Research Computing and Data Professionals
Job Elements and Career Guide

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Introduction

A Framework for CI Professionalization

This guide has been developed by the Campus Research Computing Consortium (CaRCC), www.carcc.org, with support by the National Science Foundation (NSF) in collaboration with a network of subject matter experts (listed in the appendix). The guide provides a framework for the work of research computing and data professionals operating in universities, government labs, and other research-intensive settings.

The domains of research computing and data have long served engineering and the physical sciences (such as atmospheric sciences, chemistry, cosmology, and physics). Increasingly research computing and data work are becoming pervasive in all research fields, including expansion across the social sciences and into the digital humanities with broad applications. Research computing professionals report ever more diverse applications as relevant to their work. Moreover, the uses of data in industry are expanding in unprecedented ways, with what is termed "big data" as central to the business models of many of the world's largest and most successful businesses. Parallel growth in applications is happening in government and the nonprofit sector. Thus, the professionalization of research computing and data work is happening in all sectors of the economy. This document is oriented to the research computing and data work that takes place within universities, colleges, government labs, industry research and development, and similar institutions, which are part of these larger digital revolutions in society.

The document is organized around four broad job families, defined by the focus of the work. These are as follows:

- Researcher Facing Roles
- System Facing Roles
- Software/Data Facing Roles
- Sponsor/Stakeholder Facing Role

The first part of each of the four sections of this guide outlines the job elements in each category. The second part of each section includes the overall education, experience, and skill/competency requirements. The third part of each section covers professional development and career considerations.

Themes and Applications

In constructing this guide, there are a number of overarching themes that emerged. These include the following:

- **Co-Creation:** The work of research computing and data professionals involves co-creating the computational methods and software models appropriate to research and researchers, which is a collaborative process that is very different than the delivery of traditional IT and software services that are generally more standardized.

- **Career Paths:** The career paths for research computing and data professionals are incomplete in most organizations, creating challenges for recruiting, developing and retaining these professionals.

- **Digital:** The exponential growth of digital technologies underlies work in this domain and points to accelerating change in the work due to rapid changes in hardware, software, systems, and the nature of the data itself.

- **Status:** The work of research computing and data professionals is generally held in high regard by the faculty with whom they work, but there are important status and power differences between these professionals and principle investigators that are part of a larger "two-tier" culture prevalent in most university settings.

- **Terminology:** The work of research computing and data professionals is also referred to as centered on the "cyberinfrastructure for research" and touches on many related domains, including "data science" and "high-performance computing." We use the term "data work" in places to cover data management, data curation, analytics, and other related data tasks. The work of research computing is distinct from, but connected to the work of central or enterprise "information technology" professionals.

The overall aim of the document is to achieve consistent terminology and elements across the profession, while also facilitating flexibility to match highly diverse organizational contexts.

Among the potential applications of this document are the following:

- A framework to guide conversations between HR leaders and research computing and data leaders around attracting, retaining, and developing talent.
- A vehicle for self-assessment by leaders in the research computing and data community.
- An element in the professionalization of the research computing and data community.
- A basis for managing the interfaces between the research computing and data community and related domains, including information technology, data science, computer science, and data analytics.
- A foundation for organizational development and strategic planning for the research computing and data function in organizations.
- A set of thought starters on careers for individuals and a foundation for documenting career paths as they take place in the profession.

We recognize that the settings in which this document is used will vary greatly. In some cases, there will be very large, well-resourced research computing organizations that may be either separate from campus IT and enterprise computing or directly integrated. In other cases, the research computing function may involve one or a few individuals who combine many roles in their daily work. It is with this diversity in mind, that the document should be viewed as a modular HR framework. The document encompasses a large variety of job elements with the associated skill and experience requirements that are needed to enhance research capabilities of an institution. Because there will be differences in institutional size, scope, and relationship with enterprise IT, the document is designed to allow for many different combinations of the elements provided. Each organization will have unique combinations of roles and responsibilities, but it is our aim for there to be consistent use of terminology and elements so

that the work can be comparable across institutional settings. This is all part of the professionalization of research computing and data work.

There are many indicators of the process when a domain transitions from being a community of practice into a profession. These include a defined body of expertise, professional associations, specialized degree programs, registration or certification, and other factors. The work of research computing and data professionals is moving in this direction and this document is part of the professionalization process. At present, there is very little control over entry into the profession and none is sought -- there is value in people coming from diverse areas of expertise and experience. At the same time, it is the intent to have clear career paths and well-structured opportunities for professional development. In a survey of cyberinfrastructure professionals from over 150 universities, colleges, and government labs, professional development was identified as the top priority in this domain.

