A Holistic View of European HPC

from the EXDCI project

https://exdci.eu

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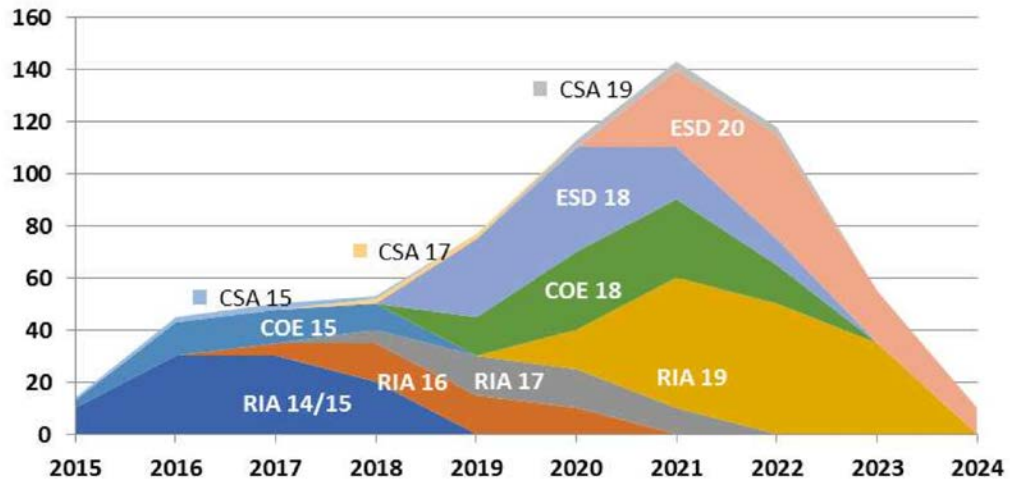
The EXDCI project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 671558

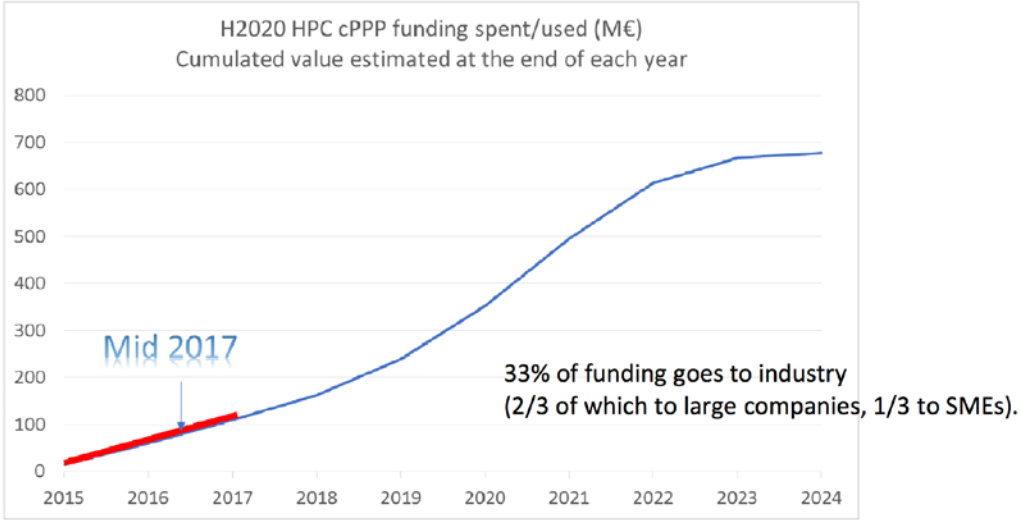
Introduction

- A holistic view of European HPC
  - How the EU is building its next generation HPC systems and applications
- EXDCI project supports the EU HPC development
  - Roadmapping
  - Strategy
  - Performance monitoring

European H2020 Investments in HPC

- Important investment from the European commission in HPC
- ~700 M€ euros to be invested between 2016-2020





