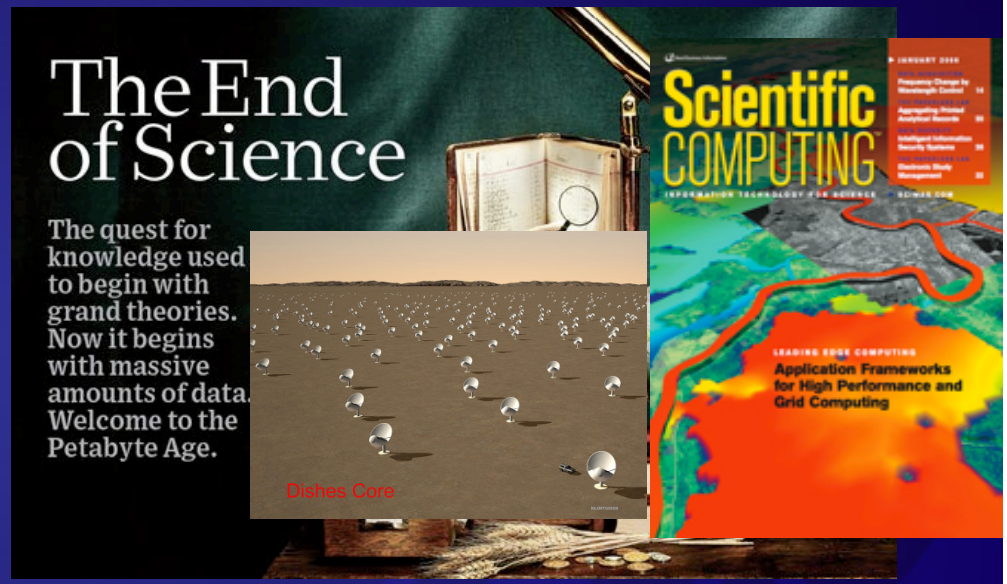
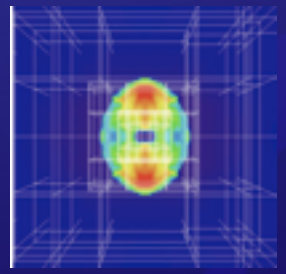
Software Infrastructure for Sustained Innovation (SI^2)

http://www.nsf.gov/si2/

Science is Revolutionized by CI

- Modern science
  - Data- and compute-intensive
  - Integrative
- Multiscale Collaborations for Complexity
  - Individuals, groups, teams, communities
- Must Transition NSF CI approach to support
  - Integrative, multiscale
  - 4 centuries of constancy, 4 decades 10^{9-12} change!
- Multiple crisis
  - Hardware, Data, Education/WFD, …





Software is Critical

- CI – Unprecedented complexity, challenges
- Software is essential to every aspect of CI – "the glue"
  - Drivers, middleware, runtime, programming systems/tools, applications, …
- This software is different …. ?
  - In its natures, who builds it, how is it built, where it runs, its lifetime, etc.
- Software crisis?
  - Software complexity is impeding the use of CI
    - Science apps have 10^3 to 10^{6+} lines, have bugs
    - Developed over decades – long lifecycles (~35 years)
  - Software/systems design/engineering issues
    - Emergent rather than by design
  - Quality of science in question

