Master Informatics Eng.

2021/22

A.J.Proença

TOP500 analysis and MACC

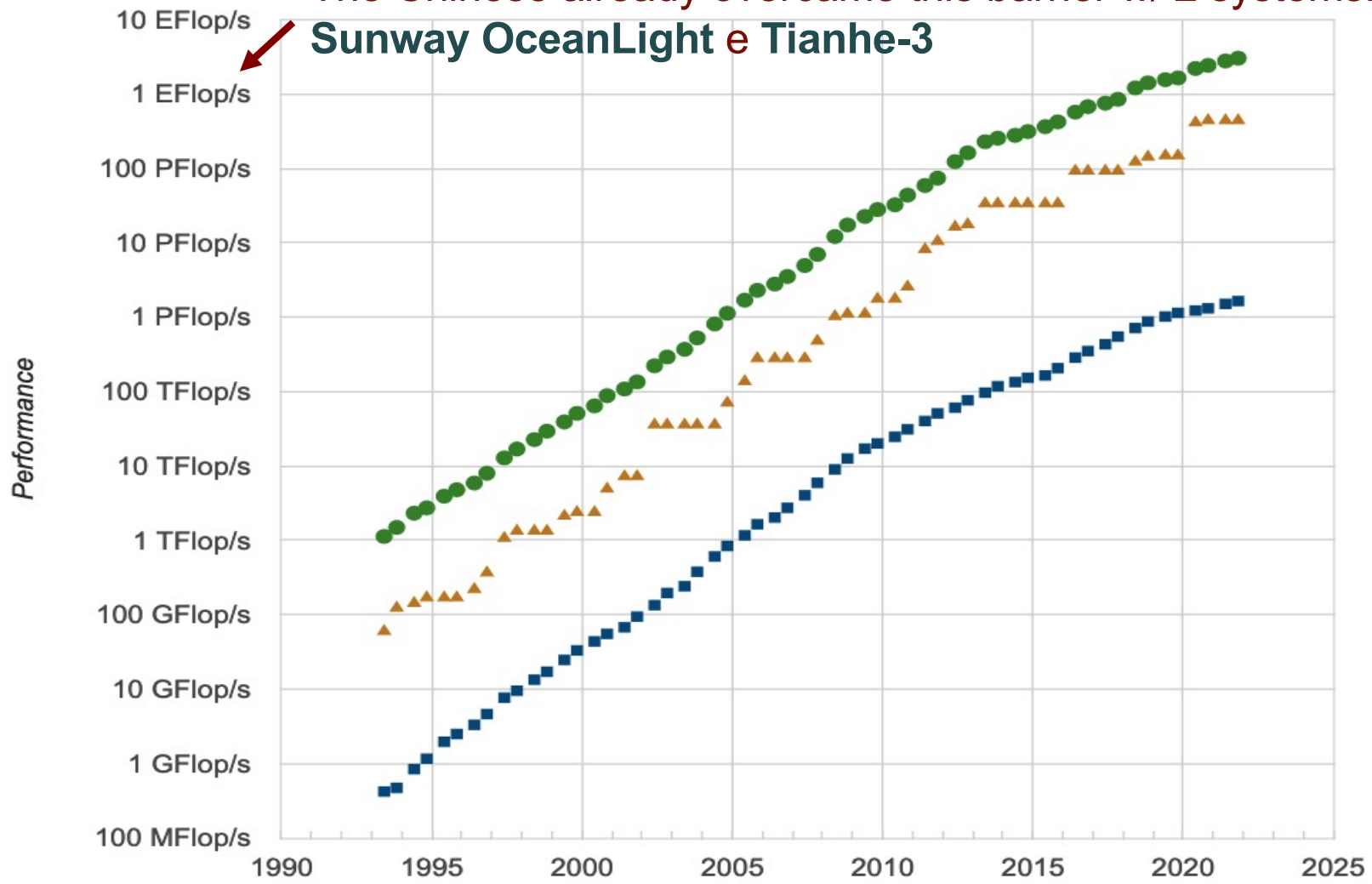
(some images are borrowed)

Discussion of homework
requested in previous session

1. Go to the TOP500 website and analyse & comment:
   i. The country distribution over the past 25 years, in #systems and aggregate performance in the TOP500 list
   ii. The evolution of the key PU chip technologies and the accelerator families in the past 25 years
   iii. The overall impact of each processor technology and accelerator family in the past 3 years

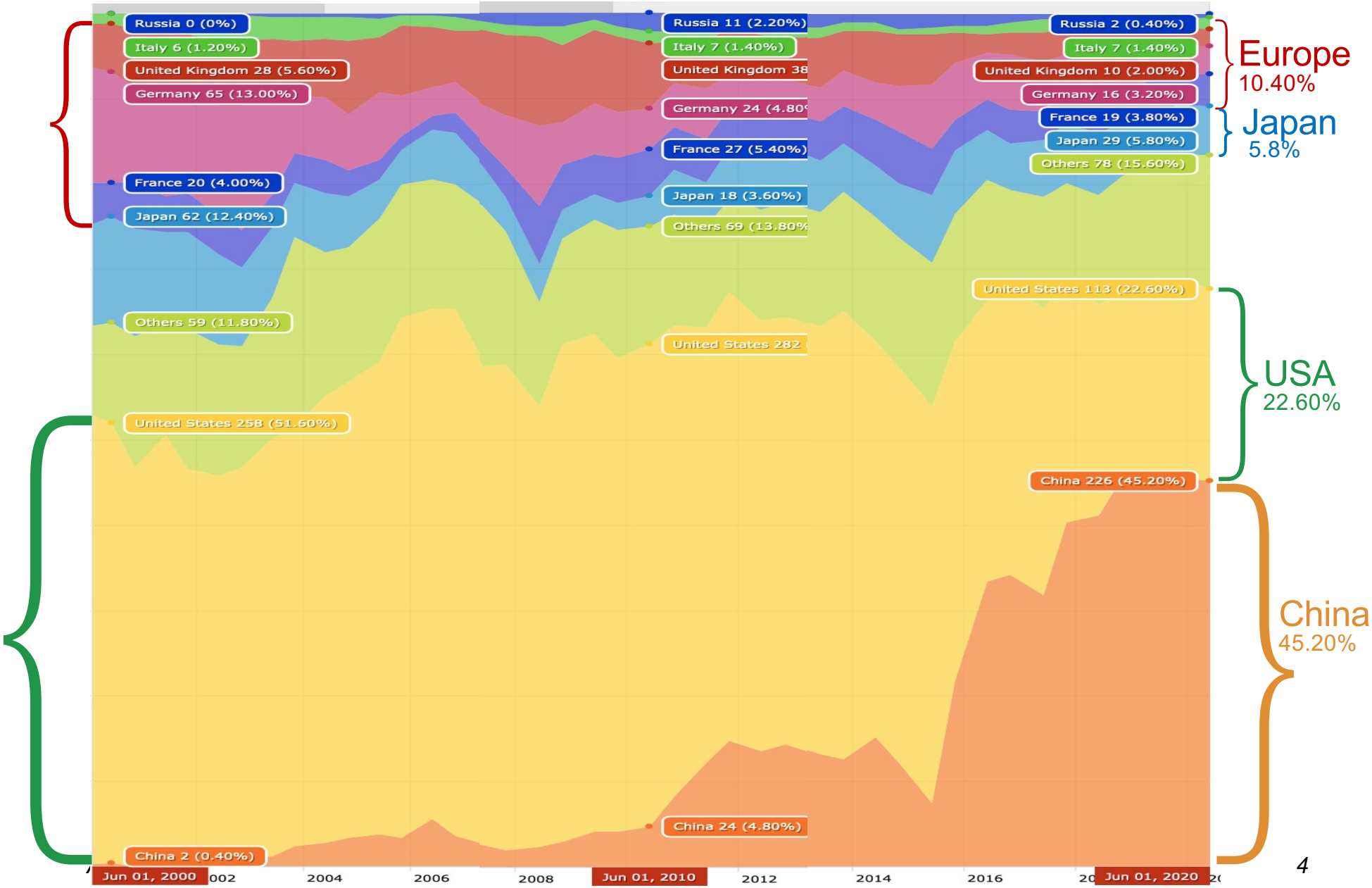
2. EuroHPC is funding 8 supercomputing centres selected in June 2019: 3 pre-exascale & 5 petascale
   i. Find & identify these 8 supercomputing centres
   ii. Characterize the architecture of Deucalion in MACC

Peak performance
1993 to 2021

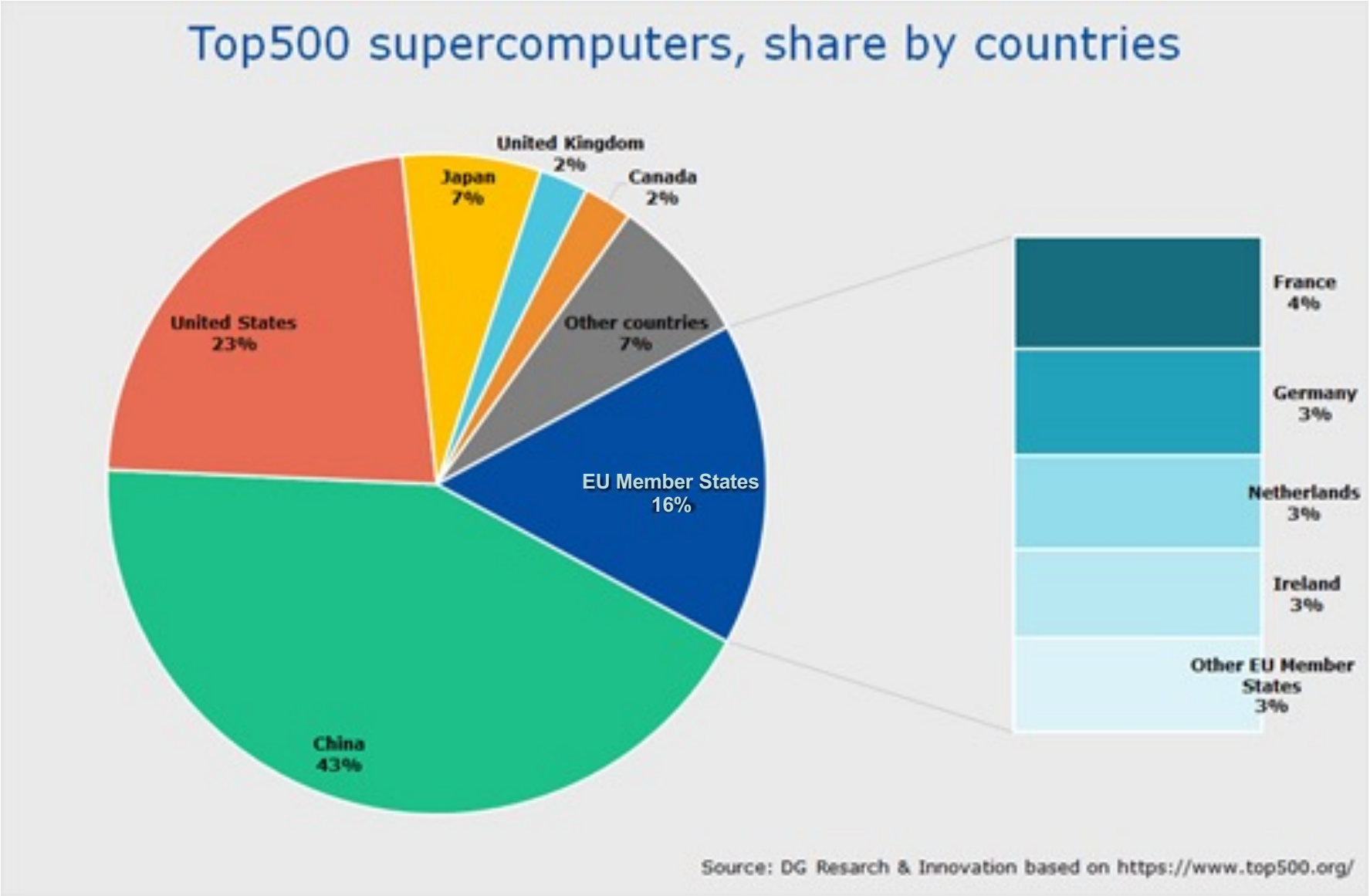


Country distribution over the past 20 years:

