

Image Credit: Exploratorium.

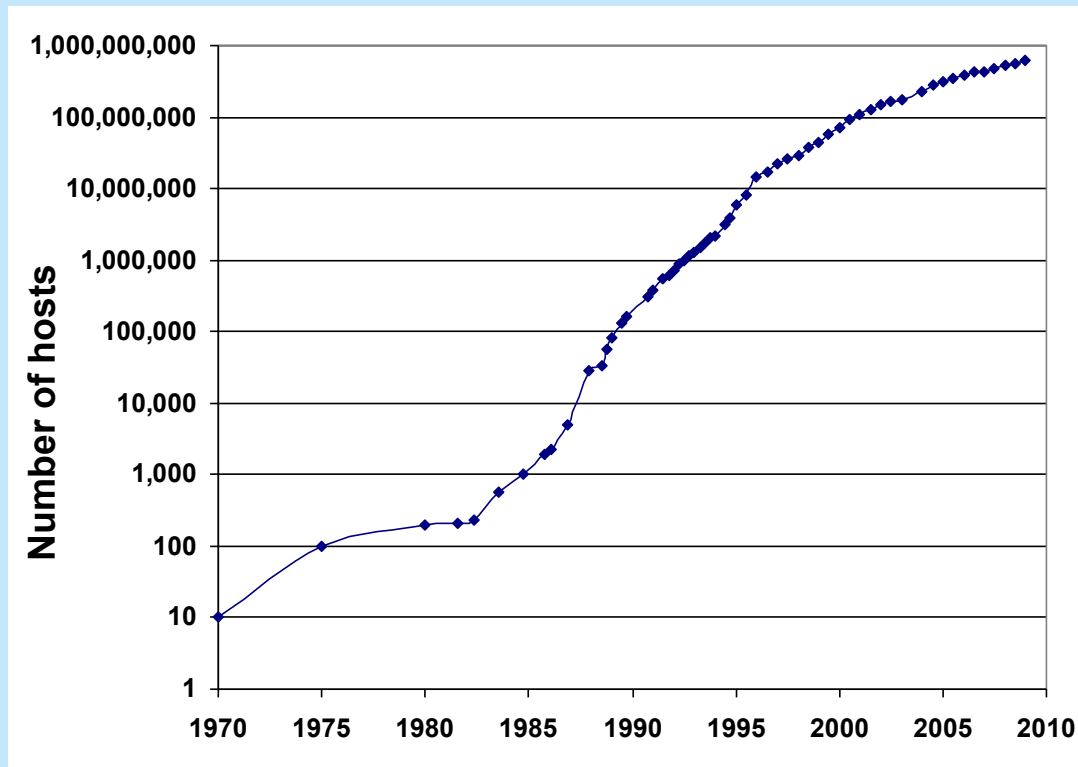
Emerging Trends in Dependability



