Co Design breakout session

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Need for Co-design

• Basic assertion: Both architectures and algorithms will change dramatically in this decade

• Need a new methodology to enable algorithms R&D for supercomputers that don’t yet exist, are much different from today and are not well-defined

• Reaching Exascale will require architectures R&D
  – Need to provide feedback on choices, prioritize investments
Co-design Breakout

- Co-design centers
- Can we really influence microprocessors, memory, architectures?
- Codesign methodology
- Co-design and the software stack
- International collaboration
Co-design Centers

• US
  – 3 initial ASCR co-design centers
  – ASC co-design centers being defined
• Europe
  – Intel labs, CERFACS, Juelich simulation labs, HP2C, Cresta
• Japan
  – 3? co-design subject areas being identified
• China
  – Significant focus for the future
• How and when to involve the vendors. Need >5yrs to impact processors, several years to impact system architectures and software.
• Will applications change in a fundamental way? General sense was yes.
Can we really influence microprocessors, memory, architectures? Generally HPC is important..

- When do key decisions need to be made? Next two years to influence research for 2018 processors.
- What information would help make these decisions? Kernels (early) to full applications (later). Frequent communications.
- Cost. Must understand and leverage roadmaps.
- IP. Ability to do deep dive and develop abstractions.

Develop a realistic view with systems/applications (e.g., is 128 PB realistic?)
Co-design Methodology

- Kernel, skeleton, compact and full applications
  - Should represent breadth of applications
  - Current applications and future needs
  - Still need communication between communities
  - Must evolve through co-design (i.e., iteration)
  - Validation
Co-design Methodology

• Performance and other Tools
  – Automatically extracting kernels
• Performance models (analytical and semi-automated)
• Simulation and Emulation
  – Needed to develop applications/algorithms for future computers and to provide feedback on architectural choices
  – HW/SW co-simulation
  – Open tools that can interface to proprietary tools
  – Multiscale
  – Validation
Co-design and the Software Stack

• Reduce the number of software stacks
• Open source
• Sharing and coordination across the co-design centers
Co-design Methodology

- Opportunities for international collaboration
  - Applications/software/architectures communities need a forum to openly exchange information, lessons learned
  - Recommendation: Continue co-design methodology discussions within IESP
    - Standing breakout
    - Deep dive at next meeting from Europe, Japan and U.S.
Applications Inventory - 21

- **Magnetically Confined Fusion**
  - Ethier, Princeton PPL
  - Guenter, Jenko & Heinzel, Max Planck Inst.
  - Koniges, LBNL
  - Nakashima, Kyoto University

- **Molecular Dynamics**
  - Zhong, Supercomputer Center, CAS
  - Swaminarayan, LANL
  - Streitz, LLNL

- **Climate**
  - Aloisio, Univ. of Salento & CMCC

- **Combustion**
  - Sankaran (Messer), ORNL

- **Radio Astronomy**
  - Cornwell and Humphreys, CSIRO

- **Aerodynamics**
  - Keyes, KAUST & Columbia

- **Fluid Dynamics and Heat Transfer**
  - Fischer, ANL

- **Neutron Transport**
  - Siegel, ANL

- **Nuclear Fuel Assemblies**
  - Berthou, EDF

- **Aerodynamics and Combustion**
  - Andre, CERFACS

- **HEDP and Rad Hydro**
  - Graziani, U Chicago
  - Messer, ORNL

- **Electronic Structure**
  - Scheffler, Blum, Heinzel, Fritz-Haber-Inst.
  - Eisenbach (Messer), ORNL
  - Harrison, ORNL