Ontology Design Patterns for EarthCube and Beyond

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EarthCube

EarthCube:

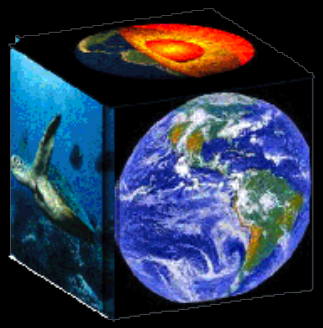
Developing a Community-Driven Data and Knowledge Environment for the Geosciences

“concepts and approaches to create integrated data management infrastructures across the Geosciences.”

“EarthCube aims to create a well-connected and facile environment to share data and knowledge in an open, transparent, and inclusive manner, thus accelerating our ability to understand and predict the Earth system.”

EarthCube requires

- information integration
- interoperability
- conceptual modeling
- intelligent search
- data-model intercomparison
- data publishing support



Semantic Web studies

- information integration
- interoperability
- conceptual modeling
- intelligent search
- data-model intercomparison
- data publishing support

Pascal Hitzler, WSU; Krzysztof Janowicz, UCSB

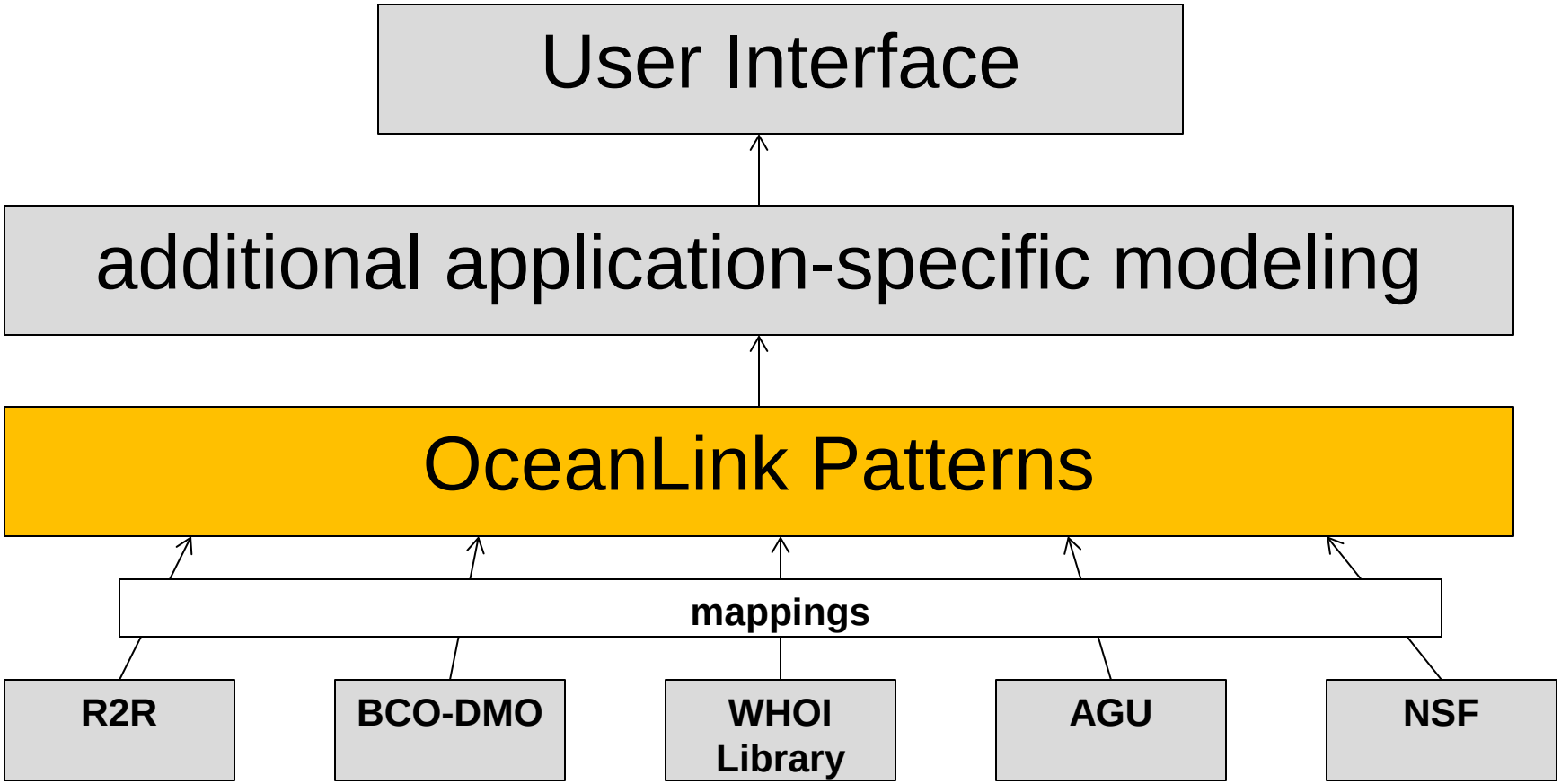
EarthCube Challenges

DaSe Lab

The EarthCube "Architecture" must be

- **modular**
- **extensible**
- **sustainable**
- **sliceable (i.e. you can adopt part of it without adopting all)**
- **simple enough for easy adoption**
- **complex enough to solve real problems**
- **scalable in terms of breadth of topic coverage**
- **elastic, in that it allows partners to decide how much they want to share**
- **respectful of individual modeling choices**

OceanLink setup



Ontology Design Patterns

DaSe Lab

“An ontology design pattern is a reusable successful solution to a recurrent modeling problem.”

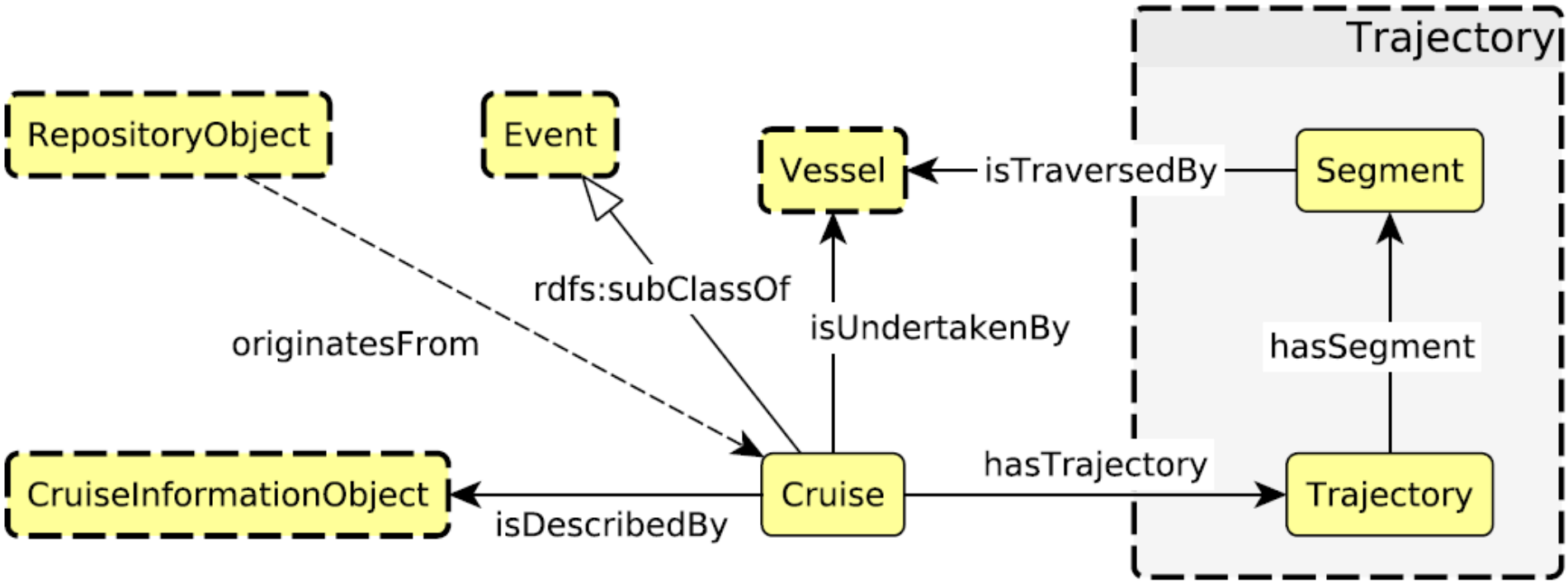
So-called *content patterns* usually encode specific abstract notions, such as process, event, agent, etc.