Src: Jean-Philippe Nominé, ETP4HPC

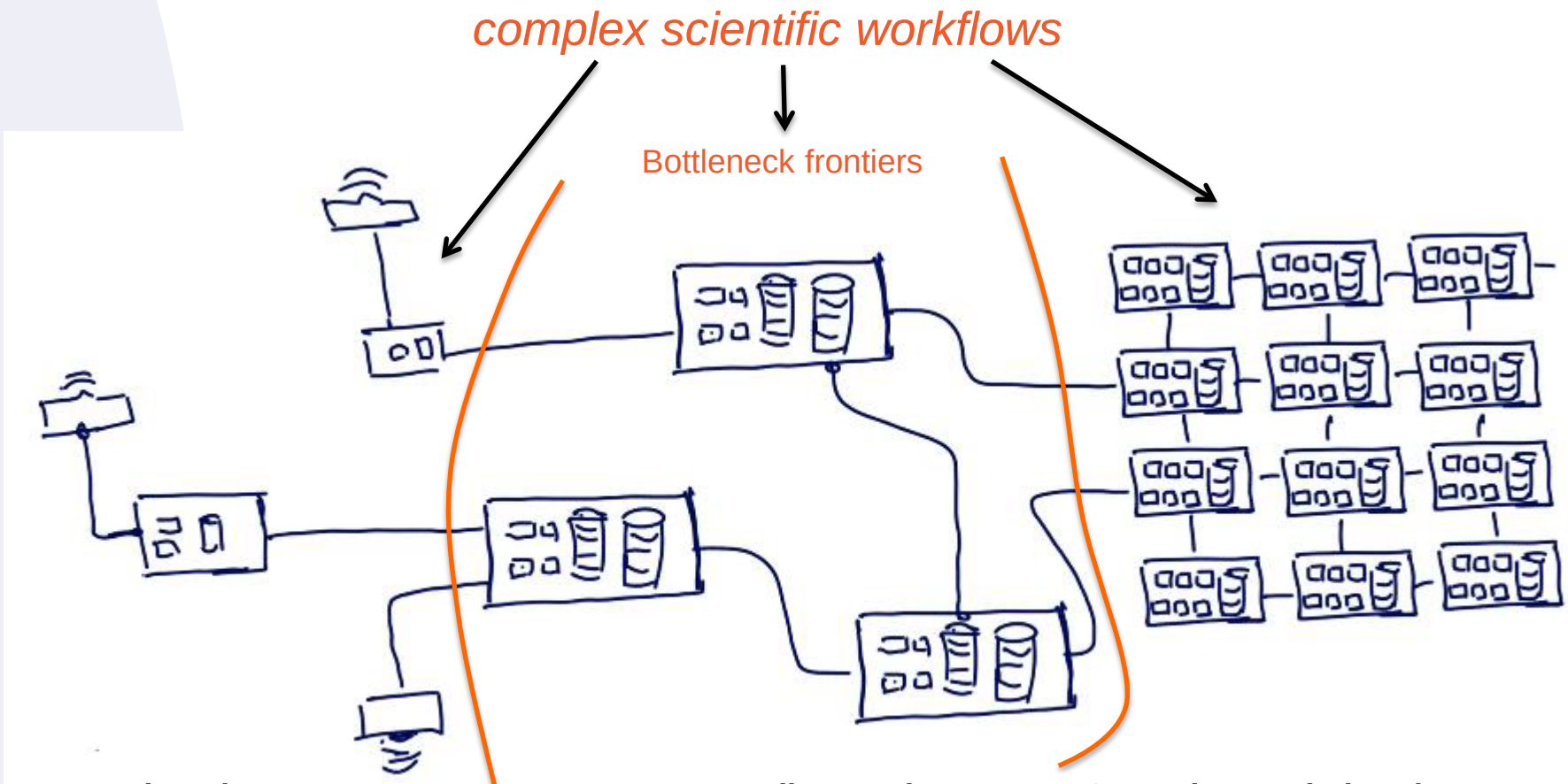
Where Are We Going?

