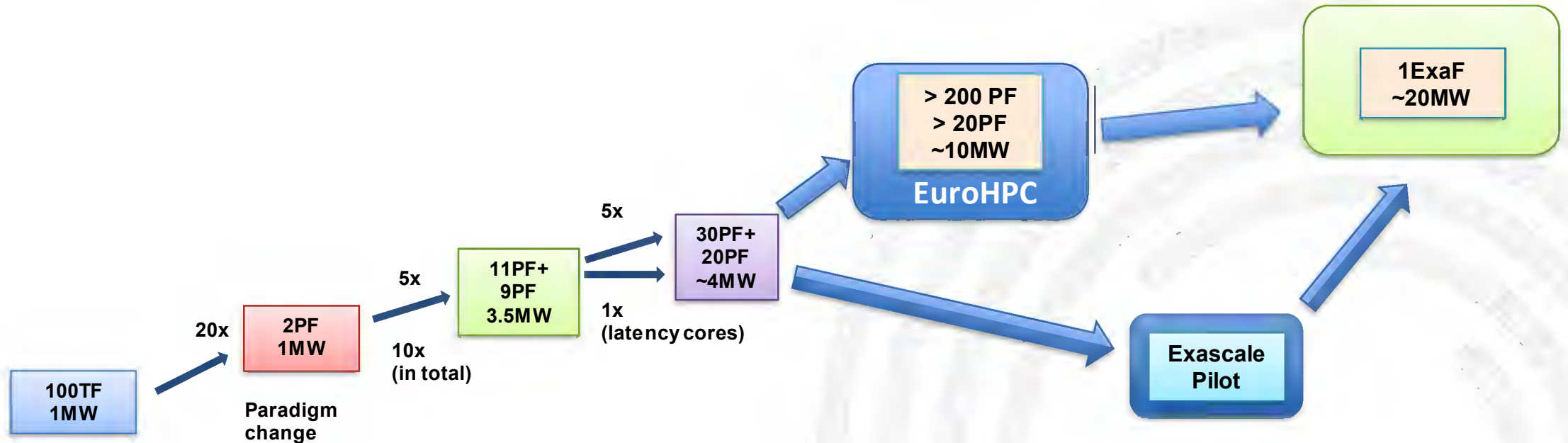
- 10 staff members
- cover technical aspects of the procurement

INFN

- 2 staff members
- provide consultancy and support for facility integration



Roadmap



2009	2012	2016	2019/2020	2021	2023-2025	2025-2027
IBM SP6 Power6	Fermi IBM BGQ PowerA2	Marconi Lenovo Xeon+KNL	Marconi PPI4HPC ICEI - PPIHBP	pre-Exascale with EuroHPC contribution	post-Marconi Exascale pilot technology (National Research Plan)	EuroHPC post Exascale/ National Full Exascale