systems

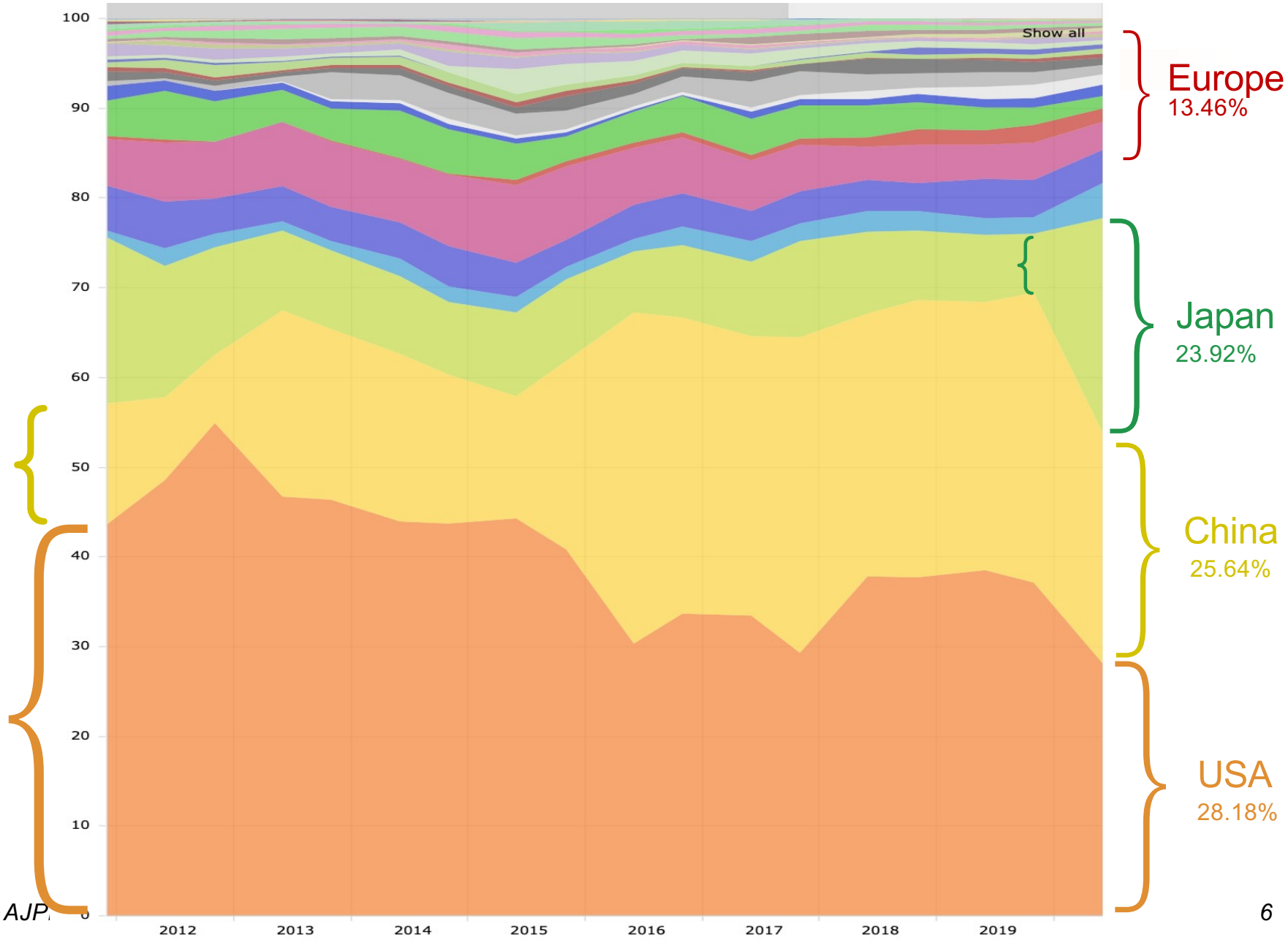


Country distribution in Nov'21:
systems

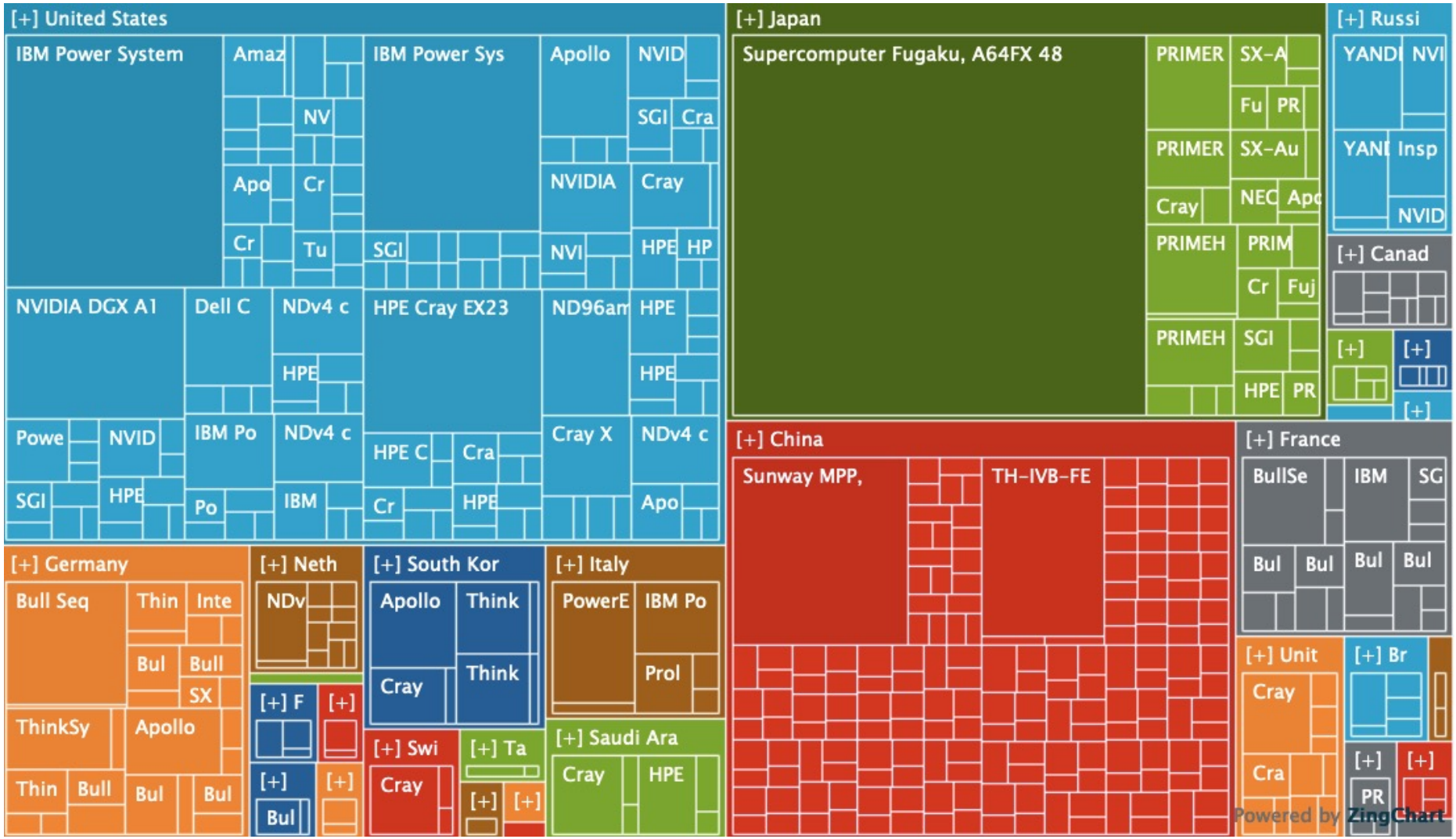


https://ec.europa.eu/newsroom/rtd/items/700622

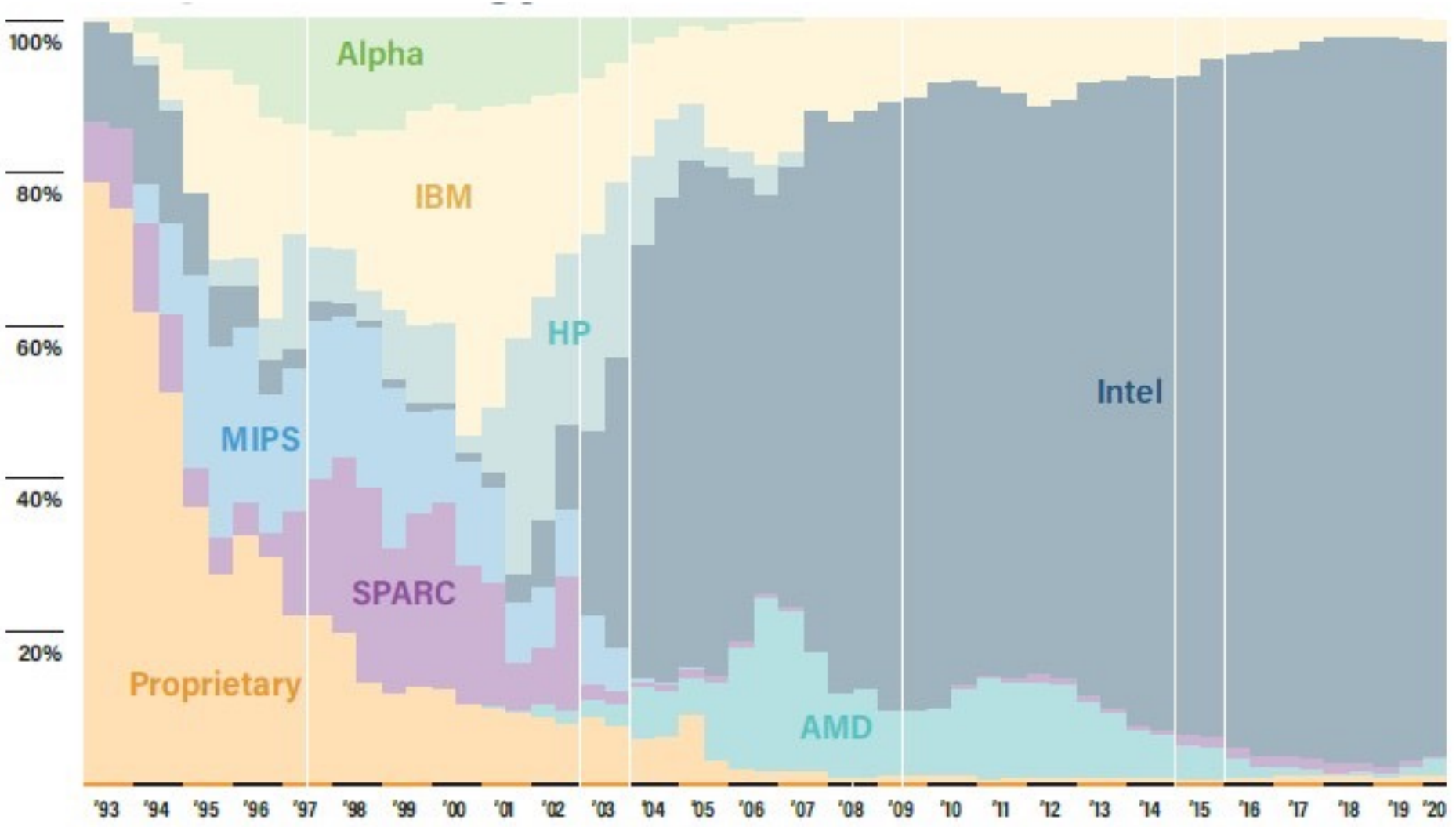
Country distribution over the past 8 years:
aggregate performance



Country distribution in Nov'21:
#systems & performance

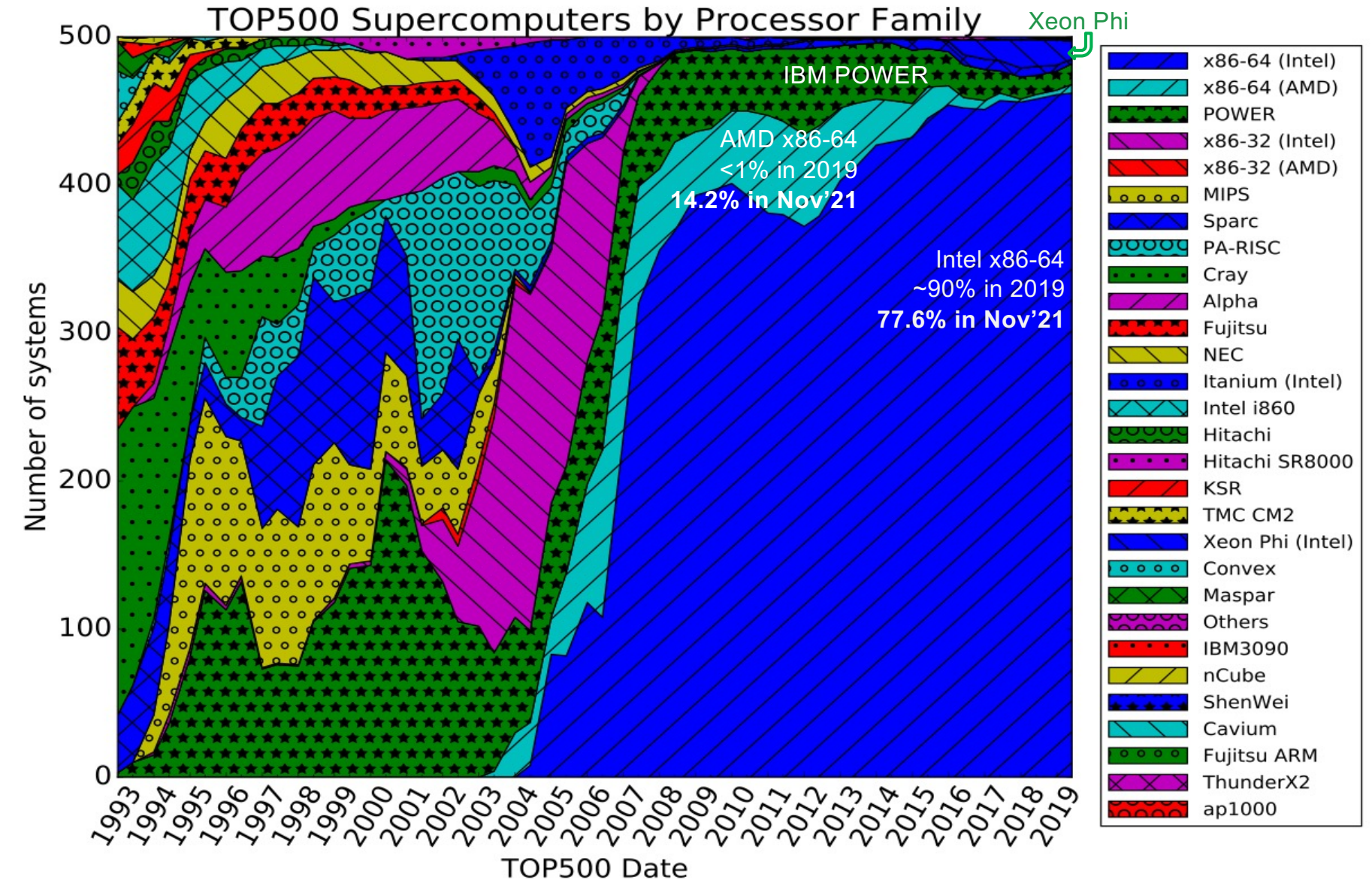


PU chip technology
1993 to 2020



https://www.nextplatform.com/2020/06/22/arm-and-japan-get-their-day-in-the-hpc-sun/

