IBM Deep Computing

Climate Workshop

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Deep Computing CTO

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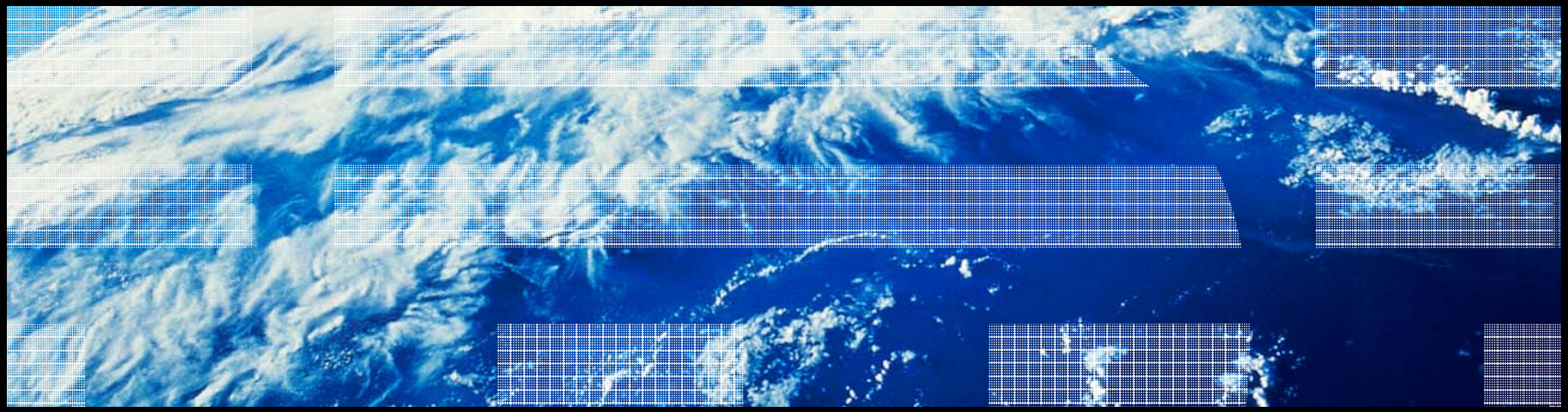
IBM Systems
Simplify your IT.

Kent Winchell – Deep Computing CTO

Let’s Build
A Smarter Planet



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Today, more than ever, organizations are under pressure to leverage a wealth of information to make more intelligent choices.

VOLUME OF DIGITAL DATA

With the proliferation of end-user devices, sensors and actuators, the nature of data is changing. Data volumes and network bandwidth are expected to grow tenfold in the next three years.

VELOCITY OF DECISION-MAKING

The market demands that businesses optimize decisions, take action based on good information and utilize advanced predictive capabilities—all with speed and efficiency.

VARIETY OF INFORMATION

With the expansion of information comes large variances in the complexion of available data—very noisy with lots of errors and no opportunity to cleanse it in a world of real-time decision-making.

SHIFT IN WHAT WE ANALYZE

Enterprises need a broader, systems-based approach to the information they examine and optimize. Stream computing and event processing capabilities are enabling the analysis of massive volumes.

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The need for progress is clear.

170 billion

Kilowatt-hours wasted each year by consumers due to insufficient power usage information.

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The opportunity for progress is clear.

10%

REDUCTION IN ENERGY COSTS

Utility networks: Pacific Northwest National Laboratory
In the Smart Grid project, consumers decreased their overall peak load on the grid by 15% when offered the opportunity to save an average of 10% on their electricity bills.[1]

[1] Sam Palmisano speech, November 12, 2008

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Smart energy and utilities:
Transforming the grid.

DONG Energy: Installed remote monitoring and control devices to gain an unprecedented level of information about the current state of the grid, lessening outage times by a potential 25-50%.

CenterPoint Energy: Created an Intelligent Utility Network that relies on thousands of smart meters and sensors across the grid to detect events, alert on problems and restore power automatically when outages occur.

