UCSD’s Research CyberInfrastructure (RCI) Program: Enabling Research Thru Shared Services

UC-CSU Shared Services Conference
July 11, 2013

Richard Moore
University of California San Diego
Why UCSD Is Investing in RCI Program

- Increase competitiveness of UCSD researchers
- Realize cost efficiencies and improve service via economies of scale and shared services
- Preserve UCSD’s digital intellectual property
- Save energy/$ and effectively use data center capital investments (colocation)
Elements of UCSD’s Integrated Research CyberInfrastructure

- Data Center Colocation
- Networking
- Centralized Storage
- Data Curation
- Research Computing
- Technical Expertise
**RCI is rolling out production shared services for UCSD researchers**

<table>
<thead>
<tr>
<th>Service</th>
<th>Status</th>
<th>Lead/contact for service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colocation</td>
<td>Production</td>
<td>Matt Campbell (SDSC) <a href="mailto:mattc@sdsc.edu">mattc@sdsc.edu</a></td>
</tr>
<tr>
<td>Networking</td>
<td>Production</td>
<td>Valerie Polichar (ACT) <a href="mailto:vpolichar@ucsd.edu">vpolichar@ucsd.edu</a></td>
</tr>
<tr>
<td>Research Computing</td>
<td>Production</td>
<td>Jim Hayes (SDSC) <a href="mailto:jhayes@sdsc.edu">jhayes@sdsc.edu</a></td>
</tr>
<tr>
<td>Centralized Storage</td>
<td>Production FY13-14</td>
<td>Wilfred Li (SDSC) <a href="mailto:wilfred@sdsc.edu">wilfred@sdsc.edu</a></td>
</tr>
<tr>
<td>Data Curation</td>
<td>Completing pilots; production FY13-14</td>
<td>David Minor (Libraries) <a href="mailto:dminor@ucsd.edu">dminor@ucsd.edu</a></td>
</tr>
<tr>
<td>Technical Expertise</td>
<td>Interim services FY13-14</td>
<td>Tad Reynales (Qualcomm Inst) <a href="mailto:treynales@ucsd.edu">treynales@ucsd.edu</a></td>
</tr>
</tbody>
</table>
Colocation – in production

- Host IT equipment in energy-efficient, manned data center
  - SDSC’s 18kft², 13MW datacenter
  - Standard rack space, secure facility, seismic protection
  - 24/7 operations staff provide facility oversight and emergency "remote hands" hardware assistance
- RCI supplements rack rate: user pays $2500/rack/year
- NGN may cover basic networking costs; evaluated case-by-case
- Up to 10 Gb networking fabric connectivity available, both thru SDSC aggregation fabric and into CENIC
- UPS and generator capabilities available
- Cage and locked rack options available for security/compliance
High-Performance Networking in the Research Lab

Lab switch - 10G up, 1G down

Lab pays for fiber from switch to lab – ~$200 to ~$2000 depending on location and building details

Lab switch - 10G up, 1G down

Lab must purchase an ACT-approved lab switch and any needed local cabling – ~$6000 for 10G up/1G down, ~$12000 for 10G up/down.

Sites requiring dedicated 1G or 10G pipes across campus (or to Internet2 or NLR) will incur specific additional costs, hard to estimate generally

- NGN3 supports 10G to the building switch & building switch 10G optics pointing towards the lab
- Department/lab pays for “last 100 feet” connectivity to use capability – fiber & lab switch
Research Computing
(in production)

- RCI has evolved SDSC’s Triton system to the RCI “Triton Shared Computing Cluster” (TSCC)
- Condo model: Researchers purchase compute nodes which are operated as part of shared cluster for 3-4 years
  - PI buys hardware & modest ops fee
  - Lower operations cost than local PI cluster; larger-scale resource available (core count and capacity); professionally-managed
- Hotel: Purchase time by the core-hour; shared queue
Data Curation – in pilot (production FY13-14)

• Completing a two-year pilot phase
  • How do lab personnel work with librarians to curate their data?
  • How much work is required to curate data and what are options?
  • What is a sustainable business model for curation within RCI project?