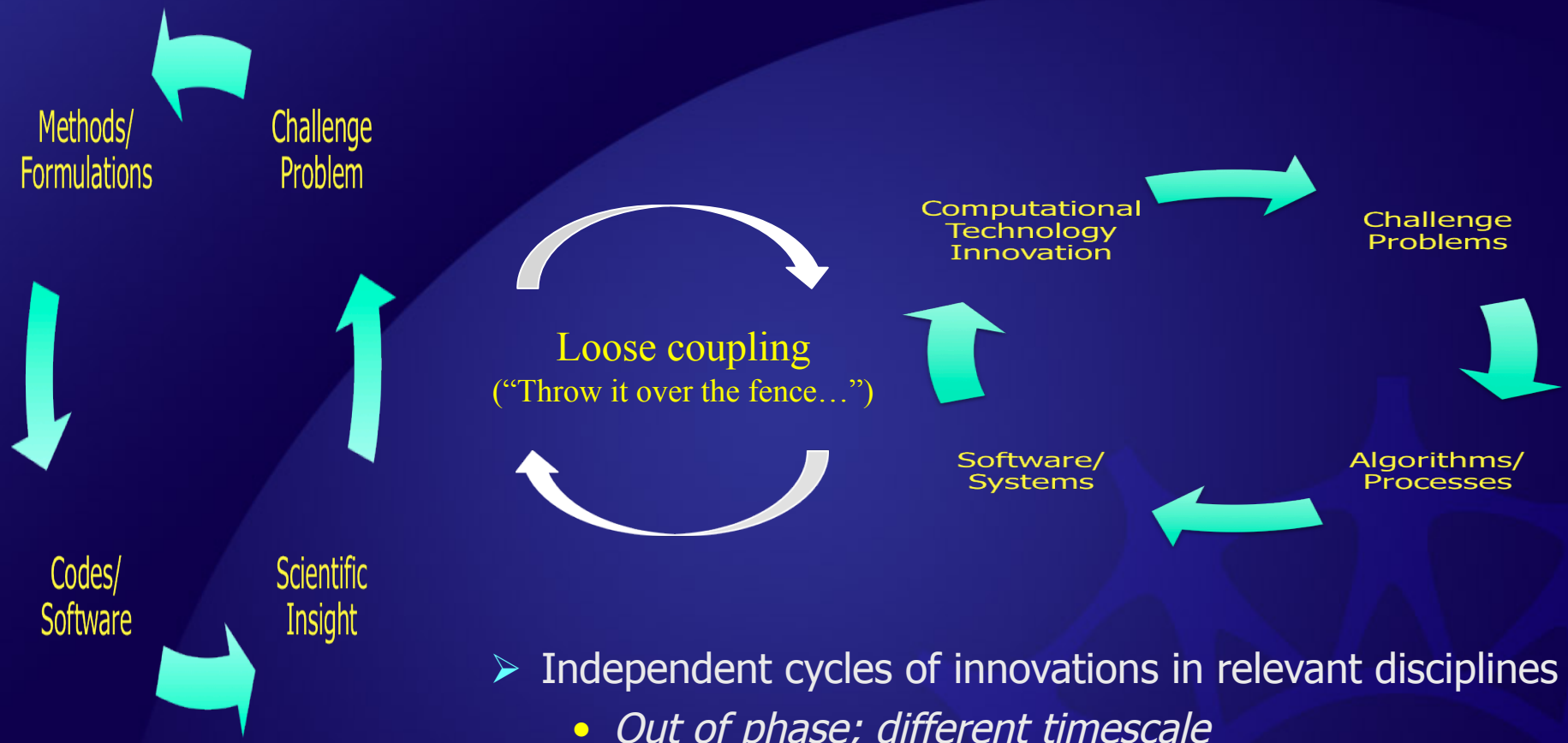
Software Grand Challenge

- SW as the modality for CF21 and Computational Science in the 21st Century
- Sustainable SW as a CI resource
  - What SW to sustain?
  - How to sustain it?
- Fundamental Grand Challenge: Robust, Sustainable and Manageable Software at CI-Scale
  - Repeatability, Reliability, Performance, Usability, Energy efficiency, ….
- Sustainability, manageability, etc., are NOT add-ons – it has to be integrated into the design

Many complex aspects….

