DataNet Federation Consortium

University of North Carolina at Chapel Hill

University of California, San Diego

University of South Carolina

Arizona State University

University of Arizona

Drexel University

Duke University

RENCI

Years 1-2:

- ✓ 6 FTEs
- ✓ 8 Staff
- ✓ 5 Faculty
- ✓ 3 Students

Years 1-2:

- ✓ 4 Universities
- ✓ 3 Consortia
- ✓ 2 Companies

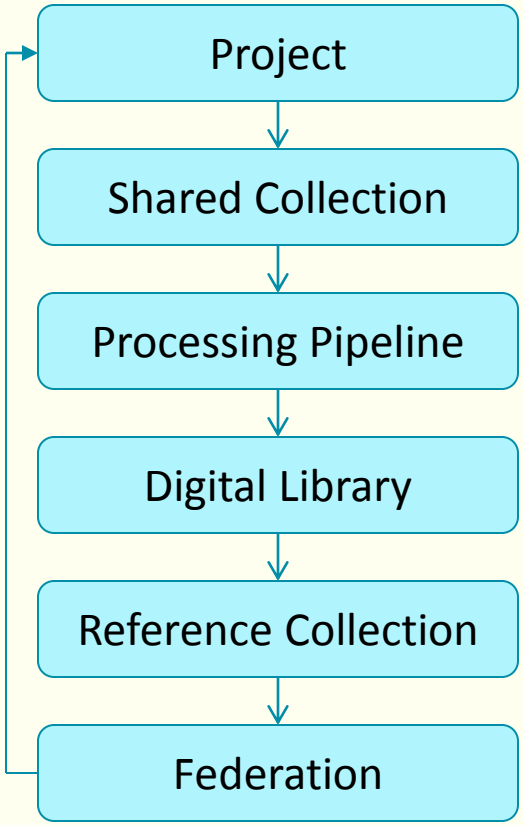
National Science Foundation Cooperative Agreement: OCI-0940841

DFC DataNet FEDERATION CONSORTIUM

Please credit the DataNet Federation Consortium when referencing this information.

DFC Vision - Data Driven Science

- **Enable reproducible science through collaborative research on shared workflows and data collections**
  - Researcher management of workflows and data
  - Policy-based management of entire scientific data life cycle from data analysis pipelines to long-term sustainability of reference collections
- **Implement NSF national scale data cyberinfrastructure**
  - Federation of exemplar data management technologies from national research initiatives
  - Provision of interoperability mechanisms
  - Proven technology implemented in extant data grids
- **Integrate "live" research data collections into education initiatives**
  - Student digital libraries accessing national data sets

