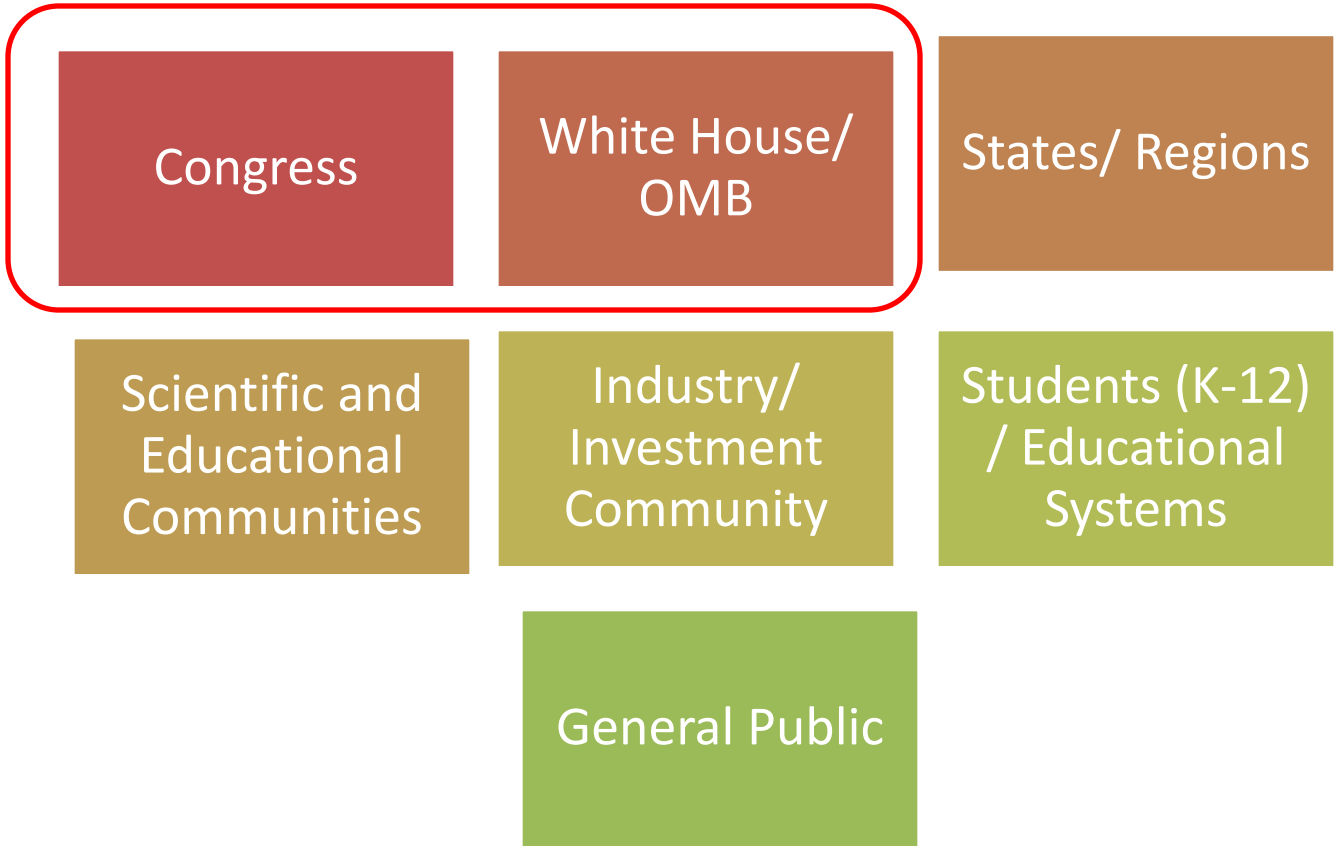
A Strategy for Evaluation and Assessment (E&A) for Engineering

Alexandra Medina-Borja, PhD.
Director, Evaluation and Assessment
Directorate of Engineering

