Extreme scale Demonstrators

- state of discussion -

EXDCI workshop
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EsDs in a Nutshell: Concept (#1/4)

- "The "Extreme-Scale Demonstrators" (EsDs) are vehicles to **optimise and synergise the effectiveness of the** entire **HPC H2020 Programme** through the integration of isolated R&D outcomes into fully integrated HPC system prototypes;
  It is a key step towards establishing European exascale capabilities and solutions." ***(From the ETP4HPC SRA, chapter 8 p.67)***
- EsD will fill critical gaps in the HPC H2020 programme:
  - Bring technologies from FET-HPC closer to commercialisation (TRL 7-8)
  - Combine results from targeted R&D efforts into a complete system (European HPC technology ecosystem)
  - Provide the missing link between the 3 HPC pillars: Technology providers, infrastructure providers, user communities (co-design)

EsDs in a Nutshell: Contribution / Role of Participants

Technology providers

- Technology integration
- System architects
- Testing and quality/performance assurance (phase A)
- Maintenance and service (phase B)

EsD Expectations

- Design points ~400-500 Pflops
- EsD target 5% (20-30 Pflops)
- Budget: 20-40 Mio. €
- Diversity of architectures
- TRL 7-8

EsDs

Application owners / CoEs

- Application requirements and key challenges (phase A)
- Port, optimize application(s), use them productively (phase

