Center for Advanced Research Computing
Internal Advisory Board
Wednesday, September 19, 3 p.m.

MINUTES

Present: **Patrick Bridges** - Director of CARC; **Jeremy Edwards** - Professor, Chemistry; **Andrea Polli** - Mesa Del Sol Endowed Chair of Digital Media Professor, Fine Arts and Engineering University of New Mexico Department of Art and Art History; **Hua Guo, Ph.D.** - Distinguished Professor, Department of Chemistry and Chemical Biology, and Department of Physics and Astronomy; **Patricia Henning, Ph.D.** - Associate Vice President of Research; **Keith Lidke, Ph.D.** - Associate Professor, Physics & Astronomy; **Monika Nitsche** - Professor, Mathematics and Statistics; **Brian Pietrewicz, M.B.A.** - Interim Deputy CIO, Information Technologies; **Gregory Taylor, Ph.D.** - Director, Long Wavelength Array; Director, Center for Astrophysical Research and Technology; Professor, Department of Physics and Astronomy; **Lee Taylor, Ph.D.** - Associate Professor, Biology; **Tom Turner** - Associate Dean for Research, Arts & Sciences, and Professor, Biology; **Tracy Wenzl** - CARC Unit Administrator

I. CARC status update, presented by Patrick Bridges, CARC Director

II. CARC User Survey overview of preliminary results

III. CARC Strategic Plan – discussion of action items achieved so far, and what to prioritize in next year.

   i) Events were discussed, and it was recommended CARC do its own events and symposia, rather than sponsoring others, to build CARC community.

   ii) GA appointments were discussed, as was their funding. It was suggested that CARC follow GAs after they move on to other positions to see if they are funded by future research, demonstrating the value of CARC GAships to the wider UNM community

   iii) It was suggested that to reach more users, CARC survey departments who might use CARC resources for further input beyond the user survey. The medical school, Biology and Chemistry were specific departments suggested for targeting of future expansion efforts.

   iv) The possibility of external partners was discussed, along with the reasons this could be difficult at this time (capacity, both equipment and human)

Minutes submitted by Tracy Wenzl, CARC Unit Administrator

Center for Advanced Research Computing
Internal Advisory Board
September 19, 2018

AGENDA

1. CARC Status Update
2. CARC User Survey
    - Review preliminary results and feedback
3. CARC Strategic Plan
    - Review Action Items and set priorities for next year

State of CARC: Fall 2018

Prof. Patrick G. Bridges

Director

Staffing

- **Leadership/Admin**
  - Prof. Bridges accepted position as non-Interim Director of CARC
- **User Support**
  - Dr. Matthew Fricke (CS Research Faculty) working 30% at CARC on user support
  - Employing 2-3 graduate students at CARC per semester from departments across campus (partial funding from OGS)
  - Increasing user support capacity
  - Examining replacement ticket system with OVPR
- **Technical team**
  - CARC-employed technical team remains largely unchanged
  - Working closely with Libraries to support virtualization and data storage

Funding

- 2 new NSF CISE/OAC research awards to CARC, discussing overhead return handling with OVPR
- "CICI: RDP: SAMPRA: Scalable Analysis, Management, and Protection of Research Artifacts"
  - Research using virtualization to support computing on sensitive data
  - $600,000 award (down from original $1M budget, all hardware cut)
  - Joint with UNM Libraries, Psychology, UNM IT
  - Plan to use as foundation for later MRI submission
- "CDS&E: Optimization of Advanced Cyberinfrastructure through Data-driven Computational Modeling"
  - Use stochastic modeling to understand and improve the performance of HPC and cloud computing applications and systems
  - $525,000 award joint with UNM CS and ECE
- Submitted DARPA MURI proposal, working with researchers on additional equipment proposals using cost model
- Other small amounts of funding - NSF EPSCoR, etc.

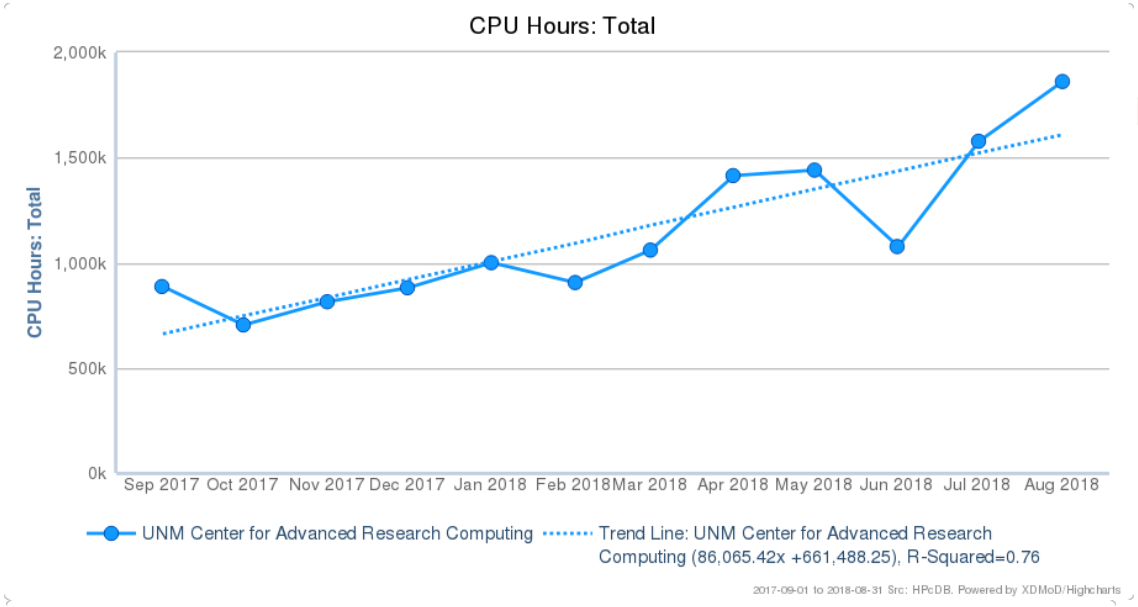
Education and Training

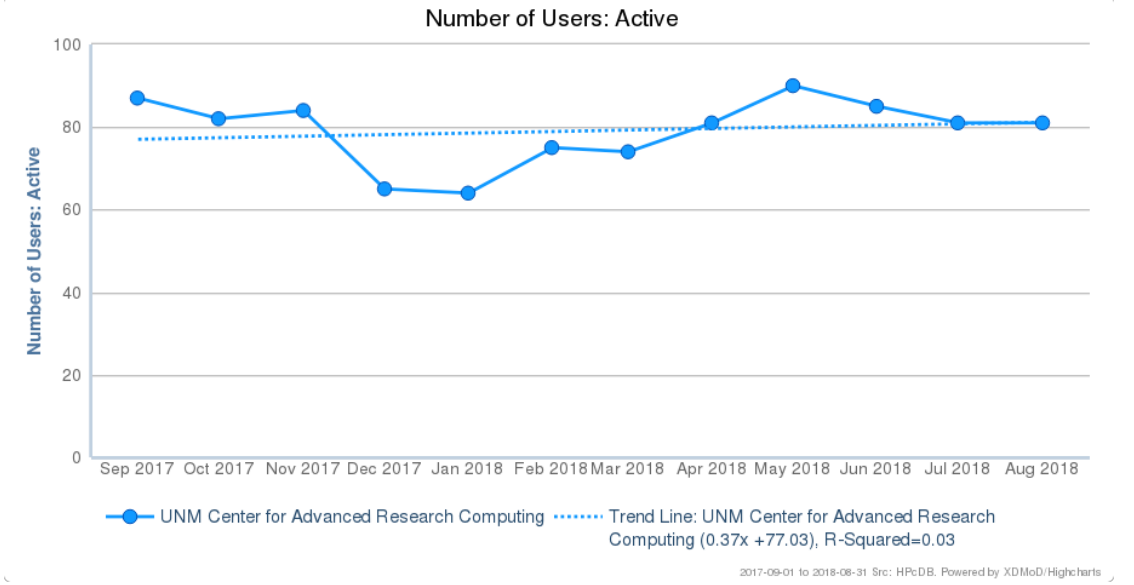
- **Submitted CSE catalog changes to simplify program and support robust specializations**
  - Finalizing Computational Fluid Dynamics with Mechanical Engineering and Math
  - Creating Data Science specialization with Math and Computer Science
- **In-person user trainings**
  - Regular schedule for Intro to CARC workshops – 11 users last week
  - Teaching modules in on-campus classes
    - Introduction to Scientific Computing
    - Introduction to Computational Fluid Dynamics
- **Developing and improving documentation**
  - Cleaning up core documentation
  - New documentation on using Apache Spark on CARC systems
  - Developing screencasts
  - Would like to online versions of in-class modules and workshops