Patterns provide modular, reusable, replaceable, pieces.

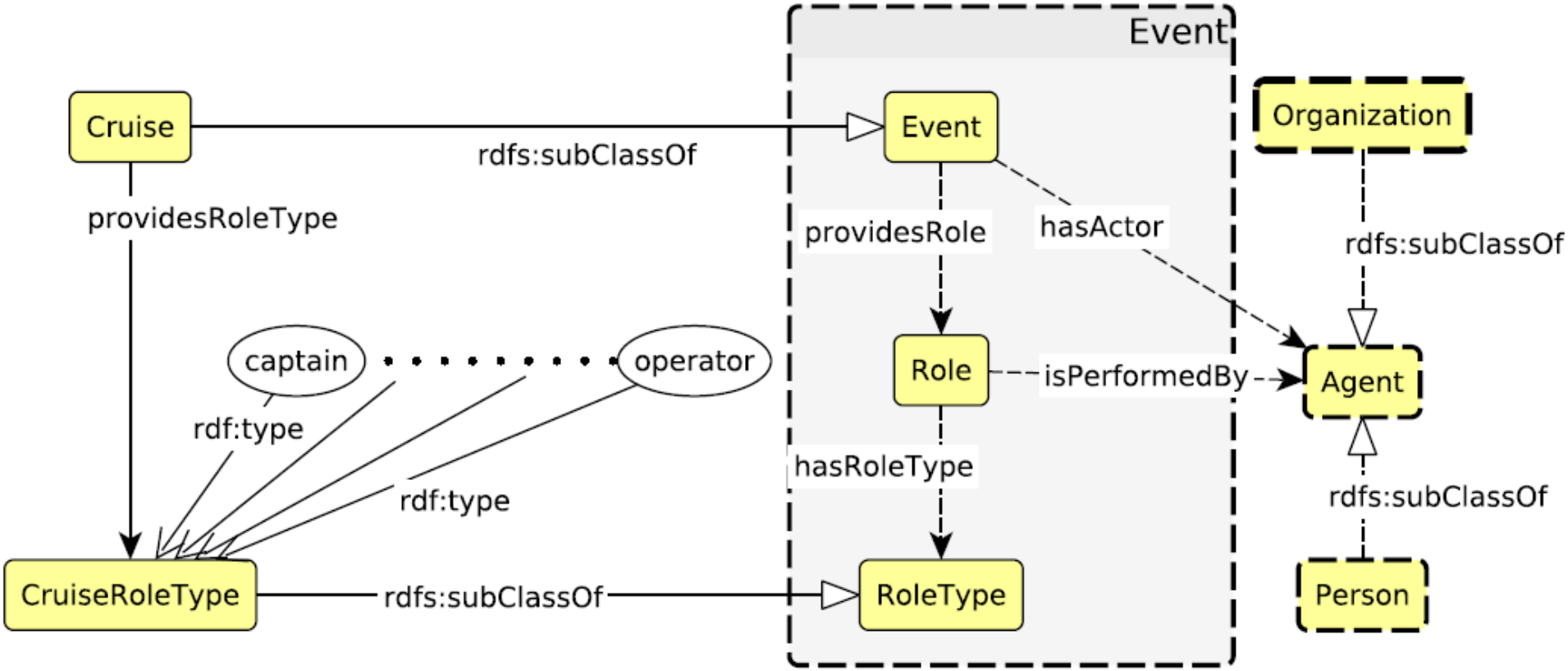
By agreeing on reuse of generic patterns (but leaving the relationships between the patterns to a specific assembly for a special purpose), we can have reuse while preserving heterogeneity.

