Ontological System for Context Artifacts and Resources

Thomas Huang, Nga T. Quach, Rudranarayan M. Mukherjee, Ph.D.

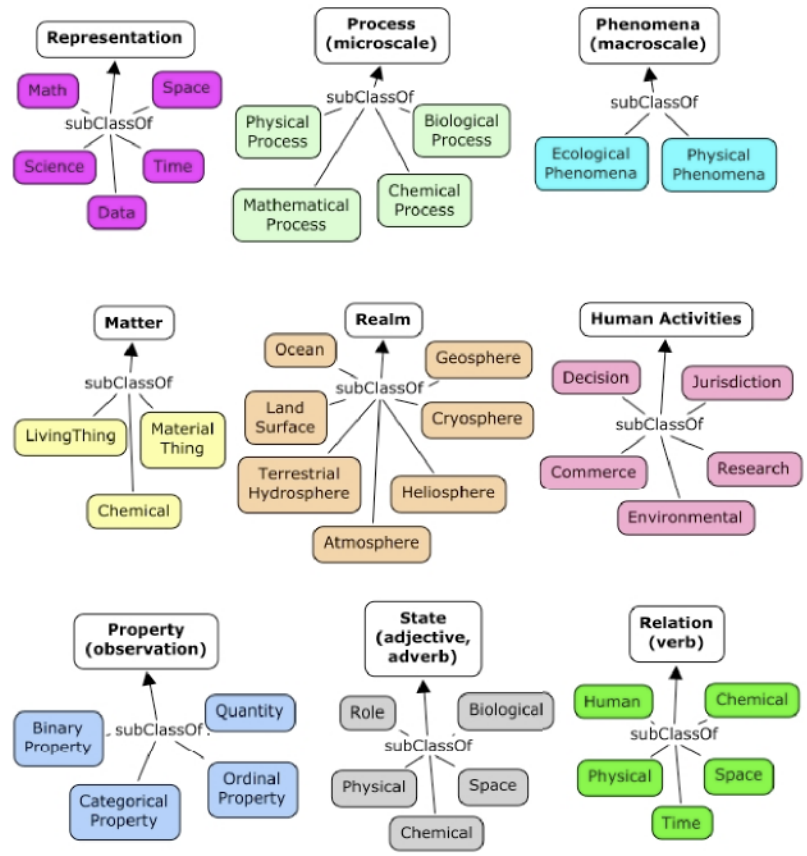
Jet Propulsion Laboratory, California Institute of Technology

Agenda

- Semantic Web for Earth and Environmental Terminology (SWEET)
- Adaptive Vehicle Make (AVM)
- Component, Context and Manufacturing Model Library (C2M2L)
- Information Modeling
- Ontological System for Context Artifacts and Resources (OSCAR)

Semantic Web for Earth and Environmental Terminology

- Enables scalable classification of Earth system science concepts
  - Expanded to Space science
- Promotes reuse – import, expand, and specialization
- Initially created (by Dr. Rober Raskin, JPL) to capture relationships between GCMD keywrods

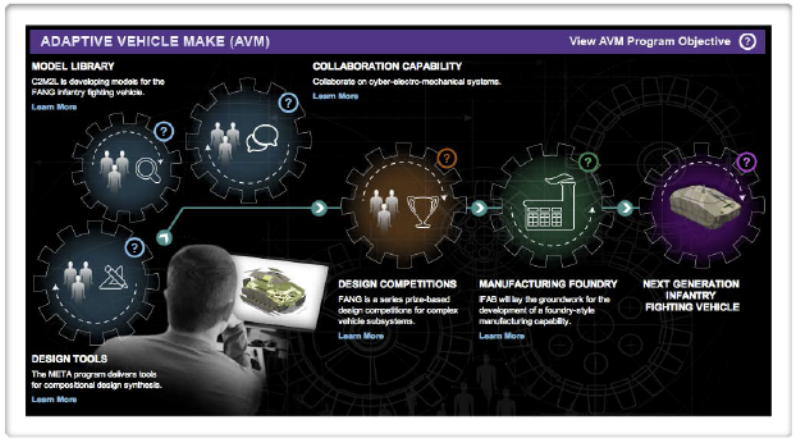


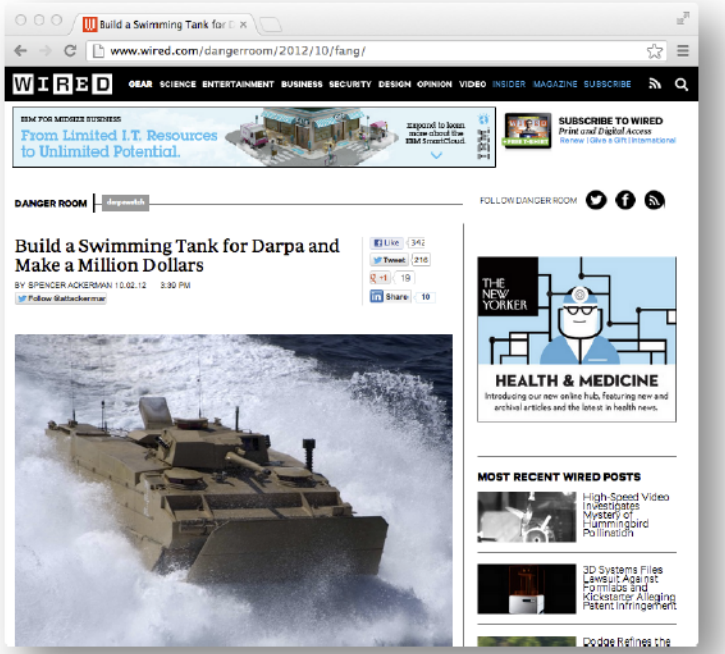
Some SWEET Users

- ESML - Earth Science Markup Language
- ESIP - Earth Science Information Partner Federation
- GEON - Geosciences Network
- GENESIS - Global Environmental & Earth Science Information System
- IRI - International Research Institute (Columbia)
- LEAD - Linked Environments for Atmospheric Discovery
- MMI - Marine Metadata Initiative
- NOESIS
- PEaCE - Pacific Ecoinformatics and Computational Ecology
- SESDI - Semantically Enabled Science Data Integration
- VSTO - Virtual Solar-Terrestrial Observatory
- **AVM - Adaptive Vehicle Make**