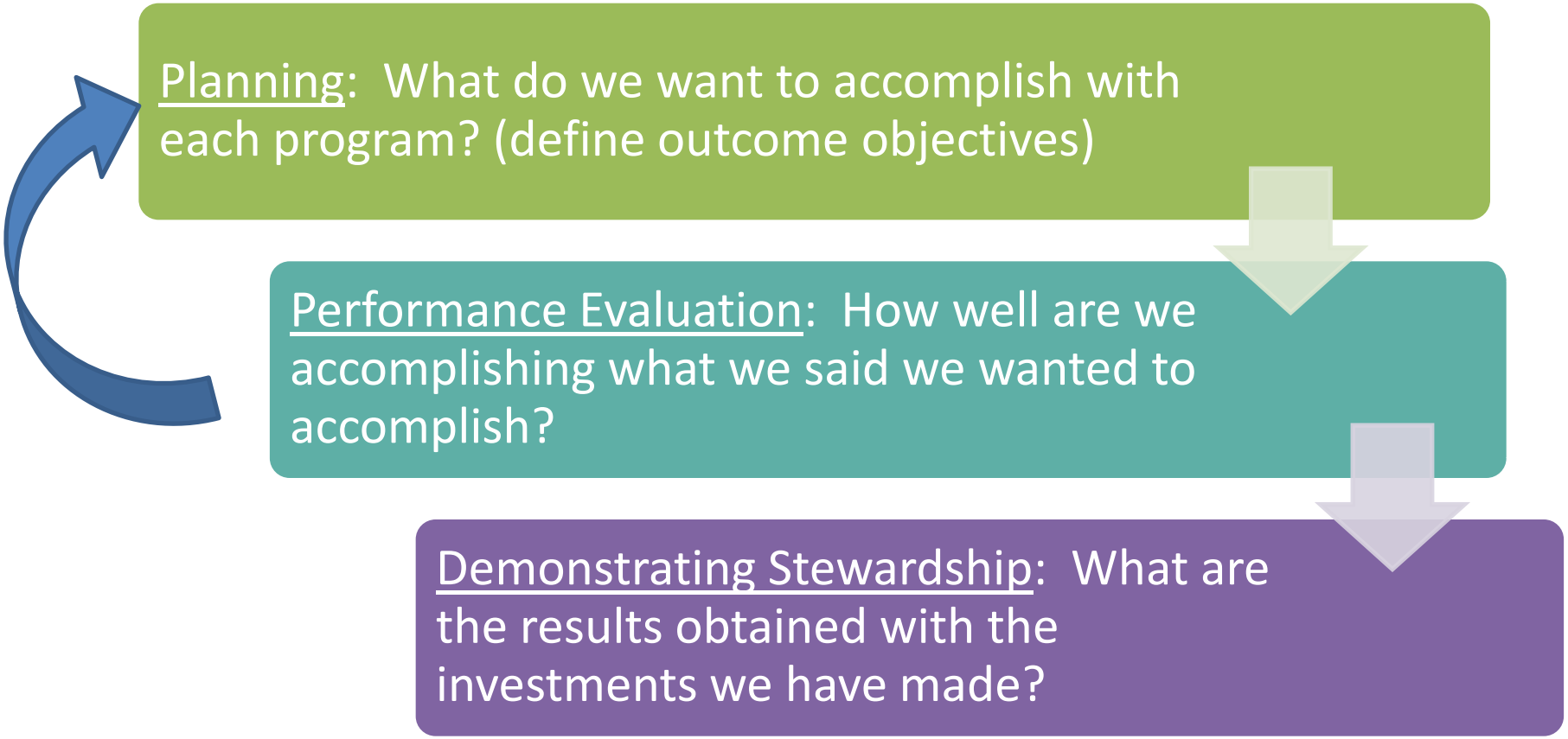
Stakeholders



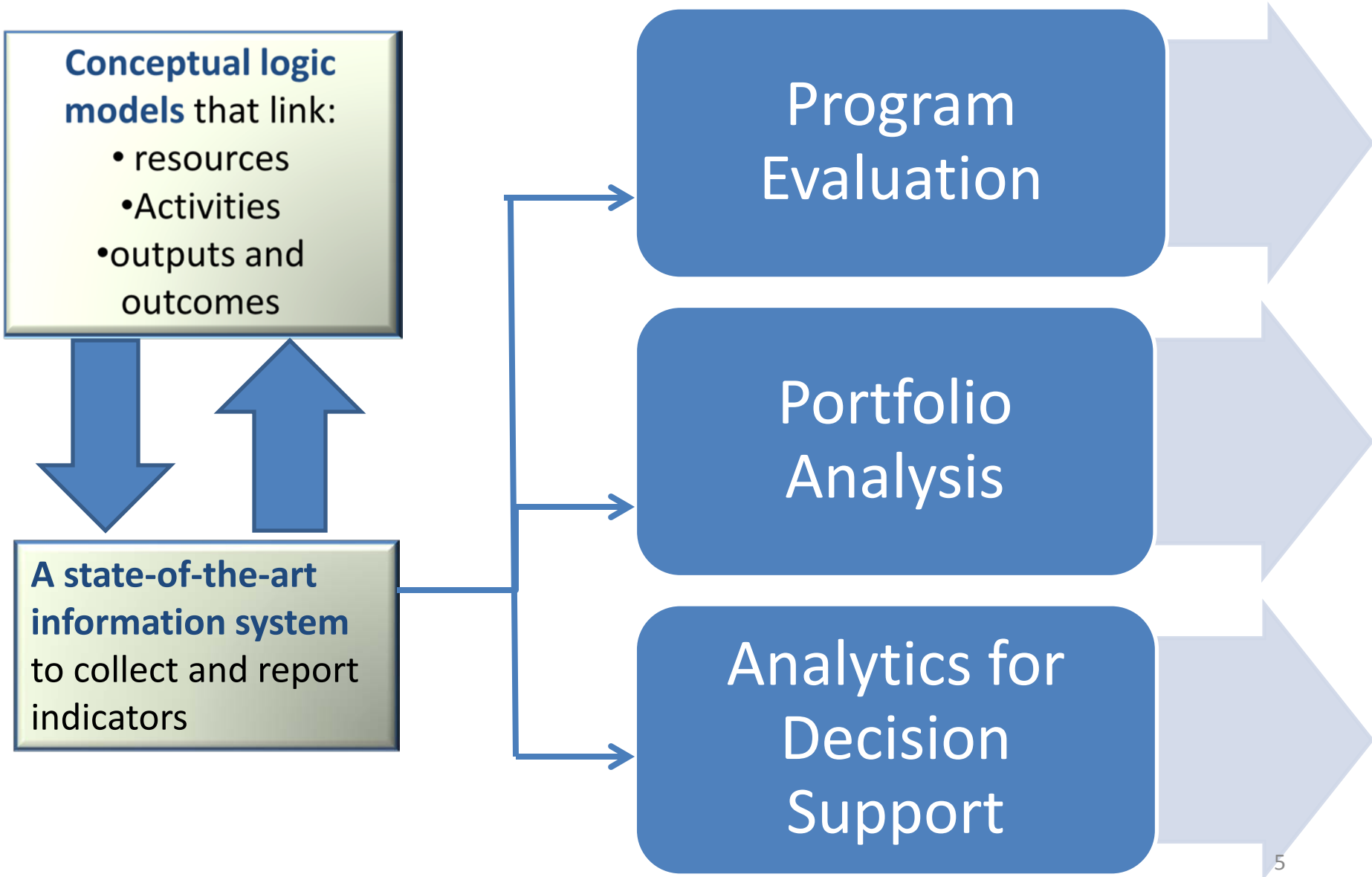
Position Statement

- OMB request: Evaluation & Assessment Plan for Priority Goals
  - Education
  - Innovation
- 2012 NSF Response:
  - Priority Goals
    1.
    2.
    3. I-CORPS
  - Performance Goals
    -
    -
    -Partnerships

GAO's Guidelines



A Primer on Evaluation & Assessment



Where do we want Engineering to be?

Conceptual logic models

- *linking fundamental research to innovation*
- *life-cycle of ideas --from basic research to innovation*
- *space to record unexpected outcomes and identify outliers.*

A set of few essential metrics

- *frontier-engineering research*
- *an ecosystem capable of producing innovation*
- *engineering education research that assists the development of the next generation of engineers*