Energie Baden-Württemberg: Offers residential customers smart appliances and meters that enable them to adjust electricity consumption based on price—reducing waste and easing peak loads.

Pacific Northwest National Laboratory: Used intelligent measurement devices, smart appliances and a virtual marketplace to help manage stress in the electric grid, achieving a 50% reduction in short-term peak electricity distribution loads and a 15% reduction in overall peak loads.

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Our world is becoming

INSTRUMENTED

Our world is becoming

INTERCONNECTED

Virtually all things, processes and ways of working are becoming

INTELLIGENT

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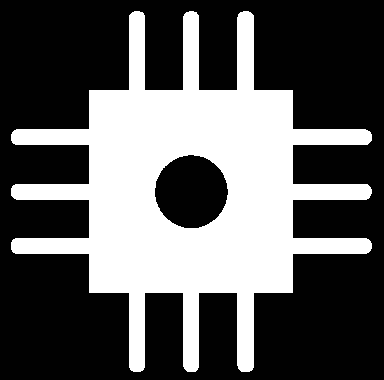

INSTRUMENTED

We now have the ability to measure, sense and see the exact condition of everything.

- Today, there are 1 billion transistors for each person on the planet.[1]
- By 2010, 30 billion RFID tags will be embedded into our world and across entire ecosystems.[1]

Everything will become instrumented: supply chains, healthcare networks, cities and even natural systems like rivers.

[1] Sam Palmisano speech, November 12, 2008

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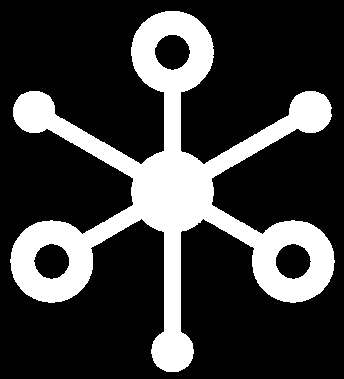

INTERCONNECTED

People, systems and objects can communicate and interact with each other in entirely new ways.

- The internet of people is 1 billion strong. Almost one third of the world's population will be on the web by 2011.[1]
- There will be nearly 4 billion mobile phone subscribers worldwide by the end of 2008.[1]

The Internet of things—cars, appliances, cameras, roadways, pipeline, pharmaceuticals and even livestock—is headed to 1 trillion.

[1] Sam Palmisano speech, November 12, 2008

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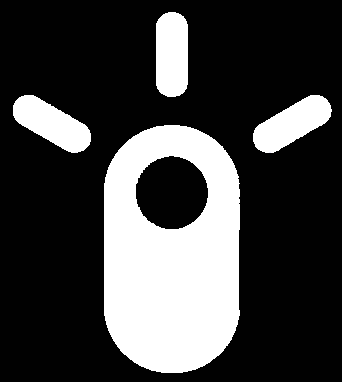

INTELLIGENT

We can respond to changes quickly and accurately, and get better results by predicting and optimizing for future events.

- Every day, 15 petabytes of new information are being generated. This is 8x more than the information in all U.S. libraries.[1]
- An average company with 1,000 employees spends $5.3 million a year to find information stored on its servers.[1]

New computing models manage the massive amounts of data generated by the proliferation of end-user devices, sensors, and actuators. Combined with advanced analytics, these technologies are making us smarter.

[1] New Intelligence White Paper from ThinkForward website

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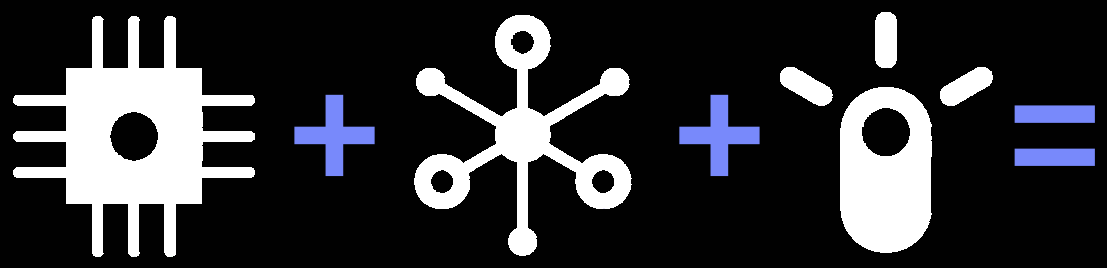

An opportunity to think and act in new ways—
economically, socially and technically.

