## Retreat Attendees

Former and current members from the CIG Executive and Science Steering Committees met in Santa Fe, New Mexico from January 18-20, 2014 to kick off the strategic planning process for the next phase of CIG. Total attendees: 14

### Executive Committee

Scott King, *Chair, Executive Committee* (Virginia Polytechnic University)

Wolfgang Bangerth (Texas A&M)

Bruce Buffett, *Vice Chair, Executive Committee* (University of California, Berkeley)

Claire Currie (University of Alberta)

Gary Glatzmaier (University of California, Santa Cruz) *former EC member*

Mousumi Roy (University of New Mexico) *former EC member*

Louise Kellogg, (University of California, Davis), *CIG Executive Director*

### Science Steering Committee

Brad Aagaard, Chair, Science Steering Committee (USGS)

Tim Ahern (IRIS)

Jed Brown (Argonne National Lab)

Roger Buck (Columbia University)

Marc Spegielman (Lamont Doherty Earth Observatory) virtual, former SSC member

Carl Tape (University of Alaska, Fairbanks) virtual

Jolante van Wijk (New Mexico Tech)

### Additional participants

Roy Savoian, *facilitator*

Lorraine Hwang, *Associate Director*

## A. Mission

The Computational Infrastructure for Geodynamics (CIG) is a community-driven organization that advances Earth science by developing and disseminating software for geophysics and related fields.

## B. Vision

We aspire to accelerate the understanding of the dynamical properties of the Earth and Earth-like systems by providing innovative methods, resources, and technologies enabling research from core to crust, and beyond.

We provide leadership in computational geophysics and drive paradigm shifts and fundamental changes in geoscience by addressing challenges in multi-disciplinary science and creating a broad-based community whose research and pedagogy are fundamentally based in modeling and computation.

## C. Core Values

We value organizational excellence through our beliefs and commitments.

*We believe in*:

- Scientific and professional integrity
- Respect for diversity
- Open access
- Fostering collaboration, bridging communities

*We commit ourselves to*:

- Advancing community science goals
- Providing an open, inclusive, and participatory environment
- Good stewardship of community resources
- Workforce development for the 21st century

# D. Situation Analysis

Situation analysis is designed to produce an understanding and assessment of the external and internal operating environments faced by CIG. The analysis involves identifying:

1. Primary Stakeholders
2. SWOT (Major Strengths, Weaknesses, Opportunities, and Threats)
3. Expected Future Trends
4. Critical Success Factors

## 1. Primary Stakeholders

A stakeholder or stakeholder group is strongly influenced by CIG in some significant way, or has the power to exert an influence on CIG. Each stakeholder has a unique involvement with CIG and differing interests, priorities, and expectations.

- Scientific community over the entire career spectrum and career paths, including researchers and educators who are both code users and code developers
- NSF and Other Government Agencies
- Member Institutions
- Key personnel
- Host Institution
- Public

## 2. SWOT Analysis

SWOT Analysis refers to an assessment of CIG in terms of its **S**trengths – **W**eaknesses – **O**pportunities – **T**hreats. SWOT Analysis is useful for determining whether and to what extent CIG can deal effectively with its external and internal operating environments. It forges the basis for developing future strategic objectives. We note that some of these are global strengths and weaknesses, and some are specific to a single area of CIG's activities.

### A. Major Strengths

Significant factors, resources or capabilities that CIG, as a community and as an organization, can utilize to deliver effectively on its mission, accomplish its vision or achieve a strategic objective.

- **Integration and Collaboration.** Effective and sustained collaboration between domain scientists and computational scientists.
- **Community Building.** Active and relevant community building and workforce development.
- **Software.** Support of state-of-the-art codes.
- **Community Platform.** Unified voice and community platform for advocacy.
- **User Community.** Interested, active and open user community.
- **Contributed effort.** Committed group of talented and respected scientists who volunteer their effort to CIG activities.

- **Credibility.** Credibility for open source & community driven software.
- **Responsiveness.** Responsive to the user community.

### B. Major Weaknesses

Critical factors, barriers or limitations that can prevent CIG from delivering on its mission, accomplishing its vision and achieving a strategic objective.

