CRAY®
THE SUPERCOMPUTER COMPANY

# The Fusion of Supercomputing and Data Analytics To Drive Scientific Discovery

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President & CEO

# Big Data and Why We Should Care

Big Data refers to data that is not easily captured, managed and analyzed by traditional tools due to:

- *Volume* (growing > 60%/yr; no sampling/curation)
- *Velocity* (often real time streaming)
- *Variety* (all forms of structured/unstructured data: logs, docs, images)

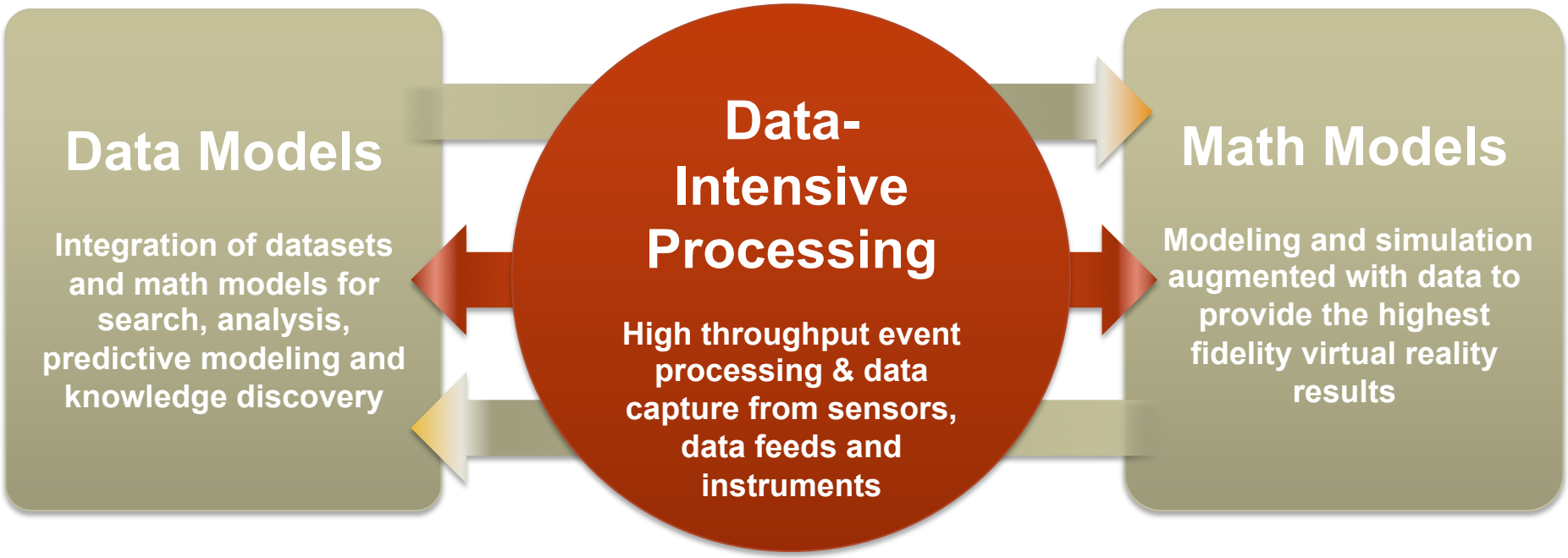
IDC expects Hadoop to run on over 50% of Big Data Projects over time representing a $8.5B market by 2015