• Five representative programs across UCSD selected as pilots
  • The Brain Observatory (Annese)
  • Open Topography (Baru)
  • Levantine Archaeology Laboratory (Levy)
  • SIO Geological Collections (Norris)
  • Laboratory for Computational Astrophysics (Wagner)

• Using existing tools whenever possible
  • Storage at SDSC, campus high-speed networking, Digital Asset Management System (DAMS) at UCSD Libraries, Chronopolis digital preservation network

• Also, develop Data Management Plan tools and provide training

• Anticipate production curation services in FY13-14
Data Management Plans

- Resources and contacts available to UCSD researchers
- Examples from submitted proposals
- Guidance, tips and recommendations for DMP preparation
- Consultation services for metadata, data repositories
- UCSD-centered version of DMP Tool

http://rci.ucsd.edu/dmp/index.html
Centralized Storage
(phaséd production thru FY13-14)

- Completed survey of a broad sample of ~50 representative PIs to understand technical and cost requirements
- Identify common needs, and define sustainable RCI business model with strong adoption
- Anticipate production centralized storage services in CY13
  - RCI Network-Attached Storage (RCI/NAS) available Spring CY13
  - Further services to be rolled out throughout the year, based on requirements analysis
**PI Interview Responses: Where is Your Data Coming From?**

<table>
<thead>
<tr>
<th>Data Source</th>
<th>%</th>
<th>Representative Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequencers</td>
<td>28</td>
<td>Biology</td>
</tr>
<tr>
<td>Software applications</td>
<td>28</td>
<td>Biology, Physics</td>
</tr>
<tr>
<td>Field sensors/instruments</td>
<td>20</td>
<td>Marine Biology, etc.</td>
</tr>
<tr>
<td>Audio visual equipments</td>
<td>10</td>
<td>Arts</td>
</tr>
<tr>
<td>Mass spectrometers</td>
<td>8</td>
<td>Biology</td>
</tr>
<tr>
<td>Tomographic instruments</td>
<td>8</td>
<td>Biology, medicine</td>
</tr>
<tr>
<td>External data repositories</td>
<td>8</td>
<td>Biology</td>
</tr>
<tr>
<td>LHC particle detectors</td>
<td>3</td>
<td>Physics</td>
</tr>
<tr>
<td>Archelogical studies</td>
<td>3</td>
<td>Humanities</td>
</tr>
<tr>
<td>Curation</td>
<td>3</td>
<td>Sociology</td>
</tr>
</tbody>
</table>

Numbers reflect percentages of PIs surveyed that utilize each solution; Individual PIs use multiple solutions, so %’s add up to >100%.

- Indicates use cases for connectivity
- Data sources:
  - ~50% campus instruments
  - ~30% simulations (XSEDE, campus, lab systems)
  - ~20% field instruments
  - ~15% other external sources
- %’s reflect PIs, not data volume
How do You Handle Data Storage/Backup?

**Storage Devices**
- Network accessible storage (NAS), USB and server local drives dominate
- Use of Dropbox for sharing
- Others use Google Drive, Hadoop, XSEDE, SDSC co-location

**Backup modes**
- Replicated copies in two NAS
- A copy in the NAS,
- A copy in local hard drive (laptop/workstation),
- And a copy in a USB drive
- Maybe a copy in email/Dropbox

