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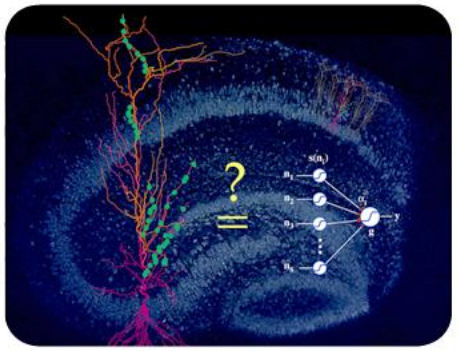

Neuro-inspired Computing, Why Now?

Michael O. Vahle

Neuro-Inspired Computational Elements Workshop
February 25-27, 2013

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Problems, Technologies, Programs Drove Computing

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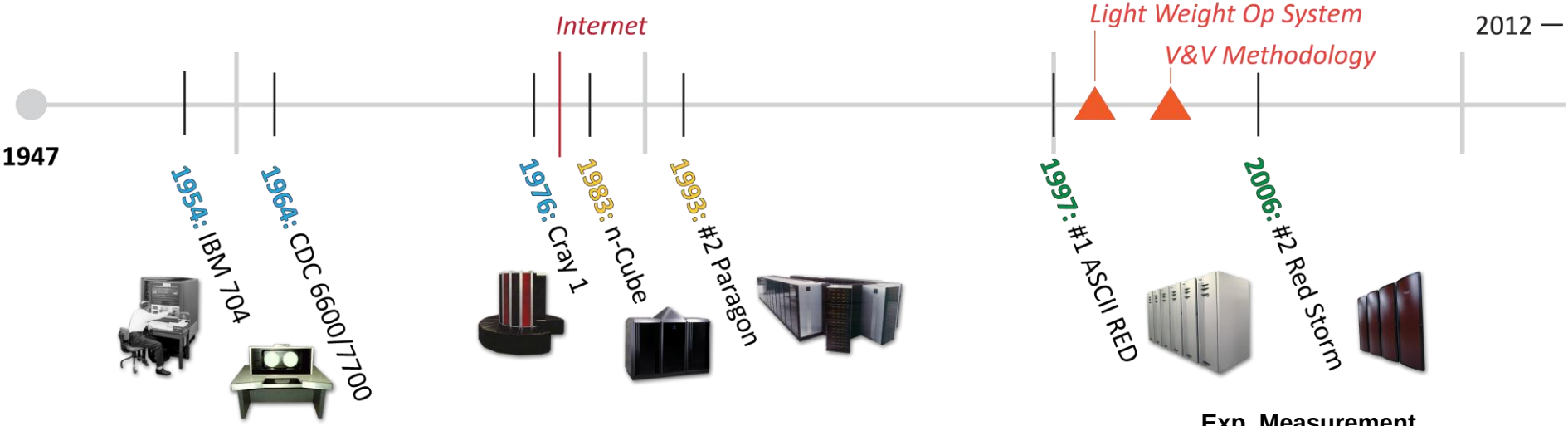
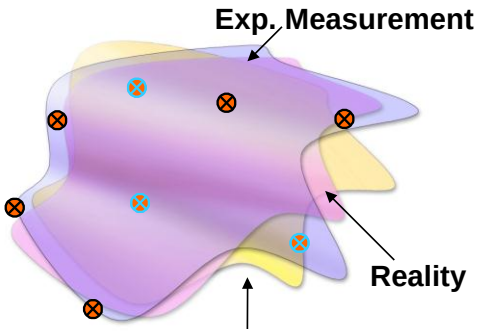
Analyzing Test Data

Stockpile stewardship (prediction)



- The problem created the imperative
  - Nuclear weapons - testing (understanding based on computing)
  - no testing (prediction based on modeling and simulation)
- The technology enabled the response
  - Moore's law
  - Parallelism
  - Methodologies to manage the results



$$||CP - Reality|| \le ||CP - Exp|| + ||Exp - Reality||$$

Barriers To Progress Are Looming Large And The Problem Driving Improvement Is Changing