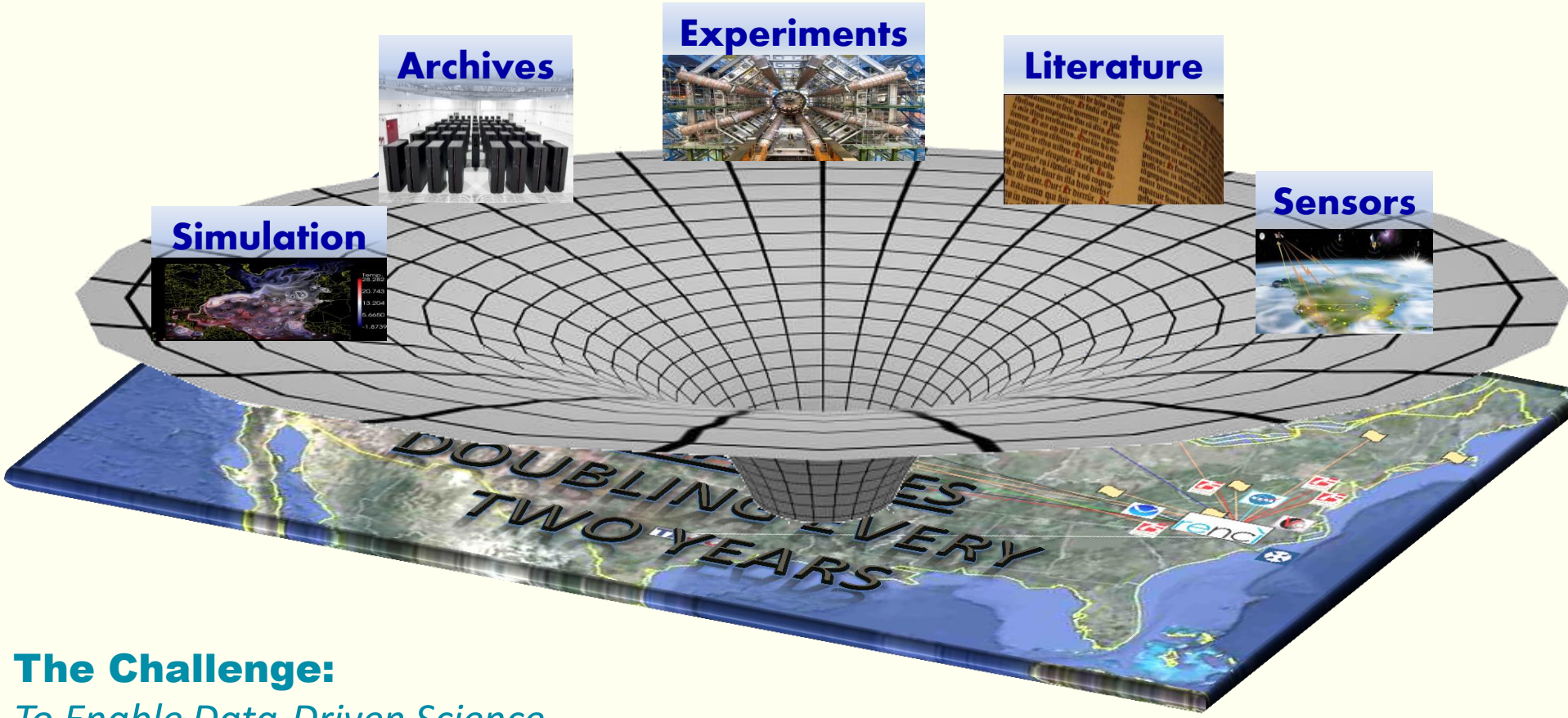


Community-based Collection Life Cycle

DFC Vision

- **Collaboration environment enables research:**
  - Registration of remote data sets into local workspace
  - Registration of analysis workflows
  - Tracking of provenance of workflows
    - Input data sets and input parameters
    - Correlation of workflows with research data products
- **Reproducible science**
  - Sharing of workflows and data
  - Re-execution of workflows by collaborators

The Future: an Explosion of Data



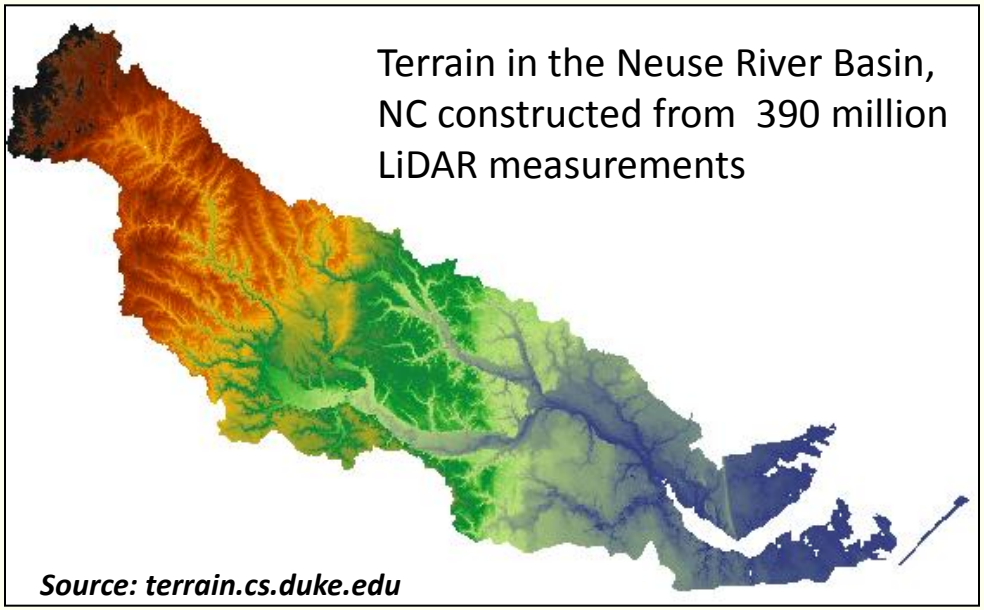
The Challenge:

To Enable Data-Driven Science

Deliver the capability to manage, mine, and analyze data in near real time and build sustainable collections.

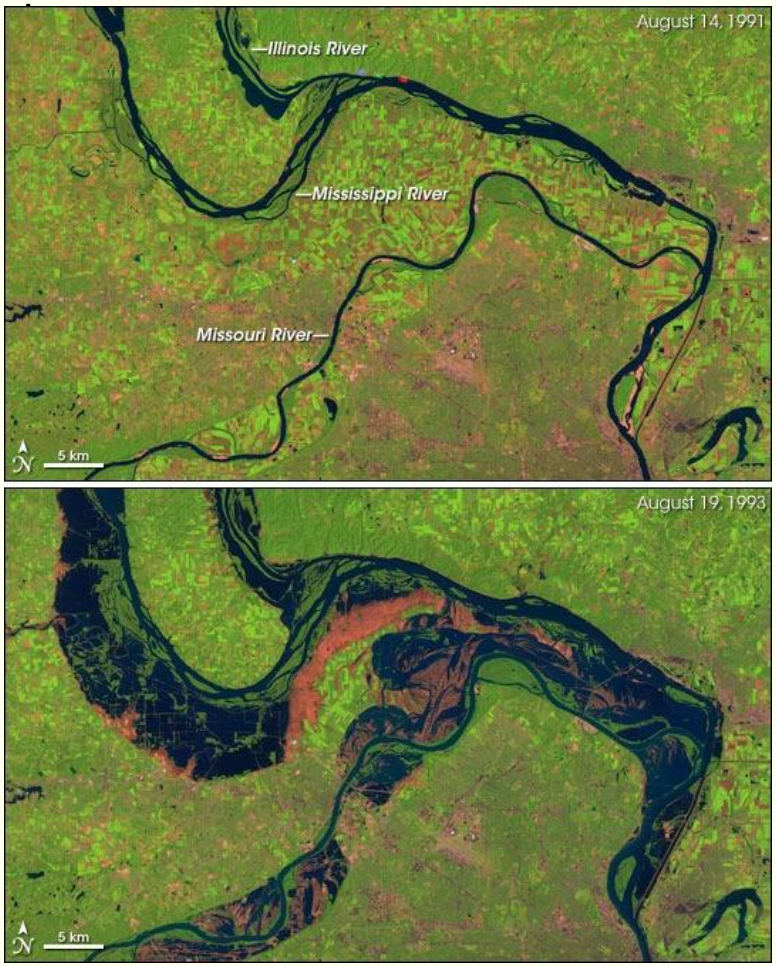
Use Case: National Water Model

Hydrologic scientist have expressed a "grand research challenge" of building a National Water Model for flood and drought applications.



