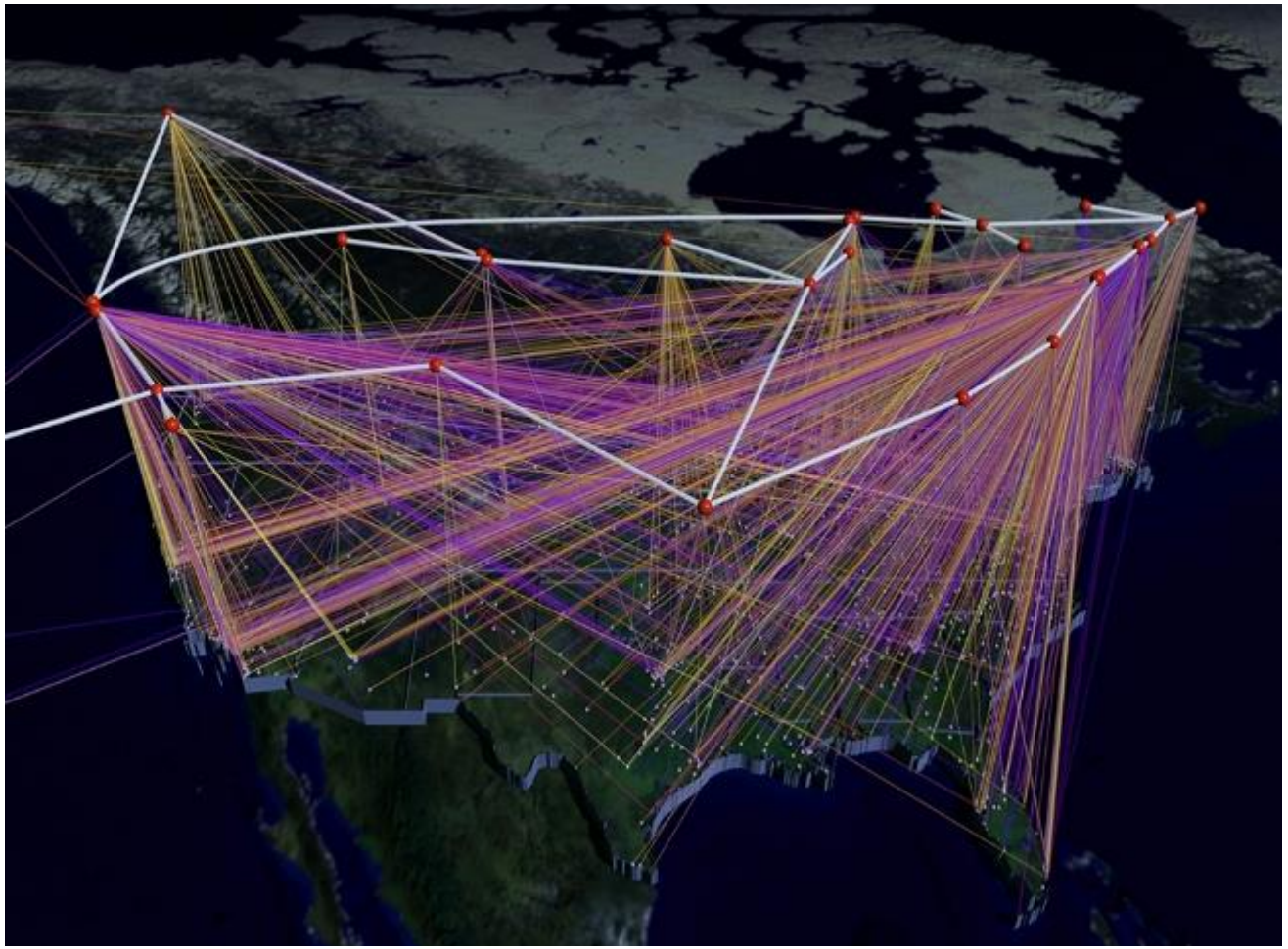
Sustainable cyberinfrastructure:
Go fast alone or go far together