Because research computing is a dynamic domain, this is intended to serve as a living document, continually being adapted through use. The very essence of digital technologies are modular (bits, bytes, etc.), with elements that can be assembled and disassembled without loss of fidelity or accuracy. In important ways, this document is conceived to also allow for modular use with, it is hoped, continued error correction. In sum, this document is meant to be a 21st Century approach to human resource management in ways that can co-evolve with the accelerating advances in digital technology.

Researcher Facing Roles

Researcher Facing Job Elements

Engage researchers as a partner to co-create and co-learn research activities and relevant advanced computing capabilities to provide possible solutions to facilitate and/or transform research, involving any of the following:

- Providing user services including help, account management, and information on available services, advanced support and training
- Creating and maintaining user documentation on relevant topics
- Making resource and compliance recommendations
- Managing the software and application stack (at some level)
- Assessing workflows
- Advocating for the value and impact of research computing to sponsor/stakeholder, administration, departments and colleges
- Participating in pilots, proofs-of-concept from a researcher on behalf of the research community (testing new capabilities, ease of use)
- Tracking usage and performance to guide researcher engagement
- Leading or consulting on data management, data processing, and analytics
- Supporting grant proposal preparation (writing, guidance, boilerplate verbiage, cost of services, summarize available facilities, letters of support)
- Participating in funded research activities either collaboratively or independently as a PI, co-PI, senior personnel, or technical professional

Facilitate collaboration and coordination, including:

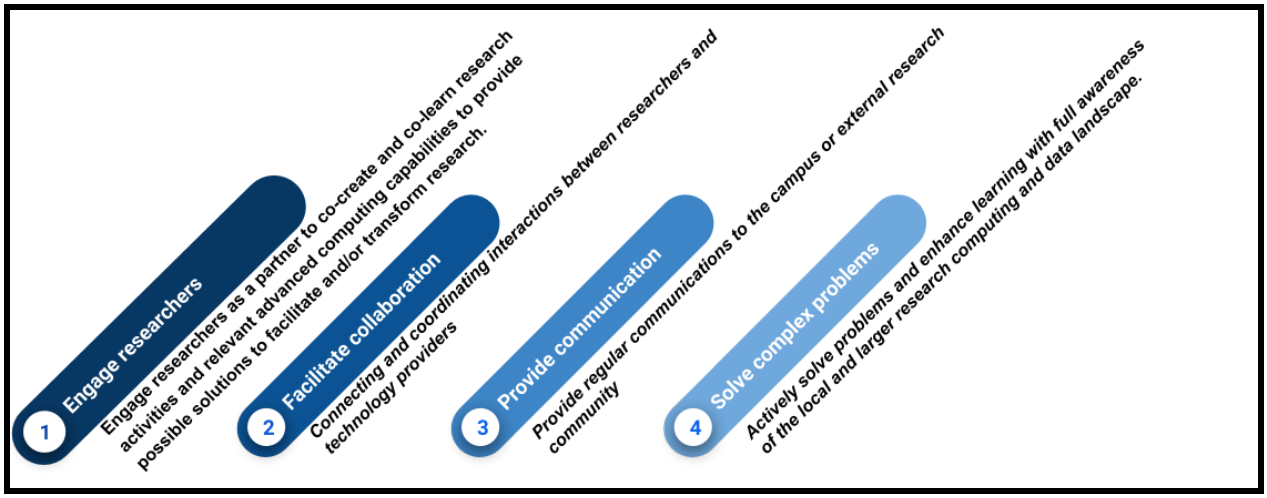
- Connecting and coordinating interactions between researchers and technology providers
- Connecting and coordinating interactions between researchers and systems-facing personnel
- Coordinating interactions among collaborating partners at collaborating institutions
- Acting as a project manager to coordinate with collaboration teams
- Facilitating highly technical and research-specific meetings

Provide regular communications to the campus or external research community by:

- Utilizing outreach mechanisms such as newsletter, website, social media, blog, etc.
- Targeting relevant constituents such as faculty, students, post-docs, research and campus IT staff, and campus leadership
- Collecting and reporting metrics of the impact of research computing (funding, success stories)
- Building community on campus, and with national/international groups, engaging in peer-mentoring, training pedagogy, and train-the-trainers activities
- Developing use-case models and creating user stories

Actively solve problems and enhance learning with full awareness of the local and larger research computing and data landscape. This includes being agile and proactive in:

- Providing technical solutions in support of researcher activities
- Developing and maintaining a comprehensive understanding of research activities across campus – in divisions, departments, disciplines
- Staying current with the national/international research landscape to apply appropriate technical solutions in support of the researcher
- Investigating and educating the research community on the availability of both internal and external CI resources
- Researching and understanding current, emerging, and innovative technologies
- Seeking opportunities to be trained in basic and more advanced research computing topics, including usage and optimization
- Investigating new approaches and technologies, researching and testing new solutions and collaborating with others with complementary knowledge



Researcher Facing Education, Experience, and Skills/Competencies

Note: Each of the following requirements can be organized into different levels of expertise, with additional education, experience, and skills/competencies requirements at different levels. Think of this as the elements needed to construct the levels as appropriate to your organization.

Education:

- Minimum bachelor's degree or equivalent work experience
- Advanced degree preferred

Experience:

- Demonstrated knowledge of the research process, proposal lifecycle, data lifecycle, and workflow.

- Knowledge related to the design of processes and research software across the organization.
- Exposure to computation-intensive and data-rich/data-intensive research workflows
- Experience with advanced skills and methodologies associated with process and software design, modification, compilation and use.
- Demonstrated experience conducting research in a higher education setting.

Skills/Competencies:

- Strong verbal and written communication skills with a service mindset
- Ability to communicate technical details to non-technical audience including training, teaching, and public speaking.
- Ability to work in a multidisciplinary environment
- Time and project management skills, including ability to manage and prioritize multiple projects, plan and implement project specifications, report project status, identify delays, and raise concerns.
- Ability to conceptualize infrastructure, computing ecosystem, and data ecosystem
- Exceptional interpersonal skills, including demonstrated ability to interact credibly with all-levels of researchers, IT staff, IT leadership, and university administrators and demonstrated tact and professionalism.
- Ability to understand practices in various research communities.
- Ability to learn new technologies and professional skills (ie collaborative strategies and communication strategies).
- Able to communicate well and build rapport quickly with students, faculty and staff. Ability to manage relationships with stakeholders (students, faculty, staff, IT).
- Awareness of compliance issues surrounding research data, including federal requirements, granting agency norms.
- Advanced knowledge of related areas of IT. Advanced understanding of issues around use of high-performance computing, high-performance networking, tools to support collaborative research, cloud storage and computing, and other technology used in the research arena.
- Demonstrated ability to envision and articulate campus-wide approaches to services and to develop and implement effective plans for service delivery.
- Demonstrated ability to analyze problems from multiple points of view, to lead consensus building within groups with differing views, and to translate consensus into planned action.
- Demonstrated ability to identify important new technology/research/data practices and standards that are critical for advancing University strategic goals and, in follow up, a proven record of being able to create a pragmatic adoption/transition plan for the improved capacities.

Additional Qualities:

- Be proactive in articulating and eliciting requirements

- Ability to think creatively and innovatively about technical and/or non-technical challenges and adapt to rapidly changing technology and requirements.
- A strong record of mentoring and inspiring the development of junior staff.

Researcher Facing Professional Development and Career Opportunities

This is an inclusive description of relevant considerations in professional development, career opportunities, and examples of relevant organizations. There is not a well-defined set of career paths that are standard across the profession, but documentation as these career paths emerge can be added to this document. This is written from the perspective of the individual. Organizations should review the items to ensure that such opportunities are provided and supported. Note that career paths can develop in many ways, including technical expertise, domain expertise, management leadership, and various combinations.

Professional Development:

- Participation in software/data carpentry workshops, instructor certification
- Participation in Communities of Practice; Occupational Communities
- Virtual residency programs (see ACI-REF for example)
- CaRCC and ACI-REF leading practices (http://aciref.org)
- PEARC participation (including organizing, presenting, training, and learning)
- Participation on XSEDE Champions email list and events
- Participation with regional, national, and international organizations associated with computing and data
- Participation in meetings with senior/exec staff, dept chairs, deans, etc.

Career Opportunities:

- Ensure pathways for campus IT and domain IT via mentorship, internships
- Ensure access to apprenticeships, internships, and pilot projects
- Mentor/management of junior staff, interns, student workers
- Opportunities to present at conferences and local institutions

Sample Organizations:

- CaRCC
- ACI-REF
- PEARC
- XSEDE
- EDUCAUSE

Systems Facing Roles

Systems Facing Job Elements

Systems facing work is often highly interdependent with enterprise IT infrastructure, and/or external (e.g., cloud) infrastructure providers. There can be wide variability in how these functions are organized, with a range of co-location or independent location of functions. Some organizations will manage the full range, while others will depend upon other organizations for some functions. These elements can be roughly understood as going "up the stack."