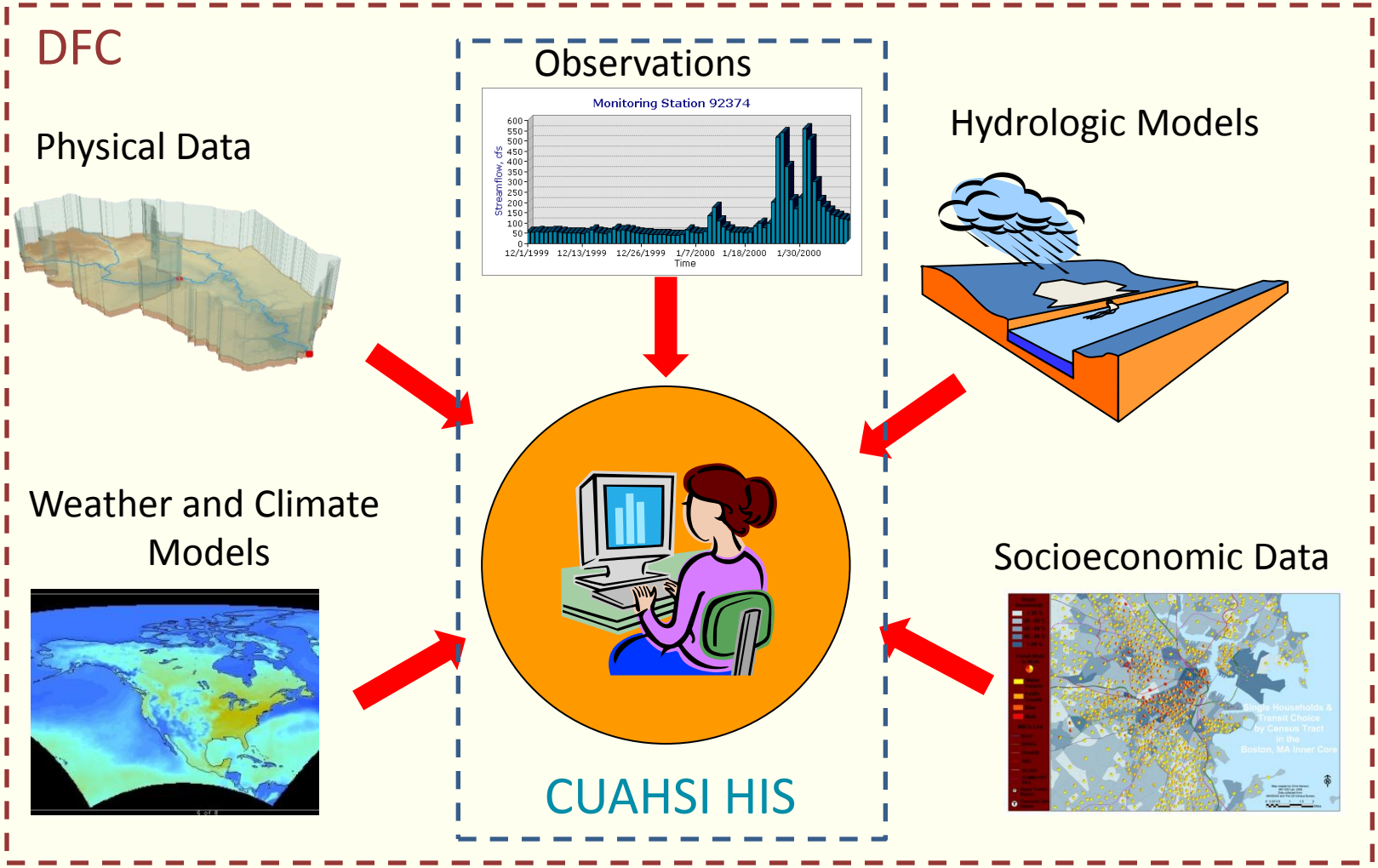
Achieving this goal will require a system like DFC to handle the massive data requirements.