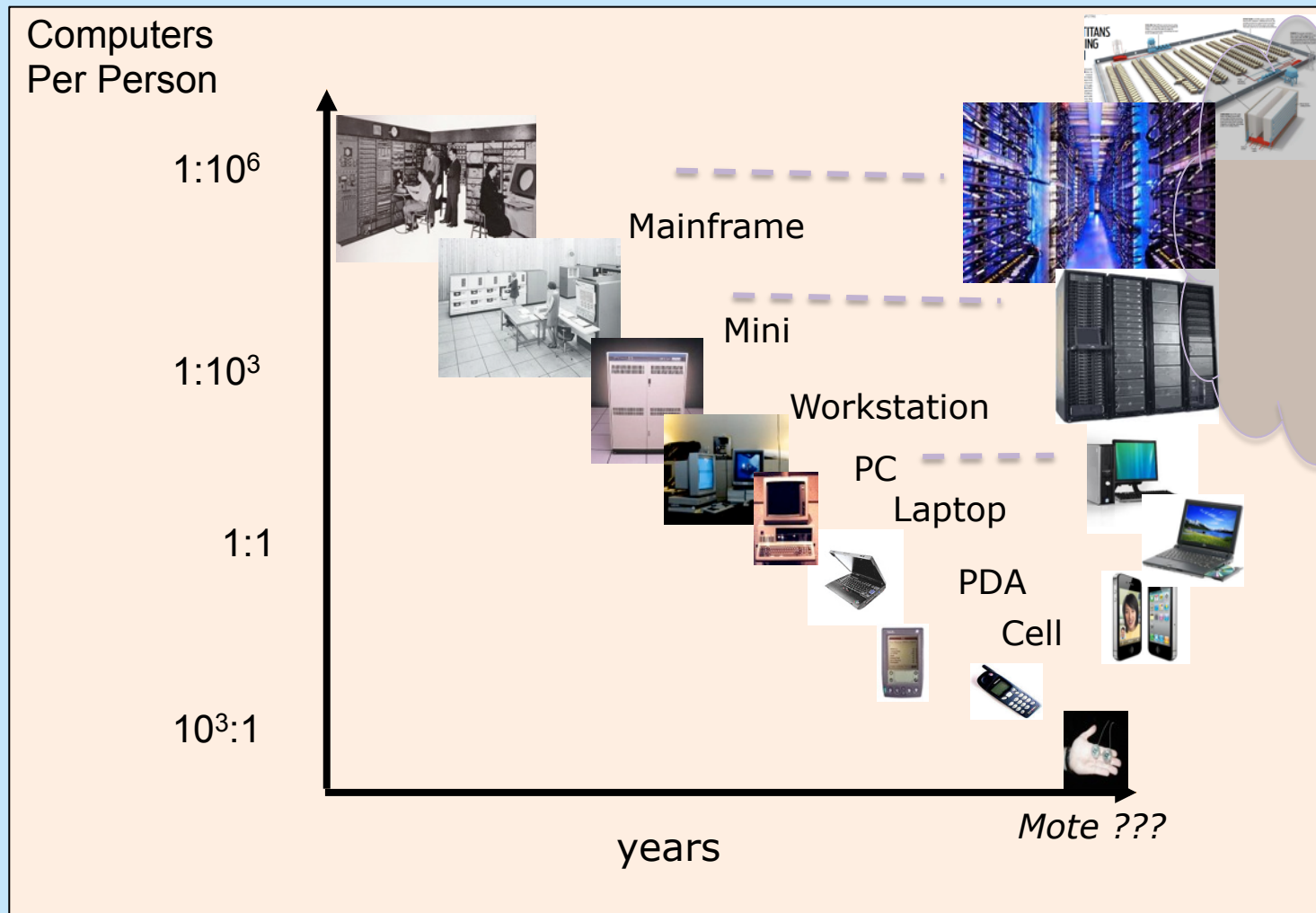
Farnam Jahanian
CISE Directorate
National Science Foundation