Data Center: Maintain the integrity of the core utilities and services that provide the space, power, cooling, and physical security of the Data Center. Maintain a relationship with utility/service providers -- either directly or in concert with others who have this direct responsibility.

- Manage facilities or partner with facilities management for physical hosting of cluster.
- Ensure dependable power supply including UPS or emergency backup power.
- Maintain or confirm budget availability for power.
- Plan for or maintain floor space for equipment and hardware.
- Identify, plan, and/or maintain cooling for cluster, such as chilled water supply, ambient cooling, hot/cold water cooling.

Physical systems: Responsible for the planning, installation, and management of physical systems installed within a facility and connected to the network.

- Compute and storage hardware: Identification and purchasing of appropriate compute and storage hardware, taking into consideration requirements, features, available architectures, etc.
- Maintenance and installation of hardware: Planning and performance maintenance and installation of compute and storage hardware in concert with researcher support, stakeholders, etc.
- Storage services: Development and maintenance of storage hardware and storage service offerings, including high-speed storage, active data storage, archival, backups, etc.
- Data transfer: Ensuring, creating, and maintaining data transfer pathways and tools between storage services.
- Network architecture: Deployment of network architecture or work with enterprise IT to provide LAN/WAN connectivity, high-speed interconnects, and specialized networking (InfiniBand, OPA, …).
- System administration: Maintenance, installation, troubleshooting, and incident diagnosis of hardware, software, and operating system of cluster.
- Managing servers or workstations interfacing with scientific instruments and other devices that sometimes with unique vendor deployments.

- System Design: Design of overall computational cluster to support usage requirements, including compute hardware, storage, networking, necessary software, etc.

Virtualized Layers: Design, implement, and manage virtual systems to provide resources for computing, storage, and software. Develop strategy for management and migration of research data to utilize cloud resources, such as the following:

- Transformation to a software-defined everything: Prepare, design, and plan strategy to move towards software-defined everything (network, data center, compute, storage, etc.).
- Configure and deploy virtual machine images.
- Provide support for containerized research workflows and pipelines.
- Deployment of cloud resources, including computing, storage, and databases.
- GridFTP file transfer services (Globus).
- Data lifecycle planning and management.

Systems Environment Management: Identify and maintain appropriate software technologies that are essential to maintaining the integrity of the large-scale cyberinfrastructure environment, including the following:

- System configuration management
- Logs of system changes
- Systems monitoring & alerting
- Account management, including password management in some cases
- Manage batch processing, scheduler configuration and policy implementation
- Troubleshooting systems
- Software packaging and deployment
- Software license management
- Usage reporting

Internal & External / Security & Privacy : Develop and manage the security posture of research systems. Responsible for operating, tuning, and reviewing maintenance of all cybersecurity tools, software suites, devices, appliances and systems. Ensures systems meet security and disaster recovery requirements of the institution, research, and data.

- Perform risk management analysis, including identification, monitoring, and incident response.
- Take risk mitigation or reduction actions.
- Recovery of systems, including response planning for an event or incident.
- Provide and maintain revision control
- Maintain authentication and authorization systems
- Identity management
- Management and ensuring compliance with operating security procedures