Computing Systems

- **Wheeler now running at (but not above) capacity**
- **Acquiring new home directory storage system**
  - Replacing 25TB Linux NAS system with 50+TB NetApp
  - Examining new storage limits for users and projects
  - Joint project with UNM libraries – CARC and libraries technical staff support each other on system maintenance
- **Continuing scratch storage problems**
- **Still working through technical debt from legacy systems**
  - Infrastructure services still aging hardware and software
  - Much of the core network infrastructure needs revamping
  - Workstations/desktops are ancient
  - Tape backup system increasingly insufficient
- **Looking at data center alternatives joint with UNM IT**

System Usage





- System resource usage increased dramatically in last year
- Number of PIs and user remains largely flat

User Satisfaction - Survey Results

- **Key initial reactions**
  - Interest in using Big Data and Research Data Management
  - On-site compute capacity and customizability not sufficient for a subset of users
  - The help ticket system, office hours, and other contact with CARC staff are widely utilized for assistance.
  - Users generally received helpful responses, but the timeliness of the responses was on average moderate at best
  - Few users found it easy to get started on CARC systems.
- **Survey only hits current users, not missed potential users**

Strategic Plan Action Items

- **Strategy 1: Increase system accessibility, ease of use, and range of supported disciplines**
  - Survey users
  - Increase outreach to users via workshops, tutorials, and documentation
- **Strategy 2: User support**
  - Online Intro to CARC workshop
  - New mechanisms to collaborate with main campus users
- **Strategy 3: Grow and enhance systems**
  - Collaborate with PIs to grow system capacity
  - Advertise cost model for above baseline CARC systems and services
  - Pursue sponsored cyber-infrastructure act research opportunities

Strategic Plan Action Items (cont'd)

- **Strategy 4: Collaborative user community**
  - Regular (weekly/quarterly/etc.) rotating events
  - Examine techniques other interdisciplinary research groups and centers use to foster collaboration - Immediate
- **Strategy 5: Industry collaboration**
  - Overhaul the CSE certificate program to include the creation of course groupings offering specializations in particular areas

Strategic Plan Next Steps

- **Potential areas of emphasis in next year**
  - Continued/increased collaboration with Libraries, IT, other units
    - Systems and technical infrastructure
    - User support and outreach
  - Improved documentation, course modules, and user outreach/training (including online)
  - Support for new tools, interfaces, approaches for working with CARC systems to enable new users
  - Better cost model documentation and advertising
  - Long-term strategy for system growth and replacement
  - Community-building activities (symposia, poster sessions, workshops)
- **Advice/suggestions for directions in which to focus?**

Center for Advanced Research Computing

Patrick Bridges
Director

2017 Annual Review Of Category 3 Research Centers/Institutes | March 9, 2018

Mission

To lead and grow the computational research community at UNM.

To fulfill our mission, we will:

· Provide access to high-end computing resources and associated infrastructure;

· Offer specialized expertise and technical support;

· Coordinate and collaborate with other UNM programs that support the community; and

· Grow the collaborative user community through education, workshops, and outreach events.

2017 Goals And Status

- Develop a strategic plan for CARC
  - In keeping with the University's Research 2020 plan, we have developed a strategic plan to better meet the needs of our users. We are also working to develop a sustainable funding model to enable the expansion of our systems and services as demand for CARC services grows and evolves.
- Develop and advertise cost center models for above baseline CARC systems and services
  - A cost model was developed in 2017 and received approval from the Internal Advisory Board. It was approved by the Executive Advisory Board and Unrestricted Accounting in 2018 and is now posted on our website.
- Work with PIs and other units and departments on sharing resources to grow capacity
  - Acquired joint enterprise storage system and virtualization system in collaboration with University Libraries
  - Recruited students from UNM departments to increase campus expertise and user support capacity
- Pursue cyber-infrastructure grant and contract research opportunities to enhance system capabilities
  - Submitted an NSF OAC proposal (pending) for researching new HPC system software approaches
  - Submitted an NSF CNS preproposal (encouraged) to deploy a system for research with streaming data

Membership of Advisory Committee

Karl Benedict, Ph.D. - Associate Professor, Director of Research Data Services. College of University Libraries and Learning Sciences

Vince Calhoun, Ph.D. - Distinguished Professor, Electrical and Computer Engineering, Biology, Computer Science, Neurosciences, and Psychiatry; Executive Science Officer, The Mind Research Network

Jed Crandall, Ph.D. - Associate Professor, Computer Science

Laura Crossey, Ph.D. - Interim Associate Dean for Research, Arts & Sciences and Professor, Earth and Planetary Sciences

Jeremy Edwards, Ph.D. - Professor, Chemistry

Miguel Gandert, M.A. - Director, Interdisciplinary Film and Digital Media (2017)

Hua Guo, Ph.D. - Distinguished Professor, Department of Chemistry and Chemical Biology, and Department of Physics and Astronomy

Patricia Henning, Ph.D. - Associate Vice President for Research; Professor of Physics and Astronomy

Jane Lehr, Ph.D. - Professor, Electrical and Computer Engineering

Keith Lidke, Ph.D. - Associate Professor, Physics & Astronomy

Barbara McCrady, Ph.D. - Distinguished Professor, Psychology; Director, Center on Alcoholism, Substance Abuse, and Addictions (CASAA)

Monika Nitsche, Professor, Mathematics and Statistics

Brian Pietrewicz, M.B.A. - Deputy CIO, Information Technologies

Edl Schamiloglu, Ph.D. - Distinguished Professor, Electrical and Computer Engineering; Associate Dean for Research, School of Engineering

Gregory Taylor, Ph.D. - Director, Long Wavelength Array; Director, Center for Astrophysical Research and Technology; Professor, Department of Physics and Astronomy

Lee Taylor, Ph.D. - Associate Professor, Biology

2017 Highlights

- Major awards
  - Received gifted computer system from Los Alamos National Laboratories, which includes 228 nodes, each featuring two quad-core 2.66 GHz Intel Xeon 5550 CPUs and 48 GB of memory. The new system, named Wheeler, was launched in two phases in 2017.
- Publicity
  - Hosted a booth at UNM Day at the Roundhouse
  - Hosted NM Supercomputing challenge student evaluations
  - Developed and deployed center communications strategy, including re-launch of social media accounts
- Major conferences
  - UNM/Los Alamos National Labs Computational Symposium
  - ACM/IEEE International Conference on Supercomputing
  - I-IWG Working Group on New Mexico Computational Science Pathway

Proposals & Awards

In prior years, CARC did not run grants through the Center; named staff were paid from funds held in other UNM departments.