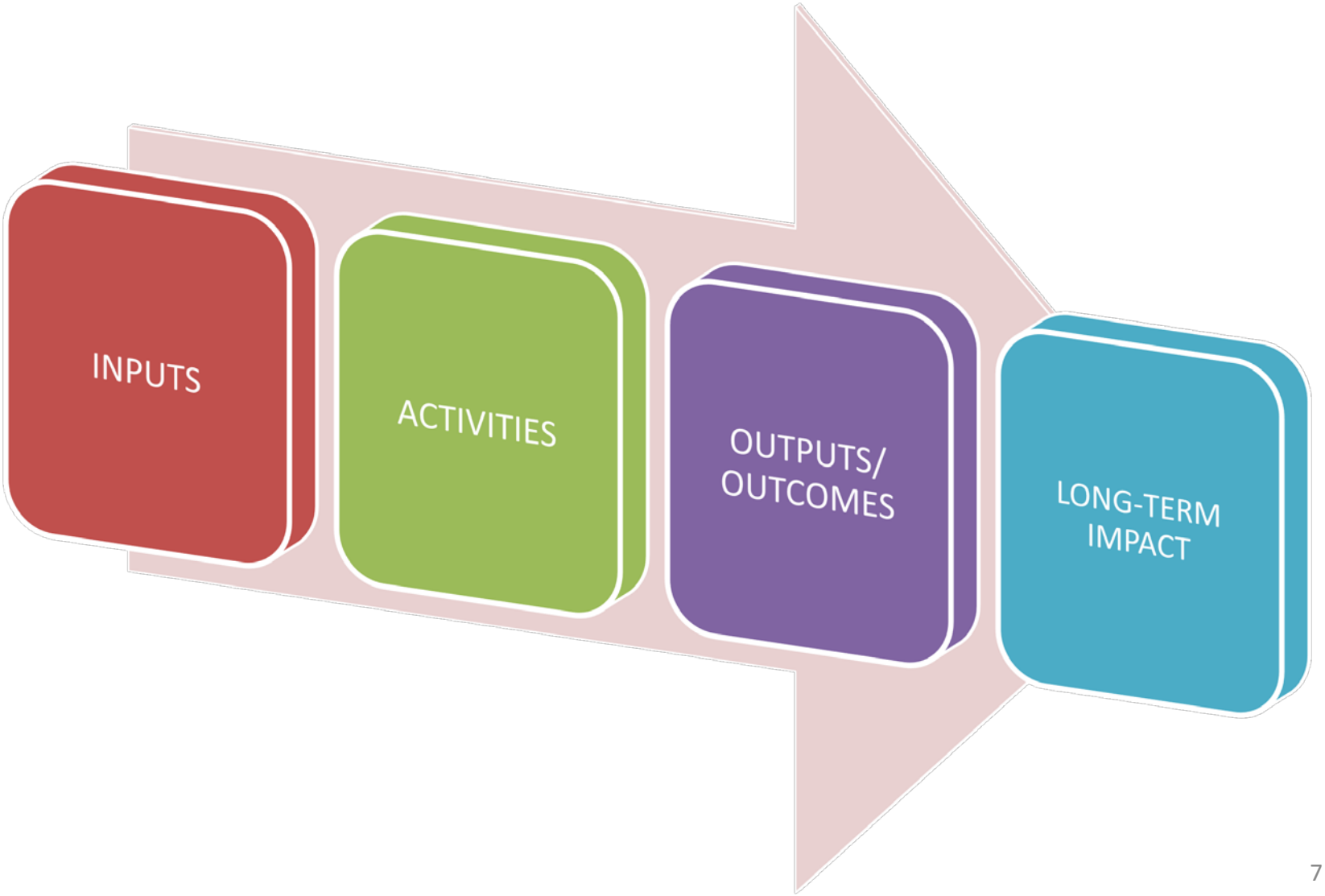
A state-of-the-art information system

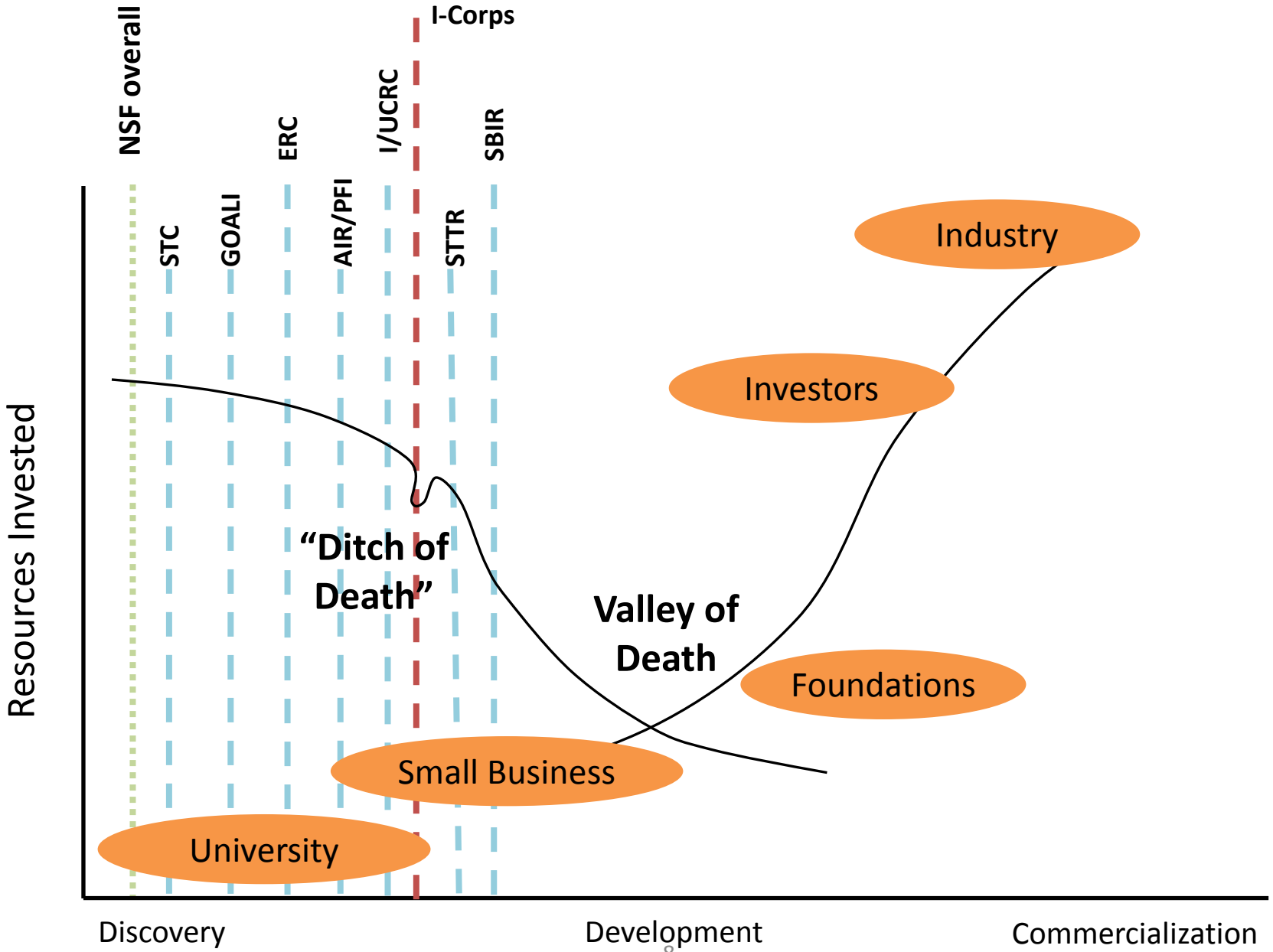
- *data collection, data visualization and data analysis*
- *business intelligence to aid decision-making*

Adaptable system: will evolve as technology, disciplinary fields and evaluation practices evolve.

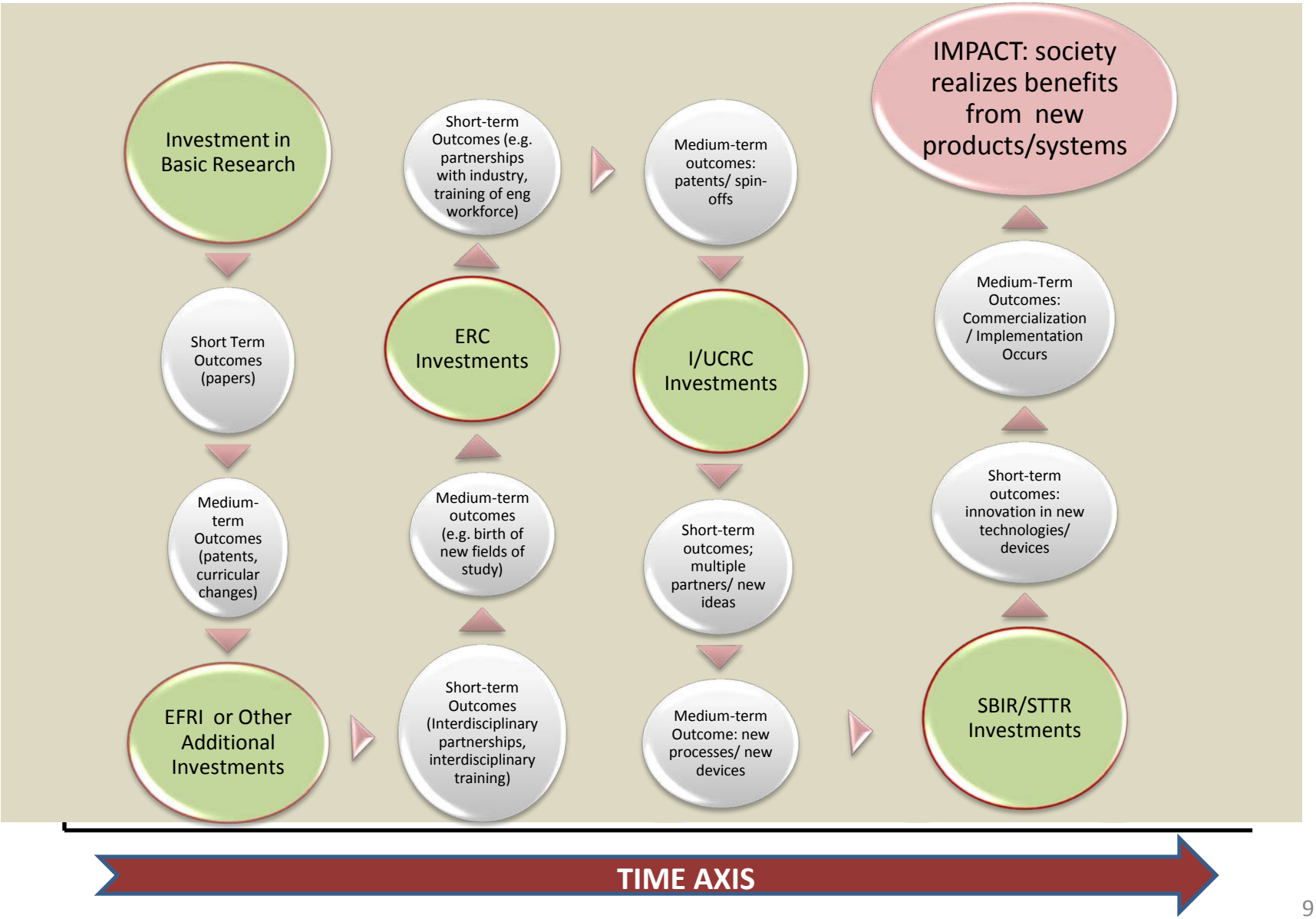
How do we move forward?

