Panel:
Many-Task Computing meets Exascales

Chairs
Ioan Raicu, Illinois Institute of Technology & Argonne National Laboratory
Ian Foster, University of Chicago & Argonne National Laboratory
Yong Zhao, University of Electronic Science and Technology of China, China

ACM MTAGS 2011
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Panelists

- ## Dr. Dan Reed
  - Corporate Vice President of Technology Policy and Strategy, Microsoft Res
  - Leader of the eXtreme Computing Group (XCG), Microsoft Research

- ## Dr. Jack Dongarra
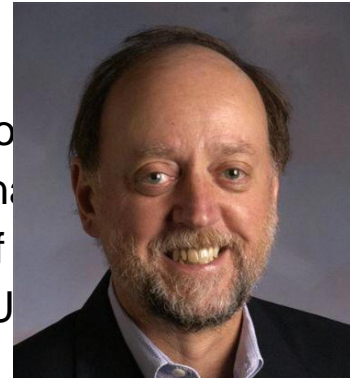 - University Distinguished Professor of EECS, University o
  - Distinguished Research Staff of CSM, Oak Ridge Nation
  - Director, Innovative Computing Laboratory, University of
  - Director, Center for Information Technology Research, U

- ## Dr. Dan S. Katz
  - Director of Science, TeraGrid GIG
  - Area Co-director for Applications, Open Grid Forum
  - Senior Fellow in the Computation Institute, University of

- ## Dr. David Abramson
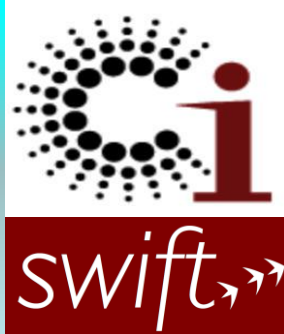 - Professor of CS, Monash University, Australia
  - Director, Monash eScience and Grid Engineering Lab, M   Australia
  - ARC Professorial Fellow, Faculty of Information Technol   ersity, Australia

Dan S. Katz: Many Task Computing for Exascale

- DOE X-stack project: ExM: System support for extreme-scale, many-task applications
- Extending the Swift programming model (http://www.ci.uchicago.edu/swift)
  - Script-based, no explicit DAG – control flow is based on data flow ("futures")
  - Swift engine reads script, turns all function calls into parallel tasks; dispatches tasks when inputs become available, runs tasks on dynamically acquired resources
  - Execution is RPC-like: transfer input, run code, transfer output
- in these areas:
  - Tasks
    - JETS: dynamically run multiple MPI tasks on an HPC resource (treats MPI jobs as atomic functions)
    - Looking at tasks that are functions rather than executables: extending the programming model to in-memory activities; pass data by message in addition to via files
  - Execution
    - Developing Turbine distributed execution engine: fully parallelizes program *evaluation*
  - I/O
    - MosaStore: intermediate file storage; use files for message passing, but stripe them across RAMdisk (or fast local filesystem) on nodes (single distributed filesystem w/ shared namespace), backing store in shared file system, potentially cache in the middle
    - AME: intermediate file storage; use files for message passing, but store them in RAMdisk on nodes where written (multiple filesystems w/ multiple namespaces), copy to new nodes when needed for reading; integrates file exchange and task dispatching
    - Collective data management (build primitives for common operations to bundle I/O ops and take advantage of HPC/site hardware, e.g. BGP I/O nodes), hardware broadcast, fast scatter/gather

MTAGS11: Panel -- Many-Task Computing meets Exascales

Jack Dongarra:
Critical Issues at Peta & Exascale for Algorithm and Software Design

- Synchronization-reducing algorithms
  - Break Fork-Join model
- Communication-reducing algorithms
  - Use methods which have lower bound on communication
- Mixed precision methods
  - 2x speed of ops and 2x speed for data movement
- Autotuning
  - Today's machines are too complicated, build "smarts" into software to adapt to the hardware
- Fault resilient algorithms
  - Implement algorithms that can recover from failures/bit flips
- Reproducibility of results
  - Today we can't guarantee this. We understand the issues, but some of our "colleagues" have a hard time with this.