- Next generation of HPC systems is multi-objectives
  - 10^{18} flops of strategic interest for a small community
  - Beyond the traditional HPC, e.g. Smart-cities, IoT
  - Convergence of HPC, HPDA and Cloud computing
  - Machine learning friendly
  - Support for complex workflows (distributed, heterogeneous, interactive, etc.)
    - Combining edges, data centers, supercomputers
- Develop EU technologies
  - Reduce dependencies
- Improve infrastructures
  - Network, storage and systems

Support for Complex Workflows

Data location and energy are the critical dimensioning parameters

- We have frontiers where we need a continuum
- Topology oblivious routing scheme is not adequate



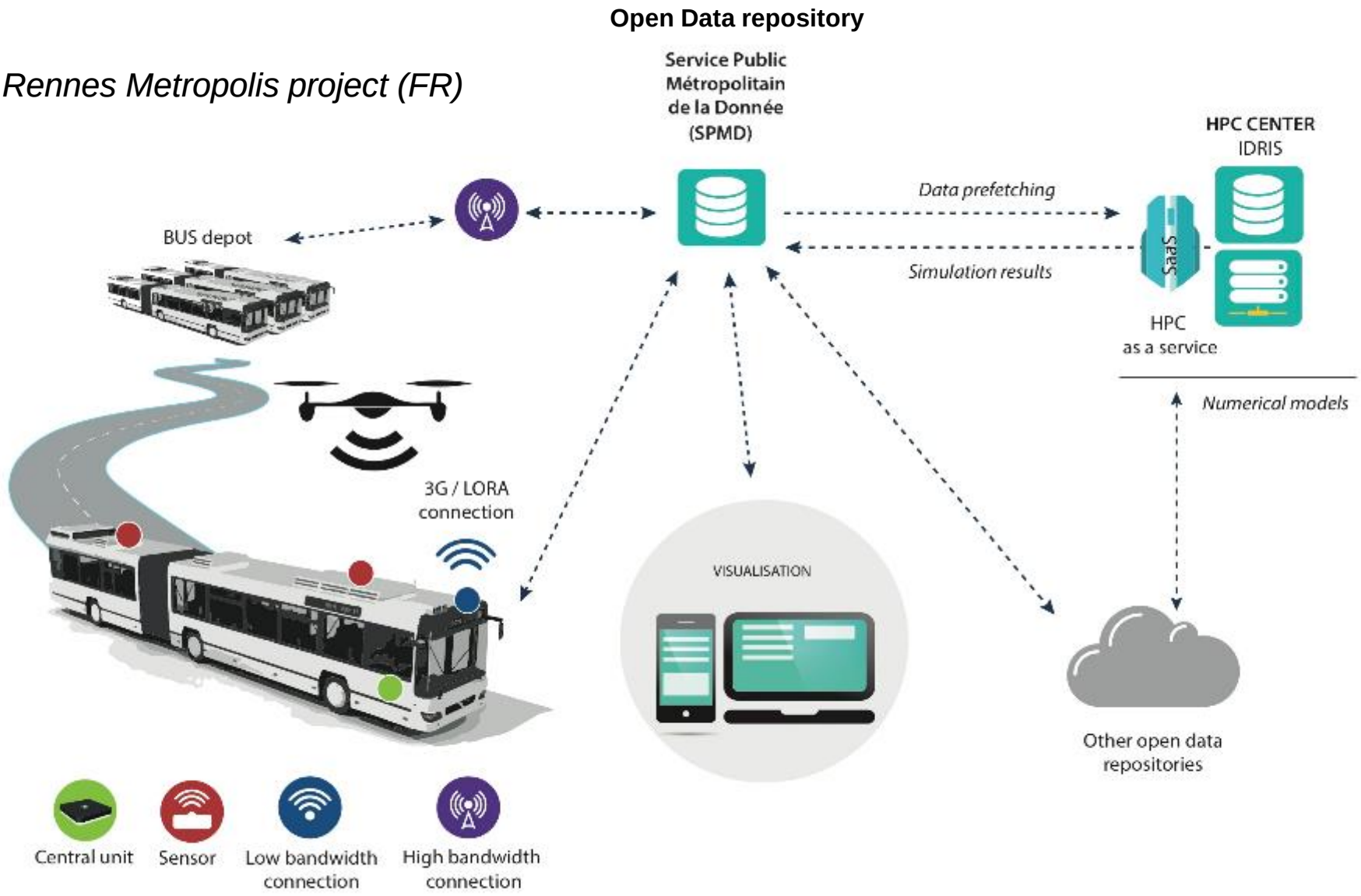
The edge

Intermediate nodes (CDN, data centers, etc.)

Strongly coupled nodes (Supercomputers, data centers, etc.

A Concrete Example

Rennes Metropolis project (FR)



Why Are We going There?