**Science will increasingly be data-driven to understand the world**

**Business will increasingly be data-driven to understand customers**

# Cray's Vision:
## The Fusion of Supercomputing and Big & Fast Data

### Modeling The World
Cray Supercomputers solving "grand challenges" in science, engineering and analytics




Advanced Analytic Appliances

Storage & Data Management

Supercomputers

# Data-Intensive Processing is driving the need for advanced architectures

Source: Eric Green, Director, National Institute of Health: NextGen 101 Workshop

# Big Data's Methods for Analysis

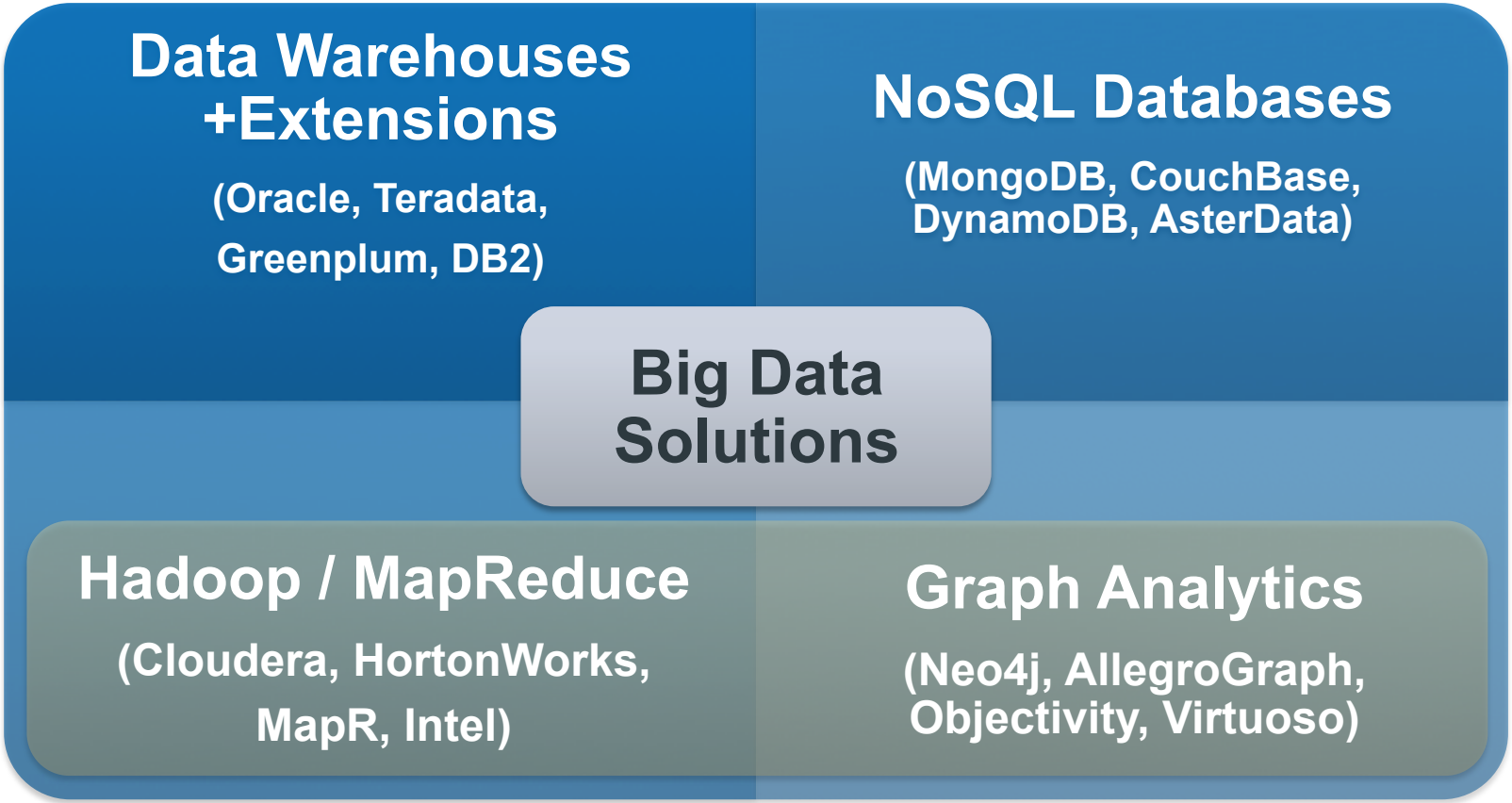
## SEARCH

"Needle in a Haystack"

## DISCOVERY

Needle in a Needlestack!