Step One - Developing Logic Models

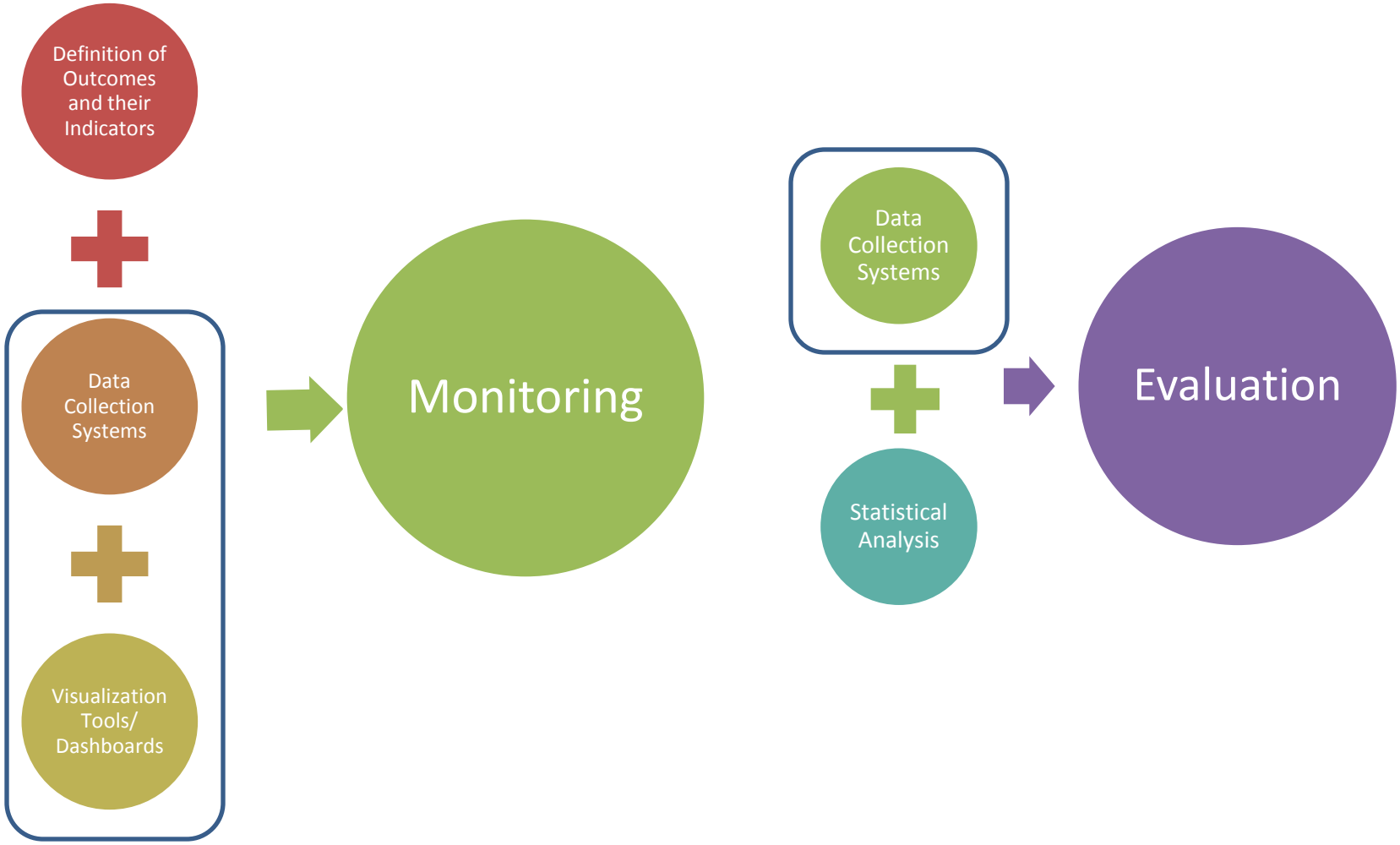



NSF overall
I-Corps
ERC
I/UCRC
SBIR
STC
GOALI
AIR/PFI
STTR
Industry
Investors
"Ditch of Death"
Valley of Death
Foundations
Small Business
University
Resources Invested
Discovery
Development
Commercialization

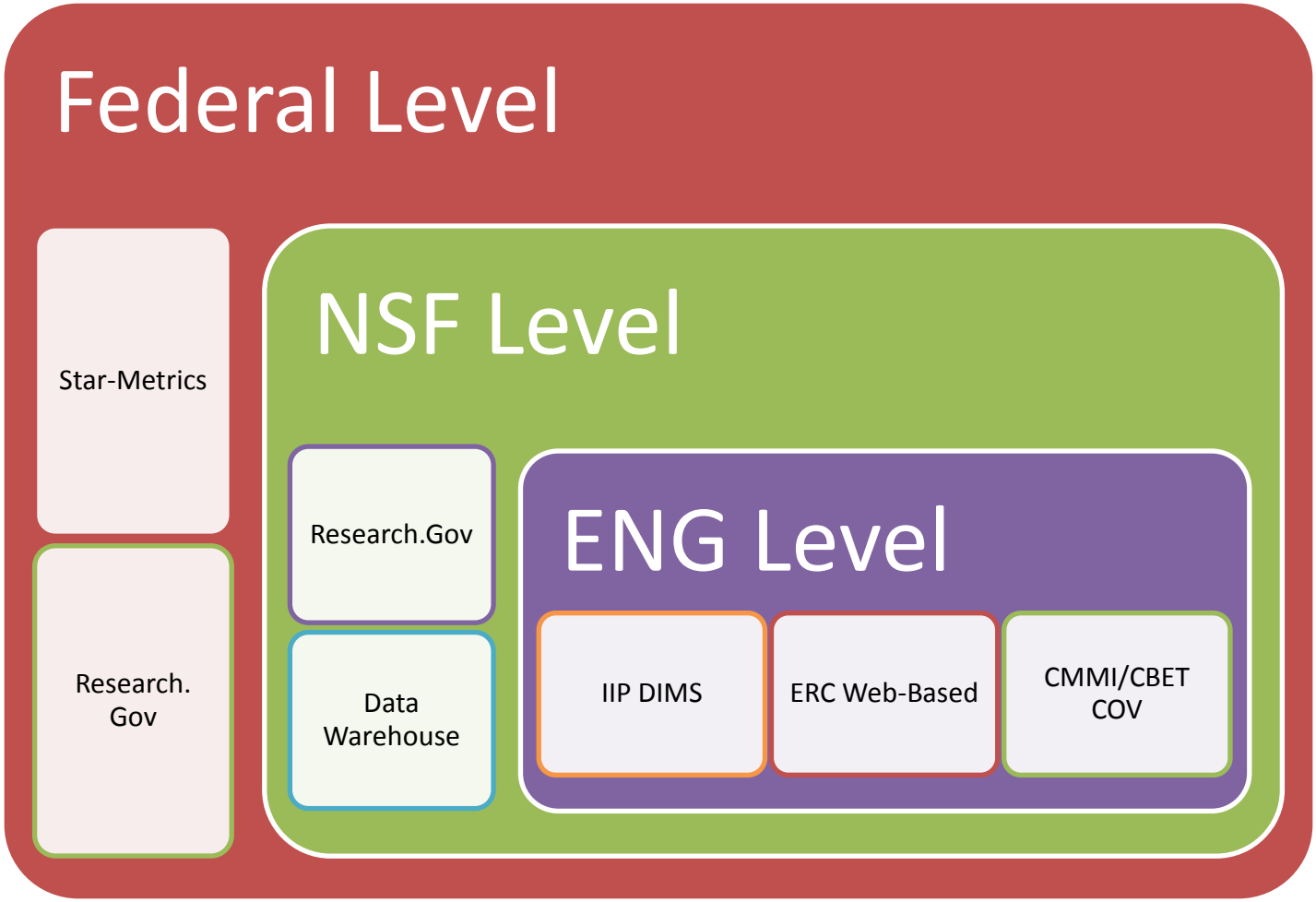
Demonstrating NSF ENG's Impact on Society