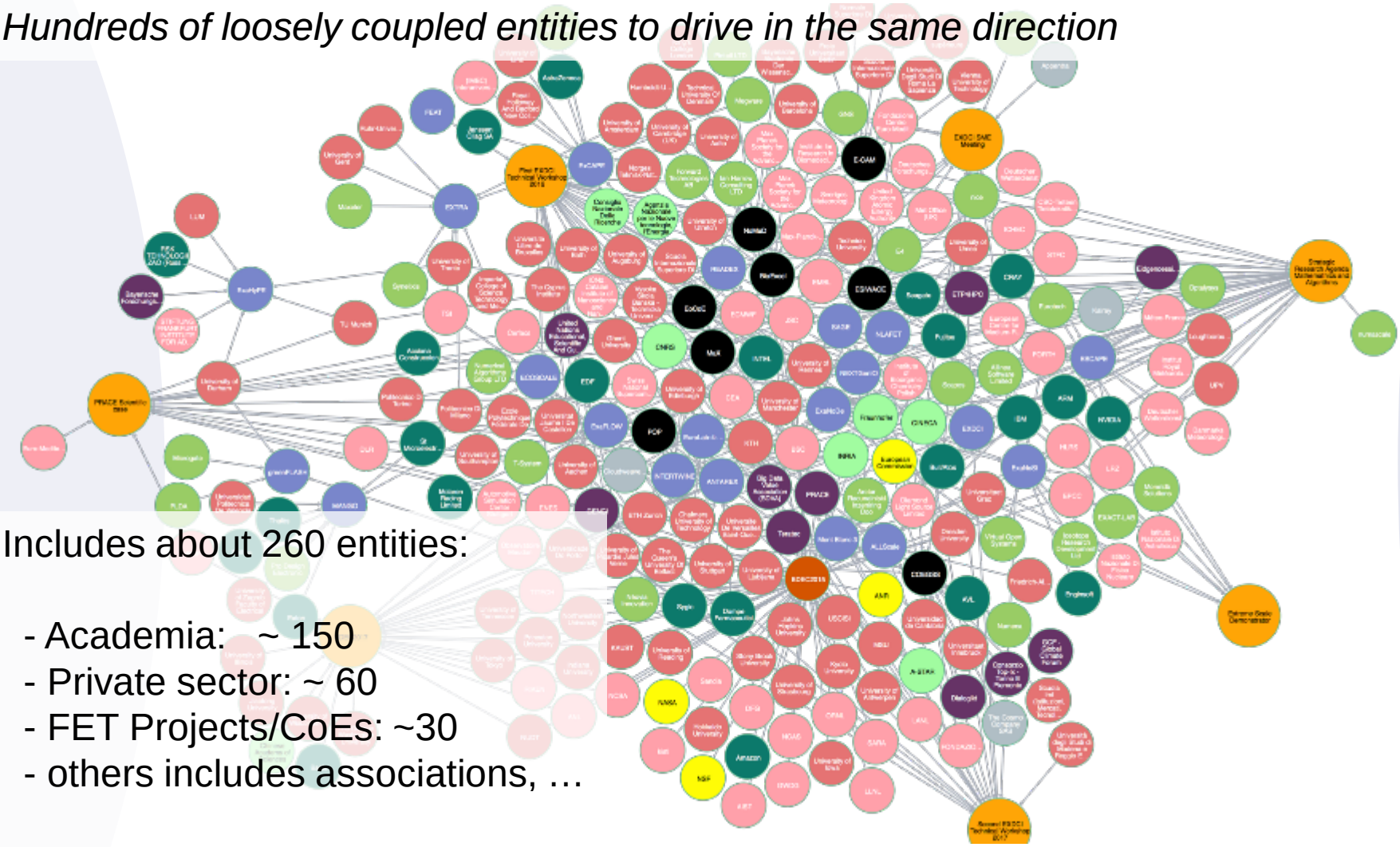
- Science needs more computing power, storage, data analysis
  - Numerical laboratories (see Pathways to convergence document)
- Specific to EU ecosystem
  - After a high expansion period we are losing ground
  - Increased competition
  - HPC at scale becomes more critical for economy, environment and metropolis development (cities systemic models, digital twins, etc.)
  - Entangled with the Big Data economy
  - New policies, e.g. make all scientific data produced by H2020 open by default
- Building a full HPC ecosystem is imperative to ensure long term value creation
  - Part of the innovation and economic growth assets
  - Training new generation of scientists and engineers
  - Securing our own independent HPC system supply

How Are We Going There?