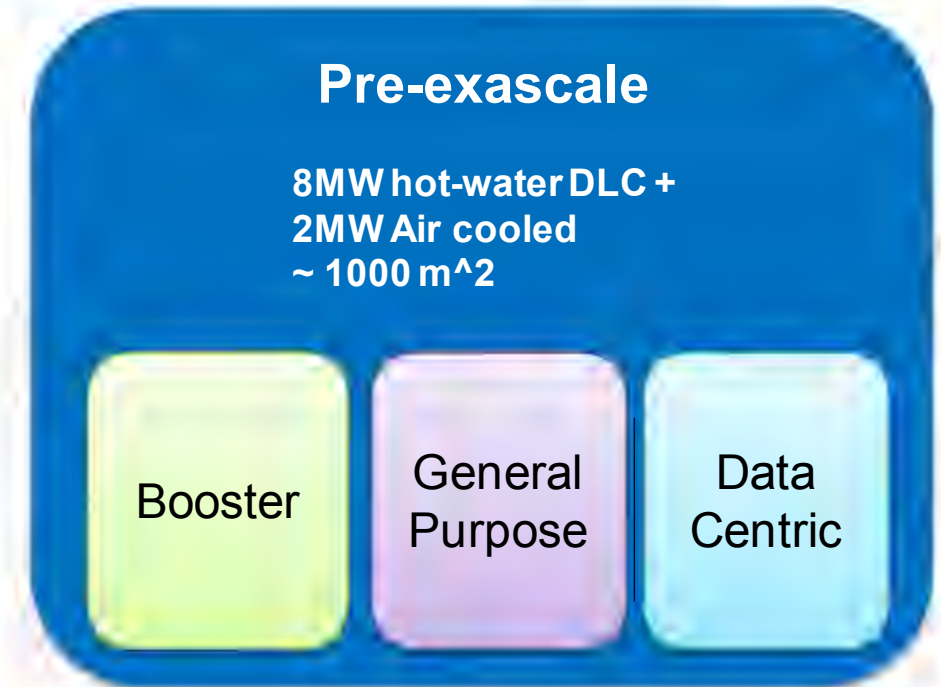
Proposed System as EuroHPC HE



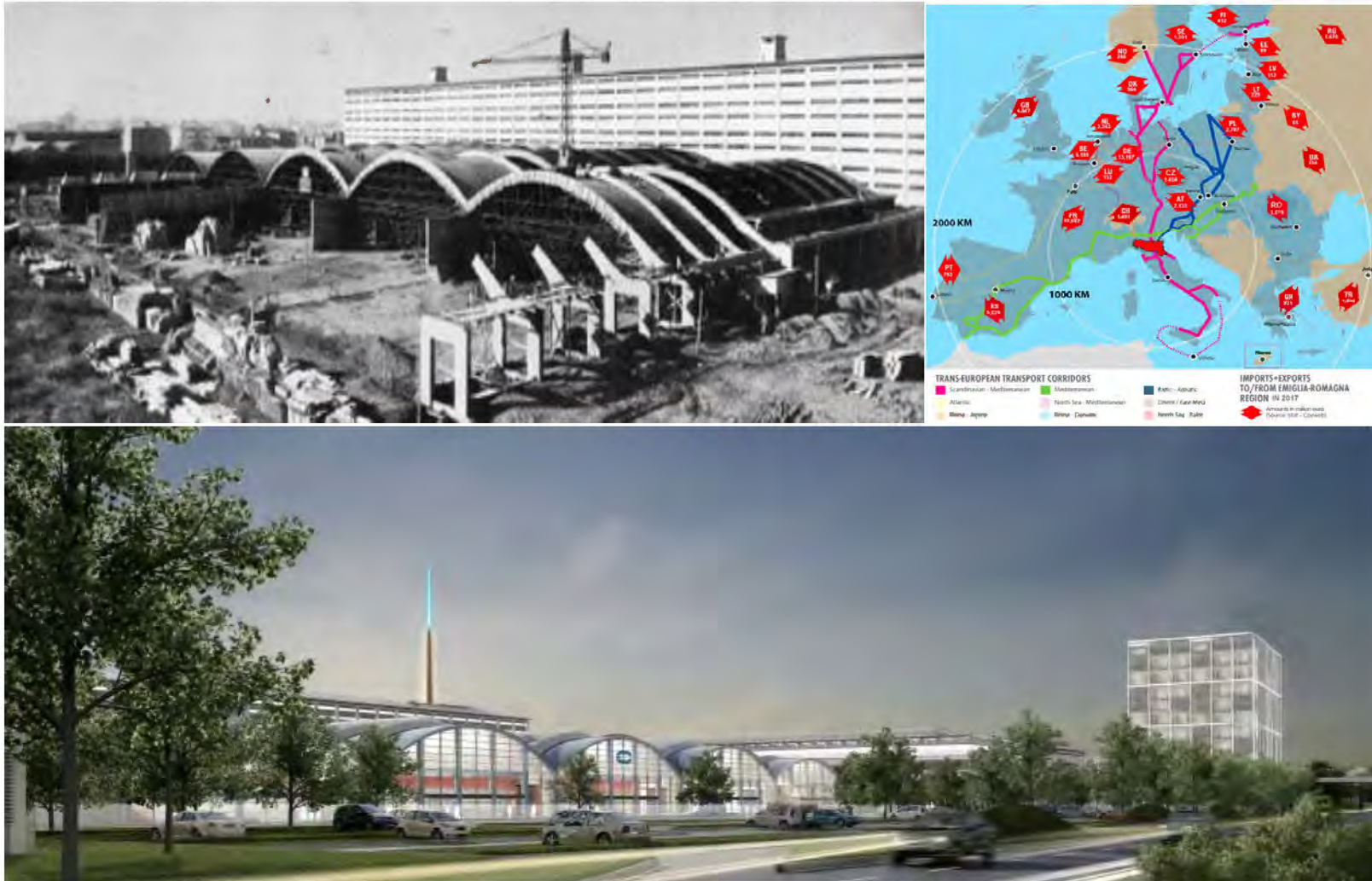
System name	Leonardo
Modules	3 (booster, general purpose, data centric)
Number of computing nodes	5000 (3500+500+1000)
Storage	Capacity: 150 PB, bandwidth: 1 TB/s
HPL Targeted Performance (peak)	150-180 PFlops (210-250 PFlops); Top 3
HPCG Targeted Performance	2.8-3.3 PFlops; Top 3
I/O	≥ 150 PB
Interconnection Bandwidth	≥ 200 Gb/s
Estimated Power consumption (after PUE)	8-9 MW (8.8-9.9 MW)

Use cases:

- 10x computing capability in a large set of key applications for science, industry and society (CoEs, HEP, Pharma, Oil&GAS), and keep the European leadership;
- gain sovereignty on strategic technologies for the European economic wealth, like Artificial Intelligence, Cybersecurity and Internet of Things;
- tackle relevant and urgent societal challenges.