Adaptive Vehicle Make (AVM)

- A portfolio of programs overseen by DARPA
- Revolutionary approaches to the design, verification, and manufacturing of complex defense systems and vehicles
- C2M2L (pronounced "camel") – Component, Context, and Manufacturing Model Library
  - Develop domain-specific models needed the design, verification, and fabrication
  - Environmental Context Model Library
    - Design and development an ontological system to capture and serve environmental models and data
    - To be used to serve the Fast Adaptable Next-Generation Ground Vehicle (FANG GV) programs





http://www.wired.com/dangerroom/2012/10/fang/

FANG – Fast, Adaptable, Next-Generation Ground Vehicle - Programmatic Overview

DARPA
RICARDO

Mobility/Drivetrain Challenge

SCOPE
- Vehicle drivetrain to meet IFV speed, efficiency, terrain, reliability objective
- Available model library to include:
  - Hybrid-electric systems
  - Novel ground interfaces

PARTICIPANT POOL
- Global

INCENTIVE
- Prize $1M for winning design
- Winner(s) judged based on multi-objective weighting function

DESIGN AGGREGATION
- Use of META metalanguage required
- Use of vehicleforge.mil optional

BUILD APPROACH
- iFAB foundry build for top design(s)

Chassis/Integrated Survivability Challenge

SCOPE
- Chassis and armor design to meet principal IFV-like survivability objectives
- Available model library to include:
  - Advanced armor concepts
  - Novel configs (monocoque, v-hulls)

PARTICIPANT POOL
- Global

INCENTIVE
- Prize $1M for winning design
- Winner(s) judged based on multi-objective weighting function

DESIGN AGGREGATION
- Use of META metalanguage required
- Use of vehicleforge.mil optional

BUILD APPROACH
- iFAB foundry build for top design(s)

Total Platform Challenge

SCOPE
- Complete IFV based on core Army objectives and distilled requirements

PARTICIPANT POOL
- Global

INCENTIVE
- Prize $2M
- Winner judged based on satisfaction of constraints and multi-attribute preference function (i.e., entirely objective approach)

DESIGN AGGREGATION
- Use of META metalanguage required
- Use of vehicleforge.mil optional

BUILD APPROACH
- iFAB foundry build for top design(s)

APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED.

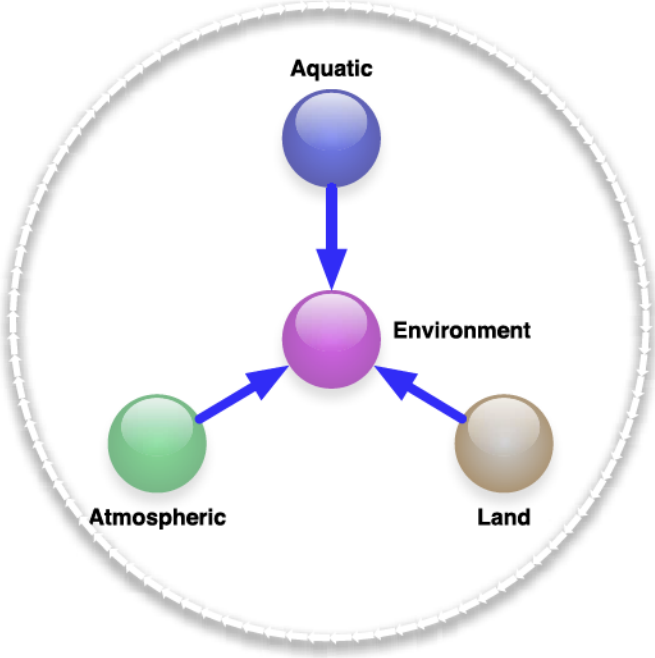
17

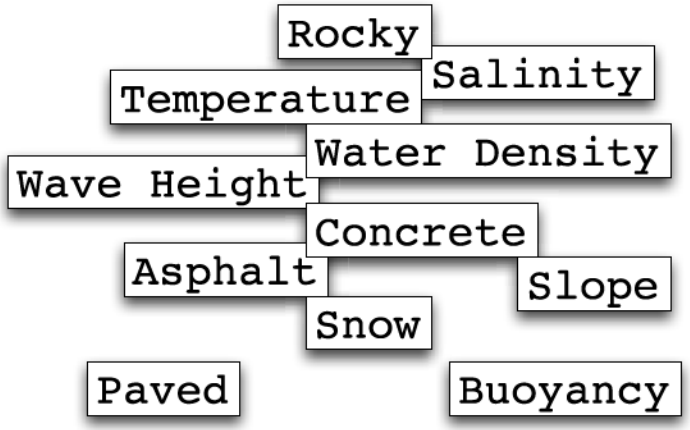
Task 1	Task 2	Task 3	Task 4	Task 5
Requirements Development	Challenge Execution	Support iFAB Build	Test and Evaluation	Curation and Support

