ETP 4 HPC

ETP4HPC webinar #1
Discover the Transcontinuum Initiative

Agenda

11:00	Housekeeping	
11:05	Introducing the ETP4HPC webinars	Jean-Pierre Panziera
11:15	Meet our new members: University of Padova	Carlo Janna
11:20	Meet our new members: M3E	Nicolo Spiezia
11:25	Meet our new members: DLR	Thomas Gerhold
11:30	Introduction to the Transcontinuum initiative	Michael Malms François Bodin Zoltán Horváth
12:00	End	

ETP 4 HPC

EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

Jean-Pierre Panziera

ETP4HPC Chairman

ETP4HPC webinar series

- Two main takeaways from our February survey: ETP4HPC members want
  - more information
  - more networking opportunities
- This drove us to initiate regular webinars, covering different topics, such as:
  - Our new members
  - Technical topic (SRA-related)
  - Meet European projects
  - Meet our SME members
  - Use cases
- Give your feedback to webinar@etp4hpc.eu
  - what topics would you like us to cover in future webinars
  - how often should we have webinars…
- These webinars are open to non-members, invite your friends!

Next ETP4HPC webinar

- 3rd July 11am to noon
- Registration open on our website (in the Events section)

- Agenda
  - Welcome to Agenium Scale (France), Do IT Systems (Italy) and European Open File System association (EOFS)
  - Meet the 4 SMEs that should have exhibited on our booth at ISC: Bright Computing, Constelcom, NAG, Submer
  - 5 questions to projects DEEP-EST and Mont-Blanc 2020

ETP4HPC membership is growing

- We currently have 98 members
  - 39 research organisations
  - 36 SMEs
  - 14 global corporations
  - 6 European corporations
  - 2 associations
  - 1 individual

Welcome to our new members

- Università degli Studi di Padova (University of Padova)
  - Full member, Research Organisation
- M3E (Mathematical Methods and Models for Engineering)
  - Full member, SME
- DLR, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)
  - Full member, Research Organisation

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EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

New members

University of Padova

Some numbers

- Founded in 1222 a.d., is the second oldest University in Italy and one of the oldest in the world;
- One of the largest University in Italy with more than 2,000 Faculty members;
- With an annual revenue of more than 600 millions of €, it is one of the largest “industries” of Padova;
- Carries out active research in several fields from human sciences to medicine, biology, pure and applied mathematics, physics, and all the fields of engineering;
- Has a strong link with industry with more than 100 spin-offs founded in the last decade.

Contact Info: Prof. **Carlo Janna**, Dept. ICEA, University of Padova, ***carlo.janna@unipd.it***

University of Padova

Our research on HPC

- Research group in **Numerical Analysis** consisting of 6 faculty members and around 10 PhDs and postdocs;
- Main reseach topics:
  - Algorithms and Software for the **discretization of PDEs**;
  - Algorithms and Software for **Large** and **Sparse Linear Algebra**;
  - Modeling of **Complex Environmental Systems** at local and regional scale;
- Main sectors:
  - Oil & Gas industry;
  - Subsurface Hydrology;
  - Structural Mechanics;

Contact Info: Prof. **Carlo Janna**, Dept. ICEA, University of Padova, ***carlo.janna@unipd.it***

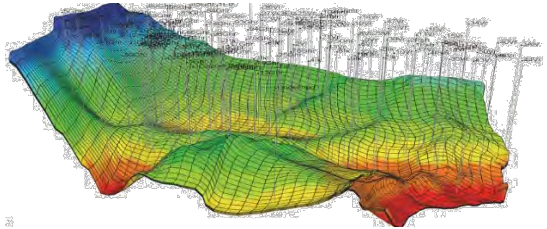
University of Padova

Recent Activity

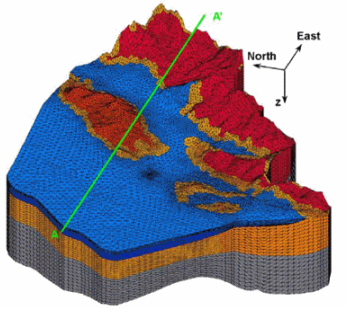
MATHEMATICAL METHODS and MODELS for ENGINEERING

- Strong and effective synergy with the spin-off M3E;

- R&D of Linear Solvers for Geomechanical and Reservoir simulation targeted for the **eni HPC5** system;



- R&D of High Perfomance tools for regional scale modeling of the evolution of sedimentary basins;



- Modeling of hydrocarbon reservoir and groundwater management also in developing countries;
  - R&D of Discretization Tools and Scalable Solvers for coupled subsurface simulations in massively parallel systems (cooperation with Stanford University and Lawrence Livermore National Lab);

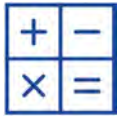
Contact Info: Prof. **Carlo Janna**, Dept. ICEA, University of Padova, ***carlo.janna@unipd.it***

Who we are

Our secret sauce

MATHEMATICAL METHODS and MODELS for ENGINEERING

M3E develops **algorithms and scientific software**
for the simulation and prediction in several engineering sectors.