Oceanographic Cruise

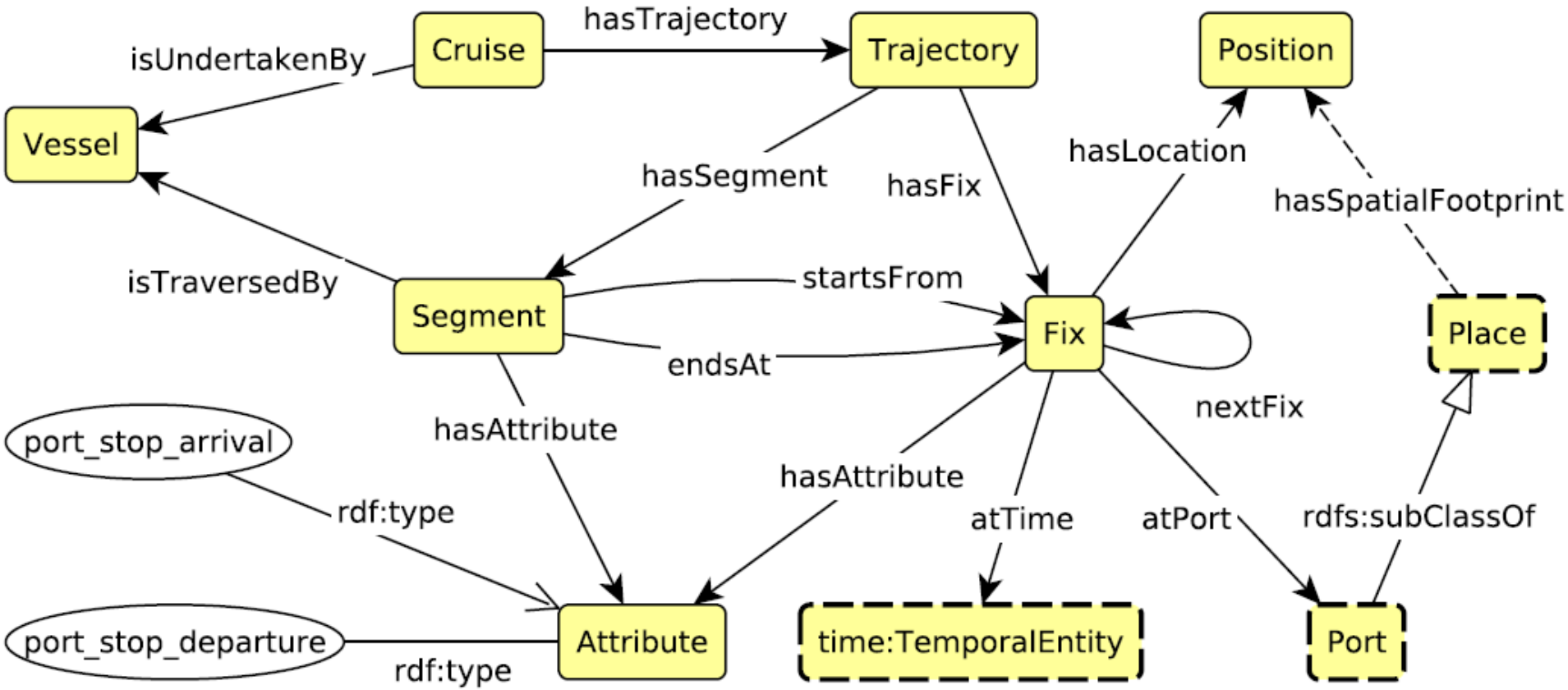
DaSe Lab



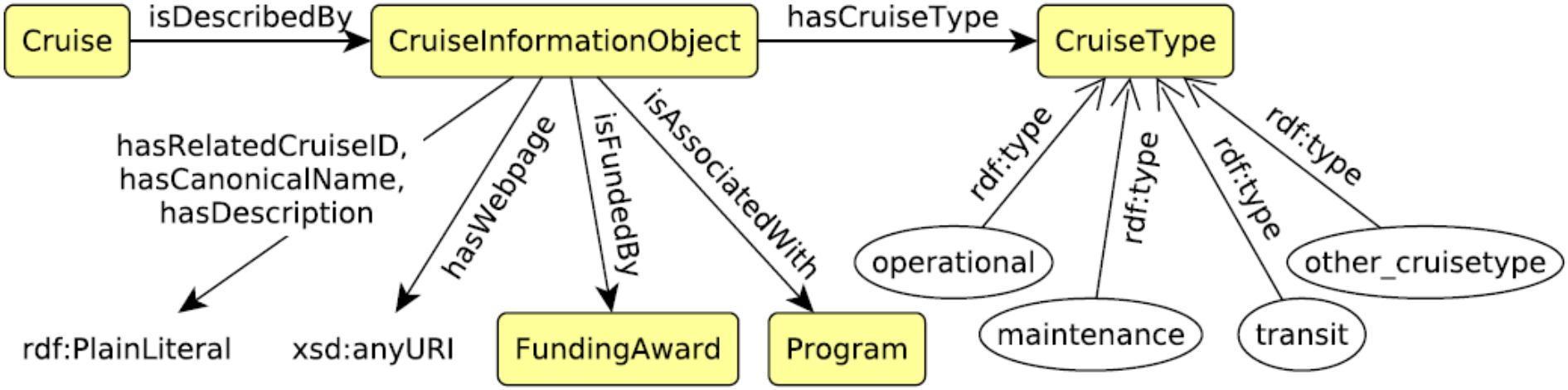
Roles (Cruise as Event)



Cruise Trajectories



Information Objects



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GeoLink (forthcoming)

DaSe Lab

We show that our approach meets the mentioned EarthCube challenges, by significantly extenting depth and breadth of topic coverage

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UCSB: Mark Schildhauer, Krzysztof Janowicz, Matt Jones, Yingjie Hu