FANG

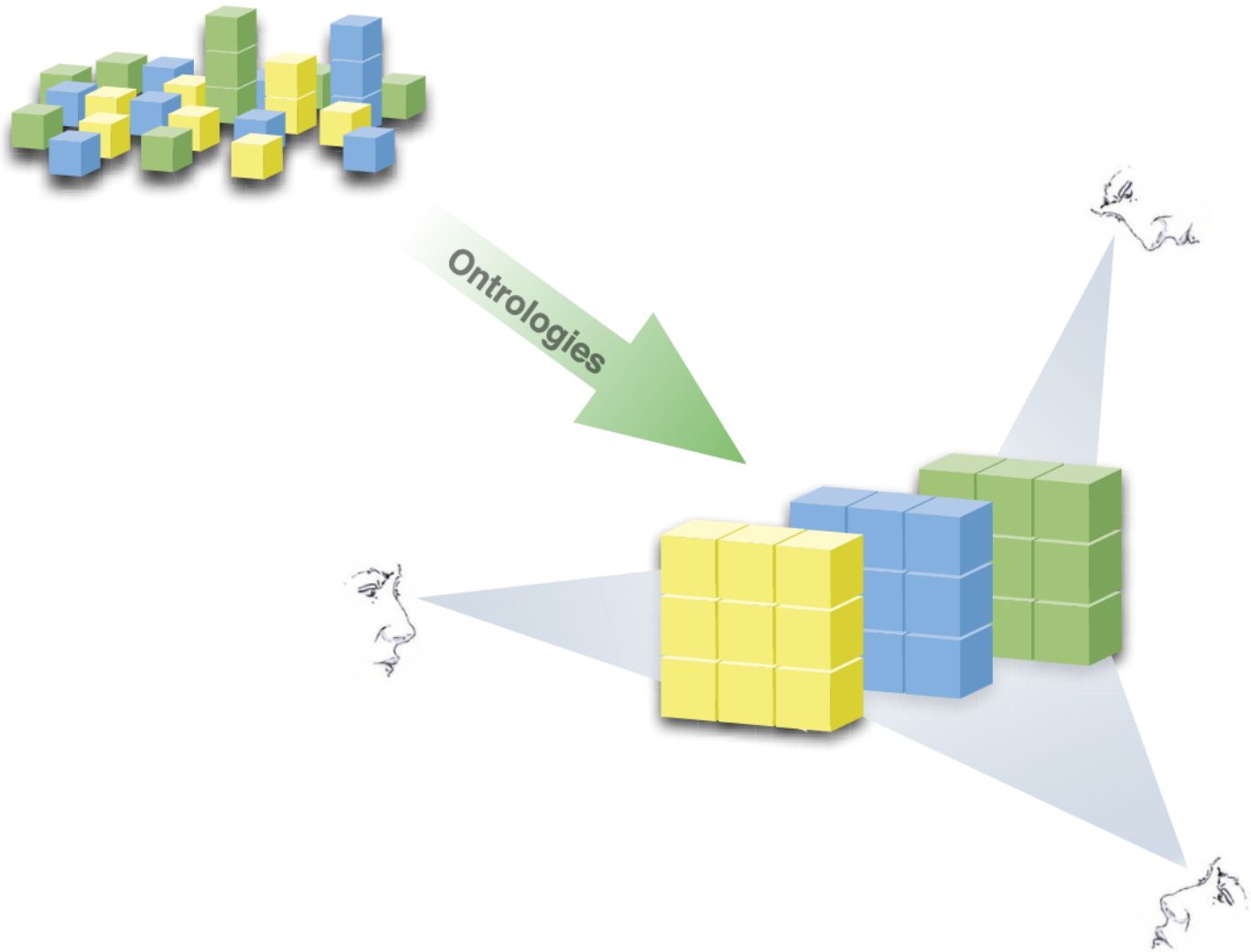
Context Model Library Goals

- Web Application
- RESTful Interface
- Provide knowledge-based linkage between environmental context and models
- Provide knowledge-based linkage between requirements and environmental context
- Provide guided discovery of associated models to be used in simulation
- Provide CRUD archival functionalities

