University of New Hampshire:
“We define sustainability as what sustains us as diverse people and communities—from clean air and water to healthcare, education and art—and making decisions in our individual and collective lives with this big picture in mind.

Sustainability is both local and global. It requires of us that we consider both the past and the future in terms of current and best practices.

At UNH, we use the sustainable learning community model developed by Dr. Tom Kelly. Sustainability involves maintaining the long-term health of biodiversity, climate, food, and culture, and where these four systems interact. “
Sustainability for Cyberinfrastructure

of hardware, software, teams...

hard skills and soft skills

with researchers, institutions’ key people, funding bodies, CI community, ...

hardware, software, algorithms, domain research
Sustainability for Cyberinfrastructure

- Climate between Research and Facilitation
- hard skills and soft skills
- Diversity in STEM
- Culture: Innovation vs. Maintenance
- Funding and resources

of hardware, software, teams...

with researchers, institutions’ key people, funding bodies, CI community, ...
Sustainability for Cyberinfrastructure

Remember the 4 facings...

Sustainability is not a local effort, it is a community effort

You are not alone!
Sustainability for Cyberinfrastructure

Get to know your
• users (diverse research domains, faculty, ...)
• stakeholders (host institution, funding bodies – NSF, NIH, DoE, DoD, DARPA, Moore Foundation, etc.)
• partners (projects, initiatives, experienced IT people)
• volunteers (contributors to open-source and/or open science)

and their challenges as well as their goals – besides publications and funding.

Often their challenges are your challenges!
• Computing resources
• Data analytics
• Preservation needs
Sustainability for Cyberinfrastructure

Bridging the Gap to Data Sharing

Researchers

"the local academic community struggles to effectively manage its assets which manifested itself in a number of challenges, and as for researchers, they lacked storage capacity and data curation processes, and the institution lacked standard metadata and indexing technologies, as well as tools that would support the whole research workflow" - Digital Asset Strategy Committee, DigitalND, 2011

Libraries

Typically, data curation happens retroactively, and as a result data is either not captured at all or available metadata is incomplete.

Pressures from the Outside

“...digitally formatted scientific data resulting from unclassified research supported wholly or in part should be stored and publicly accessible to search, retrieve, and analyze.” - White House OSTP Public Access Memo, Feb. 2013

https://presqt.crc.nd.edu/
Look at financial and non-financial support ("free" resources)

• Do you have people such as digital librarians? They are generally not only serving humanities and have great knowledge about data preservation, data lifecycle, programming skills, ..

• Do you have data scientists? They probably know about machine learning, metadata, ontologies, statistics ...

• Do you have business scientists? They know about marketing, financial strategies, how to build an enterprise, ...

They can be partners for you to support CI projects!
Elements: Small groups - create & deploy robust capabilities for demonstrated need to advance science & engineering.

Framework Implementations: Larger teams organized around the development and application of common infrastructure aimed at solving common research problems, resulting in a sustainable community framework serving a diverse community or communities.

Planning Grants for Community Cyberinfrastructure: Focus on long-term capabilities in cyberinfrastructure to serve a research community of substantial size and disciplinary breadth.

Community Cyberinfrastructure Implementations: Focus on long-term hubs of excellence in cyberinfrastructure and technologies, to serve a research community of substantial size and disciplinary breadth.
Sustainability Institutes and Excellence Hubs are funded to support the CI and research community

Support via implemented institutes is free for you! Your chance to influence conceptualizations!

Implementations
• Science Gateways Community Institute
• The Molecular Sciences Software Institute

Conceptualizations
• URSSI
• High-Energy Physics
• Geospatial
• ...
The CI Professional Ecosystem

- Clemson-led ACI-REF project
- Coalition for Academic Scientific Computation
- Campus Research Computing Consortium (CaRCC)
- Campus Champions
- CyberAmbassadors
- Linux Clusters Institute
- SIGHPC Education Chapter
- Software & Data Carpentry
- **Science Gateways Community Institute**
- UK Research Software Engineer Association
- **US Research Software Engineer Association**
- UK Software Sustainability Institute
- **Working Toward Sustainable Software for Science Practice and Experience (WSSSPE)**
- **US Research Software Sustainability Institute**
State of the Art in Research

Increased complexity of

- research questions
- hardware
- software
- instruments
- data volume
- data formats

The need for end-to-end solutions for accessing data, software, computing services, and equipment specific to the needs of a science or engineering discipline
Science Gateways

Increased complexity of

- research questions
- hardware
- software
- instruments
- data volume
- data formats

The need for end-to-end solutions for accessing data, software, computing services, and equipment specific to the needs of a science or engineering discipline

Science Gateways!
It’s a Fan!