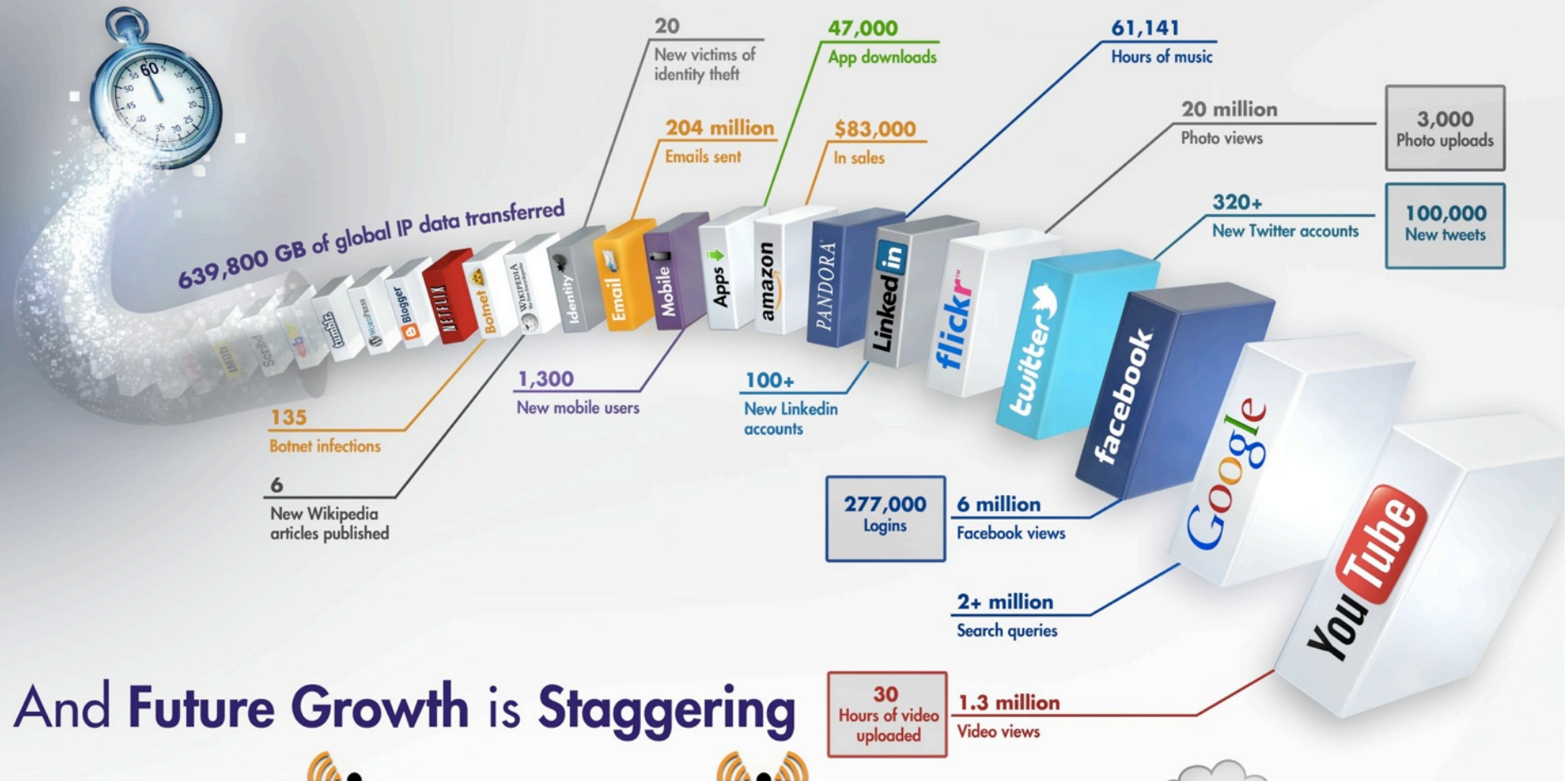
Same for the Internet



Bell's Law – due for a whole new class?



What Happens in an Internet Minute?



