Artificial Intelligence @ NIST
and Collaboration Roadmap for AI-powered Moonshots

Michael Garris

Senior Scientist
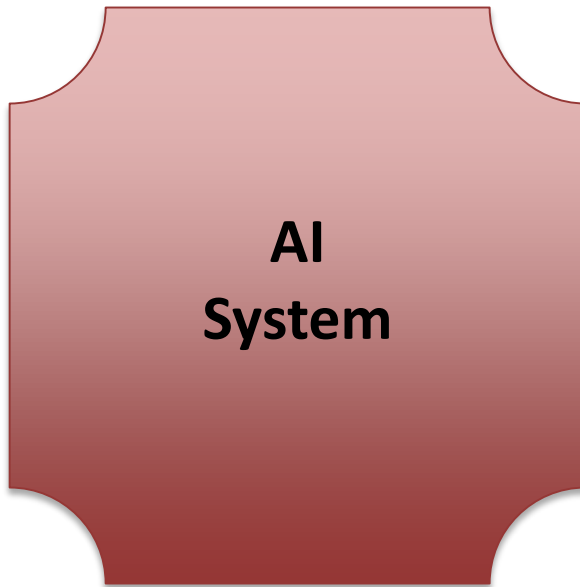National Institute of Standards and Technology

What is AI?

- Think and act like humans

- Think and act rationally

- Sometimes mutually exclusive. ☺

- AI Problem Space Categories

    - Knowledge Representation

    - Perception

    - Logical Reasoning

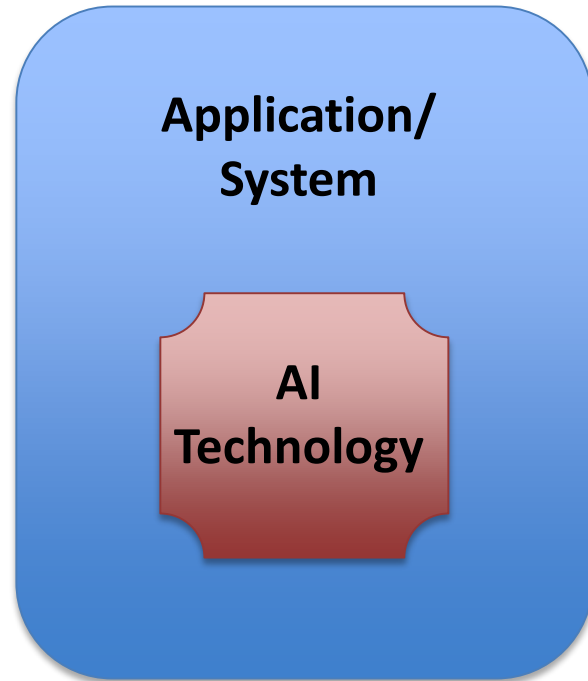   - Planning and Navigation

    - Prediction

What is AI?

- Field of Study

- Technology
  - System
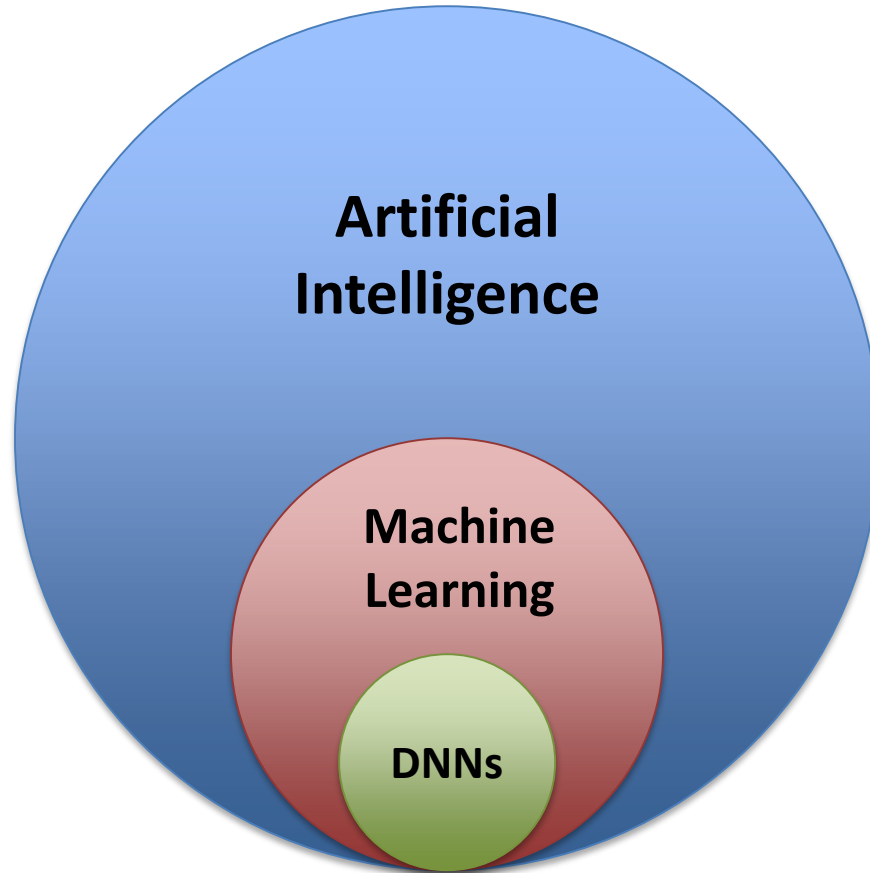 - Characteristic

AI Conceptualization (1 of 3)

Embodied

Embedded

Application/
System

AI
System

AI
Technology

AI Conceptualization (2 of 3)

Artificial Intelligence

Machine Learning

DNNs

* DNN = Deep Neural Network

AI Conceptualization (3 of 3)

Narrow AI	General AI
o Application specific/ task limited	o Perform general (human) intelligent action
o Fixed domain models provided by programmers	o Self-learns and reasons with its operating environment
o Learns from thousands of labeled examples	o Learns from few examples and/or from unstructured data
o Reflexive tasks with no understanding	o Full range of human cognitive abilities
o Knowledge does not transfer to other domains or tasks	o Leverages knowledge transfer to new domains and tasks
o Today's AI	o Future AI?