Bologna Science Park

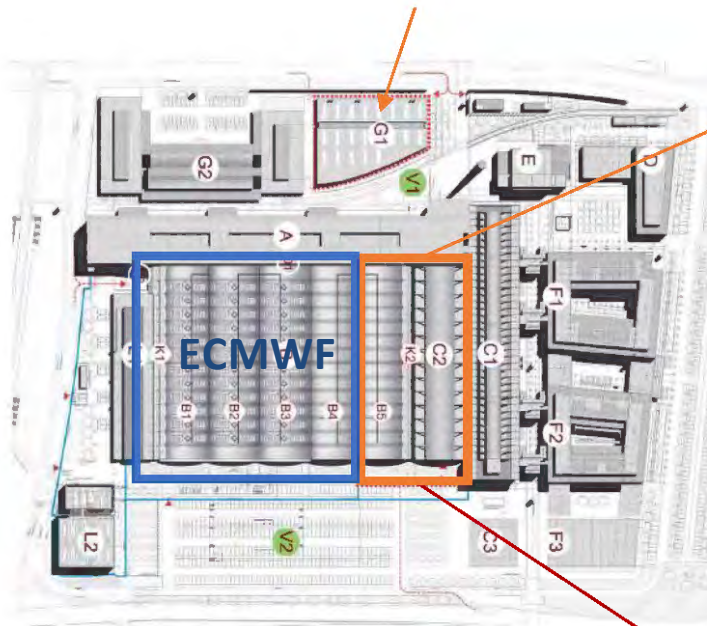


EuroHPC hosting @ Bologna Science Park

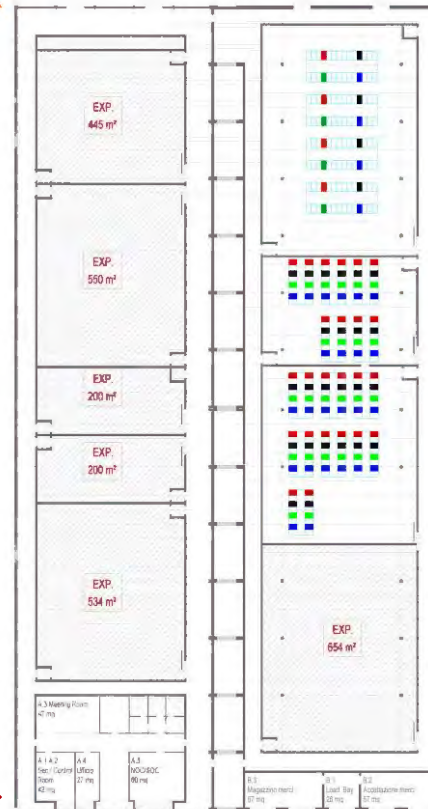


Cooling equipment
3MW (2020) - 5MW(2023)

Computer Rooms
10MW (2020) - 20MW (2023)