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We've only just begun to uncover what is possible on a smarter planet.

The world will continue to become smaller, flatter and smarter. We are moving into the age of the globally integrated and intelligent economy, society and planet.

The question is,
what will we do with it?

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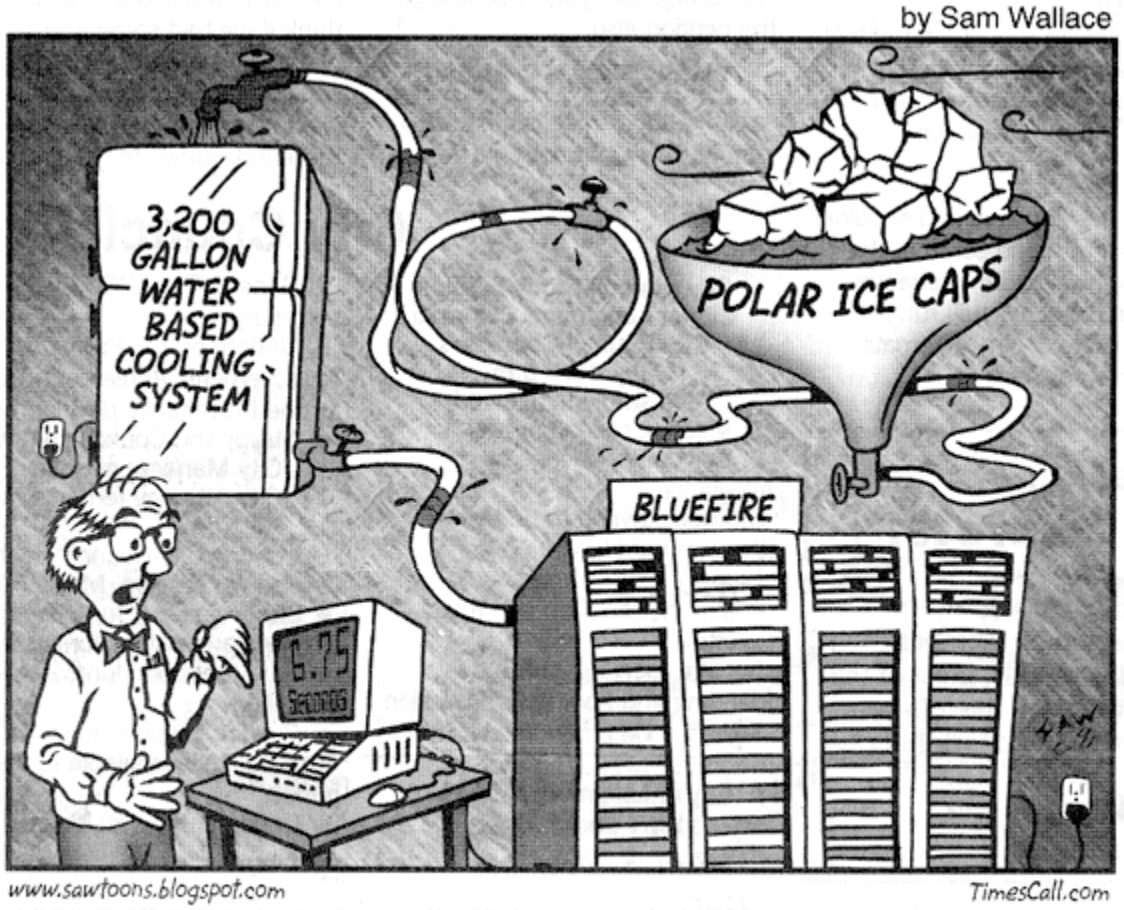


AT THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH IN BOULDER, SCIENTISTS DISCOVERED EXACTLY HOW LONG IT WOULD TAKE TO MELT THE POLAR ICE CAPS IF THEY USED THEM TO COOL THEIR NEW SUPER COMPUTER.