- **Cooperative Development.** Dependence on and difficulty with community code development to drive improvements.
- **Code Champions**. Dependence on and difficulty in developing capable, motivated developers who are domain scientists for each community code and maintaining a vibrant user community.
- **Funding.** Insufficient funds for the scope of work desired by the community; limits flexibility and scalability.
- **Afunctionality**. Codes that are not user friendly limit their usability.
- **Crossing-cutting**. Separate communities and software increases difficulties in crossing domain boundaries.
- **Depth.** Lack of depth in key positions including volunteers and staff. Limited human resources.

### C. Major Opportunities

Favorable situations, events, trends or changes in the external environment that may enhance the ability of the CIG community or support services to deliver on its mission, accomplish its vision or achieve a strategic objective.

- **New Methods.** Availability of new computational and numerical methods and techniques.
- **Uncertainty Quantification.** Providing leadership in formalizing data uncertainty and quantification for data assimilation and models.
- **Interagency Cooperation.** Cooperating with additional government agencies.
- **Relevance and Reliance.** Relevance and reliance of computational science by the broader science community.
- **Innovative Leader.** Positioning CIG as an innovative leader in education and workforce development.
- **Modularity and Extensibility.** Improving modularity and extensibility of codes to encourage community contributions.
- **Collaborations with other scientific communities.** Working with other scientific communities and their science problems.
- **International Collaboration:** Fostering new and established international ties.
- **Cryosphere.** Expand the scientific domain by creating linkages to the cryosphere.

### D. Major Threats

Unfavorable situations, events, trends, barriers or constraints in CIG's external environment that are potentially damaging to its ability to deliver on its mission, accomplish its vision of the future or achieve a strategic objective.

- **Programming skills.** Science domain researchers have a diminishing exposure to programming and computational methods.
- **Funding.** Reduced or eliminated funding from NSF as new initiatives create competition; lack of diversity in funding sources.
- **Depth.** Loss of key personnel, participants or champions could potentially create one or more single points of failure.
- **Give Back.** Inadequate mechanisms to encourage or enforce credit to CIG in citations or other avenues.
- **Maintaining relevance.** Lack of publication record for CIG codes and marketing makes it hard to show CIG relevance to stakeholders.
- **Stagnation.** Potential for codes to stagnate due to loss of champions, developers, or users.
- **Computing Resources.** Difficulty in obtaining computing resources that match the size of the scientific problems and the capabilities of codes, as well as increasing needs of users.
- **Workforce.** Insufficient recognition for code development. Competition from industry drawing away young computational geophysicists.
- **Mission Creep.** Scope increases driven by community, sponsors and need to keep science relevant without a corresponding increase in resources.
- **International competition:** Investments in science and technology that do not demand the same level of transparency fostered at CIG.
- **Transparency**. Broad access to and participation in community governance activities.

## 3. Expected Future Trends

Expected future trends reflect assumptions about external factors such as community and science priorities, technology, data, fiscal resources, and the external environment. The most significant anticipated trends affecting CIG include:

**Data**

- New and large data sets will require integration and assimilation into models
- Diverse data with different time scales, fidelity and quality
- Challenges in moving, storing, visualizing, and analyzing data
- New paradigms for big data

**Science**

- More realistic representations of the physics
- Stronger coupling between systems
- Larger problems (higher resolution, multiphysics, and long time series)
- Broader, more complex parameter spaces

**Hardware**

- More computing power on desktop.
- Increase usage and availability of GPUs.
- Growth of high performance computing technology will enable larger problems
- Improved visualization hardware

**Workforce**

- Growing need for education, including continuing education, from beginner to expert level due to increasing code sophistication
- Increase in diversity of workforce
- Decrease in students in STEM disciplines

**Changing face of scholarly publishing**

- More open-access publication, with unknown costs
- New methods for citing software, datasets
- Greater emphasis on reproducibility and citation of datasets and research tools

**Communications**

- Need for new ways to engage and respond to a growing and changing community
- Increasing public interest in research and technology investments

**Funding**

- Increased international investment in research
- Increased industry investment in simulation for resource extraction and management
- Need to diversify funding portfolio
- Less money available for fundamental research
- NSF funding redirected to other programs

## E. Critical Success Factors

Critical Success Factors are those measures that characterize CIG's success. CSF's are driven by mission, vision, and funding levels. They can be measured on a regular basis in terms of software, people and research:

**Software**

CIG is a community open source software repository and development community. As such its impact to the community is largely measured by usage. Activity can be measured by number and scientific range of:

- donated codes or modules
- code downloads
- HPC cycles used
- repository commits