Our customer-tailored products efficiently **solve**:

- Algebraic and differential equations
- Numerical algebra problems (linear system and eigenproblems)
- Optimization and calibration problems

These problems arise in every **engineering field** such as:
oil & gas, mechanical engineering, pipeline network, biomechanics, environmental engineering…

We don't simply develop algorithms and scientific software,
but we make it the **fastest possible**, leveraging on **HPC platforms**.


Padova - Italy


n.spiezia@m3eweb.it

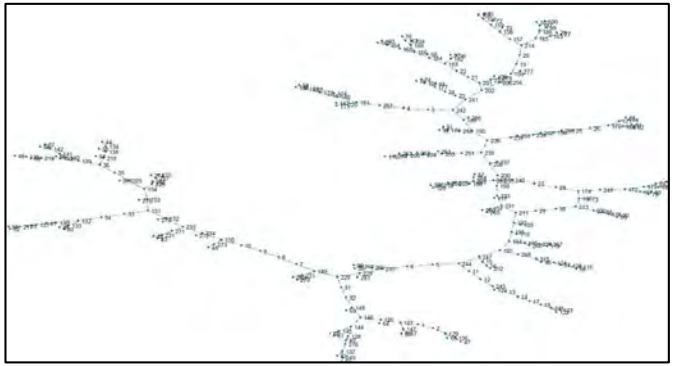

www.m3eweb.it

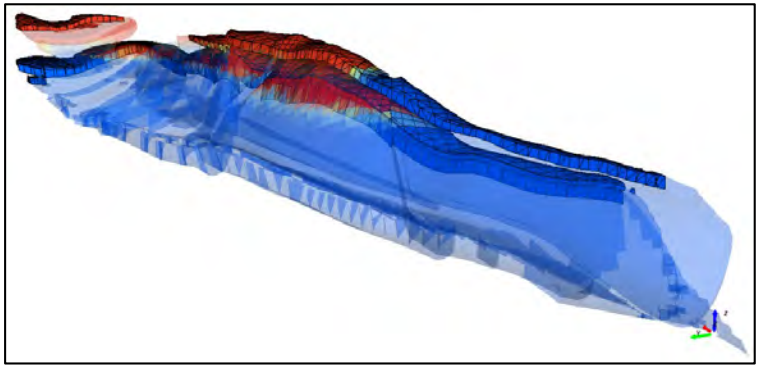

19/06/2020

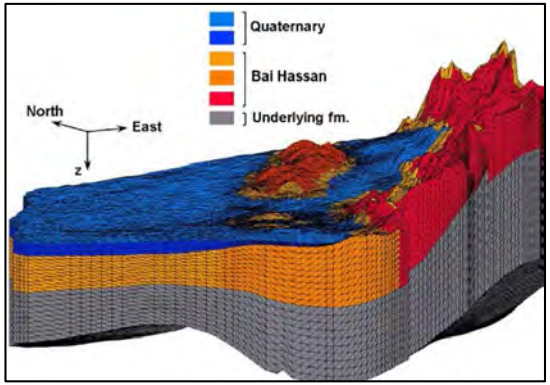
What we do

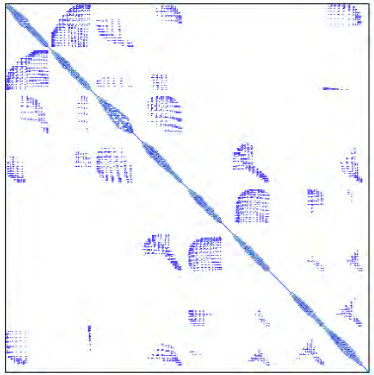
Some of our projects

MATHEMATICAL METHODS and MODELS for ENGINEERING









Geomechanical simulation, groundawater hydrology models, network of pipeline,…

We are able to solve problem with

hundreds of millions of unknowns

How we do

Our services and products

Customer type	Customer need	M3E solution
Engineering Company	The Customer has a deep knowledge on the engineering problem, but commercial code don't exist or aren't reliable for solving it.	M3E collaborates with the Customer and implements a scientific software (a very fast software!) to solve the problem.
Engineering Company or Software Company	The Customer has a property developed code/software, which gives satisfactory results, but it is unsatisfied about the computational performance.	M3E makes the code very efficient using its property computational library product (Chronos) and make it ready for multicore CPU-GPU supercomputing architecture.

Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

Thomas Gerhold

Head of Department High Performance Computing
Institute of Software Methods for Product Virtualization (Dresden)

Main contact for ETP4HPC

DLR

Deutsches Zentrum für Luft- und Raumfahrt

German Aerospace Center

- Research Institution
- Space Agency
- Project Managment Agency

50 Institutes

27 Locations

& Offices: Brussels, Paris, Tokyo, Washington D.C.
> 9000 Employees

DLR

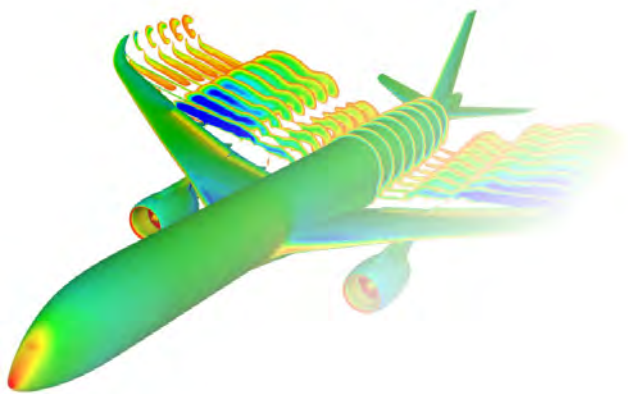
Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