In 2017, two grant applications, to be run through the Center, were submitted:

- CRI Preliminary: II-EN: Research Infrastructure for Continuous Analysis of High-Intensity Data Streams, $656,956 (encouraged, full proposal submitted in early 2018)
- CDS&E: Optimization of Advanced Cyberinfrastructure through Data-driven Computational Modeling, $523,644 (pending)

FY 2017 Budget

Salary (72%)

- All CARC staff, temp costs, and director

Infrastructure (14%)

- Computers, software, equipment and storage maintenance contracts

SC Conference (6%)

- Exhibition booth & staff travel to supercomputing conference – expenses overlap FY, most expenses from SC16*

Administration (4%)

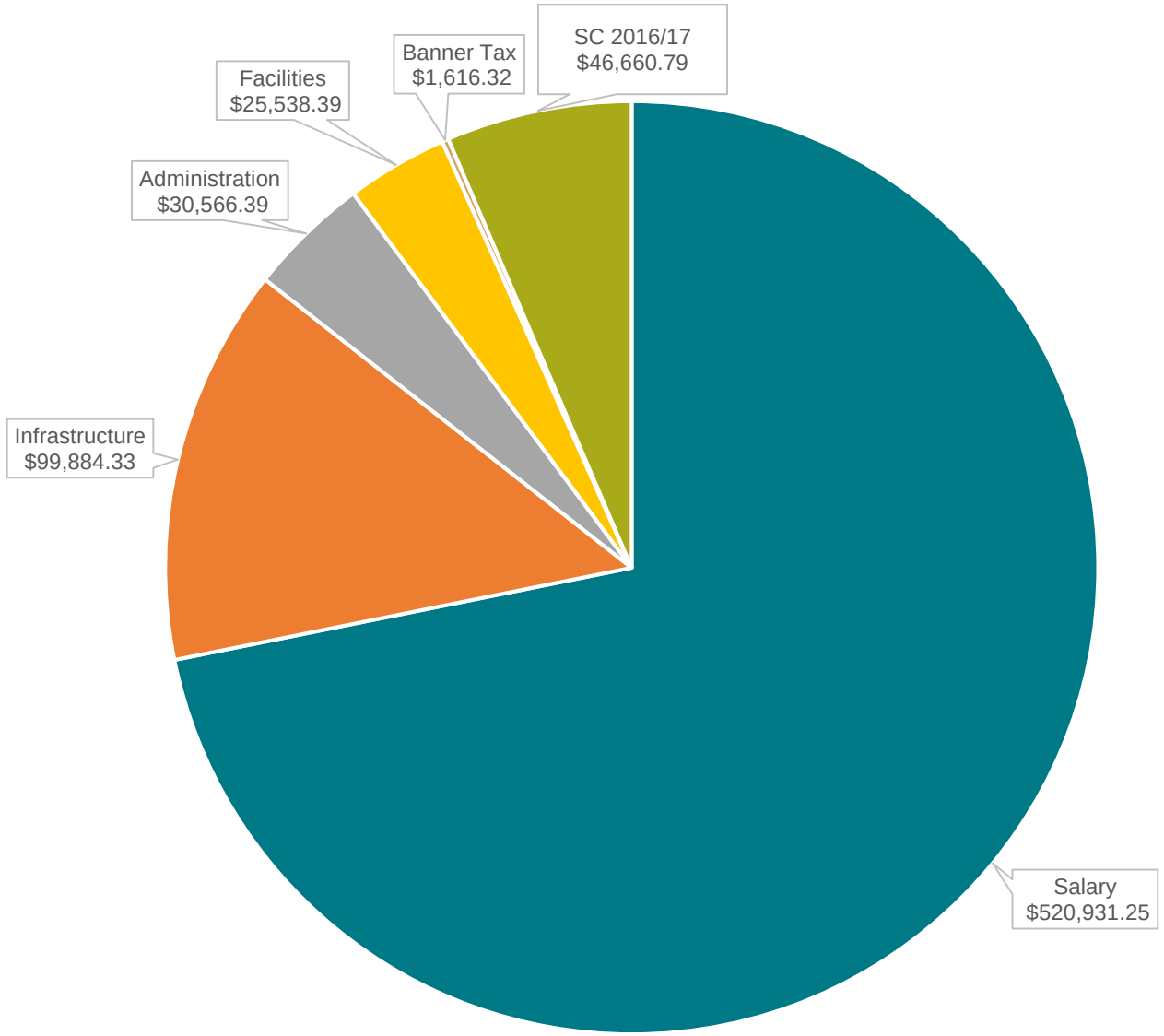
- Office supplies, phones, copier, travel, legal fees

Facilities (4%)

- Machine room (MMR) electrical work, cooling system repair

Banner Tax (0%)

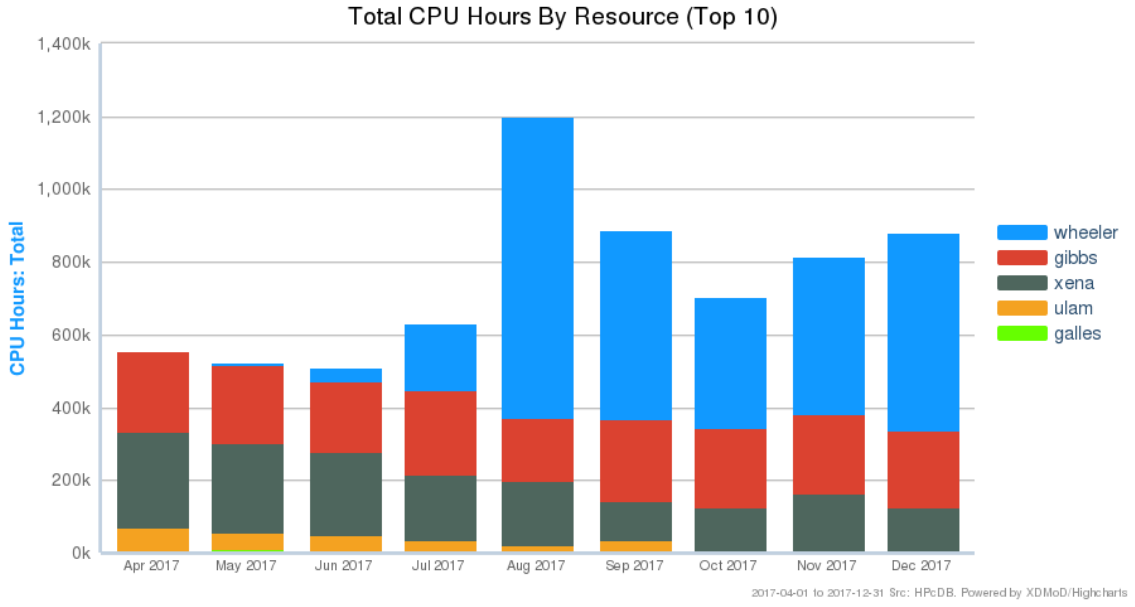
*Booth size and overall costs for SC18 reduced