Source: Donna Cox (NCSA)

IMAGINE

Dan Reed

Senior Vice President for Academic Affairs

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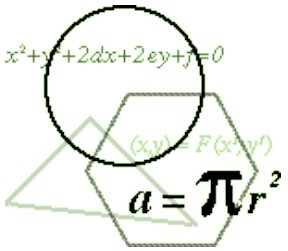
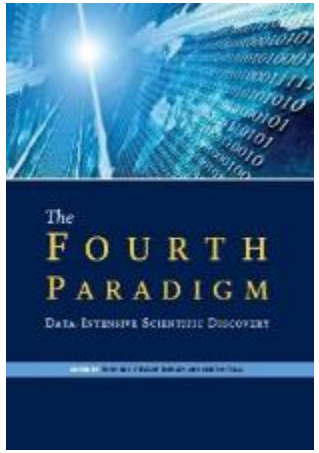
www.hpcdan.org

@UofUProvost
@HPCDan

The changing nature of research and scholarship

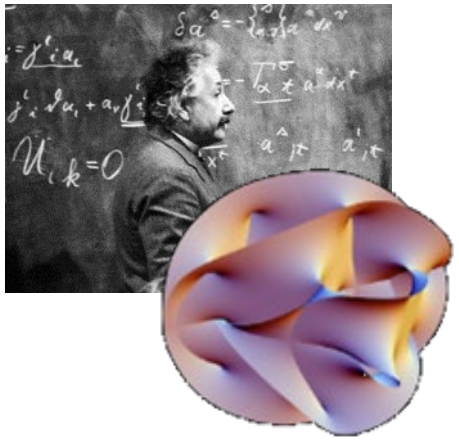


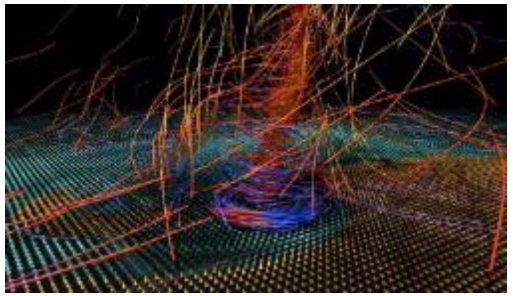
$$H(t)|\psi(t)\rangle = i\hbar\frac{\partial}{\partial t}|\psi(t)\rangle$$



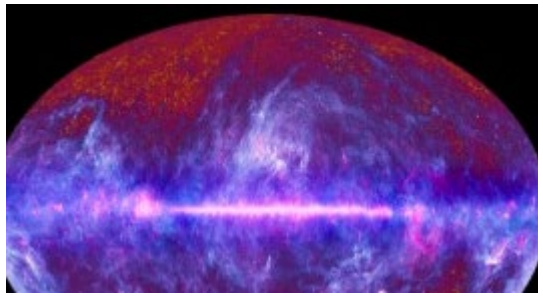
Experimental Theoretical Computational Data Exploratory

Large Hadron Collider





Severe Storm Model (NCSA)



ESA Planck Sky Survey

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Generation after generation: paradigm shifts