New Wave of AI

- Availability of Big Data
- Improved Machine Learning (ML) Algorithms
- More Powerful Computing
- Mobile Connectivity

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ML/AI for …

- Classification
- Function Approximation
- Prediction
- Control
- Simulation
- Anomaly Detection
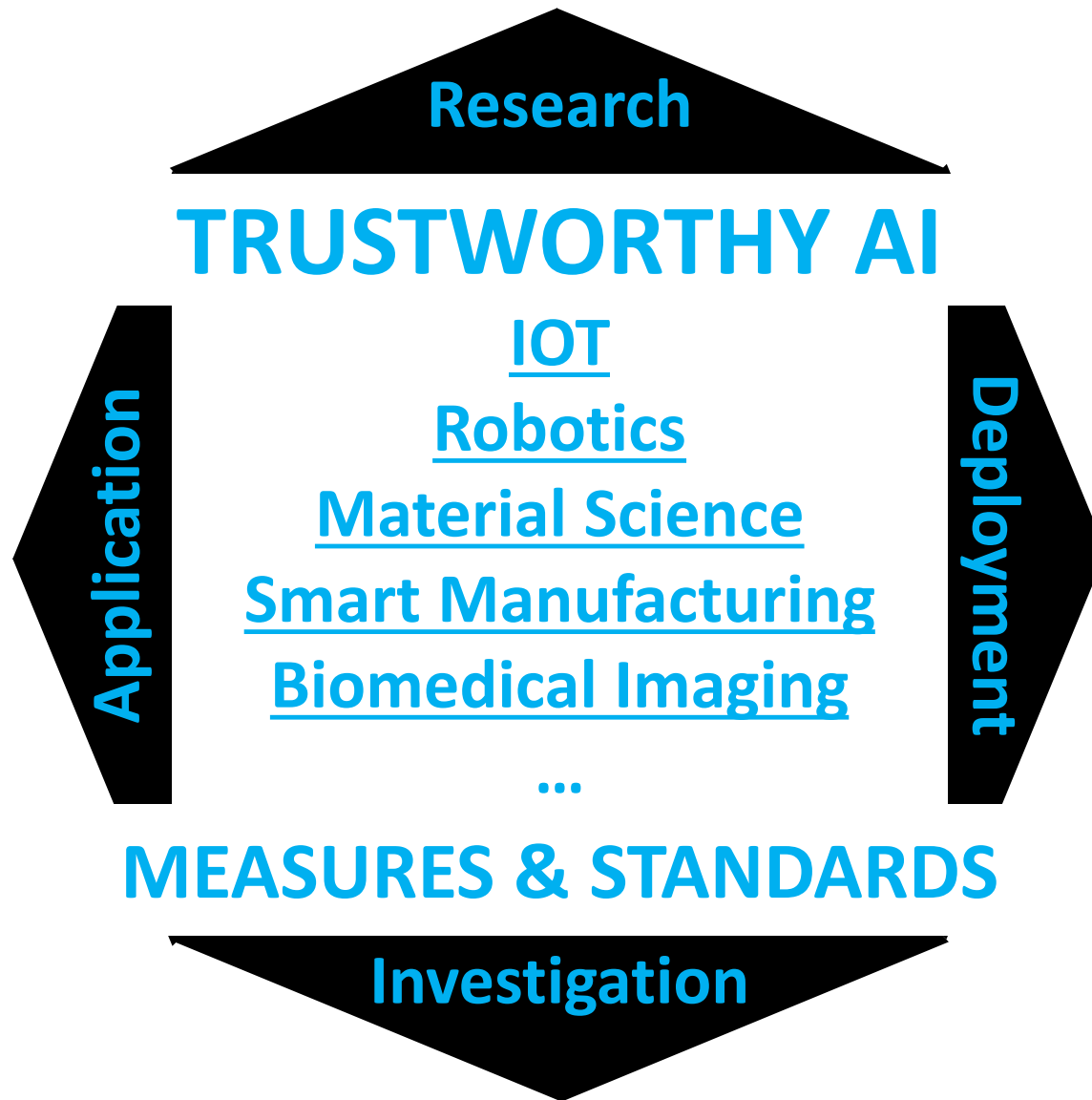- …

ML/AI Challenges

- Probabilistic
  - With inherent error rates and uncertainty

- Data Driven
  - With vulnerability to learning unwanted patterns of bias

- Extreme Dimensionality
  - Making decisions opaque (little explainability)

- Model Validation

  - Bound performance

  - Account for unforeseen outliers

  - How good is good enough?
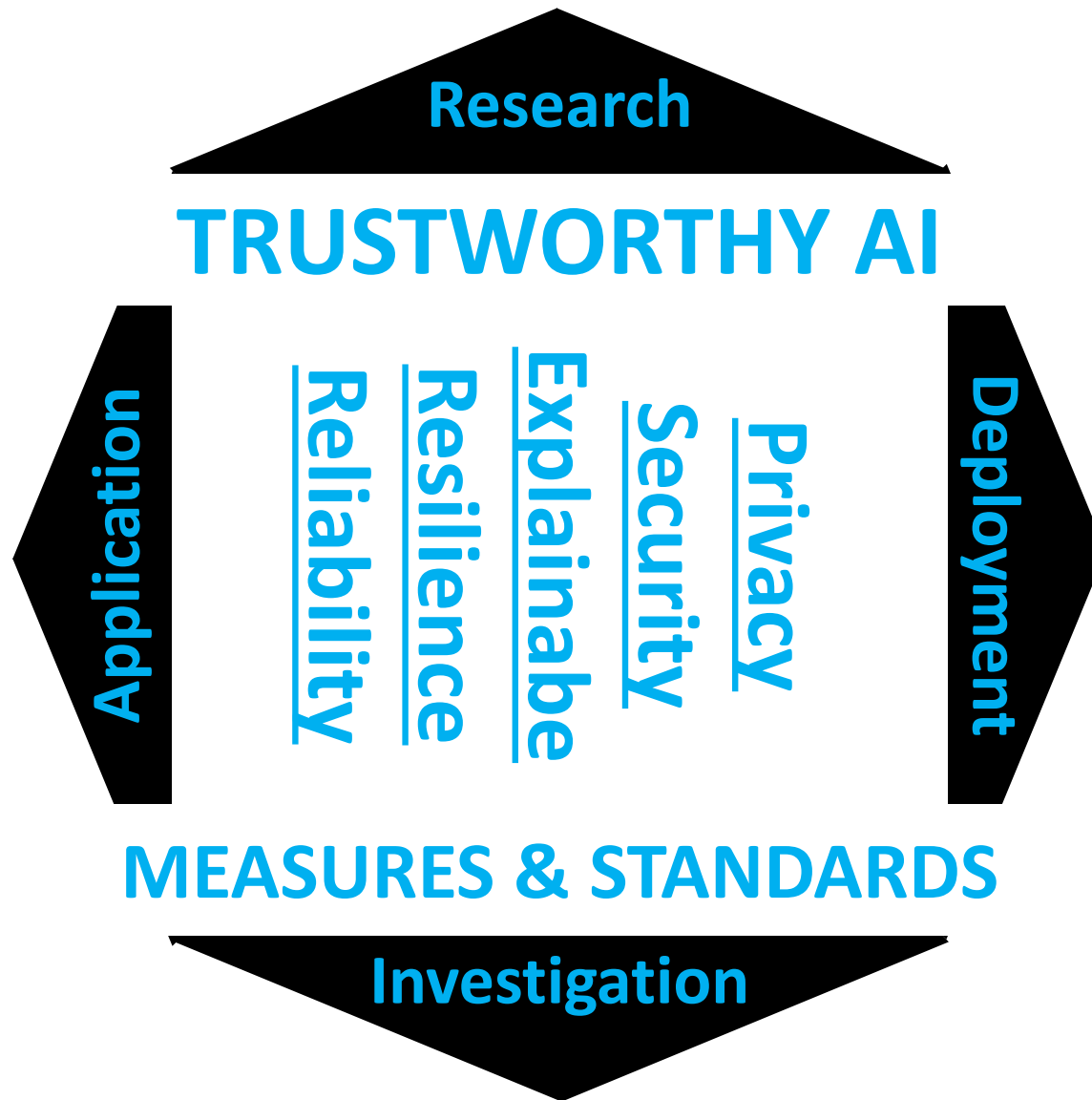
  - Now introduce dynamic / continuous learning!?*