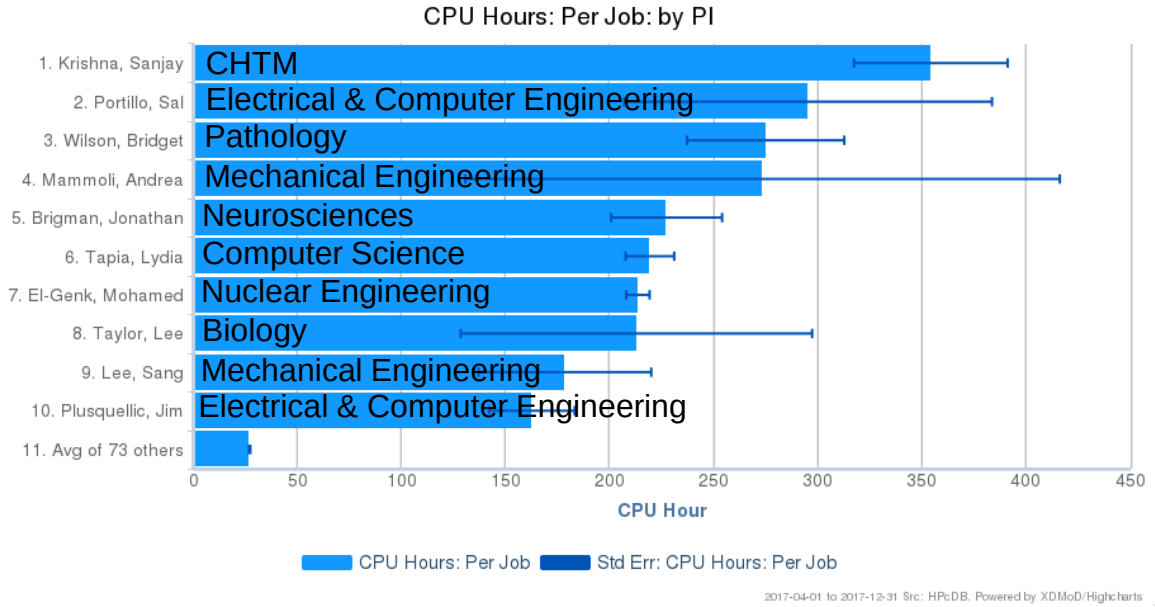


Total: $725,197.47

Research Center Impacts

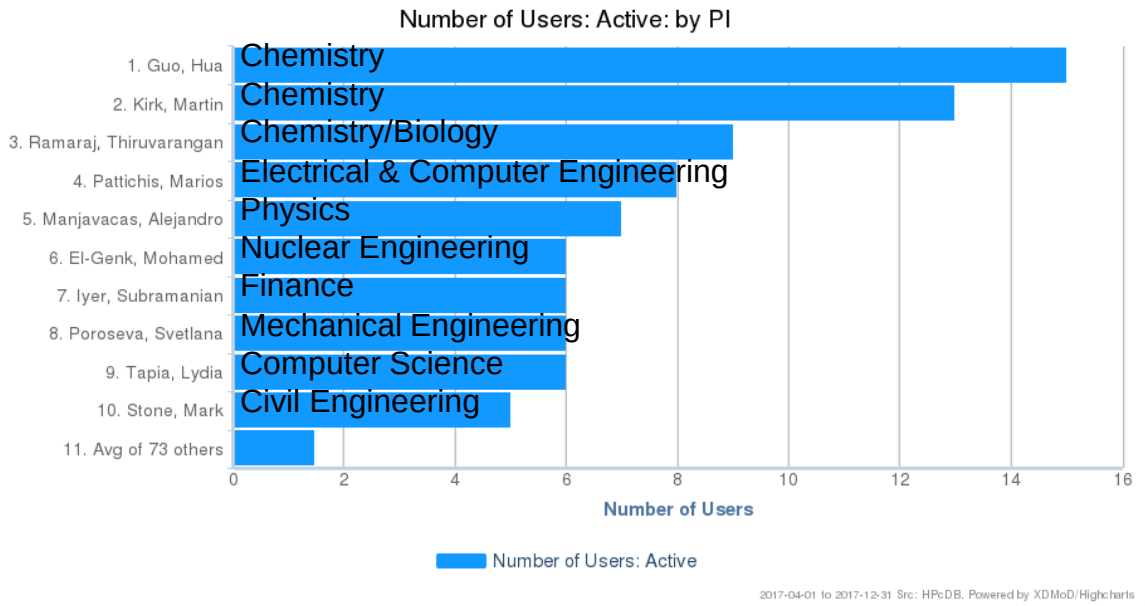
- Resources provided for the campus
  - Resources available include the 280-node/2240-core Wheeler capacity compute cluster, the 32-node Xena NVIDIA GPU cluster, and the 1.5PB Research Storage Consortium storage system.
  - Computational science application advice from expert staff
  - Computational research support for active grants
  - In-house workshops and presentations in UNM courses





Return On Investment

- Average of 80 active facility users, mostly students, across 40 active PIs per month
- 34 publications in journals such as *PLOS One*, *The Journal of Chemical Physics, The Journal of Immunology, Journal of Materials Chemistry,* and *Journal of Biogeography*
- Awards resulting in publications using CARC resources included funding from the National Science Foundation, National Institutes of Health, Department of Energy, Army Research Office MURI grant, and Ministerio de Economía y Competitividad (Spain) among others.



STRENGTHS

Support a broad range of computational research activities by the UNM community

Provide substantial computational resources to researchers free of charge

Expert user support staff

WEAKNESSES

Aging systems and facilities

Understaffed to meet campus demand

Building with significant security, maintenance, and utilization challenges

Underutilized CSE program

Lack of support for research with specialized needs or that handle sensitive data

OPPORTUNITIES

Computational science workforce demand

Increase collaboration with other computational units on campus (Libraries, IT)

External collaboration with Labs (SNL, LANL) and Industry

Leverage cloud computing resources to handle specialized research needs and sensitive data

THREATS

Staff loss to retirement, external competition

Major system or facilities failure

Decreasing price of cloud computing systems

Looking Ahead To 2018

- Significant grant/contract opportunities
  - NSF CISE Research Infrastructure (submitted)
  - NSF OAC Cyberinfrastructure for Sustained Scientific Innovation (submission planned jointly with UNM Libraries)
- New partnerships/relationships
  - Deploy and publicize system cost model to UNM main campus units
  - Develop LANL research and workforce development relationship
  - Revitalize CSE certificate program in collaboration with UNM Math, Mechanical Engineering, and Computer Science departments
- Significant plans for space
  - Consolidate systems staff into a single working space
  - Explore renovating available space in Galles building into a LANL/SNL/AFRL research collaboration facility in concert with New Mexico Consortium

Summary

The gift of our new system, Wheeler, represents a significant increase in computing capacity for the Center. This will allow more users to complete bigger and more complex projects with relative ease.

The development of a strategic plan is setting the direction for the Center in 2018. One priority is developing sustainable funding models. We have developed a cost model to address specialized computing needs by users as a first step towards this, and are actively seeking grant funding that will support equipment and staff in the future.

The revision and re-focusing of our Computational Science and Engineering certificate will allow us to begin to create a pathway from university to employment. This includes future work on creating partnerships with employers such as the New Mexico National Labs and private industry.

2018

CARC USER SURVEY

PRELIMINARY RESPONSES (SEPTEMBER 10 – 17)

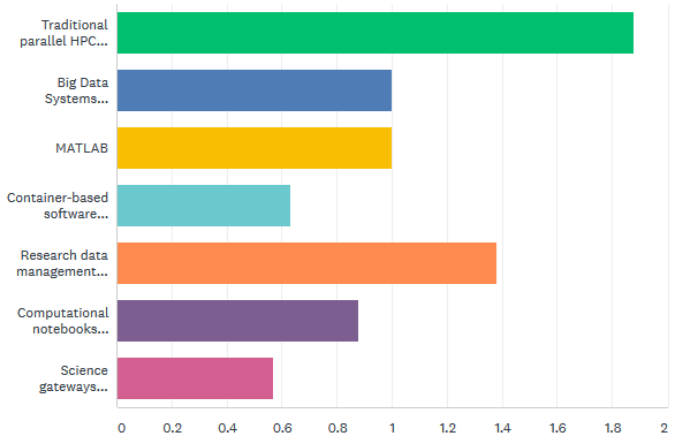
After receiving no response to the initial ask in mid-August, Survey link was sent to CARC USERS email list on 9/10 and 9/17. Survey was also sent to CARC PI email list on 9/10.Survey will close on 9/21.