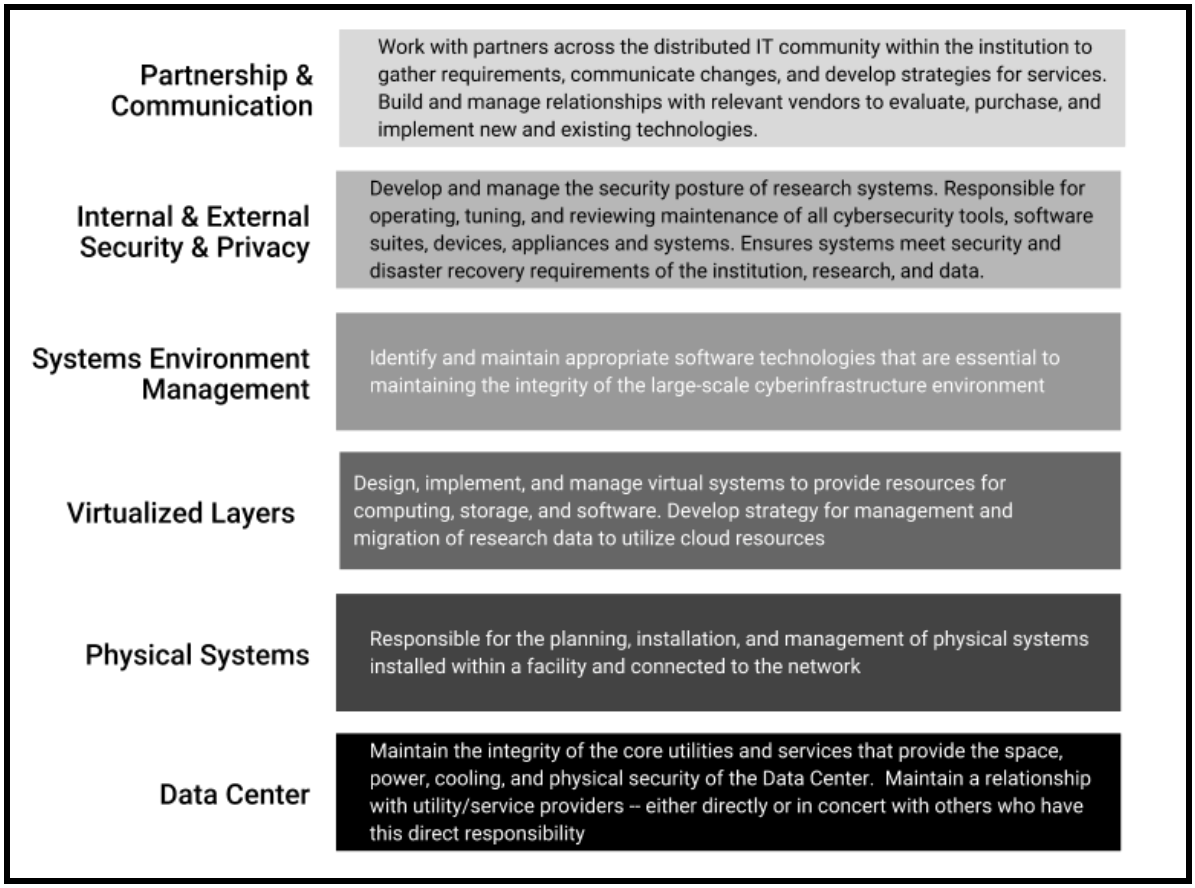
Partnership & Communication: Work with partners across the distributed IT community within the institution to gather requirements, communicate changes, and develop

strategies for services. Build and manage relationships with relevant vendors to evaluate, purchase, and implement new and existing technologies.

- Vendor management/relations
- Evaluation of future technology and application to strategy
- Creation and maintenance of documentation for systems
- Understanding users/researchers technical needs and requirements directly or through IT partners.
- Collaboration with other IT department and acting as a customer of or service for others.
- Development or participation in change management process. Ensuring change management policies are met.
- Gathering requirements for computing, storage, user experience, etc.
- Management or vendor relations, including sales and support.
- Incident, inquiry, and request management.

Additional responsibilities may include maintaining up to date documentation of systems, establishing operational procedures, overseeing multiple projects, and mentoring junior staff.

Supporting Visualization:



Systems Facing Education, Experience, and Skills/Competencies

Each of the following requirements can be organized into different levels of expertise, with additional education, experience, and skills/competencies requirements at different levels. Think of this as the elements needed to construct the levels as appropriate to your organization.

Education:

- A bachelor's degree or relevant experience in domain science and related areas
- Newer master trade technician (sometimes from the military), that have broad systems engineering experience is also acceptable

Experience:

- Basic Linux system administration, command-line, scripting
    - From local academic departments
    - From Central IT

Skills/Competencies:

- Analytic thinking, problem-solving, troubleshooting
- Demonstrated capacity to learn new technology
- Able to translate technical needs into solutions/services
- Able to operate at scale

Additional Qualities:

- Emotional intelligence and strong communication skills
- Interest in the broad spectrum of the technology stack

Systems Facing Professional Development and Career Opportunities

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Professional Development:

- Attend, present and publish (where appropriate) through conferences and workshops:
    - PEARC, SC, RMACC,
    - IEEE-HPEC, ACM SigHPC
    - LISA: Usenix

- Publish through journals, magazines, blogs, and white papers.
- Participate in training and workshops with certifications:
    - Linux Cluster Institute (LCI)
    - Red Hat Certified Architect
    - Online training:
        - https://itpro.tv/
        - XSEDE
        - Coursera
        - Lynda.com
    - Public Cloud training (Azure, AWS, GCE)
    - Cloudera
    - Local classes within the university
- Participate in the HPC Systems Professionals Group
- Attend EDUCAUSE New IT Managers Program

Career Opportunities:

- Note that a technical track is needed at most institutions
- Transition into Industry
    - Technology vendors
    - Oil/Gas
    - Big Pharma, Life Science
    - DOE Labs, other XSEDE centers
- Lead and manage projects for the development or improvement of systems and services
- Technical expertise/thought leader for system architecture or hardware. Mentor junior staff members.