Dan Reed
Many Task Computing, Clouds and Exascale

- Technical computing rides the commodity ecosystem
  - The tail follows the dog, not the other way around
- Commodities
  - Hardware (by volume): low power multicore and SoCs
  - Software: toolkits, domain specific languages, cloud services
  - Data: multidisciplinary, high volume, third parties

- Clouds, many task computing and toolkits
  - Let scientists be scientists, not programmers
    - Raise the level of abstraction
  - Trade performance for usability and expressiveness
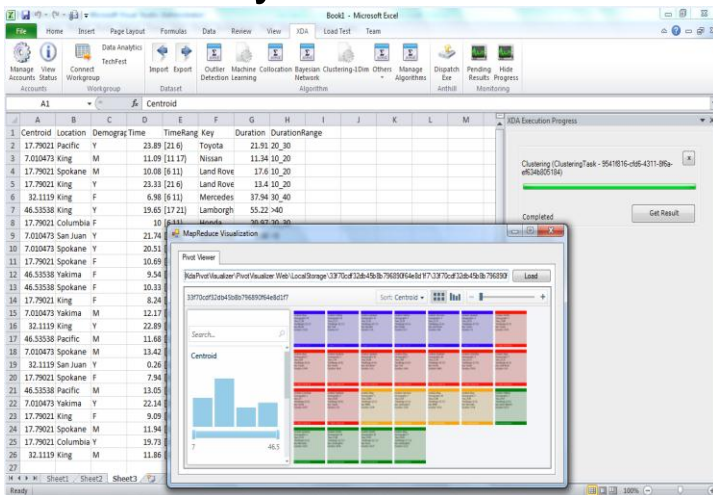   - Hide details of failures, scheduling, …

Clouds , Data **and Devices**

Dan Reed
# Clouds and Many Task Technical Computing

Similar technology issues

- Node and system architectures
- Communication fabrics
- Storage systems and analytics
- Physical plant and operations
- Programming models
- Reliability and resilience

Cultural Differences

- Resource scheduling
  - Gang scheduling and provisioning
- Network performance
  - Virtualization and networks
  - High performance interconnects
- Accelerators and virtualization
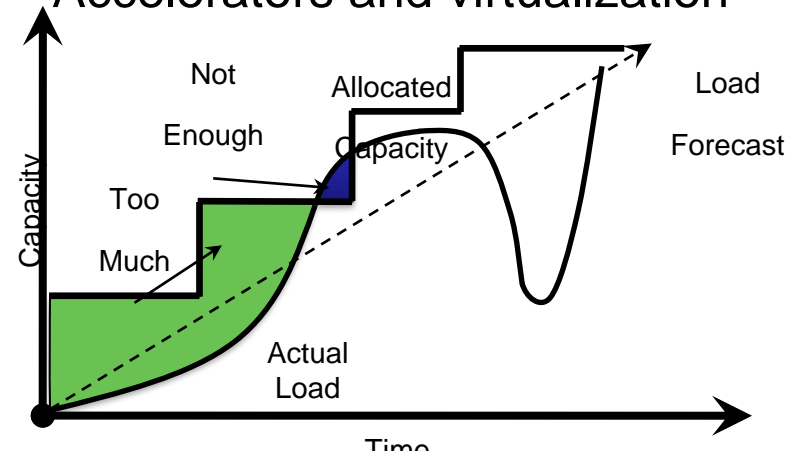
Panel Overview

- **What is Exascale Computing, and what are the major challenges?**

- **Is a Data-Centric Paradigm inevitable?**

- **Is Many-Task Computing a viable programming paradigm for exascale computing?**

What is Exascale Computing, and what are the major challenges?

- What can we expect exascale systems to look like?

- What are the major challenges of exascale computing?

Is a Data-Centric Paradigm inevitable?

- Exascale computing will bring new fundemental challenges in:
  - How we build computing systems (e.g. architecture),
  - How we manage them (e.g. operating systems, middleware, and storage)
  - How we program them (e.g. programming languages)

- Process-centrics ➔ Data-centric Computing
  - Exposing data locality throughout the computing stack

Is Many-Task Computing a viable programming paradigm for exascale computing?

- MTC might address some of the HPC shortcomings at extreme scales (e.g. reliability, programmability)
- Loosely coupled computations (asynchronous vs synchronous communication),
- Reliability mechanisms (implicit independent checkpointing vs. explicit synchronized checkpointing),
- Data-centric vs. process-centric

More Information

- MTAGS 2011 Website:
  - http://datasys.cs.iit.edu/events/MTAGS11/
- Panel info:
  - http://datasys.cs.iit.edu/events/MTAGS11/panel.html
- Workshop program (7 exciting talks in the PM)
  - http://datasys.cs.iit.edu/events/MTAGS11/program.html
- Prize giveaway (win an Apple iPad 2):
  - http://datasys.cs.iit.edu/events/MTAGS11/prize.html
- Contact:
  - mtags11-chairs@datasys.cs.iit.edu