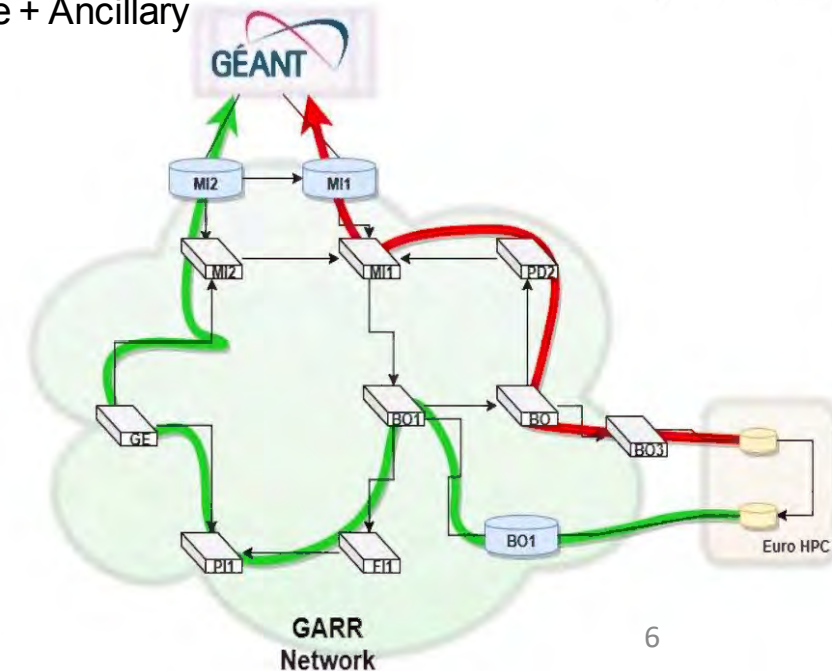
$PUE < 1.1$



DATA ROOM STAGE 1: 1600 sqm
DATA ROOM STAGE 2: 2600 sqm
ANCILLARY SPACES: 900 sqm

8MW hot water DLC
Compute nodes

2MW AIR Cooled
Storage + Ancillary



Procurement goal



Acquisition budget: 120 Million Euros

- HPC system
- 5 year maintenance and support
- Software stack and licenses

Consortium vision

- **Sustain** the computing capability for the consortium and European researchers
- Build on top of **past experience** and results
- Allow for continuity in project development towards **heterogenous systems**

Procurement goal cont.