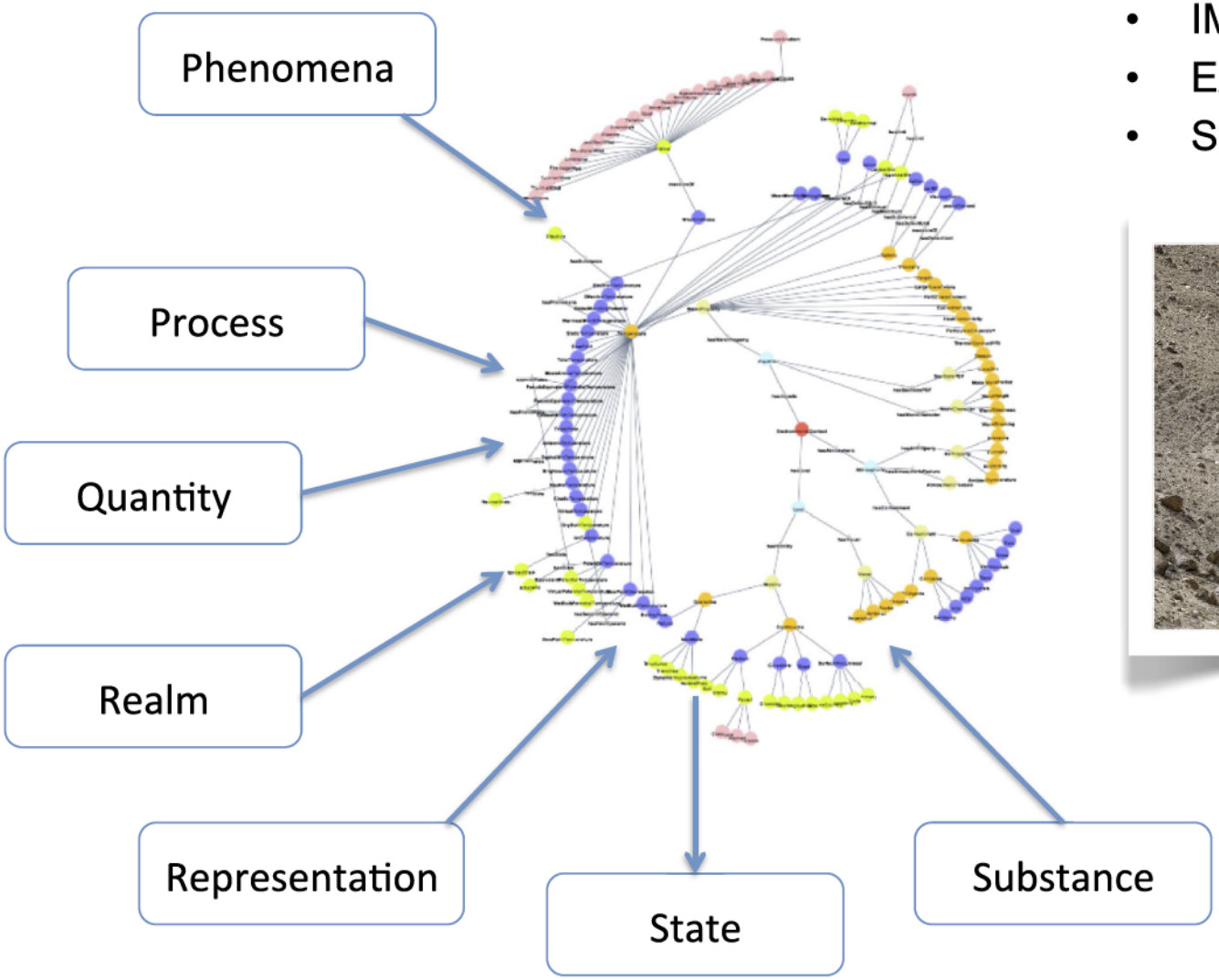




Multifaceted Approach to Data



Integration with SWEET



- IMPORT
- EXPAND
- SPECIALIZATION

Context Models

Land

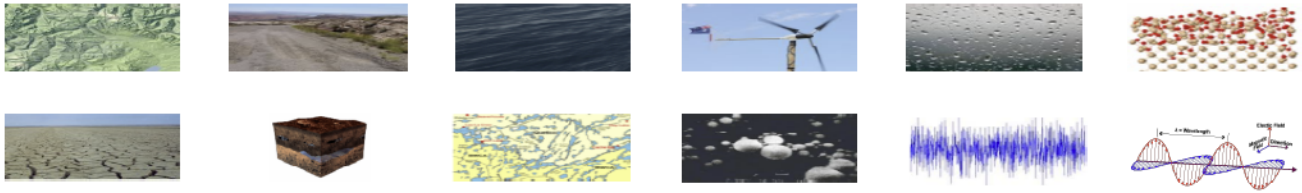
- **Gross Terrain Features** – Simple distribution for sampling likelihood of terrain slops (PDF)
- **Fine Terrain Features** – Method for modeling spatial frequencies for power spectral densities (PSD)

Aquatic

- **Wave Energy Statistics** – Simple approach for generating PSD's, pulling data from real-time stations
- **Lake Size Statistics** – Maximum entropy estimation for lake size distributions for regions (PDF)