Sample Organizations:

- DellXL, Cray User Group
- https://www.rmacc.org/ (Rocky Mountain Adv Comput Consortium)
- Internet2
- EDUCAUSE: Research Computing Constituent Group

Software/Data Facing Roles

Software/Data Facing Job Elements

Install, document, and validate existing researcher facing software packages

- Software installs
- Install software packages and libraries for research groups
- Manage licensing support, license servers, and associated compliance issues associated with software and data licenses
- Provide support for installed software, including help with running, testing, and validation of software
- Support the integration of installed libraries with one another, with other system components, and with user software.
- Manage and install needed packages for commonly used languages and environments, including python, R, etc.
- Provide domain-level software support to researchers
- Conduct assessment of software tools and packages, evaluating security, sustainability, etc.
- Provide training on the use of systems, on software maintenance, and potentially on optimization

Perform researcher workflow analysis & support researchers with the redesign of those workflows.

Provide support for the application of virtualization technologies to research workflows and support workflows in the cloud

- Provide support for the use of various container tools and frameworks
- Support ResOps (https://www.ebi.ac.uk/about/technology/2018/02/resops/)

Perform usability testing of web-based user interfaces and related tools. Design experiments to improve usability of those tools.

Design and develop web-based user interfaces to cyberinfrastructure. This includes design, programing, scripting, database development, and publication of experiences and results.

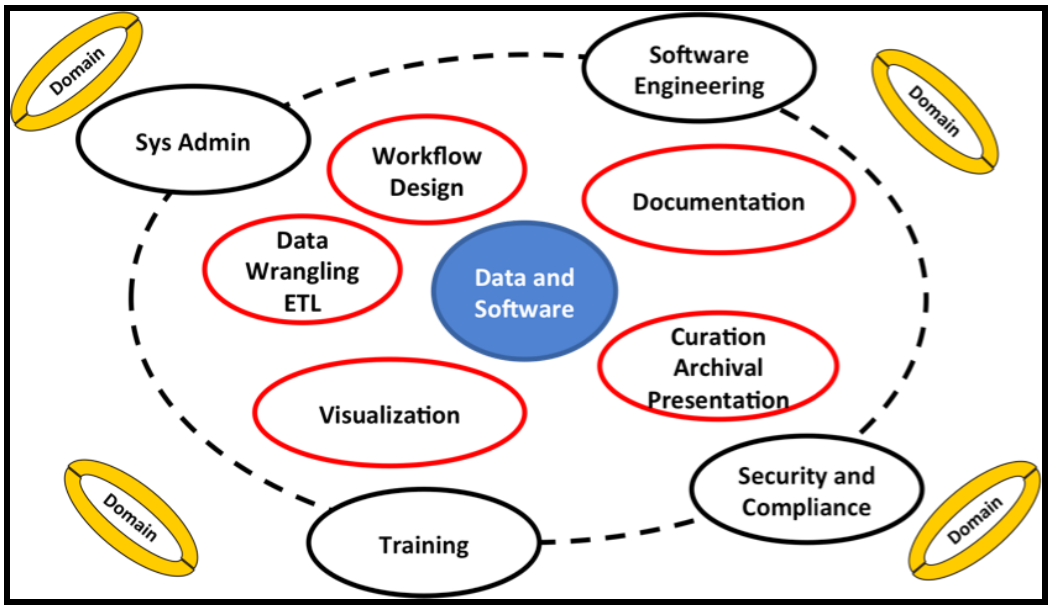
Perform new software development for researcher facing tools and gateways

- Design, develop, and support gateway development
- Design, develop, and support data portals
- Provide and/or support research software engineering
- Provide IT Architecture consulting

Research data management: Tasks include designing, building and maintaining data acquisition, data transformation and data storage systems;

- Provide and support curation of data sets
- Support Extract/Transform/Load (ETL) tools and work
- Support and consult on storage options, policy options, data transfers
- Provide consulting on data movement, include networking tools and issues
- Provide consulting on data architecture

Supporting Visualization:



Note: *Data and software facing roles are in the middle, with an inner set of core software- and data-related activities (documentation, visualization, workflow design, data wrangling, and curation/archival/presentation). A second set of activities span this and other activities, and is indicated by spanning the boundary (training, system administration, software engineering, and security and compliance). Finally, a set of domain lenses are indicated, to reflect the reality that different domains (fields and disciplines) have individual views on this model.*

Software/Data Facing Education, Experience, and Skills/Competencies

Each of the following requirements can be organized into different levels of expertise, with additional education, experience, and skills/competencies requirements at different levels. Think of this as the elements needed to construct the levels as appropriate to your organization.

