Developing the Cross-Disciplinary Information Model for NASA's Science Mission Directorate

Ruth Duerr[1], Ahmed Eleish[2], Mark Parsons[3], Daniel Berrios[4], Kaylin Bugbee[3], and Peter Fox[2]

[1]Ronin Institute for Independent Scholarship
[2]Rensselaer Polytechnic Institute
[3]University of Alabama in Huntsville
[4]NASA Ames Research Center

November 26, 2022

Abstract

The five divisions of NASA's Science Mission Directorate (SMD) represent a very broad spectrum of academic disciplines, ranging from Astronomy, to Planetary science, to Heliophysics, Earth science, Biology and Physical science with measurement scales ranging from components of atoms to the structure of the entire universe. In addition, the systems that support access to these data range from systems based on formal and broadly accepted OWL ontologies, to those based on current and historical disciplinary metadata standards, to ad-hoc or bespoke systems dating back to NASA's very earliest missions; all generally developed to support the mission or, more recently, discipline focussed data users. Consequently the access mechanisms, data structures, vocabularies, terms in use, etc. vary widely across the divisions making cross-disciplinary research at best difficult if not impossible. Currently NASA SMD is working to improve support for cross-disciplinary/transdisciplinary research by developing a system that supports discovery across all of SMD's data products, a model that can be extended to all forms of scientific output including software, tools, models, publications, etc. The core underpinnings of such a system is an information model being developed using the methodology developed by Dr. Peter Fox and Dr. Deborah McGuinness. Here we discuss the model (a knowledge graph), lessons learned along the way, and key findings for other systems attempting to bridge across broad disciplinary challenges.

Hosted file

`essoar.10509892.1.docx` available at https://authorea.com/users/147114/articles/605470-developing-the-cross-disciplinary-information-model-for-nasa-s-science-mission-directorate

Developing the Cross-Disciplinary Information Model for NASA's Science Mission Directorate

Ruth Duerr, Ahmed Eleish, Mark Parsons, Dan Berrios, Kaylin Bugbee, Peter Fox

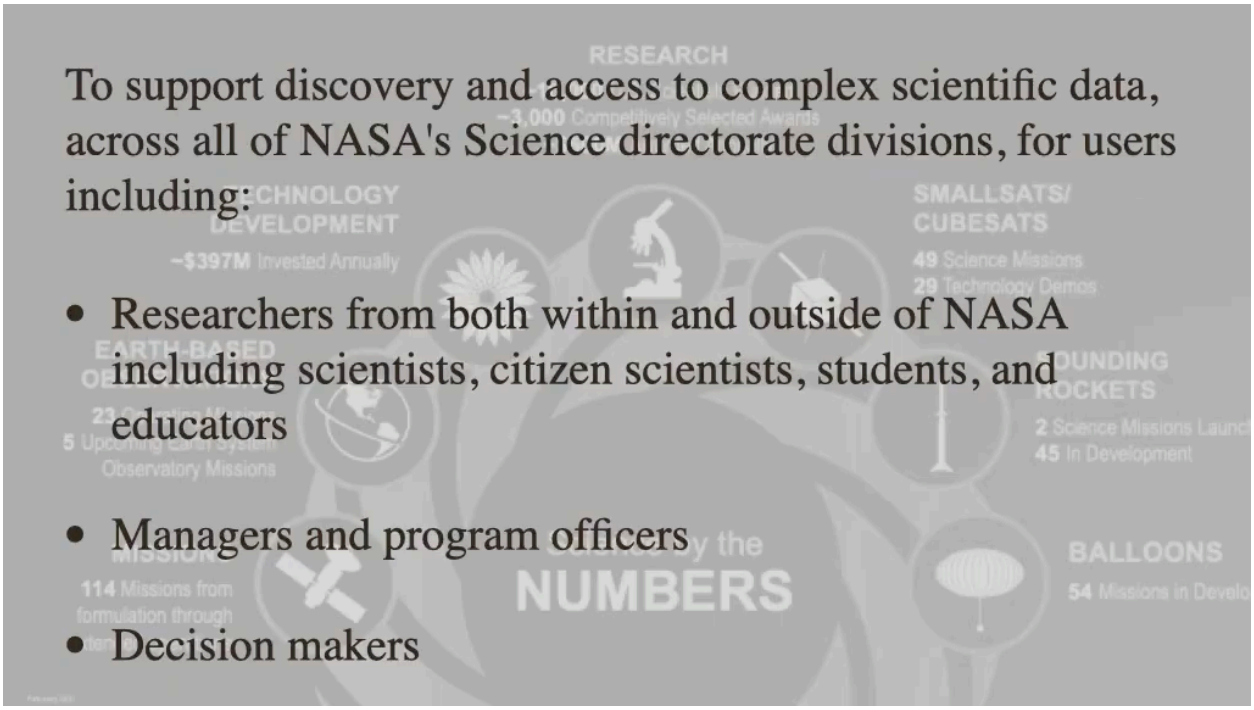
Ronin Institute, Rensselaer Polytechnic Institute, University of Alabama - Huntsville, KBR/ NASA Ames Research Center, NASA Marshall Space Flight Center

