Opinions on the State of Production Distributed Infrastructure (PDI)

Daniel S. Katz (dsk@ci.uchicago.edu)
Senior Fellow, Computation Institute (University of Chicago & Argonne National Laboratory)

(all the following are personal opinions only)
State of the Art in PDI

- PDI - a distributed set of computational hardware and software that is intended to allow multiple people who are not the developers of the infrastructure to do something useful
- Three types of PDI exist:
  - Academic/Public Production (aimed at science)
    - TeraGrid/XSEDE, DEISA (HPC), OSG, EGI (HTC), Open Science Data Cloud (cloud), etc.
  - Academic/Public Research (aimed at computer science)
    - Grid5000, DAS, FutureGrid, PlanetLab, etc.
    - Open question – how to transition lessons to production
  - Commercial (aimed at whoever will pay)
    - Amazon (IaaS), Microsoft (Paas), perhaps SGI, Penguin (HPCaaS)
- In addition, lots of other components that may not be integrated together:
  - Campus clusters (HPC), campus Condor pools (HTC)
- All seem to do what they were designed to do reasonable well
- Note: this view is mostly by funding and purpose
- Note: Could also view by interface:
  - Command-line, grid (Globus, Condor, etc.), cloud
User View of PDI

- **Need to answer:**
  - **Application developers:**
    - How do I develop an application?
    - What is the model?
    - How do I deploy an application?
    - Particularly hard for HPC
  - **Applications users:**
    - How do I find an application?
  - **Application builders:**
    - How do I compose an application?
    - First need to find components...
  - **In all cases:**
    - How do I execute an application?
Open Challenges (in R&D, code, support, and/or policy)

• Goal – deliver maximum science (at minimum cost?)
  – Note – sustainability seems to be a hot topic, but it seems to be defined as: useful work should continue to be done, with someone else paying for it

• 2 views of this?
  – What are the components of infrastructure?
    o Hardware (nodes, interconnect, storage, network), software (system software, middleware, tools/libraries, applications), training (material, people), support (people), integration into PDIs
  – What’s the vision of “the” PDI?
    o For those who build the infrastructure components, what is the architecture?
    o For applications people, what is the abstraction of the PDI?
Open Challenges (in R&D, code, support, and/or policy) (1)

- **Issues**
  - How measure delivered science
    - We don’t really know how to do this – we can measure papers (w/a small time delay) or citations (w/ longer time delay)
  - How to develop the infrastructure/tools that will best do this
    - I think we are doing reasonably well at this at an individual infrastructure/tool level—we identify things that users want to do, then provide tools/systems that let them do these things—but it’s not clear that we ever solve the whole integrated problem
  - How to integrate them
    - We can do this on a piece-by-piece basis, but don’t really know how to do this in general (maybe because we don’t have a single vision for where we are going)
    - Note that if we can do this, we can then allow the pieces to compete
Open Challenges (in R&D, code, support, and/or policy) (2)

• Issues
  – How to represent users
    o Large projects have the ability and opportunity to express their needs; small projects and individual users are often not represented
  – Role of virtualization in HPC
    o HPC executables are not portable now, but could be with virtualization
    o But virtual HPC applications don’t perform well (I/O, network issues)
  – How to build the application programming system that matches the abstract PDI?
    o We’ve had a nice run of ~20 years with the MPI model, which assumes a platform abstraction of interconnected nodes, each with CPUs and memory
Path Forward

- Greatest need is a single vision that defines the overall goal
  - NSF has CIF21 (http://www.nsf.gov/pubs/2010/nsf10015/nsf10015.pdf) which calls for such a vision, and 6 tasks forces that have created reports
  - DOE seems more focused on single large systems, and less on integrating them into an infrastructure
  - Some other US agencies looking at clouds, but not distribute computing in general
  - I haven’t seen a European vision that includes integration of all PDIs, though the UMD implies one for HPC and Grids

- and is flexible enough to allow groups to work towards that goal in various ways
  - Should define metrics (to enable progress to be measured and see which work is most useful)
  - And an overall architecture with interfaces
    - OGF is trying to do some of this, but without sufficient US buy-in

- DARPA funded effort in understanding user productivity in HPCS – but no one is doing this for PDIs
Acknowledgements

• First slide (and probably some other thinking) is based on chapter 3 of upcoming book:

• And technical report that’s coming sooner:

• And related eSI research themes (DPA and 3DPAS)