# Different Solutions for Advanced Analytics




**These solutions can overlap, but also can be very complementary as each has strengths & weaknesses**

# System Architecture Differences…

**Supercomputing**

- Scalable computing w/high BW, low-latency, Global Mem Architectures
- Highly integrated processor-memory-interconnect & network storage
- Minimize data movement – load the “mesh” into memory
- Move data for loading, check-pointing or archiving
- “Basketball court sized” systems

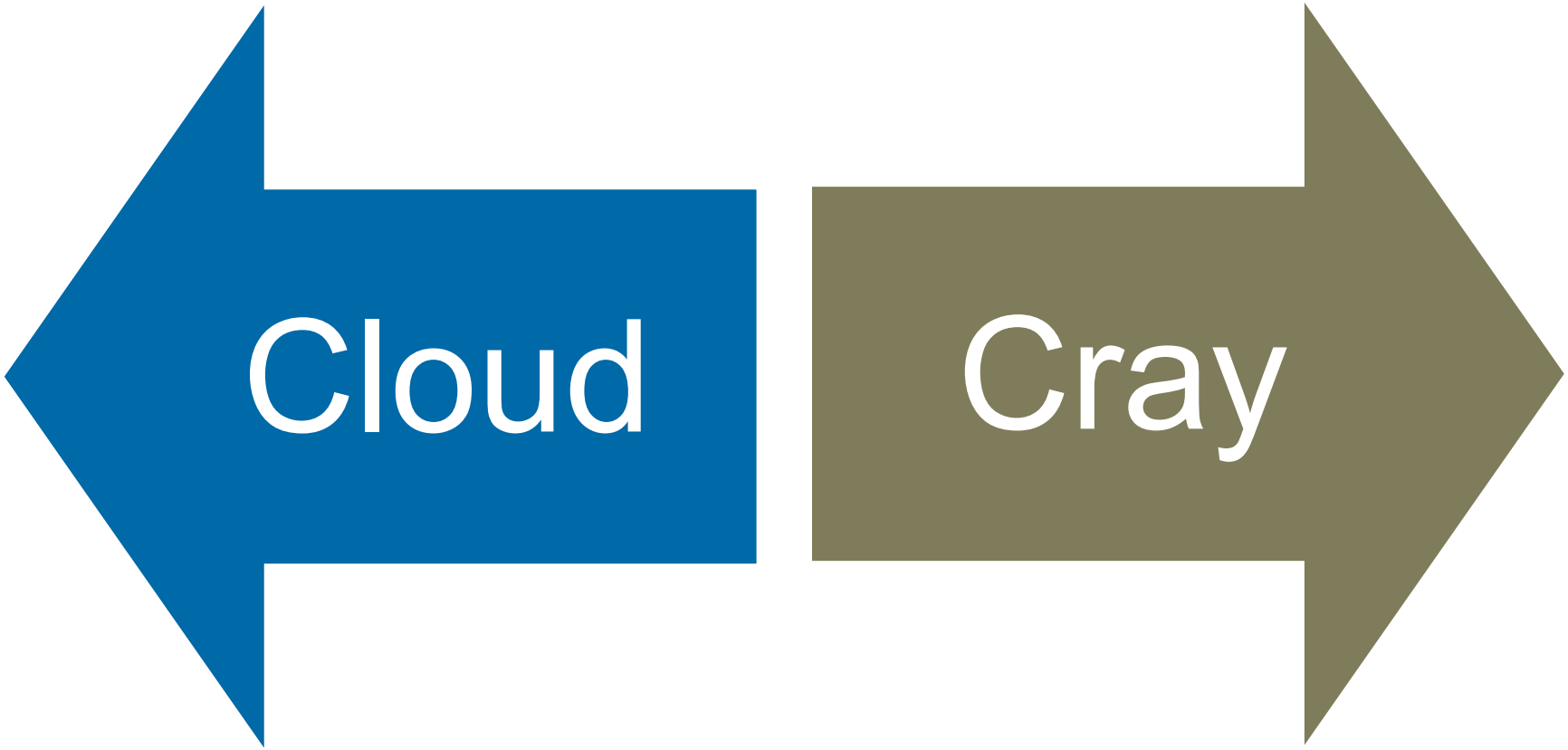
**Large-scale Data Analytics**

- Distributed computing at largest scale
- Divide-and-conquer approaches on Service Orientated Architectures
- Maximize data movement-- Scan/Sort/Stream all the data all the time
- Lowest cost processor-memory-interconnect & local storage
- “Warehouse sized” clouds