**Problems:**
- Out of sync
- Lost track of its location
- Lost version control
- High cost of recovery

---

**Table 2. Data Storage Devices and Services Utilized**

<table>
<thead>
<tr>
<th>Type</th>
<th>%</th>
<th>Primary purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network attached storage (NAS) devices</td>
<td>73</td>
<td>Standard performance network filesystem</td>
</tr>
<tr>
<td>USB Drives</td>
<td>70</td>
<td>Storage and backup</td>
</tr>
<tr>
<td>Local server hard disk drives</td>
<td>65</td>
<td>Storage and backup</td>
</tr>
<tr>
<td>Dropbox</td>
<td>33</td>
<td>Data sharing</td>
</tr>
<tr>
<td>SDSC Project Storage</td>
<td>13</td>
<td>Standard performance network filesystem</td>
</tr>
<tr>
<td>XSEDE Lustre Filesystem</td>
<td>10</td>
<td>Parallel filesystem</td>
</tr>
<tr>
<td>Google Drive</td>
<td>10</td>
<td>Storage and sharing</td>
</tr>
<tr>
<td>Amazon S3</td>
<td>8</td>
<td>Storage and sharing</td>
</tr>
<tr>
<td>SDSC Cloud Storage</td>
<td>8</td>
<td>Storage and sharing</td>
</tr>
<tr>
<td>Tape library</td>
<td>5</td>
<td>Storage and backup</td>
</tr>
<tr>
<td>Small Area Network Storage Array</td>
<td>3</td>
<td>Databases</td>
</tr>
<tr>
<td>CD/DVD</td>
<td>3</td>
<td>Storage and backup</td>
</tr>
<tr>
<td>Hadoop Filesystem</td>
<td>3</td>
<td>Replication and Map Reduce</td>
</tr>
<tr>
<td>iRODS</td>
<td>3</td>
<td>Metadata driven storage and sharing</td>
</tr>
</tbody>
</table>

Numbers reflect percentages of PIs surveyed that utilize each solution; Individual PIs use multiple solutions, so %’s add up to >100%.
PI Interview Responses: How much storage do you need: now, future, permanently?

Data Storage and Growth in the Present and Next 2 Years

- For PIs interviewed, current needs 1-1000TB
- Increasing in future
- Perceptions of permanent storage interesting – none for some, intermediate for many, large for a few
Interview responses: Metadata and retention requirements

Do you need metadata annotation capability?

- Yes, 23%
- Not yet, 33%
- Not sure, 5%
- No, 40%

How long do you need to retain your data?

- 1 year: 3%
- 2 years: 3%
- 3 years: 3%
- 5 years: 20%
- Permanently: 30%
- Duration of Project: 63%
- Other: 3%
Interview responses: What are you willing to pay for storage?

- Intentionally posed a relative question rather than absolute $’s
- Willing to pay “about the same” or “more” for shared services
- PIs comfortable with hardware costs but …
- Often ignore staff cost to operate equipment
  - “Hard to compete with slave labor” (Jim Pepin)
## Risks and Challenges to University Researchers

<table>
<thead>
<tr>
<th>Risks and Challenges</th>
<th>%</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus may cease funding for RCI</td>
<td>85</td>
<td>Adoption barrier</td>
</tr>
<tr>
<td>Constantly increasing storage demands</td>
<td>65</td>
<td>Distraction from research</td>
</tr>
<tr>
<td>Bait and switch with increased cost later</td>
<td>53</td>
<td>Poor business practice</td>
</tr>
<tr>
<td>Poor backup plan</td>
<td>50</td>
<td>Lack of expertise</td>
</tr>
<tr>
<td>No dedicated support staff</td>
<td>50</td>
<td>Distraction from research</td>
</tr>
</tbody>
</table>
What Researchers Desire as RCI

• Human expertise
  • “Critical mass of technical knowledge on computing, networking, and storage to run the facility at the state of the art level. Consulting services, particularly critical for young investigators. Technical webinars, recorded and archived, would be very useful for distributed campus units”
  • “Help design the primary data stores, fast scratch space for intermediate analysis, hosted web space for final results, and backups of everything. Connectivity to local cluster, campus and national resources, and commercial cloud services.”

• Commercial Quality and Ease of Use
  • “Amazon S3 level stability; Campus wide Active Directory (AD) support; Dropbox-like UI for users”
  • “Tiered service/cost levels to provide the minimum, mid to full experience.”
  • “Configure service offerings in ways that can be used as matching funds in grant applications.”

• Infrastructure services
  • “Centralized services (virtualized compute/storage) offered at competitive prices and performances.”
  • “Great to have unlimited run times on my own cores, without having to resubmit.”
What is RCI to me?