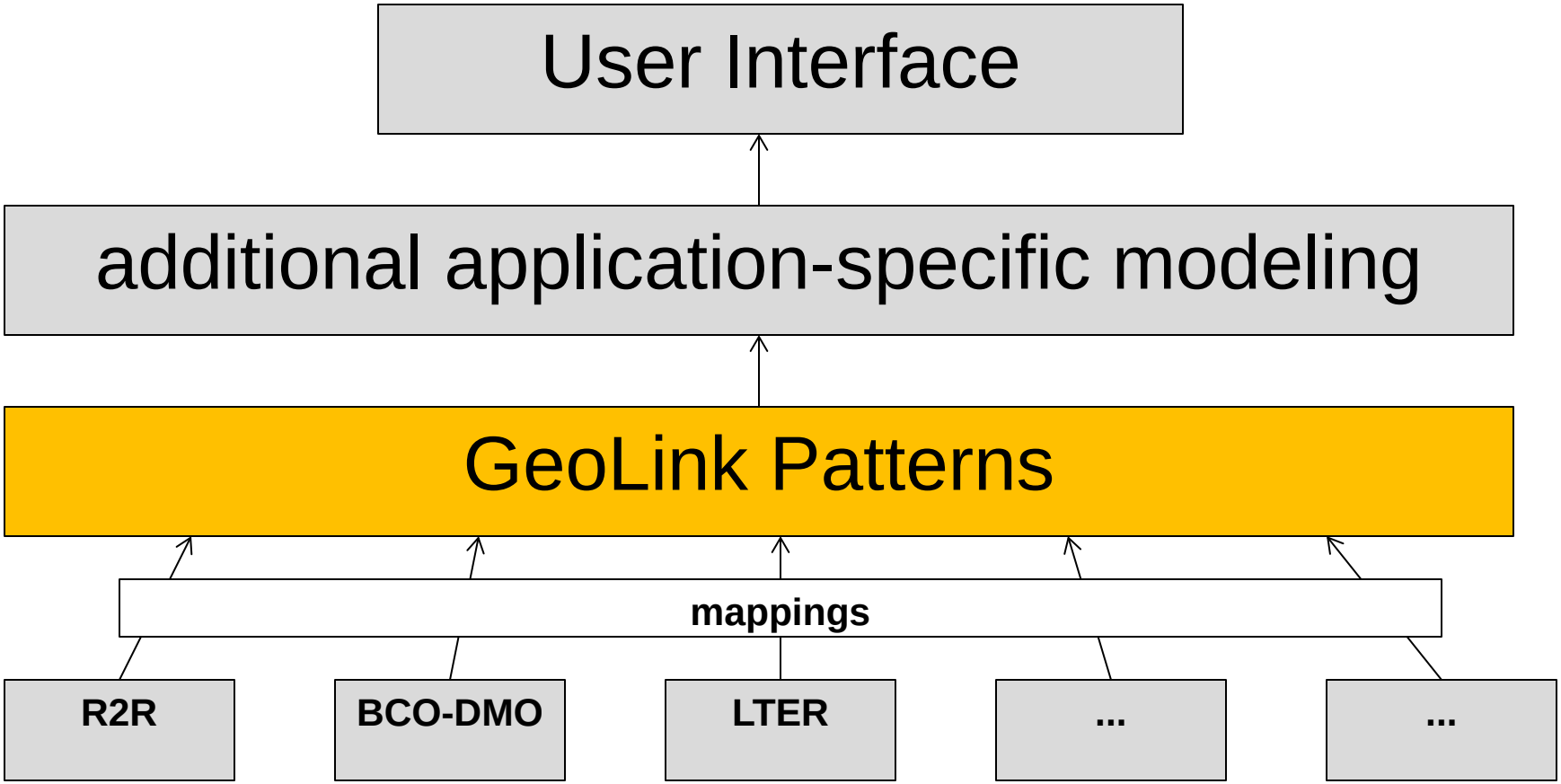
Ocean Leadership: Douglas Fils

Marymount Univ: Thomas Narock

WSU: Pascal Hitzler, Michelle Cheatham, Adila Krisnadhi

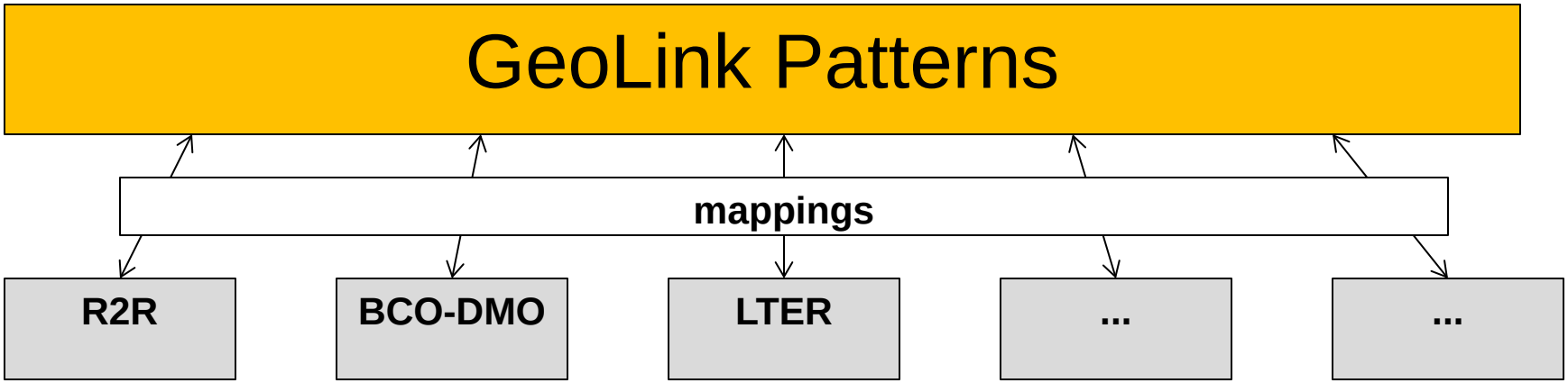
UMBC: Tim Finin

GeoLink setup



Patterns as interchange format

- **Aggregated data can be “pulled back” along the same mappings, if desired.**
- **Since the patterns are very generic, there is no loss of information by using them as interchange format.**