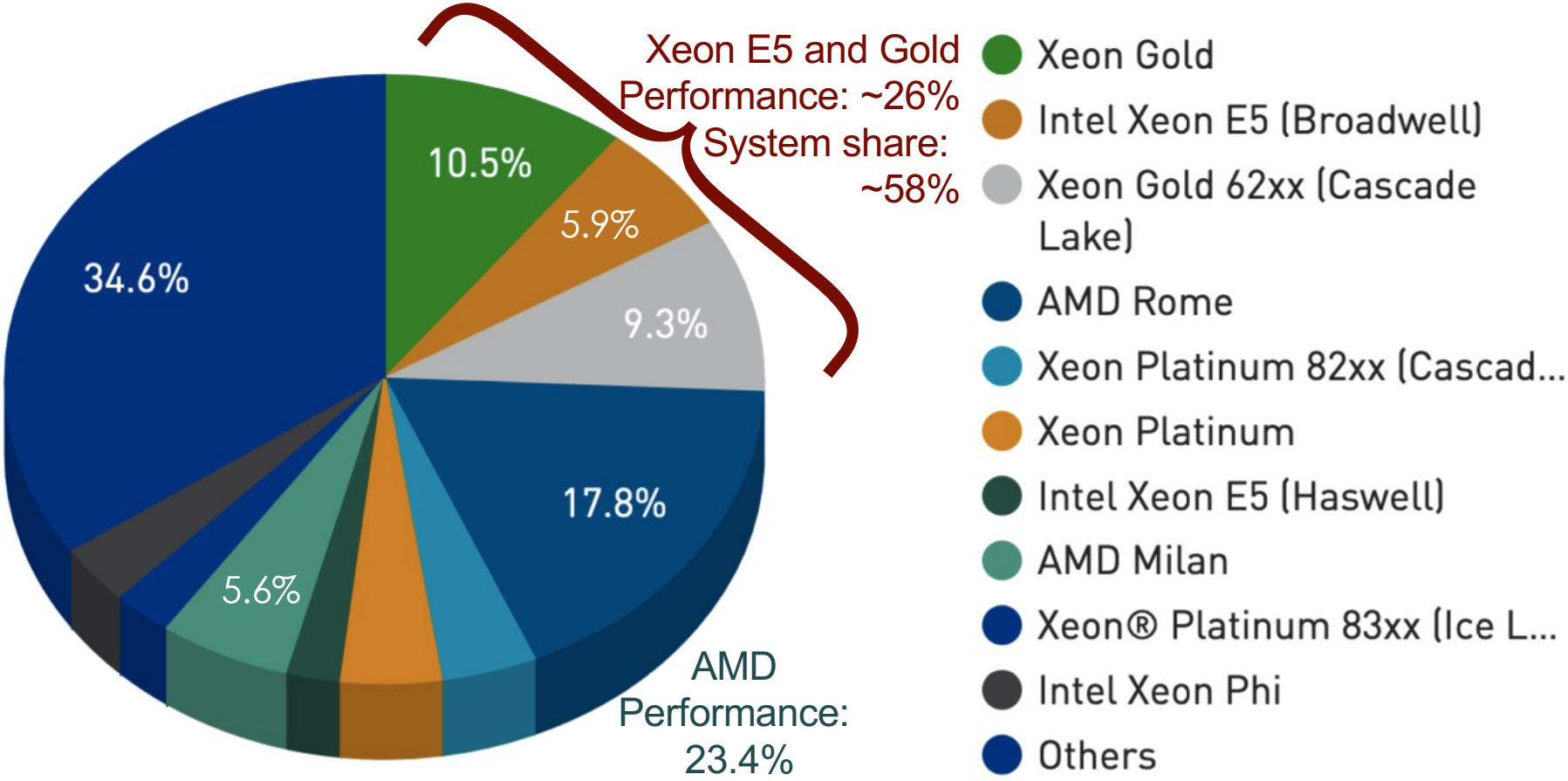
Top processor families
1993 to 2019



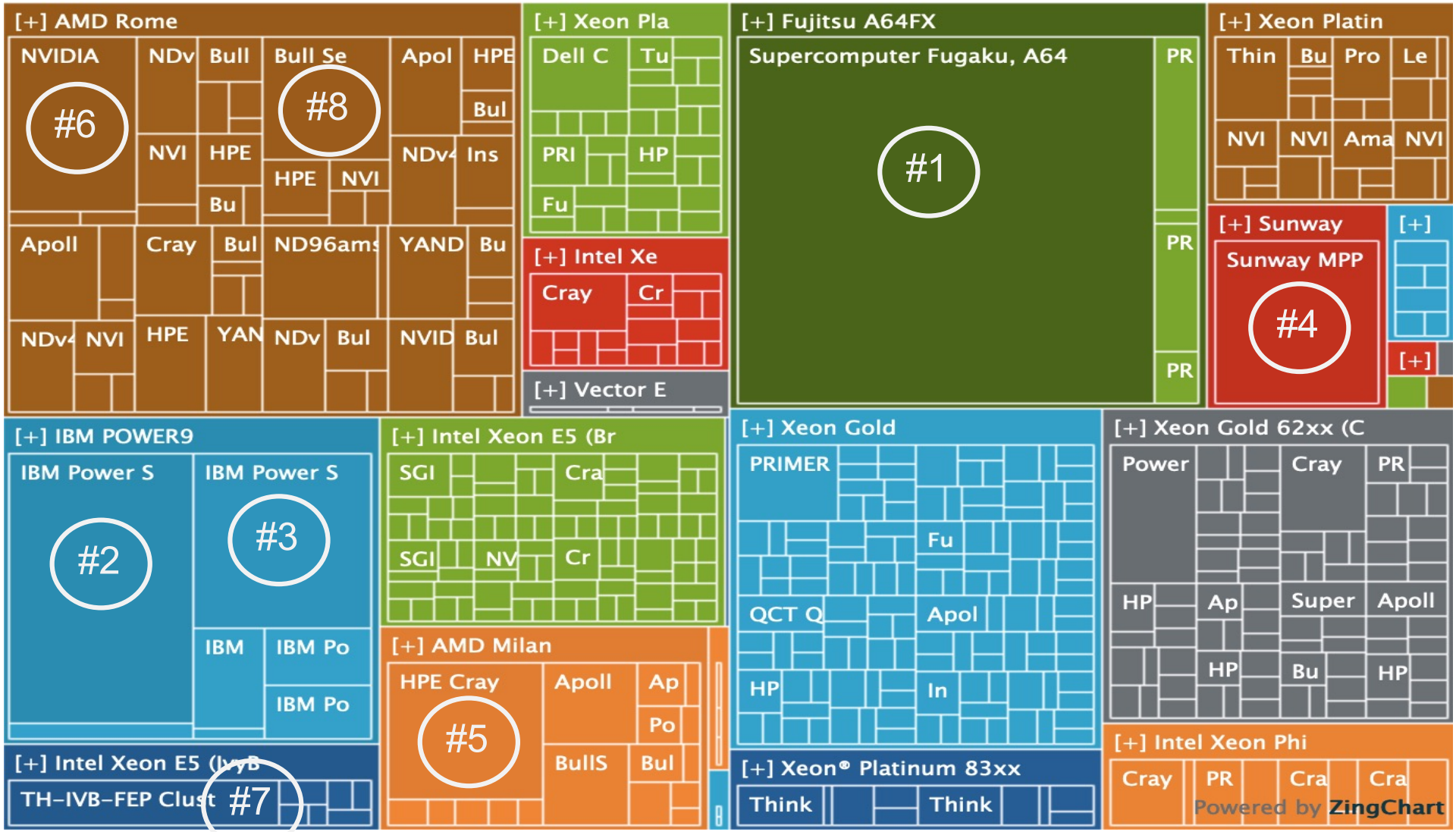
https://en.wikipedia.org/wiki/TOP500

Processor performance share
Nov'21

Processor Generation Performance Share

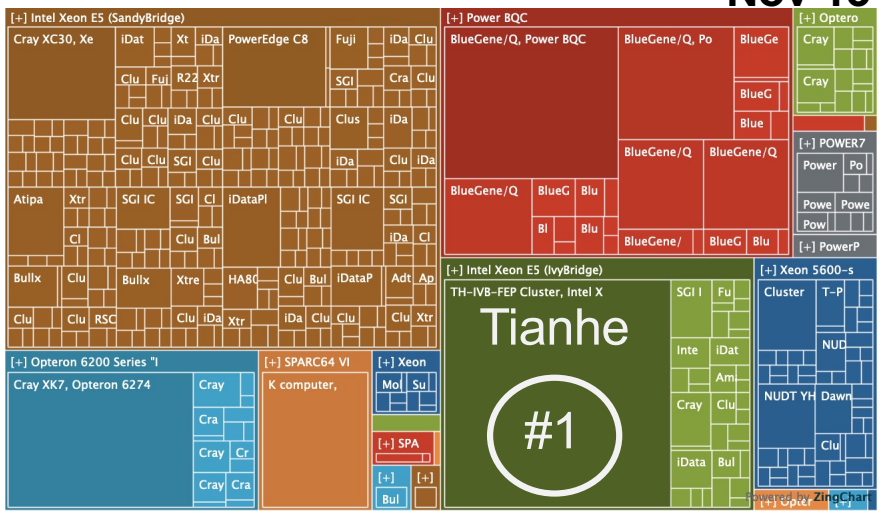


Processor distribution
Nov'21

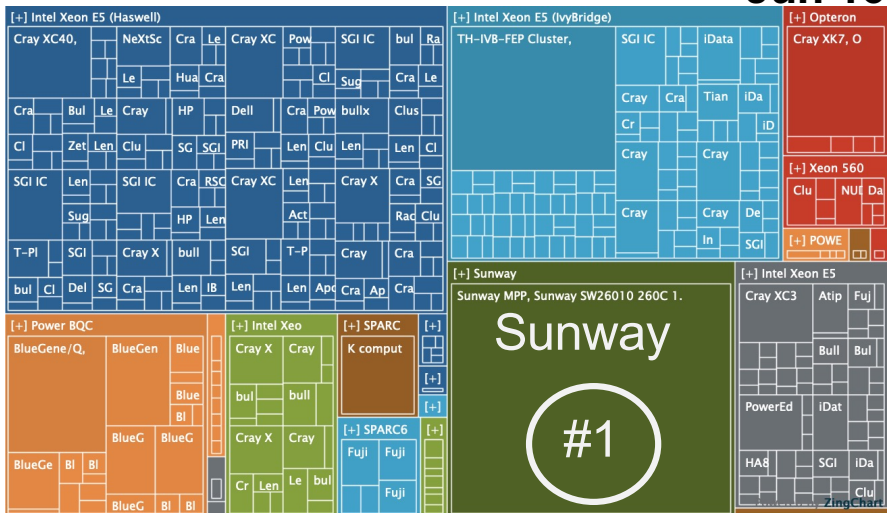


Architecture family of key #1's:
Nov'13 to Nov'21

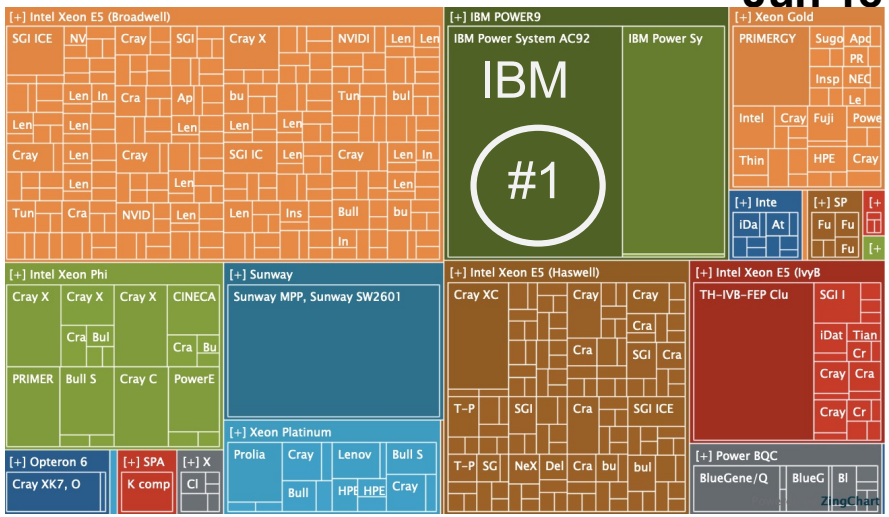
Nov'13



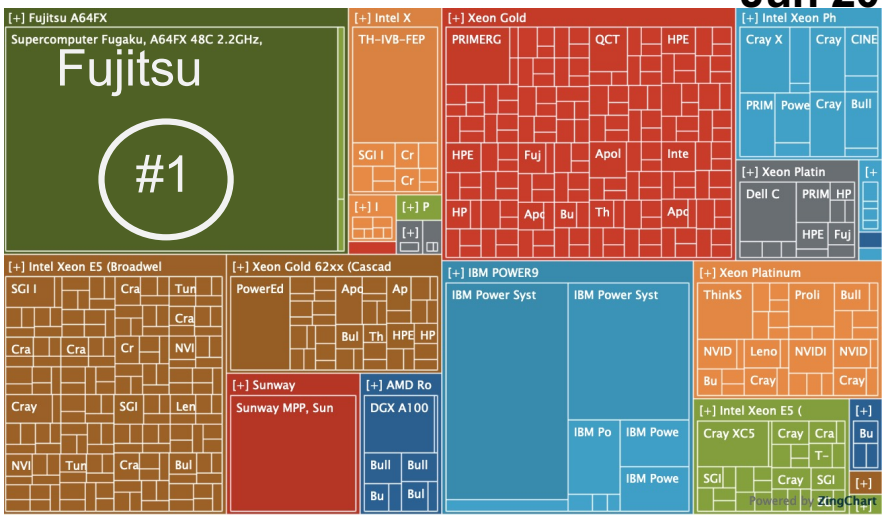
Jun'16



