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US EPA National Center for Environmental Assessment
ARA Beyond Science and Decisions Workshop
November 2, 2012

ADVANCING MULTI-SCALE INTEGRATION OF HUMAN HEALTH AND ENVIRONMENTAL DATA: COMPUTATIONAL AND CONCEPTUAL INTEROPERABILITY

Disclaimer

- These views are those of the author and do not represent US EPA policy.

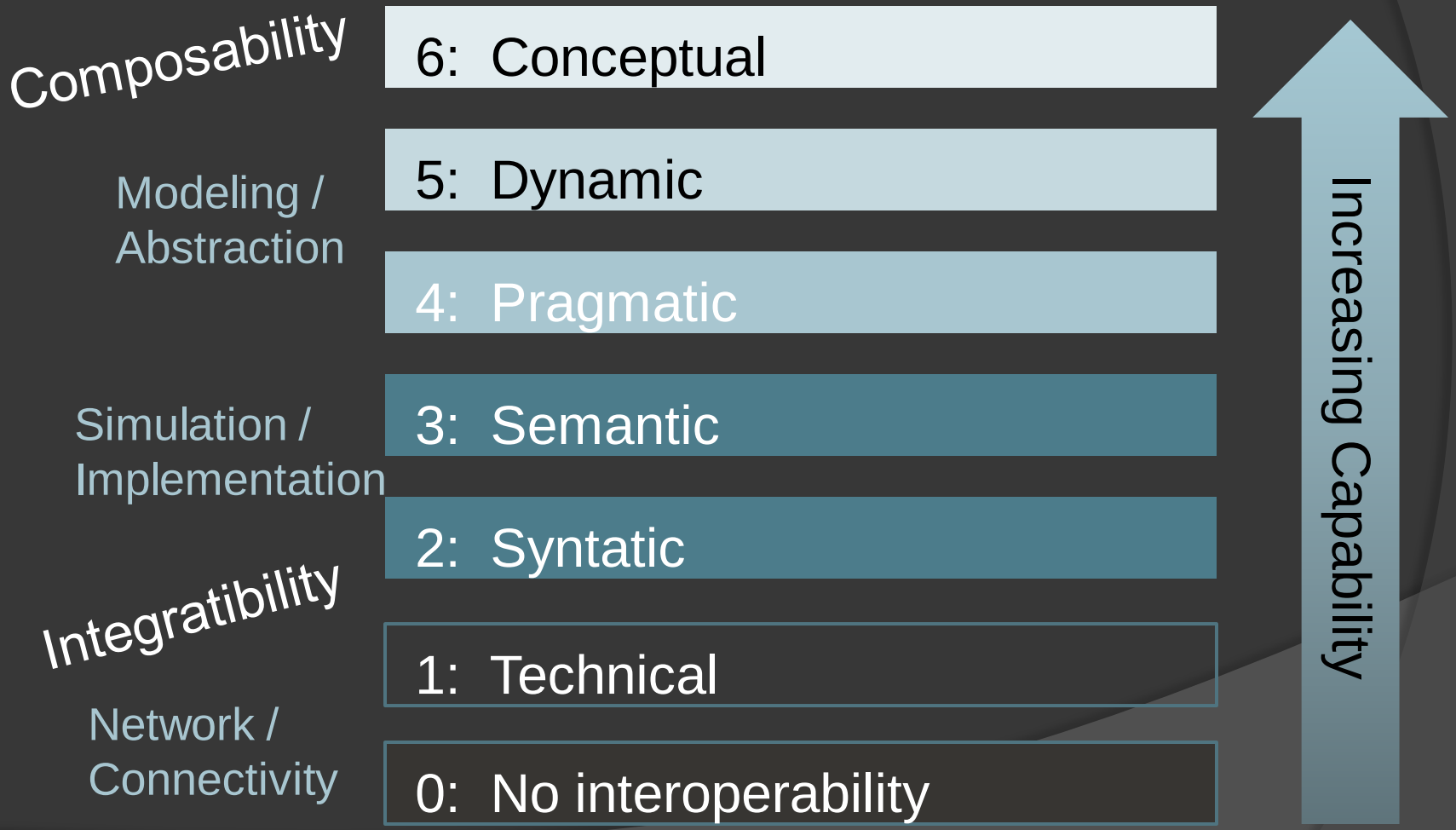
Overview

- Background
  - Interoperability and multi-scale modeling
  - US EPA ORD Global to Genome (G2G) project
  - SOT CCT B4BD Workshop
- Recommendations
- Draft system design description
- Next steps