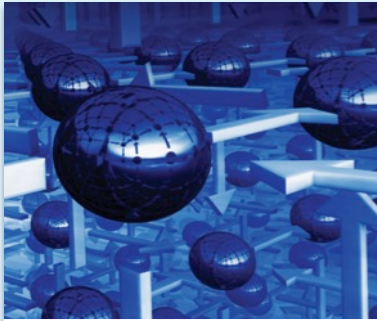
And Future Growth is Staggering



Credit: Intel Corporation



Emerging Frontiers



**Expanding the Limits
of Computation**



Data Explosion



**Universal Connectivity
and Clouds**



**Smart Systems:
Sensing, Analysis and
Decision**



**Augmenting Human
Capabilities**

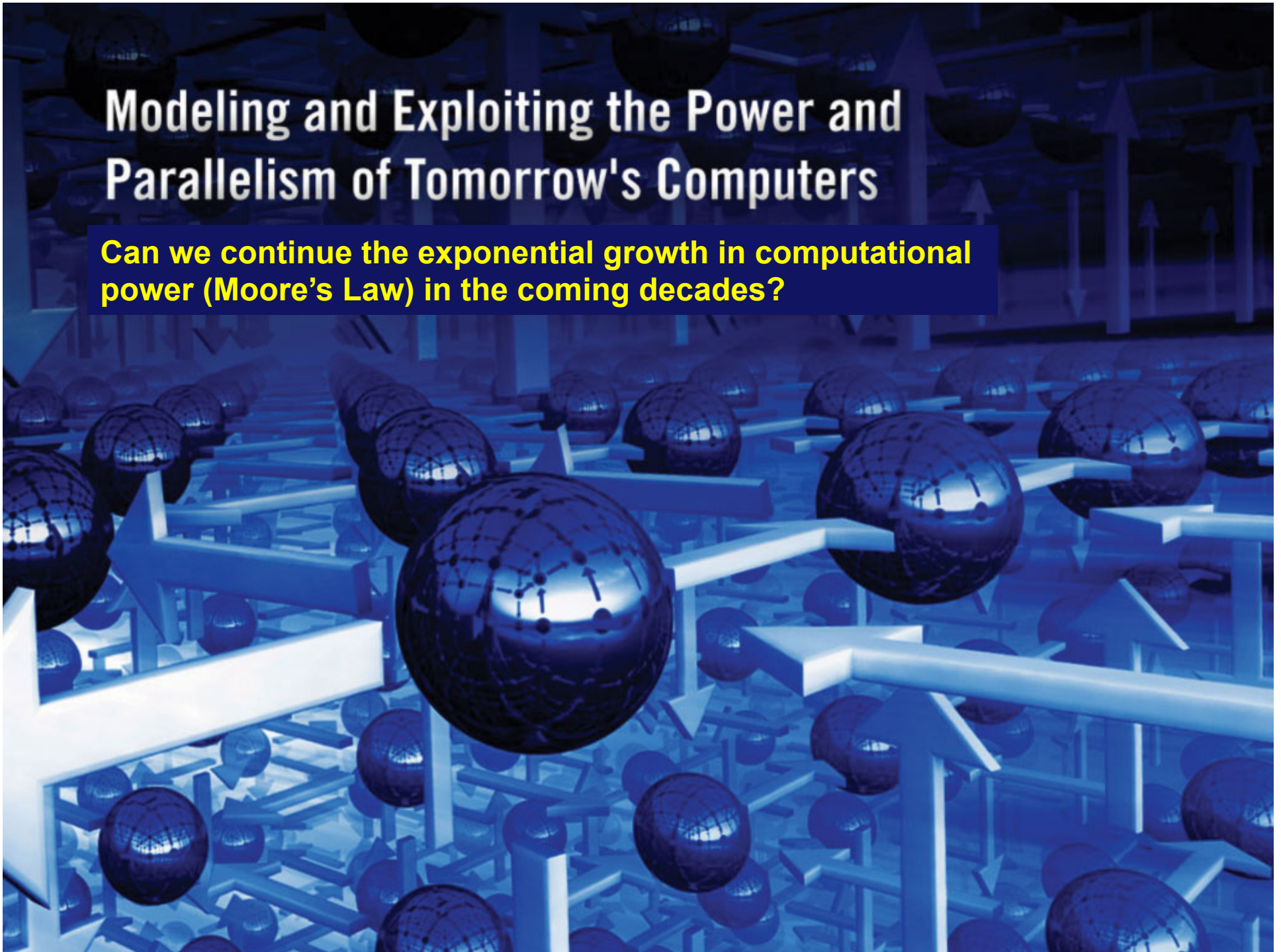


Secure Cyberspace



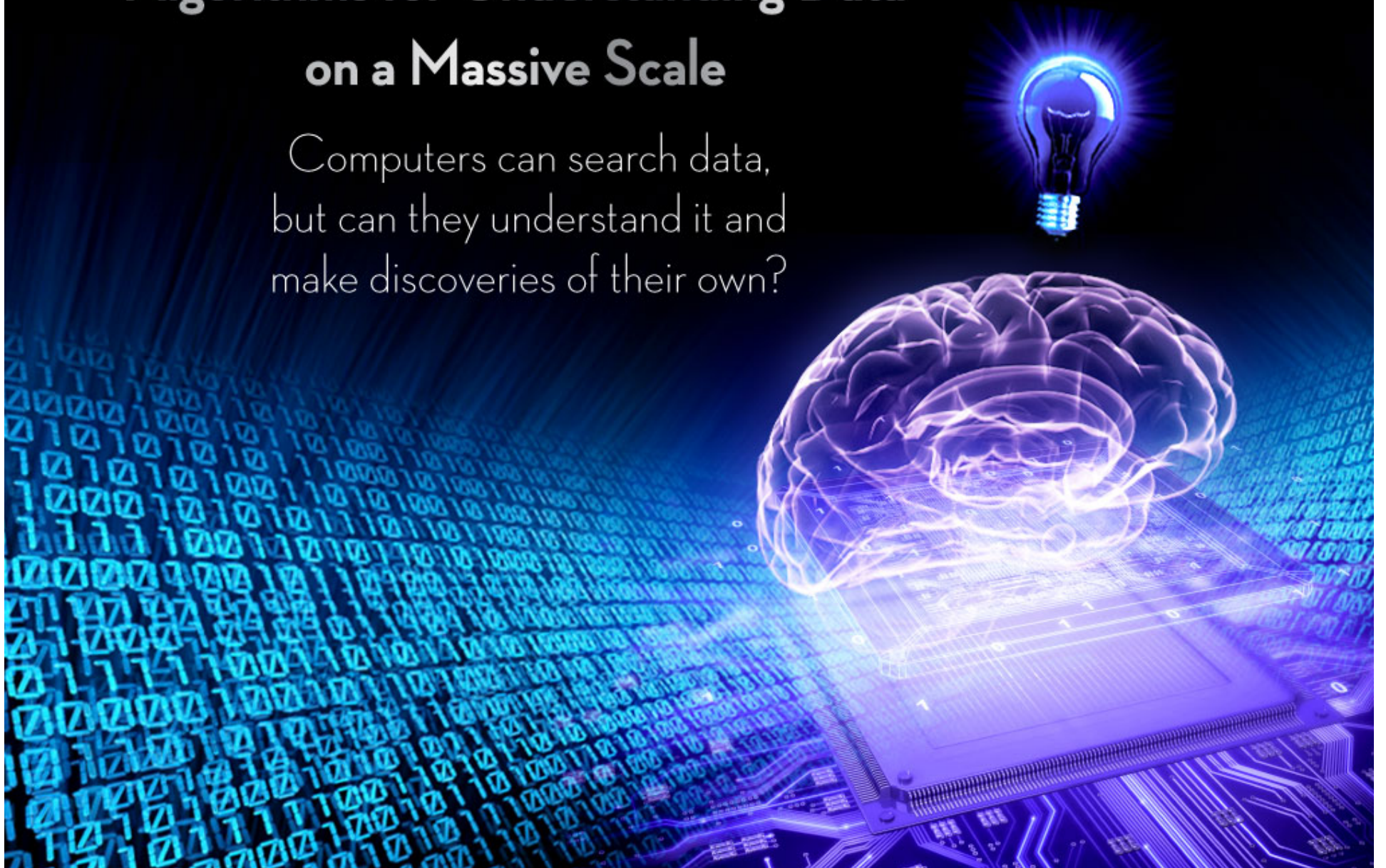
Modeling and Exploiting the Power and Parallelism of Tomorrow's Computers

Can we continue the exponential growth in computational power (Moore's Law) in the coming decades?