- new or improved software modules and codes

**People**

CIG is community organization that must be responsive to its users and at the same time grow its user base. As such, its impact is largely measured by outreach and community involvement. This can be measured by the number and diversity of:

- governance participants
- workshop participants
- mailing list membership and participation
- webinar and online tutorial participants
- views on YouTube and other media
- educational products and partnerships developed
- website traffic
- users of HPC resources

**Research**

CIG resources are used to advance research. As such, its impact is largely measured by its ability to enable research and research outcomes. These can be measured by of:

- publications (abstracts, thesis, papers) and readership
- invited presentations
- special sessions of national meetings organized around CIG resources or codes
- proposals that draw on or use CIG resources
- partnerships with other organizations
- international collaborations
- diversity of funding sources
- impact of CIG-related research on HPC infrastructure, public policy, and education
- acknowledgements and citations of CIG codes in publications and reports

## F. Strategic Objectives & Actions

Based on its shared core values, CIG will pursue 6 Strategic Objectives in order to deliver on its mission and vision. Potential **Actions** for each objective (bulleted lists) will guide development of the road map for creating and developing CIG's future.

### Strategic Objective 1: Community Leadership

*Promote and advance the CIG scientific community through the use of modern computational methods, good data and software governance, and sustainment of collaborations across communities nationally and internationally to increase the visibility of its mission and science.*

### Actions

- Promote recognition for software development and data such as standards for citation in peer-reviewed journals and other dissemination platforms.
- Create and sustain opportunities for collaboration between geoscientists and computational and mathematical scientists.
- Provide forums to address multidisciplinary scientific and computational challenges requiring broad community participation.
- Advocate nationally for programs and infrastructure addressing community needs for computationally-based science. Showcase CIG-enabled research internationally, possibly in coordination with related national organizations.
- Promote organizing of CIG-related science sessions at major meetings.

## Strategic Objective 2: Scientific Diversity

*Support integration and representation across related geoscience communities.*

### Actions

- Engage related communities through collaborations and joint workshops.
- Seek collaborative science problems to actively engage with other communities and explore opportunities to address multidisciplinary challenges.
- Explore connections with other institutions that can both leverage and expand capabilities.
- Regularly review membership and leadership for balance, diversity, and new opportunities.

## Strategic Objective 3: Infrastructure

*Support the scientific community through planning, maintenance and capacity building as requested by the research community.*

### Actions

**Management**

- Ensure management and operations meets community and sponsor needs.
- Plan for sustained software support and development.

**Resource Acquisition**

- Enable deployment of CIG codes on state-of-the art hardware, from desktop to leadership class computing and facilitate access to computing and HPC resources at all user levels.
- Promote and engage benchmarking exercises for both numerical accuracy and scientific efficiency with scalability in mind.
- Provide leadership in promoting numerical and algorithmic innovation for computational geosciences.
- Identify community needs and funding opportunities in cyber infrastructure.

**Software Support**

- Provide software infrastructure services to the community through dissemination, hosting and testing services.
- Support development of CIG community codes led by user-developers that leverage ideas and collaboration from active user communities.
- Provide guidance to software developers for code donations.
- Improve accessibility and performance of existing codes as prioritized by the community, providing state-of-art software using modern techniques for computational geoscience.
- Maintain forums to support software users and developers.

## Strategic Objective 4: Education and Outreach

*Build the capacity of the scientific community for numerical modeling in the geosciences and establish societal relevance through education and outreach activities.*

### Actions

- Build a broader developer and user community through training that builds progressively towards advanced levels.
- Promote education in modeling for the geosciences that cuts across domains.
- Develop educational materials and training to facilitate broader adoption of modern software engineering practices though out the geodynamics modeling community.
- Provide a forum to share code experience both from the user and developer perspective.
- Create societal relevance by promoting geodynamics research that supports the public interest in natural hazards and climate change.

## Strategic Objective 5: Resources

*Diversify the resource base in support of the science community.*

### Action

- Cultivate new funding in support of the overall mission including federal, industry, private foundations, and international collaborations.

## Strategic Objective 6: High Performance Computing

*Facilitate the development of High Performance Computing resources to meet the needs of the CIG community, from the mesoscale (mid-sized clusters) to leadership class computing.*

### Actions

- Facilitate access for the community to existing HPC resources such as XSEDE and INCITE.
- Inventory and report on community needs and bottleneck
- Cultivate new partnerships for access to HPC resources for community projects.