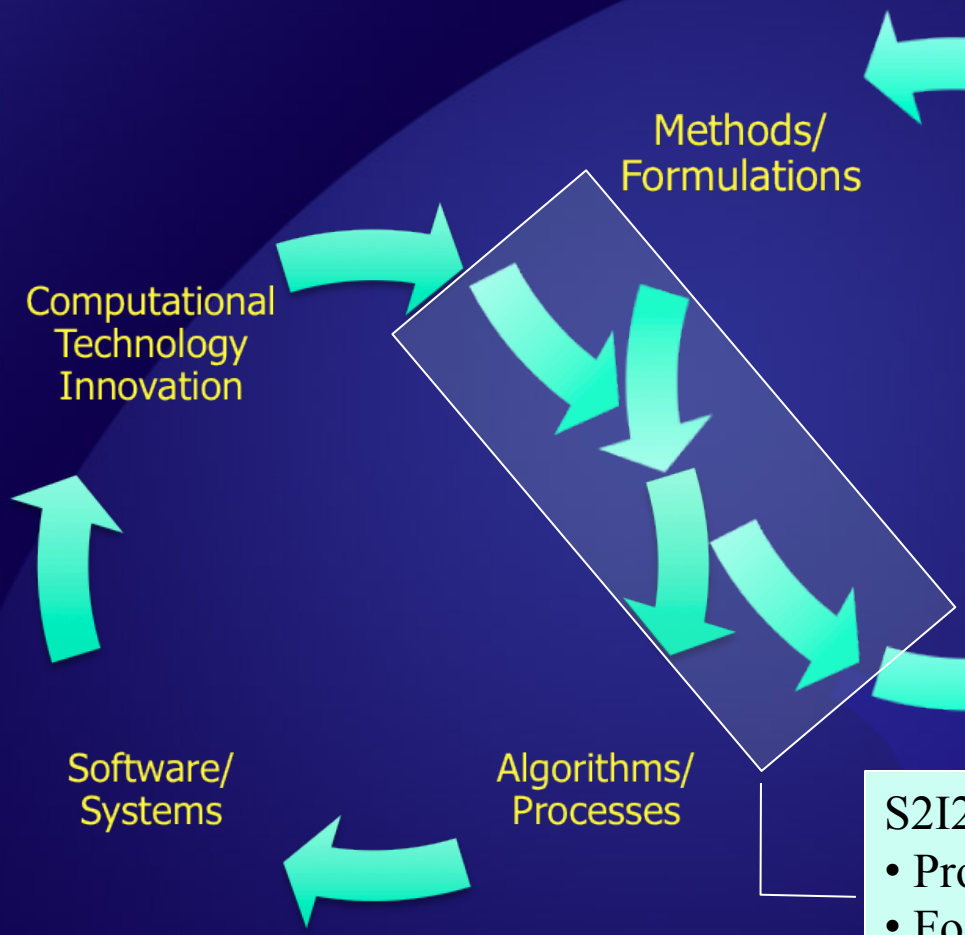
- Building the right software – application involvement, understanding requirements
  - scales, types of software, target user communities
- Building software right – teams, reward structures, processes, metrics, verification/testing
- Protecting investments – active management, sustainability, leverage/reuse, ownership, business models
- Building trust – user community must be able to depend on the availability of a robust and reliable software infrastructure!

Cycles of Innovation: The Current State



- Independent cycles of innovations in relevant disciplines
  - *Out of phase; different timescale*
- Coupling (if any) is loose and asynchronous
  - Incorrect and/or in-efficient solutions
- Few synergies; Plenty of repetition and re-invention

Cyber-Science: Synergies & Symbiosis



S2I2:

- Processes, mechanism, frameworks
- Foster, nurture partnerships
- Build trust

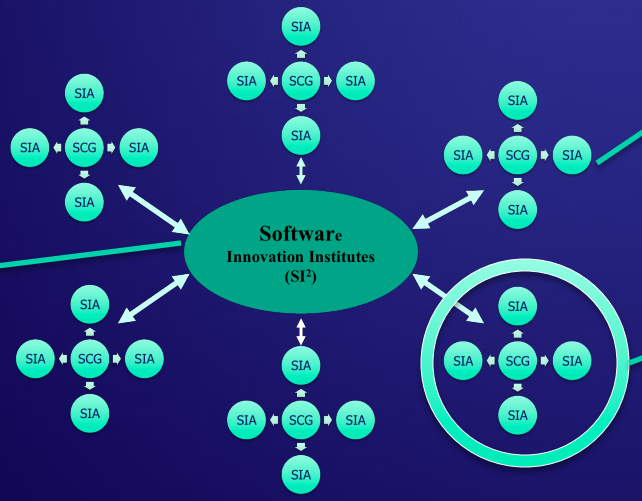
Sustained Long-Term Investment in Software

- Transform innovations into sustainable software that is an integral part of a comprehensive cyberinfrastructure
  - robust, efficient, resilient, repeatable, manageable, sustainable, community-based, etc.
- Catalyze and nurture multidisciplinary software as a symbiotic "process" with ongoing evolution
  - Domain and computational scientists, software technologists
- Address all aspects, layers and phases of software
  - Systematic approaches
    - Theory validated by empirical trials
  - Tools that embody and support processes
  - Metrics, validation mechanisms, governance structures
  - Amortised over large (global) user communities
  - Support for maintenance and user support