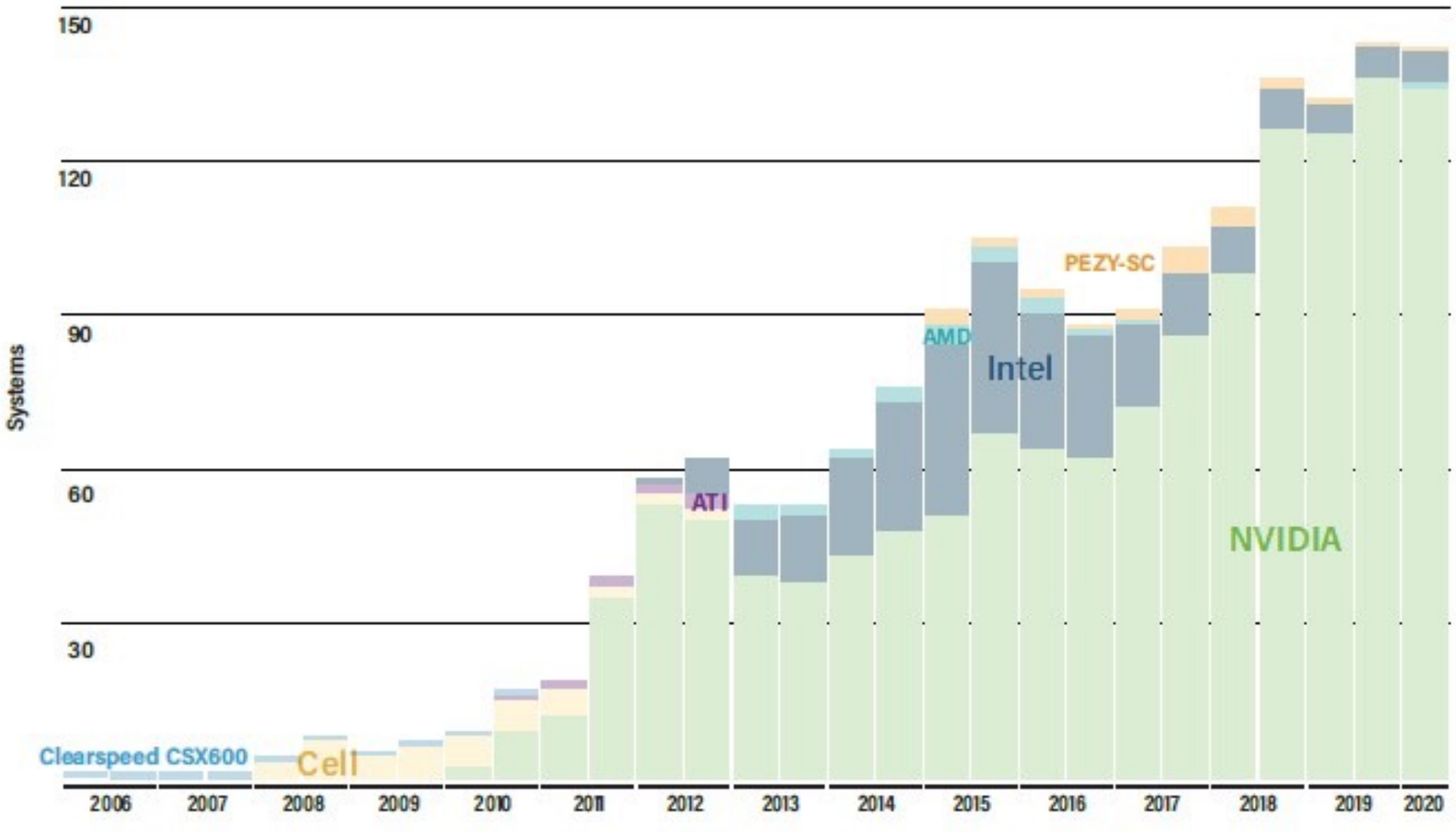
Jun'18



Jun'20

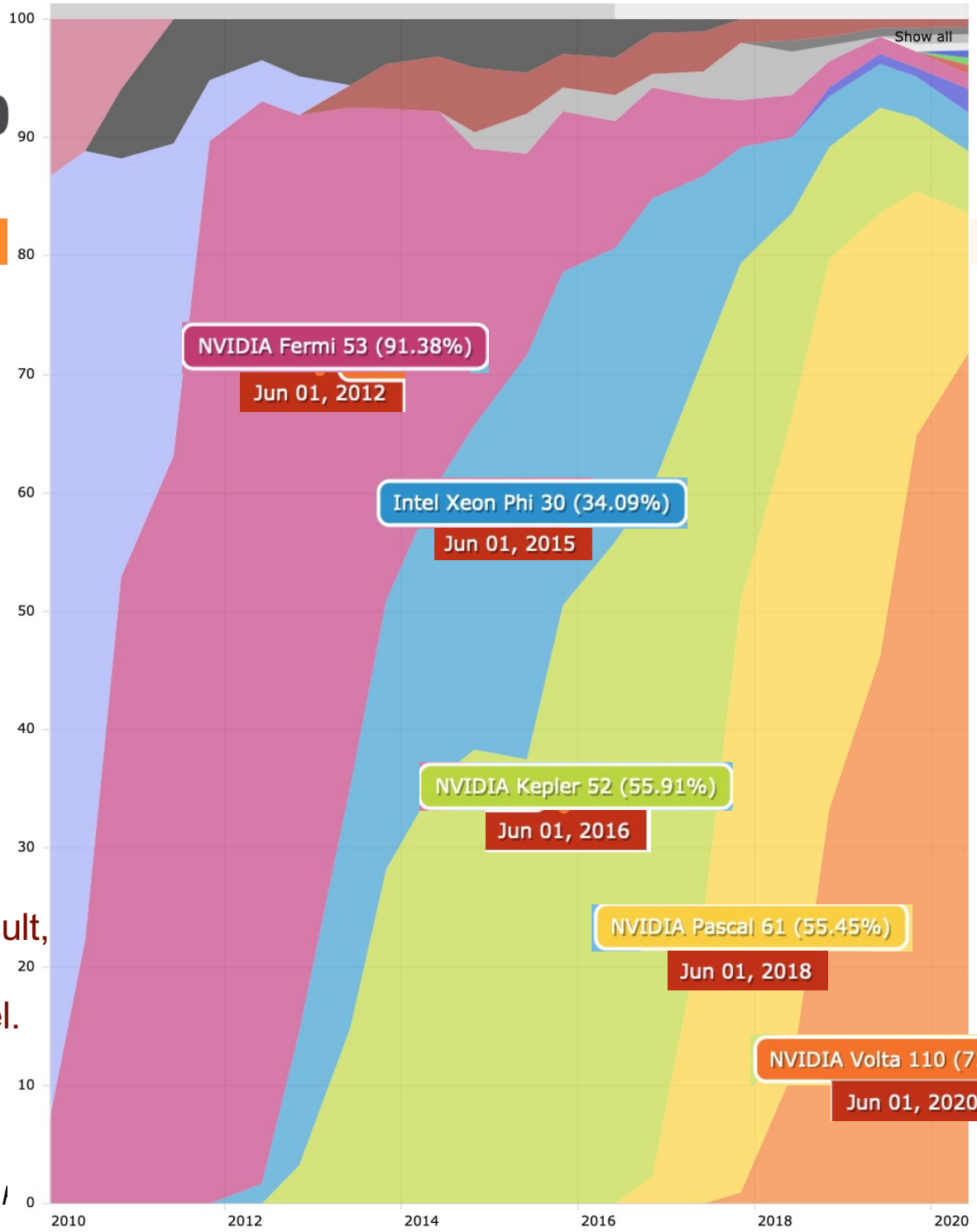


Accelerator families
2006 to 2020



https://www.nextplatform.com/2020/06/22/arm-and-japan-get-their-day-in-the-hpc-sun/

Accelerators: #systems Jun'10-Nov'21



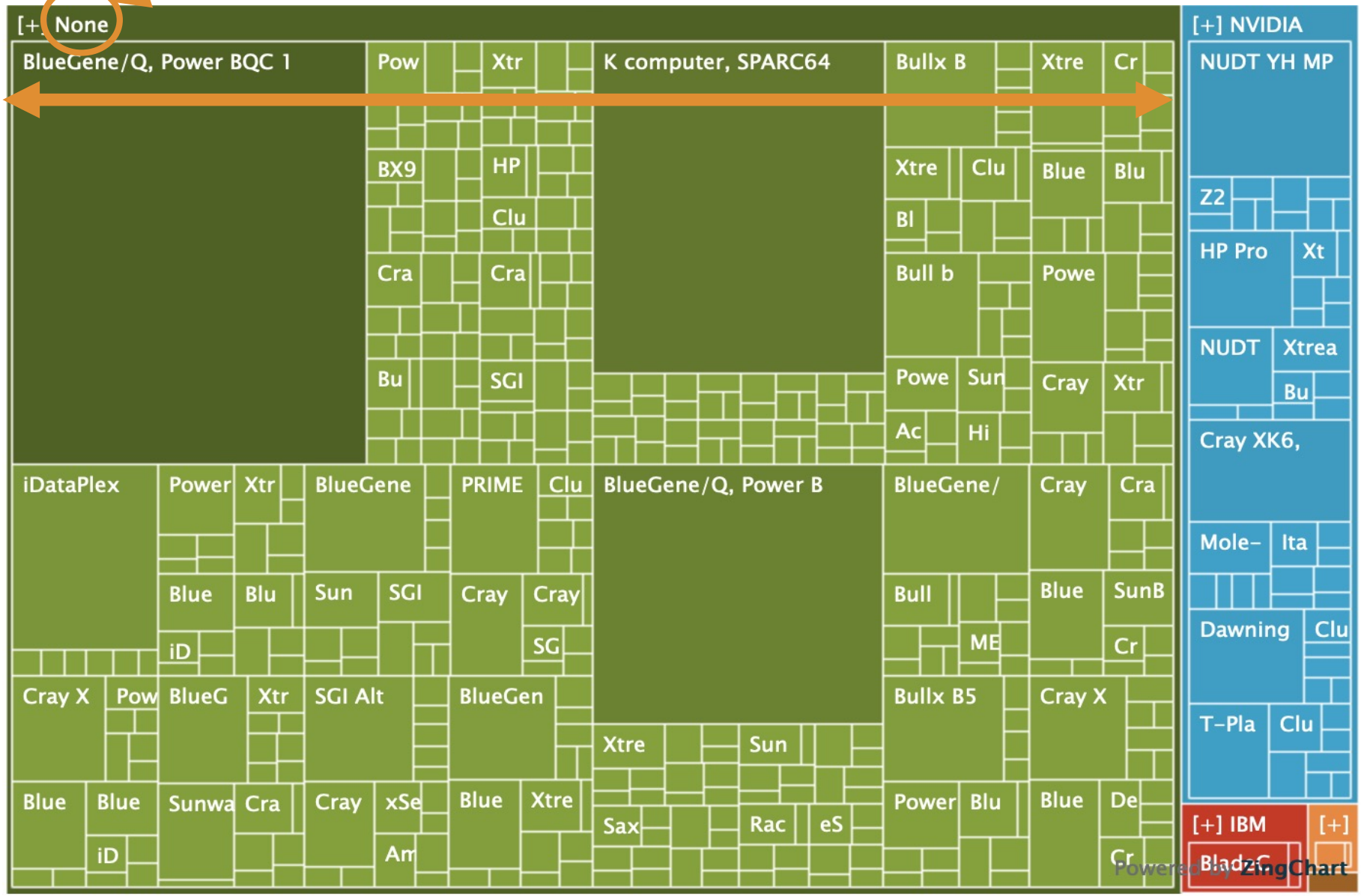
November'21

NVIDIA Volta	84
NVIDIA Pascal	8
NVIDIA Kepler	6
Intel Xeon Phi	2
NVIDIA Fermi	1
NVIDIA Ampere	43
PEZY-SC	1
Matrix-2000	1
MN-Core	1

In this plot, for each device:

date better result,
#systems,
% overall accel.