It’s a Spear!

It’s a Wall!

It’s a Snake!

It’s a Tree!

It’s a Rope!
It’s a Science Gateway

It’s a Research Portal

It’s a Virtual Research Environment

It’s a Virtual Lab

It’s a Cyber-infrastructure

It’s a Collaboratory
Science Gateways

Gateway users are 77% of active XSEDE users in Q4 2016

This is largely due to the CIPRES and I-TASSER gateways, but others are gaining...
Life Cycle of a Science Gateway

Developers typically
• work in isolation
• must bridge to variety of resources
• need building blocks in order to focus on higher-level functionality
• struggle to secure sustainable funding

Sounds familiar?
Science Gateway Survey 2014

- sent out to 29,000 persons
- 4,957 responses from across domains
- 52% from life, physical or mathematical sciences
- 32% from computer and information sciences or engineering
- 45% develop data collections
- 44% develop data analysis tools

What services would be helpful?

<table>
<thead>
<tr>
<th>Proposed Service</th>
<th>% Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation, impact analysis, website analytics</td>
<td>72%</td>
</tr>
<tr>
<td>Adapting technologies</td>
<td>67%</td>
</tr>
<tr>
<td>Web/visual/graphic design</td>
<td>67%</td>
</tr>
<tr>
<td>Choosing technologies</td>
<td>66%</td>
</tr>
<tr>
<td>Usability Services</td>
<td>66%</td>
</tr>
<tr>
<td>Visualization</td>
<td>65%</td>
</tr>
<tr>
<td>Developing open-source software</td>
<td>64%</td>
</tr>
<tr>
<td>Support for education</td>
<td>64%</td>
</tr>
<tr>
<td>Community engagement mechanisms</td>
<td>62%</td>
</tr>
<tr>
<td>Keeping your project running</td>
<td>62%</td>
</tr>
<tr>
<td>Legal perspectives</td>
<td>61%</td>
</tr>
<tr>
<td>Managing data</td>
<td>60%</td>
</tr>
<tr>
<td>Computational resources</td>
<td>59%</td>
</tr>
<tr>
<td>Mobile technology</td>
<td>59%</td>
</tr>
<tr>
<td>Database structure, optimization, and query expertise</td>
<td>59%</td>
</tr>
<tr>
<td>Data mining and analysis</td>
<td>58%</td>
</tr>
<tr>
<td>Cybersecurity consultation</td>
<td>57%</td>
</tr>
<tr>
<td>Website construction</td>
<td>57%</td>
</tr>
<tr>
<td>Software engineering process consultation</td>
<td>53%</td>
</tr>
<tr>
<td>Source code review and/or audit</td>
<td>51%</td>
</tr>
<tr>
<td>High-bandwidth networks</td>
<td>45%</td>
</tr>
<tr>
<td>Scientific instruments or data streams</td>
<td>44%</td>
</tr>
<tr>
<td>Management aspects of a project</td>
<td>38%</td>
</tr>
</tbody>
</table>
Well-designed gateways require a variety of expertise

- Usability Consultant: 34% Wished we had this, 16% Yes, we had this
- Graphic Designer: 36% Wished we had this, 30% Yes, we had this
- Community Liaison/Evangelist: 20% Wished we had this, 18% Yes, we had this
- Project Manager: 17% Wished we had this, 45% Yes, we had this
- Professional Software Developer: 31% Wished we had this, 44% Yes, we had this
- Security Expert: 26% Wished we had this, 14% Yes, we had this
- Quality Assurance and Testing Expert: 42% Wished we had this, 15% Yes, we had this
Science Gateways Community Institute

- Longer-term, hands-on support
- Diverse expertise on demand
- Workforce Development
- Student opportunities & educator resources
- Community Engagement & Exchange
- Scientific Software Collaborative
- Sharing experiences & knowledge as a community
- Extended Developer Support

SGCI
Science Gateways Community Institute
On-campus teams
It is a **centralized** team at your institution – irrespective whether you are part of a university, a national lab, an organization, a consortium or a company...