Sustained Long-Term Investment in Software

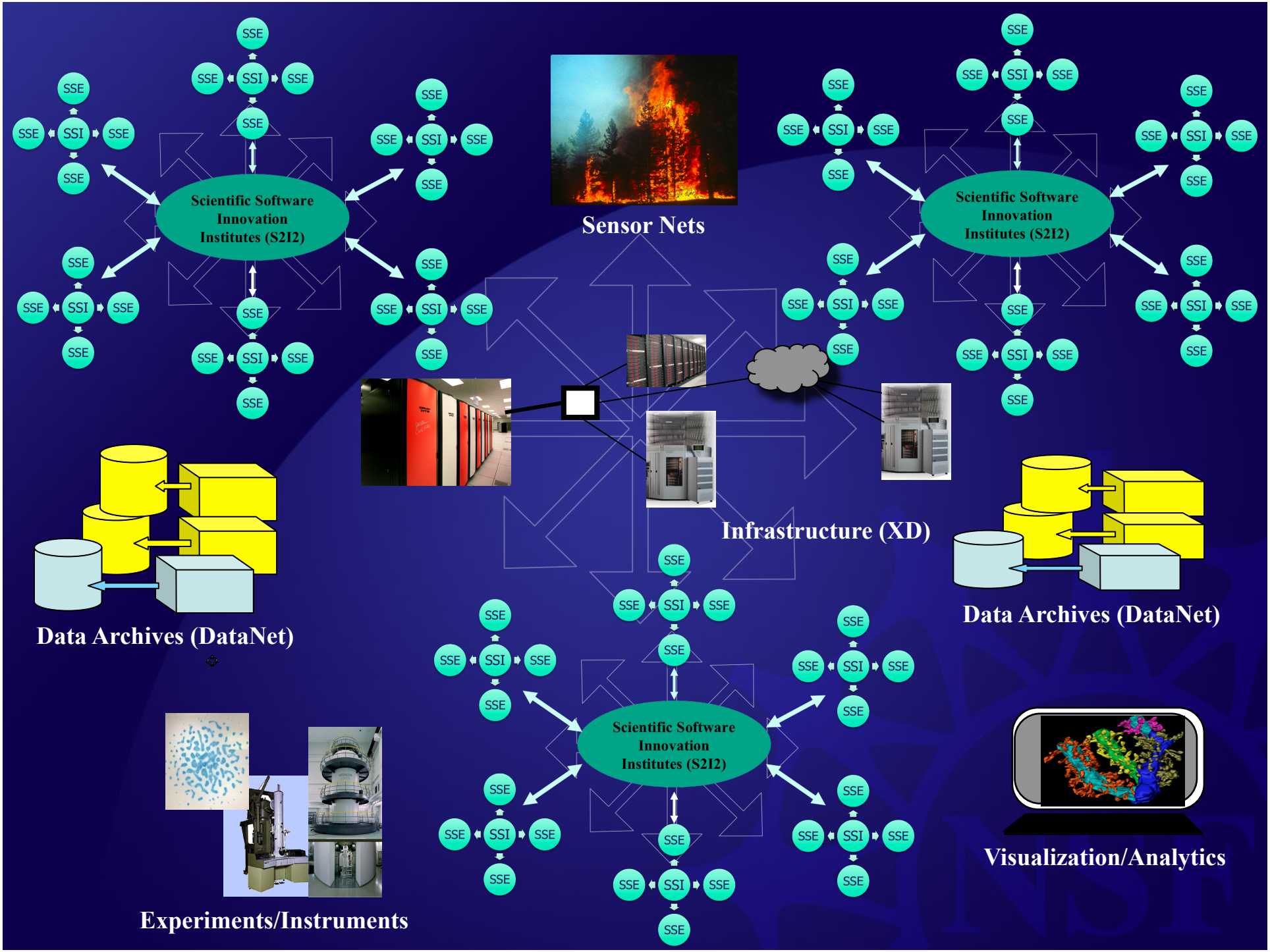
- Significant multiscale, long-term program
  - Envisions $200-300M over a decade
  - Connected institutes, teams, investigators
  - Integrated into CF21 framework