NIST Mission
(AI's Impact)

To promote U.S. <u>innovation</u> and <u>industrial competitiveness</u> by advancing <u>measurement science, standards, and technology</u> in ways that <u>enhance economic security</u> and <u>improve our quality of life</u>.

NIST

Research

TRUSTWORTHY AI

IOT
Robotics
Material Science
Smart Manufacturing
Biomedical Imaging

...

Application

Deployment

MEASURES & STANDARDS

Investigation

Research

TRUSTWORTHY AI

Application

Reliability
Resilience
Explainabe
Security
Privacy

Deployment

MEASURES & STANDARDS

Investigation

Topics @ NIST
(relating to AI/ML)

AI/ML Foundations
  - Improving ML
  - Knowledge Management
  - Ontologies
  - Visualization

Datasets & Data Management

Image Understanding
  - Biomedical
  - Biometrics
  - Neutron Radiation

Information Search & Summarization

Internet of Things &
  Cyber Physical Systems

Materials Science & Discovery

Natural Language Processing

Neuromorphic Design

Quantum AI/ML

Robotics
  - Agility
  - Collaboration

Security and Privacy

Smart Manufacturing

Spectrum

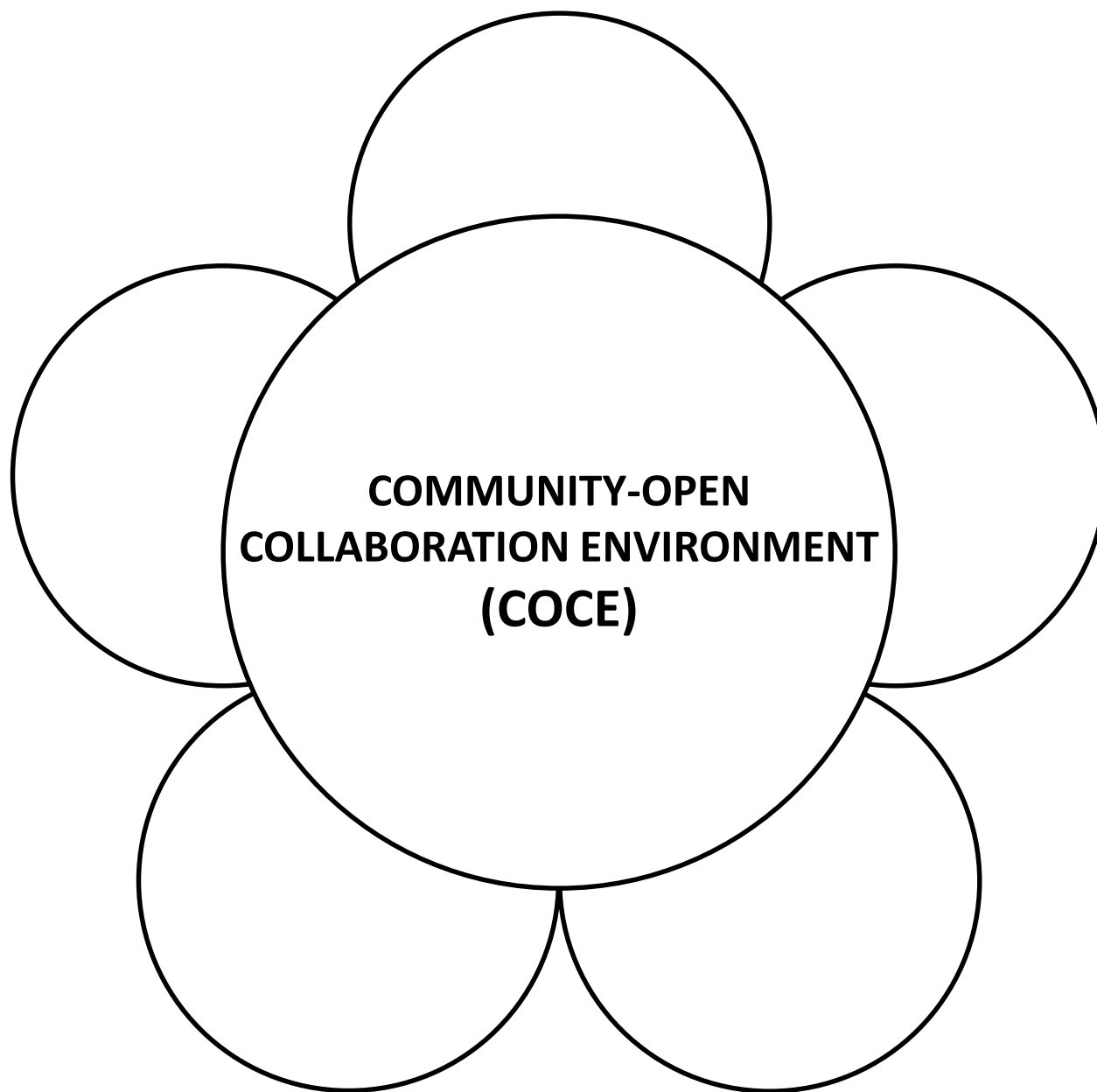Standardization

Training (staff)