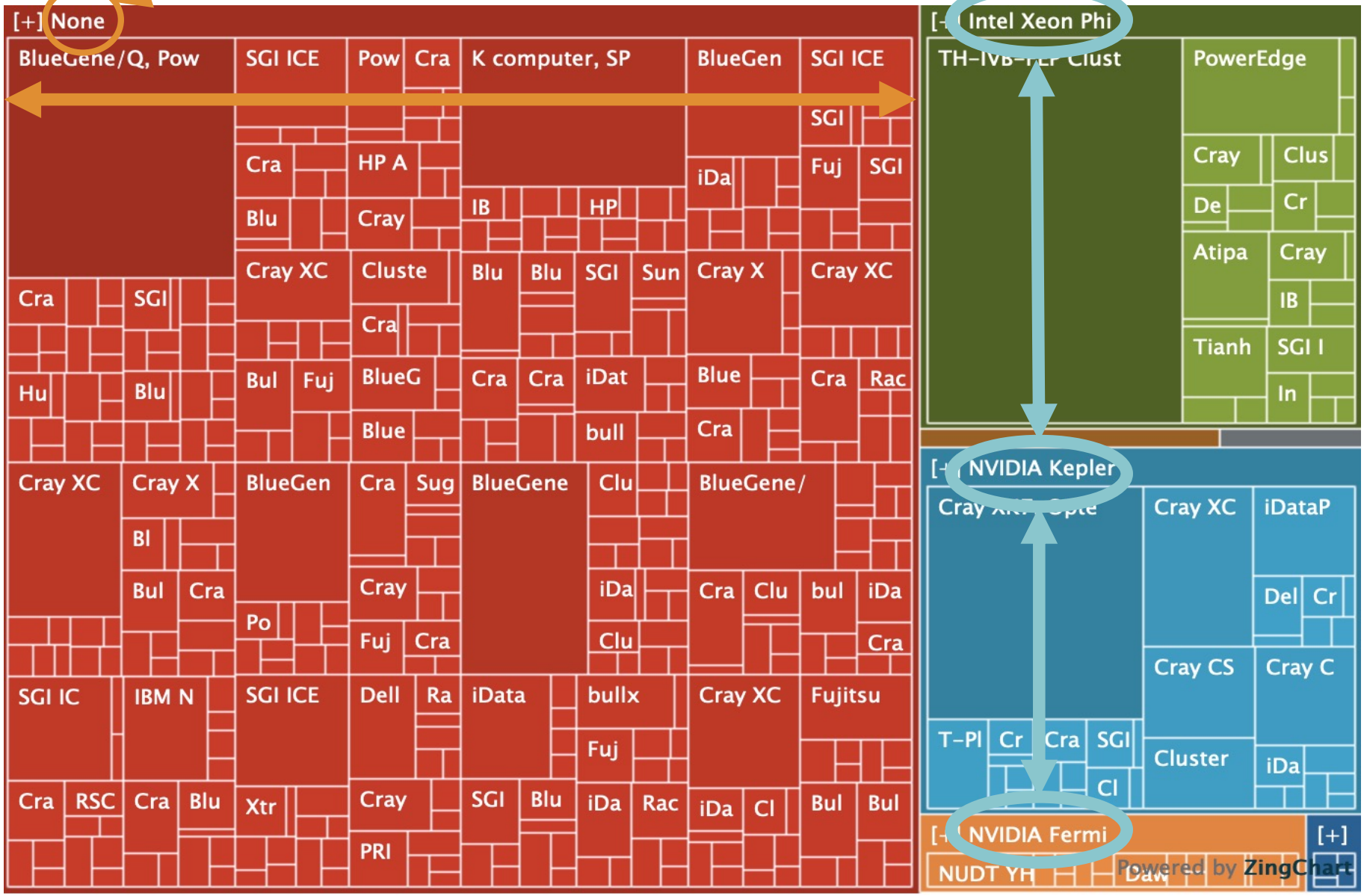
Accelerator family distribution
Jun'12



Accelerator family distribution

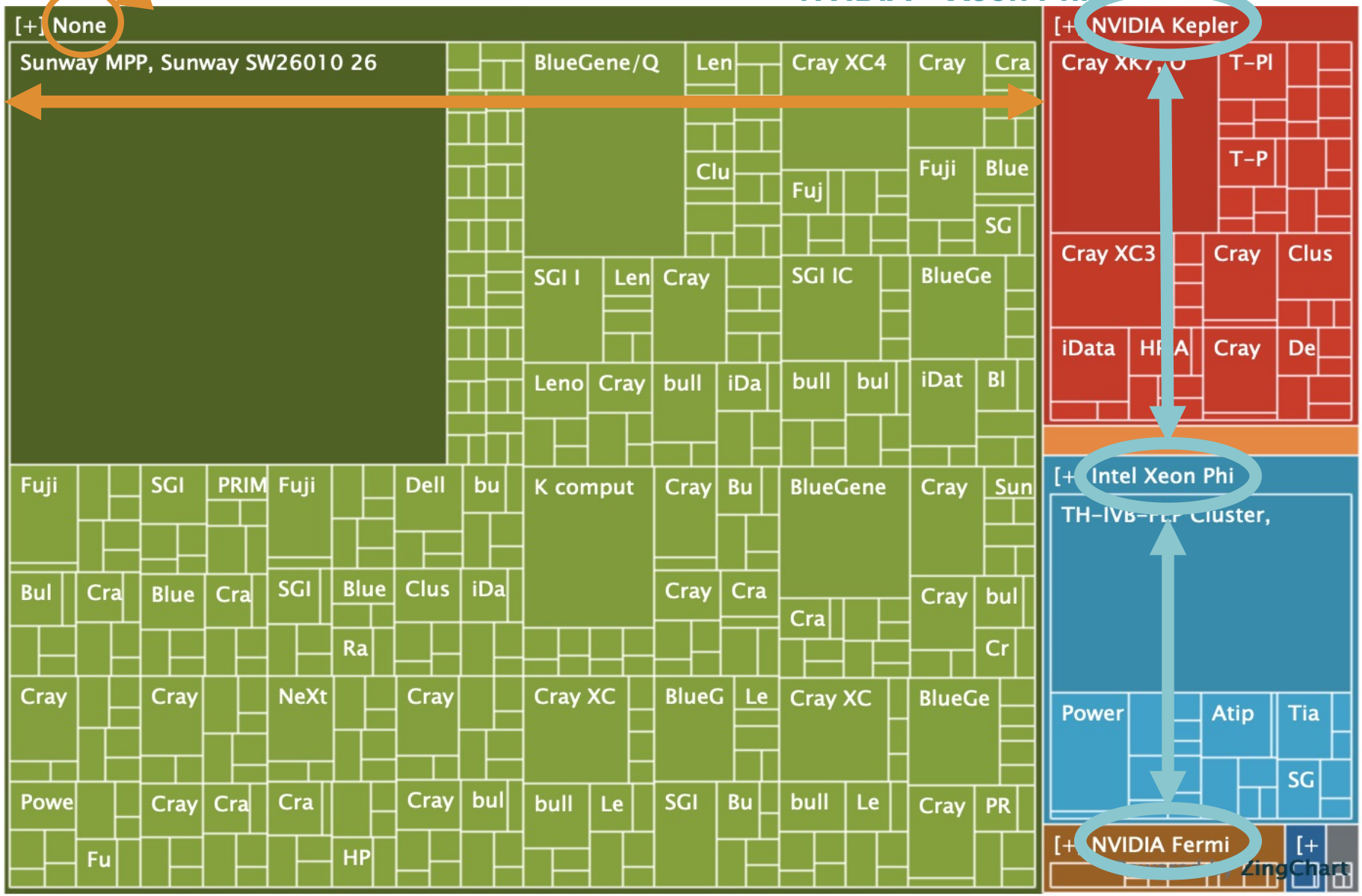
Jun'15

Xeon Phi + NVIDIA



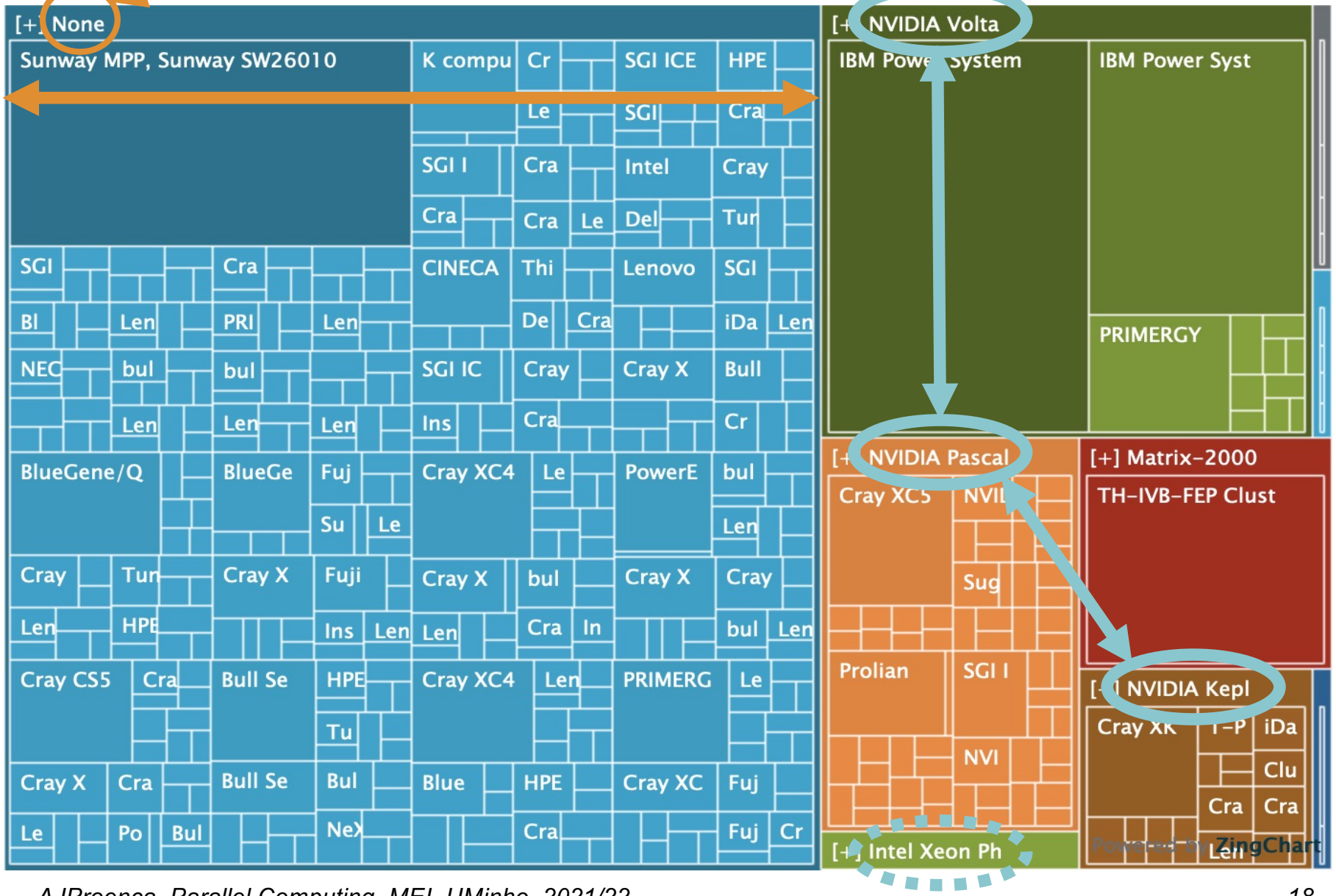
Accelerator family distribution

Jun'16



Accelerator family distribution
Jun'18

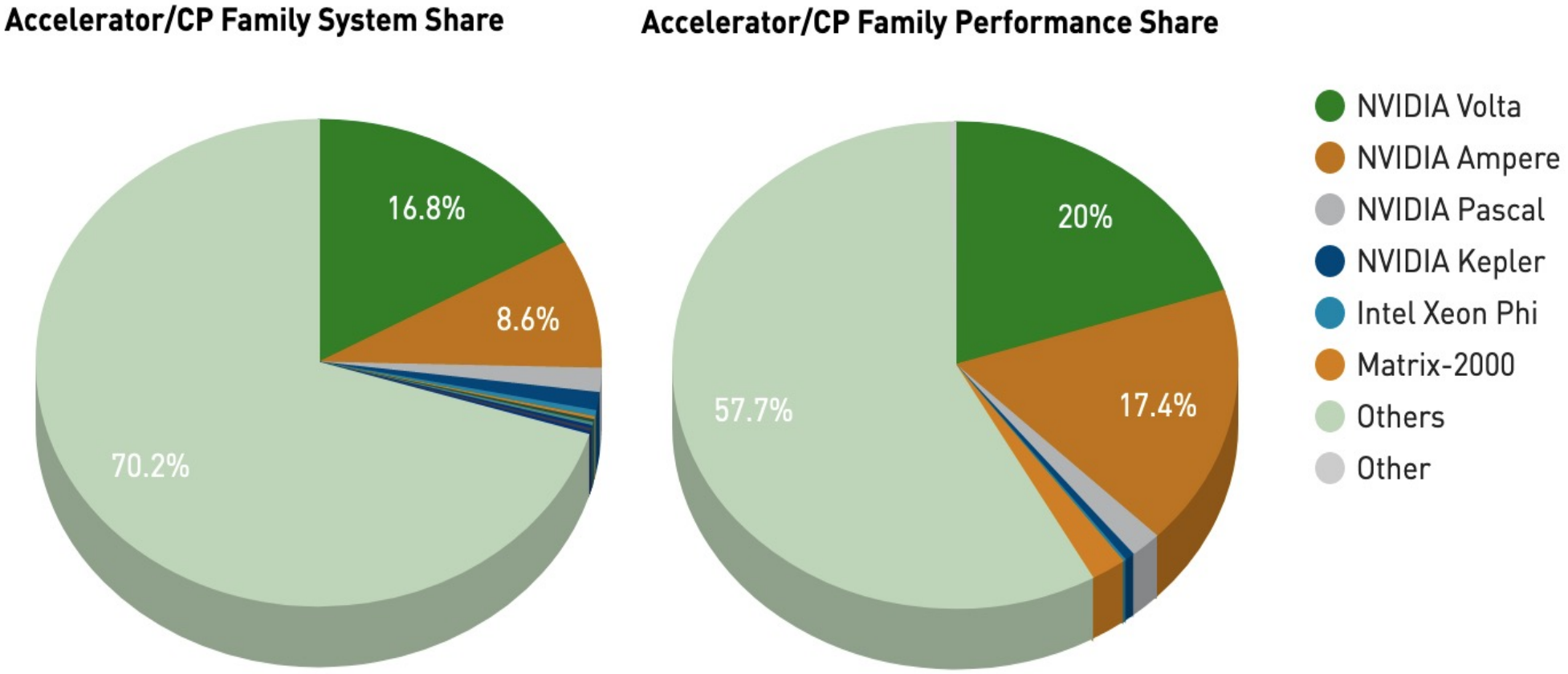
NVIDIA



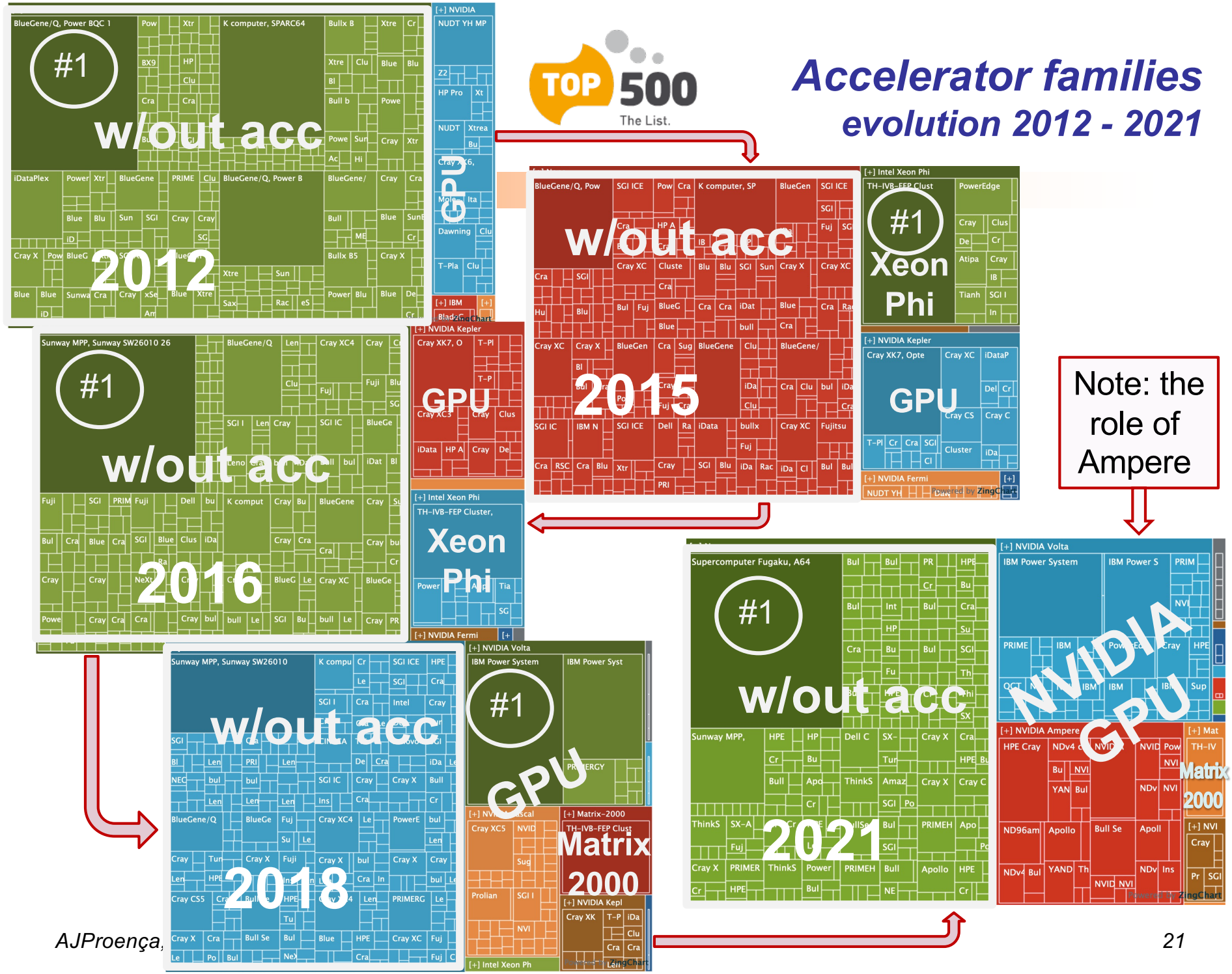
Accelerator family distribution

Nov'21

Accelerator family distribution
Nov'21



Accelerator families
evolution 2012 - 2021



Accelerator families
evolution 2012 - 2021

Note: the role of Ampere

Suggestion of homework for discussion in this session

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   ii. Characterize the architecture of Deucalion in MACC

PRACE Best Practice Guides

PRACE Application Enabling and Support' activities provides applications enabling and technical services for HPC applications codes that are important for European academic and/or industrial researchers to ensure that these applications can effectively exploit current and future HPC systems.

Beyond directly working on improving applications and libraries, one of the main objectives of the Work Package is to support European HPC research communities through the provision of Best Practice Guides, benchmarks, and technical results in White Papers.

The successful series of Best Practice Guides was initiated in PRACE-1IP and has been continuously extended since then. Topics for these Best Practice Guides include:

- A short description of the processor architecture
- Optimal porting of applications (e.g. choice of numerical libraries and compiler options)
- Architecture specific optimisation and scaling techniques