Research Areas

- Aeronautics
- Space Research and Technology
- Transport
- Energy
- Security

for more details see www,dlr.de

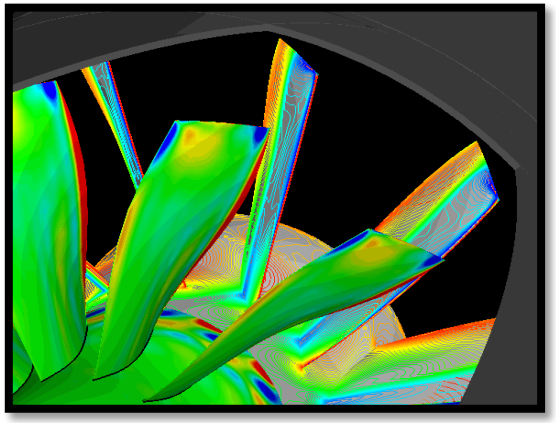
German Aerospace Center



Institutes involved in HPC activities

related to research, development and usage of HPC applications, i.e. DLR CFD solvers: Tau, Theta, TRACE and CODA (coupled with other disciplines)

- Institute of Software Methods for Product Virtualization
- Institute of Aerodynamics and Flow Technology
- Institute of Aeroelasticity
- Institute of Propulsion Technology
- Institute of Combustion Technology
- Institut for Software Technologie



… and a few other Institutes with smaller HPC activities

… and others involved in HPDA activities

for more details see www,dlr.de

ETP 4 HPC

EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

BDV BIG DATA VALUE ASSOCIATION

TransContinuum Initiative
a short introduction

Michael Malms
Francois Bodin
Zoltan Horvarth

5G IA

HiPEAC

CLAIRE

EU MATHS IN

EUROPEAN SERVICE NETWORK OF MATHEMATICS FOR INDUSTRY AND INNOVATION

Agenda:

- What triggered the TransContinuum Initiative?
- “TransContinuum” horizontal collaboration - scope & objectives
- Applied methodologies
- What are the next actions?

Let us start here...

The role of traditional HPC:

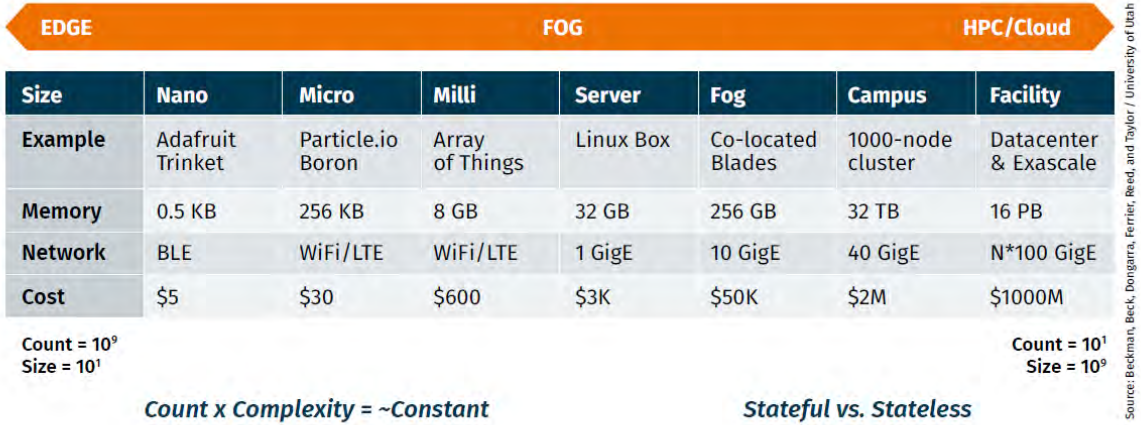
High-performance computing (HPC) is the use of supercomputers and parallel processing techniques for solving complex computational problems.

High-performance computing is typically used for solving advanced problems and performing research activities through computer modeling, simulation and analysis.

Supercomputers are used for a wide range of computationally intensive tasks in various fields, including weather and climate research, oil and gas exploration, molecular modeling, the simulation of aerodynamics of aircrafts, nuclear fusion, etc…

The "digital continuum paradigm"

....a hardware view....