Trustworthiness
  - Bias
  - Methods & Metrics
  - Validation

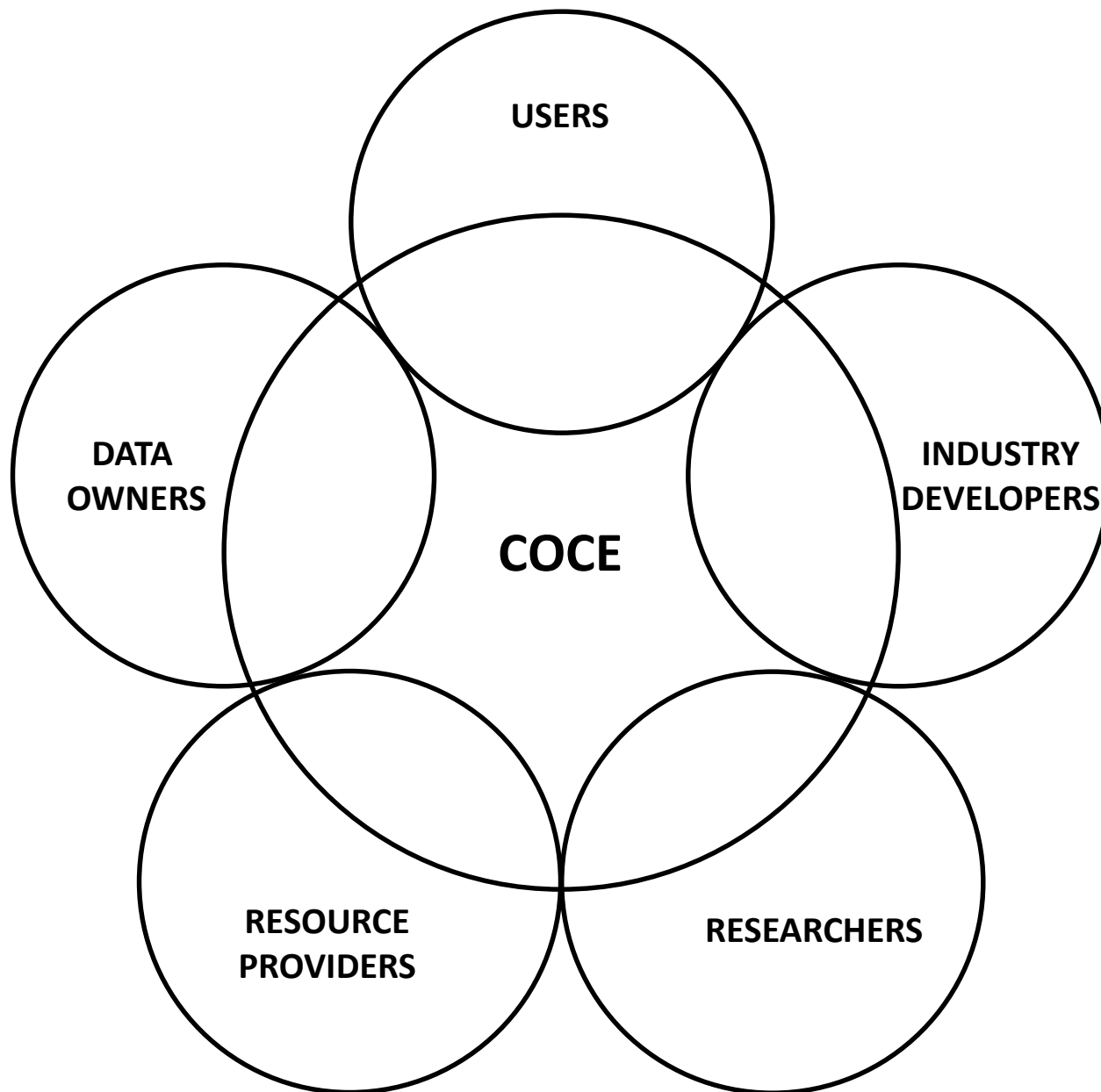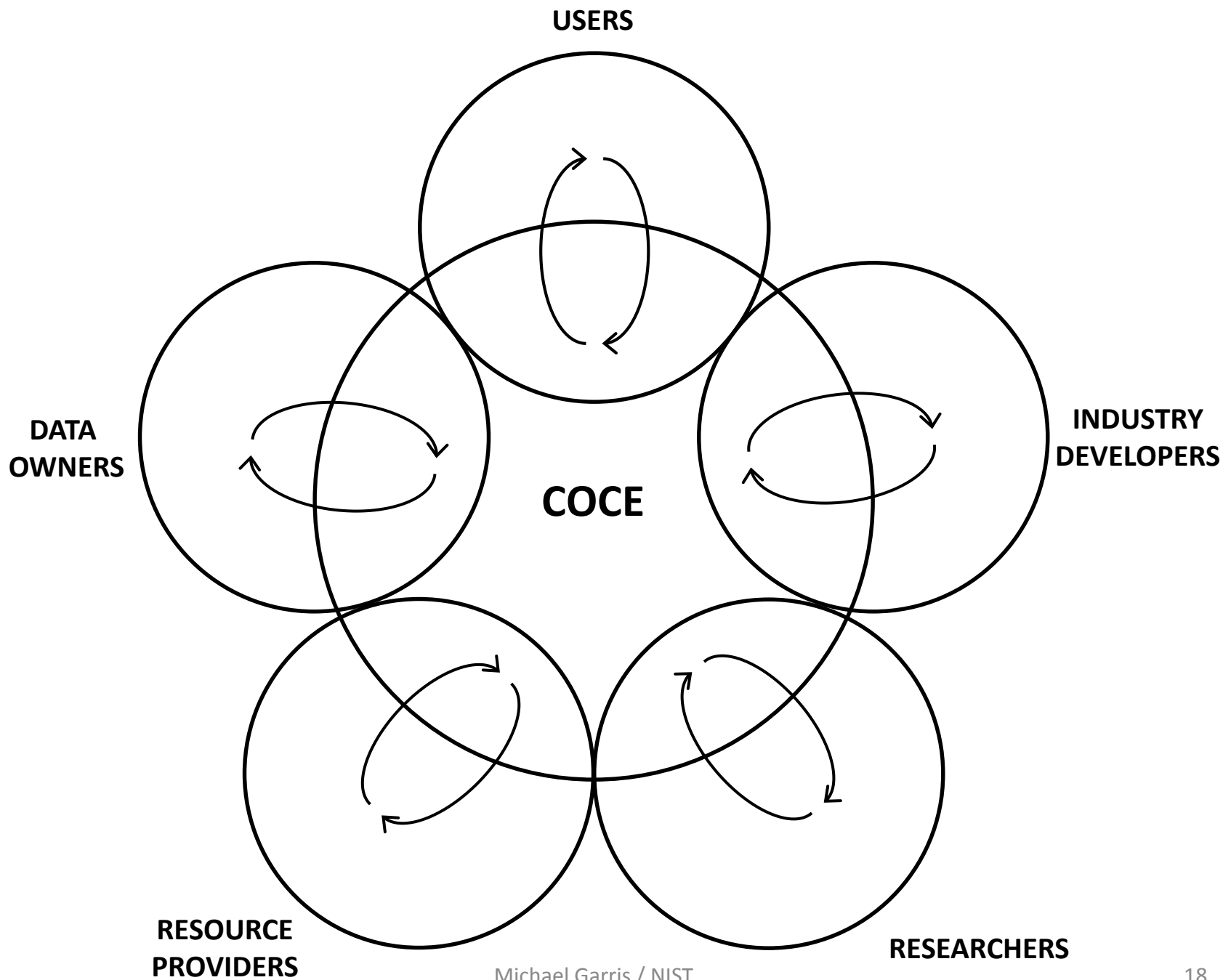# *(PAUSE FOR QUESTIONS)*