Algorithms for Understanding Data on a Massive Scale

Computers can search data,
but can they understand it and
make discoveries of their own?





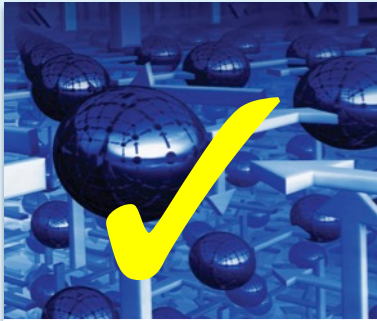
COMPUTING AS A COMMODITY:

Distributed Computing over the Global Internet

How do we enable secure, efficient, robust, and energy-aware access to resources in the cloud?



Emerging Frontiers



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Ubiquitous deployment of sensors

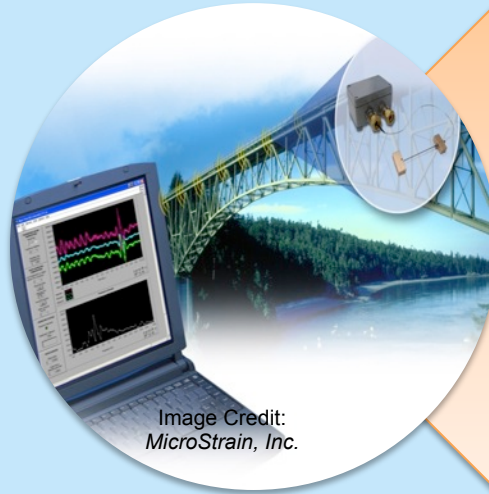
The melding of the cyber and physical worlds enables smart systems all around us.