Abstract

The five divisions of NASA's Science Mission Directorate (SMD) represent a very broad spectrum of academic disciplines, ranging from Astronomy, to Planetary science, to Heliophysics, Earth science, Biology and Physical science with measurement scales ranging from components of atoms to the structure of the entire universe. In addition, the systems that support access to these data range from systems based on formal and broadly accepted OWL ontologies, to those based on current and historical disciplinary metadata standards, to ad-hoc or bespoke systems dating back to NASA's very earliest missions; all generally developed to support the mission or, more recently, discipline focussed data users. Consequently the access mechanisms, data structures, vocabularies, terms in use, etc. vary widely across the divisions making cross-disciplinary research at best difficult if not impossible.

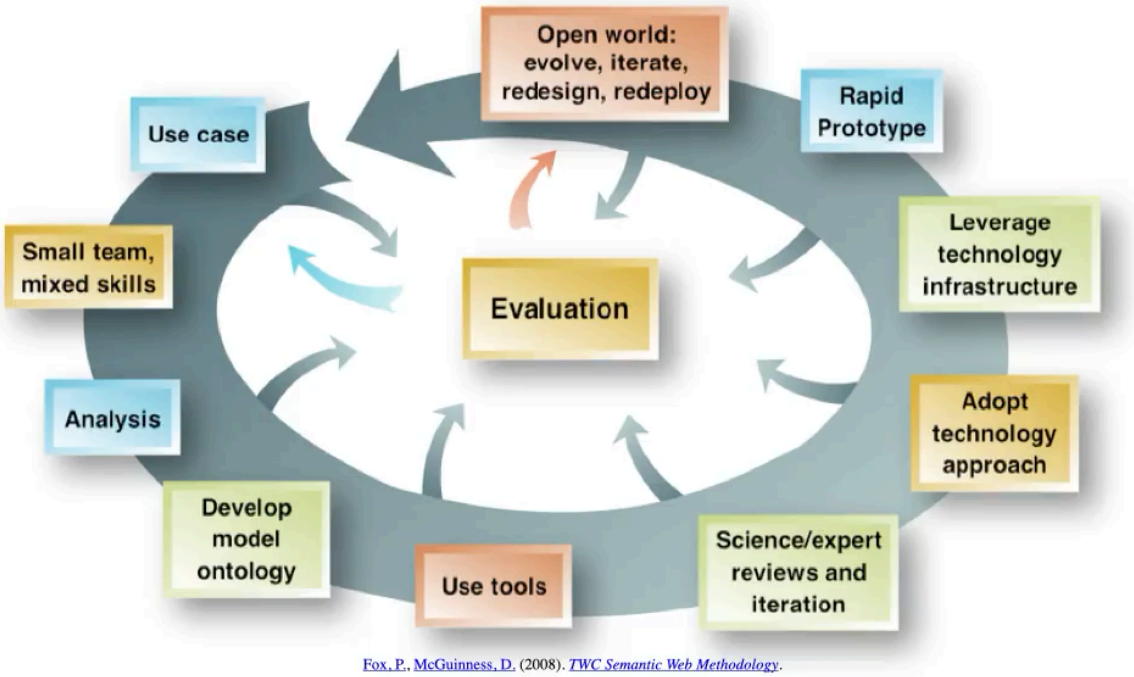
Currently NASA SMD is working to improve support for cross-disciplinary/transdisciplinary research by developing a system that supports discovery across all of SMD's data products, a model that can be extended to all forms of scientific output including software, tools, models, publications, etc. The core underpinnings of such a system is an information model being developed using the methodology developed by Dr. Peter Fox and Dr. Deborah McGuinness. Here we discuss the model (a knowledge graph), lessons learned along the way, and key findings for other systems attempting to bridge across broad disciplinary challenges.