Next
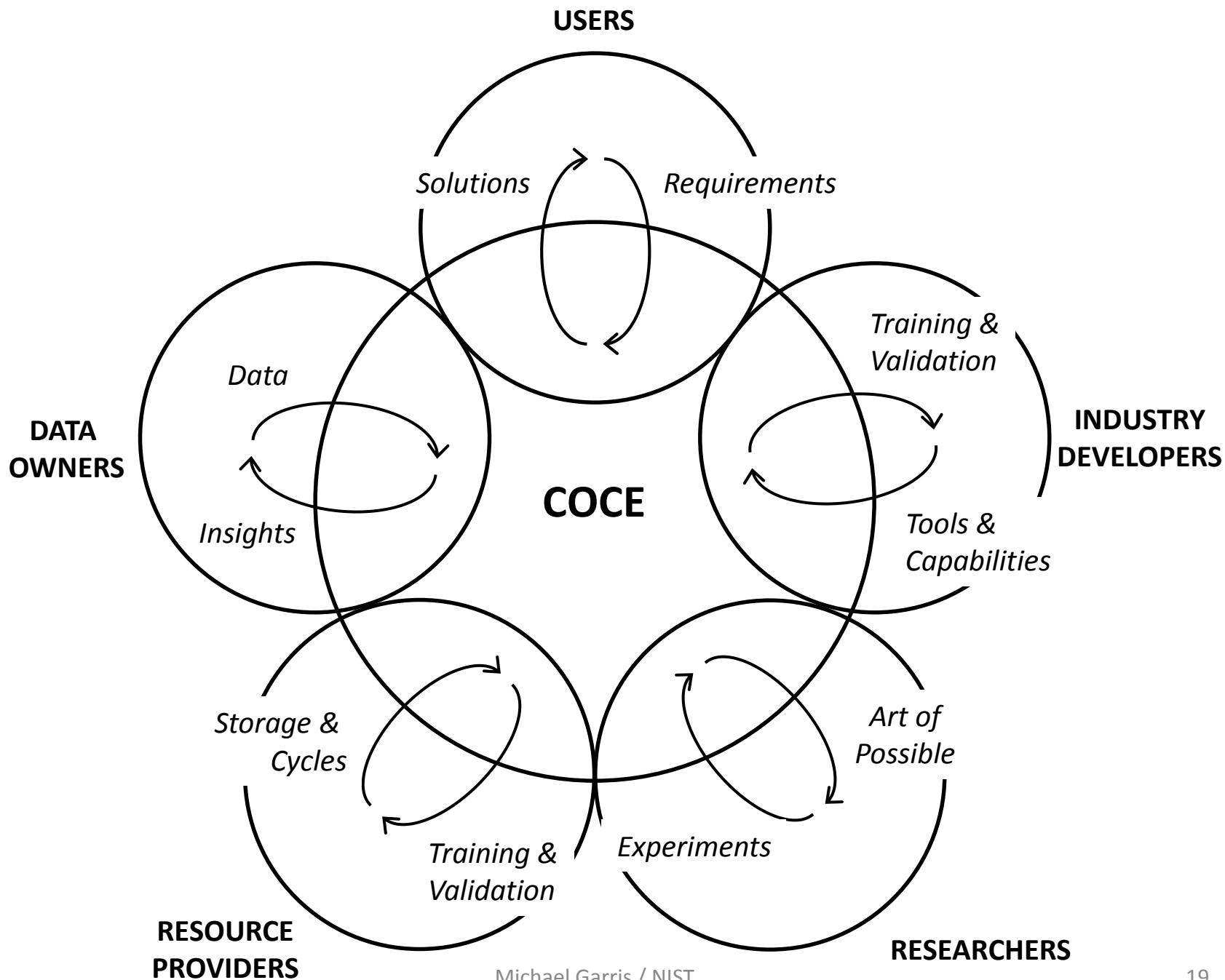## Collaboration Roadmap
for AI-powered Moonshots

COMMUNITY-OPEN COLLABORATION ENVIRONMENT (COCE)

