Data Management at the Texas Advanced Computing Center

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Texas Advanced Computing Center

- TACC is 12 years old as of last Saturday
- Serving local, statewide, and national research communities
- Leadership in NSF supercomputing, national cyberinfrastructure (XSEDE, iPlant)
- Expanding data management and analysis offerings for last ~5 years
- Stampede - #7 on TOP500 list
- World-Class visualization facilities

Data @ TACC

- Data Intensive Computing Division
  - Data Management and Collections
  - Data Mining and Statistics
- Broadly, we provide resources, services and expertise:
  - "Corral", 6PB disk-based storage
  - Experimental Hadoop-based platform
  - "Ranch", 100+PB Tape Archive
  - Training, consultation, and collaboration

Data Management and Collections

- Assist researchers in managing, sharing and preserving data collections

- "Data" is anything generated in the course of research activities

- Spreadsheets, simulation output, sensor output, statistical analyses, visualization, etc

- "Management" is having a plan for this data before you start creating it

Data Management w/o Plans

- Until recently, data management planning often happened after the fact

- Common case: long-running projects with:
  - A few terabytes of data
  - Thousands to millions of files
  - Data on a few servers, external disks, laptops
  - 0 to 1 people who know what and where it is

- Adapt to new, organized workflow on the fly

Data Management Planning

- More recently, researchers want to do this ahead of time

- TACC Collaboration with UT Library and UT ITS:
  - Central resource website w/ DMP template
  - Route researchers to appropriate information and organizational unit
  - Publications handled by library
  - Large datasets handled by TACC

Data Management Training

- Provided through XSEDE and UT System
- Several courses, 1-3 hours:
  - Data Management Planning and Execution
  - Storage Systems and Networks
  - Metadata creation and management
  - Using Corral
- Will soon begin offering full-day workshops

Storage Resources

- Historically, very few dedicated "persistent online storage" systems in NSF ecosystem

- Corral first deployed 4+ years ago as 1PB resource for data collections

- Restricted to UT Austin researchers but still fully utilized

- More recent UT Data Repository expansion supports more data, wider user base

Corral Deployment Model

- Persistent system with changing collection of technology components

- Have completed one full hardware transition (1PB to 5PB) plus expansion (5PB to >6PB)

- Add specific hardware to meet varied needs (e.g. SSD arrays for large databases)

- Eventual goal to make all technology migration transparent to data users

UT Research Cyberinfrastructure

- University of Texas System assessment of needs for research cyberinfrastructure:
  – Research data storage
  – High-Performance Computing
  – Dedicated 10 gigabit networking for research
- $23 Million total investment in 2011
  - $15 Million for network infrastructure
  - $4 Million for research data infrastructure

The University of Texas System

- 15 Total Institutions
  - 9 "Academic", i.e. non-medical
  - 6 Health Institutions
- Most prominently:
  - UT Austin
  - UT Southwestern Medical School
  - MD Anderson Cancer Center
  - UT Health (Houston)

UT Data Repository Requirements

- 5 Petabyte usable capacity

- Geographically replicated

- Open to all UT System researchers

- Scalable in performance and capacity

- Support for sharing data outside UT System

- Support for data management functions

UTDR Implementation: Corral

- 2 Installations (Austin and Arlington):
  - 12 Dell Servers w/ Infiniband & 10GigE
  - 2 Data Direct Networks storage controllers
  - 5PB raw capacity 3TB SATA drives
  - 350TB raw capacity 600GB SAS drives
  - 20GB/sec measured performance
- IBM General Parallel File System
- iRODS Data management software

Corral Software Services

- Static and Dynamic web services:
  - File Hosting
  - Java/PHP/Python web applications
  - iRODS-backed web applications
- Database applications
  - Postgres and MySQL
  - MonetDB
  - Statistical analysis with SAS/R/Matlab often tied to large databases

iRODS Data Management

- Provides virtual hierarchy overlaying multiple file systems and the tape archive

