Panel

Shaping the Future of Distributed Computing: Bottom up, or Top down

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Institute for the Future of Data and Computation

Cultivating the information **capabilities** and **trust** needed to address grand challenges

New UArizona institute focuses on making sense of data

Led by a University of Arizona alumnus, the Institute for the Future of Data and Computing also will explore the societal questions driving how and why data is used.

Research, Innovation & Impact
May 4, 2022

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Infrastructure: Deploying the information resources needed for research

Workforce: Growing peer communities and industrial partnerships

Sustainability: Developing business models needed to sustain infrastructure and artifacts

Informed: Integrating cognitive and social sciences to build ethically informed systems

Foundations: Creating virtuous cycles supporting use-inspired foundational research

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Distributed Systems

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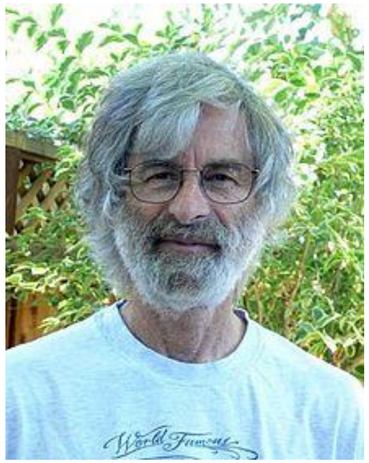

“A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable.”

Leslie Lamport, 1986

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What is a “Distributed” Data Processing System?

Philip H Enslow, Jr., **IEEE Computer** (Volume: 11, Issue: 1, January 1978)

Definition (essential characteristics)

- A *multiplicity* of general-purpose resource components, including both physical and logical resources, that can be assigned to specific tasks on a dynamic basis. Homogeneity of physical resources is not essential.
- A *physical distribution* of these physical and logical components of the system interacting through a common network.
- A *high-level operating system* that unifies and integrates the control of the distributed components. Individual processors each have their own local operating system, and these may be unique.
- *System transparency*, permitting services to be requested by name only. The server does not have to be identified.
- *Cooperative autonomy*, characterizing the operation and interaction of both physical and logical resources.

Benefits

- High system performance, fast response, high throughput
- High availability
- Reduced network costs
- Graceful degradation (fail-soft capability)
- Ease of modular, incremental growth and configuration flexibility
- Resource sharing
- Automatic load sharing
- High adaptability to changes in world load
- Incremental replacement and/or upgrading of components (both hardware and software)
- Easy expansion in both capacity and function
- Easy adaptation to new functions
- Good response to temporary overloads

Critical issue: the need to span ***multiple administrative domains***

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Classic Bottom-up Approach

- Build the system by assembling from available components
- Potential for heterogeneity in hardware and local operating systems
- Incremental growth, incremental upgrades

“Federated Instruments”

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An Alternate Conceptualization (Top-down)

- Single systems are becoming too large to fit into a single facility
  - Can’t continue growth in power, space, and cooling
  - Instruments generate large amounts of data, requiring local computation
- Potential for campus-wide interconnects
- HPC gets pushed to scientific instruments or instruments/data pulls HPC

Nodes/Cabinets of an HPC system are pushed and pulled to the “edge”

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Déjà vu, All Over Again

- Parallel programming was generally expected to be a small number of tasks
  - Each task had a specific purpose
  - Coordination (synchronization) of tasks was critical
- Massively parallel processing, and the emphasis on **scale**, changed our perspective
  - SPMD: Single Program Multiple Data
  - BSP: Block Synchronous Programming (“naturally synchronized” by boundary exchanges)
- Aside: will Extreme Heterogeneity lead to a “reversion to the mean”?

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The Panel

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Charge questions for the panel

- Which approach, bottom-up or top-down, is most likely to shape the future of distributed computing?
- To what extent will (should) economic considerations drive the future of distributed computing?
- To what extent does the notion of technology refresh rate factor into how distributed systems should be built?
- To what degree will developments in interconnect technologies, possibly including wireless technologies, be important in shaping this future?
- To what degree will the required software infrastructure be critical in shaping this future?

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Panelists

- Sadaf Alam, CSCS (Swiss National Supercomputing Center)
- Debbie Bard, Lawrence Berkeley National Laboratory
- Norbert Eicker, Jülich Supercomputer Center
- Rich Graham, Nvidia/Mellanox

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