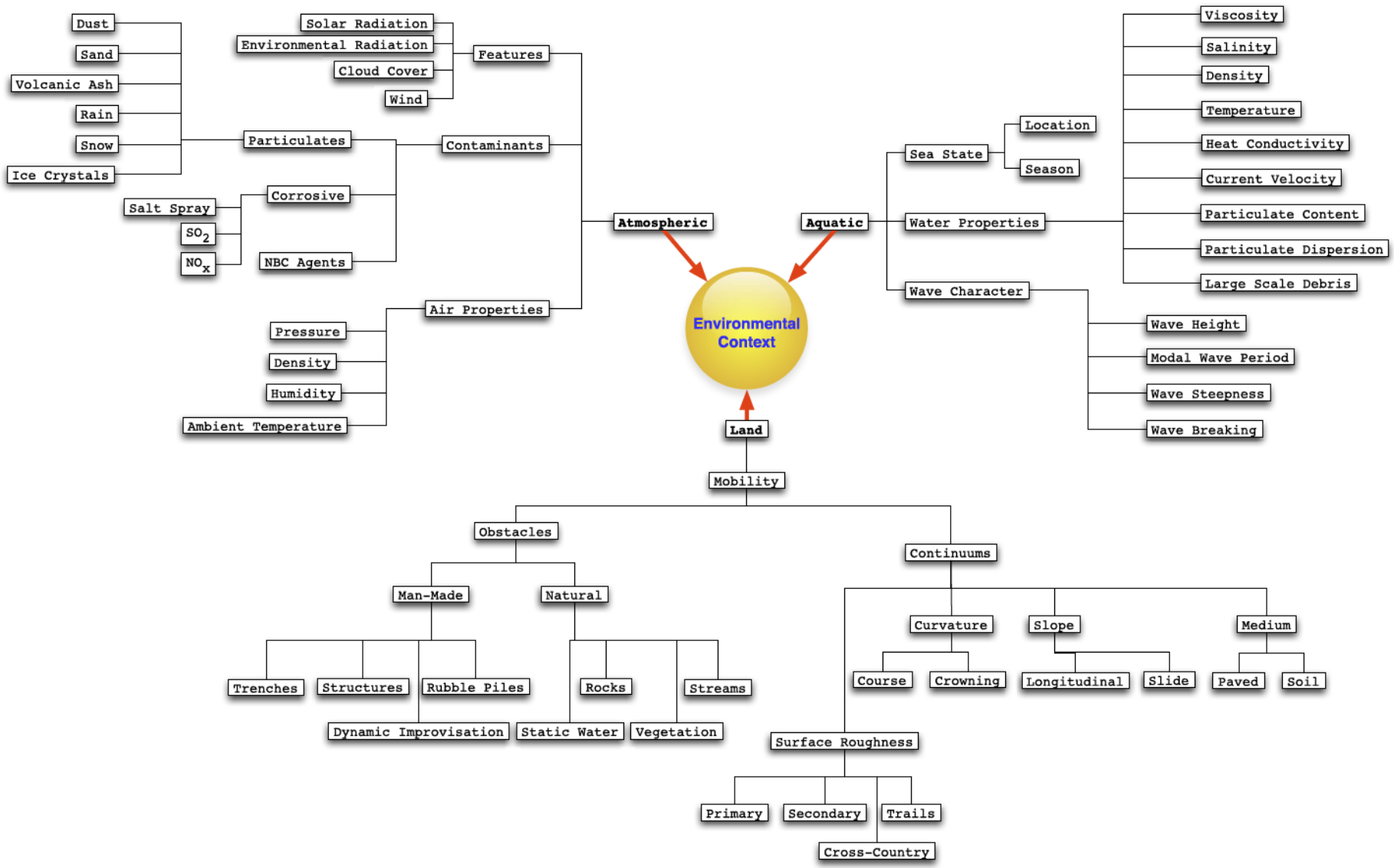
Atmospheric

- **Wind Energy Statistics** – General results for modeling wind energy distribution and autocorrelations for persistence (PDF)
- **Rainfall Statistics** – General model for rainfall distributions within storms using composite process (PSD)
- **Corrosion and Oxidation** – Model of oxidation and corrosion growth which improves on the Deal-Grove formulation (Growth Curves)
- **Thermal Dispersion** – Simplification of thermal diffusion model to account for disorder and variability in the media. (Growth Curves)
- **Particle Size Statistics** – General method for modeling size distribution of particulates such as ash and ice crystals (PDF)
- **Clutter Modeling** – Maximum entropy models for E-M signals and noise (PDF)



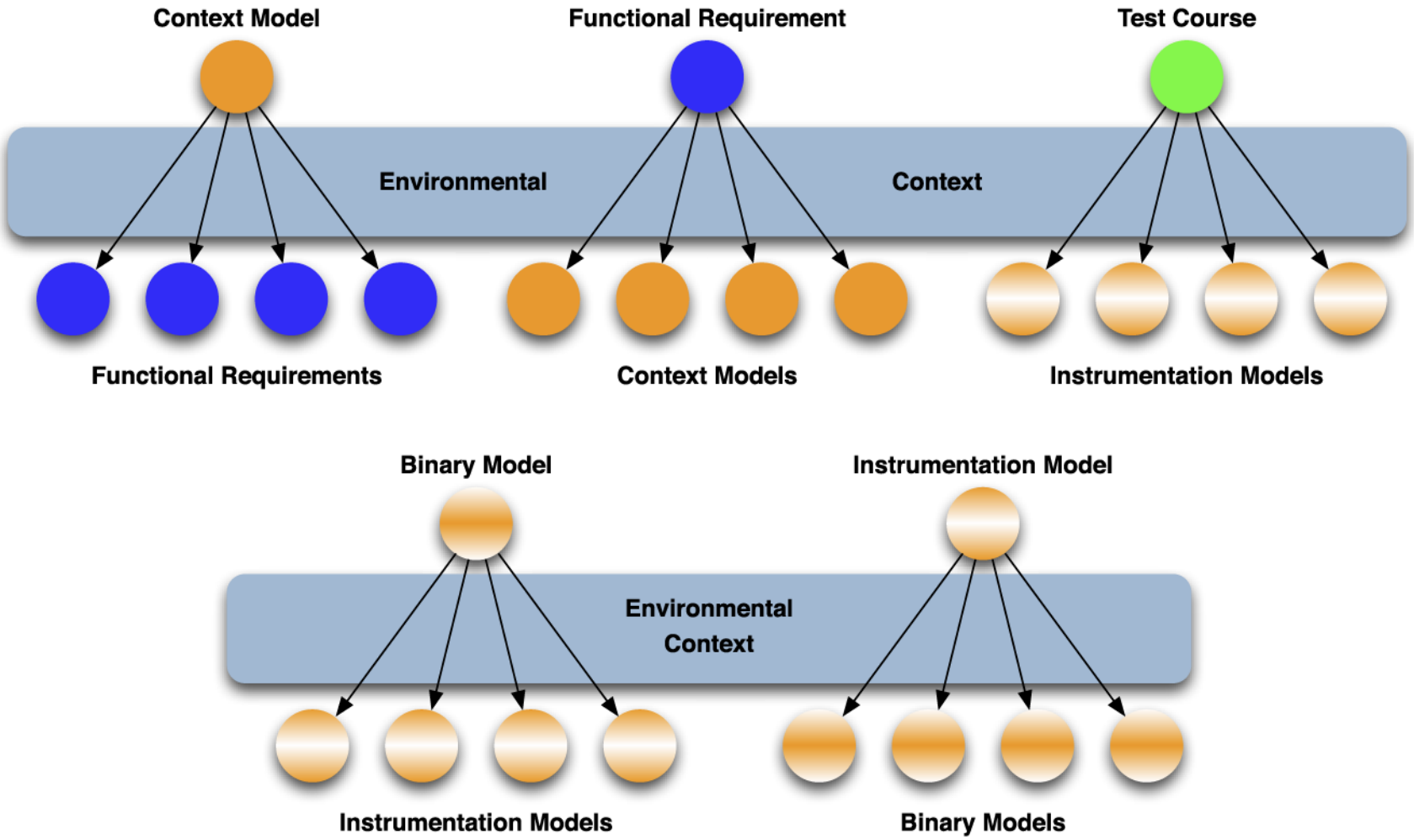
PDF – Probability Density Function
PSD – Power Spectral Density