# Applications Differences…

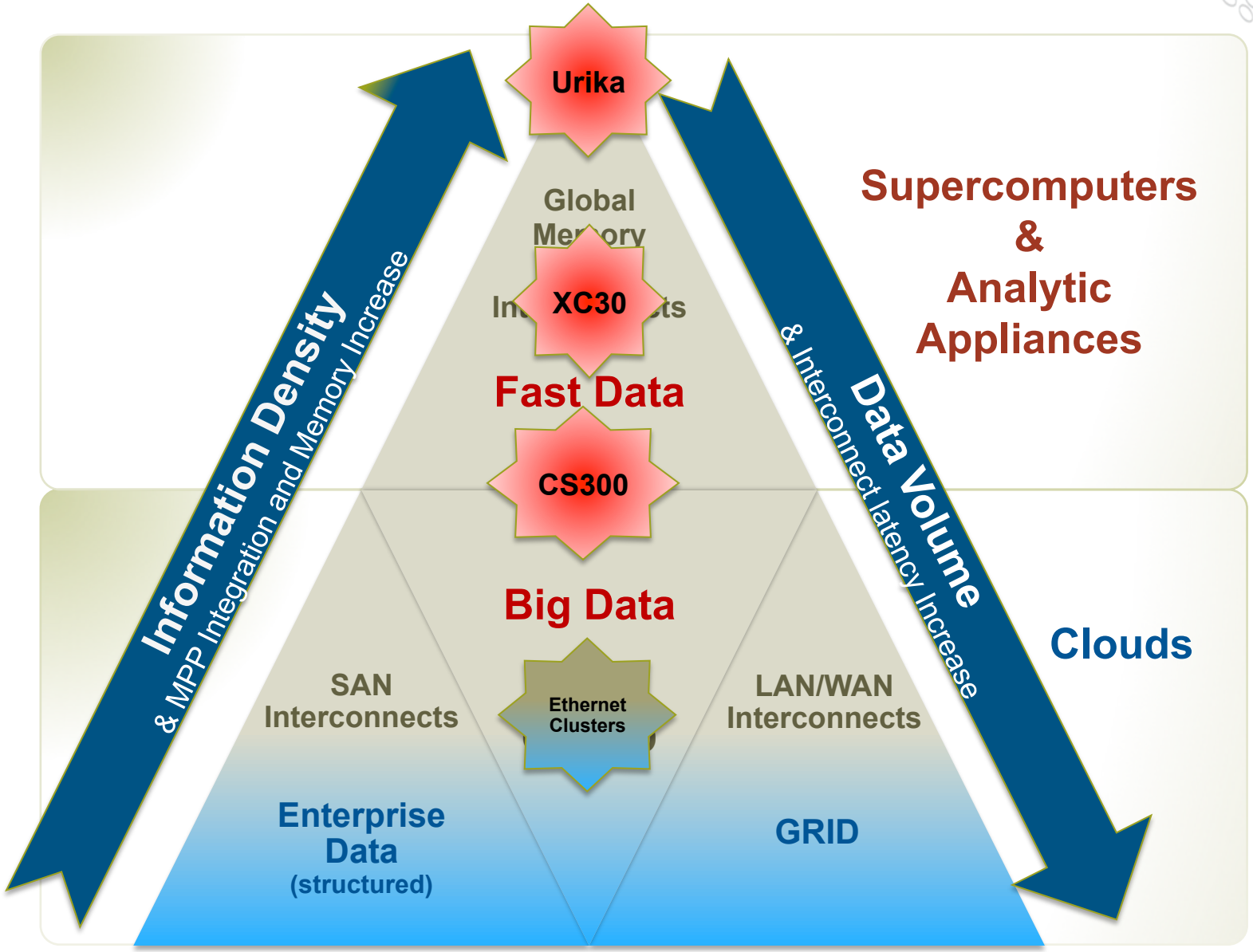
- **Computational requirements far outweighed by capacity, bandwidth or latency requirements of memory hierarchy**
  - Working data set doesn't fit in memory (Capacity limited)
  - Floating point or integer unit stalled for data access (BW limited)
  - Highly irregular, cache-unfriendly, data access (Latency limited)
- **On a given distributed platform, applications are either**
  - Memory-bound (capacity, BW, latency)
  - Interconnect-bound (BW, latency)
  - I/O-bound (Capacity, BW, latency)
- **Mirror opposite of compute-bound problems**
  - FLOPS matter less – no easy path to higher peak computing rates
- **Accordingly, SW & HW infrastructure requirements are quite different**
  - Must have specialized nodes and adaptive runtimes to handle these differences