- Supports collections with metadata and data-sharing needs

- UNIX Command-line interface, WebDAV, Web browser application, many APIs

- Supports high-performance data transfer (100s of MB/sec) where clients support it

Data Management Functions

- Development support for structured data, data management tools, metadata, web

- Hosting capabilities for all of the above

- Additional planning support for proposals

- Up to 5 year commitments for data storage

- Not yet truly "long-term" preservation

UTDR Allocation Model

- 5TB "free" for UT Principal Investigators
- Web-based account signup/allocation request
- Human review for allocations at present
- Plan to automate approvals using InCommon
- Larger allocations on a $250/TB/year basis
- Allocations often coupled with HPC or analysis resource access

UTDR Sustainability Plan

- Expectation of ongoing subsidy from UT for "free" tier of storage

- Recharge tier provides for ongoing expansion/replacement of hardware for paying users

- Subsidy not required for continued operation

Corral Adoption/Usage

- Over 100 PIs within first year of operation

- Data growth about 10% per month

- ~10% of PIs account for ~50% of usage

- Usage in almost all disciplines/departments

- Major adoption from genome researchers
  - Up to 80% of new requests in some months

Future Plans for Corral

- Implement true "long-term" preservation via Digital Preservation Network

- Expand to third site for increased replication

- Support HIPAA, other high-security data types

- Increase support of web-based data sharing

Overview of Application Space

- Many projects begin with simple need for storage of large data collections

- Storage leads to further sharing and organization

- Proximity to HPC provides for new kinds of analysis, including automated workflows

- Metadata, web development provide new sharing capabilities

Applications: Genome Sequencing

- Currently up to 80% of new data collections are DNA-related data

- Wide array of processing and analysis applications

- Multi-Terabyte datasets now common, multi-petabyte datasets not unheard of

- Significant need for data-sharing capabilities

- Comparative analyses produce major results

Applications: fMRI

- Several active collaborations in this area
- Automated ingest, processing of fMRI images
- Hosting of public data-sharing websites for fMRI data
- Collaboration on wider distribution and linkage of fMRI data across consortia
- Data collection sizes from 5-50TB

Detailed Example: ICA

- Institute for Classical Archeology
  - 2 major archeological digs with multi-decade lifespans
  - Diverse collection of geo-referenced notes, images, other digital artifacts
  - No consistent organizational scheme
  - Need to create metadata, GIS database, image archive, and linking website
  - Goal: Documentation and "processual archeology"

TACC and ICA

- Initial consultation in 2008
- 2 Initial tasks: understanding workflow and ingesting as much data as possible
- Development of standard metadata, data organization scheme, file-naming conventions
- Support for multiple websites hosting data collections for specific groups of locations
- Massive improvement in overall data management and dissemination capability

Other Major Uses

- Natural History Collections – database, web, and media sharing

- Sharing of simulation output – engineering, physics, astronomy, chemistry

- Social Science data analysis – large structured datasets, often from government sources

- "Smart Grid" applications – massive structured data inputs, analysis and simulation

Data Area Research Interests

- Benchmarking of large-scale storage systems – Object stores/HDD/SSD/etc

- Benchmarking of SQL and No-SQL solutions

- Tracking of data collections infrastructure and curation needs

- Development of automated curation workflows

- Reliable, high-performance data transfer

TACC Data futures

- 2012 O'Donnell Foundation grant
  - $10 Million to expand data-intensive computing@TACC
  - Expect VM/service hosting cluster, parallel file system, and "data analysis" components
  - File system component to be announced in June
- 100-Gigabit network expansion
- Expanding staffing across Data division

Observations on "Big Data"

- Not all the hype is true

- But, a lot of it is…
  - Data Volume and Velocity is increasing across all disciplines, in some cases exponentially
  - New capabilities for analysis/visualization/ understanding of data are being developed
  - Sharing of data across research projects enables significant new science to be done

Q & A

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