	EU Initiatives	Timing
Roadmap	Strategic Research Agenda Eurolab4HPC Roadmap HiPeac Roadmap Pathways for convergence (participation) PRACE Scientific Case	Continuous effort “ “ Final at SC17 New version 2018
Research	FET projects (RIA)	Continuous
Technology	Integrated Projects (e.g. Mont-Blanc) Extreme Scale-Demonstrator (ETP4HPC) European Low-Power Processor	Ongoing start 2018 start 2018
Infrastructure	PRACE2 (HPC centers) GEANT (networks) EOSC/EUDAT (European Data Infra.)	Ongoing Ongoing start 2018
Application Development	Centers of Excellence (CoE) CEF HPC-OpenData	Ongoing start 2018
Economy	SMEs/Startups instruments	Ongoing

Who is Going There?

Hundreds of loosely coupled entities to drive in the same direction



Includes about 260 entities:

- Academia: ~ 150
- Private sector: ~ 60
- FET Projects/CoEs: ~30
- others includes associations, …

Ecosystem as seen from EXDCI

Conclusion

- ETA for Exascale is currently 2023
- EU ecosystem is accelerating
  - More continuity in actions and organizations is helping (less reset from one call to another)
- EXDCI continuation
  - More emphasis on HPC & HPDA convergence
  - Coordination for the Extreme Scale Demonstrators
- EHPCSW 2018 in Slovenia
  - 28 May to 01 June 2018
  - Gather the EU HPC community (and others are welcome)
- BoF BDEC Wednesday 5:15pm (710-712)
  - Details about the pathways for convergence

An Update on the U.S. D.O.E. Exascale Computing Project –

Paul Messina

Argonne National Laboratory and
Inaugural Director, Exascale Computing Project

SC17

Denver, Colorado

November 14, 2017

ECP has multiple components to meet national goals

Performant mission and science applications @ scale

Foster application development	Ease of use	Two diverse architectures	US HPC leadership

Application Development	Software Technology	Hardware and Integration	Project Management
Develop and enhance the predictive capability of applications critical to the DOE	Produce expanded and vertically integrated software stack to achieve full potential of exascale computing	Integrated delivery of ECP KPPs and products on targeted systems at leading DOE computing facilities	Project scheduling, tracking cost tracking, analysis, and accountability across the entire project spread across the country

EXASCALE COMPUTING PROJECT

The work is carried out at many institutions

EXASCALE COMPUTING PROJECT

DOE LABORATORIES & AGENCY PARTNERS
22

PRIVATE SECTOR PARTNERS
10

UNIVERSITY RESEARCH PARTNERS
39

INDUSTRY COUNCIL MEMBERS
18

THE ECP ECOSYSTEM

- 800+ Researchers
- 25 Application Development Projects
- 66 Software Development Projects
- 5 Co-Design Centers

U.S. DEPARTMENT OF ENERGY | Office of Science

NNSA National Nuclear Security Administration

Members of the ECP Industry Council

United Technologies
Westinghouse
Lilly
GM
Cummins
ExxonMobil
CASCADE TECHNOLOGIES
FedEx
GE
Altair
ANSYS
P&G
MARS
Chevron
TRI ALPHA ENERGY
THE POWER OF INGENUITY
Dow
Whirlpool CORPORATION
DREAMWORKS

EXASCALE COMPUTING PROJECT

76

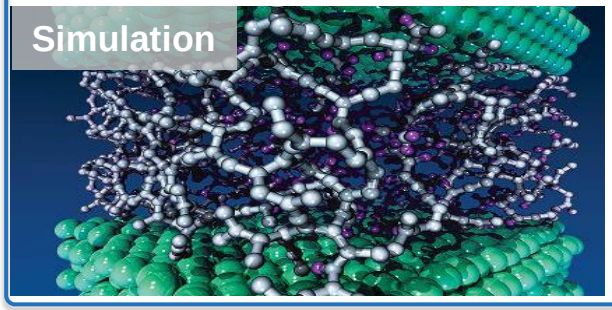
DOE supercomputing facilities will acquire and operate the exascale systems

