

IESP-8 Working Group on:

Revolutionary Approaches

Approaches for Delivering Disruptive New Technology

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**CENTER FOR RESEARCH
IN EXTREME SCALE
TECHNOLOGIES**

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What is “Revolutionary”?

- Decoupled from conventional practices
- Exploitive of ideas (new?) not incorporated in traditional thinking
- Benefits from new opportunities that can only be exploited through non-typical means
- Dramatic change, with potentially disruptive consequences
- Inappropriate if near equivalent results may be realized through incremental progressions
- Essential if offers only viable path to achieving critical goals
- Controversial, risky, and unpopular
- May be less risky than ineffective application of common strategies



Summary from IESP-7 (Cologne)

Working Group on Revolutionary Approaches

- Considered revolutionary methods potentially essential to addressing strategic challenges to Exascale
- Principal focus
 - High impact candidates for revolutionary methods
 - Disruptive effects and means of mitigation
- Challenges that may require revolutionary solutions
 - Efficiency, scalability, resilience, power, programming, correctness
- Possible revolutionary opportunities
 - Paradigm, execution model, runtime system, intelligence/introspection
 - Programming: semantics of parallelism and asynchrony control



Strategic Challenges

- Performance
 - Efficiency: latency, overhead, contention
 - Scalability: starvation, resource management, scheduling
- Energy
 - Bounded power
 - Minimized energy
- Reliability
 - Continued operation in the presence of faults
- Programmability
 - System transparency
 - Portability across system classes, scales, and generations
- Generality
 - STEM
 - Knowledge management and understanding



Concepts towards a new Paradigm

- Split-phase transactions
 - Avoid blocking
 - e.g., lightweight multi-threading
- Message-driven computation
 - Move work to data
 - Parcels and Percolation
- Constraint-based synchronization
 - Declarative criteria for work
 - Event driven
- Data-directed execution
 - Merger of flow control and data structure
 - Exploits intrinsic parallelism implicit within meta-data structures
- Shared name space



Working Group Charter

- Determine approaches for delivering disruptive new technologies.
- Establish how to devise a full system software architecture.
- Who are the recipients?
- What are the delivered technologies required and their form?
- How to mitigate disruptive aspect (non-traditional) of new technologies to facilitate processing of legacy codes?
- Next steps?



Preliminary Modalities of Delivery

- Concepts
 - Paradigm
 - Execution model
 - Abstract machine model
 - User interface semantics
- Research
 - Theoretical findings
 - Emulations and simulations
 - Experimental results
- Proof-of-concept prototype systems
 - API
 - Runtime and operating system software
 - Architecture and hardware design
 - Physical components and deployed systems



Production-grade Modalities of Delivery

- Open-source reference implementation
- Community provided tools
- Independent software vendor developed & maintained
- Vendor-provided commercial total system products



Today's Discussion Topic

- Who are the customers for such disruptive software technologies?
- What are the possible general strategies?

