HITACHI’S TECHNOLOGY AND VISION FOR E-RESEARCH

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HITACHI DATA SYSTEMS
ERESEARCH AT HITACHI DATA SYSTEMS

- ...will become at scale agile processes
- realized by multidiscipline teams
- leveraging a variety of data categories and types flowed through various technologies,
- including provisions for security and privacy.
- The end result – timely discovery of sparks of insights leading to valuable innovation and knowledge.
- I.e., really just what e-researchers have been doing for a long time
WAYS TO THINK ABOUT COMPUTATION AND BIG DATA

- “The purpose of computing is insight, not numbers.” Richard Hamming, pioneer in numerical computing.

- “It’s about curiosity followed by action. You look at the dataset and then go deeper to discover something.” Richard Janert, author of *Data Analysis with Open Source Tools*.

- “For what I do—and this is really the only data analysis I can speak about with any sense of confidence—the most important skill is curiosity.” Richard Janert, author of *Data Analysis with Open Source Tools*.
HITACHI, LTD. GLOBAL RESEARCH AND DEVELOPMENT: RESEARCH ACROSS MANY DISCIPLINES

Production Engineering Research Laboratory
System Development Laboratory
Advanced Research Laboratory
Hitachi Research Laboratory
Central Research Laboratory
Mechanical Engineering Research Laboratory
HOW TO USE DATA TO INCREASE OIL PRODUCTION? A PROBLEM I’VE BEEN WORKING ON...
BAKKEN BASICS

• Primarily in northwest North Dakota, Montana, Alberta
• Largest contiguous oil formation ever measured by US Geological Survey — discovered in 1951
• Up to 900 billion barrels oil in place, up to 45 billion recoverable
• 2000 wells drilled per year in North Dakota alone, currently about 8000 wells producing, another 30,000 to 40,000 to be drilled
  – $10 million per well capital cost, roughly $20 billion per year across the play
  – Texas’s Eagle Ford shale oil play on a similar scale
• Incredible leverage for big data insights: can be applied across thousands of wells
Bakken Development Plan

- Original dual-zone development plan
  - 8 wells per 1,280 acres – 4 MB, 4TF
  - 603,000 Boe EUR per well (avg. 24.5 stages/completion)
  - ECO-Pad® design: 2 wells south, 2 wells north

- Additional Three Forks potential
SO WE HAVE THE DATA, WHERE AND HOW CAN WE APPLY MACHINE LEARNING?

• Here are some potential ideas:
  • Well Optimization Model
  • Geological Classification
  • Well Classifier
  • Localized Sensitivity Analysis

• Note: statistical analysis and machine learning needs to be driven by potential hypothesis and insights

• To get to the point where you have potential hypothesis and insights, you need to spend a lot of time curiously examining the data, talking to your multidisciplinary team members, and iterating in this process
Lay flexible foundation for the future to grow with your needs.

- **Infrastructure**
  - Virtualization, mobility
  - Integrated management
  - Data center convergence
  - Infrastructure on demand

- **Content**
  - Search, discover and integrate independent of applications
  - On demand content
  - Archiving as a service

- **Information**
  - Business intelligence
  - Big data today
  - Analytics
  - Integration

Single virtualization platform for infrastructure, content and information.
THE 5 PHASES OF E-RESEARCH DATA

- Collect
- Analyse & Rationalise
- Share
- Preserve
- Re-use
THE 5 PHASES OF E-RESEARCH DATA

REQUIREMENTS & ATTRIBUTES

1. Collect
   - High speed transfer
   - Parallel transfer of Data

2. Analyse & Rationalise
   - Rapid Provisioning
   - Efficient Capacity Allocation

3. Share
   - Simultaneous Connectivity
   - Standard/De facto interfaces

4. Preserve
   - Protected in original form
   - Dynamically & Automatically Mobile

5. Re-use
A RANDOM WALK THROUGH SOME RELEVANT HITACHI TECHNOLOGIES FOR E-RESEARCH
WHERE DO WE PLAY? (TODAY AND TOMORROW)

SCHEMATIC VIEW OF HIGH PERFORMANCE ENVIRONMENTS

HDS TODAY

ENABLED TOMORROW (complete HDS portfolio plus Lustre)

• KEY INNOVATION AREAS FOR HITACHI GOING FORWARD

  • Cheap and deep
  • FLASH
  • Optical archives
  • Converged infrastructure
  • HPC capable hardware
HSFS : Hitachi Striping File System
- Share Single File System with Multiple Nodes (Max 1024 Nodes)
- Distribute Files over Multiple I/O Servers
- High Throughput Performance by Parallel I/O on each I/O Server
- Two Striping Features (File Striping & Block Striping) Available
- Support AIX and Linux System, Also AIX–Linux Heterogeneous System
- Available for Hadoop (Replacement for HDFS)
HITACHI AND EXASCALE

- Japan’s K Computer
  - Fastest in the world, last year
  - > 11 PF
  - 30MW

- Next Generation being planned
  - Projected for 2018
  - 1 EF goal
  - HSFS(2) file system
    - 128K Nodes
    - HSM
      - 1 PB memory
      - 10 PB Tier 1 File System storage on SSD
      - 100’s PB Tier 4, optical, etc.
CHALLENGES OF DEPLOYING FLASH MEMORY

THE NEED FOR A NAND FLASH CONTROLLER

- NAND Flash cells are programmed
  - Can Read and Writes to pages using LSF scheme
  - Updates need previous Erasing of a large Block
  - Causes «Write Cliff» when free blocks are exhausted

- Write Endurance of Flash Cells is limited
  - SLC vs MLC (1 vs 2 bits per cell = 100K vs 10K write cycle)
  - Needs very robust Error detection and correction logic
  - Additional techniques must be applied:
    - Log Structured File approach for Writes
    - Overprovisioning
    - Garbage Collection
    - various compression schemes
    - Wear Leveling
HITACHI ACCELERATED FLASH STORAGE

RACK OPTIMIZED FLASH MODULE DRIVE

Flash Module Drive (FMD)
1.6TB Capacity
3.2 TB in 1Q2013

Flash Module Unit (FMU)
12 FMD’s in 2U Chassis

Flash Module Drive Chassis (FBX)
With Max 48 FMD’s

RAID-1, RAID-5, and RAID-6 (managed by VSP) - Single FBX scales 6.4TB to 307.2TB
Today, you can buy new standard drives that are compatible with media written over 30 years ago. This trend will continue due to markets for consumer and distribution driven volume.
Holographic Storage store data elements as images at different angels.

- **Write**: Laser illuminates SLM, reference beam and signal beam interfere, and data is recorded in the SLM.
- **Read**: Laser illuminates CMOS, data is read out by presenting the reference beam to the media.

Record by interference between the signal and reference beam.

Readout by presenting reference beam to the media.

2 Dimension Data (Mega pixels)
Current eResearch Node infrastructure supported by Hitachi
- Intersect Australia
- eResearch SA

Additional related academic infrastructure
- Griffith University [Nathan Campus]
- Queensland Brain Institute
- Geoscience Australia

Garvan Institute of Medical Research
- awarded Hitachi’s Health and Life Sciences Innovation Award
THANK YOU