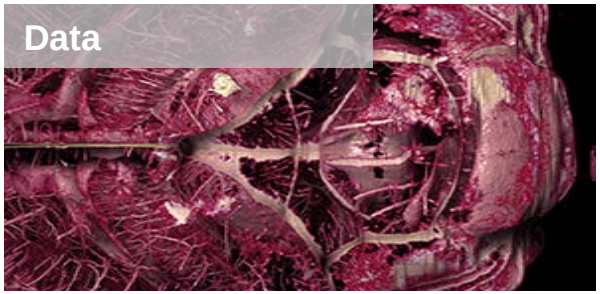
- The mission of those facilities is to provide access to the most powerful computing systems at any given time
- Hence the ECP is working closely with the DOE supercomputing facilities to ensure that the systems meet the mission needs
- Current plans call for delivery of the first exascale system to Argonne National Laboratory in 2021, with additional exascale systems to follow at other SC and NNSA laboratories in 2021-2022 and over the next several years to meet identified mission needs

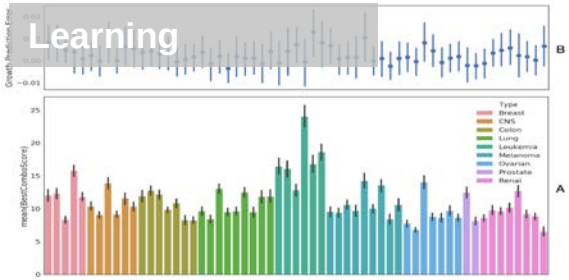
ALCF 2021 Exascale Supercomputer – A21

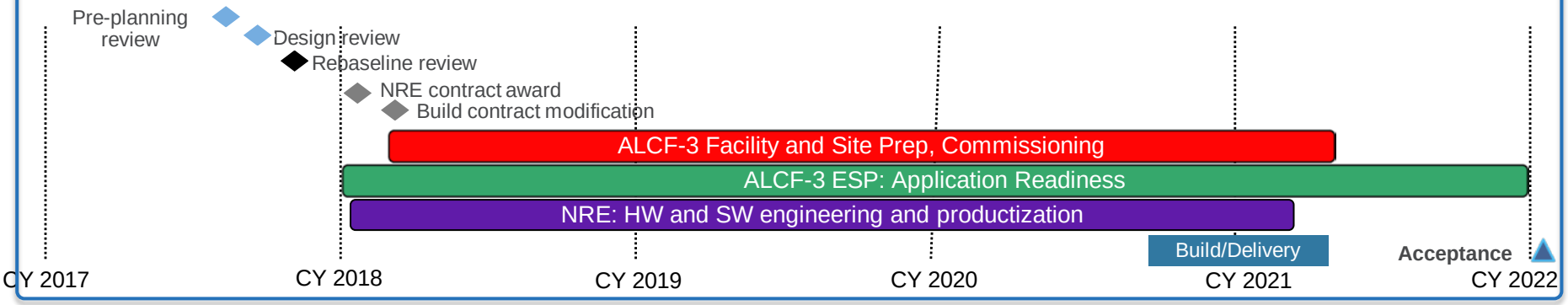
Intel Aurora supercomputer planned for 2018 shifted to 2021
Scaled up from **180 PF to over 1000 PF**

Support for three "pillars"









Argonne Targets for Exascale

Simulation Applications

- Materials Science
- Cosmology
- Molecular Dynamics
- Nuclear Reactor Modeling
- Combustion
- Quantum Computer Simulation
- Climate Modeling
- Power Grid
- Discrete Event Simulation
- Fusion Reactor Simulation
- Brain Simulation
- Transportation Networks