Q1

Customize | Save As

Please indicate your interest in the following research programs and methods:

Answered: 8 Skipped: 0



	I USE THIS NOW.	I AM INTERESTED IN THIS.	I AM NOT INTERESTED IN THIS.	TOTAL	WEIGHTED AVERAGE
Traditional parallel HPC (computational chemistry, fluid dynamics, etc)	87.50% 7	12.50% 1	0.00% 0	8	1.88
Big Data Systems (Hadoop, Spark, etc)	25.00% 2	50.00% 4	25.00% 2	8	1.00
MATLAB	37.50% 3	25.00% 2	37.50% 3	8	1.00
Container-based software (Docker, etc)	25.00% 2	12.50% 1	62.50% 5	8	0.63
Research data management (research databases, archival)	50.00% 4	37.50% 3	12.50% 1	8	1.38
Computational notebooks (Jupyter, etc)	37.50% 3	12.50% 1	50.00% 4	8	0.88
Science gateways (Galaxy)	14.29% 1	28.57% 2	57.14% 4	7	0.57

Comments (2)

RESPONSES (2) TEXT ANALYSIS TAGS (0)

Add tags | Filter by tag | Search responses

Showing **2** responses

advanced compilers/self-installation of SW and self-builds

9/13/2018 5:14 PM View respondent's answers

Abaqus Ansys

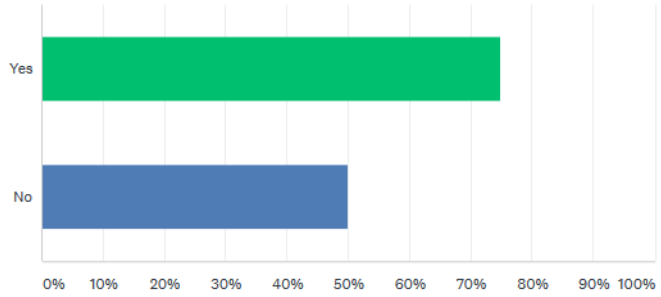
9/11/2018 10:09 AM View respondent's answers

Q2

Customize | Save As

Are our compute systems sufficient for your research needs?

Answered: 8 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	75.00%	6
No	50.00%	4
Total Respondents: 8		

Comments (5)

RESPONSES (5) TEXT ANALYSIS TAGS (0)

Add tags | Filter by tag | Search responses

Showing 5 responses

for routine computation, yes, but for 'latest-and-greatest' high-end architectures, need other resources. Some iinstalled applications software is not up-to-date.

9/13/2018 5:14 PM View respondent's answers

Up to a point

9/11/2018 3:14 PM View respondent's answers

Parallel computing needs are full filled but a higher processing capabilities would allow to run finite element models faster

9/11/2018 10:09 AM View respondent's answers

See items 3 and 5

9/11/2018 9:38 AM View respondent's answers

Yes, extremely useful and I depend on it a lot, but I wish there were more opportunities to launch own VMs or container-based apps

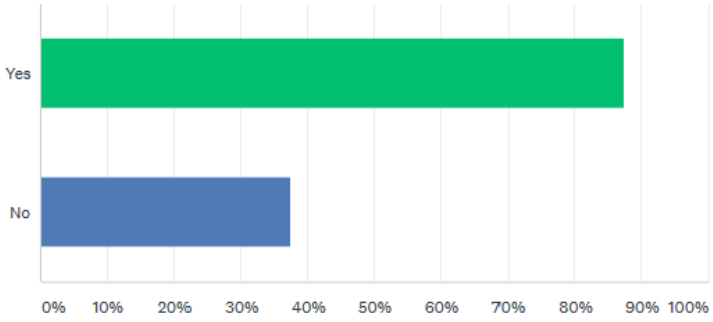
9/11/2018 9:22 AM View respondent's answers

Q3

Customize | Save As

Are our storage systems sufficient for your research needs?

Answered: 8 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	87.50%	7
No	37.50%	3
Total Respondents: 8		

Comments (3)

RESPONSES (3) TEXT ANALYSIS TAGS (0)

Add tags Filter by tag Search responses

Showing 3 responses

We provide our own archive at CARC.

9/11/2018 9:52 AM View respondent's answers

Double answer, direct numerical simulations of fluids are extremely demanding. See item 5 what I am currently using for that. I currently use CARC for design-level simulations.

9/11/2018 9:38 AM View respondent's answers

Yes, but it would be great to have some synchronization frontend, something like own-cloud to be able to access the data from many end-points and link to other storage that is used in my lab like S3/Dropbox etc.

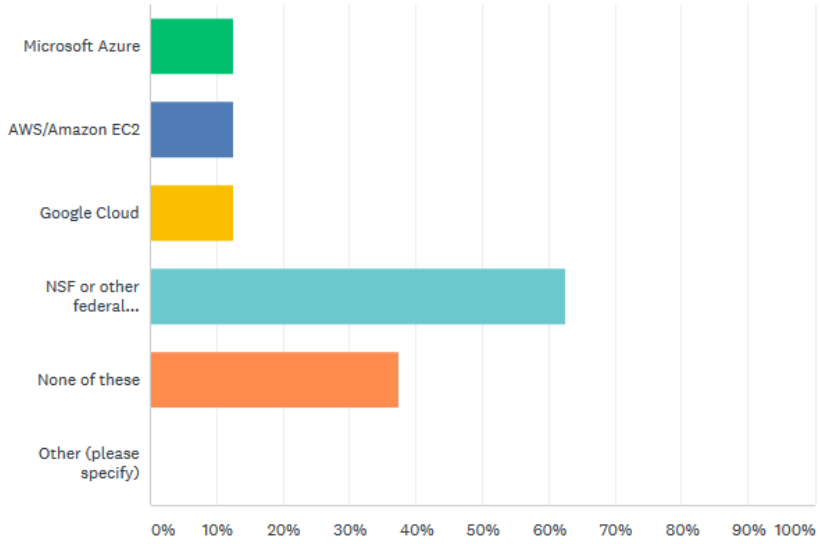
9/11/2018 9:22 AM View respondent's answers

Q4

Customize | Save As

Have you used any of the following external computing resources? Check all that apply.

Answered: 8 Skipped: 0



ANSWER CHOICES		RESPONSES	
Microsoft Azure		12.50%	1
AWS/Amazon EC2		12.50%	1
Google Cloud		12.50%	1
NSF or other federal supercomputing center		62.50%	5
None of these		37.50%	3
Other (please specify)	Responses	0.00%	0
Total Respondents: 8			

Q5

Save As

If you used external computing resources as noted in Q4, what did those systems provide that CARC does not?

Answered: 6 Skipped: 2

RESPONSES (6) TEXT ANALYSIS TAGS (0)

Apply to Selected Filter by tag Search responses

Showing 6 responses

current versions of widely-used applications; more advanced architectures

9/13/2018 5:14 PM View respondent's answers

Much larger and faster computing capabilities

9/11/2018 3:14 PM View respondent's answers

na

9/11/2018 10:09 AM View respondent's answers

Computing local to collaborators at other institutions.

9/11/2018 9:52 AM View respondent's answers

https://www.nas.nasa.gov/hecc/resources/pleiades.html I cannot yet conduct DNS of fluids at CARC

9/11/2018 9:38 AM View respondent's answers

Ability to launch my customVMs, create some web-services - easy for outside of UNM collaborators to access, sometimes Very high Memory/CPU instances as well.

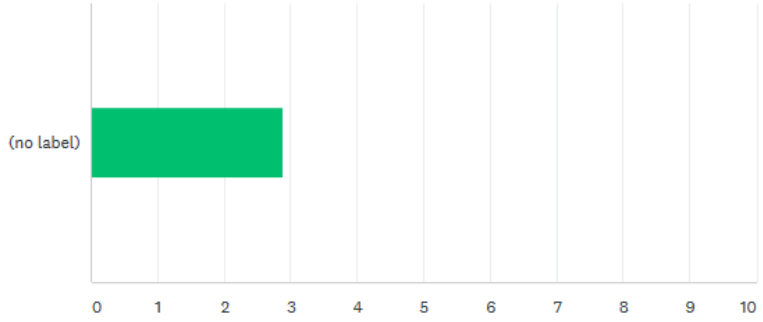
9/11/2018 9:22 AM View respondent's answers

Q6

Customize | Save As

How easy was it to get started at CARC?