The purpose of computing is insight, not numbers.
Richard Hamming

HPC → Deep Learning → Edge AI

Vector Supercomputers
Cray-1

Shared Memory Multiprocessors
SGI Power Challenge

Massively Parallel Processors
TMC CM-5

Linux Clusters

Accelerated Clusters
ORNL Summit

Edge + Deep Learning

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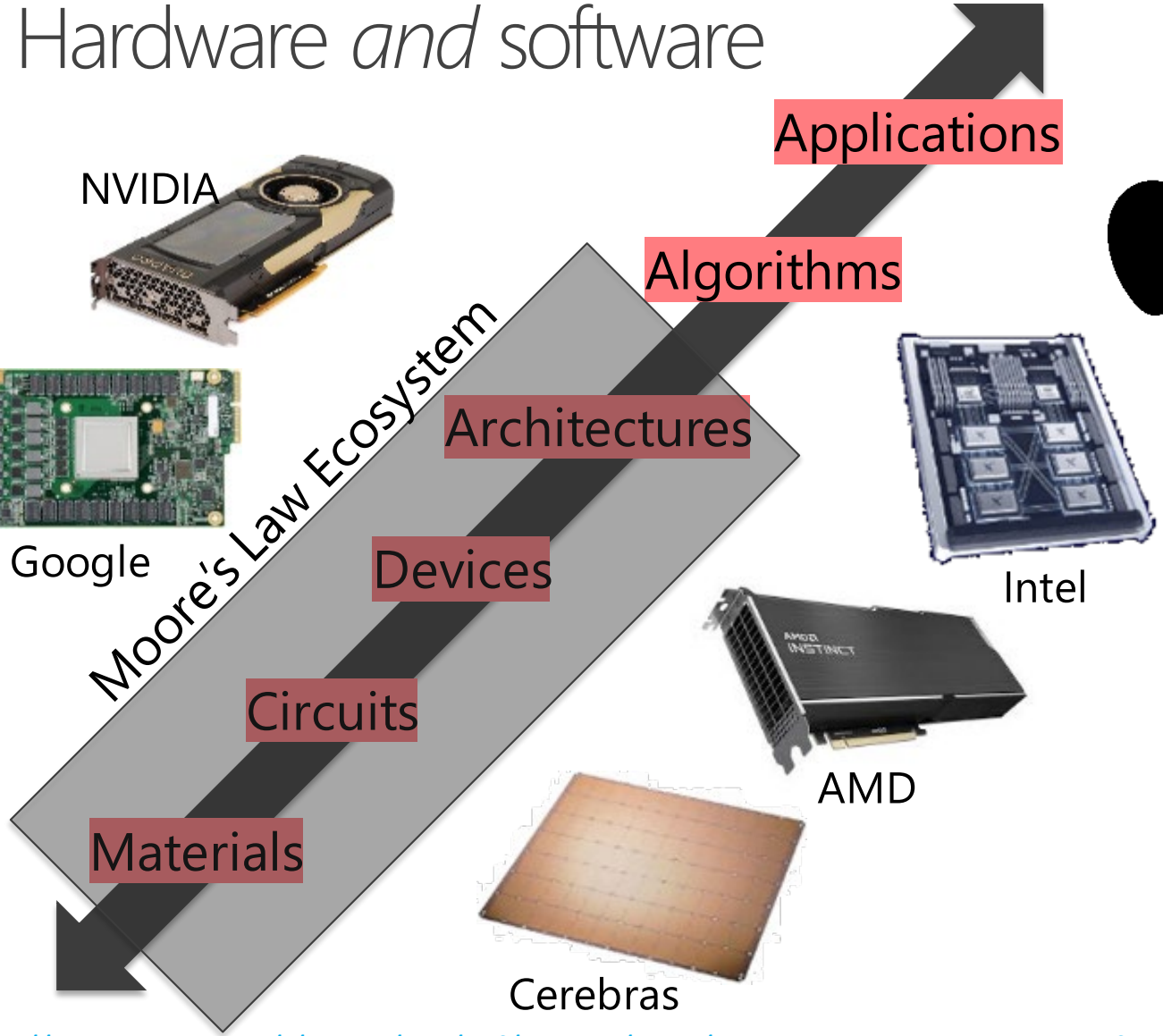
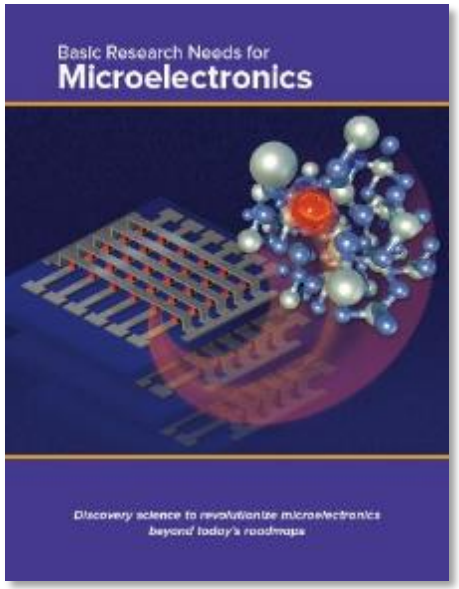
Even greater computing heterogeneity ahead:
Hardware *and* software