EDGE			FOG			HPC/Cloud	
Size	**Nano**	**Micro**	**Milli**	**Server**	**Fog**	**Campus**	**Facility**
Example	Adafruit Trinket	Particle.io Boron	Array of Things	Linux Box	Co-located Blades	1000-node cluster	Datacenter & Exascale
Memory	0.5 KB	256 KB	8 GB	32 GB	256 GB	32 TB	16 PB
Network	BLE	WiFi/LTE	WiFi/LTE	1 GigE	10 GigE	40 GigE	N*100 GigE
Cost	$5	$30	$600	$3K	$50K	$2M	$1000M

Count = 10^9
Size = 10^1

Count = 10^1
Size = 10^9

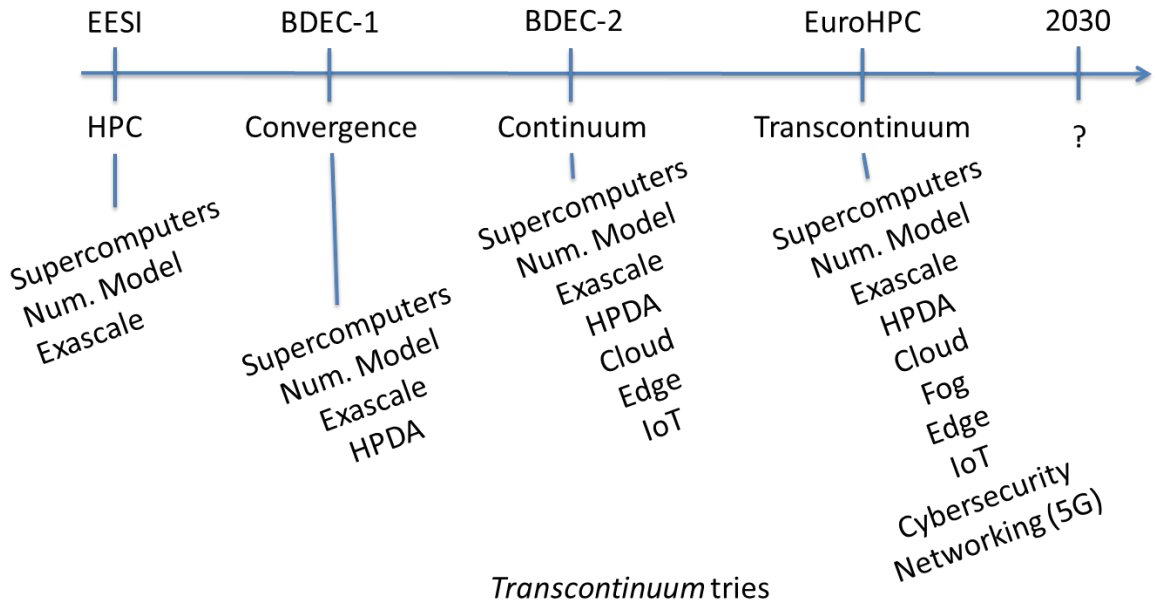
Count x Complexity = ~Constant

Stateful vs. Stateless

Source: Beckman, Beck, Dongarra, Ferrier, Reed, and Taylor / University of Utah

Figure 12: The Digital Continuum paradigm seen from a count-complexity perspective[42]

Transcontinuum: the origin



Transcontinuum tries

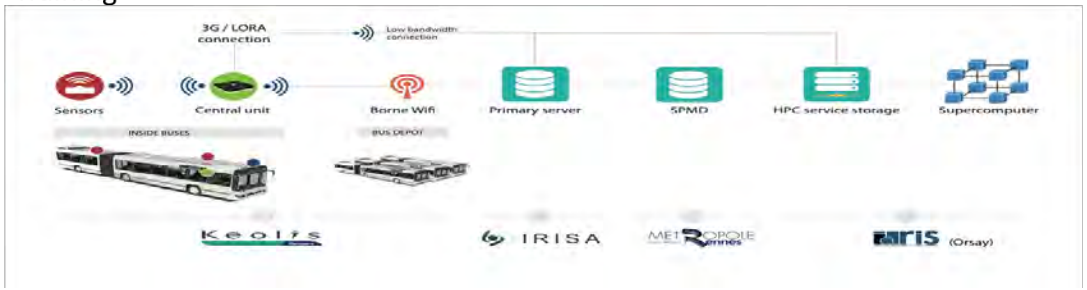
1) to capture the idea that infrastructures element cannot be used independently…
2) by providing a coherent and effective view of the cyberinfrastructure for end-to-end applications

https://www.exascale.org/bdec/

Pathways to Convergence, IJHPCA, 32(4), 2018.

Transcontinuum challenges

- Complex application workflows
  - Multi-tenant, multi-owner, heterogeneous, distributed, programming, orchestration, etc.
- Data logistics
  - Data life cycle, storage, network, privacy, access control, metadata, etc.
- Resources allocations / orchestrations
  - Provisioning, billing, urgent computing, re-configurability, etc.
- Cybersecurity
  - Transversal authentication, monitoring, resilience, trusted communications, etc.
- AI everywhere
  - At the edge : data locality, bandwidth efficiency, privacy, etc.
  - AI for science, cyberinfrastructure for AI, AI for cyberinfrastructure
- Sustainability
  - Energy efficiency, resource saving, data reduction, algorithm efficiency, etc.
- Training



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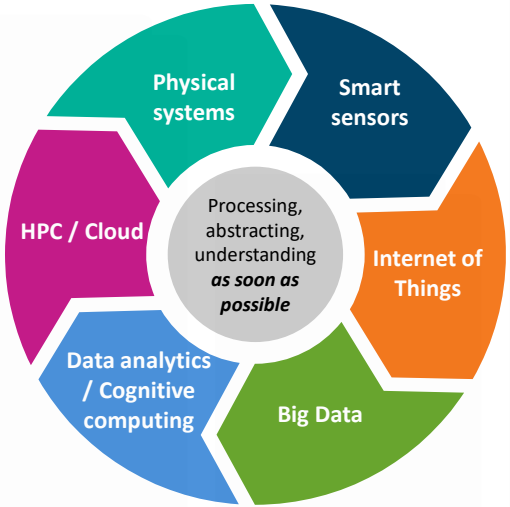
http://aqmo.irisa.fr

....a more holistic view....