- Optimal system environment (e.g. tuneable system parameters, job placement and optimised system libraries)
- Debugging tools
- Performance analysis tools
- Programming environments

Details of European Workshops On HPC Infrastructures can be found here.

https://prace-ri.eu/training-support/best-practice-guides/

PARTNERSHIP FOR ADVANCED COMPUTING IN EUROPE

PRACE: Best Practice Guides

2021 PRACE Best Practice Guides

- Modern Accelerators (June 2021)

2020 PRACE Best Practice Guides

- Application porting and code-optimization activities for European HPC systems (April 2020)
- Modern Processors (October 2020)

2019 PRACE Best Practice Guides

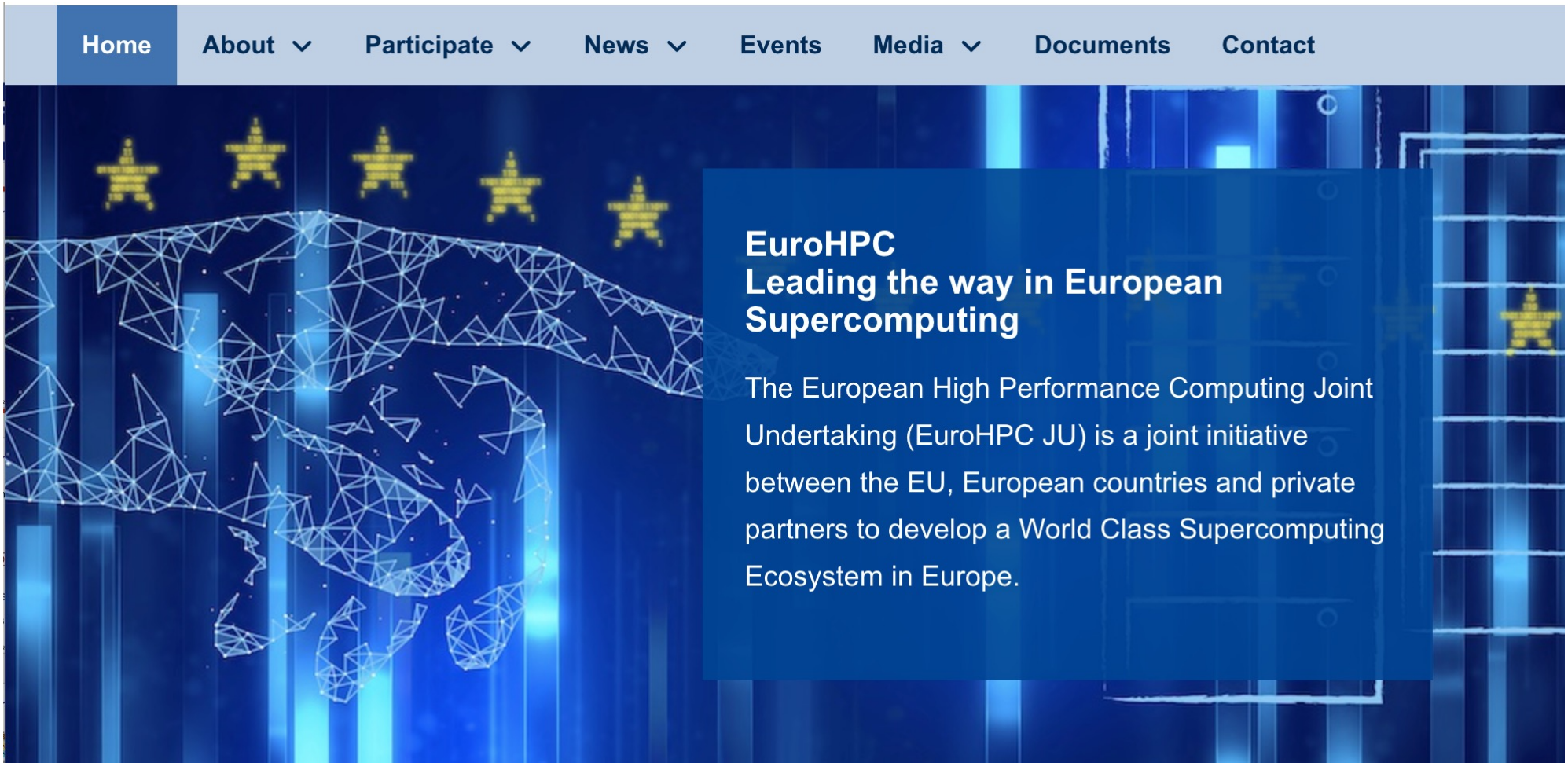
- AMD EPYC (February 2019)
- ARM64 (February 2019)
- Deep Learning (February 2019)
- Modern Interconnects (February 2019)
- Parallel I/O (February 2019)
- HPC for Data Science (January 2019)

2017 PRACE Best Practice Guides

- GPGPU (January 2017)
- Haswell/Broadwell (January 2017)
- Intel Xeon Phi (January 2017)

https://prace-ri.eu/training-support/best-practice-guides/

EuroHPC



https://eurohpc-ju.europa.eu/

EuroHPC supercomputers

EuroHPC selected 8 supercomputer centres for funding

- **3** pre-**exascale** supercomputers:
  - **MareNostrum 5** (BSC, Spain): >**205** peak PFLOPS
  - **Leonardo** (CINECA, Italy): **322.6** peak PFLOPS
  - **LUMI** (CSC, Finland): **552** peak PFLOPS

current #2 in TOP500

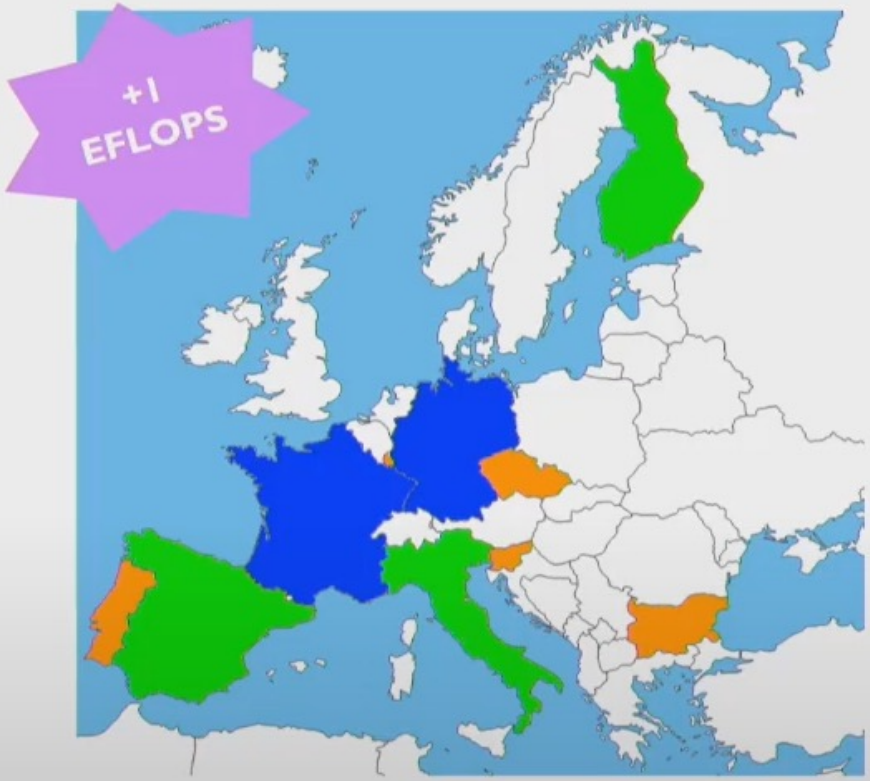
- **5 petascale** supercomputers:
  - **MeluXina** (LuxConnect, Luxembourg): **15+** peak PFLOPS
  - **Karolina** (IT4 Innov. Nat. Supercomp. Centre, Czech Rep.): **15.7** peak PFLOPS
  - **Deucalion** (MACC, Portugal): **10** peak PFLOPS
  - **Vega** (IZUM, Slovenia): **10.1** peak PFLOPS
  - **Discoverer** (Sofiatech, Bulgaria): **6** peak PFLOPS