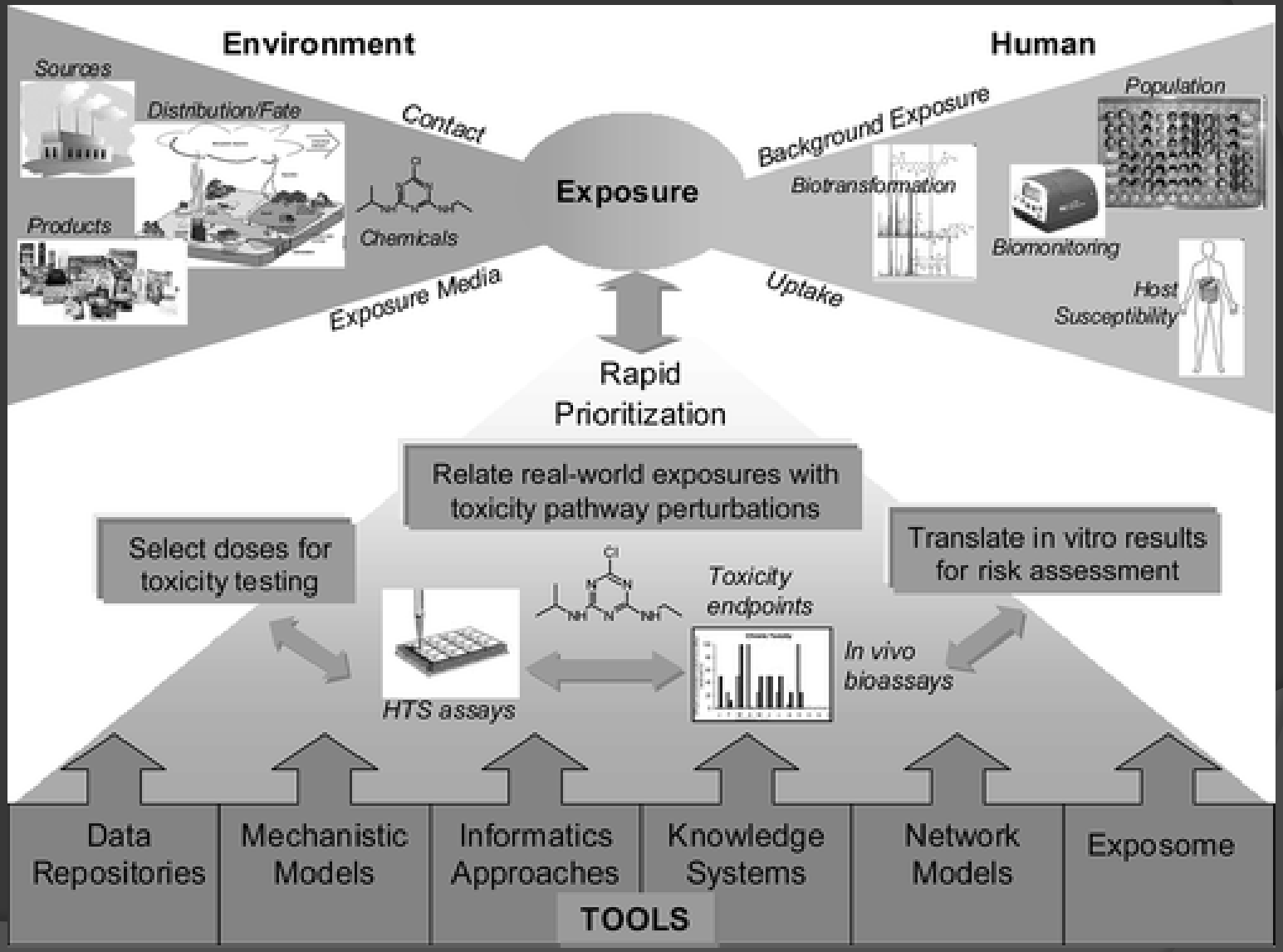
Interoperability

- The ability of two or more systems or components to exchange information and use the information in end user applications, present or future, any restricted access or implementation
- The ability of diverse systems and organizations to work together

LCIM: Levels of Conceptual Interoperability Model Wang et al. (2009)



Disciplinary Interoperability



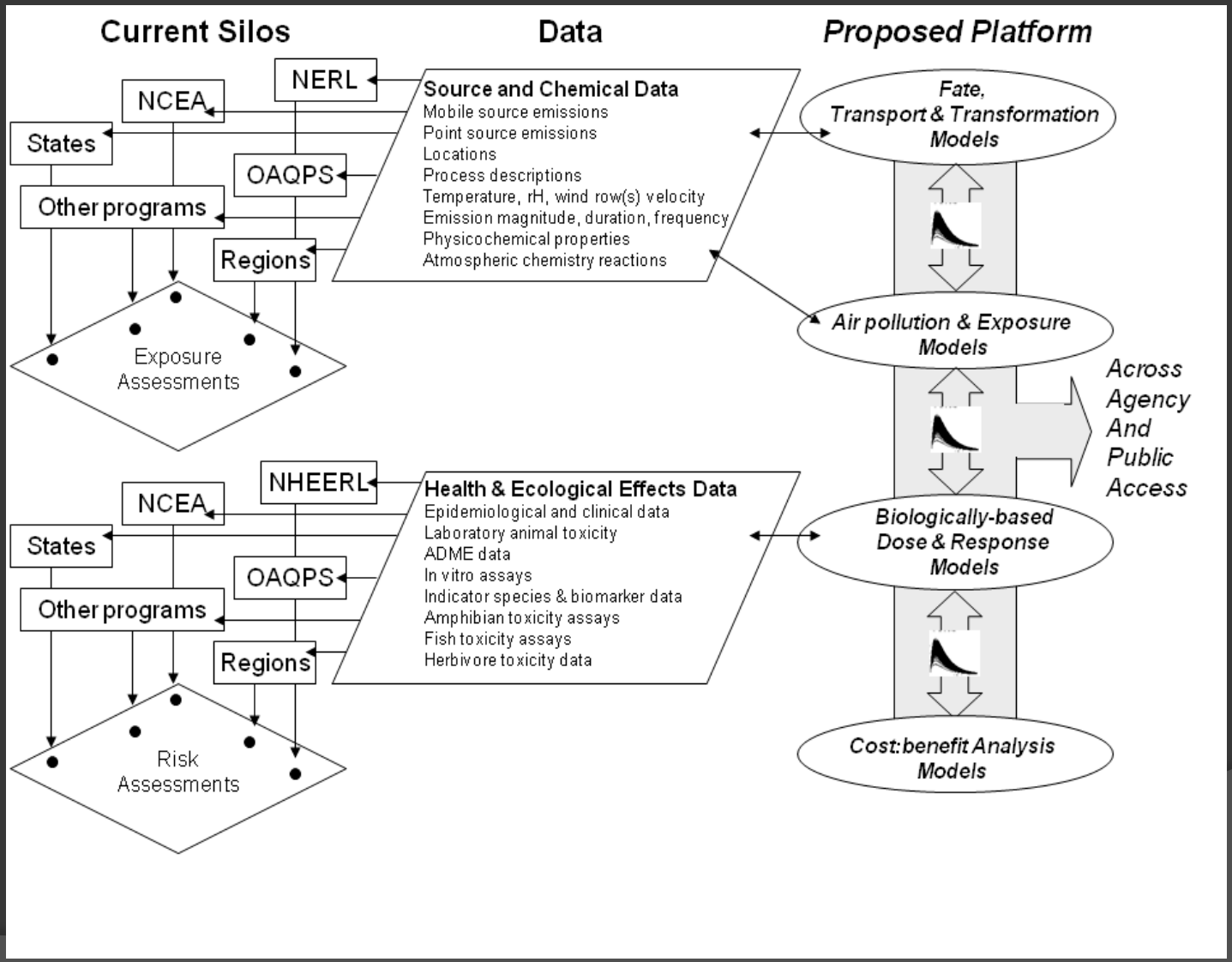
US EPA ORD Pathfinder Innovation Project: Global to Genome (G2G)

- GOAL: *Specification* of a Computational Platform for Agency-wide, Seamless Data Flow and Computational Modeling in Support of Health, Ecological, and Climate Risk Characterizations