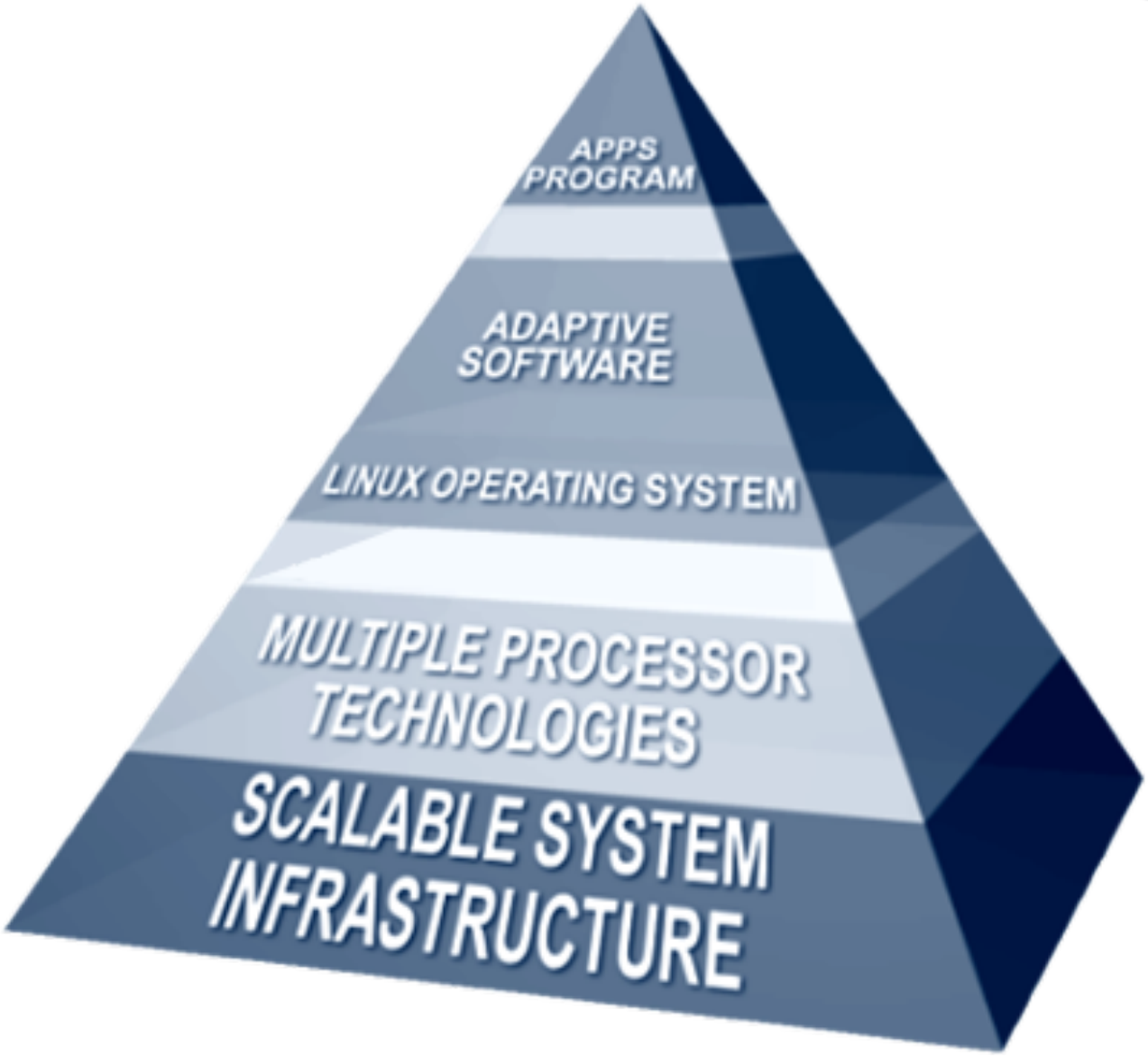
# Can't "The Cloud" Do This?