Thanks!

www.oceanlink.org

www.geo-link.org

OceanLink Collaborators

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Adam Shepherd, Woods Hole Oceanographic Institution
Peter Wiebe, Woods Hole Oceanographic Institution

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References

- Pascal Hitzler, Frank van Harmelen, A reasonable Semantic Web. Semantic Web 1 (1-2), 39-44, 2010.
- Prateek Jain, Pascal Hitzler, Peter Z. Yeh, Kunal Verma, Amit P. Sheth, Linked Data is Merely More Data. In: Dan Brickley, Vinay K. Chaudhri, Harry Halpin, Deborah McGuinness: Linked Data Meets Artificial Intelligence. Technical Report SS-10-07, AAAI Press, Menlo Park, California, 2010, pp. 82-86. ISBN 978-1-57735-461-1. Proceedings of LinkedAI at the AAAI Spring Symposium, March 2010.
- Pascal Hitzler, Krzysztof Janowicz, *What's Wrong with Linked Data?* http://blog.semantic-web.at/2012/08/09/whats-wrong-with-linked-data/ , August 2012.
- Krzysztof Janowicz, Pascal Hitzler, Benjamin Adams, Dave Kolas, Charles Vardeman II, Five Stars of Linked Data Vocabulary Use. Semantic Web 5 (3), 2014, 173-176.

References

- Pascal Hitzler, Krzysztof Janowicz, Linked Data, Big Data, and the 4th Paradigm. Semantic Web 4 (3), 2013, 233-235.
- Krzysztof Janowicz, Pascal Hitzler, The Digital Earth as Knowledge Engine. Semantic Web 3 (3), 213-221, 2012.
- Gary Berg-Cross, Isabel Cruz, Mike Dean, Tim Finin, Mark Gahegan, Pascal Hitzler, Hook Hua, Krzysztof Janowicz, Naicong Li, Philip Murphy, Bryce Nordgren, Leo Obrst, Mark Schildhauer, Amit Sheth, Krishna Sinha, Anne Thessen, Nancy Wiegand, Ilya Zaslavsky, Semantics and Ontologies for EarthCube. In: K. Janowicz, C. Kessler, T. Kauppinen, D. Kolas, S. Scheider (eds.), Workshop on GIScience in the Big Data Age, In conjunction with the seventh International Conference on Geographic Information Science 2012 (GIScience 2012), Columbus, Ohio, USA. September 18th, 2012. Proceedings.
- Krzysztof Janowicz, Pascal Hitzler, Thoughts on the Complex Relation Between Linked Data, Semantic Annotations, and Ontologies. In: Paul N. Bennett, Evgeniy Gabrilovich, Jaap Kamps, Jussi Karlgren (eds.), Proceedings of the 6th International Workshop on Exploiting Semantic Annotation in Information Retrieval, ESAIR 2013, ACM, San Francisco, 2013, pp. 41-44.

References

- Yingjie Hu, Krzysztof Janowicz, David Carral, Simon Scheider, Werner Kuhn, Gary Berg-Cross, Pascal Hitzler, Mike Dean, Dave Kolas, A Geo-Ontology Design Pattern for Semantic Trajectories. In: Thora Tenbrink, John G. Stell, Antony Galton, Zena Wood (Eds.): Spatial Information Theory - 11th International Conference, COSIT 2013, Scarborough, UK, September 2-6, 2013. Proceedings. Lecture Notes in Computer Science Vol. 8116, Springer, 2013, pp. 438-456.
- Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, *Foundations of Semantic Web Technologies*. Chapman and Hall/CRC Press, 2009.