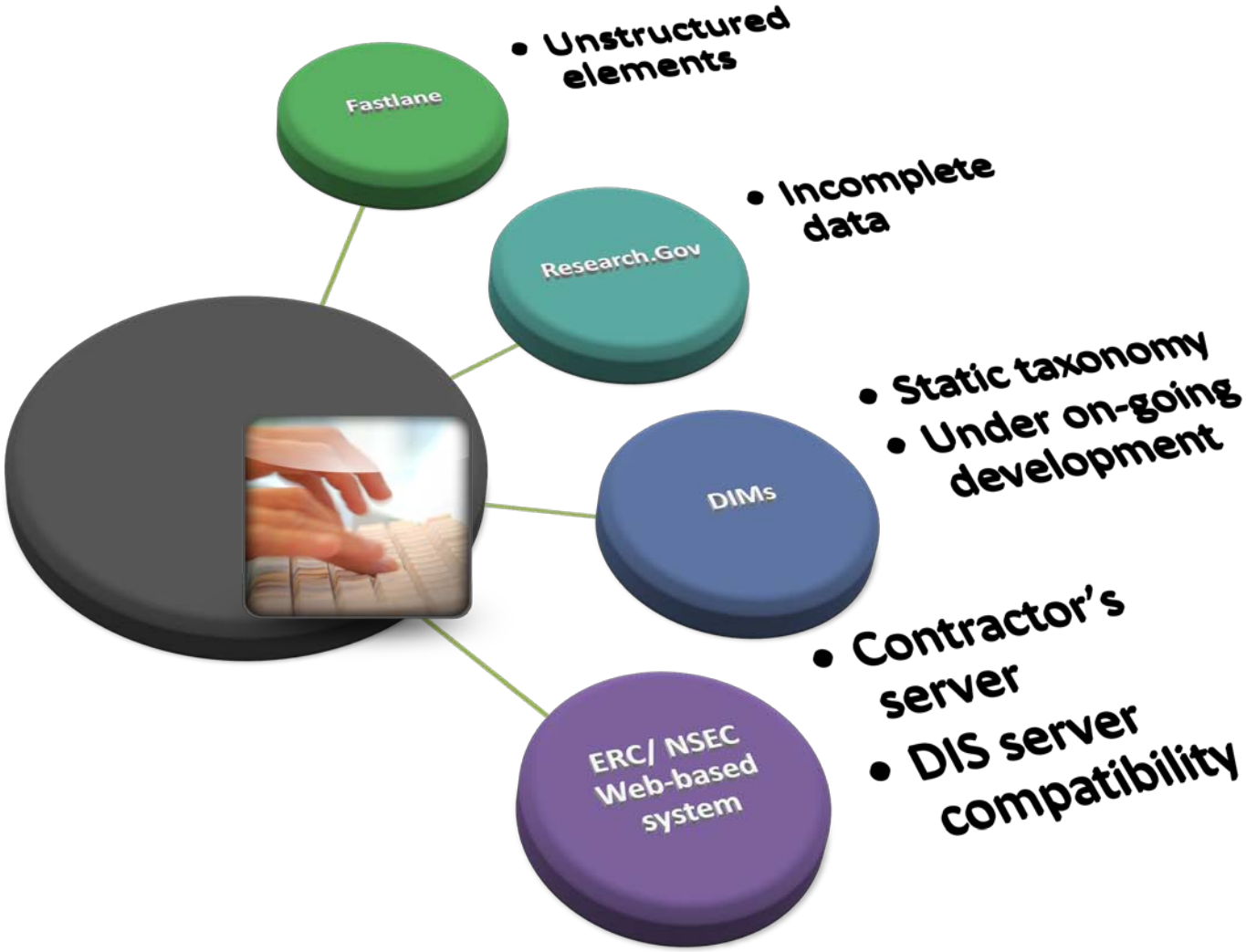
What are some of the major hurdles?



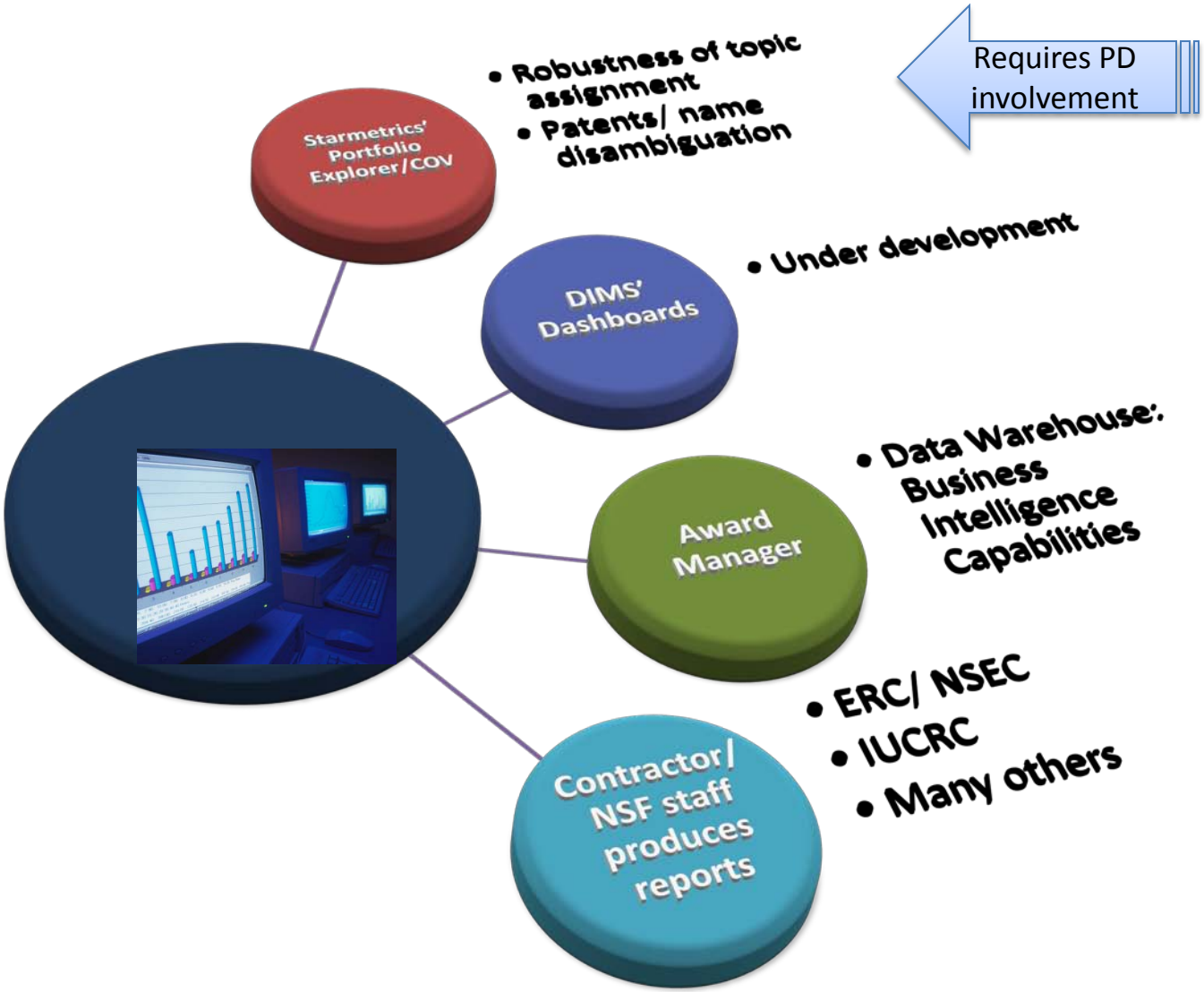
Different visions for data collection/ visualization