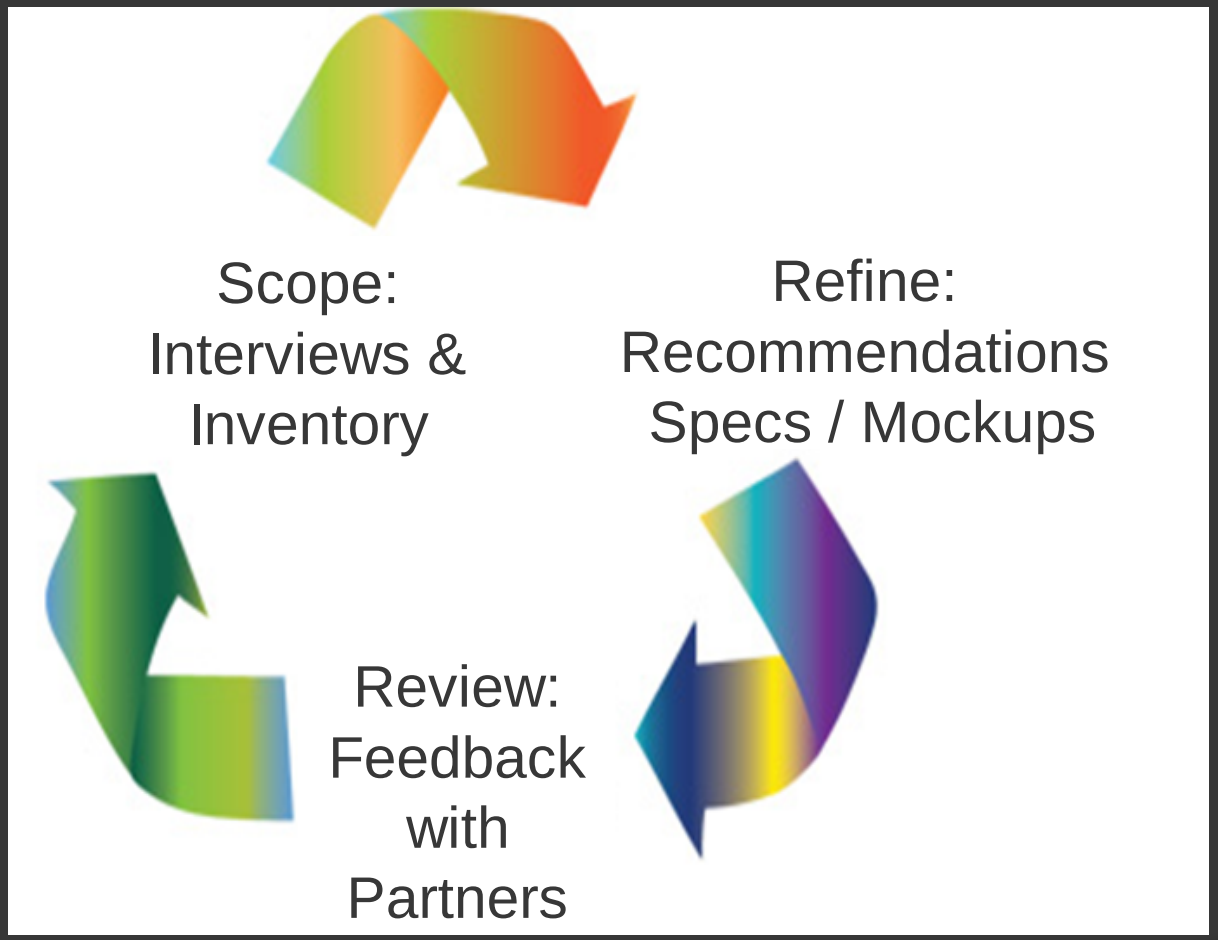
G2G Team Members

- NCEA: *Annie Jarabek*, David Miller, and Lyle Burgoon
- NHEERL: *Rory Conolly*, Stephen Edwards and William LeFew
- NERL: Gene Whelan, Cecilia Tan and Michael Breen
- OSIM: David Lyons

G2G: Problem and Promise



G2G Process



- Internal
  - ORD labs and centers
  - Program Offices
  - Regions
- External vetting

SOT CCT Workshop

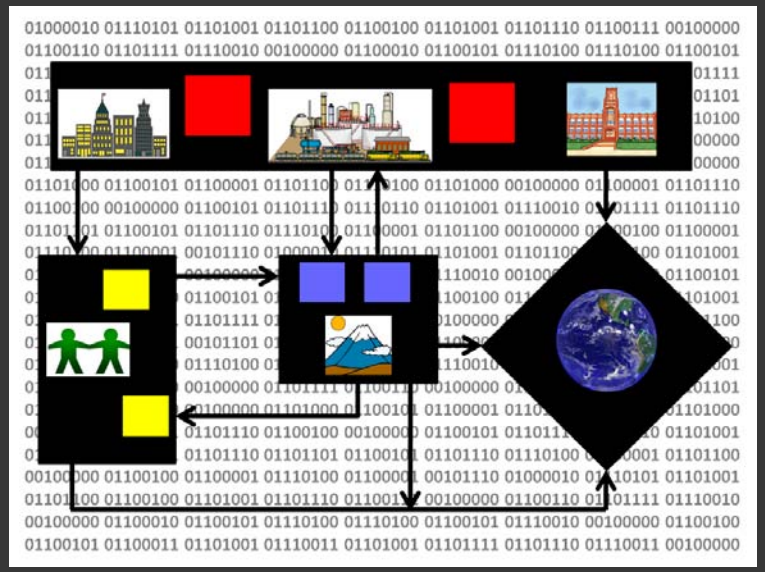
Building for Better Decisions (B4BD): Multi-scale Integration of Human Health and Environmental Data

- Held @ EPA RTP campus May 8 – 11, 2012
- https://www.toxicology.org/ai/meet/cct_b4bd.asp
- International workshop with sponsors across sectors

Government	Professional Society	Private Sector
US ACE	SETAC	American Chemistry Council
USDA	SRA	Environ International Corp.
US FDA	ISES	ICF International
USGS	iEMSs	OGC
US NRC		OpenMI
PNNL		TERA

SOT CCT B4BD Organizing Committee

- Lyle Burgoon, Co-chair, US EPA NCEA RTP
- Robinan Gentry, Co-chair, Environ Corporation
- Annie Jarabek, Co-chair, US EPA NCEA IO
- Richard Corley, US DOE PNNL
- George Daston, Proctor and Gamble, Co., Inc.
- Paul Price, The Dow Chemical Co.
- Edward Perkins, US Army Corps of Engineers
- Glenn Suter, US EPA NCEA Cincinnati
- Bruce Vigon, SETAC
- Gene Whelan, US EPA NERL Athens
- Timothy Zacharewski, Michigan State University

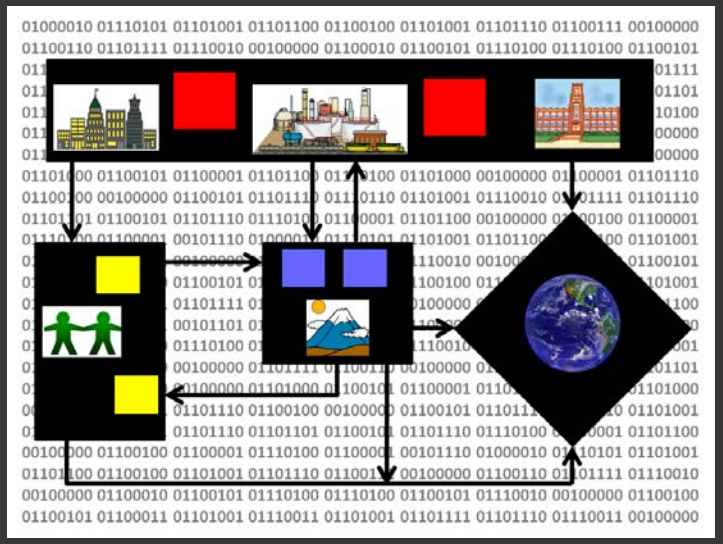


B4BD Context: Motivation, Concepts and Challenges

- Protecting the public health and environment requires analysis, translation, and integration of data along source to effect pathways
- Technological advances challenge scientific community to harness larger and increasingly complex data in a transparent, integrated fashion