Flooding in the Mississippi River Basin, August 1993 observed from satellite



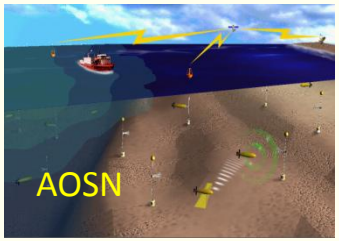
Source: nasa.gov

Data and Model Integration Needed to Support Hydrologic Science

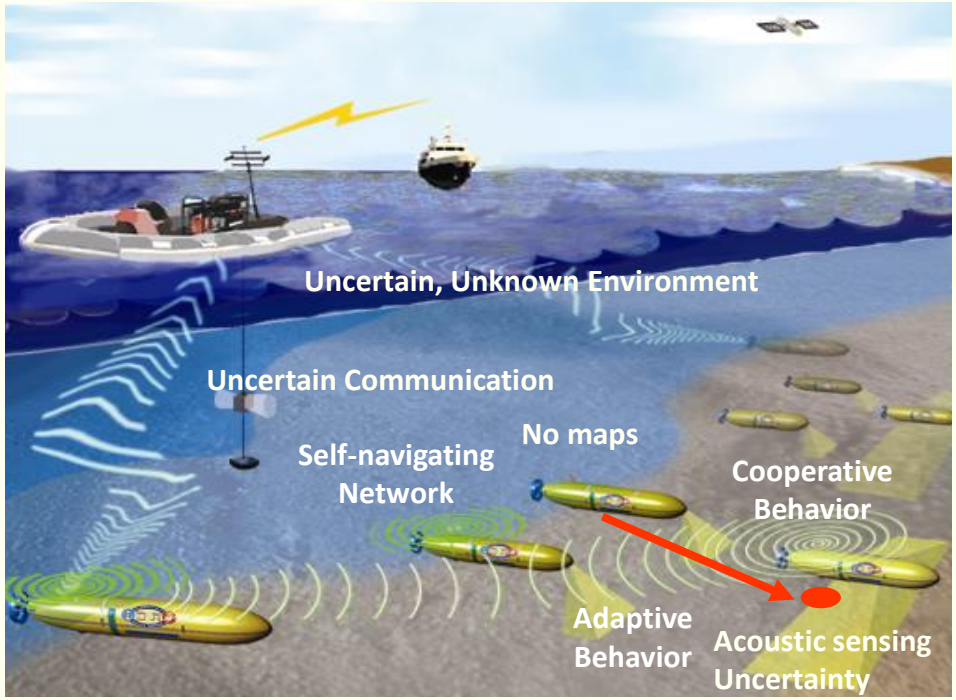


Ocean Sensing Systems Paradigm Shift

Platform-centric Sensing Systems



Net-centric, Distributed Autonomous Sensing Systems



Federation of real-time sensor data

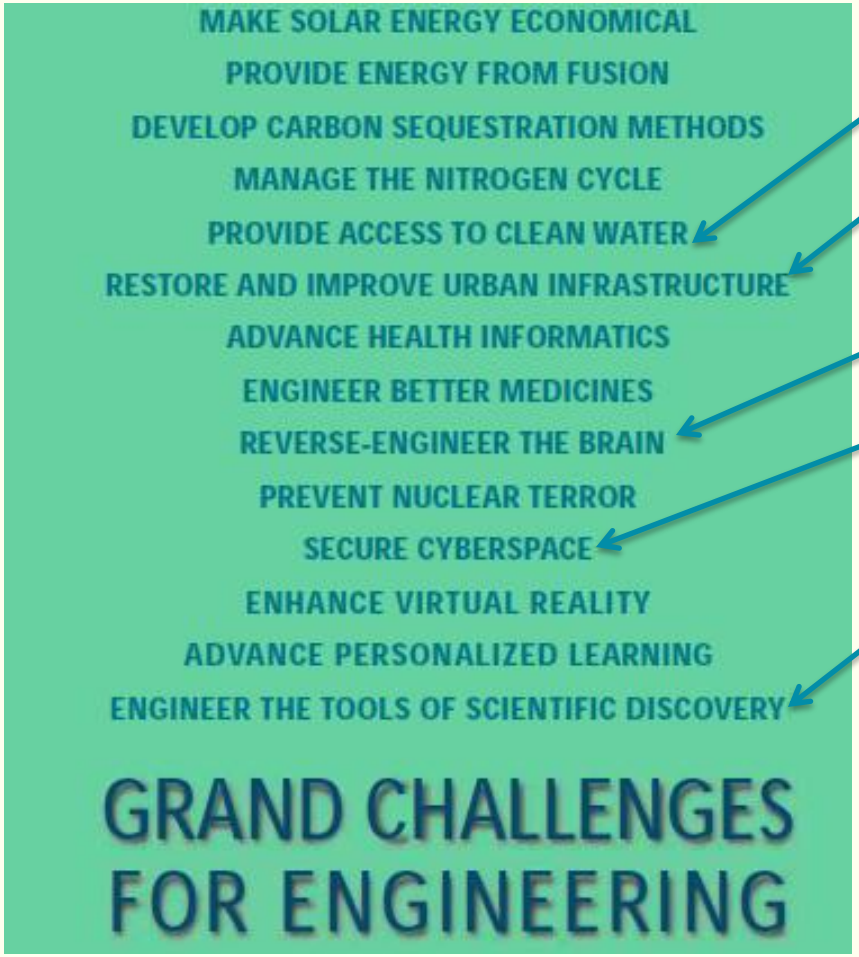
Use Case: Ocean Observatories

- **Use data grid technology within OOI**
  - Manage real-time sensor data stored as files
- **Collaborate on installation of data grids at NOAA**
  - Ingest and access to NOAA data records
- **Federate with NOAA data archives**
  - Automate deposition into NOAA archive
  - Generate climate data records

State of Engineering Design Education

- Improving Engineering Design: Designing for Competitive Advantage (1991)
- The Engineer of 2020: Visions of Engineering in the New Century (2004)
- Educating the Engineer of 2020: Adapting Engineering Education to the New Century (2005)
- Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future (2007)
- Is America Falling Off the Flat Earth? (2007)

DFC Supports NAE "Grand Challenges" Efforts



- **CUASHI**
- **Drexel "Engineering Cities" Initiative**
- **TDLC**
- **Drexel's ACIN Initiative**
- **iRODS and DFC tools *are* <u>*the*</u> tools for data-driven scientific discovery!**

Community-based Collection Life Cycle

Each collection life cycle stage re-purposes the original collection

Project Collection	Data Grid	Data Processing Pipeline	Digital Library	Reference Collection	Federation
Private	Shared	Analyzed	Published	Preserved	Sustained
Local Policies	Distribution Access Policies	Analysis Service Policies	Description Format Metadata Policies	Representation Policy	Re-purposing Policy

- **The stages correspond to addition of new policies for a broader community.**
- **We virtualize the stages of the collection life cycle through policy evolution.**

Goals and Challenges

Opportunity and Capabilities

Scientific Goals	Challenges
• Data-driven science	(capturing metadata)
• National data cyberinfrastructure deployment	(massive collections)
• Enable collaborative research	(controlled sharing)
• Improve research productivity	(workflow registration)

New Opportunities and Capabilities	
• Time-dependent data support	(new data modalities)
• Federation of repositories	(integration across systems)
• Reference collections for educational use	(active collections)
• Virtualization of stages of data life cycle	(sustainability)