current #58 in TOP500

EuroHPC supercomputers

EUROHPC IN THE RACE TO EXAFLOPS

Invested in 2022/21: >500M€ → >1 ExaFlops



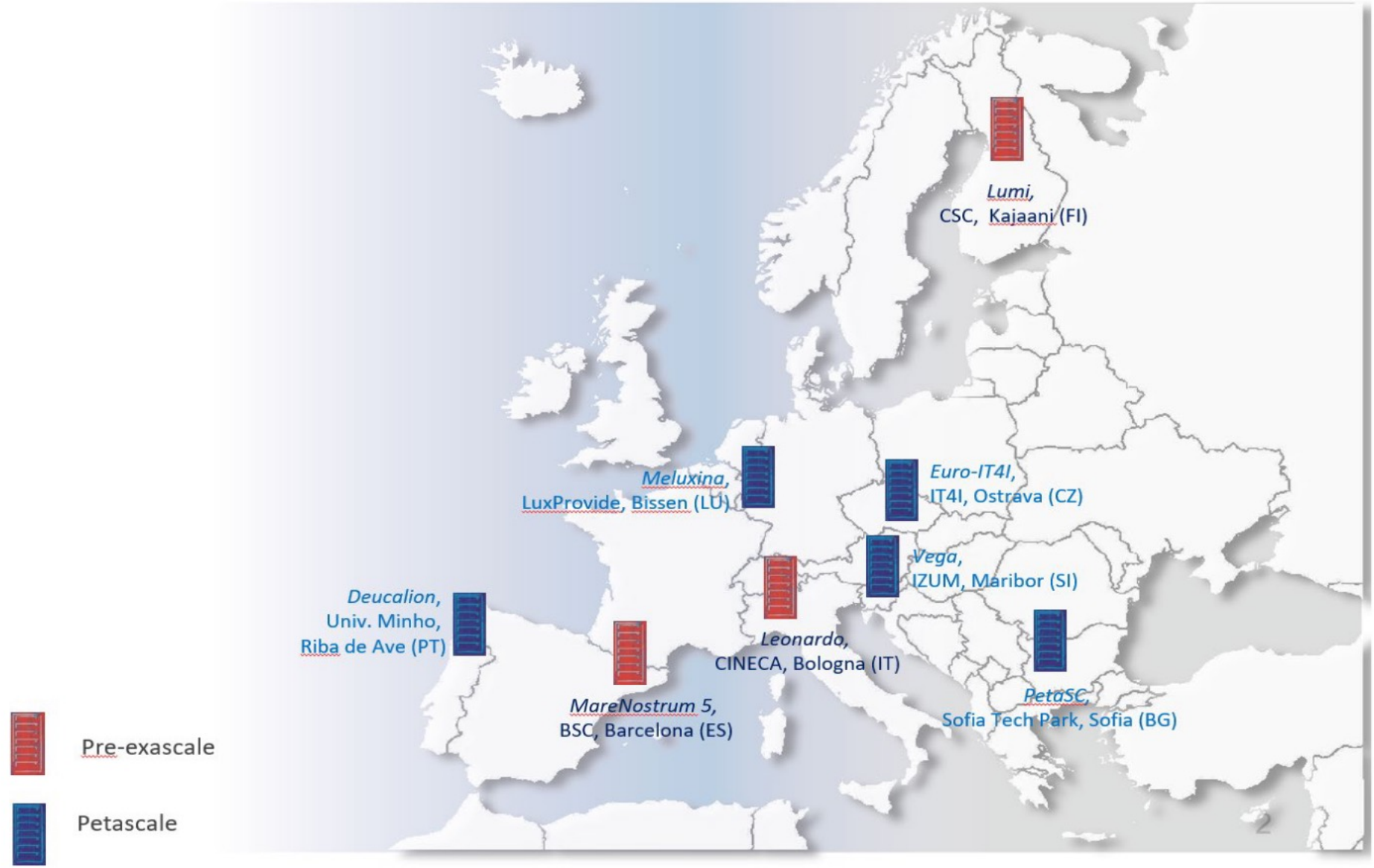
Country	Machine	Supplier	PFLOPS	Year
Finland	LUMI	HPE	550	2021/22
Italy	Leonardo	ATOS	248	2021
Spain(*)	*MareNostrum5*	*TBD*	*>200*	*2022*
Luxembourg	MeluXina	ATOS	10	2021
Portugal	Deucalion	Fujitsu ATOS	10	2021
CZ Rep	IT4I (name tbd)	HPE	15,2	2021
Bulgaria	SofiaTech	ATOS	6	2021
Slovenia	IZUM	ATOS	6,8	2021
TBD (DE?)	*TBD(**)*	*TBD*	*>1,000*	*2023*
TBD (FR?)	*TBD(**)*	*TBD*	*>1,000*	*2024*

>1,000	Pflops
38	Pflops
38	Pflops

(*) announced in 2021
(**) with EU processor based on EPI delivrables

Copyright © European Processor Initiative 2021.

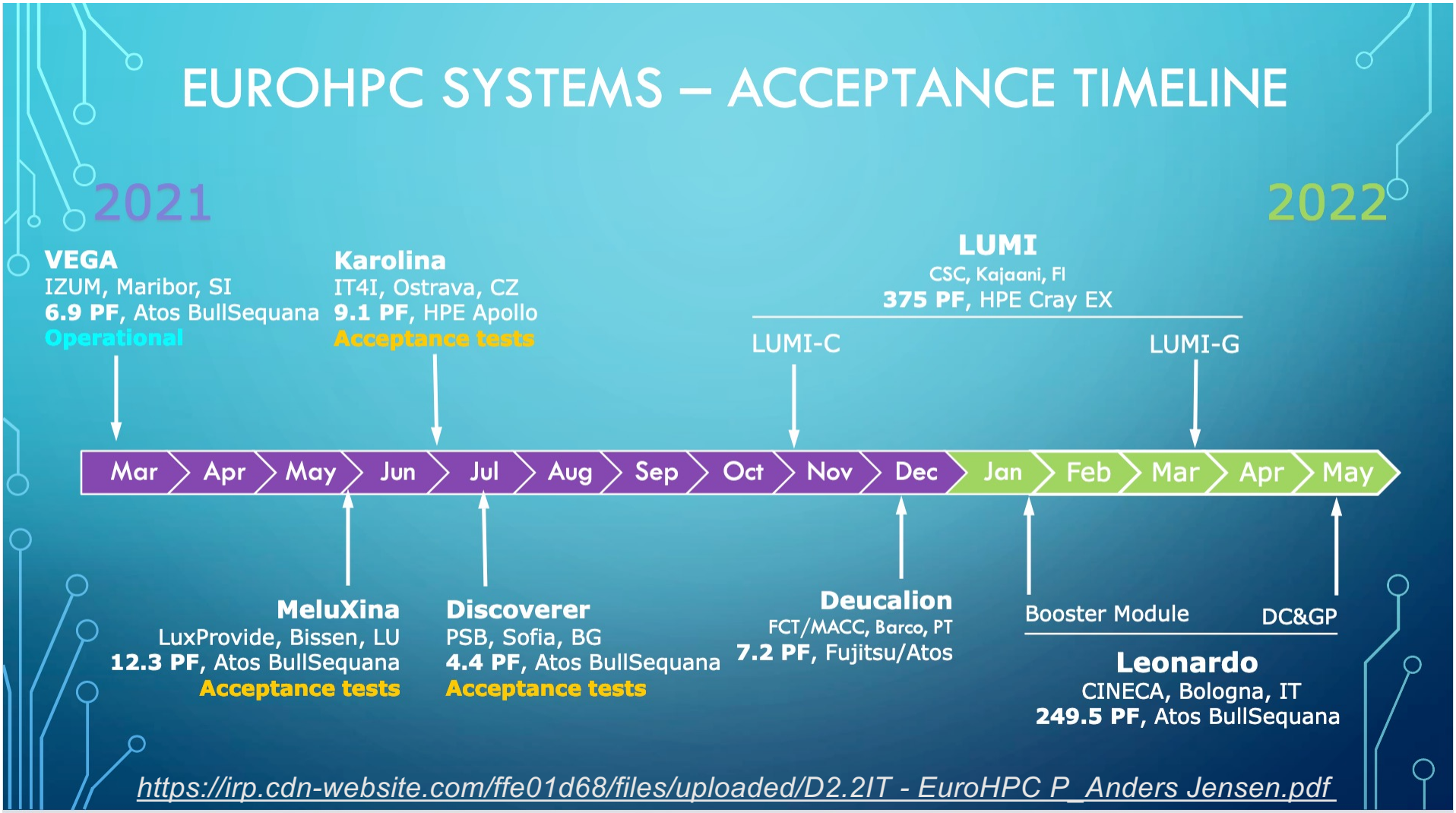
EuroHPC supercomputers:
their locations



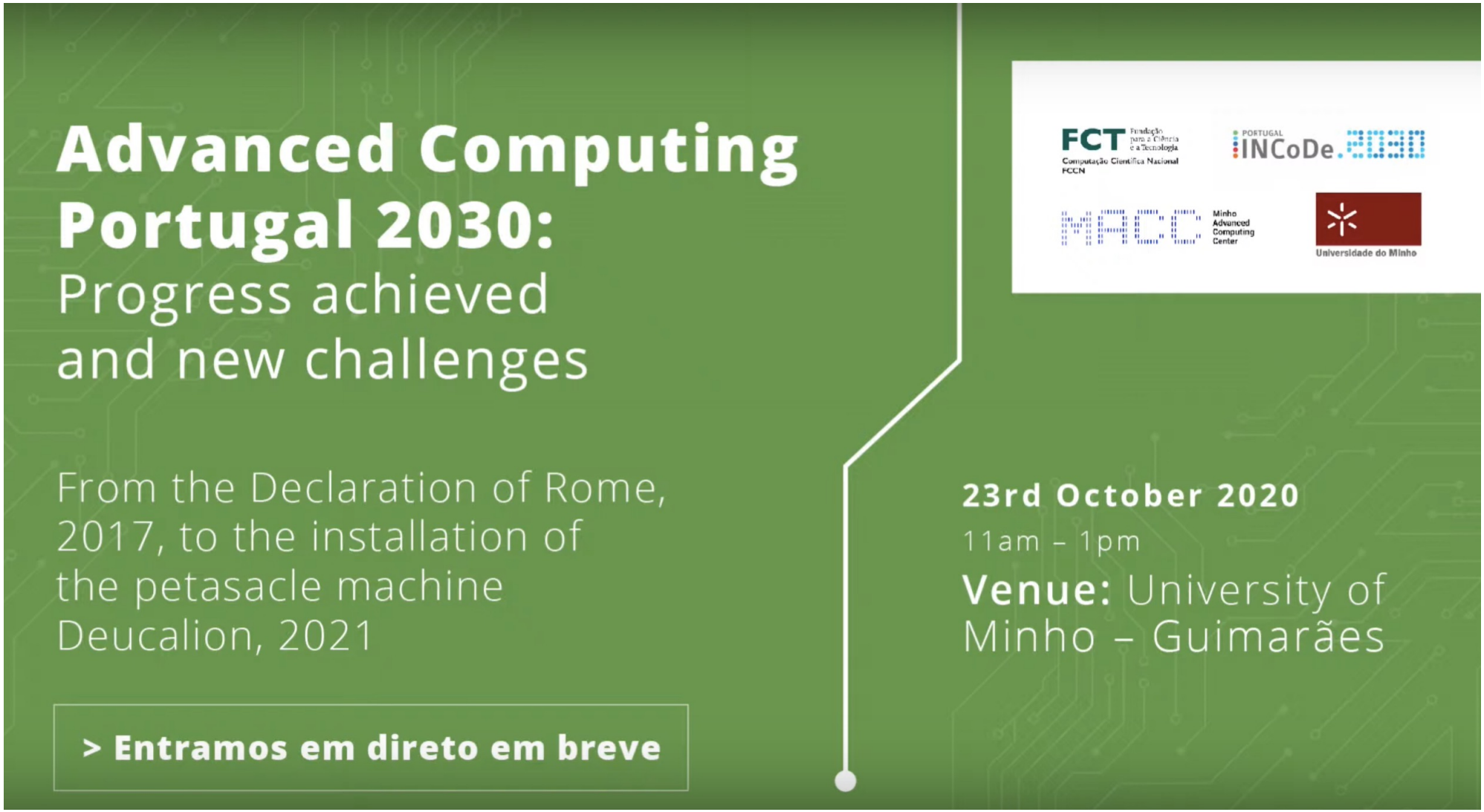
https://eurohpc-ju.europa.eu/sites/default/files/2021-10/EuroHPC%20Systems%20Report-Sep2021.pdf

EuroHPC acceptance timings

(values are sustainable performance)



Advanced Computing Portugal 2030 (1)

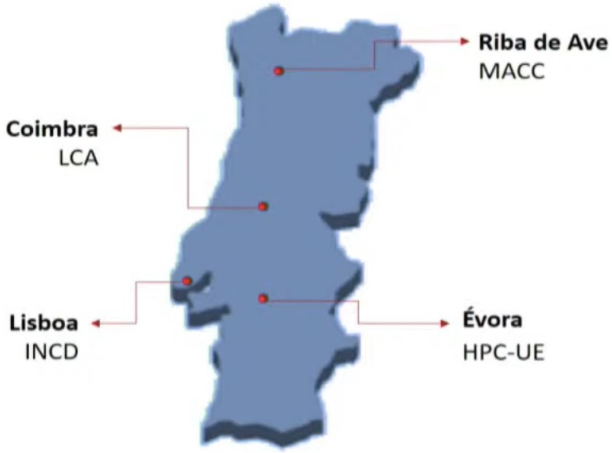


Advanced Computing Portugal 2030 (2)

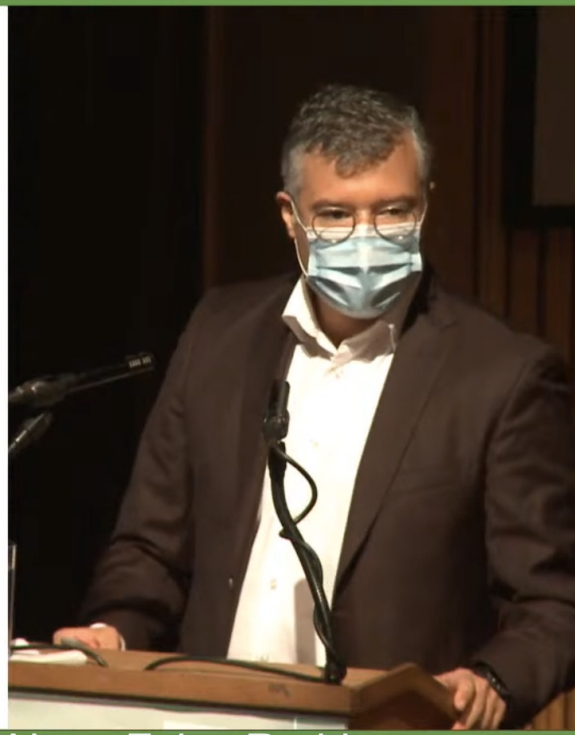
Advanced Computing Portugal 2030

INFRASTRUCTURE | OC

Advanced Computing Operation Centres (OC)



- **MACC** → Bob
- **LCA** → Navigator(+)
- **UPC-UE** → Oblivion
- **INCD** → Stratus, Cirrus



Nuno Feixa Rodrigues
Vice-Presidente FCT

Advanced Computing Portugal 2030 (3)

Advanced Computing Portugal 2030

MACC | Bob -> Deucalion

- 1PFLOP; 800 Compute Nodes; 12.800 cores; 1.5PB
- After some initial setbacks (storage), usage has been steadily increasing

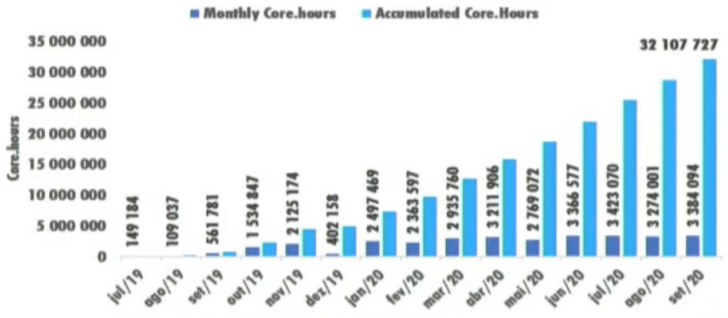


Figure 3 - Monthly and accumulated usage from July 2019 until September 2020.