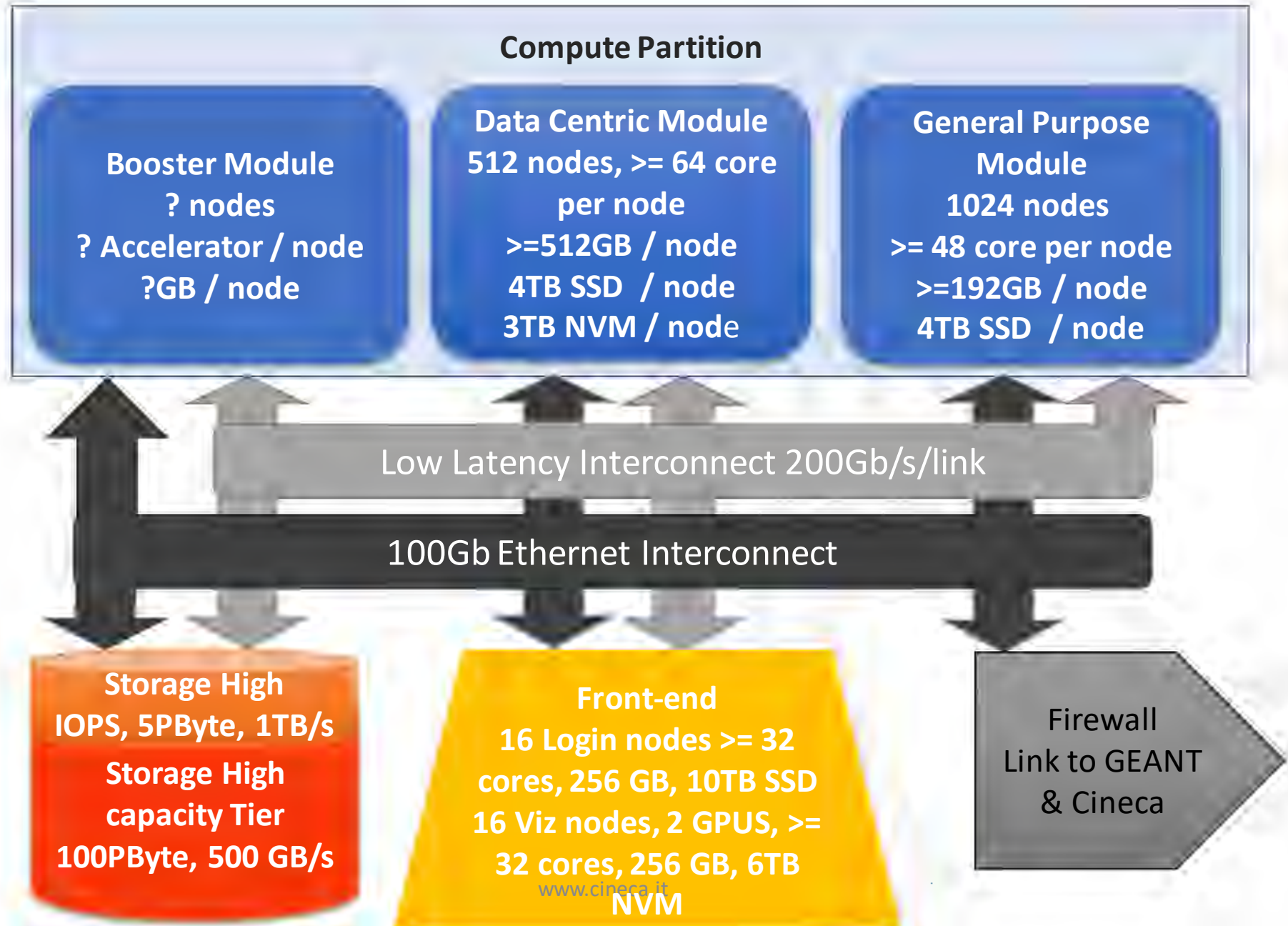
Technical specifications

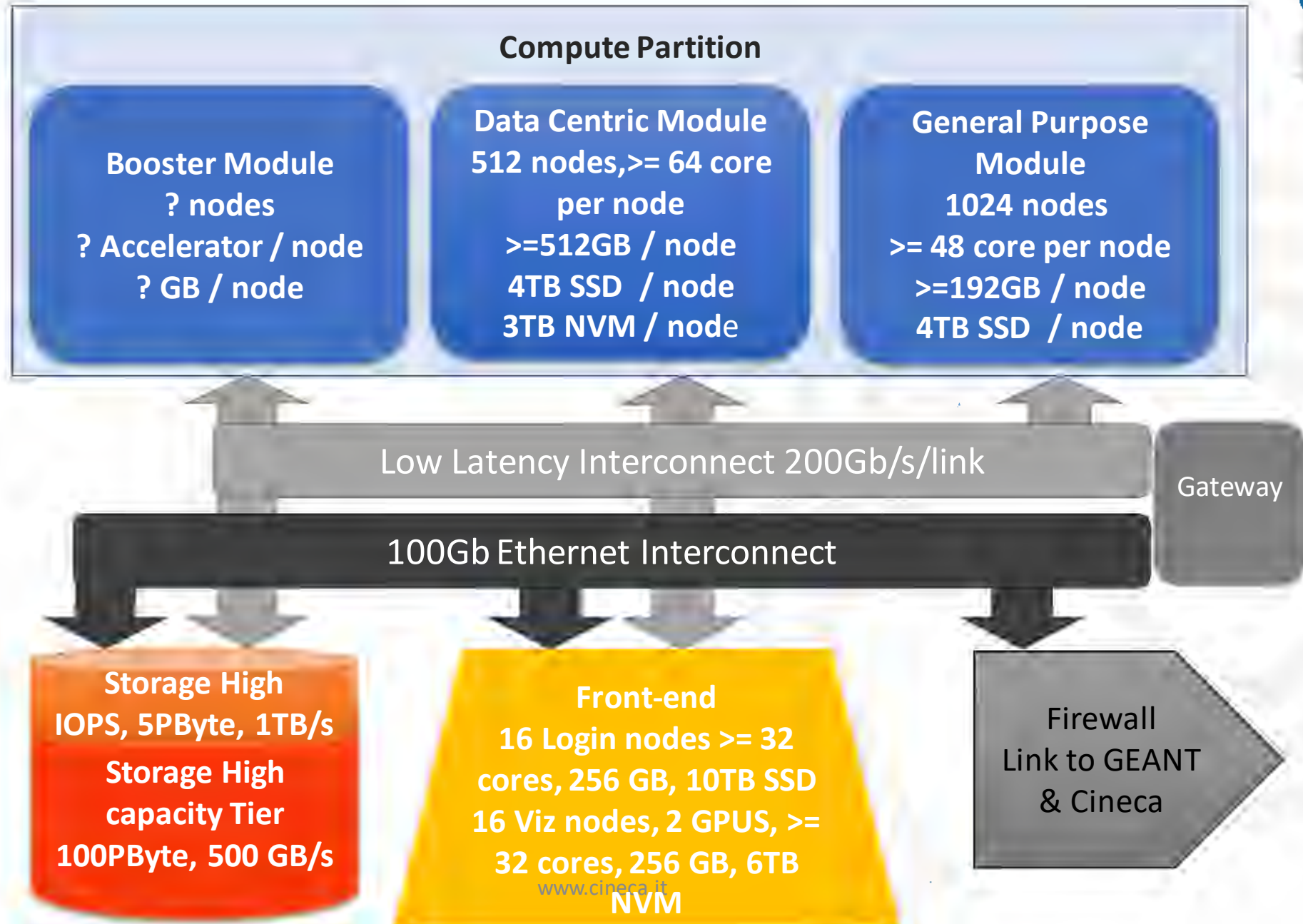
- promote **competition**
- **most** of the mandatory requirements for the facility integration
- **few** mandatory requirements for the node design
 - Mostly for Data Centric and General Purpose nodes
 - > number of cores, NVM, DRAM
- **Allow** to propose the same design for Data Centric and General Purpose nodes
- Pretty **free** Booster node design
 - Competitive dialogue as a guarantee to avoid too esoteric architecture/design
 - Can result in more aggressive offers
- I/O design
 - Requirements on capacity and aggregated performance