Addressing the Challenges

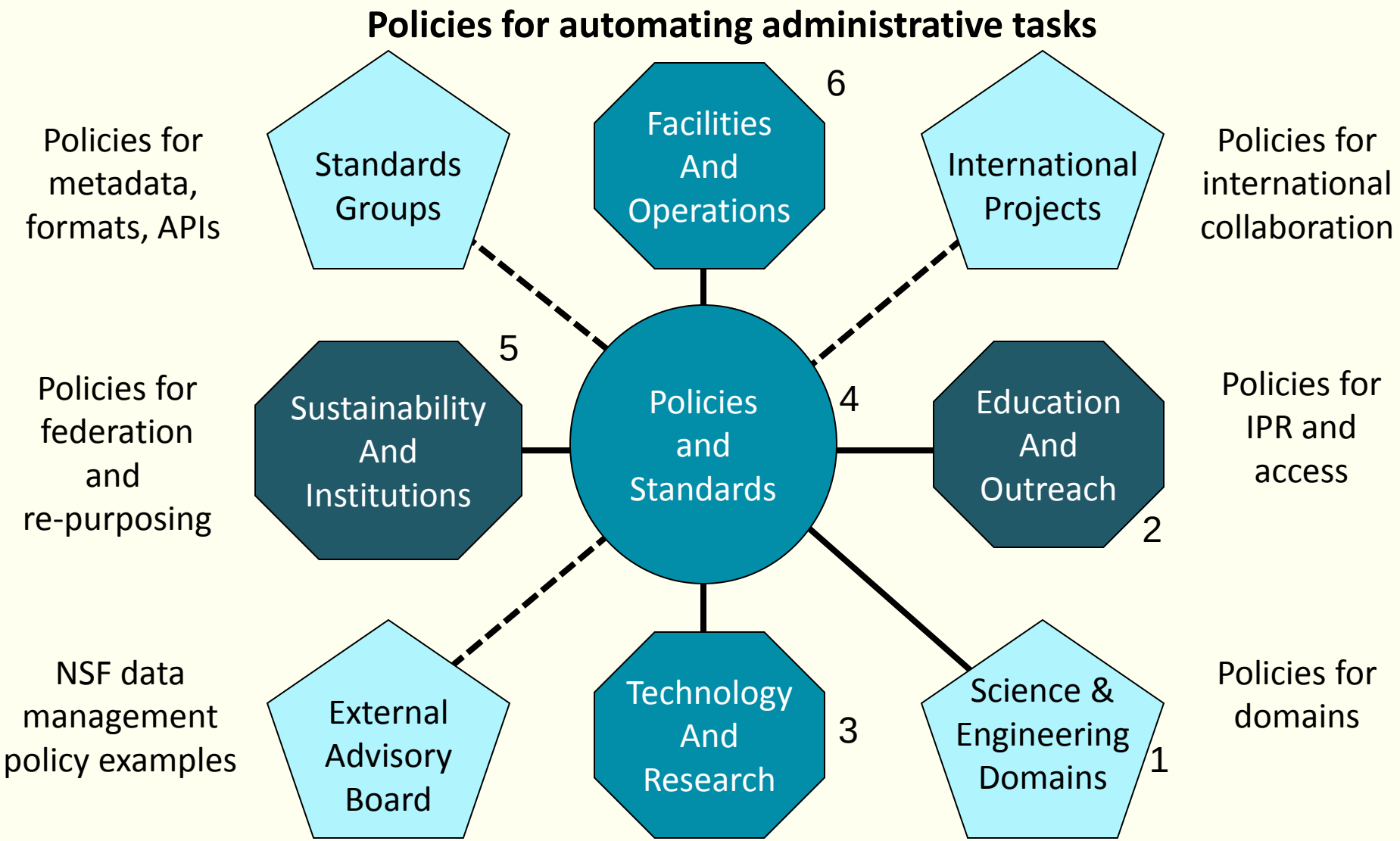
Highly extensible, scalable, modular policy-based framework

- Policy-based data management
- Interoperability across clients and storage resources
- Automation of administrative tasks
- Validation of assessment criteria
- Workflow management
- Federation of repositories

Sustainability of infrastructure, collections, policies

- Repurposing of collections
- Federation of repurposed collections
- International development collaborations (EUDAT)
- Enterprise-iRODS version (RENCI)

Communities of Practice



Science Domain Partners

Years 1-2

GeoScience - Hydrology

Jon Goodall – USC

Ocean Observatories Initiative (OOI)

John Orcutt – UCSD

Cyberinfrastructure-Based Engineering Repositories for Undergraduates (CIBER-U)

William Regli – Drexel

Years 3-5

Temporal Dynamics of Learning Center (TDLC)