Challenges

- Inadequate scientific understanding, especially of “narratives”
- New types of data
- User expectations
- Limitations / vulnerability of technologies
- Proprietary considerations
- Regulatory process and institutional structures
- Doing more with less



Process

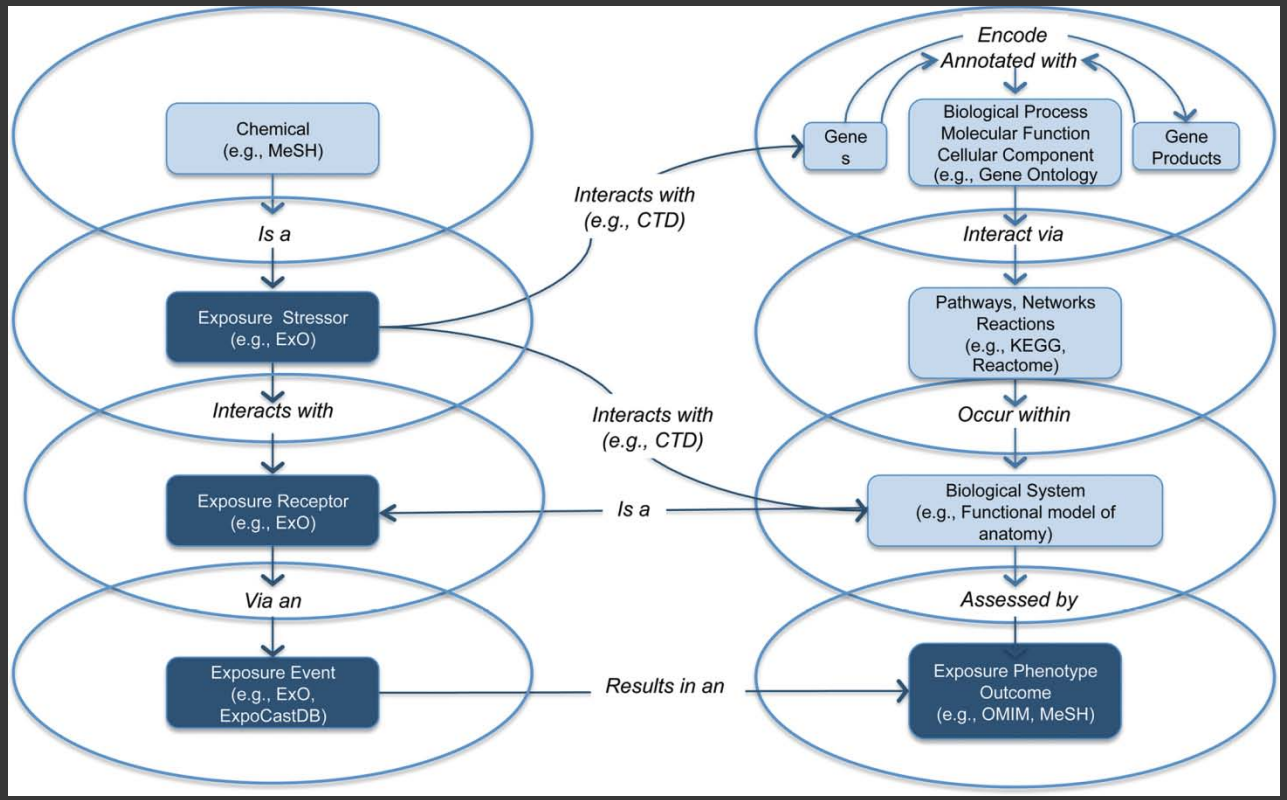
- Plenary presentations
  - Across sectors and disciplines
  - Emphasis on IT
- Theme discipline discussions
  - Invited participant experts across sectors
  - “Ambassadors” from other themes
- Reports from themes to entire plenary
- Attendees across all
- Poster session / reception by themes

SOT CCT B4BD Disciplinary Themes

- **Theme A:** Exposure Assessment, Transport and Transformation
  - Paul Price, The Dow Chemical Co. / Brenda Barry, American Chemistry Council
- **Theme B:** Ecotoxicological Assessment, Ecosystem Services, Climate Change
  - John Johnston, US EPA NERL Athens / Glenn Suter, US EPA NCEA Cin
- **Theme C:** Dose-response, Tox21 and Risk Assessment
  - Michael Waters, Integrated Laboratory Systems, Inc. / Rory Conolly, US EPA NHEERL and Lynne Haber, TERA
- **Theme D:** Life-cycle / multi-criteria Assessment and Cost:Benefit Analysis
  - Bruce Vigon, SETAC / Christina Powers, US EPA NCEA
- **Theme E:** Information Technology
  - Roger Perkins, US FDA NCTR / Bernadette Highland, 3 Round Stones