How can we build and verify “dependable” systems upon which people can - and will - bet their lives?

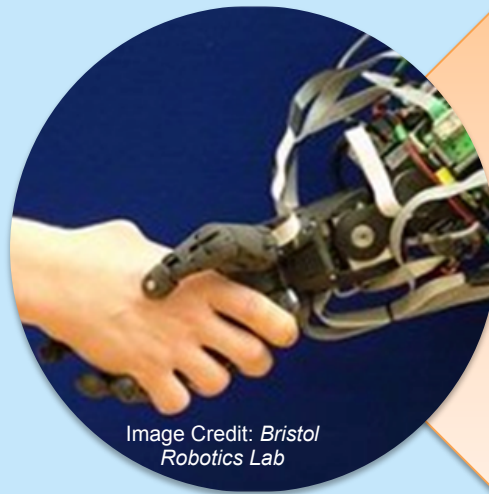


Research to Enable Smart Systems



Cyber-Physical Systems (CPS)

- *Deeply integrate computation, communication, and control into physical systems*
- Aspects of CPS include pervasive computation, sensing and control; networking at multi- and extreme scales; dynamically reorganizing/reconfiguring systems; and high degrees of automation
- Dependable operation with high assurance of reliability, safety, security, and usability



National Robotics Initiative (NRI)

- *Develop the next generation of collaborative robots, or co-robots, that work beside and cooperatively with people*
- A nationally concerted cross-agency effort among NSF, NASA, USDA, and NIH
- Initiative includes aim to understand the long-term social, behavioral, and economic implications
- Potential to enhance personal safety, health, and productivity