Advanced Computing Portugal 2030 (4)

Advanced Computing Portugal 2030

BOOTSTRAPPING MACC WITH BOB

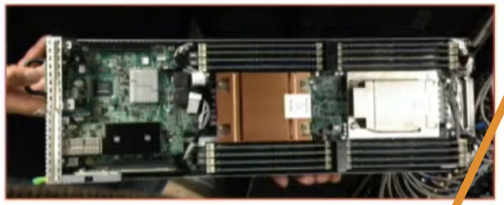
UTAustin Portugal

PART OF TACC'S STAMPEDE SUPERCOMPUTER

800 DUAL INTEL XEON + XEON PHI NODES

1.5 PB HIGH PERFORMANCE STORAGE

1PF PEAK PERFORMANCE



6	**Stampede** - PowerEdge C8220, Xeon E5-2680 8C 2.700GHz, Infiniband FDR, Intel Xeon Phi SE10P, Dell EMC Texas Advanced Computing Center/Univ. of Texas United States	462,462

TOP500 The List.

June 2013

Rui Carlos Oliveira
Diretor do MACC

Advanced Computing Portugal 2030 (5)

Advanced Computing Portugal 2030

FCT Fundação para a Ciência e a Tecnologia — Computação Científica Nacional FCCN | PORTUGAL INCoDe.2030 | MACC Minho Advanced Computing Center | Universidade do Minho

FROM BOB TO DEUCALION

DEUCALION

EuroHPC

Annex 1
to the call for expression of interest for the selection of Hosting Entities for Petascale Supercomputers
REF: EUROHPC-2019-CEI-PT-01

APPLICATION FORM

Application Ref: DEUCALION

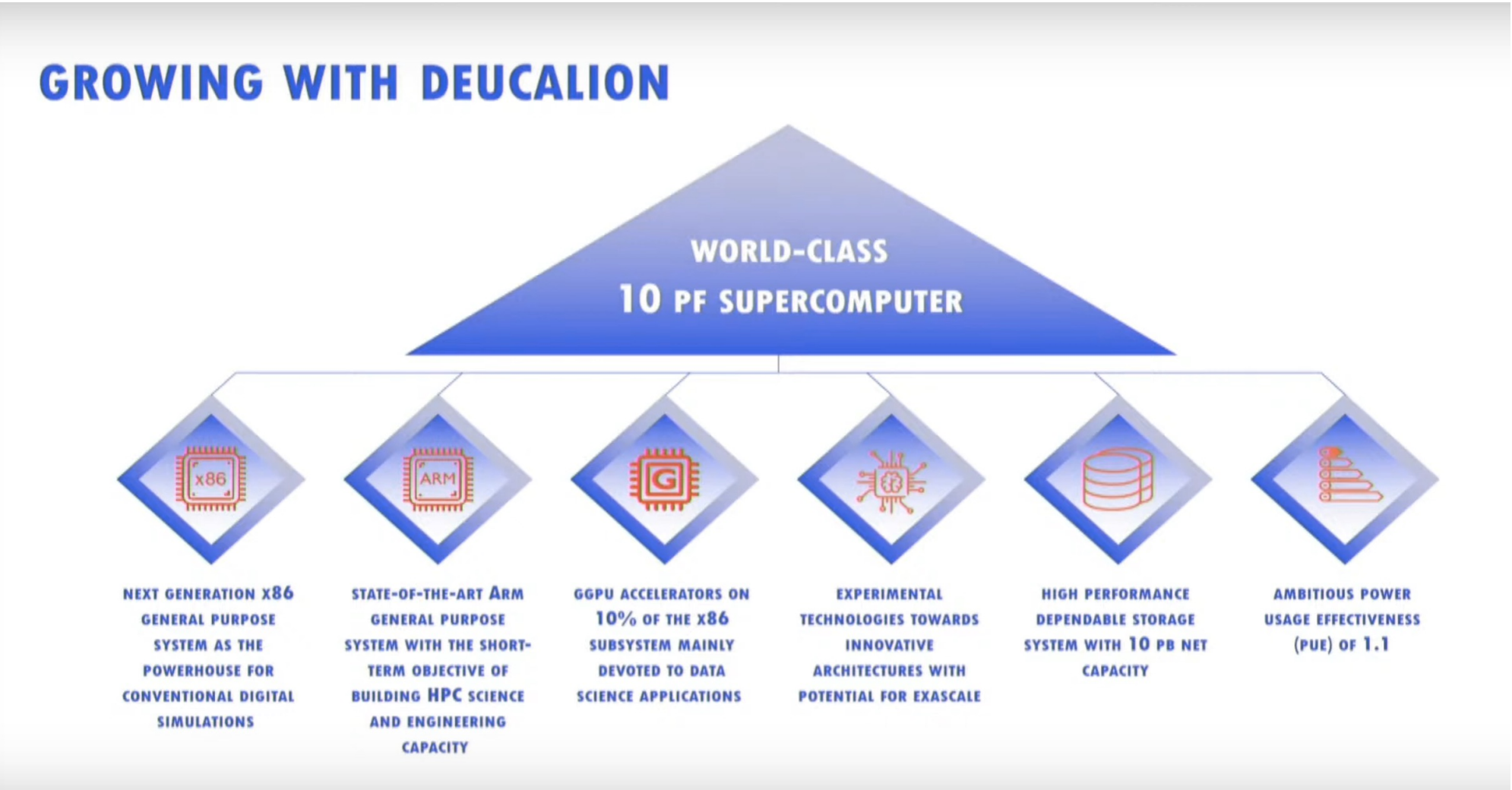
15 April 2019

26 November 2019

DEUCALION

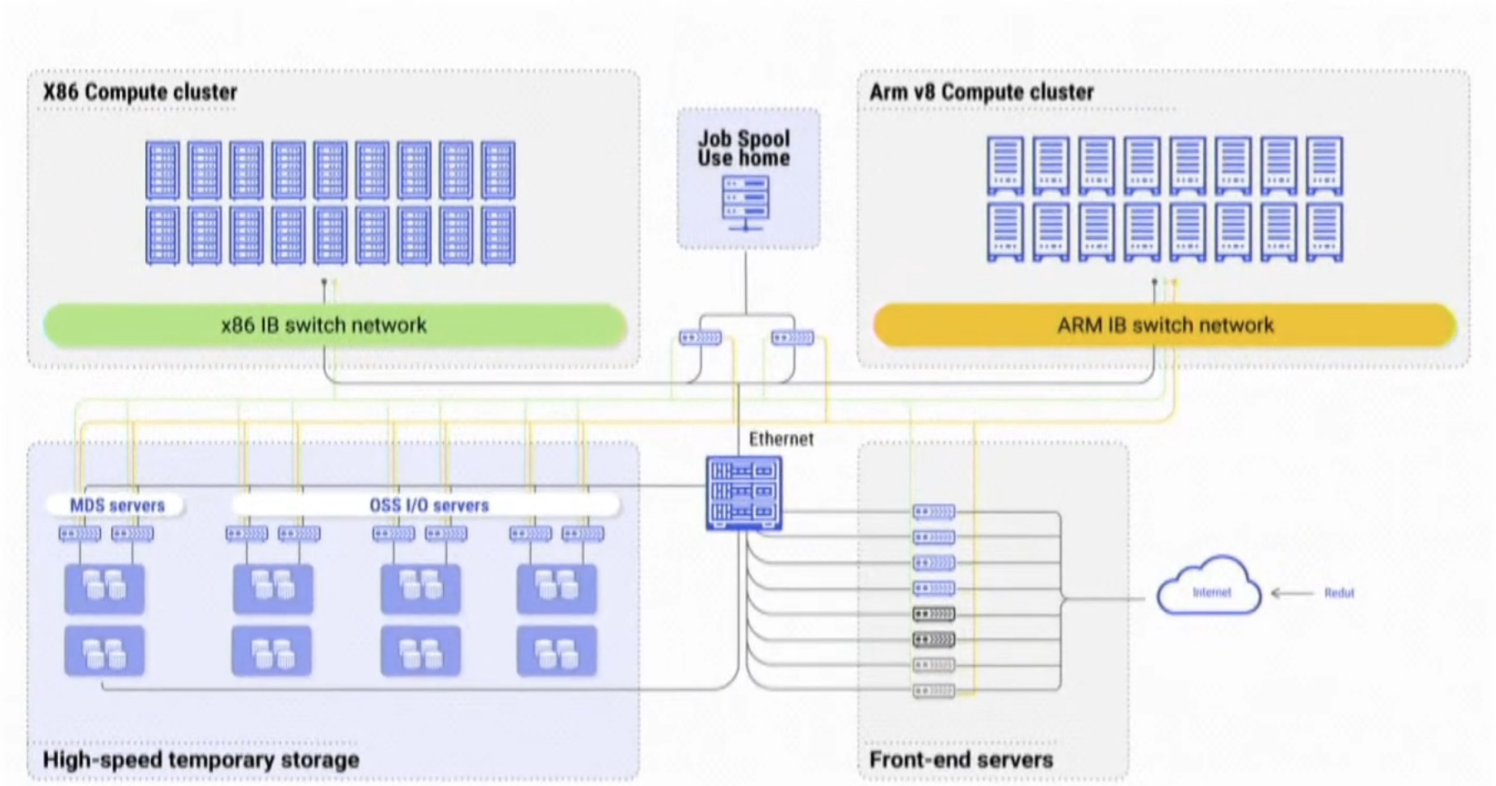
(16 October 2020)

Advanced Computing Portugal 2030 (6)



Advanced Computing Portugal 2030 (7)

DEUCALION OVERALL ARCHITECTURE



AMD X86 CLUSTER
EPYC Rome 7742 2.25GHz
500 DUAL NODES
64000 CORES
128TB RAM

NVIDIA A100 CLUSTER
33 DUAL + QUAD NODES
16 TB RAM + 5TB HBM

FUJITSU ARM CLUSTER
Fujitsu A64FX 2.0GHz
1632 NODES
78336 CORES
52TB HBM RAM

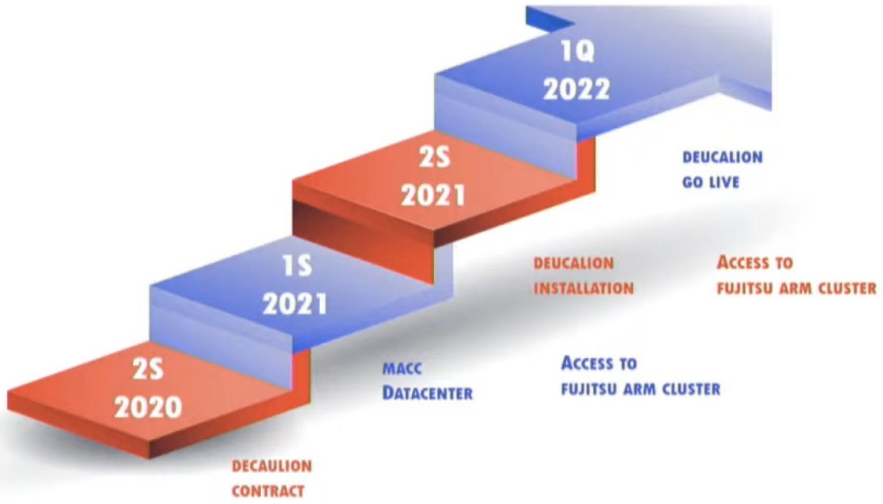
DDN HSS
10 PB SSD+HDD

Advanced Computing Portugal 2030 (8)

Advanced Computing Portugal 2030

FCT Fundação para a Ciência e a Tecnologia — Computação Científica Nacional FCCN | PORTUGAL INCoDe.2030 | MACC Minho Advanced Computing Center | Universidade do Minho

MACC TIMELINE



MACC:
https://macc.fccn.pt/

MACC Minho Advanced Computing Center

Advancing knowledge discovery for

Minho Advanced Computing Center is empowering all partners to discover, innovate, and