Broader Biological Context for Exposure

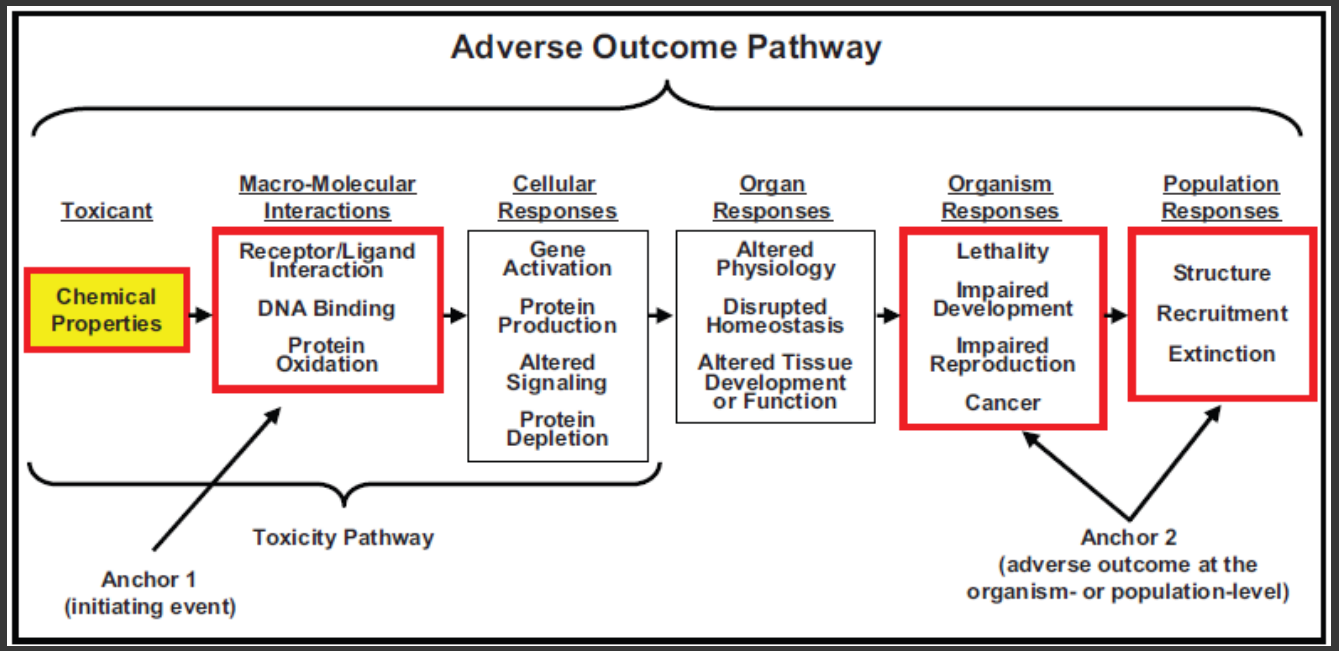
Theme A



Mattingly et al (2012) Environ. Sci. Technol. In press.

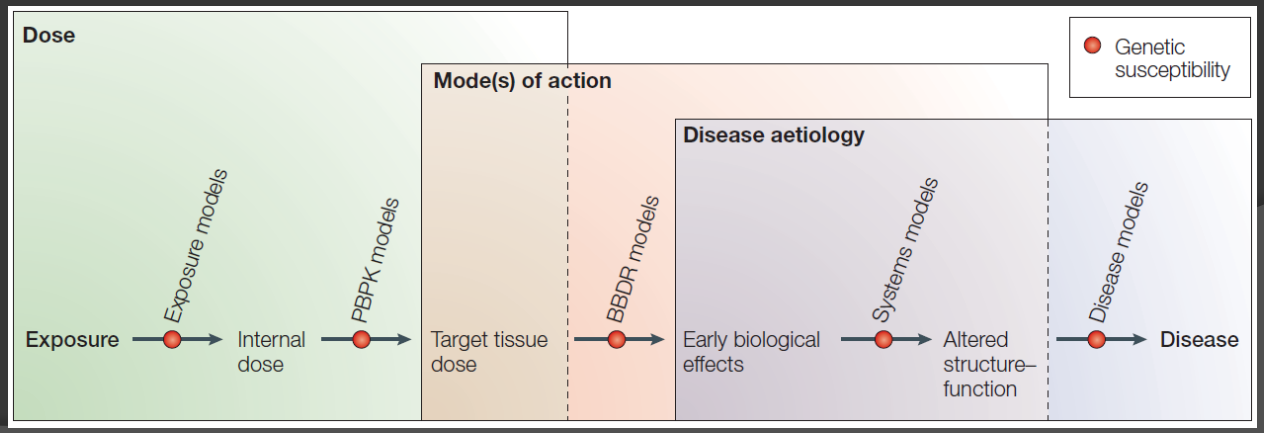
Adverse Outcome Pathways

Theme B



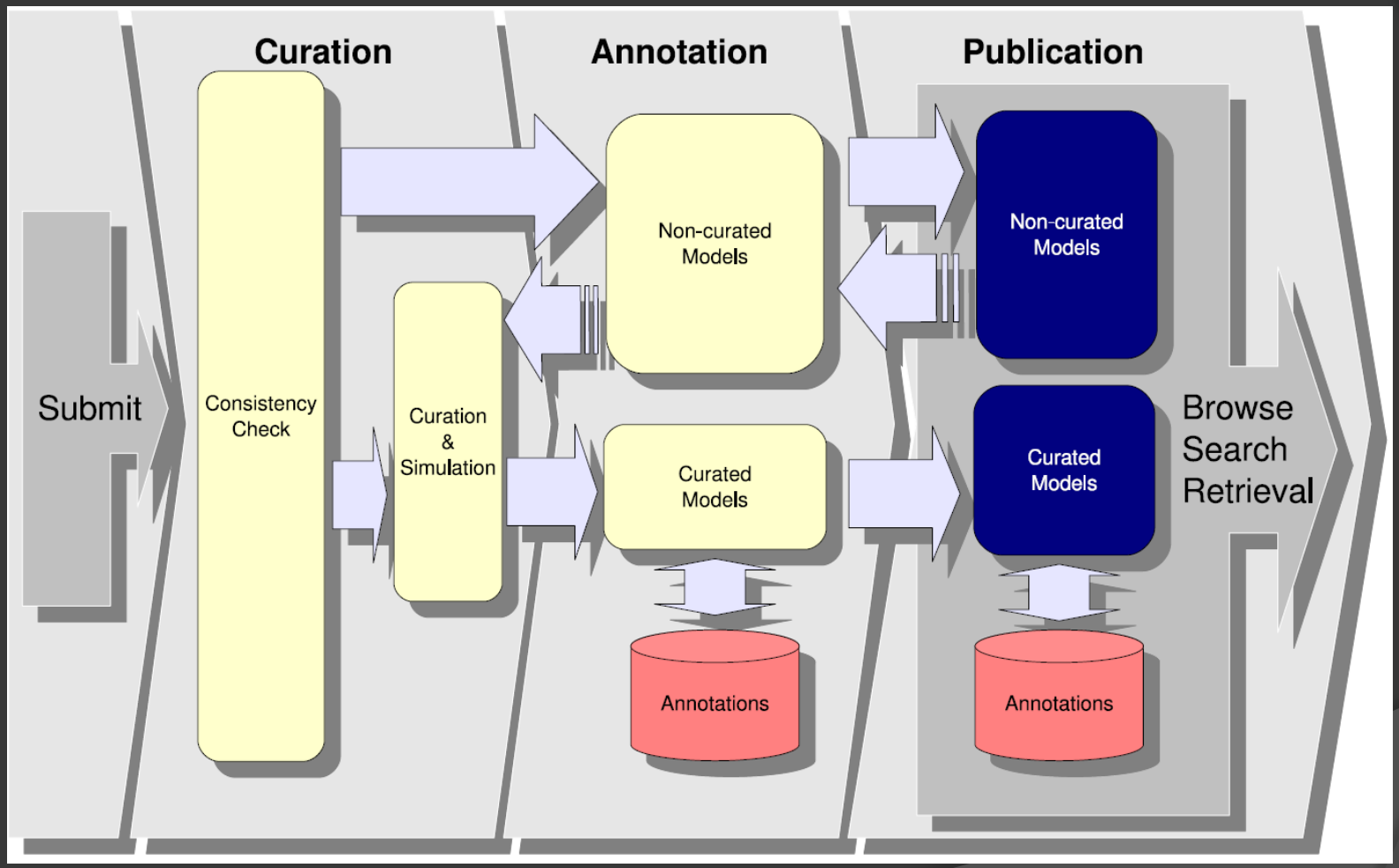
Ankley et al. (2010) Environ. Toxicol. Chem. **29**, 730.