Education:

- Any masters as minimum requirements

- PhD, provided also has the listed “Additional Qualities” (see below)

Experience:

- Understanding of research process (world)
- Domain expertise
- Experience with large scale systems (where they start to become overwhelming)
- Evidence of sustainable, reproducible practices

Skills/Competencies:

- Problem solving
- Quick learner
- Efficiency
- Time and project management
- Balance between learning/doing
- Communication
- Ops documentation
- Scripting/automation
- Skills per position
    - Languages
    - Tools

Additional Qualities:

- Passion
- Curiosity
- Team member
- Humility

Software/Data Facing Professional Development and Career Opportunities

This is an inclusive description of relevant considerations in professional development, career opportunities, and examples of relevant organizations. There is not a well-defined set of career paths that are standard across the profession, but documentation as these career paths emerge can be added to this document. This is written from the perspective of the individual. Organizations should review the items to ensure that such opportunities are provided and supported. Note that career paths can develop in many ways, including technical expertise, domain expertise, management leadership, and various combinations.

Professional development:

- Participate in relevant academic courses
- Attend and present at conferences (and report back):
    - Galaxy
    - SuperComputing

    - Linux user groups
- Host hackathons
- Develop training modules
- Contribute to community (open source/ open docs …)
- Set aside unprioritized time for exploration
- Organize user groups at local or regional level

Career Opportunities:

- Technical expertise/thought leader tools/languages
- Develop focused expertise (learning about domain, challenges, jargon)
- Develop broad expertise/architecture/consulting
- Develop management/leadership skills
- Assist in training and instructional design

Sample Organizations:

- Science Gateways Institute
- XSEDE
- Supercomputing
- ACM
- IEEE

Sponsor/Stakeholder Facing Roles

Sponsor/Stakeholder Facing Job Elements

Job Element Categories:

1. Leadership/Vision
2. Education/Promotion/Communication
3. Sustainability
4. Stakeholder Management/Collaborations
5. Benchmarking/Assessment
6. Community/Workforce
7. Governance/Processes

Provide overall leadership and vision regarding research computing and data work

- Strategic planning -- bringing in the various groups to understand the roles.
- Tracking the distribution of power: everything starts with organizational power. Understanding where it is and how it is changing as a role of leader. Decision authority, access to resources. Organizational alignment and mission alignment.
- Leadership/Vision - establishing a vision and managing toward that vision. Also managing performance against the vision.

Lead in ensuring education, promotion, and communication regarding research computing and data work.

- Education/promotion of CI service to stakeholders. This may run the gamut from marketing to identifying value of the service, depending on the audience (e.g., end-user vs. institutional leadership, etc.)
- Explainer/promoter/diplomat. Translator (vertically/horizontally). Outreach.
- Broker: Of expectations, resources, priorities, etc.

Ensure the sustainability of the research computing and data functions

- Sustainability, scalability, and future-proofing. Ability to broker against expectations, vision that this could be sustainable. Making the case for funding, ongoing work, etc. If you do not use the proper language, it will not work. Value of advocates to make the case for us (not just IT/research alone).
- Managing constraints: Using your constraints to create opportunities and focus on other mechanisms for growth. Knowing your resources (and limits). Don't go after constraints you know that you can't change or that become unfunded mandates. Also being flexible/adaptive (e.g., if federal or internal funding is cut, etc.). Also coordinating outside institution -- collaborating with consortia, etc. Tracking other institutions' efforts.
- Entrepreneurship. Prospecting opportunities. Scanning for opportunities, but also the ability to pivot and change to take advantage of unexpected opportunities. Balance, though, between being responsive and being visionary -- when is there not

enough to do there, versus when do you find there is some work. Making the case for doing something new (or knowing when to step back).

