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.

Architectures

- 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 methodolgy 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