amazon web services™

Azure

Google Cloud



https://science.osti.gov/-/media/bes/pdf/reports/2019/BRN_Microelectronics_rpt.pdf
https://www.src.org/about/decadal-plan/

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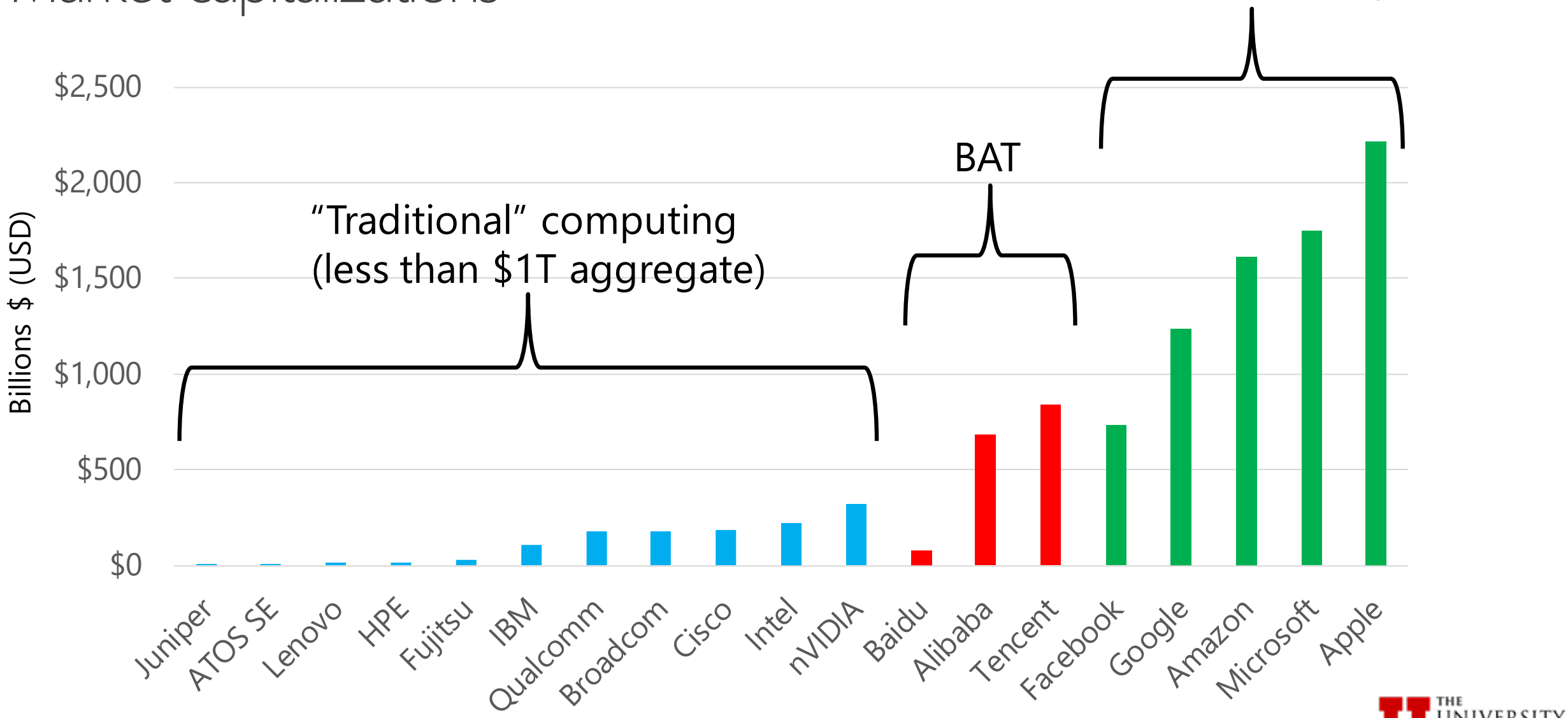
Our world has changed