Answered: 8 Skipped: 0



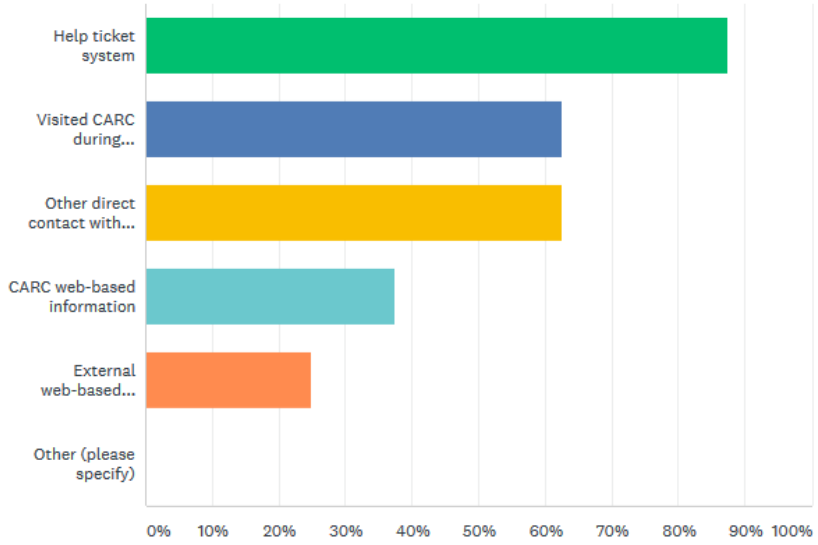
	VERY DIFFICULT	(NO LABEL)	(NO LABEL)	(NO LABEL)	VERY EASY	TOTAL	WEIGHTED AVERAGE
(no label)	0.00% 0	37.50% 3	50.00% 4	0.00% 0	12.50% 1	8	2.88

Q7

Customize | Save As

Have you made use of any of the following user support services?

Answered: 8 Skipped: 0



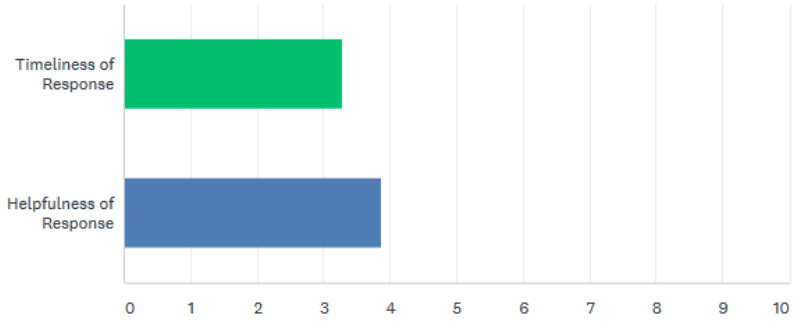
ANSWER CHOICES		RESPONSES	
Help ticket system		87.50%	7
Visited CARC during scheduled office hours		62.50%	5
Other direct contact with CARC user support staff		62.50%	5
CARC web-based information		37.50%	3
External web-based information		25.00%	2
Other (please specify)	Responses	0.00%	0

Q8

Customize | Save As

If you utilized the CARC ticket system, office hours or direct user support, how well were your needs met in terms of:

Answered: 7 Skipped: 1



	LEAST HELPFUL	(NO LABEL)	(NO LABEL)	(NO LABEL)	MOST HELPFUL	N/A	TOTAL	WEIGHTED AVERAGE
Timeliness of Response	0.00% 0	28.57% 2	28.57% 2	28.57% 2	14.29% 1	0.00% 0	7	3.29
Helpfulness of Response	0.00% 0	14.29% 1	14.29% 1	42.86% 3	28.57% 2	0.00% 0	7	3.86

Q9

Save As

Do you have any suggestions to improve user support at CARC?

Answered: 5 Skipped: 3

RESPONSES (5) TEXT ANALYSIS TAGS (0)

Apply to Selected Filter by tag Search responses

Showing **5** responses

adding faster m/cs

9/11/2018 3:14 PM View respondent's answers

na

9/11/2018 10:09 AM View respondent's answers

Timeliness of response has to be improved...

9/11/2018 9:38 AM View respondent's answers

Provide timely replies to Help Tickets, and in-person support if requested.

9/11/2018 9:25 AM View respondent's answers

Sometimes there are emergencies, such as the batch system doesn't accept jobs or something. It can take sometime to get a response, and usually no response over the weekend, which is understandable but it would be good to have someone take care of these issues. But overall good job there!

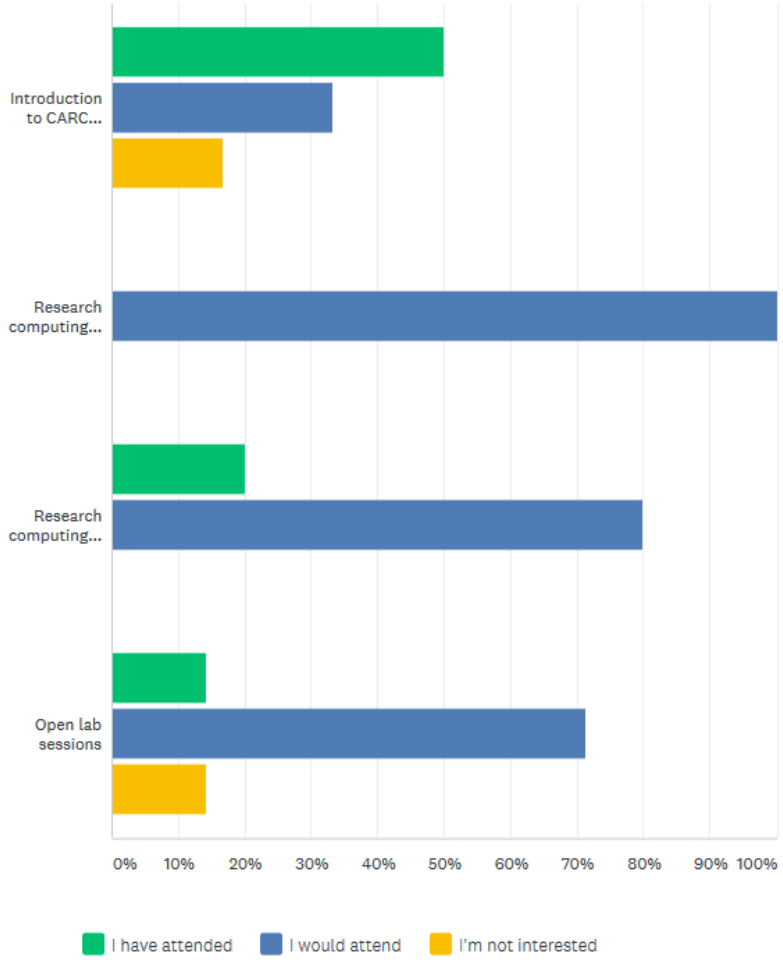
9/11/2018 9:22 AM View respondent's answers

Q10

Customize | Save As

Please indicate your interest in the following training opportunities at CARC:

Answered: 7 Skipped: 1



	I HAVE ATTENDED	I WOULD ATTEND	I'M NOT INTERESTED	TOTAL
Introduction to CARC workshop	50.00% 3	33.33% 2	16.67% 1	6
Research computing skills workshop	0.00% 0	100.00% 5	0.00% 0	5
Research computing symposia/presentations	20.00% 1	80.00% 4	0.00% 0	5
Open lab sessions	14.29% 1	71.43% 5	14.29% 1	7

Comments (0)

Summary of findings:

a. Interest in using Big Data Systems (Hadoop, Spark, etc) and Research Data Management (databases, archival)
b. On-site compute capacity and customizability not sufficient for a subset of users; need to either increase on-site capacity or provide smoother transition to offsite resources.
c. Additional advantages of external resources include advanced architectures, more up-to-date software/applications, increased speed/capacity, user customization/VMs, and allows for easy collaboration with external collaborators
d. The help ticket system, office hours, and other contact with CARC staff are widely utilized for assistance. Users generally received helpful responses, but the timeliness of the responses was on average moderate, with multiple users stressing a need for improvement in this area.
e. Few users found it easy to get started on CARC systems. We need to improve documentation, training, and interfaces for users
f. Many users have or would attend the Intro workshop. There is strong interest in a research computing skills workshop, research computing symposia, and open lab sessions.