HPC in the loop*



Enabling Intelligent data processing at the edge:

- Fog computing
- Edge computing
- Stream analytics

Transforming data into information as soon as possible

Collaboration between edge devices and the HPC/cloud ensuring:

- Data security and Privacy
- Lower bandwidth
- Better use of HPC/Cloud

→ creating a continuous flow

See pages 15-20 of SRA - 4

* Courtesy of :

From SRA, page 97

A large-scale collaborative effort: Transcontinuum Extreme-Scale Infrastructures

Recent hardware and software advances have motivated the development of a *transcontinuum digital infrastructures* concept to account for the convergence of data and compute capabilities. This concept is not in a straight line from the past efforts and a paradigm change is needed: we will have to design systems encompassing hundreds of billions of cores distributed over scientific instruments, IoT, supercomputers and Cloud systems through LAN, WLAN and 5G networks.

Pushed by massive deployments of compute and storage capabilities at the *Edge*, we require new system design to accommodate the ecosystem change to be expected in the coming decades (environmental and technological) and horizontally integrate the different actors. The new demands and challenges that combine data and compute, distributed across the continuum, and the maintenance and resource efficiencies, are pushing for drastically increased software and hardware *sustainability*. Furthermore, the need to provide high-level *cybersecurity* is profoundly changing the game. Efficiency and resilience will have to reach levels never achieved so far, while taking into account the intrinsic distributed and heterogeneous nature of the continuum. In addition, the question of dealing with such high volumes of data needs to be faced, and quality versus quantity will become unavoidable. These considerations will spread over all components. Long-lifetime hardware devices will have to be reconfigurable, modular, and self-aware in order to be operational over extended periods. Algorithm efficiency will need to be drastically pushed up (e.g. more efficient AI). Management and deployment of large-scale application workflows will have to be adapted or invented. Network protocols will have to offer better control over the data logistics, etc.

Furthermore, it is widely recognised that AI will play a central role in these extreme-scale, continuum infrastructures. This will occur at three levels:

- AI for Digital Infrastructure,
- Digital Infrastructure for AI, and
- AI for Science, Industry and Societal Challenges.

The first addresses how AI can pilot and monitor the continuum and in so doing provide solutions to the points listed in the previous paragraph. The second treats the question of re-designing the e-infrastructure to efficiently deal with data analysis and machine learning, which means tuning of data access, I/O, and low precision arithmetic. The last deals with the ever-increasing needs to exploit AI techniques for extreme-scale, combining Data and Compute through the interpretation and coupling of computing results, measurements and observations (e.g. Digital Twins in extreme earth modelling, combining climate models with satellite data and on-ground sensors).

The overall objective is to target high TRL solutions (7 and more), based on horizontal synergies between all the concerned digital infrastructure technologies: HPC, Big Data, Machine Learning, IoT, 5G, cybersecurity, processor technology (EPI) and robotics. All of these components of the digital infrastructure will *together* be able to address the critical societal challenges and sustainable development goals by mobilising their amazing potential all the way across the continuum. ■

ECS
EUROPEAN CYBER SECURITY ORGANISATION

BDV BIG DATA VALUE ASSOCIATION

ETP 4 HPC

5G IA

HiPEAC

CLAIRE

EU MATHS IN
EUROPEAN SERVICE NETWORK OF MATHEMATICS FOR INDUSTRY AND INNOVATION

Transcontinuum – Collaboration

- Strengthen R&I in Europe to support Digital Continuum - infrastructure
- Define set of research focus areas/topics requiring interdisciplinary actions
- Horizontal collaboration between 7 European Associations/Networks of scientists

Recap: how to derive R&I priorities for the TransContinuum?

The Digital Continuum – an abstract view

(technical characteristics and major challenges

see "Transcontinuum" text as a first proposal, SRA-4*, page 97

Small set of use cases

(use cases in line with important societal challenges in Europe, ambitious, solutions with significant impact

see "Extremes prediction in the Digital Continuum" – use case as one potential candidate, SRA-4*, pages 20ff

Translate into use case specific technical challenges

(define the puzzle pieces of technical challenges and the necessary interdisciplinary players)

Recommendations for R&I calls

MFF 2021-2027: work programmes

(Digital Europe, Horizon Europe, **Missions…**)

EuroHPC

Calls with interdisciplinary objectives

consortia with mixed contributors

Other JUs (e.g. Key Digital Technologies, KDT)