Top-Level Model Organization

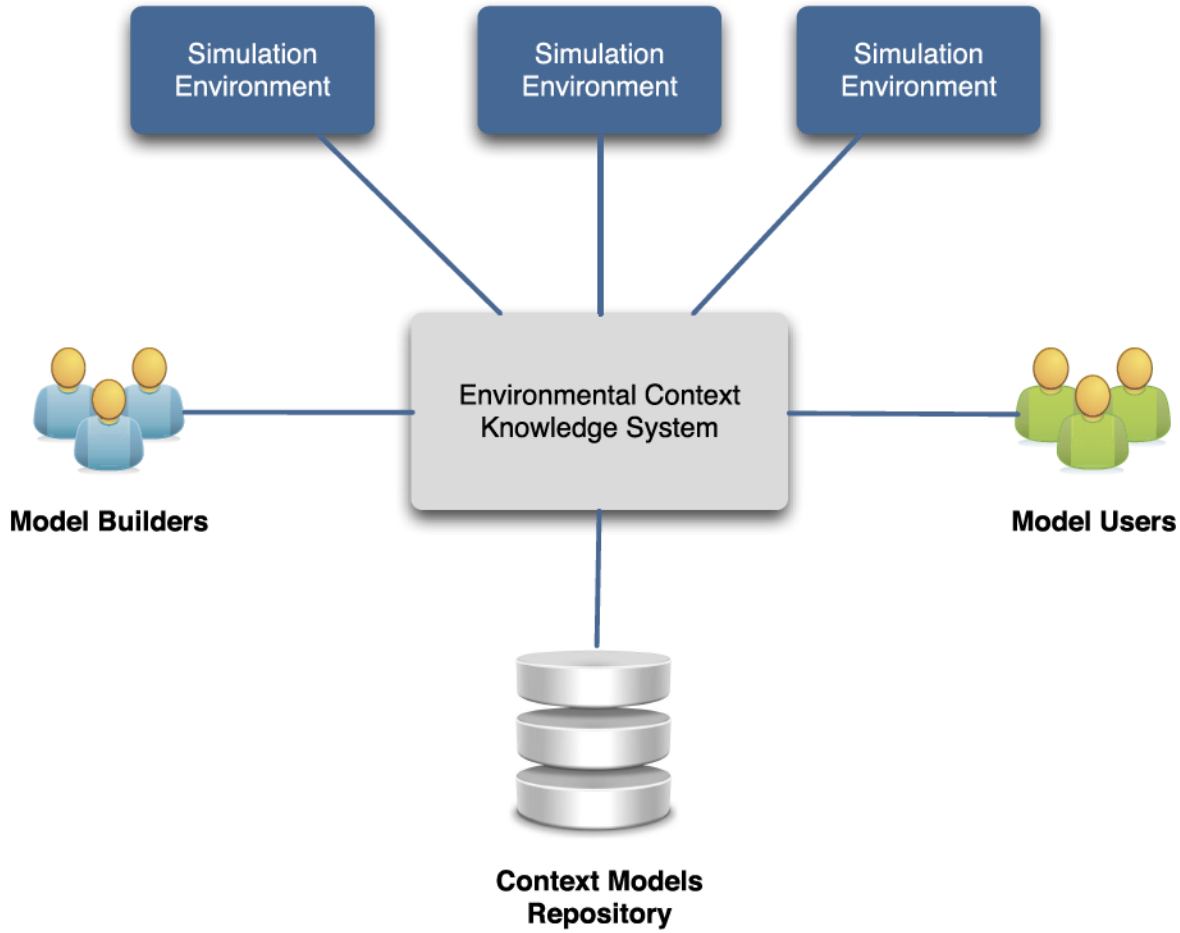


Linked By Context

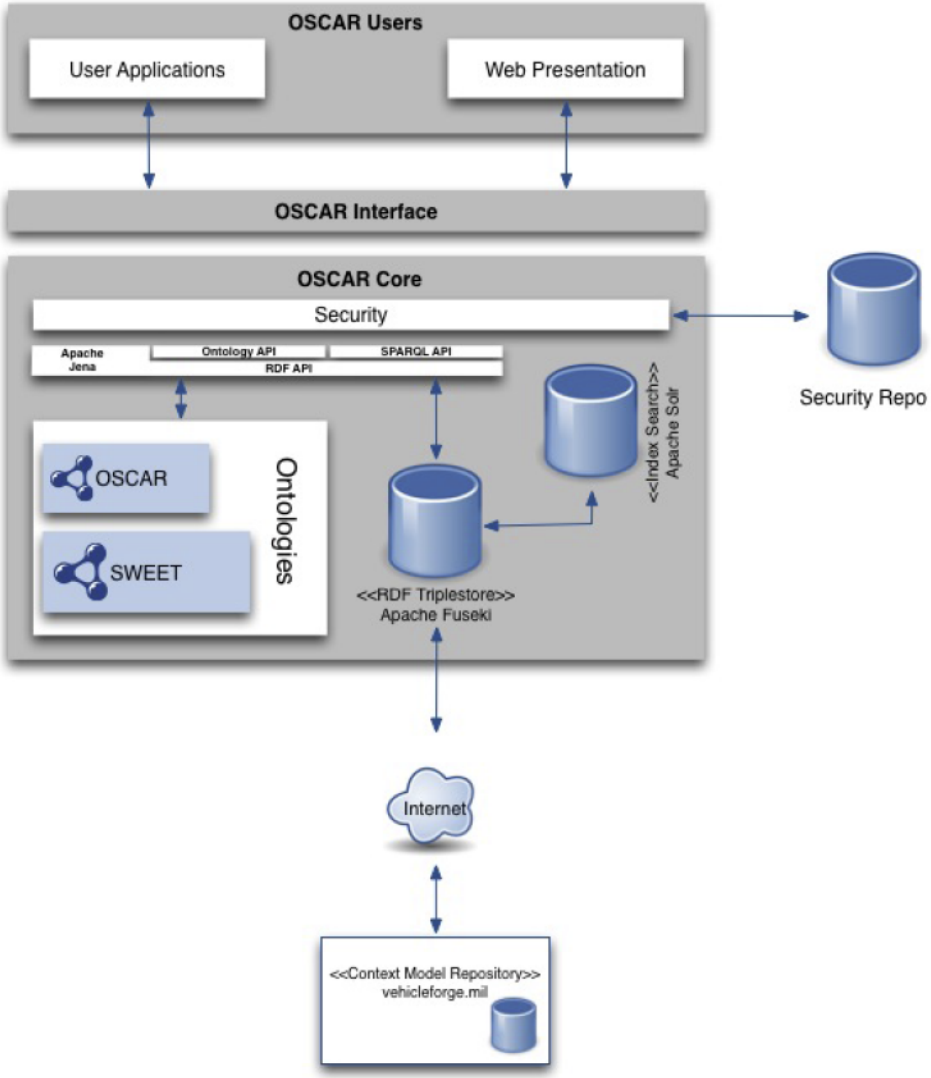
Complex Relationships