**Convergence is at the high-end, not universal**

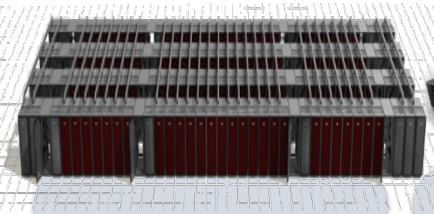
# Big Data → Fast Data






# *Extending Adaptive Supercomputing to Big Data Workloads*

# A Unique "Partnership" Business Model

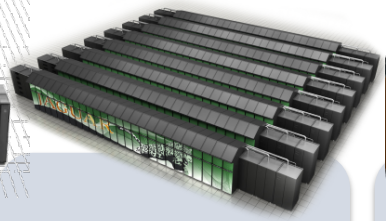


## Cray XT3

Sandia National Laboratories

Pittsburgh Supercomputing Center

AMD



## Cray XT4 & XT5

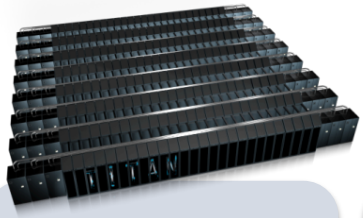
OAK RIDGE National Laboratory

## Cray XE6

NERSC

Los Alamos NATIONAL LABORATORY EST. 1943

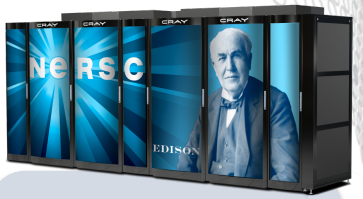
Sandia National Laboratories



## Cray XK6 & XK7

OAK RIDGE National Laboratory

NVIDIA




## Cray Cascade

DARPA

Department of Energy United States of America

intel

# Urika Was Built On Key Partnerships…

MAYO CLINIC

Institute for Systems Biology
Revolutionizing Science. Enhancing Life.

Sandia National Laboratories

CSCS

OAK RIDGE National Laboratory

Pacific Northwest NATIONAL LABORATORY

PSC
PITTSBURGH SUPERCOMPUTING CENTER


Gartner

G00232737

## YarcData's uRiKA Shows Big Data Is More Than Hadoop and Data Warehouses

**Published:** 11 September 2012

**Analyst(s):** Carl Claunch

The hype about big data is mostly on Hadoop or data warehouses, but big data involves a much wider and varied set of needs, practices and technologies. We offer recommendations for IT organizations seeking a solution to "graph" problems, including use of the uRiKA graph appliance.

### Impacts

- IT organizations faced with previously infeasible graph-style discovery problems may succeed using a focused solution like uRiKA.
- To address all their data requirements, IT organizations may be forced to duplicate data between systems such as uRiKA and transactional systems.

### Recommendations

- Select candidates to place on uRiKA where processing is graph-oriented, the data is large-scale, and discovery of complex relationships is a core focus.
- Validate the appropriateness of specialized systems and achievability of performance targets by proof-of-concept and pilot tests.
- Carefully define the volume and performance requirements for processing data.
- If requirements can be met using fewer machine types and the economics make sense, use the fewest platform types possible.

Sandia National Laboratories

| | # PROCESSORS | TIME |
|---|---|---|
| Traditional Approaches + months of optimization | 48 | 10.8 Hours |
| YarcData's Urika | 32 | 30 sec |

~2,000X Faster

Institute for Systems Biology
Revolutionizing Science. Enhancing Life.