Booster Node comparison

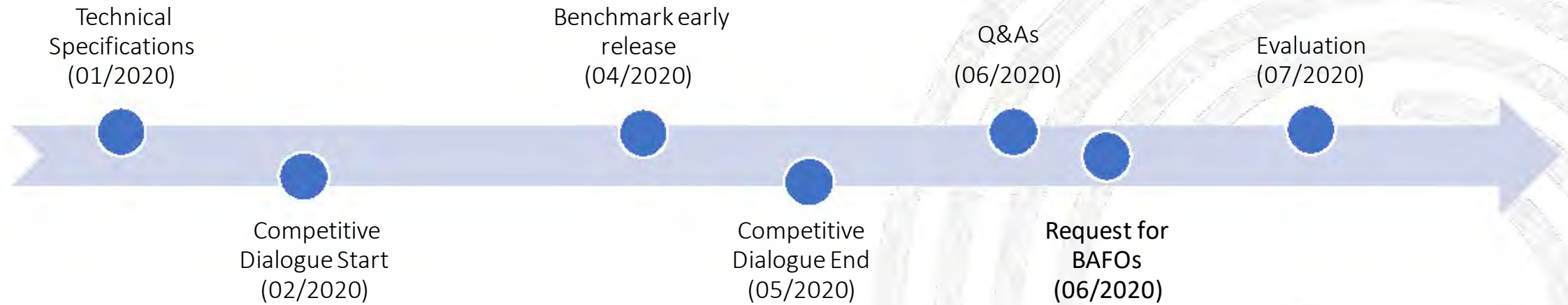


	Marconi-100	Leonardo
CPU	2 POWER9	> = 1
Cores	32 (16 per P9)	No hard requirement
Memory	256 GB	Enough to saturate channels
Memory Bandwidth	340 GB/s (2 x 8 x 21.25)	No hard requirement
CPUs : Accelerators	2:4	No hard requirement
Accelerators	4 Volta V100	No hard requirement
System Memory	320 GB	No hard requirement
Accelerator DP Flops	28 TF	No hard requirement
Accelerator Memory	64 GB HBM2	No hard requirement
Accelerator Memory Bandwidth	3.6 TB/s (900 GB/s x 4 GPUs)	No hard requirement
SSD Capacity	1.6 TB	No hard requirement





Procurement Timeline



Procurement Timeline



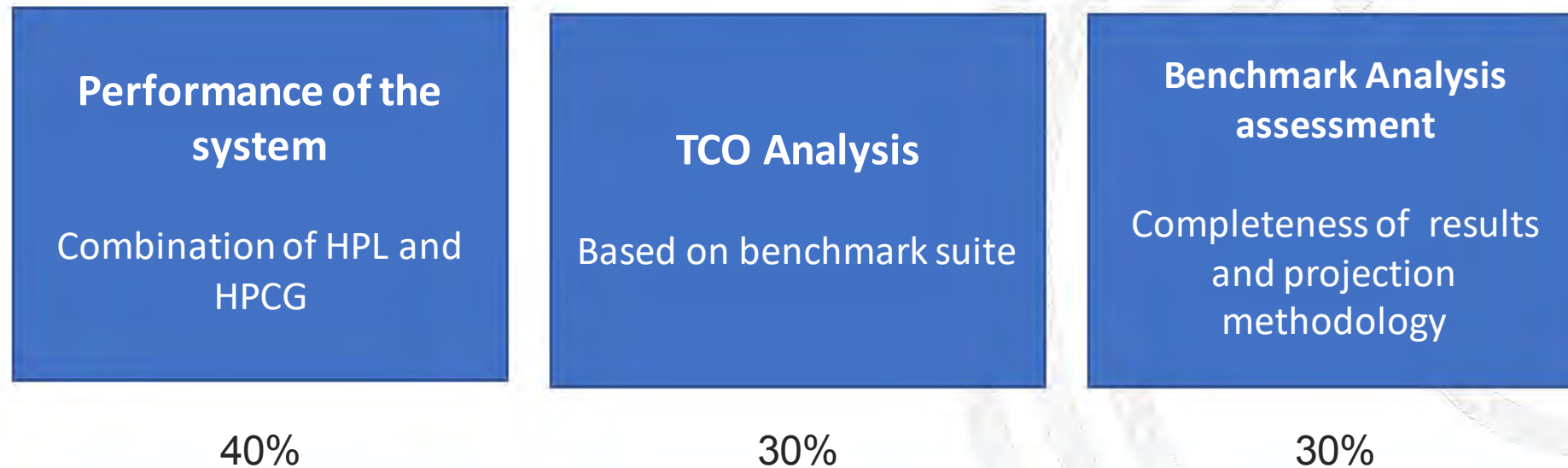
- ☐ Technical specifications to enter the competitive dialogue released in January 2020
- Competitive dialogue dates:
 - ✦ Session I, 13-14 February 2020 (4 hours each candidate)
 - ✦ Session II, 2-3 April 2020 (4 hours each candidate)
 - ✦ Session III, 14-15 May 2020 (4 hours each candidate)
- ☐ Final RFP released on June 4, 2020
- ☐ BAFOs (best and final offers) expected June 29, 2020
- ☐ Evaluation July 2020
- ☐ Award Autumn 2020