- **Cost**
  - "**Dependable, economically reasonable storage for data protection**; Current SDSC Cloud/Project Storage are too expensive; Pricing models close to hardware cost plus part time labor needed"
  - "Campus may be required to provide matching funds for equipment donations and external funding. Shared internal resources are difficult to get commitments from donors."
  - “Love to find ways to archive data for long term that is cost effective and efficient, which do not need to be online most of the time.”

- **Grants**
  - “**Cost-effectiveness is key in national competitions for grants**. Universities with large shared resources that provide additional opportunistic resources increase their competitiveness.”
  - “**Help to keep costs within constraints of grant budget, and free research personnel/developers to do better things**.”

- **Metadata**
  - “Where is the data from my student who just left?”
  - “**Who else is working on this gene on campus?**”
What’s Changed Along the Way?

• Technical expertise remains central to RCI’s objectives, but it’s harder to ‘package’ into a scalable service

• Should view storage and curation in the context of an integrated data life cycle
  • Emergence of NSF’s DMP and NIH’s data sharing requirements impacts what researchers need

• Colocation services should be viewed campus-wide, with consistent costs and incentives
  • Very different facilities and costs; should RCI offer a range of options?

• Can campus support a dedicated research network in addition to shared campus network infrastructure?
  • Issues of grant-funded networking capability
**RCI Lessons Learned**

- **We should have asked for a multi-year budget commitment at outset**
  - PIs need to be confident program will be there; ‘condo’ programs impossible

- **Campus needs to subsidize total cost of ownership in order to overcome a natural preference for autonomy and control**
  - PI’s often have different views of the total cost-of-ownership

- **Incentives need to be consistent**
  - e.g. Using a closet down hall is free to PI, while energy-efficient colo costs$

- **Project needs diverse skills, not just technology, working together**
  - Need technical skills, marketing, user support processes, business plans, finances, metrics, and campus governance – across multiple organizations

- **Adoption takes time (marketing down, managing up)**
  - Demonstrated commitment, persistence and consistency (including costs)
  - Hearing from colleagues has a lot more credibility than from service provider
  - Get cost of services into new grant proposals, not redirecting current budgets
How to get more info about RCI

• Web site: rci.ucsd.edu
• For each production service, site includes
  • Description of services
  • Cost summary
  • Approved verbiage for PIs to use in proposals
• Email rci@ucsd.edu
• Call Richard Moore, RCI Proj Mgr, ext 858-822-5457
UCLA SHARED CLUSTER AND CLOUD STORAGE PROGRAM

Bill Labate, Director
Research Technology Group
Institute for Digital Research and Education

UC/CSU Shared Services Conference
UCI, Irvine, CA
July 11, 2013
Shared Cluster Program Goals

- Allow researchers to concentrate on research while their HPC tools are maintained for them by the campus in a manner that maximizes resource use while lowering overall cost.

- Researchers only pay for the part of the system that has a high turnover rate, i.e., the hardware they need to satisfy their individual requirements.

- The campus pays for all core services and infrastructure where economies of scale can be realized.

- Incentivize researchers to do the right thing, for themselves and by extension, the campus
Shared Cluster Program - Challenges

- Building trust on the campus
- Getting researchers to share
- Hiring and retaining the right people
- Providing a broad service – but not too broad
  - Allow customization but,
  - The overall stability and security of the system cannot be compromised!
- Keeping the infrastructure funded
  - Charging for the service is the “kiss of death”
    - Drives researchers underground with no cost or operational efficiencies
- Technology upgrades
  - When, how much, mixed infrastructure support
Shared Cluster Program - Stats

- Currently 1,141 nodes* and 11,052 cores*, ~103 Tflops. ~360 Tflops with GPU’s.* With Dawson2 GPU Cluster
- 1,400+ users, 175+ research groups from 80 departments
- Processed 20 million jobs, 50 million core-hours in 2012

As of 7/09/13:
Shared Cluster Program - Lessons Learned

- MUST have startup funding
  - Infrastructure, “incentives” to kick off the program
- Stable funding for support staff, operating expenses
- Trust is key to participation by faculty
  - Be prepared to spend the time to develop it
- The right balance of support/consulting
  - Basic versus advanced needs
- Make it a “no brainer” to use your service
  - The benefit should be extremely compelling
  - Mandating use won’t work
- Defined service but still flexible
- Sharing CAN work
 Provide archival and backup of research data with the following characteristics:

- Professionally run, flexible, full service offering
- A highly competitive price which is
  - Lower than external Cloud Storage providers
    - Data is kept on campus. No extra data movement charges
- Better than the usual DIY solutions which generally:
  - Have lower reliability, scalability, performance
  - Never account for labor costs — 2-4hrs/mo. ~$350-$700/yr. which is typically paid from research funds
- "Good enough", no extras that drive the cost up
- A balance of ease of use, performance, reliability, flexibility, maintainability versus cost
Cloud Storage Program – Why?

- A large percentage of UCLA’s precious research data is currently backed up in “consumer-level” systems
- Increasing demand for multiple terabytes of “inexpensive”, “good enough” backup/archival research data storage.
- Our HPC storage is overkill, too expensive, and difficult to make available outside of our cluster environment.
- A need to satisfy various granting agency data plan requirements for retention and sharing
Cloud Storage - Approach

- We built a self-contained service
  - Funds itself, covers cost of the service only
    - Keep rates down - does not spread cost over our entire operation
  - Leverage our buying power and negotiating skills
    - Volume purchase
    - Sized to identifiable (initial) demand
- Cost appropriate
  - Priced at or below what users are spending now for “junk”
  - Offer discounts for volume and time commitments
Cloud Storage - Challenges

- Three problems
  - Will vendors play ball?
    - Turns out, yes, they will
    - Not so surprising
  - Will university play ball?
    - Turns out, also yes (!)
    - Very surprising
      - Although it has taken twelve months to work the details
  - Will users buy enough to justify the program?
    - Our survey results say yes
Cloud Storage – The Compromise

- Cannot be everything to everyone
  - It will ruin our cost model
  - We will do it badly
  - Everyone will be unhappy
  - We don’t want to duplicate what others are offering

- We made two important choices
  - Virtualize the front end and the storage
  - Everything to everyone – up to a point
    - Not saying yes and not saying no
Cloud Storage - Implementation

- Reliability over performance
  - But we do not expect the performance to be an issue
- Enterprise/HPC level hardware
- We will offer local mirroring of data
  - Two copies across two, on campus, data centers
- Future service to offer off campus replication
  - Separately charged service
  - Location TBD
Cloud Storage - Status

- Financials and rates have been approved
- Storage will be available in
  - Volume increments of 1TB, time increments of 1 year
- Discount rate structure
  - Breaks at 2, 4, 8, 16, 32 and 64TB and
  - At 2, 3, 4 and 5 years
  - Prices
    - From less than $168 down to $118 /TB/Year
    - 29.5% discount from highest to lowest rate
- Availability
  - UCLA first, other UC campus to follow if demand is there
  - CSU and others will require a separate set of rates
  - Testing now, end of August production
  - Interested in non-UCLA testers/users
- Working Protected Data compliance procedures
Cloud Storage Program

Cloud Storage Services Price Comparison

<table>
<thead>
<tr>
<th>Cloud Storage Program</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rackspace</td>
<td>$922</td>
</tr>
<tr>
<td>Dropbox***</td>
<td>$795</td>
</tr>
<tr>
<td>Amazon S3**</td>
<td>$776</td>
</tr>
<tr>
<td>Google**</td>
<td>$738</td>
</tr>
<tr>
<td>I2 Box.net***</td>
<td>$540</td>
</tr>
<tr>
<td>IDRE HPC*</td>
<td>$500</td>
</tr>
<tr>
<td>IDRE Cloud</td>
<td>$138</td>
</tr>
<tr>
<td>DIY RAID6</td>
<td>$124</td>
</tr>
<tr>
<td>DIY RAID5</td>
<td>$93</td>
</tr>
</tbody>
</table>

1TB of Usable Storage per Year

Single Copy

* No single replica option.  ** Without read traffic charges.  ***Replica on user’s desktop

Includes no labor costs
THANK YOU

Bill Labate, Director
Research Technology Group
Institute for Digital Research and Education

labate@idre.ucla.edu