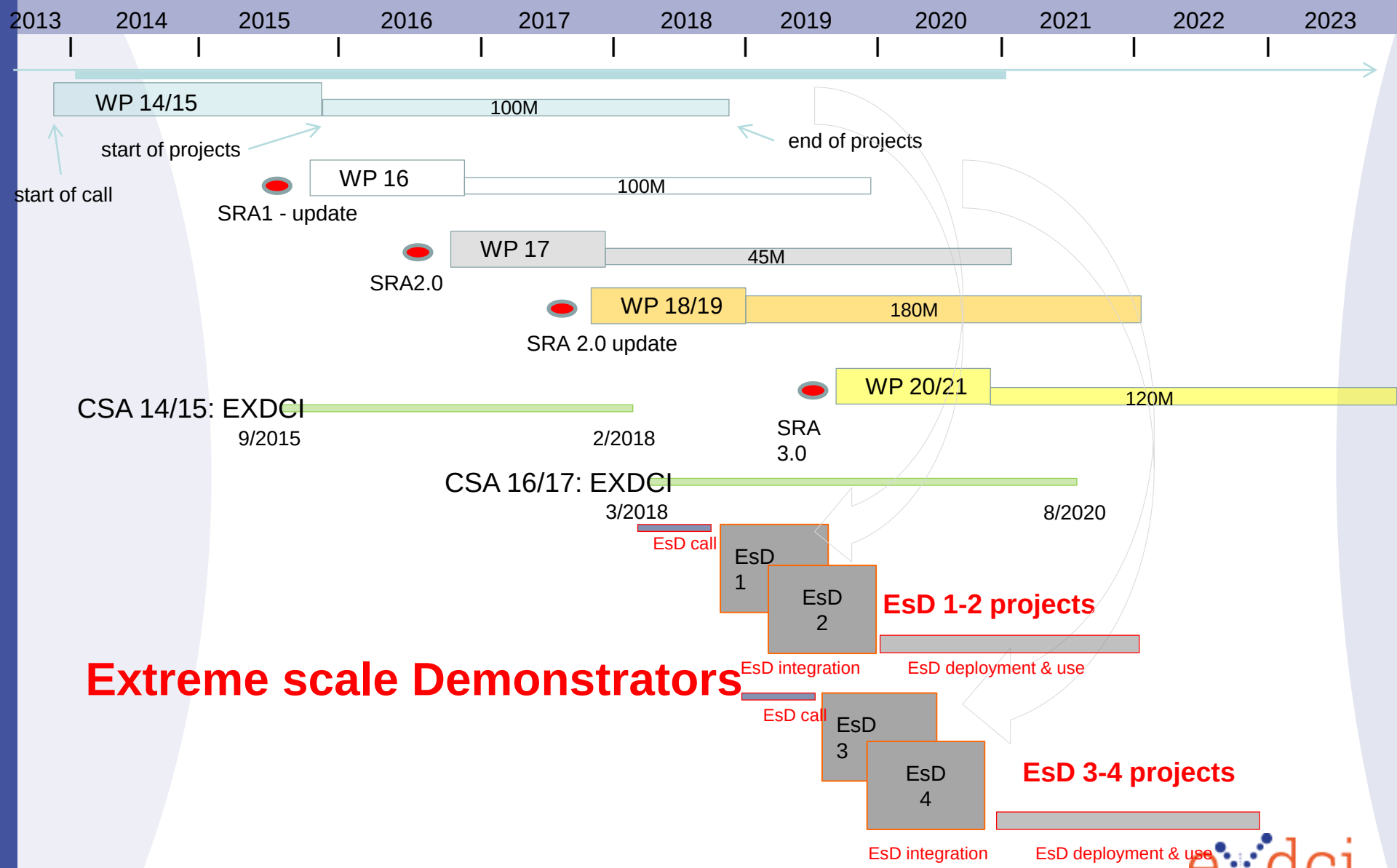
HPC Centres

- Participate in co-design
- Manage system deployment (phase A)
- System operation, validation (phase B)

EsDs in a Nutshell: Proposal Calls (#3/4)

- Two EsD calls, each leading to two projects
  - Calls target technologies developed under FETHPC, but are open
  - EsD projects should start after end of FETHPC projects in WP2014/15 and WP2016/17
- EsD project structure
  - Phase A (18-24 months): Development, Integration and Testing
    - Little or no basic technology research
    - Substantial R&D focus geared towards integrating components and sub-systems developed in the preceding R&D projects
  - Phase B (18-24 months): Deployment and Use
    - Operated by a hosting center
    - EsD made available to application owners for code porting and development
    - Characterization and EsD validation, benchmarking based on real use-cases.

EsDs in a Nutshell: HPC-Horizon 2020 roadmap (#4/4)



Version 5.1

EsD State of Play

- EsD concept is outlined in the latest ETP4HPC SRA
- Next SRA will provide more details: enable cPPP to propose concrete calls
- Previous Workshops focus:
  - EXDCI Workshop '15, Rome: Kick-Off
  - HPC Summit '16, Prague: Discuss EsD concept in community and with EC:
    - Technical system characteristics, budget, procurement model, consortia, use cases
  - ISC '16, Frankfurt:
    - continue Prague discussion
    - focus: from Use Cases to System Specs

    } Remainder of this presentation: report on Workshop Write-Up
- Focus of this Workshop: system integrators
  - Gather input on expectations, interests, constraints, …
- Next steps
  - Digest results from workshop
  - Progress towards next version of SRA

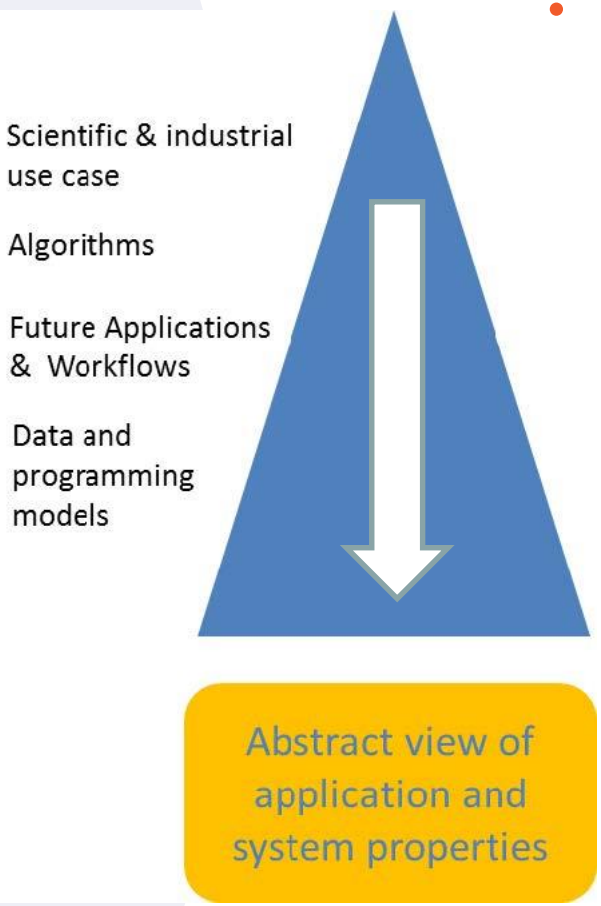
Use Case Analysis (E.Laure)