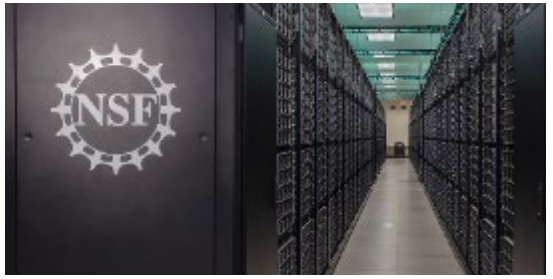
Market capitalizations



The science instrument continuum

BIG and FEW

Multidisciplinary Data Fusion & Modeling



SMALL and MANY

Vehicles

Array of Things

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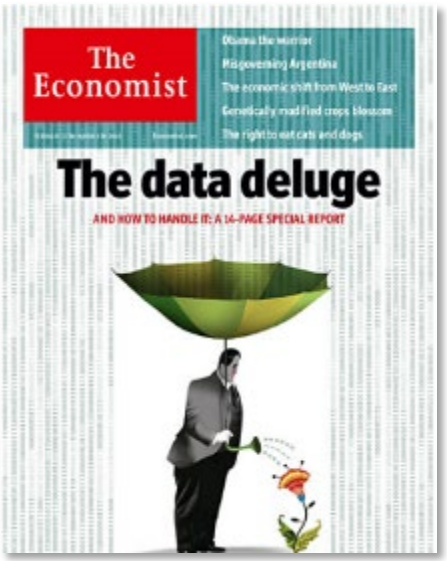
Sociology, markets and the data deluge



Known questions, the traditional approach

- I know the question and I have the data, but not the answer

Unknown questions, the big data approach

- **We** have data, but I do not yet know what it could tell me

Radical sociology shifts

- From *scarcity to deluge* and from *individual to common*
- FAIRness (findability, accessibility, interoperability, reusability)
- Provenance and triage (deaccession)

Data marketplaces and avoiding the *tragedy of the commons*

- Expose and bear true costs
- Develop curation and retention metrics (economic, social, technical)
- Create a metric-driven marketplace (sustainable and FAIR)