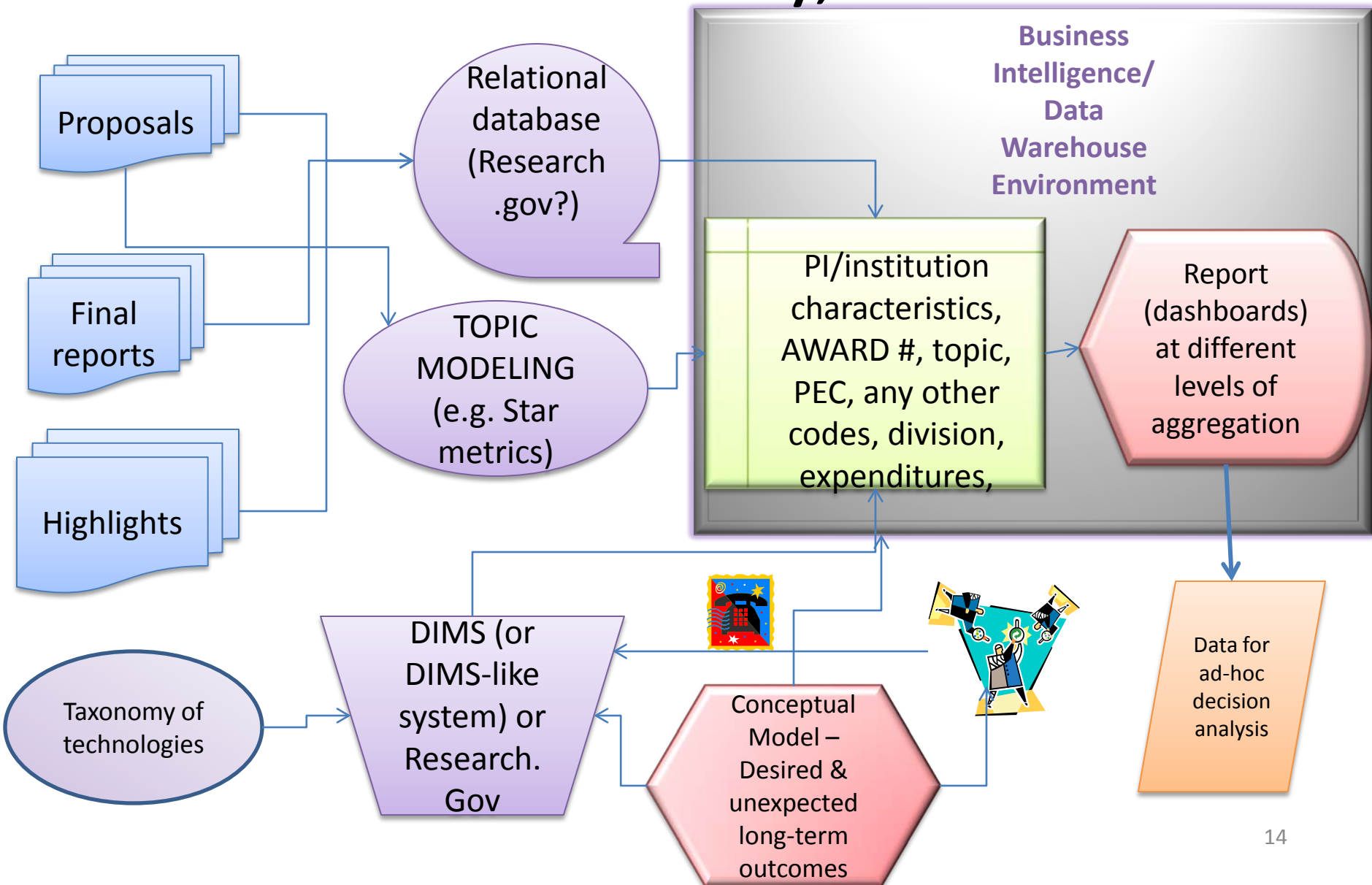
Data collection systems



Data retrieval / visualization systems



At the end of the day, I am an IE…



Variations in Logic Model Development

PROGRAMS FOCUSED ON PREPARING THE ENGINEER OF THE FUTURE

PROGRAMS FOCUSED ON FOSTERING AN INNOVATION ECOSYSTEM

PROGRAMS FOCUSED ON INTERDISCIPLINARY FRONTIERS

CENTERS

PROGRAMS
FOCUSED ON BASIC RESEARCH THAT MAY OR MAY NOT BE INTERDISCIPLINARY

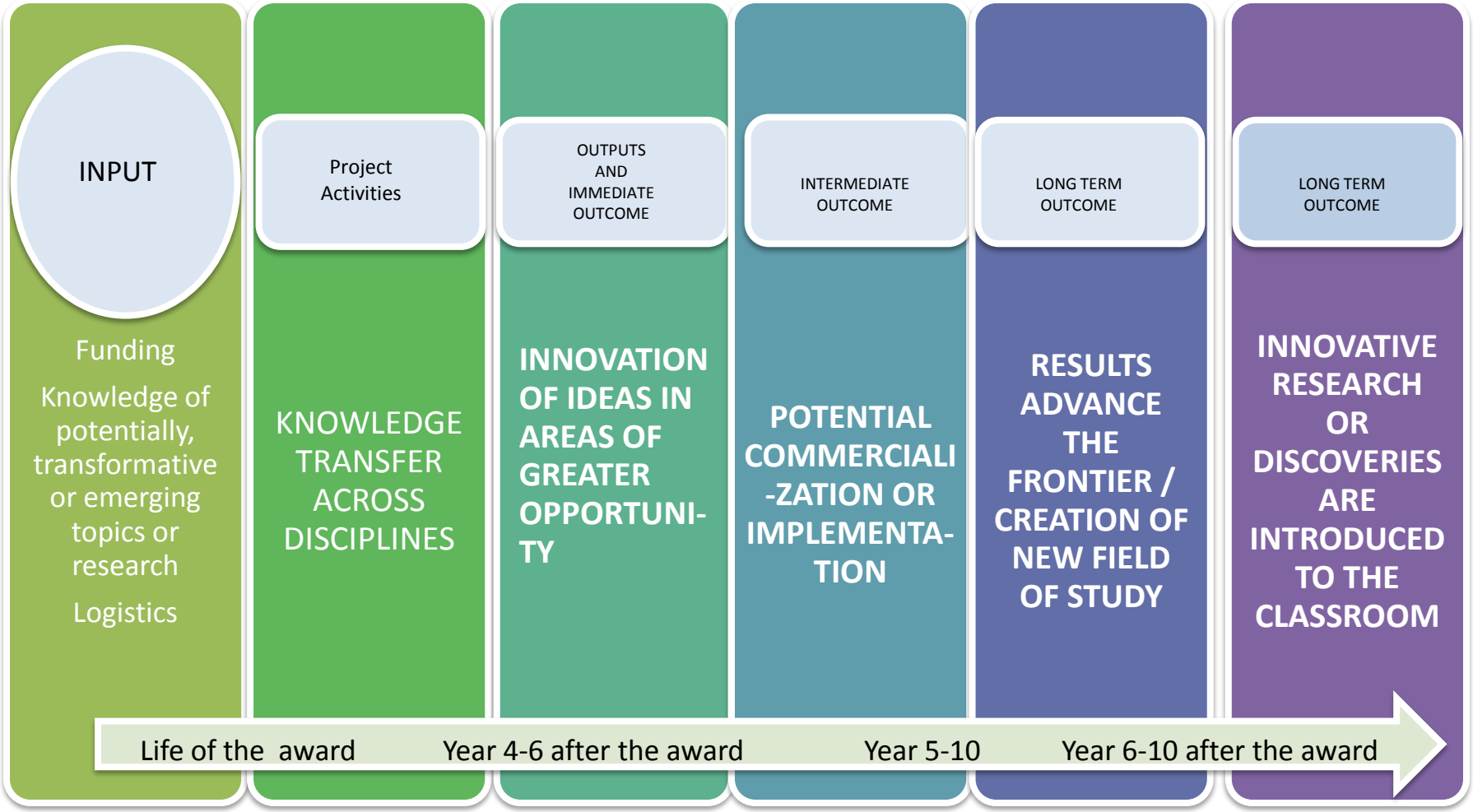
Potential Variations

- When the intentions of the program make the outcomes to be measured evident:
  - Engineering education, broadening participation, I-corps
- When the intentions of the program have a clear broader objective besides the basic research:
  - Programs fostering interdisciplinary efforts
- When the objective is to support basic research in a field or fields and societal outcomes might not be as clear

What have we done so far….?

Defining outcome indicators and linking them to data collection systems

EFRI's Logic Model



DESIRABLE OUTPUTS/OUTCOMES	POTENTIAL INDICATORS
PROJECT OUTPUTS/ KNOWLEDGE TRANSFER ACROSS DISCIPLINES	•Number of Interdisciplinary collaborations (or percentage of grants with this characteristic) •Number of students involved in projects (undergraduate, graduate) •Number of exchange students across labs (inter-disciplinary, inter-institutional)
INNOVATION OF IDEAS IN AREAS OF GREATER OPPORTUNITY	•Number of grants co-funded (or supported) by other agencies (or percentage of grants with this characteristic) •Number of researchers exchanged across laboratories (inter-disciplinary, inter-institutional) •Number of grants with international collaborations (or percentage of grants with this characteristic)
POTENTIAL COMMERCIALIZATION OR IMPLEMENTATION	•Number of grants with additional continuation of funding at a larger scale (or percentage of grants with this characteristic) •Number of patents
PROJECT RESULTS ADVANCE THE FRONTIER / CREATION OF NEW FIELDS OF STUDY	•Number of grants that have developed out-of-the-box approaches or what disciplinary experts would consider new methods or methodologies (or percentage of grants with this characteristic) •Number of grants that have induced or are partially responsible for paradigm shifts •Percentage growth in number of publications in the area (calculated from the first year of funding as a baseline) •Number of graduate students that pursue research in areas related to EFRI projects
INNOVATIVE RESEARCH METHODS OR DISCOVERIES ARE INTRODUCED TO THE CLASSROOM	•Number of grants that have generated curriculum changes or inclusions of modules to teach methods, discoveries or innovations funded by EFRI