Theme C

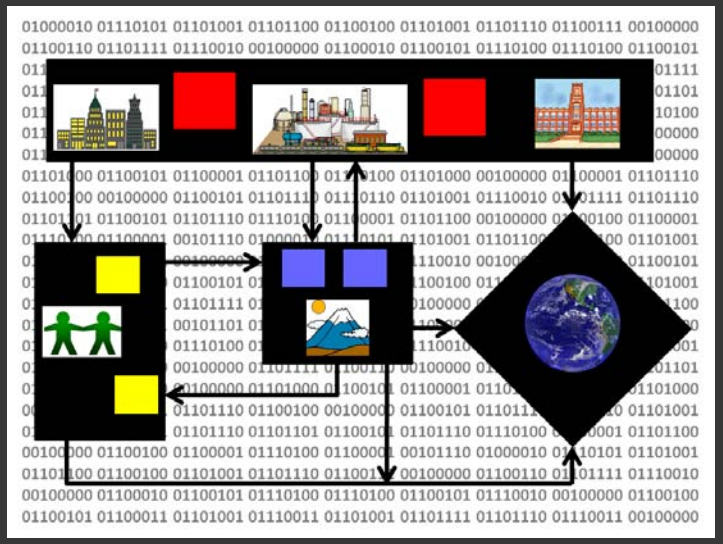


Waters and Fostel (2004) Nature Rev. Genetics, **5**, 936.

Data Management Issues



Li et al. (2010) *BMC Systems Biology* **4**, 92.



Products

- Disciplinary manuscripts
  - State of the science / best practice
  - Identify IT needs to advance on path forward
- Synthesis summary of meeting
- Glossary (e.g., vein)
- Community of Practice of Integrated Environmental Modeling (CIEM) survey
- Demonstration project

Benefits

- Transparency, documentation, communication
  - Tractable work flows / calculations
  - Assumptions and limitations
  - Propagation of uncertainty
- Efficiency
  - Dockets for regulatory processes / reviews
  - Real-time response to peer review
    - Comparison of alternative approaches
  - Template models and resource leveraging
- Scalable
  - Fit-for-purpose applications
  - Repurposing of data
- Coordination and consistency across Agency
  - Education
  - Contemporary methods and approaches

Recommendations

- VISION: Empower *BOTH* research and decision making
- DEFINITION: Address *interoperability* in 2 domains
  - Technical: RDF, software, machine code, etc.
  - Cultural: Community of practice, processes
- NEEDS
  - ACCESS to discover, collect, and integrate data in a coordinated fashion to inform research and decision making
  - REPURPOSE data for own analysis REQUIRES context for data (meta data) including annotation and curation history
- BENEFITS
  - Increased integration of data that could be truly iterative
  - Increased transparency, efficiency, and communication
- IMPLEMENTATION
  - Standards and recommendations
  - Demonstration projects

Proposed G2G Platform for EPA

- Research and Decision Support Tool
  - CENTRAL on-line Agency location containing or referencing databases, models, algorithms, spreadsheets, etc.
  - An information / metadata hub containing current research, desired extensions / needs, regulatory policy positions, etc.
- Workbench
  - An online tool to find and show connections between models so that inputs, outputs, and uncertainty are explicitly and transparently propagated. Provide a portal to platforms that facilitate this process (e.g. FRAMES).

