IESP-8 Working Group on:

Revolutionary Approaches
Approaches for Delivering Disruptive New Technology

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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?