June 18, 2008 – Petascale Delivered!

Roadrunner Breaks Petaflop Milestone

Date added: 18 Jun 2008

The computer nicknamed "Roadrunner" was built for the Department of Energy's National Nuclear Security Administration and will be housed at Los Alamos National Laboratory in New Mexico. IBM engineers in Poughkeepsie, N.Y., Rochester, Minn., Austin, Texas and Yorktown Heights, N.Y., worked on the computer, the first to break a milestone known as a "petaflop" -- the ability to calculate 1,000-trillion operations every second. The computer packs the power of 100,000 laptops -- a stack 1.5 miles high. Roadrunner will primarily be used to ensure national security, but will also help scientists perform research into energy, astronomy, genetics and climate change.

Groundbreaking system will have a profound impact on science, business and society

Market Dynamics and Design Principles; Petascale and Beyond

- Capacity systems have become “good enough” for majority of HPC and set a price point that discourages capability
- Small design issues become dramatic at Petascale
  - Memory/core
    - Cost of 1GB/core vs 2 GB/core - $20M
  - Power consumption – single thread performance
    - 10 PF range from 100K cores to 1.5M cores
    - 10 PF range from 20 MW to 5 MW
  - Reliability and Scalability for 10^{15} and beyond....

A mix of market forces, technological innovations and business conditions have created an inflection point in HPC

System-level Performance & Reliability

- Petascale computing enabling new paradigm in complex systems analysis
- x86-based clusters dominate – but are not meeting ever-increasing requirements for ultra-scale users

Ecosystems & Collaboration

- Mix of traditional HPC and "edge" applications will require new skills
- Growing necessity for collaborative initiatives to enhance solution context and manage risk

Science Driving HPC

- Growing number of grand challenge problems
- Digital world - simulations increasing in fidelity

Software

- ISV business model challenged by new systems
- Scaling limits reached in many segments

HPC at an inflection point

Environmentals

- Growing importance and limitations on power consumption, datacenter space, cooling capabilities, noise
- Likely governmental actions that will influence system designs

How can we exploit these shifts to meet our Performance & Productivity requirements?

Dilemmas well documented – path forward ?

- System performance is increasing by more cores not faster cores
- Memory BW/core is going down
- Single thread performance is going down
- Most applications don't scale to 10,000+ cores
- Baseline of MPI enabled simulations
  - Can't rewrite simulations for short lived hardware acceleration
- Cohesive software and application paradigm is critical