USERS

DATA OWNERS

INDUSTRY DEVELOPERS

COCE

RESOURCE PROVIDERS

RESEARCHERS

USERS

Solutions   *Requirements*

DATA
OWNERS

Data

Insights

COCE

INDUSTRY
DEVELOPERS

*Training &
Validation*

*Tools &
Capabilities*

*Storage &
Cycles*

*Art of
Possible*

*Training &
Validation*   *Experiments*

RESOURCE
PROVIDERS

RESEARCHERS

USERS

Solutions *Requirements*

DATA
OWNERS

Data

Insights

DATA
$$

INDUSTRY
DEVELOPERS

*Training &
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Capabilities*

*Storage &
Cycles*

*Art of
Possible*

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Experiments

RESOURCE
PROVIDERS

RESEARCHERS

Michael Garris / NIST
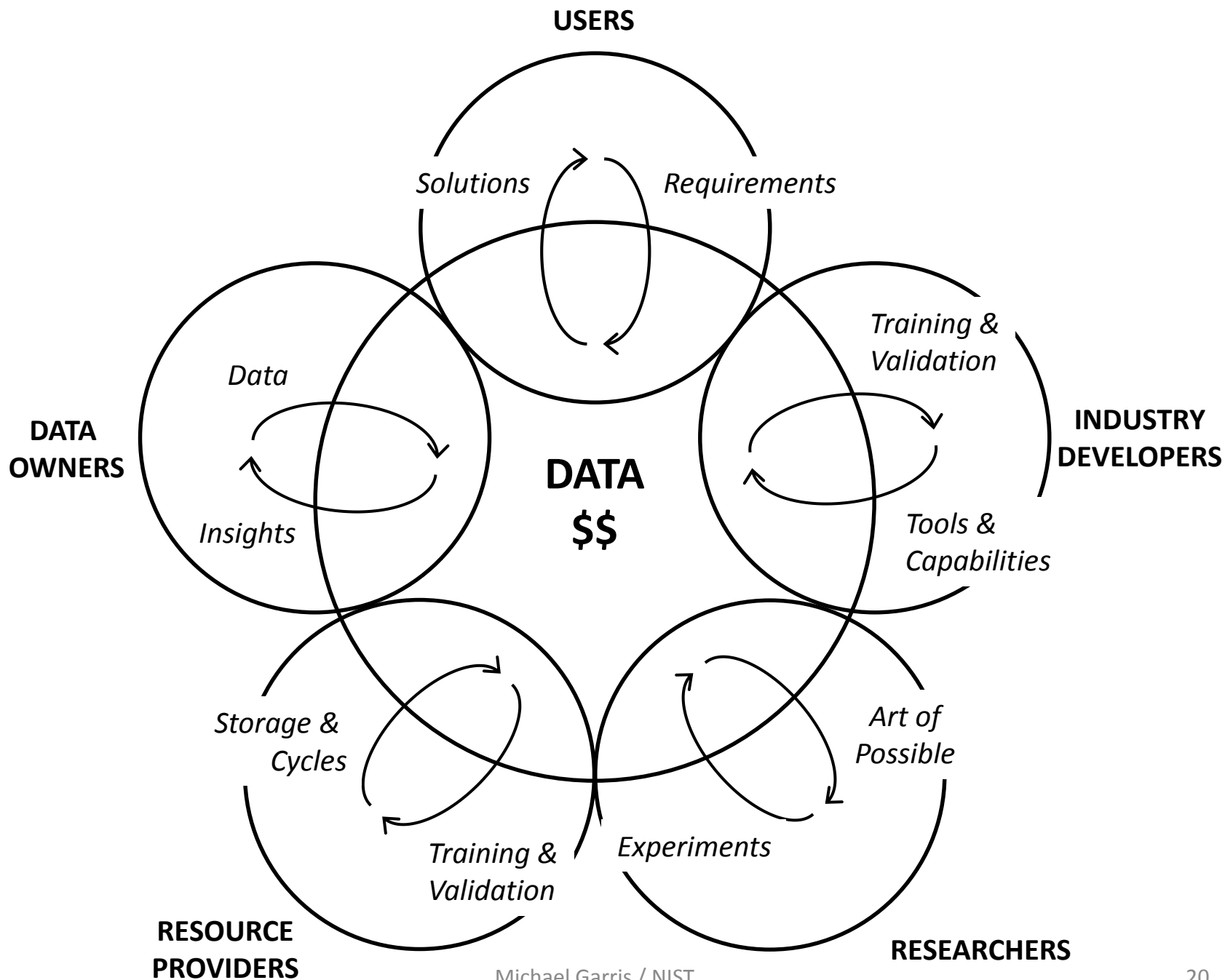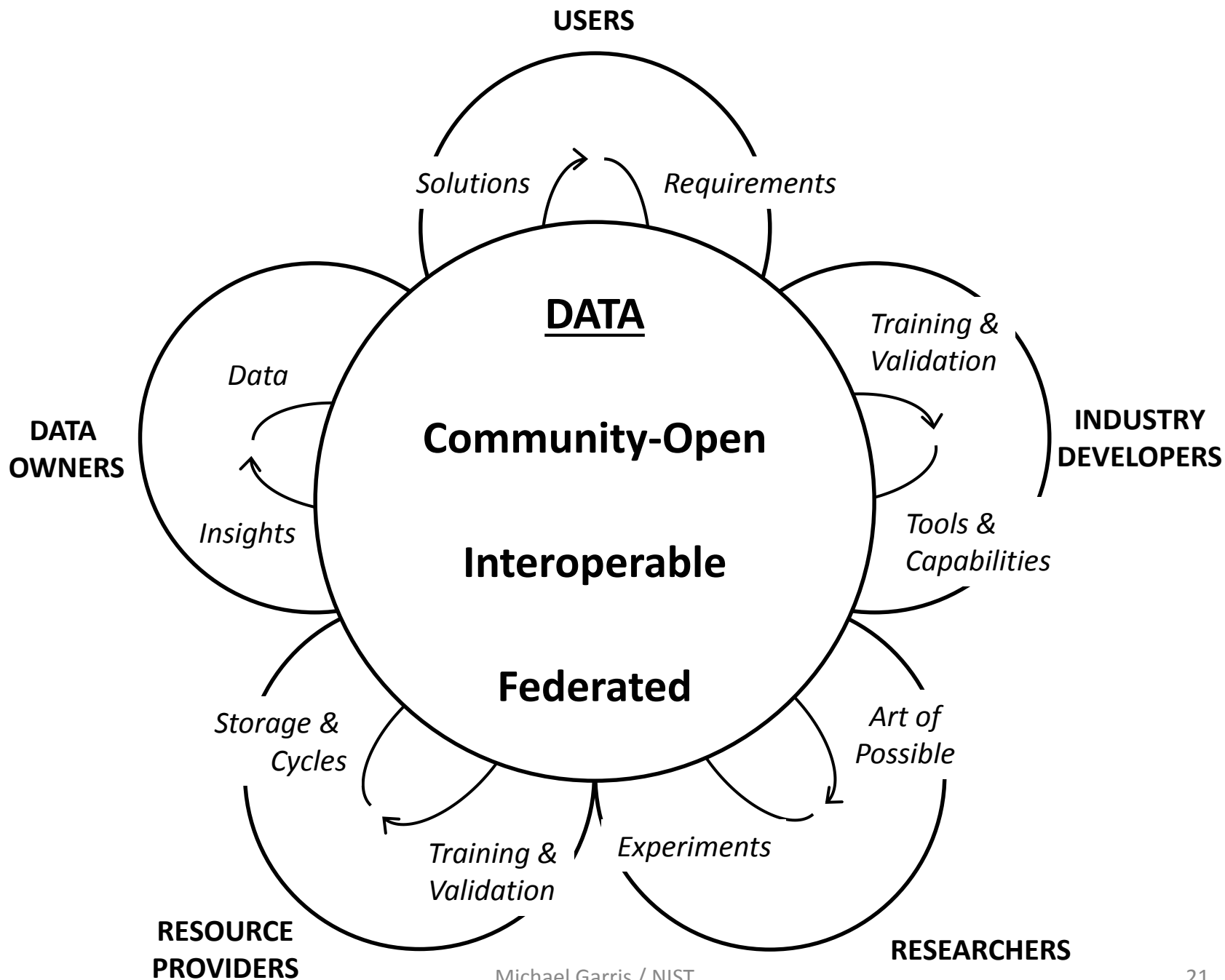
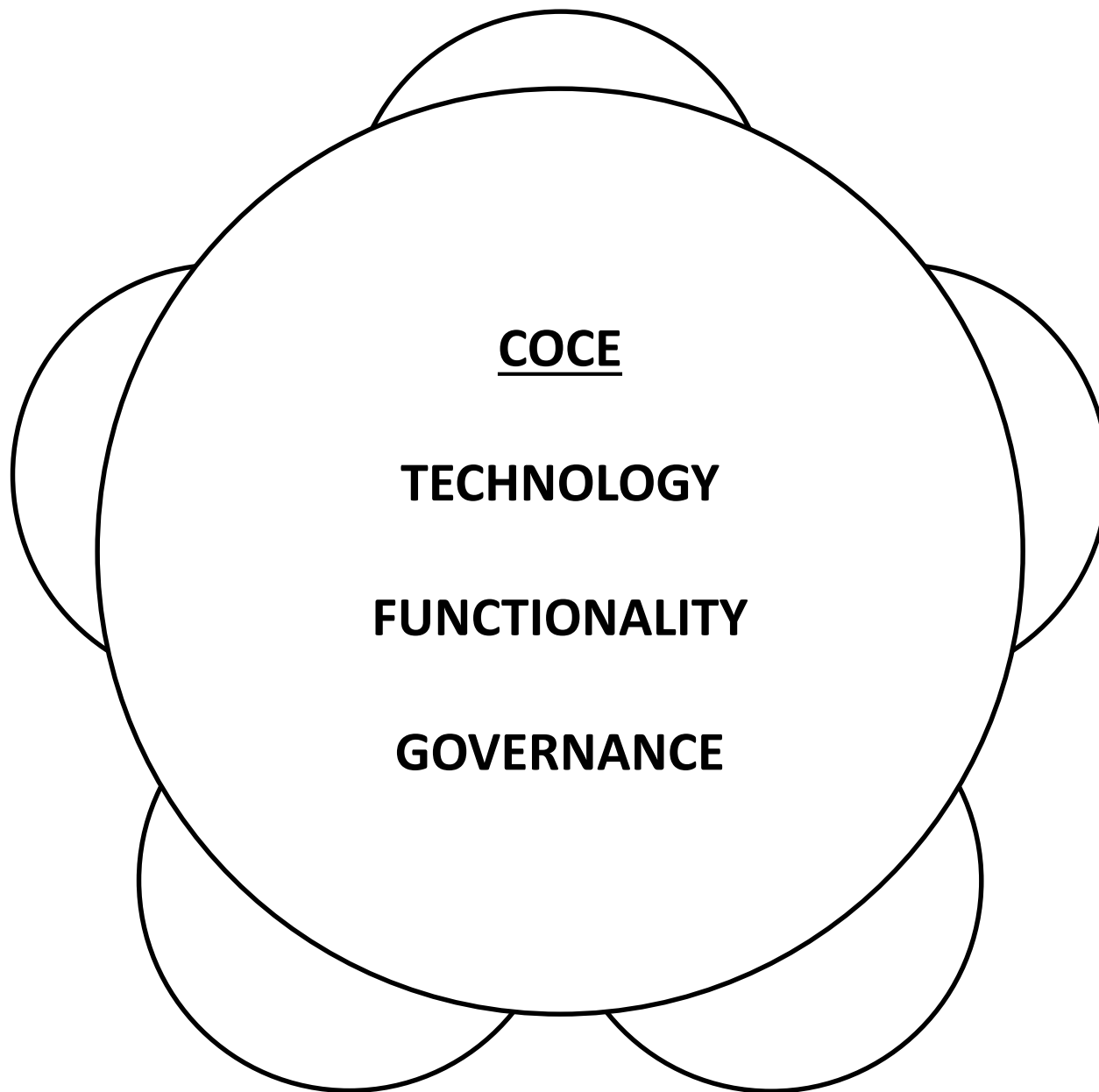**COCE**