3-6 centers, 5+5 years, for critical mass, sustainability



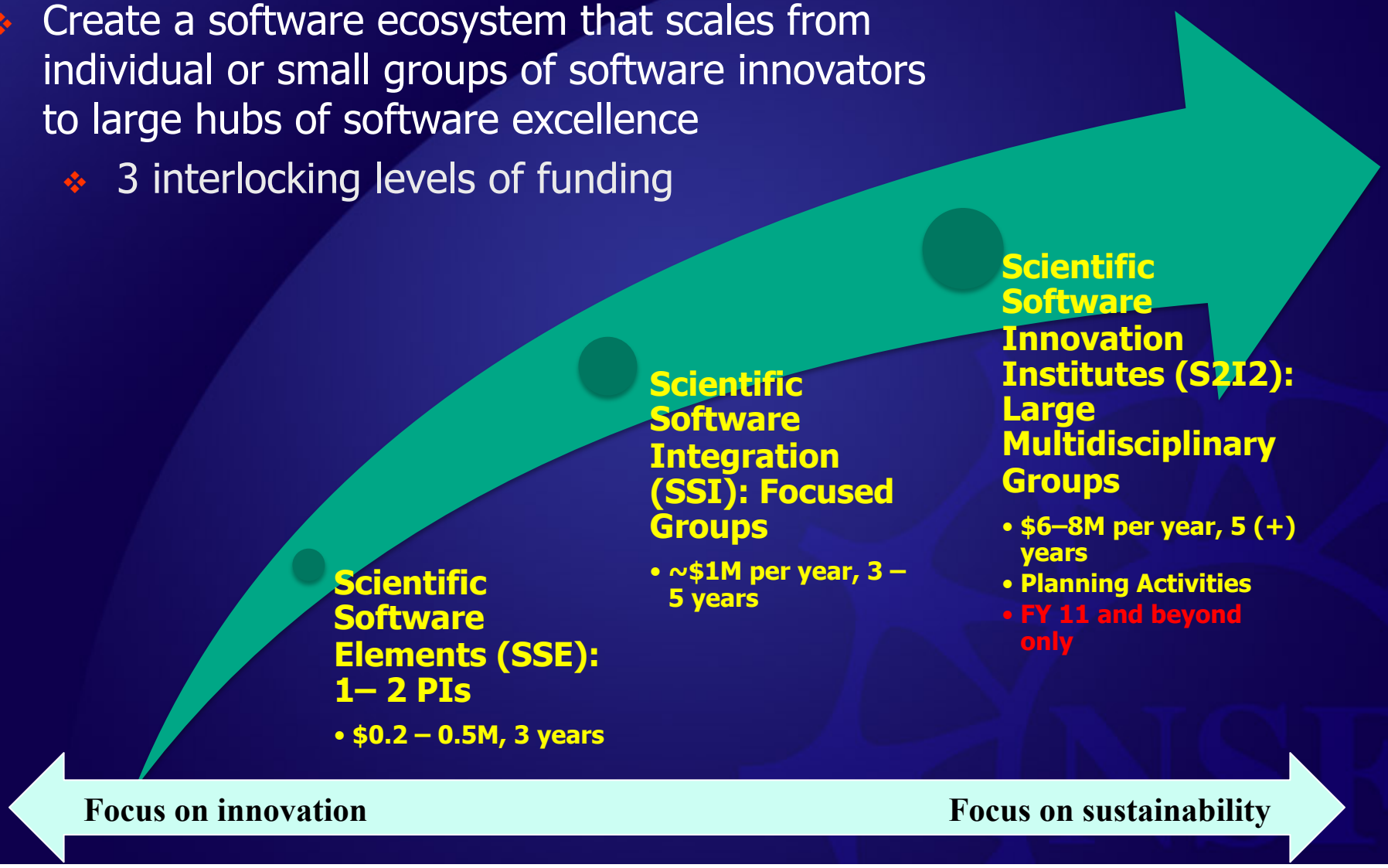
Many individuals w/short term grant

Numerous teams of scientists and computational and computer scientists with longer term grants


SSE
SSI
Scientific Software Innovation Institutes (S2I2)
Sensor Nets
Infrastructure (XD)
Data Archives (DataNet)
Data Archives (DataNet)
Experiments/Instruments
Visualization/Analytics