Andrea Chiba – UCSD

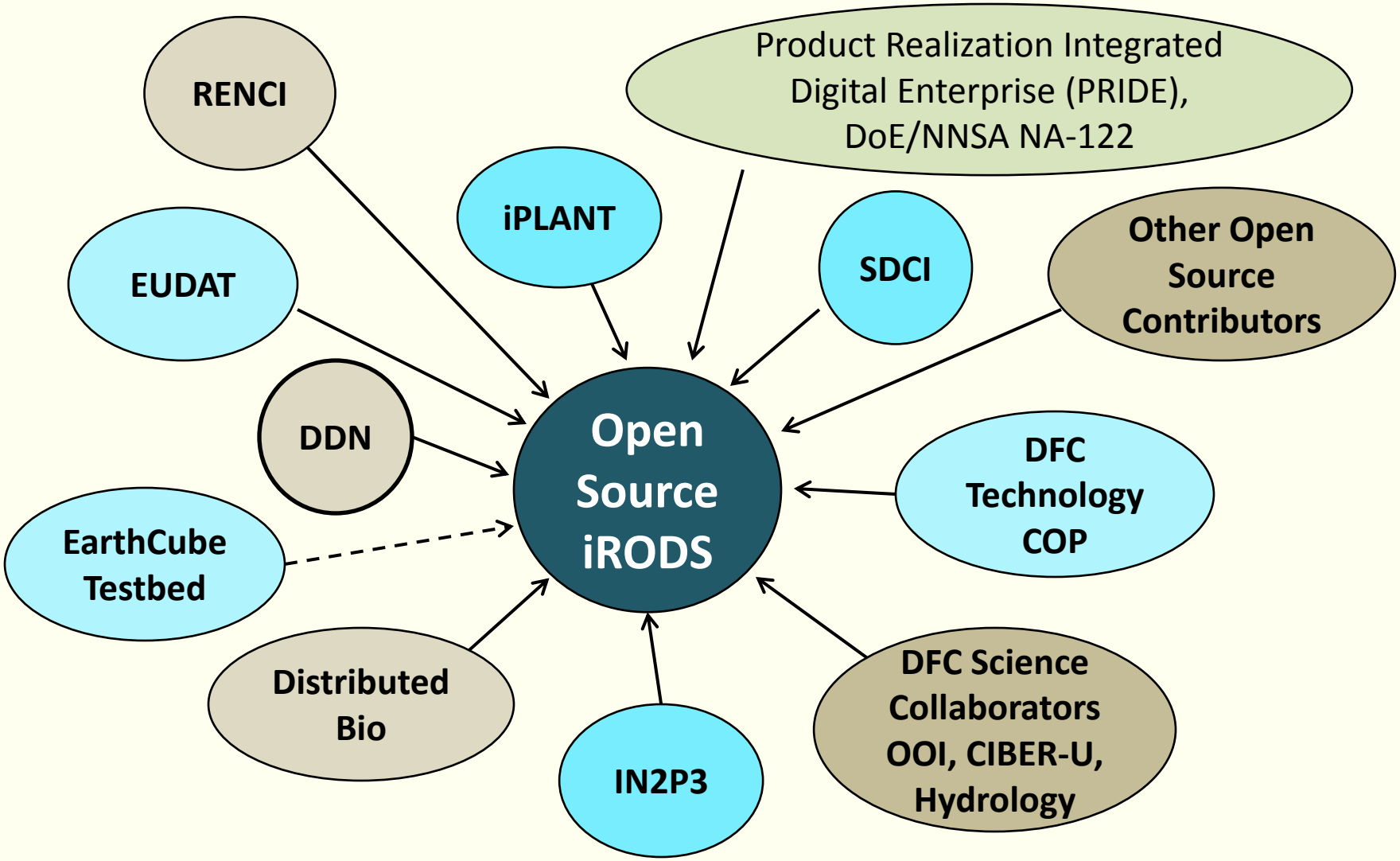
iPlant Collaborative

Sudha Ram – University of Arizona

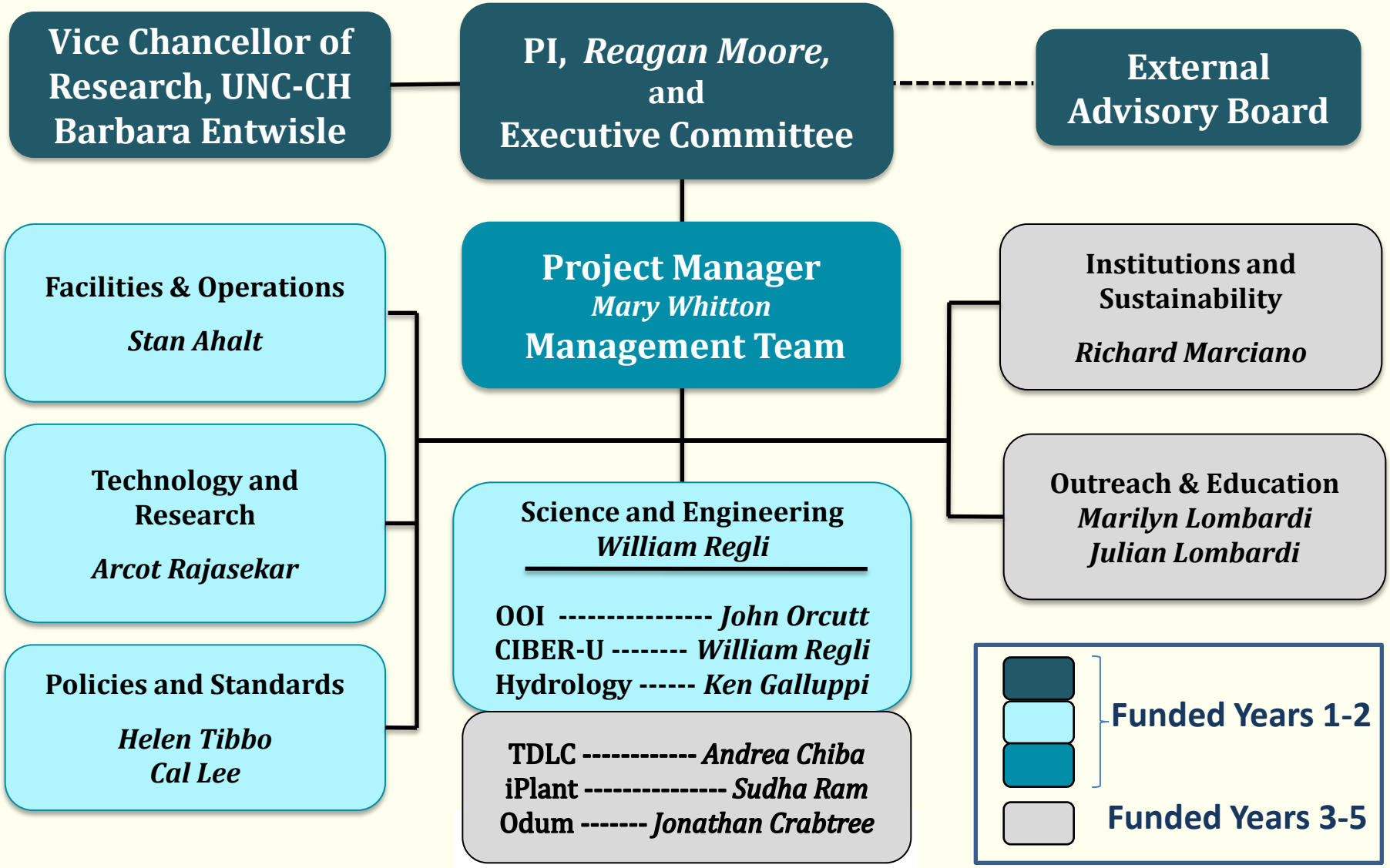
Odum Institute for Research in Social Science