2018

CARC Strategic Plan

CENTER FOR ADVANCED RESEARCH COMPUTING

Introduction

The Center for Advanced Research Computing is the hub of computational research and education at the University of New Mexico. CARC houses the largest high-performance computing resource at UNM and is hub for the UNM high-speed research network. A base level of access to CARC systems is available to faculty, staff, and students free of charge. CARC's computing resources can be accessed at any time remotely, while CARC staff are on hand during business hours to assist.

In keeping with the Office of the Vice President of Research's Research2020 plan, we have developed a strategic plan to better meet the needs of our users. We are also working to develop a sustainable funding model to enable the expansion of our systems and services as demand for CARC services grows and evolves. One piece of this plan is a cost model to address services needed beyond the free baseline.

Vision

The Center for Advanced Research Computing (CARC) is an interdisciplinary community at the University of New Mexico (UNM) that uses computational resources to create new research insights.

Mission

To lead and grow the computational research community at UNM.

To fulfill our mission, we will:

- Provide access to high-end computing resources and associated infrastructure;
- Offer specialized expertise and technical support;
- Coordinate and collaborate with other UNM programs that support the community; and
- Grow the collaborative user community through education, workshops, and outreach events.

Objectives

1. Increase the number of research projects, grants, awards, publications, and other creative works supported by CARC by 10% annually, on average
    - Measure 1: Numbers of PIs whom have used CARC systems per year as measured by CARC XdMoD accounting system
    - Measure 2: Number of grant proposals submitted or collaborated on by CARC personnel per year, including as PI, co-PI, senior personnel, or letter of collaboration
    - Measure 3: Number of peer-reviewed publications by active CARC PIs per as indexed by Google Scholar or other University-designated publication assessment instrument
2. Increase the number of people actively engaged with CARC by 10% annually, on average
    - Measure 1: Number of users whom have actively used CARC systems per year as measured by CARC XdMoD accounting system
    - Measure 2: Number of new CARC research projects created per year
    - Measure 3: Number of users who attend CARC workshops and symposia per year
    - Measure 4: Number of students enrolled in Computational Science and Engineering certificate program

Objective 1 measures	2017
Measure 1: Numbers of PIs whom have used CARC systems per year as measured by CARC XdMoD accounting system	Average 42 monthly
Measure 2: Number of grant proposals submitted or collaborated on by CARC personnel per year, including as PI, co-PI, senior personnel, or letter of collaboration	15
Measure 3: Number of peer-reviewed publications by active CARC PIs per as indexed by Google Scholar or other University-designated publication assessment instrument	32

Objective 2 measures	2017
Measure 1: Number of users whom have actively used CARC systems per year as measured by CARC XdMoD accounting system	Average 81 monthly
Measure 2: Number of new CARC research projects created per year	53
Measure 3: Number of users who attend CARC workshops and symposia per year	47
Measure 4: Number of students enrolled in Computational Science and Engineering certificate program	1

Strategies

Strategy 1: Increase system accessibility, ease of use, and range of supported disciplines

CARC will support a broader range of supported users and disciplines by making the systems easier to use. This includes supporting a wider range of interfaces to computational systems and offering a broader range of scientific and data analysis techniques.

Strategy 2: User support

CARC will grow the user support materials and courses offered in-house. This includes workshops to educate new and continuing users and printed/online materials. CARC will work to establish strategies to address the direct funding of staff lines in a way that enables staff to support users appropriately.

Strategy 3: Grow and enhance systems

CARC will grow and enhance systems to better support users. This will include improving basic system infrastructure, adding condo and MRI-funded systems for specialized users, and consideration of cloud options over a five-year timeframe.

Strategy 4: Collaborative user community

CARC will create a collaborative user community that includes forums, seminars, colloquia, and other events that encourage collaboration between people, departments, and communities.

Strategy 5: Industry collaboration

CARC will seek collaboration with local industry on research, education, and training.

Action Items

Strategy 1: Increase system accessibility, ease of use, and range of supported disciplines

1. Survey users (students and PIs) to find what they use, what they want to use and what other needs and wants they have about CARC systems, facilities, and training materials - Immediate
2. Increase outreach to users via workshops, tutorials, and classes - Immediate
3. Prototype and deploy new user environments that support a broader range of applications and disciplines (e.g. JupyterLab, RStudio, and Spark) – Short
4. Develop and deploy comprehensive research data management techniques in collaboration with University Libraries – Long
5. Work with IT to support researchers in meeting compliance needs - Long

Strategy 2: User support

1. Develop online Intro to CARC workshop for use in UNM courses and for our new users - Immediate
2. Create mechanisms and collaborations to help CARC staff effectively collaborate with users on main campus - Short
3. Pursue CARC grants to grow CARC user support staff, including NSF Cybertraining, Campus Cyberinfrastructure, and Sustainable Software Infrastructure NSF grants, and Intel and other corporate funding for infrastructure development – Short
4. Deploy shared collaboration and coordination tools with other research support staff on campus - Short
5. Actively collaborate and coordinate with designated campus/department/unit IT staff (“CARC Champions”) to support users - Short
6. Create a sustainable technical staffing plan and strategy - Long
7. Use Supercomputing Conference booth and regional partnerships with labs and other academic research computing organizations to increase visibility and identify partners for funding opportunities - Long

Strategy 3: Grow and enhance systems

1. Work with PIs and other units and departments on sharing resources to grow capacity, for example shared storage systems with University Libraries - Immediate
2. Advertise cost model for above baseline CARC systems and services – Immediate
3. Pursue cyber-infrastructure grant and contract research opportunities to enhance system capabilities - Immediate
4. Identify instrumentation and center proposal opportunities for acquiring and hosting specialized computing systems – Short

5. Deploy virtualization technology for providing robust, modern local infrastructure services – Short
6. Redesign CARC network architecture to enhance cross-campus collaboration and upgrade data services available to campus users - Long
7. Explore shared machine room with UNM IT for physical machine hosting - Long

Strategy 4: Collaborative user community

1. Lead regular (weekly/quarterly/etc.) rotating events to encourage collaboration, such as research presentations, research socials/poster presentations, and symposia; conducting these jointly with different UNM units may increase outreach - Immediate
2. Survey techniques other interdisciplinary research groups and centers use to foster collaboration - Immediate
3. Develop better research collaboration, workshop, and tutorial facilities in partnership with existing UNM departments and current and emerging research collaborators - Short
4. Publicize CARC systems and services to the UNM community, CARC users, and UNM leadership - Short
5. Increase collaboration and shared events with computational research groups in New Mexico, including at Sandia and Los Alamos National Labs, Air Force Research Laboratory, the Santa Fe Institute, and the National Radio Astronomy Observatory, building on existing research contacts both at CARC and in UNM departments - Long
6. Host educational partners and events (e.g. Supercomputing Challenge or summer schools or workshops) at CARC to increase visibility and outreach - Long
7. Engage with local technical computing/big data user groups (e.g. Spark User Group) - Long
8. Partner with middle and high schools to encourage early involvement in computational research - Long