Calls with interdisciplinary objectives

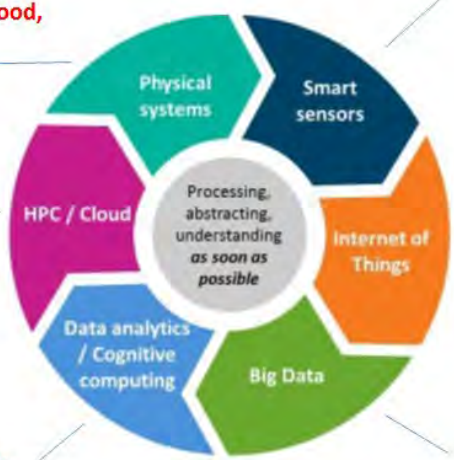
consortia with mixed contributors

* https://www.etp4hpc.eu/pujades/files/ETP4HPC_SRA4_2020_web(1).pdf

Mapping "Extremes' prediction in the Digital Continuum" to the loop

Cyber-physical entanglement of real-time, digital twin of Earth system, optimal information of user-specific information on demand and physical systems in impact areas: energy, water, food, health, law

Smart sensors in mobile phones, cars, wind farms, agriculture farms, cities etc. for weather and air quality



Extreme-scale computing to generate digital twin

IoT for accessing relevant data & IoT for disseminating user specific information

Machine learning for information extraction, product tailoring, surrogate modelling

Extreme-scale data collection-processing-dissemination on tight schedules

Novel
Emerging
Established

Recommendations for EuroHPC work programme 2021-23

Priorities 2021-2023

Applications

- Application pillar proposal for calls
  - Aligned with technology pillar

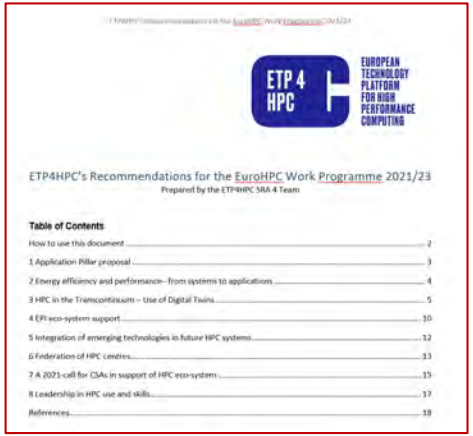
Technologies

- Energy efficiency and performance – from system to application
- HPC in Transcontinuum – use of Digital Twins
- EPI eco-system support
- Integration of emerging technologies in future HPC systems
- Federation of HPC centres
- A 2021 call on CSAs in support of the HPC eco system

HPC use & skills

- Leadership in HPC use and skills

In more detail*:


ETP4HPC's Recommendations for the EuroHPC Work Programme 2021/23

Prepared by the ETP4HPC SRA 4 Team

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7 A 2021-call for CSAs in support of HPC eco-system 15
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*https://drive.google.com/drive/folders/1UOzNMynlX11BEQna0KQ5FaoZfzY8PDxE

Overview of EU-MATHS-IN and MSODE

European Service Network of Mathematics for Industry and Innovations

- Dutch foundation since 2013, started after Forward Look report of ESF (European Science Foundation)
- Network of national industrial mathematics networks
  - 21 countries
  - 200 maths-lead interdisciplinary research groups
  - 2000 maths researchers
  - 100 new contracted, high TRL R&I projects per annum
  - Industrial Core Team: Siemens, Michelin, Shell, Bosch, Atos, Dassault, Nors, EcoMT

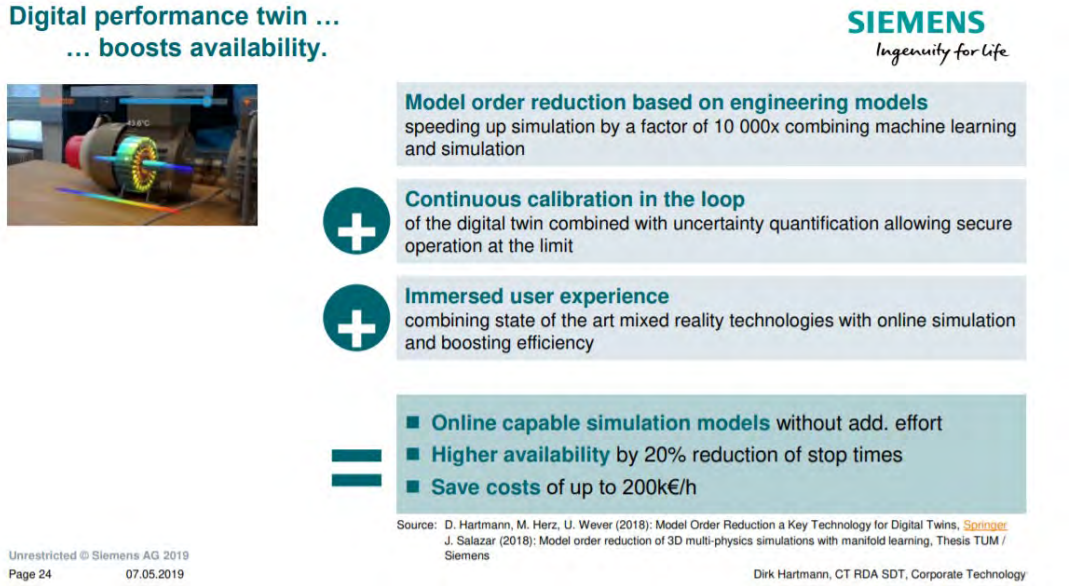
- Main goals:
  - One-stop-shop of **MSODE** services for industry in Europe

    MSODE: Modelling, Simulation and Optimization in Data-rich Environment → model based Digital Twins
  - Coordinate and maintain SRA for MSODE
    - Working Group (WG) leaders are prominents of EU top research centres and industries
    - WGs: Modelling, Model order reduction, Sim., Optim., Systems & Control, Inverse p., UQ, HPC, ML/Big Data

Digital Twins

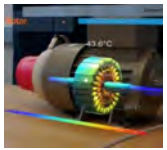
A Digital Twin consistently **integrates all data** (test, operation data, ...), models (design drawings, engineering models, analyses, ...), and other information (requirements, orders, inspections, ...) **of a physical asset** generated **along its life cycle** to leverage business opportunities (real-time monitoring and diagnostics - virtual sensors, predictive maintenance, model based control, …).