Cost Performance Analysis



- The most relevant criteria
 - 45/120 points (35%)
- 3 contributions



TCO Analysis



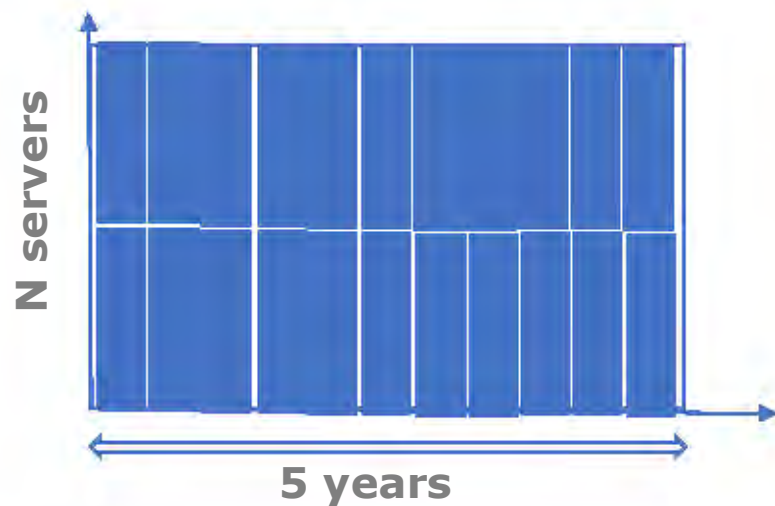
TCO analysis

- Built on top of **PPI4HPC experience** (<https://www.ppi4hpc.eu/>)
- sharing experience and lesson learned between partners (BSC, CINECA, CEA, JSC)
- Define a **common framework**
- **Tested and proved**

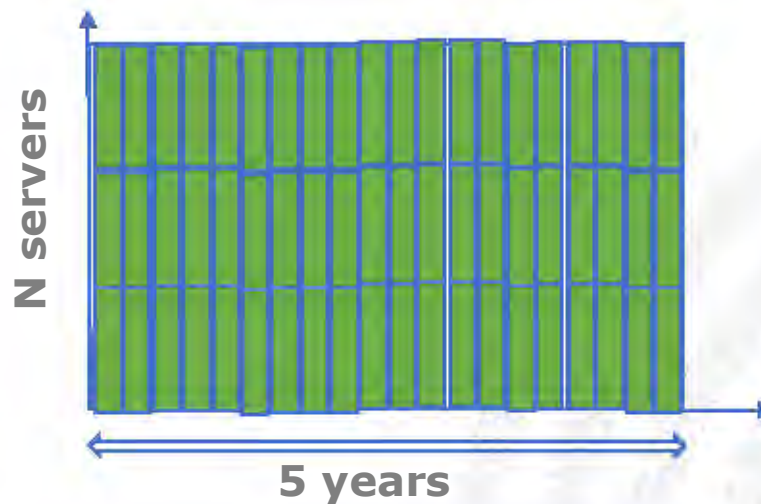
Aim to define a "value for money" criteria

- The "Value" bases on the estimated (average) **number of workloads** that can be run on the entire lifetime of the system
- "Money" comes from a **TCO approximation**

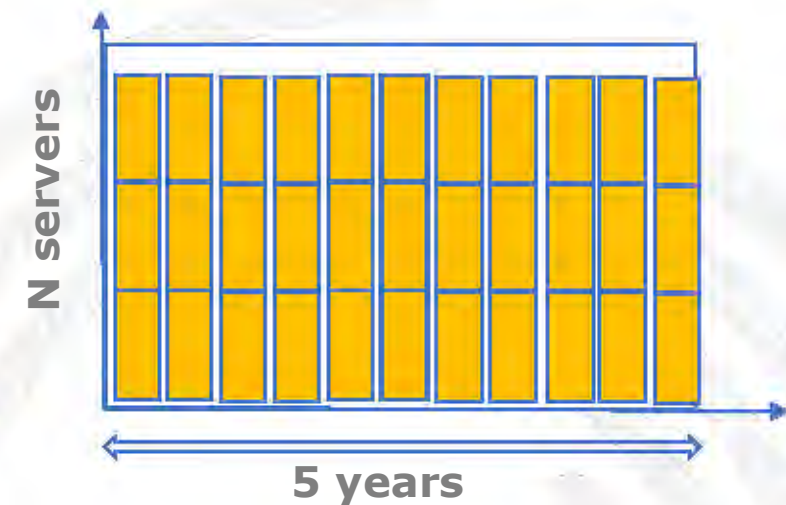
TCO analysis



n.Workload = **22**



n.Workload = **60**



n.Workload = **33**

$$\text{Value} = \frac{n.Workload}{TCO} = \frac{n.Workload}{Energy.LifeTime * PUE * Price}$$