Goals and Background



Movie #1: In this short video the goals of the SMD catalog project are described, as are their implications for the Information Model component of the project.

Methodology



Fox, P., McGuinness, D. (2008). *TWC Semantic Web Methodology*.

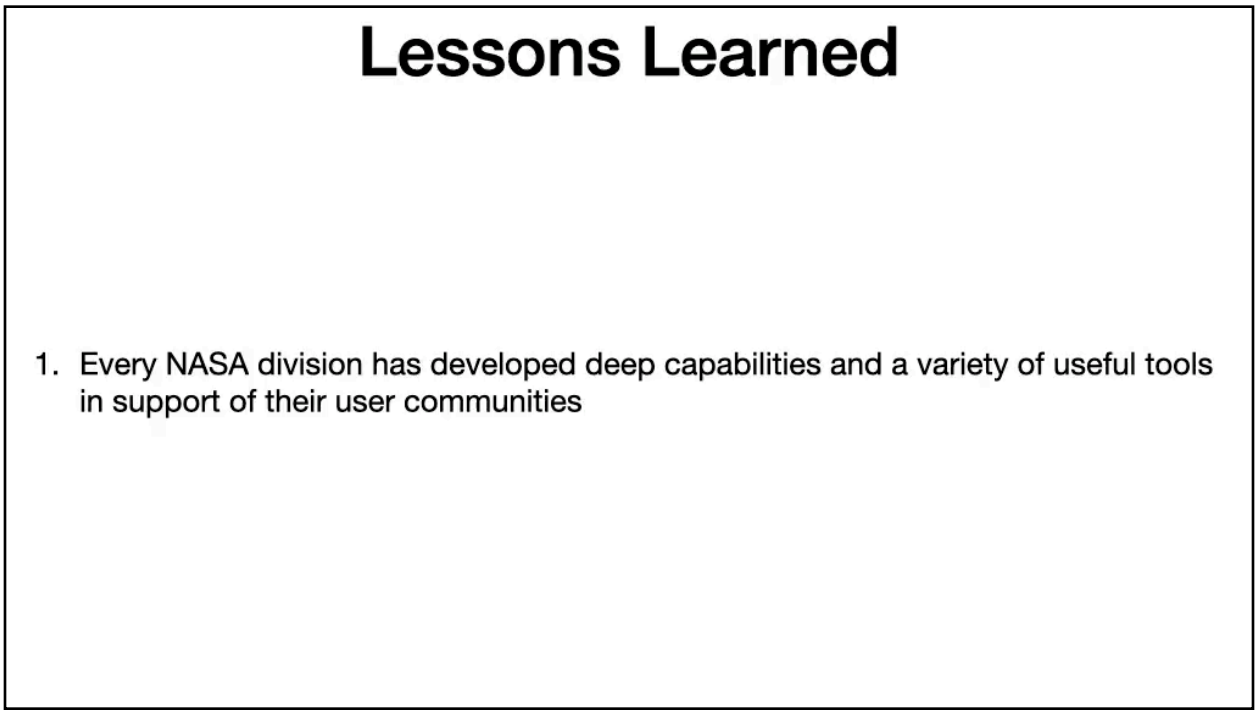
Key Insight

Use cases have shown that scientific data discovery involves more than metadata.