Application sectors



Transportation



Energy and Industrial Automation



Health and Medical Care



Critical Infrastructure



Augmenting Human Capabilities

Converging technologies for enhancing performance and quality of life

MEMEX

Evidence-based decision support

Procedural memory coach

Enhanced perception

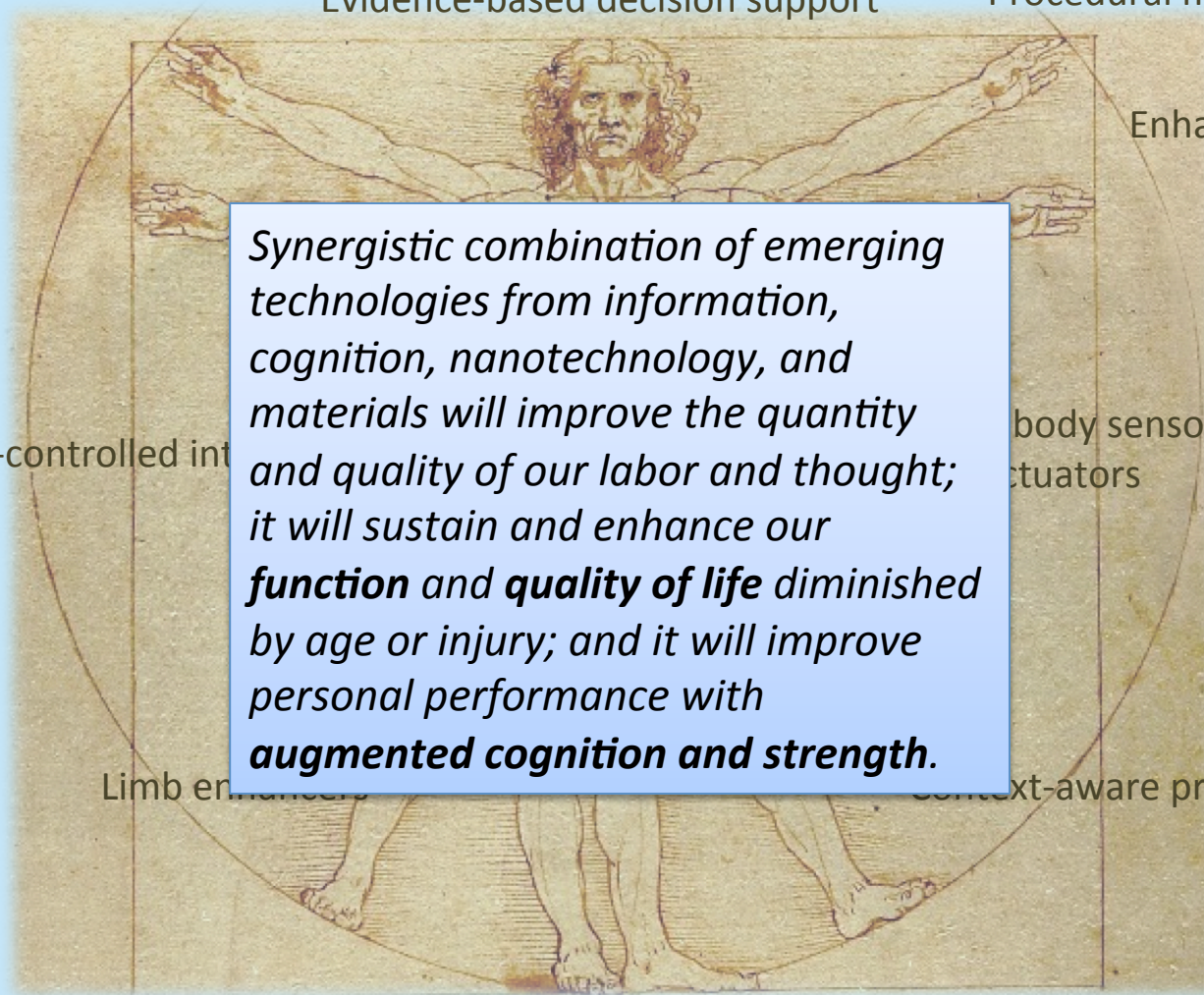
Brain-controlled int

body sensors
actuators

Limb enhancers

Context-aware prosthetics

*Synergistic combination of emerging technologies from information, cognition, nanotechnology, and materials will improve the quantity and quality of our labor and thought; it will sustain and enhance our **function** and **quality of life** diminished by age or injury; and it will improve personal performance with **augmented cognition and strength.***

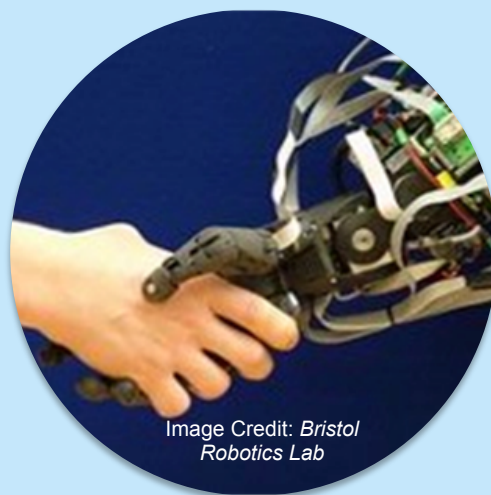


Augmenting Human Capabilities

must advance both the creation and our understanding of the complex and increasingly coupled relationships between humans and computing

Diverse Platforms

- mobile devices
- robots
- wearables
- Implanted devices



Varied Interaction Modalities

- displays
- haptic
- audio
- brain-machine interfaces
- science fiction



Range of Scales

- individual devices/single users
- collaborative groups
- large and evolving heterogenous socio-technical systems



