Cray Earth Sciences Update

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Topics

- Cray’s Presence in Earth System Modelling Community
- Emerging Trends in Weather & Climate Data Analysis
- Cray’s Vision for Converged Modelling & Analytics Platforms
Cray Solutions for Earth System Modelling

● Cray offers a complete, single-vendor solution for ESM:
  ● Balanced integration of compute, storage and analytics

● Cray’s industry leading technology enables customers to address a broader & more challenging set of problems

● Cray has huge experience delivering and operating the world’s largest and most complex systems, both in operational & research environments
  ● Emphasis on total cost of ownership – from power and upgradability, to efficiency.

● Cray is committed to long-term partnerships that provide significant ongoing value to our customers.
Cray Announcements in Weather, Climate and Oceanography over the Last Two Years

- Sept 2013
- Feb 2014
- April 2014
- April 2014
- June 2014
- June 2014
- Oct 2014
- Jan 2015
- July 2015
- Aug 2015
- Sept 2015

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Bureau of Meteorology, Australia

• In the second half of 2015 Cray will deploy a new Cray supercomputer at the Bureau of Meteorology. The new Cray facility will allow BoM to increase forecasting capabilities by providing high performance computing to support:
  • Increased resolution and model enhancements
  • Introduce ensemble runs for global & local regions

System Overview

- Dual Cray XC40 systems for operations and research/backup
- Systems expanded in 2018 with latest Intel Xeon processors
- Cray Sonexion storage
- Applications include global, regional, city-scale & tropical cyclone and climate research.

”At the moment we're at about a 4km grid degree of resolution on the city models. By 2020 we'll be down to a 1km grid for the city model. We'll also be running more regular and frequent updates - 24 times a day by 2020, where at the moment we run it four times daily. We'll also be able to run high, on-demand models for tropical cycles and run two extreme weather events side by side. The benefits to the community, the economy, emergency services, national security and various parts of the industry will be quite marked.”

Lesley Seebeck, BoM CIO. As told to iTnews.com.au
Danish Meteorological Institute

• Cray was recently selected by DMI to provide their next two generations of supercomputing systems, succeeding their current Cray XT5 platforms. The supercomputers will be hosted in Iceland, taking advantage of the cool climate and abundant geo-thermal and hydro electricity.

• Initially the Cray systems will deliver three times the performance of the current systems, rising to a 10x performance after a mid-life upgrade in 2018

Dual Cray XC40 systems for operations and research/backup
• Systems upgraded in 2018 with latest Intel Xeon processors
• Cray Sonexion storage
• Applications include high resolution regional forecasts for Denmark and the North Atlantic including Iceland & Greenland

It was paramount to us to find a business partner with the organization and skills to install a supercomputing solution in Iceland that could operate remotely 1,300 miles away from Denmark, and Cray filled all the criteria

Mrs. Marianne Thyrring, Director General of the Danish Meteorological Institute.
Trends in Weather & Climate Data Analysis

- Data volumes generated by supercomputers growing rapidly
  - Driven by increasing resolutions, ensembles members & number of experiments

- Cumulative archives also expanding rapidly
  - ~40-50% CAGR not unusual
  - DKRZ expect to grow at ~75PB p/a with new supercomputer
  - ECMWF archive growing at about 50PB/year (>60% CAGR)

- Even simple data analysis efforts can be I/O bound
Weather/Climate Informatics

- Emerging analysis approaches adopted from data analytics & machine learning space

- Examples includes:
  - Complex network & graph based approaches
  - Scalable optimization methods
  - Supervised/unsupervised learning

- Some use-cases:
  - Detecting links between elements in climate system
  - Automated forecaster guidance/decision support
  - Optimizing integration of multi-model climate ensembles

- Computation & communication intensity likely to grow, with IO remaining very important

- Analysis will also become more tightly coupled within overall workflow
Weather/Climate Informatics

ICCS 2015: “Computational Science at the Gates of Nature”

Sixth Workshop on
Data Mining in Earth System Science (DMESS 2015)

Co-conveners: Forrest M. Hoffman, Jitendra Kumar, and J. Walter Larson

Reykjavik, Iceland | June 1–3, 2015

Analysis will also become more tightly coupled within overall workflow
Cray Today
Urika-XA Extreme Analytics Platform

**Urika-XA**

**Turnkey Advanced Analytics Platform**
- Open platform for both pre-configured and user-installed tools
- Hadoop and Spark ecosystem
- Emerging high performance analytic workloads
- Unified system management interface

**Next-Generation System Architecture**
- High performance storage technologies
- Battle-tested on cutting-edge government/scientific analytic applications
- Ready for the enterprise

**Engineered for Performance**
- Dense footprint: over 1,500 cores, 6TB memory
- 38TB SSD and 120TB POSIX-compliant high-performance storage
- InfiniBand performance networking
- Cray Adaptive Runtime for Hadoop
- Scale out to multi-rack configurations

**Advanced Analytics at Lower TCO**
Cray DataWarp I/O Acceleration for Cray XC40

- **Pure performance**
  - 70 thousand to 40 million IOPS per system
  - Quality of Service to applications

- **Breakthrough efficiencies**
  - 5x the bandwidth of disk at the same cost

- **Flexible Usage Models**
  - Local and Shared I/O models
  - No application changes required

*DataWarp overcomes the performance gap between compute and disk storage*
Containers on Cray XC

- Allow user-defined environment
  - Either customized, or pre-defined for particular workflow

- NERSC are experimenting with this – likely to form a key element of the 2016 Cori XC40/KNL system

Prototype Implementation: “Shifter”

- Supports
  - Docker Images
  - CHOS Images
  - Will be able to support other image types (e.g., qcow2, vmware, etc)

- Basic Idea
  - Convert native image format to common format
  - Construct chroot tree on compute nodes using common format image
  - Directly use linux VFS namespaces to support
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.
Exascale Computing Memory Trends

Today

On Node

CPU

Memory (DRAM)

Storage (HDD)

Off Node

Future

On Node

CPU

Near Memory (HBM/HMC)

Far Memory (DRAM/NVDIMM)

Near Storage (SSD)

Far Storage (HDD)

Off Node

● Good: Helps reduce/mitigate cost of moving data

● Bad: Even more complexity in programming models
Future Converged Architecture

Converged Compute & Analysis System

- Massively Parallel Simulations
- Single/Lightly Threaded Pre-/Post-Processing
- Batch & Interactive Visualization
- Container-hosted analysis workflows
- Machine Learning & Complex Network Analysis
- Distributed In-Memory Databases
- Other Memory & Compute-Intensive Tasks

High Speed Fabric

Flexible IO Acceleration Layer

Data Services

Parallel Storage

Automated Data Movement

Cache, Metadata & Data Movement

Archival Storage

Bulk Storage

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Integrated HPC Environments are the capability that will turn data into insight and discovery.
Thank you!