*"In the amount of time it takes to validate one hypothesis, we can now validate 1,000 hypotheses – increasing our success rate significantly."*

*– Dr. Ilya Shmulevich*

# Early MapReduce on Cray Systems

**Excellent progress at NERSC providing MapReduce capability on their XE6 systems**

- New capabilities for job policies and the run-time environment to support very large numbers of Joint Genome Institute jobs.
- Utilize the Cray Cluster Compatibility Mode (CCM) to support tools like Java and support a throughput oriented scheduling environment
- An excellent real-world example of meeting the needs of the data-intensive community in the world of traditional simulation and modeling

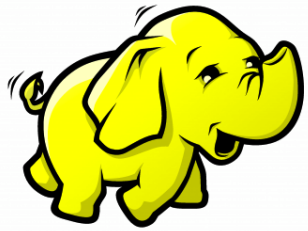
**Sandia's Development of MapReduce in MPI (MR-MPI)**

- MapReduce functionality implemented in MPI context (no Java)
- MR-MPI library performs data movement between processors and supports and requires local disks for "out of core" large data sets

**Active Collaborations underway with DOE labs and NSF centers**

# Cray Cluster Supercomputers for Hadoop: Purpose-Built, Turnkey Hadoop Solutions





## Best Hadoop Distribution

- **Security**– Comprehensive, and fast, encryption
- **Performance** – Faster Hive, Cache acceleration, etc.
- **Management** – Intel Manager for Hadoop Software

+

## Performance of a Cray

- **Proven HPC** – Cray technology & expertise
- **Vast Scale** – Grow to meet any mission requirements
- **Holistic Design** – Balanced compute, networking & storage

+

## Turnkey Solution

- **Reliable** – Rapid ROI… runs as-advertised
- **Support** – One throat to choke, for the whole stack
- **Maintenance** – Update & evolve, without concerns

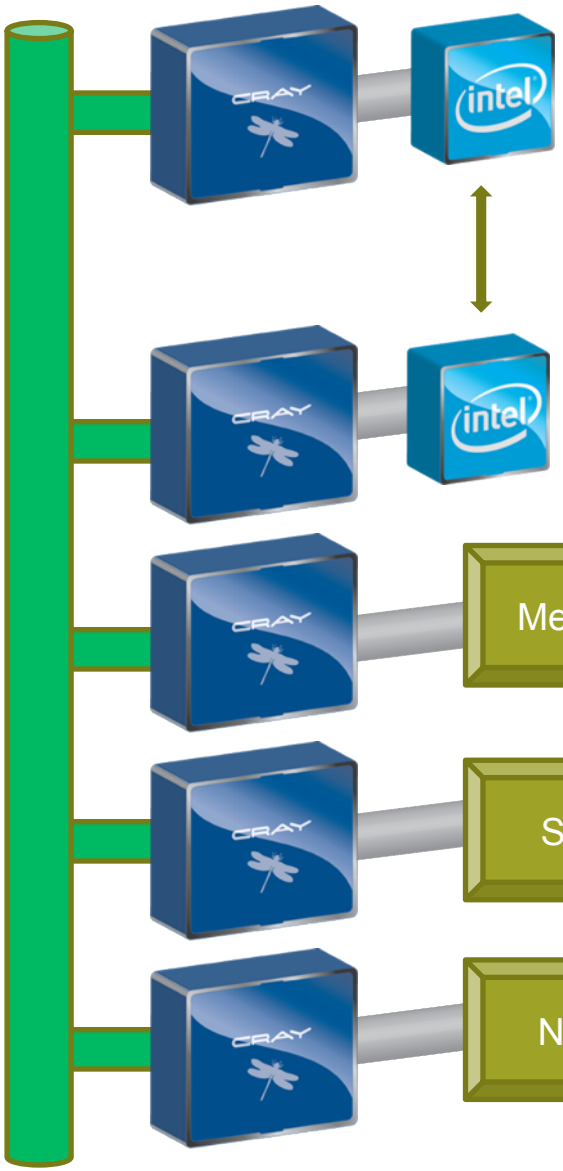
=

## High Value Hadoop

- **Performance** – Power to accommodate current & future goals
- **Reliability** – Will meet any challenge, without surprises
- **Maintenance** – Easy to maintain & accommodate change