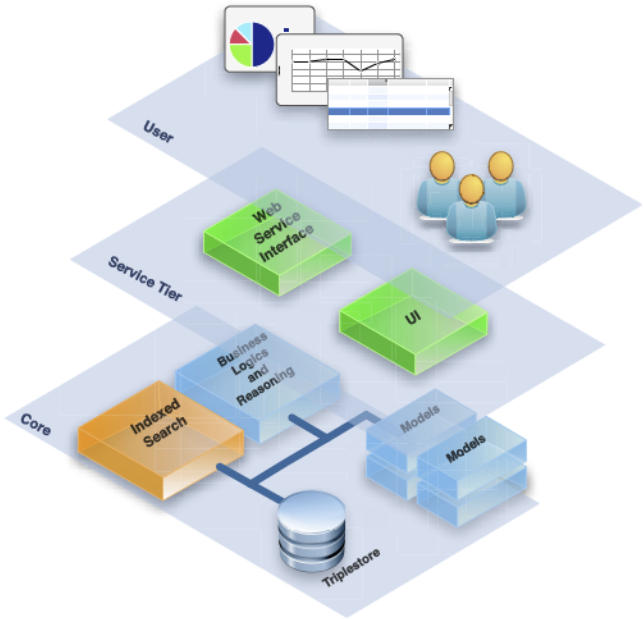
Environmental Context Knowledge System



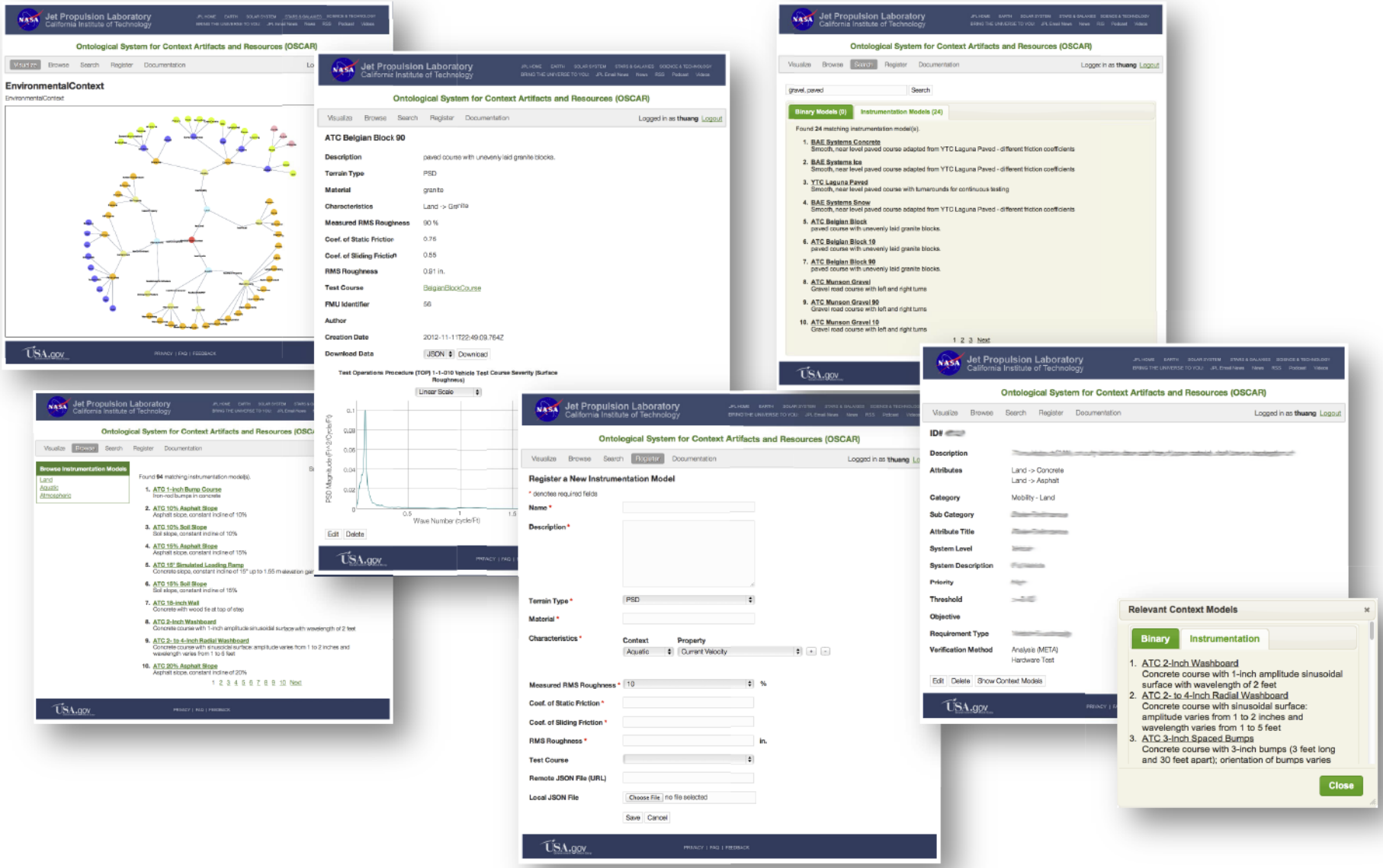
Ontological System for Context Artifacts and Resources (OSCAR)



