POLARIS

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POLARIS

(Planning and Operations Language for Agent-based Regional Integrated Simulation)

- Mandates from FHWA:
  1. Model Traffic Control Centers and other ITS Systems
  2. Enhance Interoperability among Existing Tools

- Core Goals and Philosophies of the POLARIS Effort:
  - Develop Transportation Modeling Standards and Protocols
  - Create an Open Source Model Development Environment and “Concept” Repository
  - Seek Out Opinions from and Actively Listen to the Transportation Community
  - Separate Model Functionality from Computational Logistics
  - Offer Tools and Structure without Inhibiting Developer Flexibility, Code Modularity, or Performance
  - Foster Cooperative Model Development Among Many Diverse Groups
Confluent Trends Shaping Transportation Modeling

- Existing models previously considered unrelated have realized the need to interoperate with one another to answer more complex questions.

- Computational capabilities have crossed a threshold such that a transportation simulation can model large scale high fidelity systems in a reasonable time frame.

- Significant advances in data collection, intelligent transportation system technologies, and new transportation modeling theories beg for inclusion in these more comprehensive models.

- Matured research is readily available in highly applicable fields such as: artificial intelligence, agent based modeling, the computational sciences, and video game engine design.
Common Conceptual Threads in Transportation Models

- Differing descriptions of attributes, behaviors, and conceptual organization of the same real world transportation objects and agents: travelers, traffic signals, vehicles, roadways, etc...

- Discrete event simulation evolves the multi-agent system’s behavior to more cost effectively test the outcome of practical decisions and develop intuition about real world behavior

- Iteration routines calibrate model parameters to seek optimal and/or real world solutions

- Conceptual disaggregation or aggregation of the real world objects and their behaviors are applied in order to mold and re-scope the model to answer specific questions
Who is the POLARIS User Community?

- **Transportation Researchers**
  - Test and validate theories in an integrated environment quickly and easily
  - Refine and expand the transportation ontological model and add building blocks to the transportation functional and object libraries

- **Integrated Transportation Model Developers**
  - Weave together model components developed by researchers
  - Bring in new technologies and connect with existing models of interest

- **Transportation Modelers**
  - Apply models created by the Integrated Model Developers
  - Solve real world problems using POLARIS
POLARIS Component View

- **COR**: Data Layout, Memory Management, and Parallel Execution Scheduling
- **TOM**: Ontological Representation of Transportation System Components
- **TFL**: Description of Transportation Object Functionality
- **TOL**: General Purpose Pre-Configured Transportation System Building Blocks
- **TSF**: Sandbox for User-Defined Components
- **EXM**: Simulation Initialization and Execution
Transportation Ontology Model

Element

Entity

Directable Agent
- Some Destination Chooser

Routable Agent
- Some Route Chooser

Route Chooser
- Get Route ( )
  - Basic
  - Network Path

Fast Route Chooser
- Get Route ( )
  - Basic
  - Network Path
  - Fast
  - Arrival Variance

Alternative Dest. Chooser

Faculty

Destination Chooser
- Get Dest. ( )
  - Basic
  - Network Dest.

Fast Destination Chooser
- Get Dest. ( )
  - Basic
  - Network Dest.
  - Fast
  - Suitability

Robust Dest. Chooser
- Get Dest. ( )
  - Basic
  - Network Dest.
  - Robust
  - Alternative Dest.
The POLARIS Component Construction Process

**Concepts:** Standardized Data and Function Accessors

**Functional:** Function Implementation

**Transmutation:** Data or Function Request Resolution

**Known External Types:** Named Typedef

**Data Layout:** Variable Type and Location

**Transportation Simulation Framework (TSF):**
- Inherit Existing Concepts of Interest
- Inherit Functional and Transmutation Behaviors of Interest
- Inherit Existing Data Layout and Known External Types of Interest
- Define/Overload Data Layout and Known External Types of this Component
- Describe/Overload Functional and Transmutation Behavior of this Component
- Describe/Overload Concepts of Interest to this Component
- Inherit Existing Concepts of Interest
Specific Developer Tools Provided by POLARIS

- High Performance Memory Manager
- Automated Data Placement Service
- Resource Constrained Task Scheduling
- Adaptive Dependency-Aware Task Execution Engine
- Automated Thread Parallelization
- Compile Time Polymorphism
- Thread Safe Data Structures
The Long View of the POLARIS Effort

- **Initial Phase:** *Design in Full, Implement in Part*
  - Proof of Concept Prototype
  - Integrated Model Case Study
  - Interoperable Model Case Study
  - Limited Release

- **Follow Up Phase:** *Clean Up, Implement in Full*
  - Focus on Usability and User Interface
  - Improve Core Algorithms
  - Stress Testing, Beta Testing, and Full Release

- **Final Phase:** *Technology Transfer, Community Adoption*
  - Create User Interaction and Collaboration Faculties
  - Training Courses, Presentations, and Research Papers
  - Foster and Support Project Growth