Local teams vs. distributed and remote teams:
For local teams it is **still easier** to build more **trust**, to be more **efficient** and to create a **strong culture**.

https://www.codementor.io/blog/modern-engineering-teams-4ea9dpftzs
Connect with SGCI

Incubator Sustainability Bootcamp
- https://sciencegateways.org/engage/bootcamp

- 5 full days
- Teams on projects
- Interactivity
- Community formation
- Putting away the normal daily routine
- Homework

- twice per year
- additional ones can be booked (travel expenses for presenters)
- adapted to feedback
Connect with SGCI

Incubator Sustainability Bootcamp
• https://sciencegateways.org/engage/bootcamp

Work with us
• https://sciencegateways.org/consulting/work-with-us

We can work with gateways at any stage of their lifecycle: a new idea, a proposal seeking funding, a gateway under construction, or an established gateway.

If you’re ready to get help from one of our consultants, fill out our Consulting Services Request Form.

If you’re writing a proposal and want to include our services in your proposal, request a letter of collaboration.

If you’re just getting started and need server space for hosting your gateway, request access to our hosting service.

If you have a general or short question, just email us at help@sciencegateways.org.
Connect with SGCI

Incubator Sustainability Bootcamp
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Work with us
• https://sciencegateways.org/consulting/work-with-us

Yearly Conference: Early-bird registration ends today!
• https://sciencegateways.org/engage/annual-conference
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Yearly Conference Early-bird registration ends today!
• https://sciencegateways.org/engage/annual-conference

Become involved as a partner or affiliate
• https://sciencegateways.org/about/partners

The goal of our Partner Program is to build long-term strategic partnerships between organizations, projects, and the SGCI to benefit the community in multiple ways.

The objectives of the SGCI Partner Program are to:

• Leverage the expertise of complementary organizations to support and advise the gateway community in the best possible way.
• Exchange existing services to provide the best array of services to gateway clients.
• Cross-promote resources and services offered by SGCI and our partners.
• Provide a streamlined process to access resources and services provided by a partner.
• As appropriate, provide student exchange or internship opportunities.
Connect with SGCI

Incubator Sustainability Bootcamp
  • https://sciencegateways.org/engage/bootcamp

Work with us
  • https://sciencegateways.org/consulting/work-with-us

Yearly Conference
  • https://sciencegateways.org/engage/annual-conference
  Early-bird registration ends today!

Become involved as a partner or affiliate
  • https://sciencegateways.org/about/partners

Software/Gateway Catalog
  • https://catalog.sciencegateways.org/

Science Gateways Catalog

Save time — reuse gateway technologies or discover gateways and virtual research environments that you can use for your own research, teaching, and learning

Total Entries: 412
Connect with SGCI

Incubator Sustainability Bootcamp
  • https://sciencegateways.org/engage/bootcamp

Work with us
  • https://sciencegateways.org/consulting/work-with-us

Yearly Conference  Early-bird registration ends today!
  • https://sciencegateways.org/engage/annual-conference

Become involved as a partner or affiliate
  • https://sciencegateways.org/about/partners

Software/Gateway Catalog
  • https://catalog.sciencegateways.org/

Train students in internships
  • https://sciencegateways.org/engage/student-focused

Webinars, blogs, newsletter, Twitter, LinkedIn etc.
  https://sciencegateways.org
Remember Henry’s Question: How much time Do You Get to Learn Your Job as Facilitator?
Remember Henry’s Question: How much time Do You Get to Learn Your Job as Facilitator?

| NSF Org:                  | OAC  
Office of Advanced Cyberinfrastructure (OAC) |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Initial Amendment Date:</td>
<td>December 21, 2017</td>
</tr>
<tr>
<td>Latest Amendment Date:</td>
<td>December 21, 2017</td>
</tr>
<tr>
<td>Award Number:</td>
<td>1743188</td>
</tr>
</tbody>
</table>

**Start Date:** December 15, 2017

**End Date:** June 30, 2019 (Estimated)

**Awarded Amount to Date:** $499,999.00

Maybe -6 days;-)
Research Software

Use 90% 95%

Can't continue without 70% 63%

http://doi.org/10.5281/zenodo.843607
> 50% neither formal nor informal training in software engineering

<table>
<thead>
<tr>
<th>Use</th>
<th>90%</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can't</td>
<td>70%</td>
<td>63%</td>
</tr>
<tr>
<td>continue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>without</td>
<td></td>
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</tbody>
</table>

http://doi.org/10.5281/zenodo.843607
## Research Software

| Use | 90%  |
| Can't continue without | 70%  |
| 95%  |
| 63%  |

Lack of career paths

http://doi.org/10.5281/zenodo.843607
Research Software

How to cite software?