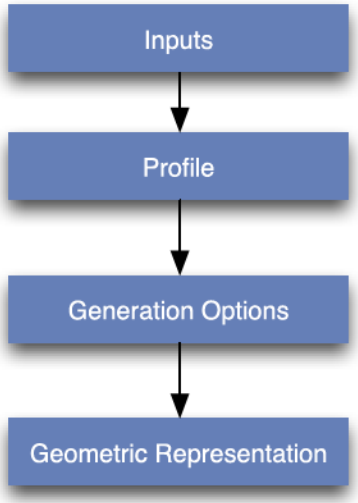
- A semantic web based system
- Leverages previous successful JPL data service projects
- RESTful service architecture
- Ontology based on SWEET and adapted to specific mobility contexts for C2M2L
- Create, Read, Update, and Delete (CRUD) context model artifacts
- Indexed and guided searches

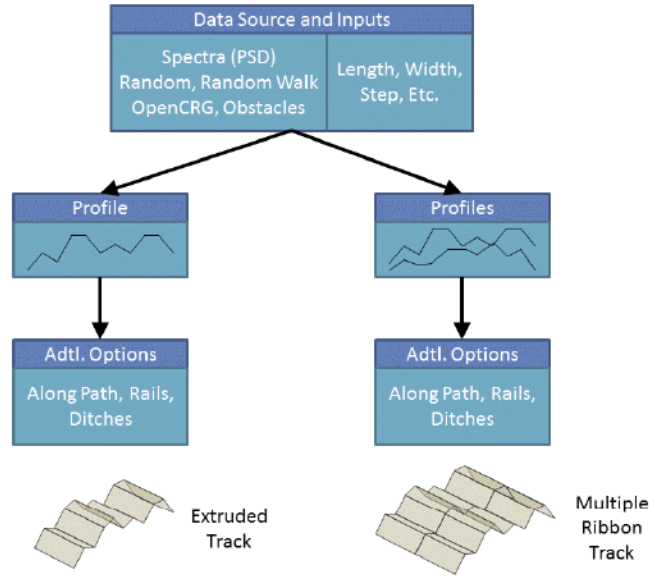


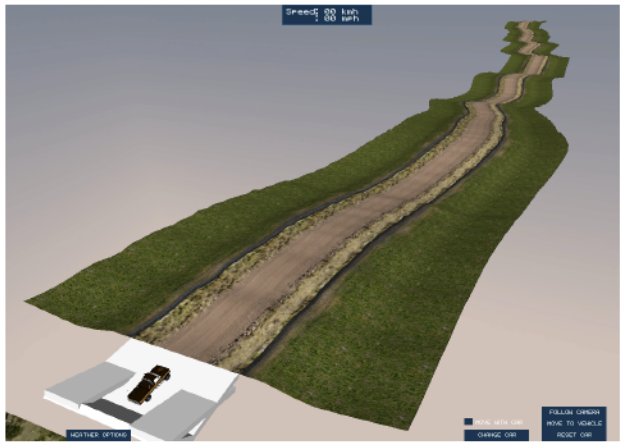
OSCAR In Action



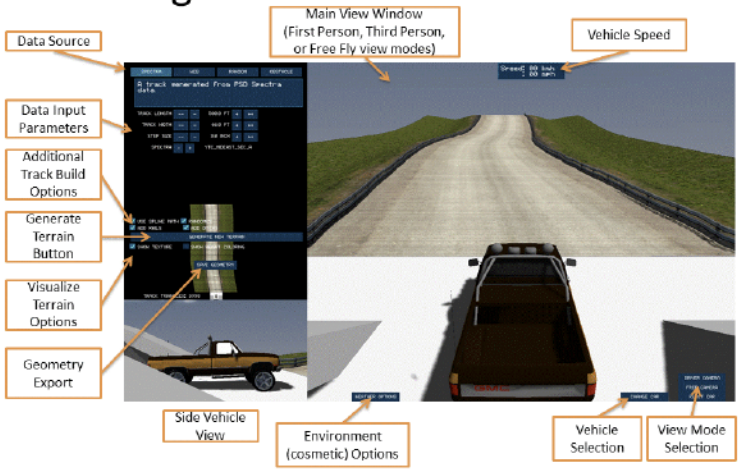
Application of Context Models
3D Track Generation







Program Interface Overview



References

- SWEET Ontology

  http://sweet.jpl.nasa.gov

- ESIP Federation Semantic Web Cluster

  http://wiki.esipfed.org/index.php/Semantic_Web

Special Thanks to BAE Systems Team

Dr. Daniel J. Challou

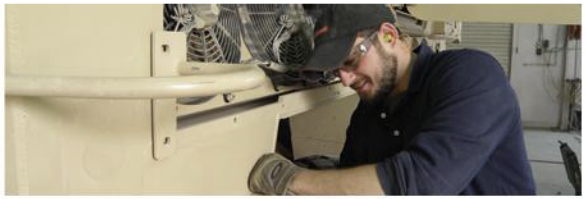
Dr. Paul R. Pukite

Chris J. Wentland

David St. Louis

Roger K. Poiston

Jeremy D. Ames



Thomas.Huang@jpl.nasa.gov
Nga.T.Chung@jpl.nasa.gov
Rudranarayan.M.Mukherjee@jpl.nasa.gov