TCO Analysis



- Benchmark suite preparation **took 4 months**
 - Only **4 applications** were taken into account
 - Well tested on multiple HPC architectures to **avoid last minute surprise**
 - **Easy to manage** for Procurer and Candidates
- All input sets, applications and instructions were publicly available through a **git repository**
 - **Early release** of small input to test code
 - We request Candidates to **check the repository frequently**
 - Complete set before 2nd meeting of the Dialogue Phase
- We provided
 - A **Changelog** to track repository updates
 - A **Benchmark information** document
 - All rules for compilation and benchmark run
 - **Questions and Answers** document
 - To track requests from Candidates
 - All questions were anonymized and answered

Cost Performance Analysis



B

benchmark

☆ Star 0

Project ID: 482

152 Commits

1 Branch

0 Tags

2.3 GB Files

2.3 GB Storage

master

benchmark

History

Find file

Clone

Aligning README and Changelog file
Mirko Cestari authored 4 months ago

94e2fb59

README

CHANGELOG

No license. All rights reserved

Auto DevOps enabled

Name	Last commit	Last update
MILC	Fixed directory tree	5 months ago
PLUTO	Added changelog in the Pluto README	5 months ago
QuantumESPRESSO	Removed difference between MARCONI and GALILEO ...	5 months ago
SPECFEM3D	correction of typos	5 months ago
Changelog	Aligning README and Changelog file	4 months ago
Lot3-Benchmark_Information_v2.0.0.docx	Updated version of the Benchmark Information docum...	5 months ago
Lot3-Benchmark_Information_v2.0.1.docx	correction of typos	5 months ago
QA-Benchmarkprocedure-v2.1.pdf	Added clarification on SPECFEM3D bechmark	4 months ago
README.rst	Aligning README and Changelog file	4 months ago

Cost Performance Analysis



Cost_Performance_Analysis_scenarios ☆

File Modifica Visualizza Inserisci Formato Dati Strumenti Componenti aggiuntivi Guida [L'ultima modifica è stata apportata il 24 marzo](#)

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TCO							
	A	B	C	D	E	F	G
11	App1	TTS s	ETS kWh	Nodes	TTS s	ETS kWh	Nodes
12	C1	22,4	0,212	64	85	1,1	64
13	C2	17,5	0,215	64	76	1	64
14	C3	66,3	0,896	86	50	0,55	103
15							
16	App2	TTS s	ETS kWh	Nodes	TTS s	ETS kWh	Nodes
17	C1	421,2	1,018	16	405	1,018	16
18	C2	331,8	0,927	16	330	0,927	16
19	C3	359	0,995	16	405	0,995	16
20							
21	App3	TTS s	ETS kWh	Nodes	TTS s	ETS kWh	Nodes
22	C1	156	0,283	16	127	1	16
23	C2	163,9	0,377	16	153	0,72	16
24	C3	210	0,196	4	230	0,25	4
25							
26	App4	TTS s	ETS kW	Nodes	TTS s	ETS kW	Nodes
27	C1	583	1,492	16	540	2,6	16
28	C2	762,7	2,33	16	617	2,8	16
29	C3	2473	1,985	4	2473	2	4
30							
31	PROJECT INFO AND DERIVED DATA						
32							
33	T inlet	PUE					
34	30	1,11					
35	40	1,08					

Performance		
	w (HPL)	w (HPCG)
w(k)	0,5	0,5
Lk	150000	2700
	HPL TFlop/s	HPCG PFlop/s
C1	152000,50	4123,5
C2	158000,50	5001,6
C3	174000,00	3200,4
	M1	M2
C1	0,08	0,62
C2	0,33	1,00
C3	1,00	0,22
	Pc	
C1	0,35	
C2	0,67	
C3	0,61	

Evaluation of the offers



CINECA technical team

- Worked on the **technical response template**
 - Offers a common way to provide the BAFO
 - Ease **comparison** between offers (tables)
 - Clearly state the **scoring principles**
 - All technical specification requirements must be mapped into scoring points
- Provided the **Cost Performance Analysis Template**
 - Ease evaluation process

Result: We received 3 very competitive offers. Each one was very worth it

Lessons learned



- **Enter the competitive dialogue stage with few hard requirements**
 - Exploit the competitive dialogue process
 - Try as much to be inclusive
 - Adjust to meet technology roadmap
 - Lower priority requirement if possible
- **Cost Performance Analysis**
 - **Early** release of Benchmark suite
 - simplify as possible to **ease evaluation**
 - Assessments of benchmark quality

Leonardo



Thank you

Dr. Mirko Cestari

HPC and Cloud Technology team coordinator

CINECA, www.cineca.it

Mail: m.cestari@cineca.it