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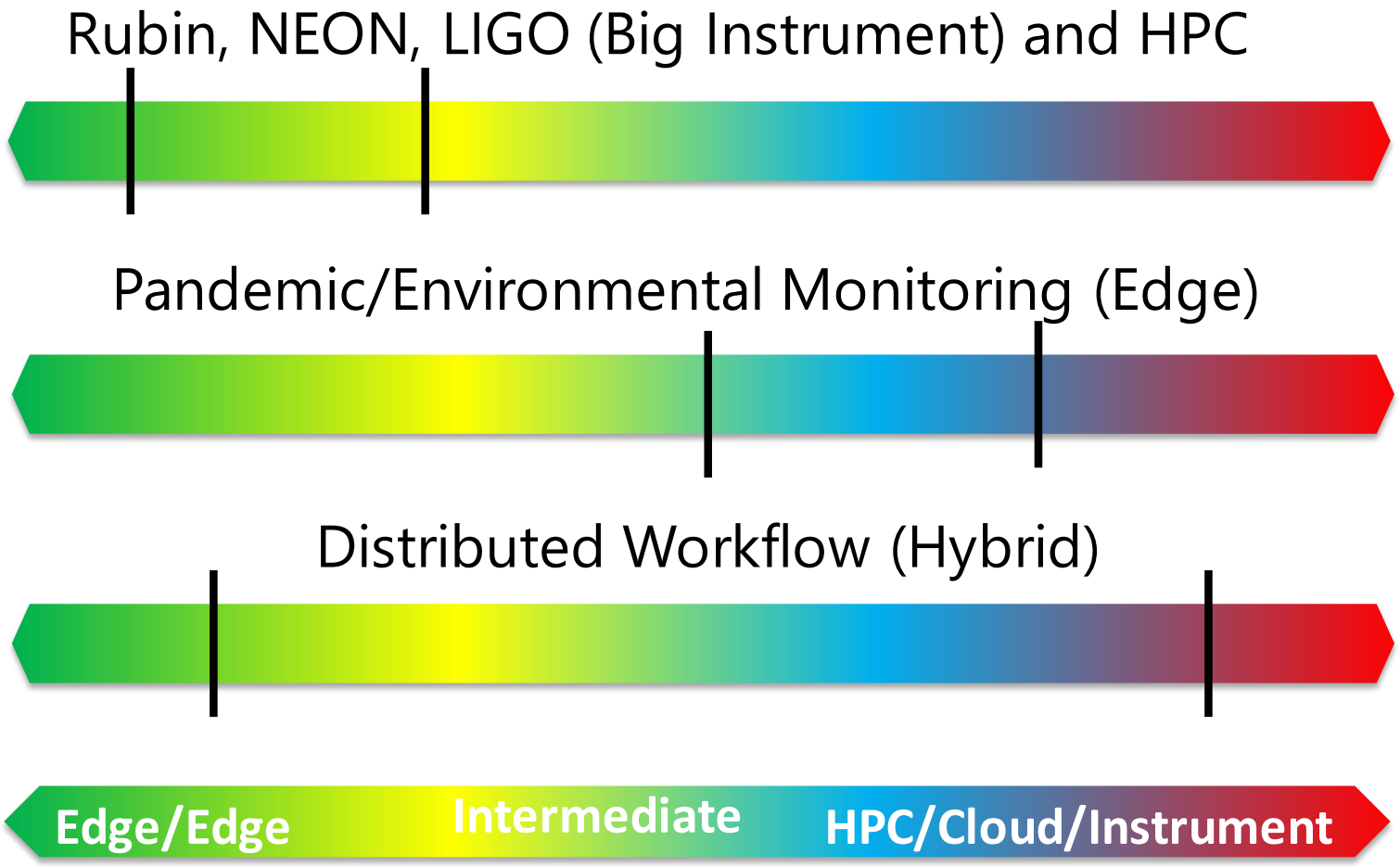
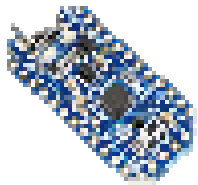
Building fluid/reusable cyberinfrastructure frameworks





EarthCube

Adaptively mapping
- What
- Where
- When

Subject to changing
- Speed
- Capacity
- Latency
- Resilience
- Security
- Interoperability
- …

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Sustainable cyberinfrastructure

EXASCALE COMPUTING PROJECT

Interoperability
Sustainability
Portability
Adaptability
Standards
Abstractions

Common culture
Shared community
Defined metrics
Recognized rewards
Decadal timescales
True costs

If you want to go fast, go alone. *If you want to go far, go together.*

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Workforce continuum and sustainability