Application Drivers



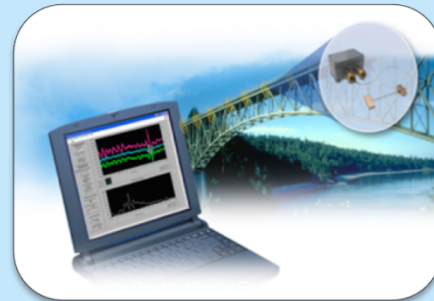
Image Credit: Nicolle Rager Fuller, NSF

Health & Wellbeing

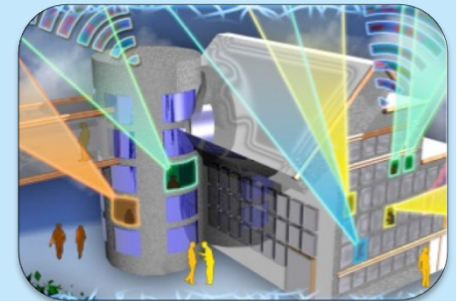


Image Credits: Texas A&M University

Transportation & Energy



Smart Infrastructure and Industrial Automation



Broadband & Universal Connectivity



Image Credit: ThinkStock

Emergency Response & Disaster Resiliency

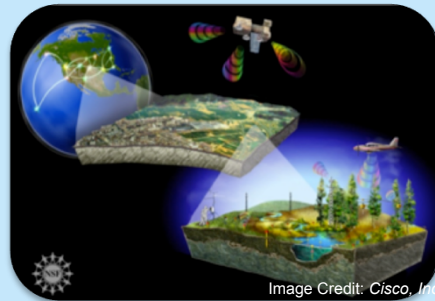


Image Credit: Cisco, Inc.

Environment & Sustainability



Image Credit: Georgia Computes! Georgia Tech

Education and Workforce Development





THE BEST OF BOTH WORLDS:

Achieving Privacy & Utility

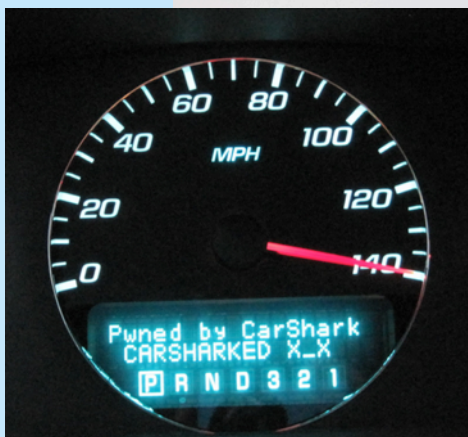
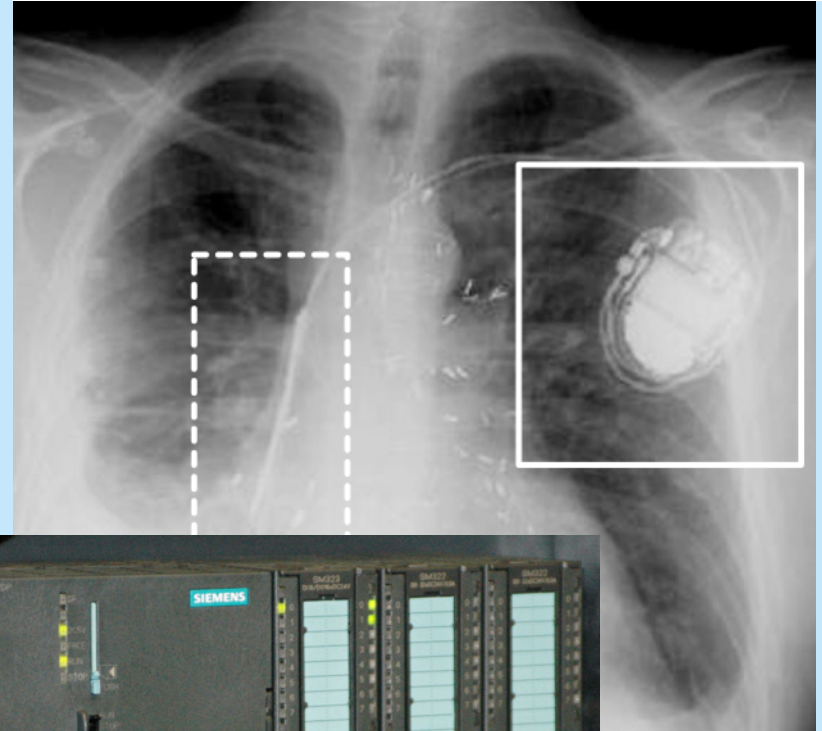
Reaping the benefits of a data-rich world
without sacrificing our privacy

Cyber-physical Security



Law Enforcement Communications

Embedded Medical Devices



Automobiles



Control Systems





Thanks!

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