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