- Approach at SC ’16 Workshop
  - Communities invited to present use cases: scientific challenges & HPC requirements
  - Present: Astronomy, Biomolecular simulation, Climate, Energy, Materials, Bayesian Uncertainty Quantification
  - Data available also from PRACE Scientific Case, EESI reports
- High-level recommendations
  - Scientific challenges/application characteristics to drive system design
  - EsD proposals to identify challenges they contribute to
  - Co-Design from the very beginning
  - Funding needed for porting/optimisation within or outside EsD budget method/application development out of scope
  - Full applications needed to achieve objectives; mini-apps useful for testing & development
  - Success metrics: science enabled, not Linpack-Flops

Use Case Analysis continued (E.Laure)

- Communities stated requirements for System Characteristics
  - Floating Point / Node Performance
    - Powerful nodes preferred over extreme scalability
    - Floating Point performance important, but less than double precision possible in some domains
    - Expect to deal with heterogeneous components (CPU/GPU)
  - Network Latency – more a concern than bandwidth
  - High Memory Bandwidth/Flops ratio for data-driven application
  - I/O – important, especially for check-pointing and workflows
  - HTC/Workflows – challenges I/O and system management
- Observations
  - Requirements expressed in the 'usual' low-level characteristics
  - more discussion needed with more communities

Workload Requirements & System Characteristics (H.C.Hoppe)



- Co-Design (upper half-cycle):
  - How to get from use cases to system characteristics ?
- Proposed approach
  1. Use cases provide high–level properties of apps:
     - Data Structures
     - Computational and data algorithms
     - Scaling and parallelism, usage model
  2. Derive quantifiable system properties
     - Compute performance (Flops, integer, …)
     - Memory size and performance
     - Interconnect performance
     - I/O volumes & patterns
     - Energy to solution
  3. Derive non-quantifiable properties
     - Programming & execution models
     - Communication & I/O structures,
     - memory access patterns
     - Heterogeneity (CPU/GPU, …)

Loose Ends #1: System Characteristics

- What is the right level to define the system capabilities/characteristics?
  - High-level properties (data structures, algorithms, scaling, …)
  - Quantifiable system characteristics (Flops, GB, GB/s, …)
  - In other words: what kind of information is to be requested from use case providers?

<u>Some observations from WP2-WP3 interlock session on Wednesday</u>

- Data provided by presenters (WP3)
  - Flops and memory size requirements
  - I/O capacity and speed requirements
- Some questions asked by audience (WP2)
  - Scalability of system parameters with problem size
  - Limits of strong scaling
  - Relative quantities: Memory/Core, Cores/Node, Bytes/Flop, Latency/Cycle, …
- Conclusions
  - Idea: start Co-design cycle at lower half: propose system options
  - Dialogue needed: system design – suitable for application ?
  - This requires some level of performance modelling and profiling

Call Engineering / Budget (M.Muggeridge)