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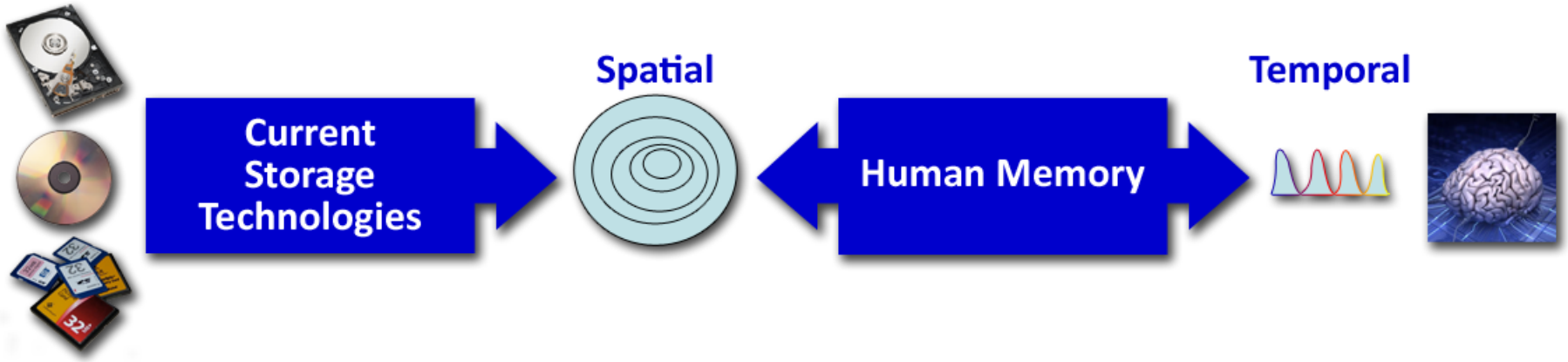
- Power, memory speeds are reaching physical limits
- Data has become large, noisy, and incomplete and semantic (being driven by both the Internet and the size and nature of modeling and simulation data sets)
- 9/11 has changed the security problem from one where PDEs dominate to one where new techniques are needed



All Roads Lead To Rome
Or Is It Neuro-Inspired Computing

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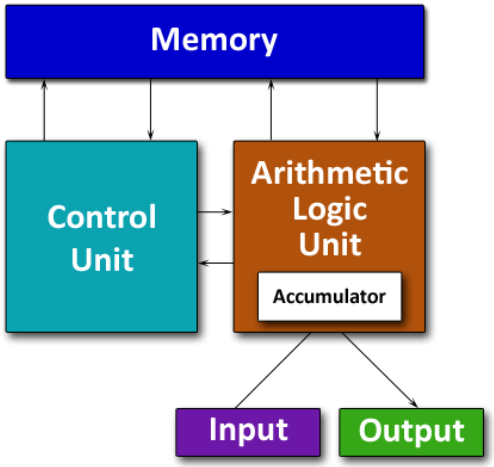
- The size of the machines and limitations of technology (power, reliability, memory access) are calling into question the von Neumann architecture
- The shear amount of data requires new techniques to manage and process it
- The problem is taking on characteristics that the “brain” seems particularly well suited to handle



So Maybe We Knew The Answer From The Beginning

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- Turing's Cathedral - George Dyson tells the story of the digital universe
- von Neumann, Turing, Baricelli, etc. are the heroes
- Evolution was there from the beginning - the problems (however, Nuclear Weapons and Weather Prediction won the day)
- So it appears that we have gone full circle and arrived to where a biological analogue is once again in play

Some Questions

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Is pattern matching the right paradigm?

Does the brain provide the right model?

- How do you program the problems?
- How do represent the data?

Is the technology attainable?

Are the Ethical and cultural issues understood?

With foresight, can we avoid the pitfalls that plague modern computers and networks (i.e., viruses, worms, hacking ...)