Science Data Discovery Need	RadBio Use Case Examples	Organic Exomoons Use Case Examples
Data Analysis	Integrate GOES 5 min Proton data to create calculated doses and dose rates	Determine stellar properties, Estimate spectral properties
Model	Linear no-threshold (LNT) model of radiation effects	Stellar Spectral Energy Distribution Model, HITRAN/ MODTRAN, Planetary Spectrum Generator
Event	Solar Particle Event, Geomagnetic Storm	Coronal Mass Ejection
Feature	South Atlantic Anomaly, Inner Radiation Belt	Spectral Energy Distribution, Radiant Energy Budget

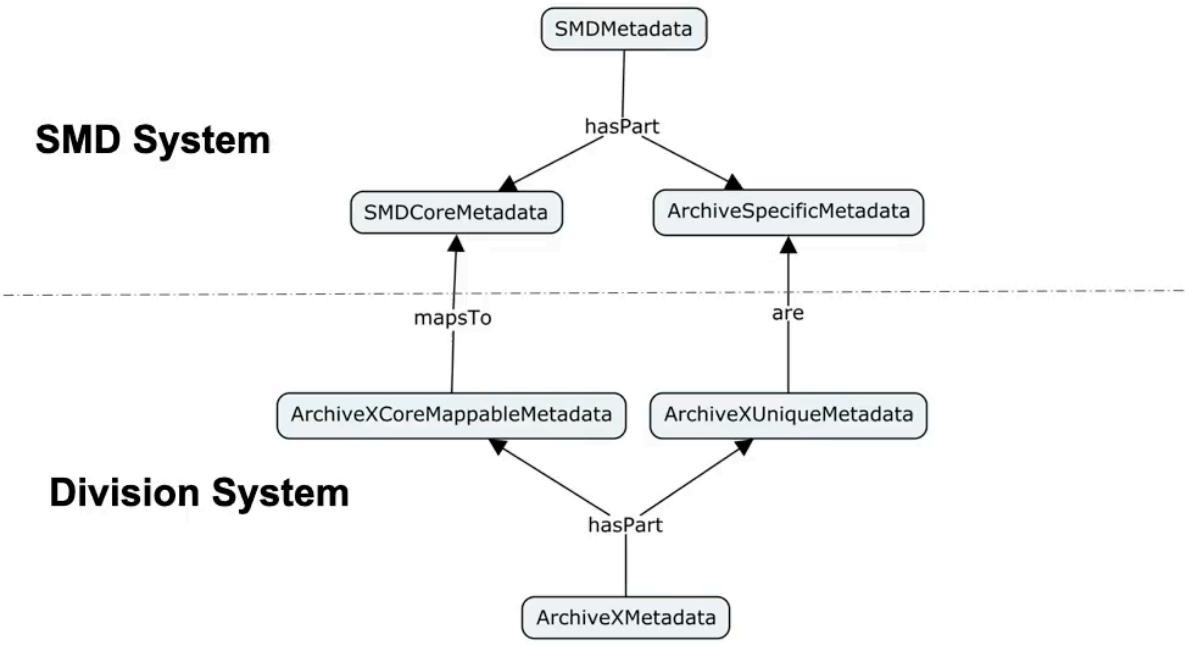
Table 1: Examples of different kinds of things, other than data, needed in order to satisfy a science discovery use case mentioned during the two use case workshops held to date.

Lessons Learned



Movie #3: Several lessons learned while analyzing the various systems within NASA's SMD are described.

The Information Model



Movie #4: After a brief discussion of metadata variations across scientific disciplines, this movie describes the main components of the SMD Information Model.