INDICATOR	POTENTIAL DATA SOURCE
•Number of Interdisciplinary collaborations (or percentage of grants with this characteristic) •Number of students involved in projects (undergraduate, graduate) •Number of exchange students across labs (inter-disciplinary, inter-institutional)	RESEARCH.GOV AND PROJECT REPORT OR ADDITIONAL DATA COLLECTION INSTRUMENT SELF-REPORTED BY PI
•Number of grants co-funded (or supported) by other agencies (or percentage of grants with this characteristic) •Number of researchers exchanged across laboratories (inter-disciplinary, inter-institutional) •Number of grants with international collaborations (or percentage of grants with this characteristic)	
•Number of grants with additional continuation of funding at a larger scale (or percentage of grants with this characteristic) •Number of patents	E-JACKET/ REPORT SERVER PATENTS MODULE OF STARMETRICS PORTFOLIO EXPLORER
•Number of grants that have developed out-of-the-box approaches or what disciplinary experts would consider new methods or methodologies (or percentage of grants with this characteristic). •Number of grants that have induced or are partially responsible for paradigm shifts	EXTERNAL EVALUATION EXPERTS (surveys , interviews, summative evaluation)
•Percentage of growth in number of publications in the area (calculated from the first year of funding as a baseline) •Number of graduate students that pursue research in areas related to EFRI projects	Web of Science/ Google Scholar/ Potentially Star Metrics/ External evaluators

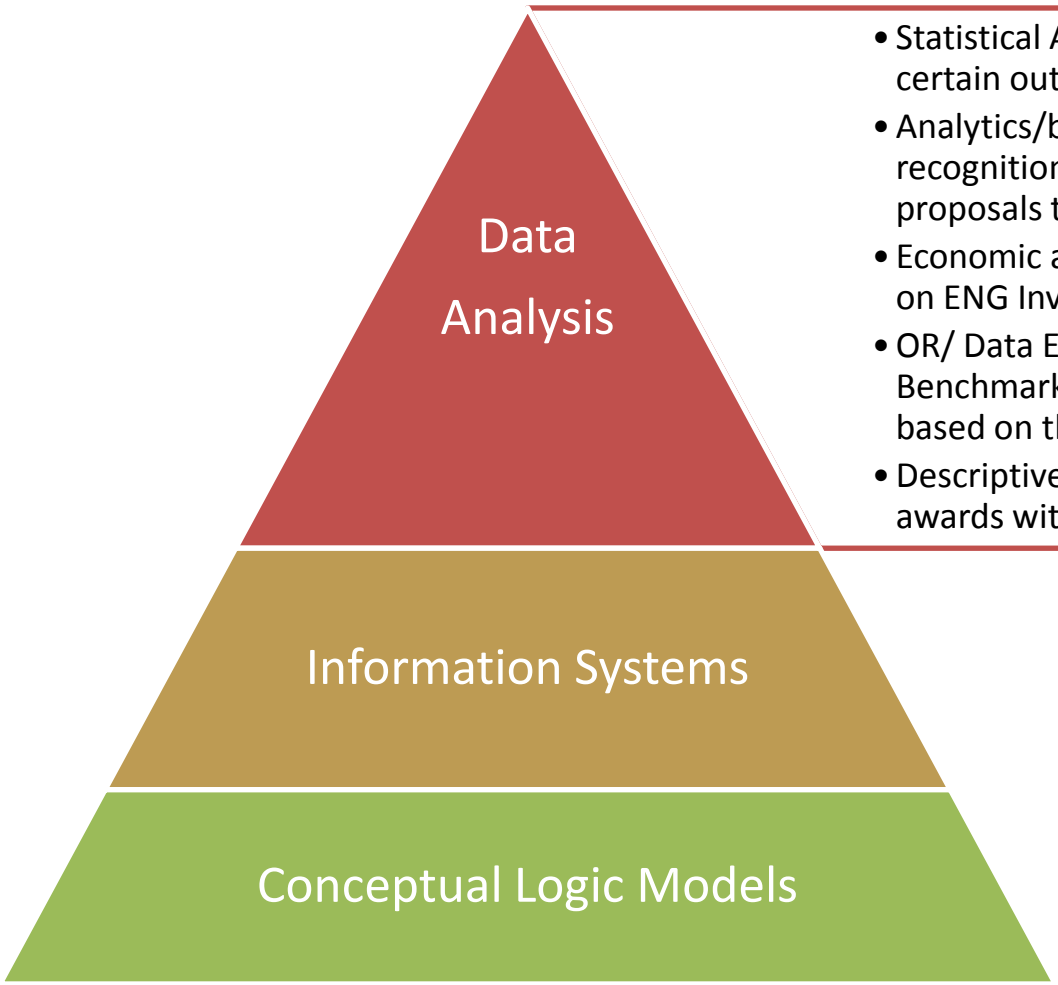
Dealing with Outcome Development for Basic Research:
Reverse Outcome-Development Process

(1)
What are the **major needs in society** at large which could be alleviated by advances (discoveries) in this discipline?

(2)
What **innovations** do we need to alleviate those needs?

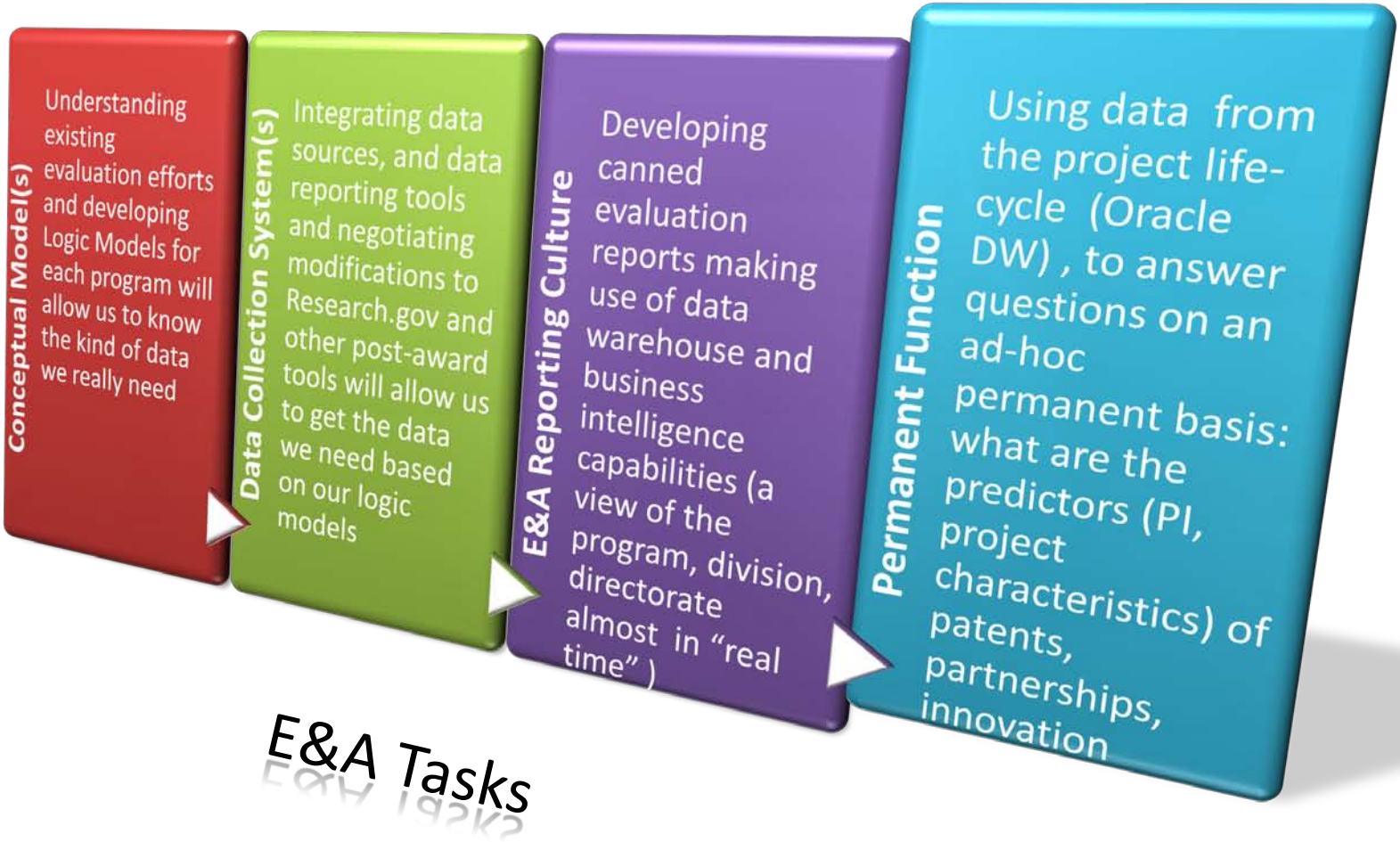
(3)
What specific **gaps in knowledge** exist --within the scope of this program description-- that prevent us to develop those innovations?