The role of the Digital Twin is to **predict and optimize performance**.



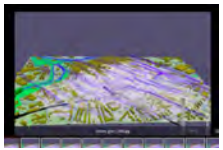
Digital twin use cases

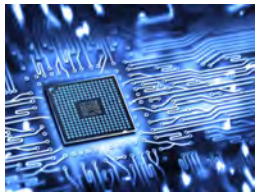
1. Online Health- and Lifetime Monitoring of complex physical assets (**bridges, motors, floating wind turbines**, etc.)



2. Digital-Twin-based Controls (**high energy- and resource-intensive process plants)**

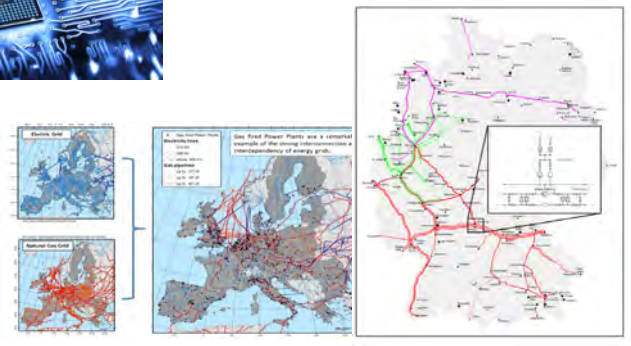
3. Digital Twin for the **Urban Air Pollution**