**Similar offering in development on XC platform**

# Adapting to Data-Intensive Computing: Adding Value at the Edge of the Network




**Data Processors**
- x86
- Many-core
- GPU

**Adaptive Supercomputing**
- Compilers, Auto-tuning

**Operating System**
High throughput scheduling, Adaptive Runtime, Network

**High Performance Memory**
- DRAM
- Active NVRAM

**Storage**
- SAS to PCIe
- Tightly coupled Software Stack for RAID
- Very Low Latency

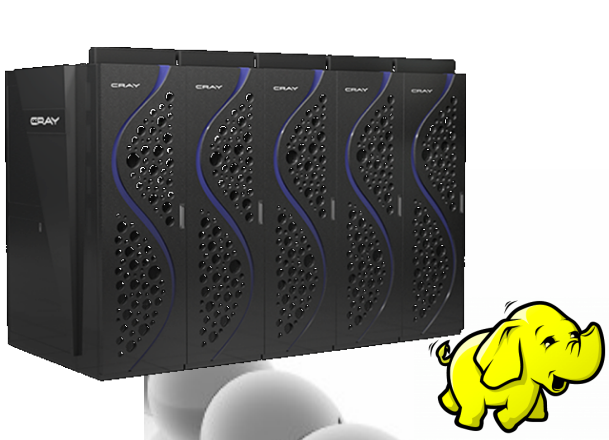
**Intelligent I/O**
- Protocol Load Balancing
- Specialized Data Ingest
- Policy Based Data Movement

Software Defined Network

***The most capable interconnects will be key to analytic workloads***

# Cray's Roadmap "Fusion"

***Data Ingest (Cloud)*** ***Simulation*** ***Analytics***





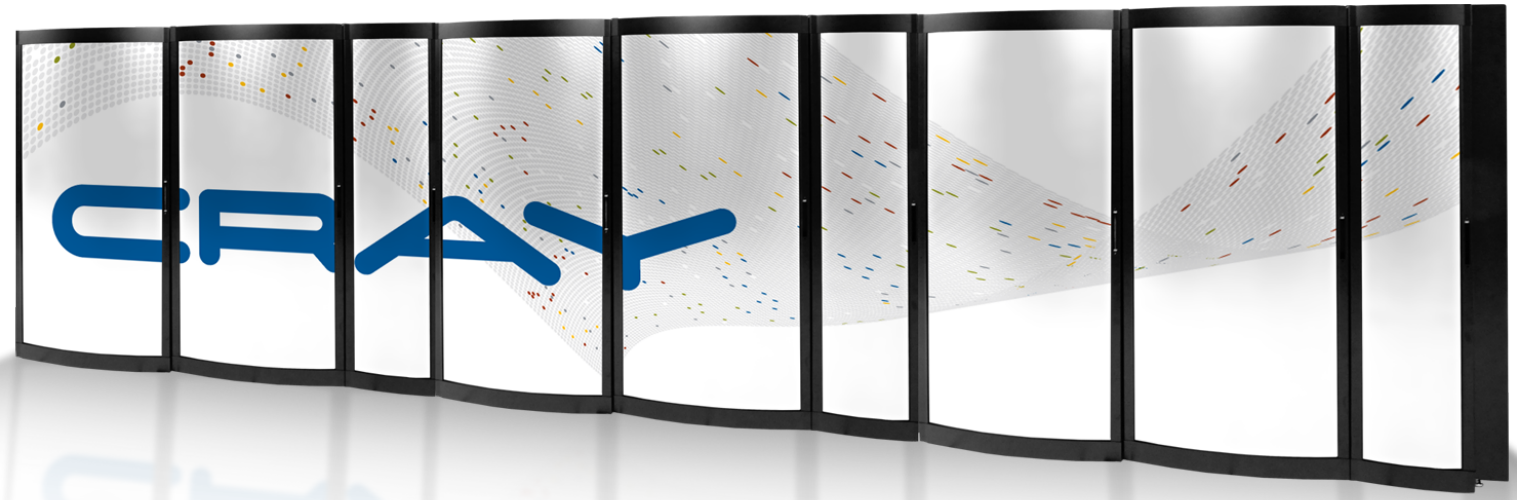
**Multiple Roadmap Steps:**

*Combine workflows & data into a single system*

*Aggressive local and global memory capabilities*

*Tightly integrated software stack (& runtimes) across all 3 capabilities*

# Our Vision…



**Build a world-class integrated supercomputing environment that enables transformational computing across a broad set of science, engineering and advanced analytics (big data) applications**

# Thank You