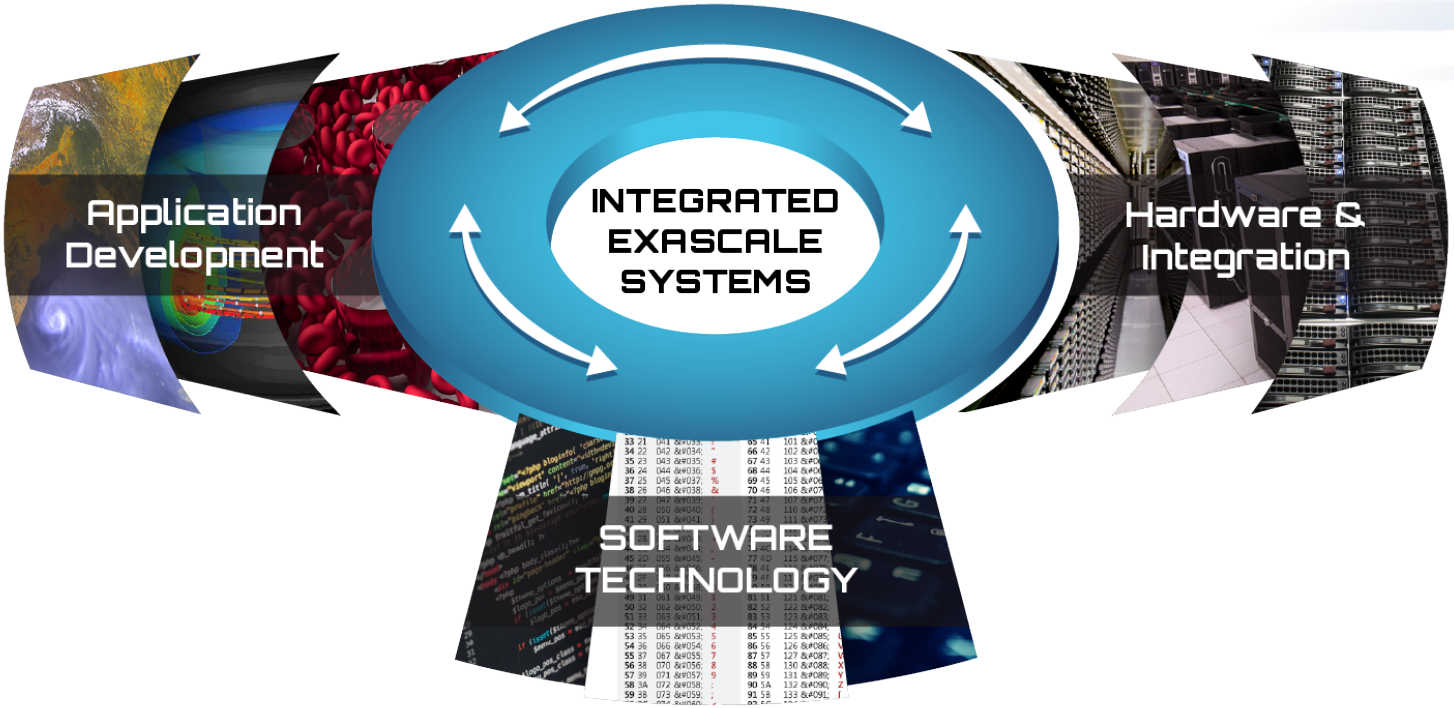
Big Data Applications

- APS Data Analysis
- HEP Data Analysis
- LSST Data Analysis
- SKA Data Analysis
- Metagenome Analysis
- Battery Design Search
- Graph Analysis
- Virtual Compound Library
- Neuroscience Data Analysis
- Genome Pipelines

Deep Learning Applications

- Drug Response Prediction
- Scientific Image Classification
- Scientific Text Understanding
- Materials Property Design
- Gravitational Lens Detection
- Feature Detection in 3D
- Street Scene Analysis
- Organism Design
- State Space Prediction
- Persistent Learning
- Hyperspectral Patterns

Co-design is the key to creating the ecosystem and there has been excellent progress



EXASCALE COMPUTING PROJECT

The Exascale Computing Project (ECP)

Collaboration

2 US Department of Energy organizations

- Office of Science
- National Nuclear Security Administration

Execution

800+ researchers (22 laboratory and agency partners; 39 universities) engaged in:

- 66 software projects
- 25 science application projects
- 5 co-design centers

Goal

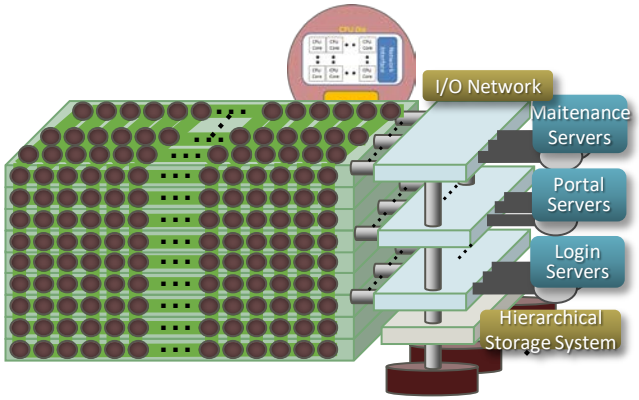
Drive pre-exascale science, application development, hardware and software R&D to ensure that the US has a **capable exascale ecosystem** in 2021

Exascaleproject.org

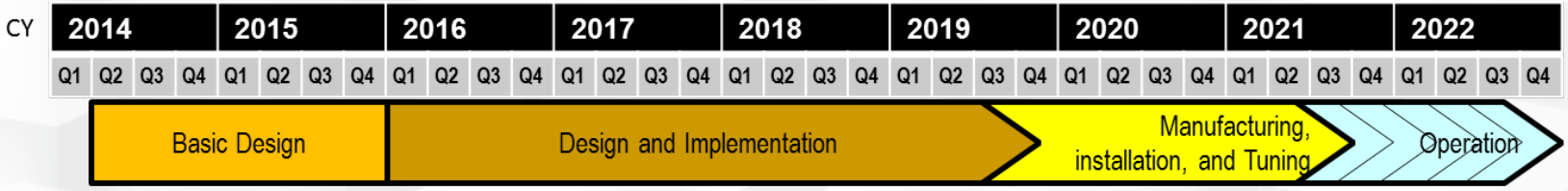
EXASCALE COMPUTING PROJECT

This research was supported by the Exascale Computing Project (17-SC-20-SC), a joint project of the U.S. Department of Energy's Office of Science and National Nuclear Security Administration, responsible for delivering a capable exascale ecosystem, including software, applications, and hardware technology, to support of the nation's exascale computing imperative.

Update: FLAGSHIP2020 Project



- Missions
  - Building the Japanese national flagship supercomputer, post K, and
  - Developing wide range of HPC applications, running on post K, in order to solve social and science issues in Japan
- Project organization
  - Post K Computer development
    - RIKEN AICS is in charge of development
    - Fujitsu is vendor partner.
    - International collaborations: DOE, JLESC, CEA
  - Applications
    - The government selected
      - 9 social & scientific priority issues and their R&D organizations.
      - 4 Exploratory Issues
- Status
  - "Basic Design" was finalized and now in "Design and Implementation" phase.
  - We have decided to choose ARM v8 with SVE as ISA for post-K manycore processor.
  - We are working on detail evaluation by simulators and compilers



Post K's Ecosystem

- **ARM Community & OSS Community**
  - Wide range of applications, tools, libraries, and compilers
  - Contributing to Open Source Community
- **International Collaborations**
  - DOE-MEXT
    - Optimized Memory Management, Efficient MPI for exascale, Dynamic Execution Runtime, Storage Architectures, Metadata and active storage, Storage as a Service, Parallel I/O Libraries, MiniApps for Exascale CoDesign, Performance Models for Proxy Apps, OpenMP/XMP Runtime, Programming Models for Heterogeneity, LLVM for vectorization, Power Monitoring and Control, Power Steering, Resilience API, Shared Fault Data, etc.
  - CEA
    - Programming Language, Runtime Environment, Energy-aware batch job scheduler
  - JLESC (NCSA, INRIA, ANL, BSC, JSC, RIKEN)

Linaro

https://www.linaro.org/sig/hpc/

The HPC SIG drives the adoption of ARM in HPC through the creation of a data center ecosystem. It is a collaborative project comprised of members and an advisory board. Current members include ARM, HiSilicon, Qualcomm, Fujitsu, Cavium, Red Hat and HPE. CERN and Riken are on the advisory board.

openHPC

OpenHPC is a Linux Foundation Collaborative Project whose mission is to provide a reference collection of open-source HPC software components and best practices, lowering barriers to deployment, advancement, and use of modern HPC methods and tools.

PANEL

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