Faculty

Publication Driven

Disciplines

Post-doctoral Researchers

Graduate Students

Support Staff

erinfrastructure Staff

Outcome Driven

Research staff and postdocs often have limited career paths in academia

Conversely, cyberinfrastructure staff have career options most faculty lack

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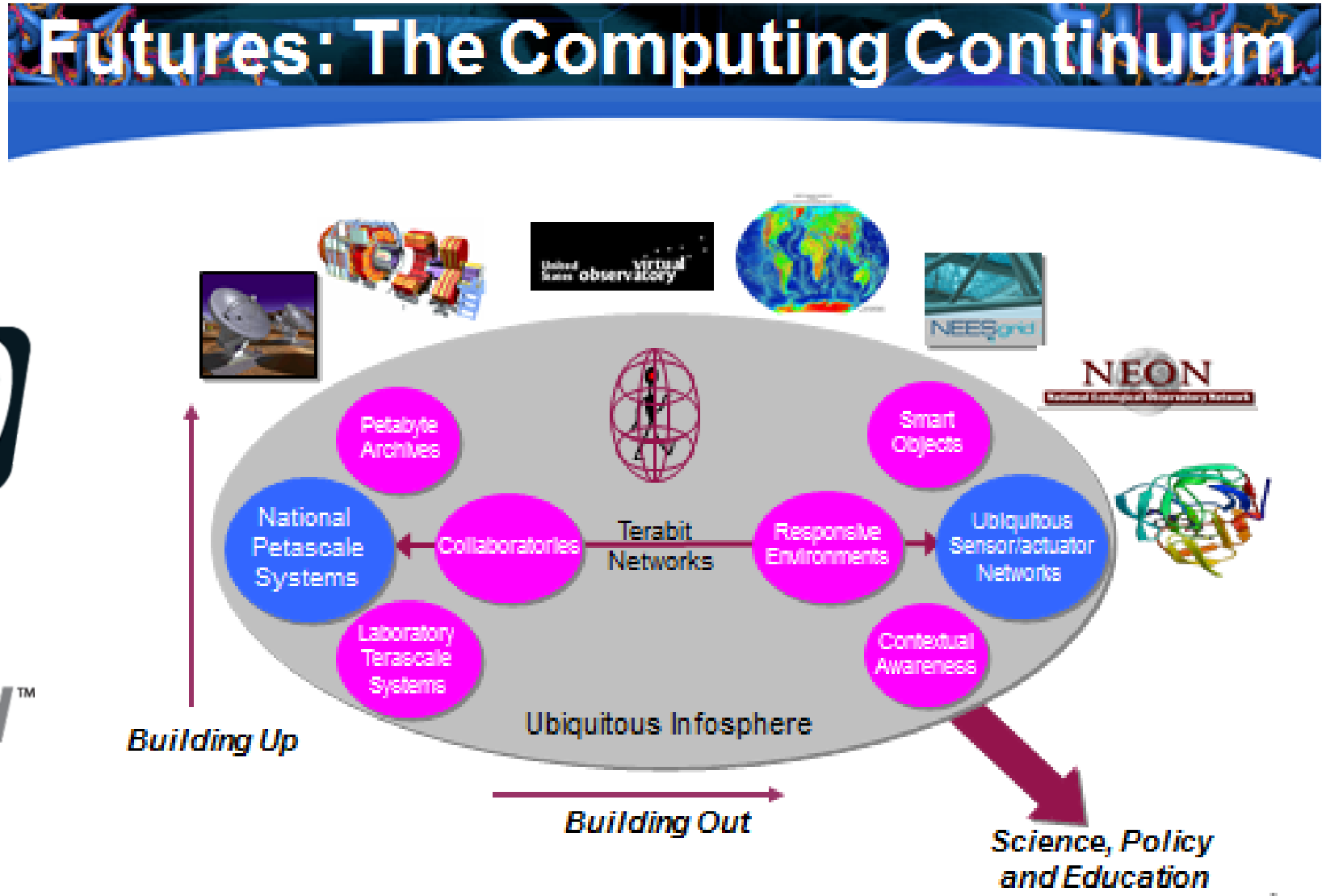
Not yet fully realized … my 2002 prediction



TeraGrid™

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