Facilitate continued alignment of stakeholders and engagement with collaborations involved in research computing and data work

- Collaborations -- including contracts, agreements, MOUs, diplomacy, advocacy.
- Institutional engagement -- strategic planning, collaboration, etc. (ties back to a lot of what had before)
- Apologist: How do we address when something *doesn't* go right and to acknowledge it and be transparent about it. Continuous improvement. Responsiveness to the customers/stakeholders. Montana: Change, Assess, and Change Again.
- Do we need to develop a code of practice for CI professionals? Openness, ethics, sharing, relationships, etc. Focus on business/research goals of the customer, prioritizing them.
- Anti-hubris. It's not about the CI, it's about the customer/stakeholders. Recognizing the downside of measurement and management (just because you can measure something doesn't mean it provides useful). The data isn't the goal, the data to be used to inform the goal.

Conduct continued benchmarking and impact assessment of research computing and data work

- Benchmarking, best practices, best in class, and assessment. What is a good-size or appropriate-size infrastructure for the needs of the university. How do you balance the needs of the institution with the needs of the researcher. Be able to help with validation and discussions both with institutional and departmental leadership.
- Valuation: Assessment/tracking/outcomes/metrics/impact.
- Use of BI -- gathering, and using it properly. Managing it -- collecting, analyzing, and acting on it.

Contribute to the research computing and data community, including workforce and professional development

- Being an active community member. Engaging with others in the field who are doing this kind of work, leveraging best practices or other services, implementation vs. the origin.
- Workforce: being able to identify when changes in HR may be needed and how to advocate for that; career paths; and individual development (including advocating for your own needs).

Ensure effective and agile governance and enabling processes

- Change Management -- especially as the pace of change accelerates. Formalizing it enough to provide some guidance, but not too formal where it becomes constraining.
- Service Management. See CM above (structure but not overdone).

- Scope creep: be careful about that. Not getting pulled into teaching, administrative, etc. -- whatever may be out of primary focus of research support -- to the detriment of the role (or best interests of the individual).
- Enforcer: Be able to enforce policies at all levels.
- Process vs. Product. Metrics often speak to the product, but the process is also very important -- for transparency, CI work satisfaction, customer satisfaction, stakeholder satisfaction, etc.

Sponsor/Stakeholder Facing Education, Experience, and Skills/Competencies

Each of the following requirements can be organized into different levels of expertise, with additional education, experience, and skills/competencies requirements at different levels. Think of this as the elements needed to construct the levels as appropriate to your organization.

Education:

- MBA curricula or related practical knowledge
- Advanced degree, offset by experience (credibility)

Experience:

- Working in a research intensive environment
- Research culture
- Dealing with sponsors
- Compliance (NDAs, COIs, IRB)
- Ability to partner across institutions
- Package concepts to market
- Teaching experience in some form
- Managing people/projects/timelines
- Mentoring peers/others
- Strategic planning (vision/mission)
- Recovery from failure
- Translator of business-to-research and research-to-business

Skills/Competencies:

- Management & leadership
- Communication: presenting, writing, communicating complex ideas to varied audiences
- Negotiations
- Emotional intelligence
- Knowledge of technology: current & emerging
- Life long learner
- Project planning
- Time management
- Conflict resolution

- Analytical approach

Sponsor/Stakeholder Facing Professional Development and Career Opportunities

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Professional Development:

- Participate in the MOR Institute, American Management Association (MOR Leaders Program)
- Participate in university fundraisers program (CASE conferences, etc)
- Develop skills in navigating ambiguity (making decisions in the face of uncertainty)
- Commit to continuous improvement in decision making
- Pursue internship/experiential programs: to create variety in experience
- Participate in mentoring programs (as both mentor and mentee)
- Environmental focus on economy & business
- Specialized tracks at conferences to foster collaboration & networking
- Develop skills in cadence & timing of results
- Seek exposure to strategic planning projects
- Pursue assignments outside individual comfort zones
- Use new/recent business case models as a learning opportunity
- Consider extreme cross-training (outside your usual area of focus)
- Read trade journals (e.g., Chronicle of Higher Education)

Career Opportunities:

- Consider lateral job rotation as well as advancement to higher levels
- Take on committee and service roles in your institution beyond the research computing domain
- Take responsibility for developing career paths in the function/profession
- Consider leadership roles in professional associations, regional consortia, and other aspects of the larger profession
- Consider opportunities in new organizations providing broader scope (and commit to developing leadership able to step in when you leave)

Sample Organizations:

- MOR Institute, American Management Association
- SuperComputing

- XSEDE
- EDUCAUSE
- CaRCC
- CASC
- PEARC
- Internet2
- Common Solutions Group (CSG)

Contributors

This guide is the product of an NSF-funded workshop focused on the development of the CI Infrastructure, which included the following individuals who participated in the working sessions focused on the various sections of this guide. In addition, over a dozen of the participants volunteered at the end of the workshop to contribute further in shaping the guide.

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