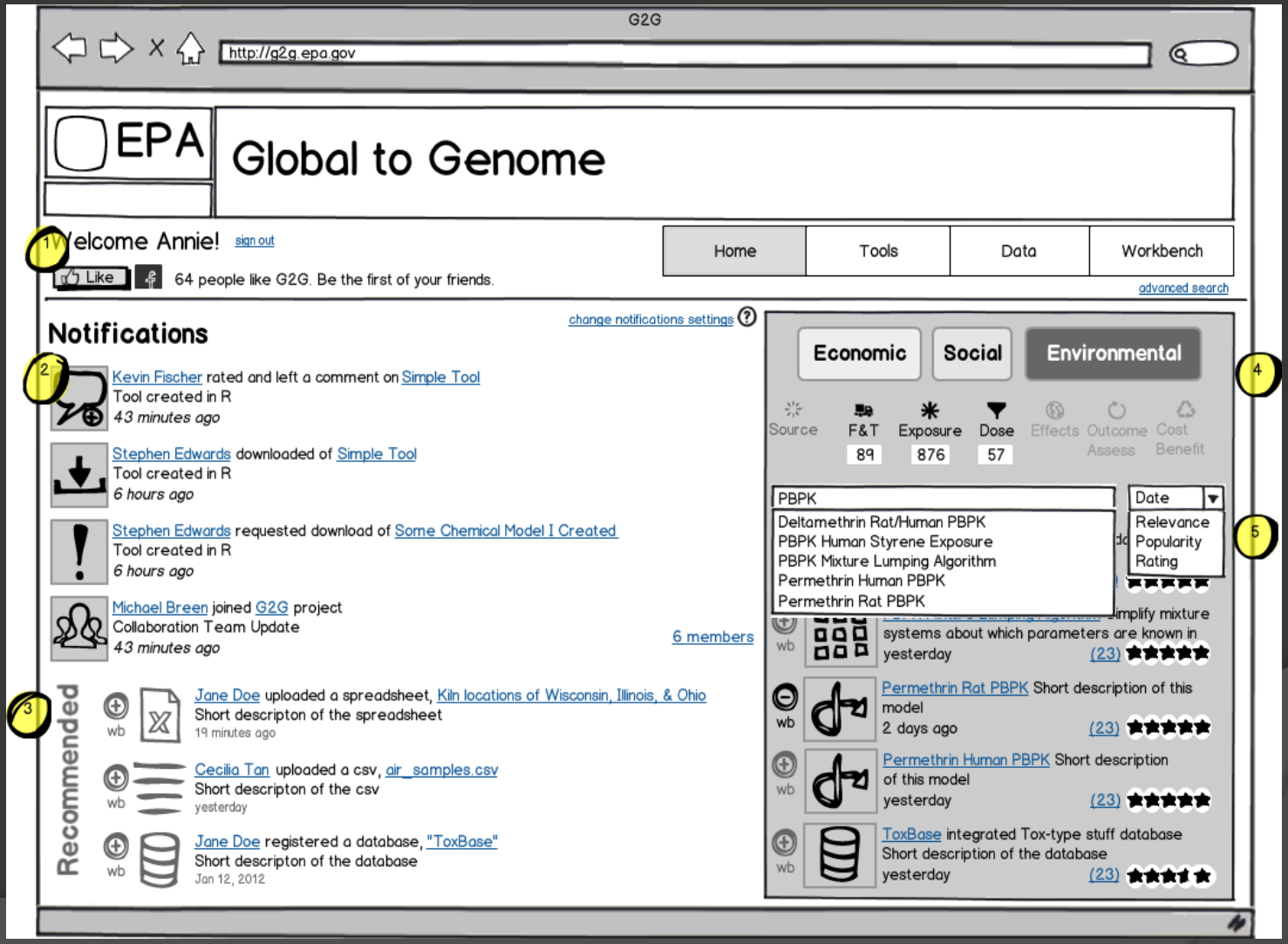
G2G Specifications: Technical

- Research and Regulatory Support Tool
  - Access is primary issue (CBI? Public? Contractors?)
  - Simplicity of data entry and user interface
  - Repurposing of data, models
  - Thorough documentation via metadata
  - Transparency of assumptions and uncertainty
  - Encourage collaborative development
- Workbench
  - Emphasize standards for interoperability
  - Enable and assist in construction of connectors
  - Simplify comparison of models
- Data and Model Management
  - Support migration of data and models (e.g., PI based)
  - Archiving, documentation, decision records, policy updates

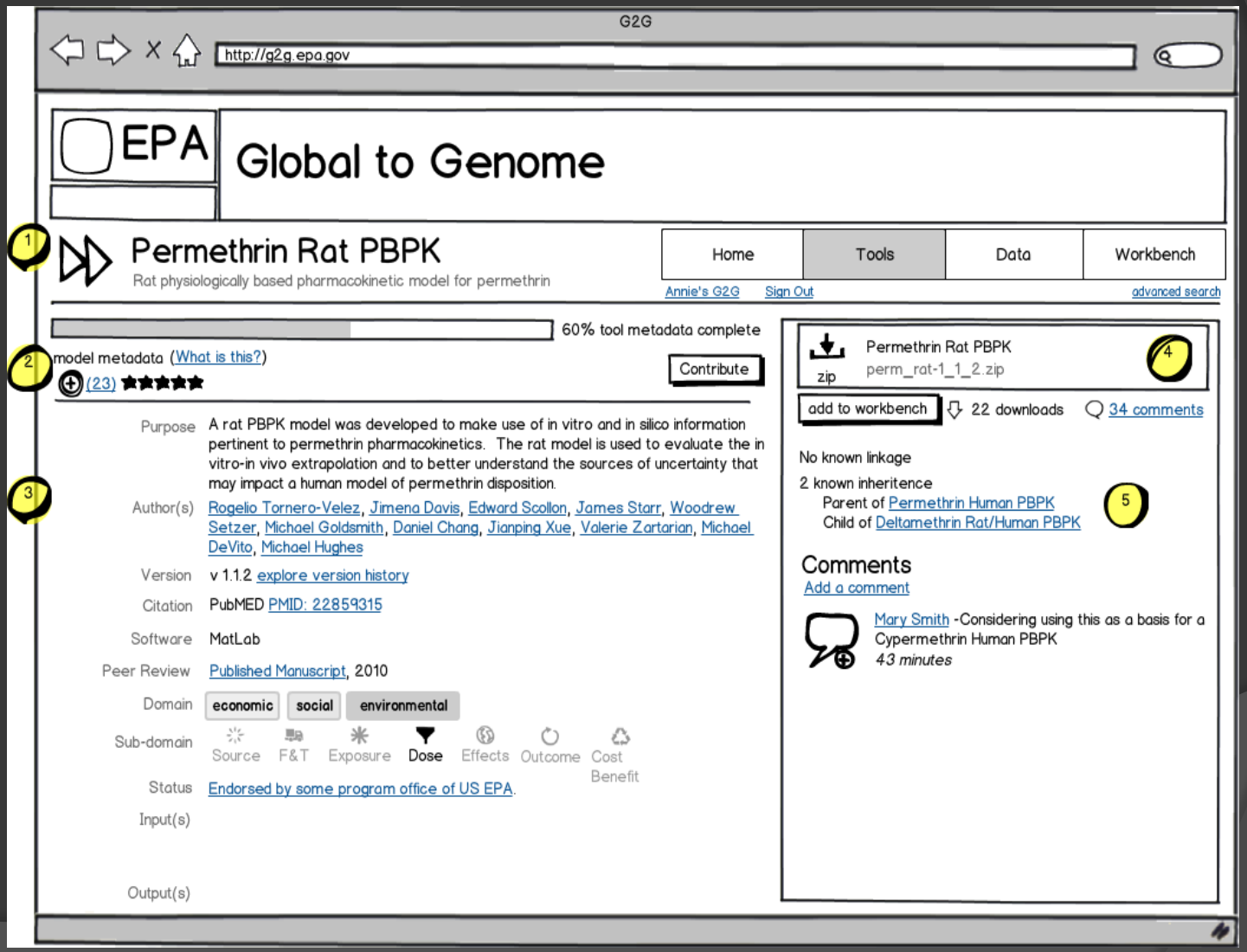
G2G Specifications: Cultural

- Realization
  - Top-level champion is essential
  - Requires sufficient management support and resources
- Implementation
  - Institutional home is necessary
  - Do not create a behemoth – leverage extant systems
  - Team to develop, disseminate and coordinate
  - Position tool to be useful to both research and regulatory support
- Adoption
  - Incentives for sharing models and publication of data
  - Content must be maintained and updated
  - Support and resources from development AND for duration
  - Utilize programmatic and disciplinary champions