Use
90%
95%

Can't continue without
70%
63%

http://doi.org/10.5281/zenodo.843607
Areas of Concern

- Functioning of the individual and team
- Functioning of the research software
- Functioning of the research field itself

Developing a pathway to research software sustainability
Functioning of the Individual and Team

- Training & education
- Ensuring appropriate credit for software development
- Enabling publication pathways for research software
- Fostering satisfactory and rewarding career paths for people who develop and maintain software
- Increasing the participation of underrepresented groups in software engineering
Functioning of Research Software

- Supporting sustainability of the software
- Growing community, evolving governance, and developing relationships between organizations, both academic and industrial
- Fostering both testing and reproducibility
- Supporting new models and developments (e.g., agile web frameworks, Software-as-a-Service)
- Supporting contributions of transient contributors (e.g., students)
Functioning of the Research Field Itself

- Growing communities around research software and disparate user requirements
- Cataloging extant and necessary software
- Disseminating new developments
- Training researchers in the usage of software
- Understanding and improving pipelines of diverse developers and maintainers
URSSI and Other S2I2 Projects
Goal: Close collaboration and fill in gaps on each axis
Conceptualization

- Workshops
- First workshop took place in April in Berkeley
Conceptualization

• Workshops
  • First workshop took place in April in Berkeley
  • Next workshop will take place in October in Chicago
• Software credit workshop
• Incubator workshop
• Survey
• Ethnographic studies
• Mission and vision working group
How to Connect

• Website http://urssi.us/

Developing a pathway to research software sustainability
How to Connect

- Website http://urssi.us/
- Materials https://github.com/si2-urssi
How to Connect

- Website http://urssi.us/
- Materials https://github.com/si2-urssi
- Blog posts http://urssi.us/blog/

Results from a US survey about Research Software Engineers

Daniel S. Katz, Sandra Gesing, Olivier Philippe, and Simon Hettrick, June 21, 2018

In 2016, the UK Software Sustainability Institute (SSI) ran a first survey of Research Software Engineers (RSEs): the people who write code in academia. This produced the first insight into the demographics, job satisfaction, and practices of RSEs. To support and broaden this work, the Institute planned to run the survey every year in the UK and an ever-expanding number of countries so that insight and comparison can be made across the globe. Ultimately, the SSI hopes that these results, the anonymized version of which are open licensed, will act as a valuable resource to understand and improve the working conditions for RSEs.

In 2017, led by Olivier Philippe and Simon Hettrick from the SSI, a set of such surveys were run across the the UK, Canada, Germany, the Netherlands, South Africa, and the US. One or more people from each non-UK country “translated” the questions so that they made sense in the local language and culture. The UK team ran the surveys, with the collaborators from the other countries—Scott Henwood (Canada), Stephan Janosch and Martin Hammitzsch (Germany), Ben van Werkhoven and Tom Bakker (Netherlands), Anelda van der Walt (South Africa), and Daniel S. Katz and Sandra Gesing (USA)—helping to publicize the survey in their countries. When the surveys were complete, the UK team analyzed the
How to Connect

- Website http://urssi.us/
- Materials https://github.com/si2-urssi
- Blog posts http://urssi.us/blog/
- Mailing list http://urssi.us/

Join the Mailing List

[Email address input field] Subscribe
How to Connect

- Website http://urssi.us/
- Materials https://github.com/si2-urssi
- Blog posts http://urssi.us/blog/
- Mailing list http://urssi.us/
- Discuss https://discuss.urssi.us/
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- Mailing list http://urssi.us/
- Discuss https://discuss.urssi.us/
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• Mailing list http://urssi.us/
• Discuss https://discuss.urssi.us/
• Twitter https://twitter.com/si2urssi
• Workshops http://urssi.us/workshops/

Join us for our next workshop in Chicago
October 23-24!
Lessons Learned on International Level

UK SSI and UK Research Software Engineer Association

• Buy-in from universities
• Viable career path
• Large community
The importance of sustainability

Sustainability means that the software you use today will be available - and continue to be improved and supported - in the future.