TECHNOLOGY

FUNCTIONALITY

GOVERNANCE

TECHNOLOGY

Data
Storage & Compute
Implementation Platform
- **Operational Prototypes**
- **ML & Analytic Engines**

Standards
- **Data Formats**
- **APIs**

Benchmarks

FUNCTIONALITY

User / Contributor Facility

Product Development

Foundational Research

Fork->Dev->Test->Integrate

Challenge Problems &
     Technology Evaluations

Human Factors Design

Standardization

GOVERNANCE
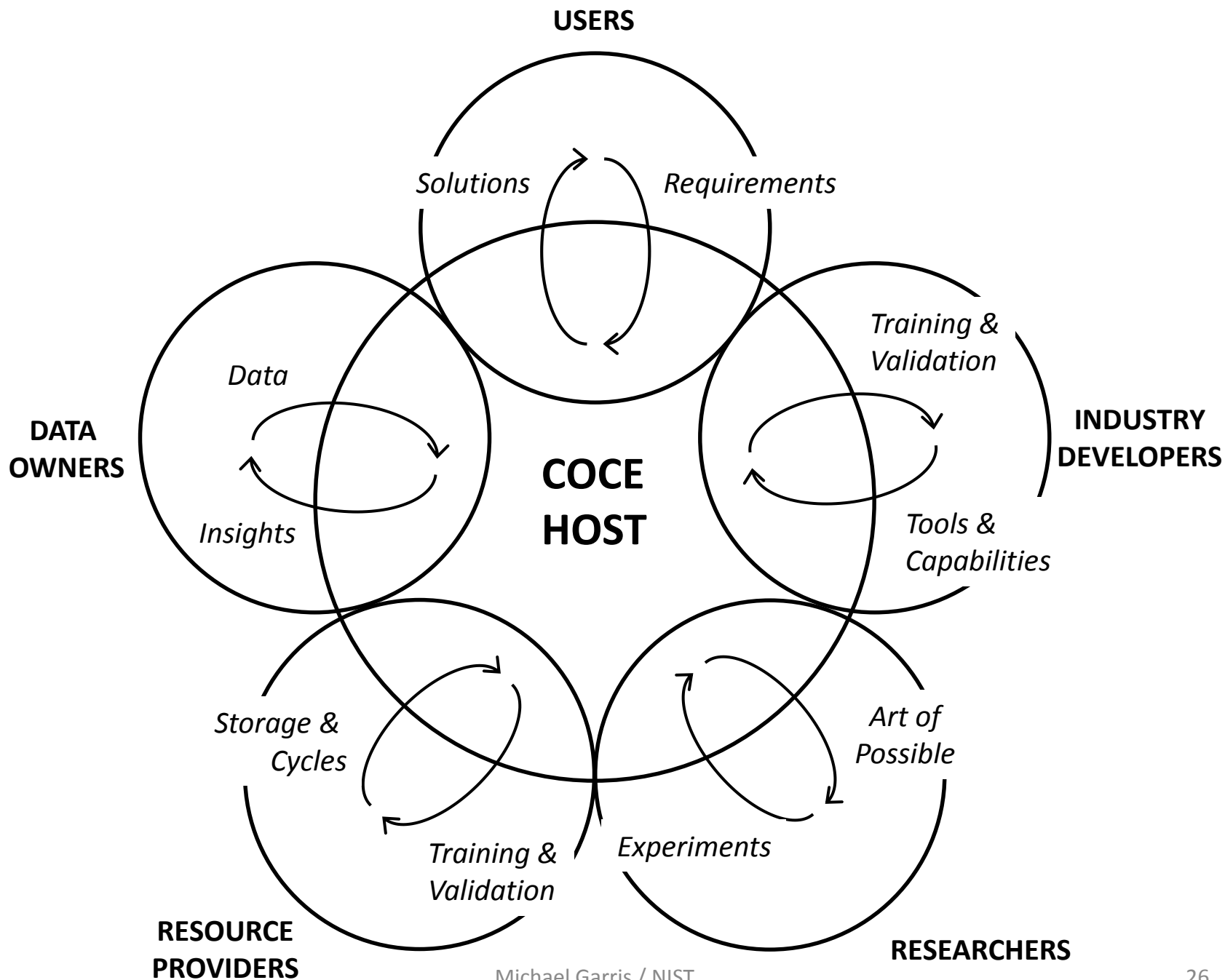Community Appointments
Community Membership
- User & Licensing Agreements

Security & Privacy Controls
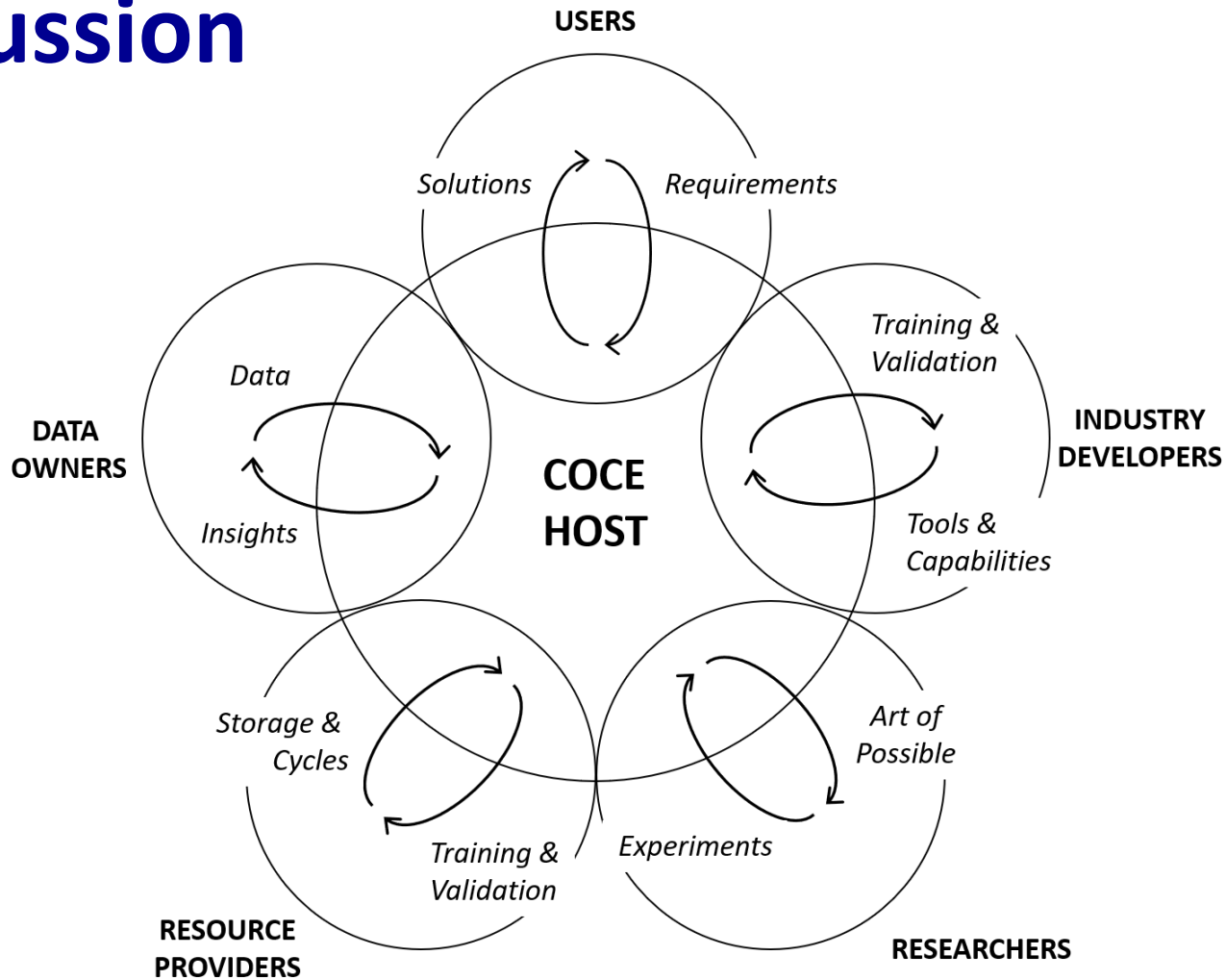Regulatory Compliance &
  Risk Managed
Strategic Orchestration
Host = Federal R&D Data Owner
- NIH, DOE, NASA, DOD, …

Discussion

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