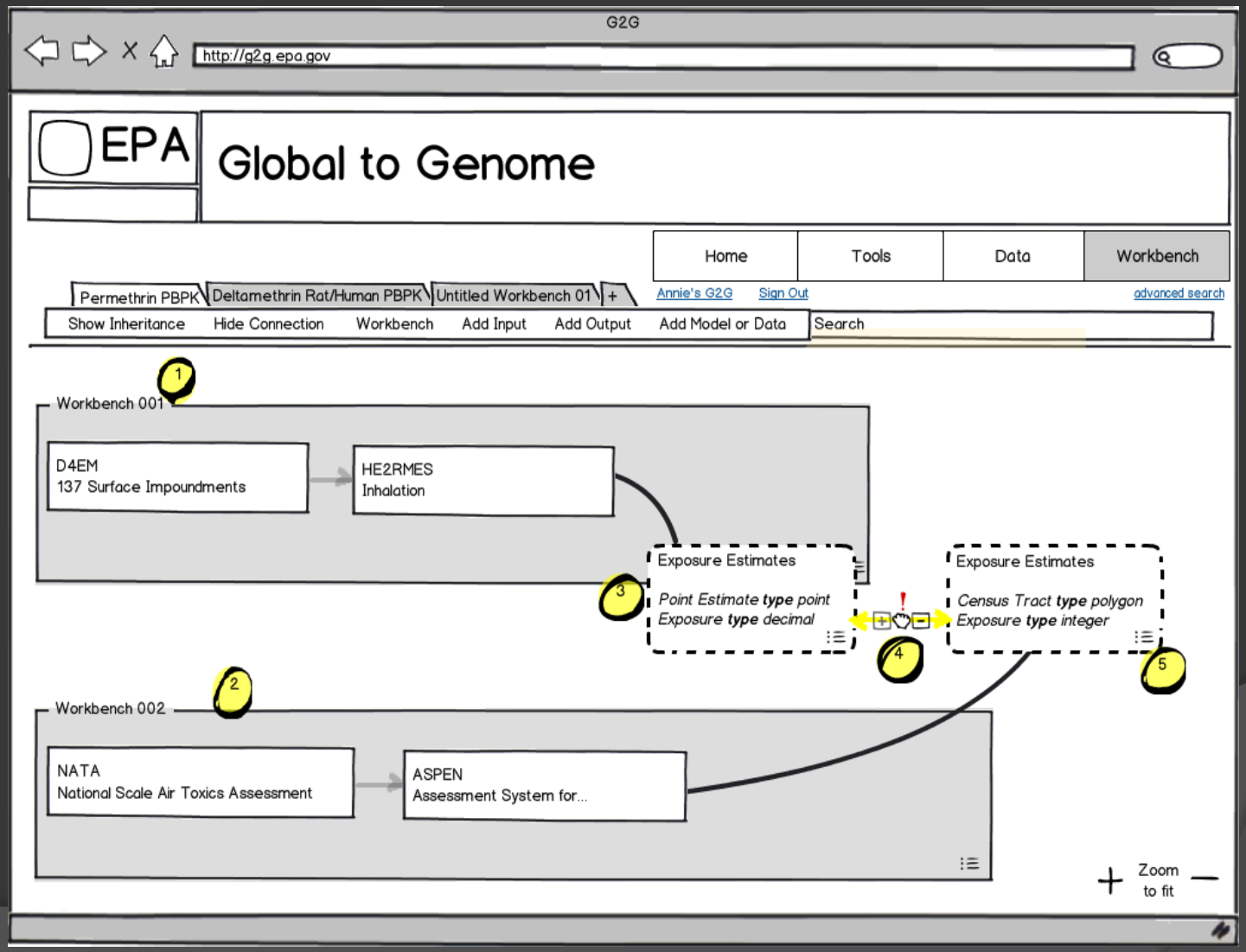
G2G Mockup: User entry



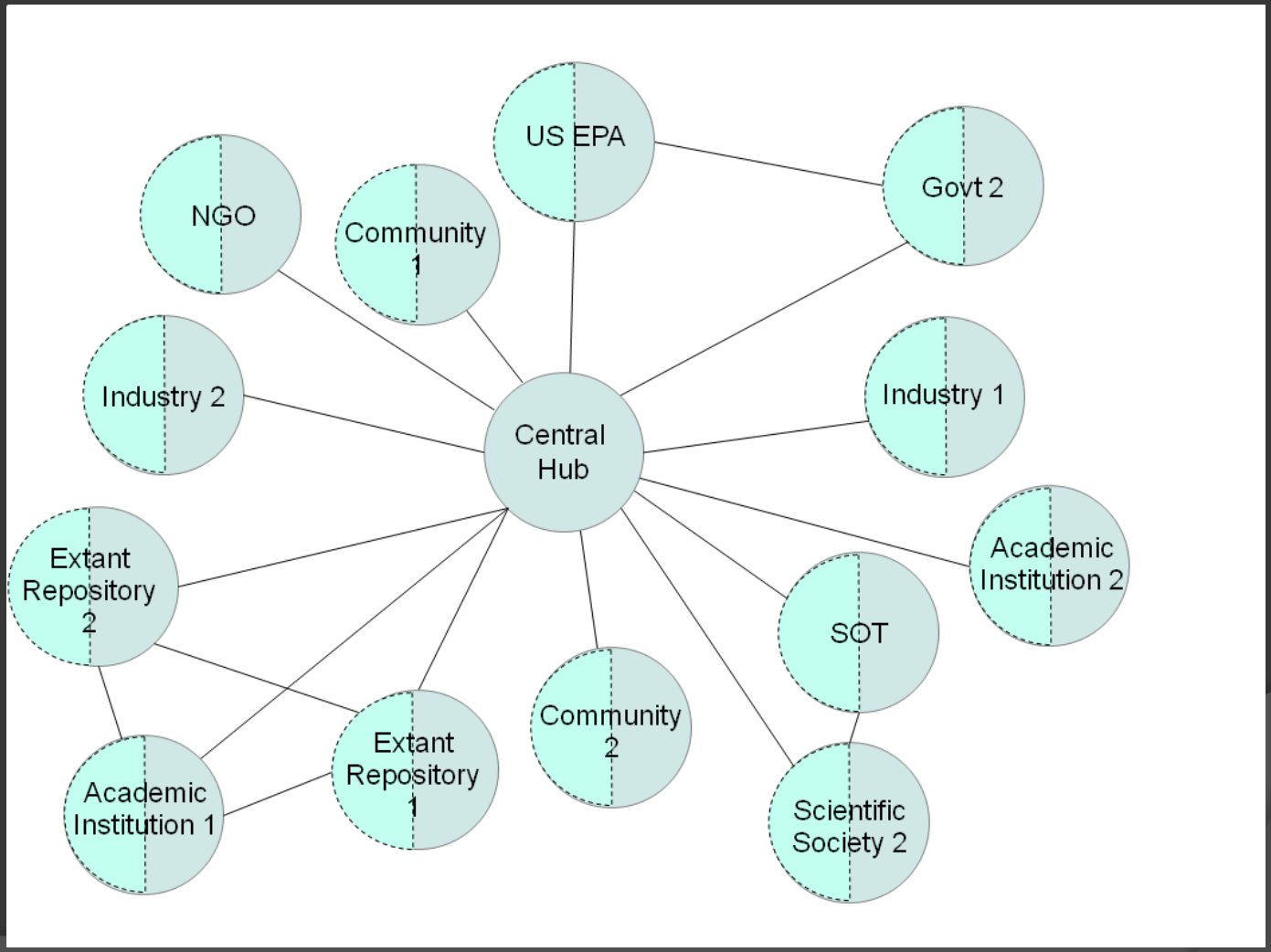
G2G Mockup: Tool Page



G2G Mockup: Workbench



G2G in the Future: Federation



SOT CCT B4BD Demonstration Project

- Engage all disciplines
  - LCA frame for problem
  - Embedded computational/scientific issue for each theme
- Candidates under consideration
  - Mercury in light bulbs
  - Arsenic in different drinking water sources
  - BPA
- Others?
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