When can we have answers to our programmatic questions



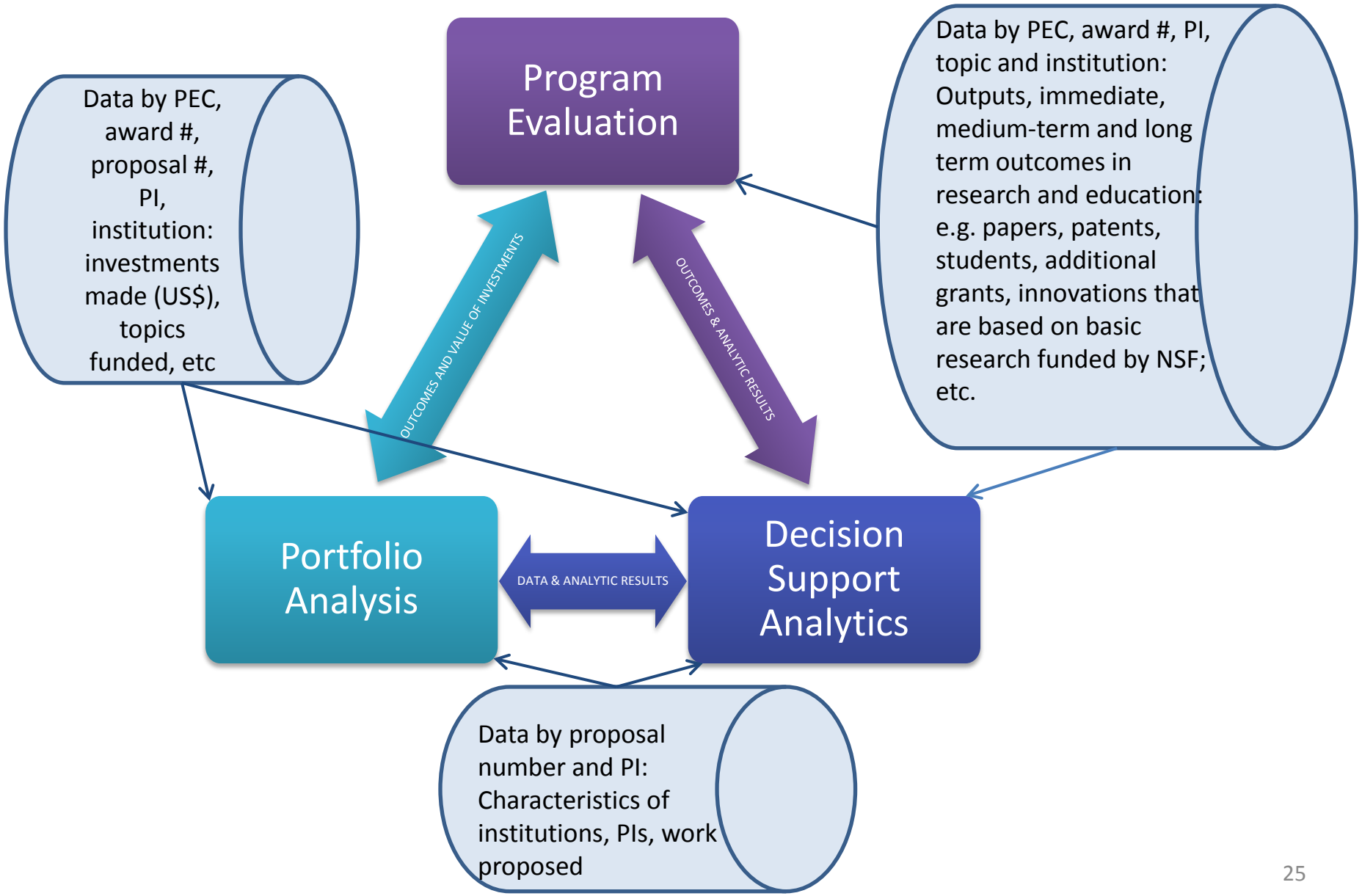
- Statistical Analysis: main predictors of certain outcomes
- Analytics/business intelligence/ pattern recognition/ data mining: likelihood of proposals to obtain certain outcomes
- Economic analysis: Benefit-Cost, Return on ENG Investment
- OR/ Data Envelopment Analysis: Benchmarking proposals/ PIs, programs based on their efficiency/ effectiveness
- Descriptive statistics: e.g. percentage of awards with certain characteristics

What is the road ahead?



We want your feedback regarding the vision, the plan and the strategies to achieve our vision

How do E&A functions come together?



BRIGE LOGIC MODEL

*focused on underrepresented groups, including minority ethnicities, persons with disabilities, women and veterans

INPUTS

Funding

Logistics/ Broadening Participation Plans

Research Plan

Inputs from other coordinating agencies and Institutions (equipment, facilities, etc.)

Project Activities

Research Activities and Training

-Undergraduate, graduate and post-doc students* participate in research, some through supplement mechanisms (REUs, RETs, GRDs).

-Minority serving institutions, and community colleges are engaged with the project.

-Training of high school students and K_12 teachers in research activities.

-Tutoring and mentoring occurs

-Collaborating activities with institutional

OUTPUTS AND IMMEDIATE OUTCOME

Research & Outreach Outputs

-Students* trained in labs

-K-12 teachers trained in engineering research concepts

-Workshops and meetings

-Community outreach events

-Training materials produced

-Curricula developed

Faculty and students publish the results of research

-BRIGE Faculty perceived as role models

-Awareness of students' challenges* increases

INTERMEDIATE OUTCOME

Academic career of BRIGE awardees thrives.

Increased excitement about STEM among students.*

-K-12 teachers trained introduce engineering research topics in their classes

-Participating students start considering research or engineering careers

-BRIGE faculty experience recognition

-Increased communication among PI, students and other faculty

LONG TERM OUTCOME/ IMPACT

BROADENING PARTICIPATION

INCREASE OF SUCCESFUL WOMEN, UNDERREPRESENTED GROUPS AND VETERANS IN STEM FIELDS

-Increased engagement of BRIGE faculty** in STEM research

-Increased diversity in faculty composition in departments touched by a BRIGE award

-Increased diversity in students from underrepresented groups touched by activities related to a BRIGE award graduating with STEM degrees (undergraduate and

Life of the award → Year 1-4 after the award → Year 5-10 after the award → Year 6-10 after the award

INDICATOR	POTENTIAL DATA SOURCE
•Number of papers resulting from research discoveries •Number of conference presentations •Number of underrepresented students trained in labs •Number of K-12 teachers trained • Number of workshops held with minority participation •Number of community outreach events •Number of training materials produced	RESEARCH.GOV / PROJECT REPORT / DW OR ADDITIONAL DATA COLLECTION INSTRUMENT SELF-REPORTED BY PI
•Number of awardees who report that they introduced innovations in the curricula of classes they teach after the award	
•Number of BRIGE awardees who are promoted to Associate in the usual P&T time at their institutions or less •Number of BRIGE awardees who apply for additional funding from NSF and other federal agencies •Number of BRIGE awardees who get an award from NSF as PI or CO-PI after getting the BRIGE •Number of BRIGE awardees who get a CAREER award or other major award that shows recognition	DW/Proposal Search/ E-Jacket/ STAR METRICS
•Number of BRIGE awardees who increase collaborations national and international after the award •Percentage of students who perceived their BRIGE faculty member as a mentor •Number of participating students who state that they started considering research or engineering careers after their involvement with the BRIGE award activities •Number of teachers who introduce changes in the classroom after participating in BRIGE activities •Percentage of faculty from underrepresented groups actively engaged in STEM research •Percentage of students from underrepresented groups graduating with STEM degrees in departments touched by a BRIGE award •Percentage of new hires who are considered a minority (women, underrepresented groups or veterans) •Percentage of BRIGE-touched students who stated that they perceive an increase in	EXTERNAL EVALUATION EXPERTS (surveys or summative evaluation) or external sources (e.g. ASEE)