- Challenges
  - Ensure good value for money (funding)
  - Ensure a set of EsDs that covers the full system capability space / avoid 4 very similar systems
- Proposed solution (not discussed in Workshop): 2 staged evaluation
  1. Stage:
     - proposals offer core system + incremental extensions (incl. cost model: fixed, variable with size/duration of operation)
     - EC selects an optimal set of proposals and recommends size of core system and selection and size of extensions to globally optimise call budget
  2. Stage:
     - Selected consortia submit final proposal based on recommendations
     - Final evaluation by EC
- Proposed overall Budget for 2 calls: 200 Mio. €

Loose Ends #2: Call Engineering

- Orchestration vs. Open Competition:

  The objective to ensure EsDs cover all relevant system capabilities/ characteristics (avoiding 4 similar systems) calls for orchestration

- Strengths/opportunities of Orchestration (via 2-staged evaluation)
  - Fosters that EsDs cover all relevant system capabilities/characteristics (it at least 1 proposal includes it)
  - Global optimisation of value for money
- Weaknesses/threads of Orchestration
  - H2020 rules do not foresee orchestration
  - 2-staged evaluation is available in H2020, but for a different purpose (fight low success rates, by pre-selection based on 7-pager)
  - Increased complexity
- Alternative options
  - Trust in standard EC processes (and hope for the best)
  - Place constraints in calls, e.g. 'it is foreseen to fund at least one proposal addressing HPDA use cases'

Options for Acquisition (D.Pleiter)

- PCP + PPI
  - + Well-defined, innovation-driven process
  - – Long process: 3+ years
  - – PPI required significant contribution from procurer
  - – Strict separation between procurer and supplier
- Public procurement by hosting partner within RIA project
  - + Well established process; HPC centres have strong experience
  - – Public procurement rules may conflict with call objectives
  - – Need to avoid open procurement; other providers may challenge it …
- Purchase by system integrator within RIA
  - + Simple, well established process
  - – Integrator cannot buy from itself (need to purchase from manufacturers)
  - – Financial risks may be too high for smaller companies – excludes SME

Acquisition – Open Questions (D.Pleiter)

- How to ensure neutral role of integrator
  - Large partners may favour own solutions
- Access limitations to the system?
  - Exploitation of EsD by commercial operators outside consortium?
  - Dependence on ownership?
- Management of support contracts, license agreements (also with 3rd party suppliers)
- Involvement of SMEs
  - Contributor of technologies
  - Investigation and demonstration of simulation services
  - Financial risks may prevent SMEs from acting as integrator
  - FORTISSIMO-model: low-effort calls to provide access to services to SMEs (added as 3rd parties to consortium)

Extreme scale Demonstrators: some words upfront (2)

System integrators play a pivitol role in the EsD concept both during Phase „A" (development & integration) as well during phase „B" (evaluation/ benchmark and deployment).

(Note: the term „system integrator" is vage and can span a variety of roles and steps towards making a system „shippable").

It is important for the definition of the next layer of the EsD concept to understand and discuss the different positions of interested EsD system integrators such as:

Suggested topics for the presentations of the system integrators:

1. What is your motivation for potentially assuming the role of a system integrator in one of the Esd projects ?
2. What are the responsibilities and scopes you wish to cover:
   - System architect
   - Development of own subsystem(s) or subcomponent(s)
   - Integration of entire system including third party subsystems & components
   - System Test and EsD-release
   - Maintenance & support
3. What is your view on how best to implement the object of „integrate technology researched and prototyped in pevious FETHPC projects"? (analysis-process, estimated time and resources required, IP-aspects, etc.)
4. What is your view on the governance – structure of an EsD project, what are your fundamental requirements?

Extreme scale Demonstrators: some words upfront (1)

- Agenda for this session:
  - Quick recap of the current status of the EsD proposal (Thomas Eickermann, 30 min)
  - System integration related discussion points (next page) (Michael Malms, 15 min)
  - Presentation of System Integrators (15 min each)
    - Lenovo
    - Cray
    - Megware
    - E4(?)
    - Atos
    - Eurotech
    - Fujitsu
  - Discussion „essential steps towards executable EsD projects" (All, 60 min)