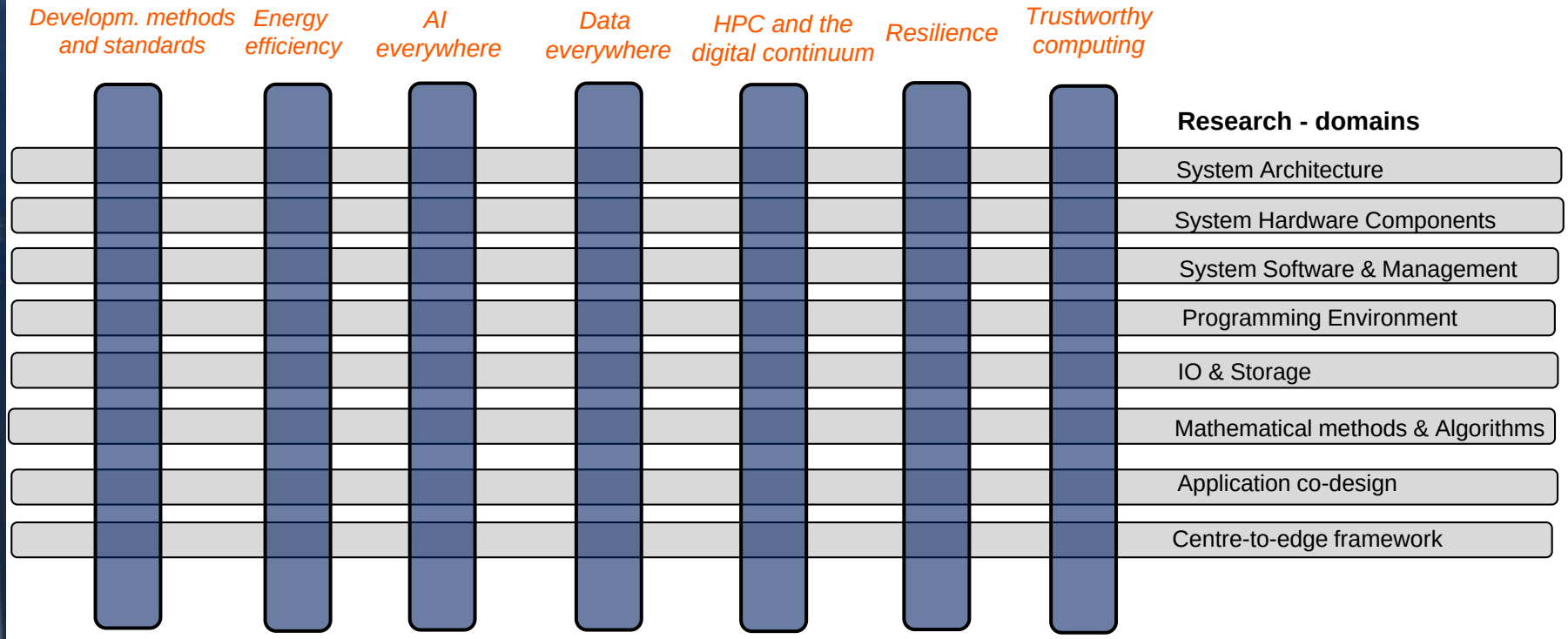


4. Digital Twin for SPICE (DT for **integrated circuits** design)

5. Digital Twins of **Gas Transport Systems**



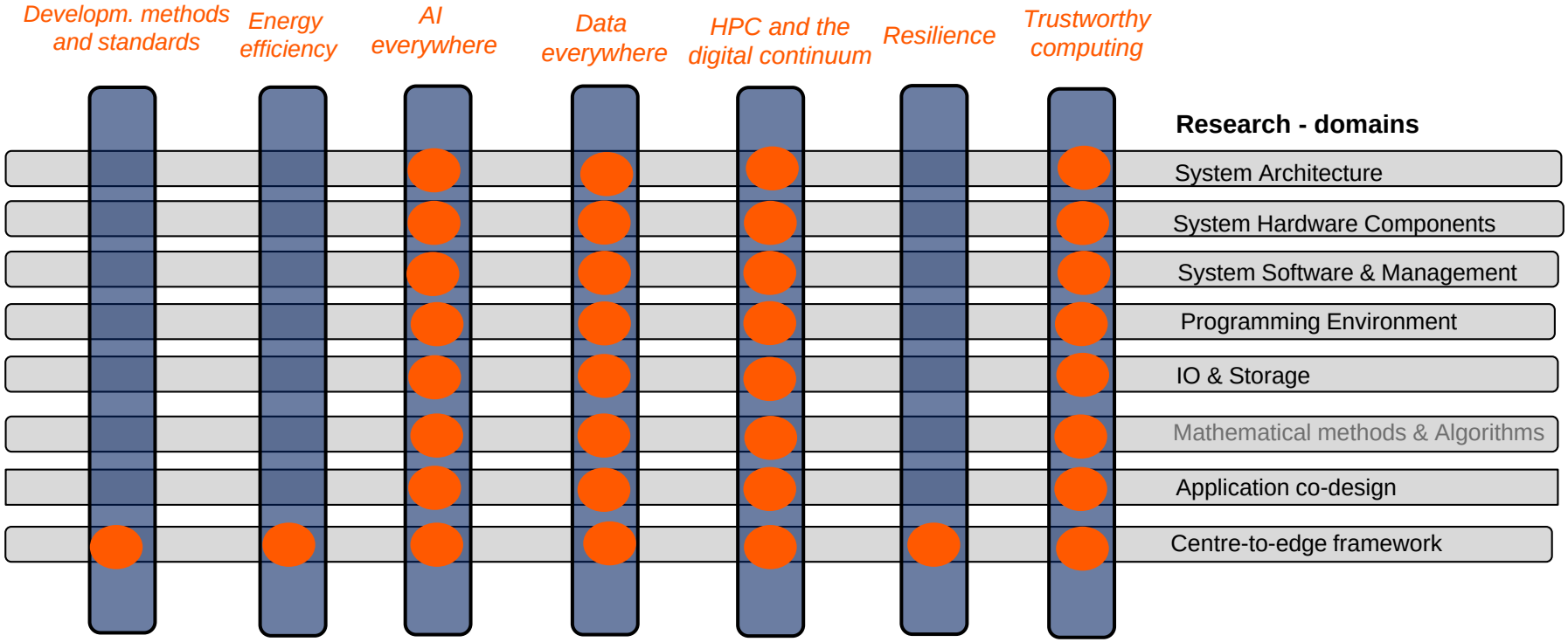
Structure of technical chapters: "Research clusters" and "Research Domains"



See also SRA-4, page 35 ff

.....partial, HPC centric view....

Support for HPC in the Transcontinuum



Scope and objectives of the TransContinuum Initiative ("TCI")

…..to be further elaborated in the "TCI-vision working group" (kick-off was 12.6.)

- Identify priorities and recommendation for European R&I workprogrammes
- Interlock with European R&I funding agencies and R&D programmes (e.g. JUs, Missions)
- Generate and foster interdisciplinary network to prepare for EU project proposals
- Contribute to SR(I)As, webinars, events of TCI-collaboration partners

A

MFF 2021-2027(1279b)

Single market, Innovation and Digital (187b)

Digital Europe (9.2b)

Horizon Europe (100b)

EuroHPC(2.7b)

..... Pillar 2 (52.7b) .....

Clusters

Missions

15b

B


EUROPEAN COMMISSION

Brussels, 19.2.2020
COM(2020) 66 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

A European strategy for data

https://ec.europa.eu/info/sites/info/files/communication-european-strategy-data-19feb2020_en.pdf

C

https://www.bmwi.de/Redaktion/EN/Dossier/gaia-x.html

ETP4HPC

Next actions

- Generate TCI vision 2-pager signed by participating 7 associations/projects (WG1)
- Start reaching out to EC-missions, Destination Earth and KDT-JU
- Create framework for digital continnum use case analyses (WG2)
- A “reference architecture” for continuum workflows (WG3)
- Analyse Digital Twin (DT) scientific and industrial use cases

ETP 4 HPC

EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

THANKS!

Next webinar: 3rd July 10:30am
https://attendee.gotowebinar.com/register/7283696494138752783

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