Tom Carsey, Jon Crabtree – UNC-CH

Extended Collaboration Communities



DFC Organizational Structure



Transition to Production Infrastructure

Principal Investigator
Reagan Moore

Project Manager
Mary Whitton

Executive Committee

Members are:

- The PI
- The Project Manager
- Community of Practice and Science Domain representatives (rotating membership)

- Manages overall vision
- Manages *external* relationships
- Meets quarterly

Management Team

Members are:

- The PI
- The Project Manager
- Community of Practice and Science Domain representatives

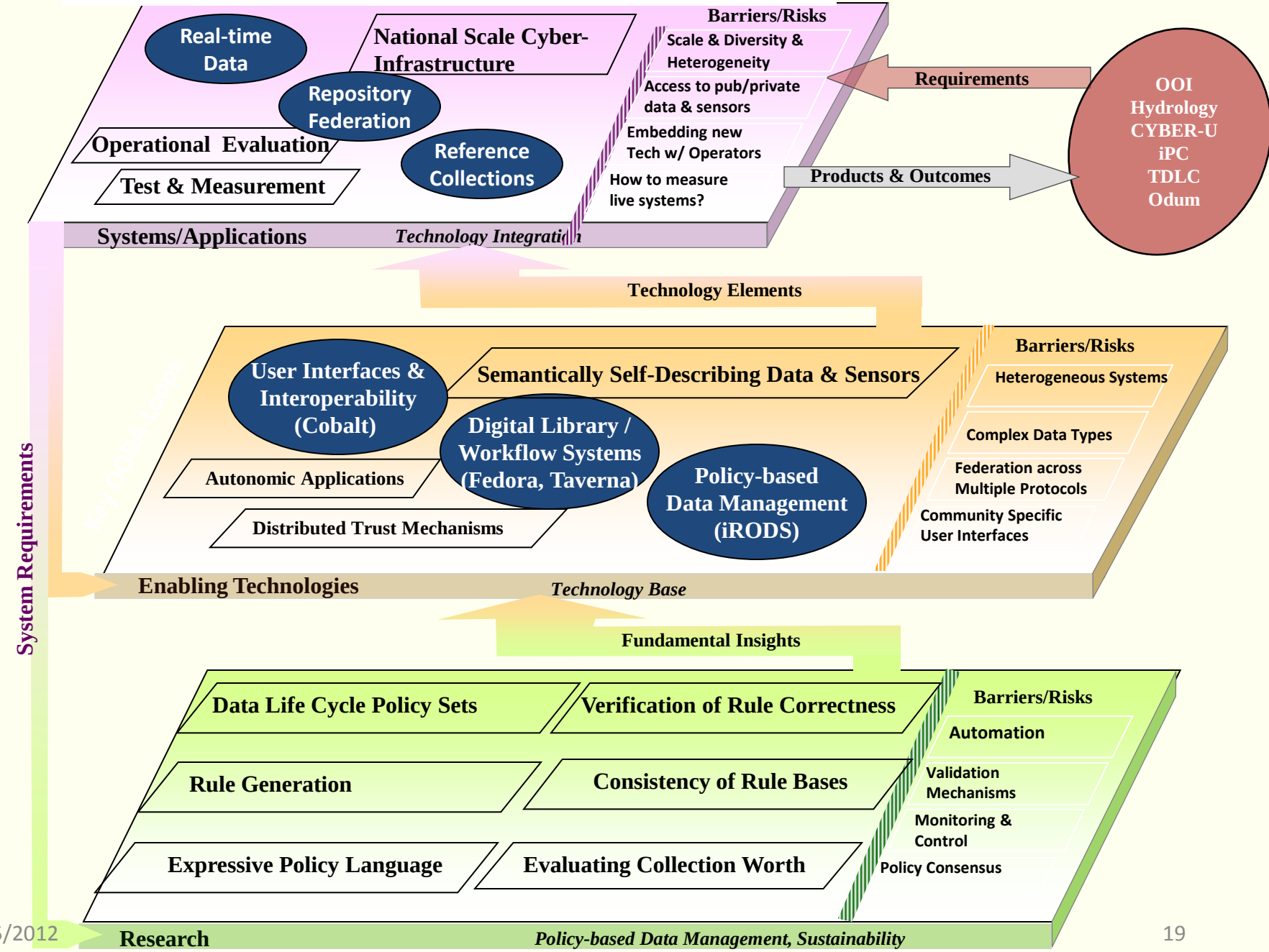
- Manages *internal* activities and implementation
- Meets weekly