Performance and Productivity Challenges require a Multi-Dimensional Approach

Highly Productive Systems

POWER6

POWER7

HPCS PERCS

Highly Scalable Multi-core Systems

BLUE GENE

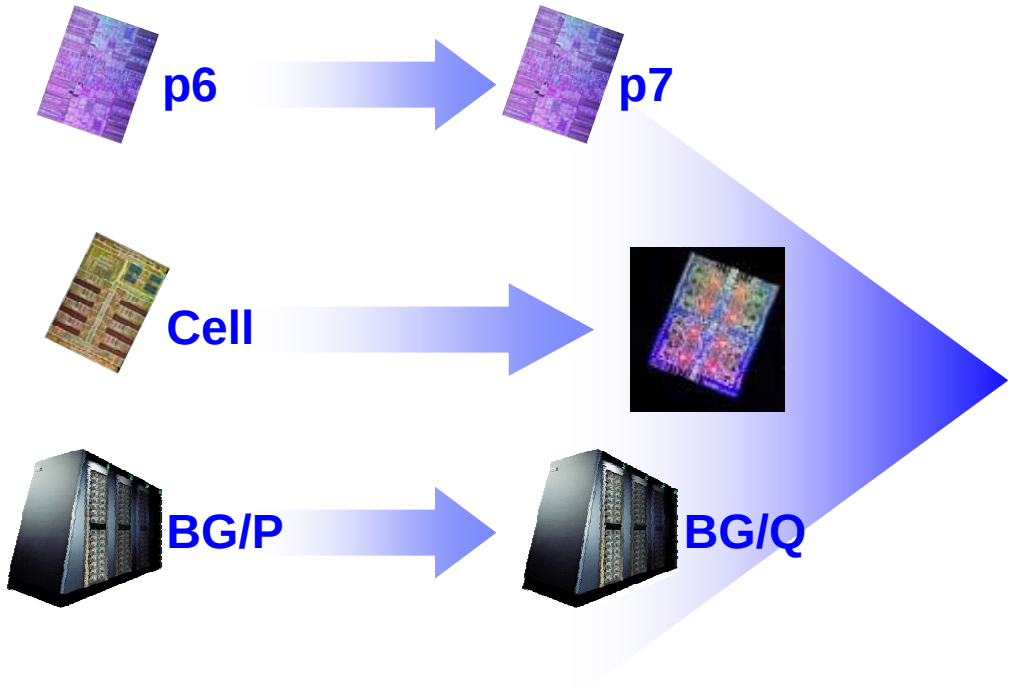
Hybrid Systems

Comprehensive (Holistic) System Innovation & Optimization

Next Era of Innovation – Hybrid Computing
The Next Bold Step in Innovation & Integration

Symmetric Multiprocessing Era

Today *Tomorrow*

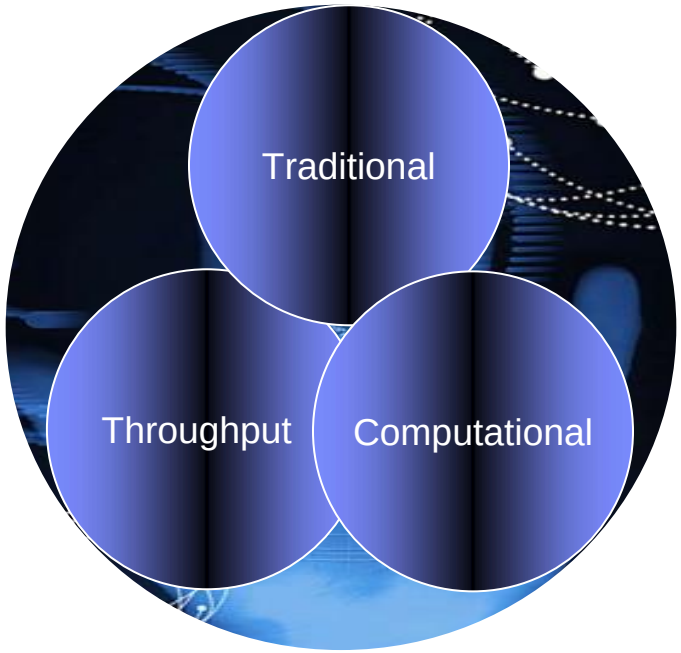


Technology Out

Driven by cores/threads

Hybrid Computing Era

Future



Market In

Driven by workload consolidation

Future Trends

- Dense HPC systems all water cooled
- Power adaptive scheduling
- Enablement of standards for multi-core/hybrid
  - OpenMP, OpenCL
- Rapid provisioning to change system to match application workload
- Cloud computing to aggregate capacity systems for capability work

In the end, it's not about the technology; It's accomplishing the mission

- **Continue to innovate across the whole systems stack to deliver leadership in performance and usability**
- **Help solve problems that are currently intractable via collaboration**
- **Accelerate discovery in science, engineering, and business**

Thank you...