Strategy 5: Industry collaboration

1. Overhaul the CSE certificate program, to include the creation of course groupings offering specializations in particular areas, such as data science, materials, computational biology, and/or computational mechanics - Short
    a. Consult with CSE program leadership and CARC advisory board to identify target CSE specializations
    b. Partner with appropriate departments to draft example specialization curricula
    c. Develop a process for getting CSE program approvals – small committee
2. Create pathways for students to computing industry positions in collaboration with other UNM units - Short
3. Work with UNM Foundation to identify potential industry partners - Short
4. Develop partnerships with tech employers to sponsor CSE tracks, generating future employee pipelines or upskill opportunities - Long
5. Explore industry partnerships and paid services, leveraging CARC workshops, trainings, and service center cost models - Long
6. Leverage Supercomputing Conference attendance/booth for outreach to potential corporate partners - Long

Funding Strategy

The CARC funding plan encompasses several strategies:

1. CARC receives base funding from main campus sources to provide a baseline level of free service (e.g. compute cycles and storage) to all CARC users.

Baseline Service

The primary element of the CARC service model is baseline service provided to UNM main campus users, including faculty, staff, students, and collaborators, free of charge. The baseline is shown in Table 1.

The baseline is handled as follows:

Service	Unit	Per User	Per Project
Compute Nodes	**Node-Years**	2	16
Enterprise Storage	**TB**	0.2	2
Scratch Storage	**TB**	2	20
Server Colocation	**U**	0	16
Storage Administration	**Partitions**	0	1

- The baseline is set for each approved CARC research projects based on the number of CARC users associated with that research project.
- The baseline includes set levels of access to CARC-managed compute nodes, enterprise storage, scratch storage, server co-location space, VM hosting, and storage administration.
- All user support is provided free of charge to main campus CARC users.
- Custom system administration is **not** included in the free baseline service.

2. CARC is implementing a cost model for users wanting above baseline compute and storage capabilities beyond what is available free of charge. The model allows users to budget for increased services, including increased research support or semi-dedicated compute and/or storage systems housed at and supported by CARC.
3. CARC will pursue external cyberinfrastructure funding to further increase center capabilities; this includes NSF Cybertraining, Campus Cyberinfrastructure, and SI^2 grants, DOE and DoD grants, and corporate research funding from Intel, VMWare, and other corporations.

CARC will also remain actively involved with the development of a campus IT funding model and the UNM IT Research Technologies Committee, both of which are examining funding models for both the UNM IT department and funding for broader campus IT activities, including research computing.

Action Items by Timeframe

Immediate (0-1 year)

Strategy	Action Item	Timeframe
Strategy 1: Ease of system use	1. Survey users (students and PIs) to find what they use, what they want to use and what other needs and wants they have about CARC systems, facilities, and training materials	Immediate
Strategy 1: Ease of system use	2. Increase outreach to users via workshops, tutorials, and classes	Immediate
Strategy 2: User support	1. Develop online Intro to CARC workshop for use in UNM courses and for our new users	Immediate
Strategy 3: Grow systems	1. Work with PIs and other units and departments on sharing resources to grow capacity, for example shared storage systems with University Libraries	Immediate
Strategy 3: Grow systems	2. Develop and advertise cost center models for above baseline CARC systems and services	Immediate
Strategy 3: Grow systems	3. Pursue cyber-infrastructure grant and contract research opportunities to enhance system capabilities	Immediate
Strategy 4: Collaborative user community	1. Lead regular (weekly/quarterly/etc.) rotating events to encourage collaboration, such as research presentations, research socials/poster presentations, and symposia; conducting these jointly with different UNM units may increase outreach	Immediate
Strategy 4: Collaborative user community	2. Survey techniques other interdisciplinary research groups and centers use to foster collaboration	Immediate

Short term (1-3 years)

Strategy	Action Item	Timeframe
Strategy 1: Ease of system use	3. Prototype and deploy new user environments that support a broader range of applications and disciplines (e.g. JupyterLab, RStudio, and Spark)	Short
Strategy 2: User support	2. Create mechanisms and collaborations to help CARC staff effectively collaborate with users on main campus	Short
Strategy 2: User support	3. Pursue CARC grants to grow CARC user support staff, including NSF Cybertraining, Campus Cyberinfrastructure, and Sustainable Software Infrastructure NSF grants, and Intel and other corporate funding for infrastructure development	Short
Strategy 2: User support	4. Deploy shared collaboration and coordination tools with other research support staff on campus	Short
Strategy 2: User support	5. Actively collaborate and coordinate with designated campus/department/unit IT staff ("CARC Champions") to support users	Short
Strategy 3: Grow systems	4. Identify instrumentation and center proposal opportunities for acquiring and hosting specialized computing systems	Short
Strategy 3: Grow systems	5. Deploy virtualization technology for providing robust, modern local infrastructure services	Short
Strategy 4: Collaborative user community	3. Develop better research collaboration, workshop, and tutorial facilities in partnership with existing UNM departments and current and emerging research collaborators	Short
Strategy 4: Collaborative user community	4. Publicize CARC systems and services to the UNM community, CARC users, and UNM leadership	Short
Strategy 5: Industry collaboration	1. Overhaul the CSE certificate program, to include the creation of course groupings offering specializations in particular areas, such as data science, materials, computational biology, and/or computational mechanics a. Consult with CSE program leadership and CARC advisory board to identify target CSE specializations b. Partner with appropriate departments to draft example specialization curricula c. Develop a process for getting CSE program approvals – small committee	Short
Strategy 5: Industry collaboration	2. Create pathways for students to computing industry positions in collaboration with other UNM units	Short
Strategy 5: Industry collaboration	3. Work with UNM Foundation to identify potential industry partners	Short

Long term (3-5 years)

Strategy	Action Item	Timeframe
Strategy 1: Ease of Use	4. Develop and deploy comprehensive research data management techniques in collaboration with University Libraries	Long
Strategy 1: Ease of system use	5. Work with IT to support researchers in meeting compliance needs	Long
Strategy 2: User support	6. Create a sustainable technical staffing plan and strategy	Long
Strategy 2: User support	7. Use Supercomputing Conference booth and regional partnerships with labs and other academic research computing organizations to increase visibility and identify partners for funding opportunities	Long
Strategy 3: Grow systems	6. Redesign CARC network architecture to enhance cross-campus collaboration and upgrade data services available to campus users	Long
Strategy 3: Grow systems	7. Explore shared machine room with UNM IT for physical machine hosting	Long
Strategy 4: Collaborative user community	5. Increase collaboration and shared events with computational research groups in New Mexico, including at Sandia and Los Alamos National Labs, Air Force Research Laboratory, the Santa Fe Institute, and the National Radio Astronomical Observatory, building on existing research contacts both at CARC and in UNM departments	Long
Strategy 4: Collaborative user community	6. Host educational partners and events (e.g. Supercomputing Challenge or summer schools or workshops) at CARC to increase visibility and outreach	Long
Strategy 4: Collaborative user community	7. Engage with local technical computing/big data user groups (e.g. Spark User Group)	Long
Strategy 4: Collaborative user community	8. Partner with middle and high schools to encourage early involvement in computational research	Long
Strategy 5: Industry collaboration	4. Develop partnerships with tech employers to sponsor CSE tracks, generating future employee pipelines or upskill opportunities	Long
Strategy 5: Industry collaboration	5. Explore industry partnerships and paid services, leveraging CARC workshops, trainings, and service center cost models	Long
Strategy 5: Industry collaboration	6. Leverage Supercomputing Conference attendance/booth for outreach to potential corporate partners	Long