Project Manager

- Manages
  - finances
  - personnel
  - risk tracking and mitigation
  - project information systems
- Liaises with university & sponsoring agencies
- Performs other duties as assigned

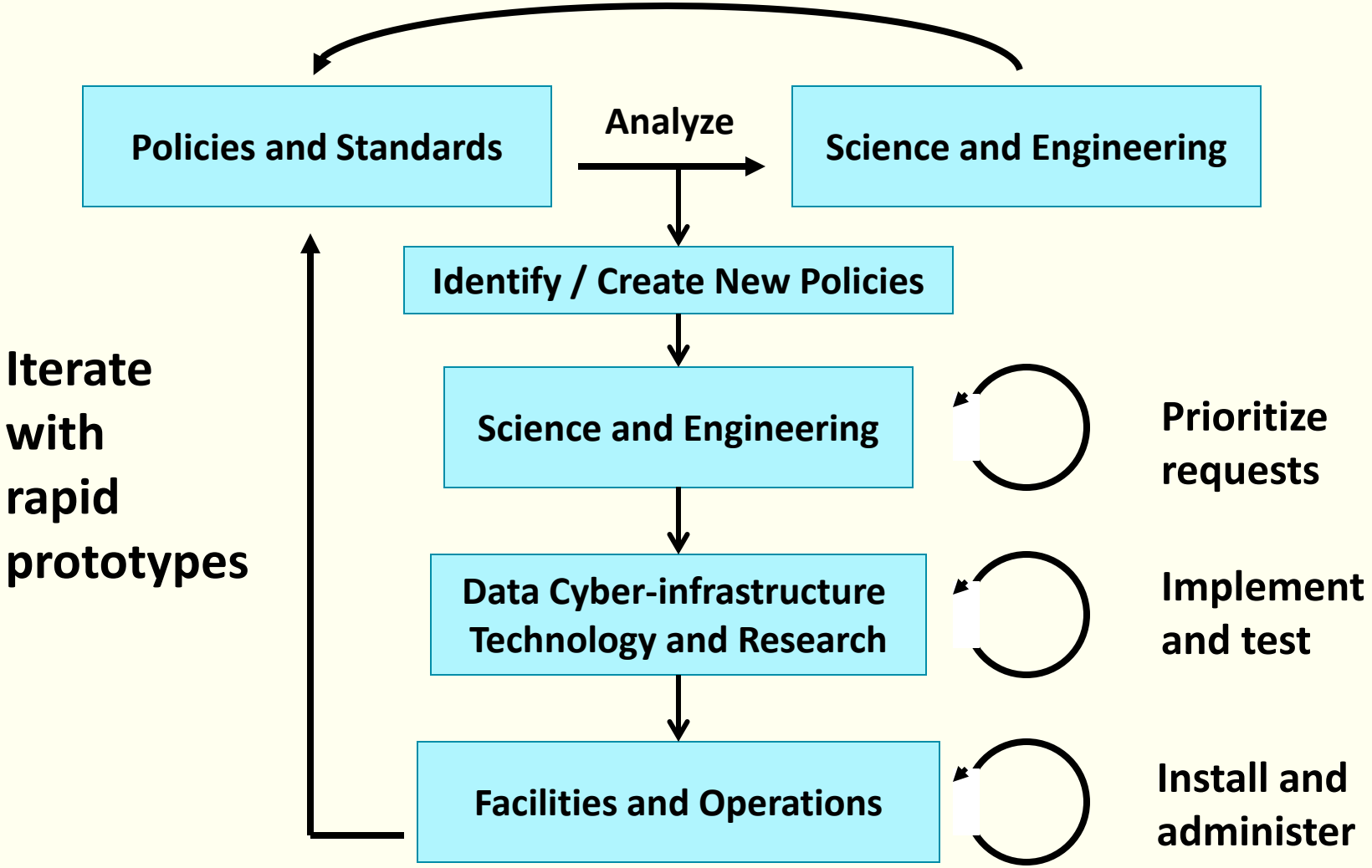
Strategic (vision) → **Tactical (operations)**

Strategic Framework for Organizing Work Plan



Key Management Elements

Evolution of Domain Policies



Policy-Based Roadmap

- ***Purpose*** - reason a collection is assembled
- ***Properties*** - attributes needed to ensure the purpose
- ***Policies*** - enforce and maintain properties
- ***Procedures*** - functions that implement the policies
- ***State information*** - results of applying procedures
- ***Assessment criteria*** - validate that state information conforms to the desired purpose
- ***Federation*** - controlled sharing of logical name spaces to enable repurposing of community collections for long-term sustainability

DFC Deliverables

Year 1

Implement a National Data Management Infrastructure

Requirements Analysis and Middleware Installation

Within first 3 months:
Develop Program Execution Plan

Year 2

Develop Reference Implementations

Develop Interoperability Mechanisms

Research: Education Policies

Year 3

Develop Services for Structured Data

Develop Social Network Services for Data Use in Education

Research: Policy Validation

Year 4

Automate Validation of Assessment Criteria

Implement Rules to Validate Assertions about Collections

Research: Collection Value

Year 5

Build Consensus for Standards

Validate Social Networking Models

Develop Sustainability Models

Research: Policy Creation

Our Approach - Federation

Social consensus for the sharing of data, policies, methods, practice

- Each community controls their own collection policies
  - Policies can be dynamically changed, versioned, and audited
- Explicit computer actionable rules control the type of federation interactions
  - Peer-to-peer, central archive, master-slave data distribution, chained data grids, deep archives

Interoperability mechanisms to support technology integration

- Community specific clients, policies and procedures
- Cross registration of data
- Structured information resource drivers

Questions?