Software Infrastructure for Sustained Innovations (SI^2) - Mechanisms

- Create a software ecosystem that scales from individual or small groups of software innovators to large hubs of software excellence
  - 3 interlocking levels of funding



Software Infrastructure for Sustained Innovation (SI^2): FY10 First round

- Letters of Intent (Required) – May 10, 2010
  - Title, Team, Synopsis (science/engr. drivers, target user community, specific software elements)
- Full Proposals – June 14, 2010
  - SSE: ~2 PIs + 2 GAs, 3 years
  - SSI: ~3-4 PIs, 3-4 GAs, 1-2 senior personnel/developers, 3-5 years
  - No S2I2 in FY 10
- Proposals from all parts of NSF were received
  - 200 projects were submitted
  - ~10% overall funding rate is anticipated
- **Now we look to the future of this program!!!!**

Scientific Software Innovation Institutes (S2I2) – Call for Exploratory Workshop Proposals

- Goals:
  - Inform NSF on what should be included in the solicitation
  - Inform the community as it responds to the solicitation in FY11
  - Provide a forum of discussions about the SI2 vision, and S2I2 models and structures within and across communities.

Scientific Software Innovation Institutes (S2I2) – Call for Exploratory Workshop Proposals

- Questions
  - What scientific areas have significant challenges that can benefit, in terms of scientific innovation/discovery as well as productivity, from an S2I2
    - Is there an need for such an Institute and if so what would be the appropriate focus area(s) and scale?
    - What communities would it serve, who would participate, what interconnections would it have to the larger community of computational scientists, experimentalists, and beyond.
  - What are the key attributes of an S2I2? What are appropriate organizational, personnel and management structures, as well as operational processes?

Scientific Software Innovation Institutes (S2I2) – Call for Exploratory Workshop Proposals

- Questions
  - What expertise and capabilities should an S2I2 provide and how should it interface and interact with science communities? What education and outreach functionalities are meaningful in an S2I2?
  - What are the critical linkages between an S2I2 and other components of a community cyberinfrastructure (i.e., software tools, databases, instruments, etc.)? What is the unique role of an S2I2 in the broader cyberinfrastructure ecosystem (e.g., TeraGrid/XD, DataNet, MREFC, etc.)?

Scientific Software Innovation Institutes (S2I2) – Call for Exploratory Workshop Proposals

- Questions
  - What are meaningful metrics, evaluation mechanisms and governance structures for an S2I2? What are appropriate approaches to sustainability of the S2I2?
  - How would an S2I2 impact the science and engineering community and impacts its practices, capabilities and productivity?

Software Infrastructure for Sustained Innovation (SI^2): Metrics of Success

- Buy-in from the broader community
- Demonstrated leverage and reuse
- Emergence of successful models, processes, architectures, metrics for S&E software – empirically validated
- Emergence of models and mechanisms for community sustainability of software institutes
- Accepted research agenda by academic community

Software Infrastructure for Sustained Innovation (SI^2) – More Information

- DCL
  - http://www.nsf.gov/pubs/2010/nsf10029/nsf10029.jsp?WT.mc_id=USNSF_179
- Solicitation
  - http://www.nsf.gov/si2/
- S2I2 DCL
  - http://www.nsf.gov/pubs/2010/nsf10050/nsf10050.jsp?org=NSF
- SI^2 POC: Manish Parashar

  mparasha@nsf.gov

Summary

- Science is being revolutionized through CI
  - Compute, data, networking advance suddenly 9-12 orders of magnitude after 4 centuries
  - All forms of CI—integrated—needed for complex science
- NSF responsive: developing much more comprehensive, integrated CF21 initiative
  - Community deeply engaged in planning
  - Activities begin FY10, ramp up FY11-12 and beyond
- Focus on sustainability, people, innovation
  - Longer term programs, better linked, hubs of innovation
  - Support development of computational scientists who develop and/or use advanced CI
- Robust, reliable, sustainable software is critical!

Thank You!

Voyager Spacecraft (1977 -):

Long-lived, enduring, tenacious, robust

Sustainable System

"meets the needs of the present without compromising the ability of future generations to meet their own needs"

[UN Brundtland Report 1987, of sustainable development]