Better science through superior software

Our work is focussed around four themes we believe are fundamental to doing research correctly in the digital age. These are related to our manifesto.

The first of these is Skills and Training: creating a capable research software community by enabling access to software development training for all researchers and teaching them methods to advance their research.

Recognition and Reward promotes and contributes to systems of credit for good software development and reuse practice.

Career Paths recognises and champions the varied job roles associated with research software; with a primary focus on the academic sector but suggesting industrial practice where applicable.

Finally, Reproducible Research promotes the fundamental place of software in supporting confidence in the research process and its results.

Taken together, these enable the efficient and effective use of software to tackle both the grand challenges that push the boundaries of human knowledge to day-to-day research software tasks.

https://www.software.ac.uk/about
Sustainability

The Ecosystem offers a lot of opportunities

But

• Another mail list
• Another newsletter
• Another discussion list
• Another slack channel
• Plenty of workshops
• Plenty of surveys

Overwhelming? Too many scattered approaches?
How to sustain knowledge on and collaboration with sustainability approaches?
### Henry’s Travel Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed Feb 21 - Fri Feb 23</td>
<td>Dallas TX</td>
<td>Project meeting</td>
</tr>
<tr>
<td>Mon March 12 - Wed March 14</td>
<td>Alexandria VA</td>
<td>CaRC CI Professionalization Workshop</td>
</tr>
<tr>
<td>Thu March 15 - Fri March 16</td>
<td>Washington DC area</td>
<td>Review panel</td>
</tr>
<tr>
<td>Wed March 14 - Fri March 16</td>
<td>Alexandria VA</td>
<td>Coalition for Academic Scientific Computation spring meeting</td>
</tr>
<tr>
<td>Fri Apr 10</td>
<td>Oklahoma City OK</td>
<td>Cameron University Computing Technology Day Speaker</td>
</tr>
<tr>
<td>Tue Apr 17 - Wed Apr 18</td>
<td>Stillwater OK</td>
<td>Coalition for Advancing Digital Research &amp; Education Conference</td>
</tr>
<tr>
<td>Wed May 16</td>
<td>Dallas TX</td>
<td>University of Texas Dallas Innovation &amp; Technology Summit Speaker</td>
</tr>
<tr>
<td>Wed May 30 - Fri June 1</td>
<td>Kansas City MO</td>
<td>Great Plains Network GPN Annual Meeting</td>
</tr>
<tr>
<td>Sun July 22 - Thu July 27</td>
<td>Pittsburgh PA</td>
<td>PEARC 2018 conference</td>
</tr>
<tr>
<td>Sun Aug 5 - Fri Aug 10</td>
<td>Norman OK</td>
<td>Advanced Cyberinfrastructure Research &amp; Education Facilitators Virtual Residency Workshop Facilitator</td>
</tr>
<tr>
<td>Mon Sep 17</td>
<td>Rolla MO</td>
<td>Missouri U of Science &amp; Technology Research Technology Day Speaker</td>
</tr>
<tr>
<td>Tue Sep 25 - Wed Sep 26</td>
<td>Norman OK</td>
<td>Oklahoma Supercomputing Symposium 2018 Conference Chair/Speaker</td>
</tr>
<tr>
<td>Sun Nov 11 - Thu Nov 15</td>
<td>Dallas TX</td>
<td>Supercomputing 2018</td>
</tr>
</tbody>
</table>
Lessons Learned on International Level

What is different in the UK?

• It’s a smaller country - not a characteristics we can change for the US

• The culture between research, software engineering and facilitation is different (SE and facilitation are more appreciated by researchers) – we can work on this, the more positive examples, white papers, metrics, etc. the more buy-in...
Lessons Learned from Sustained Teams/Projects

Commonalities

• Evangelist
• Diverse mechanisms of funding
• Community building
• Open source and open science
• Collaboration, collaboration, collaboration
What Are Our Next Steps?

- Evangelists for diverse initiatives – not every approach suits all
- Define a roadmap for collaboration and community building
What Are Our Next Steps?

How to make it less scattered and without duplicating effort? How to change research culture?

- Catalog on sustainability projects?
- Catalog on events?
- Catalog on metrics?
- Catalog on success stories?
- Evangelist and an outreach specialist?
- “Exchange” instructors between events?
- Involve faculty, HR people, stakeholders in events?
What Are Our Next Steps?

Let’s make the next steps together!

Thanks!

sandra.gesing@nd.edu