A Modeling Framework for Synchronizing Global and Local Situation Awareness

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Agenda

- Global and Local Situational Awareness
- Supporting Technologies
  - MEBN/Probabilistic Ontologies
  - DEVS/Pragmatic Frames
- The COP Framework

Common Operational Picture

- Provides timely and accurate information for shared SAW across multiple commands

- Hard to obtain and maintain
  - Distributed nature of the enterprise
  - Heterogeneity of its distributed components
  - Lack of interoperability of its communication systems.
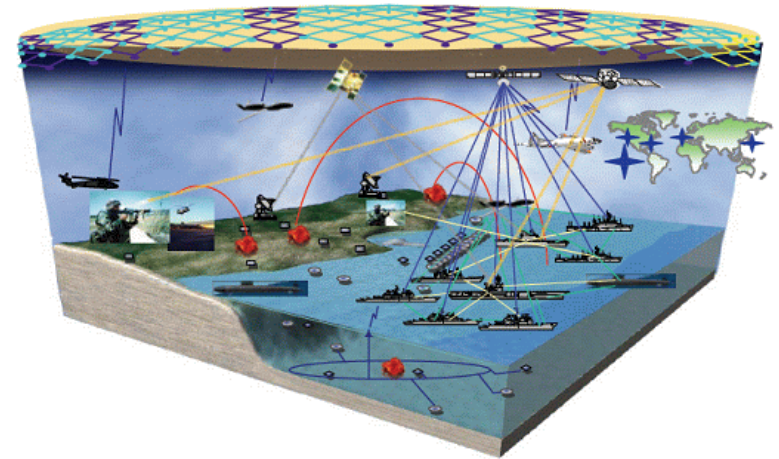
Complexity in COP

- The underlying structure / behavior dependencies force local decisions to have global impact breaking neat design patterns

- Environments impose a plethora of special situations and an exponentially growing number of parameter combinations

- Consequences include evident signs of complexity explosion, such as:
  - Proliferation of incompatible variations on same themes
  - Ubiquitous heterogeneity
 - Vertical integration (Stove piping).
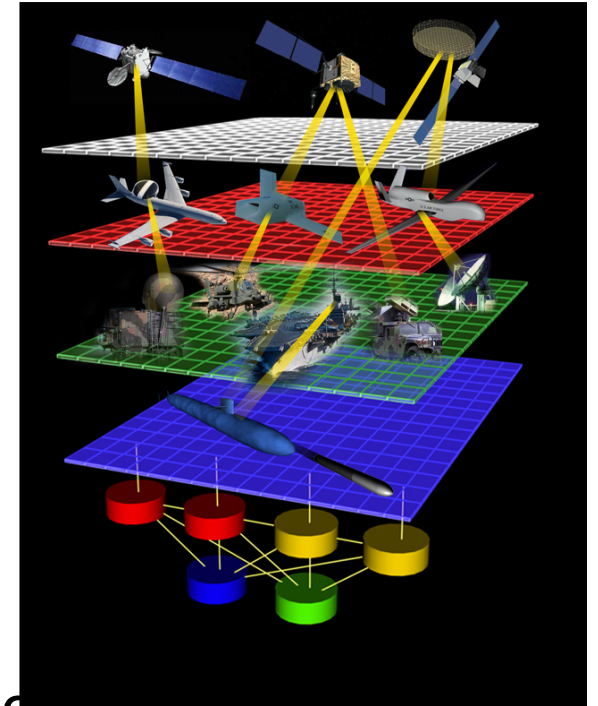
Local Models

- Have direct sensor- based awareness of their local situations

- Maintain this situation as a state of a model, which can then be used to respond queries of interest

- Have a more detailed representations of their (limited) environments

- Are oriented to addressing questions of local interest

The Global Concentrator

- Gathers information from distributed systems to create a COP

- Maintains the COP as a state of a model, which can then be used to respond queries about the domain being modeled.

- Projects this state into the future in support of evaluation of plans, interventions, and actions
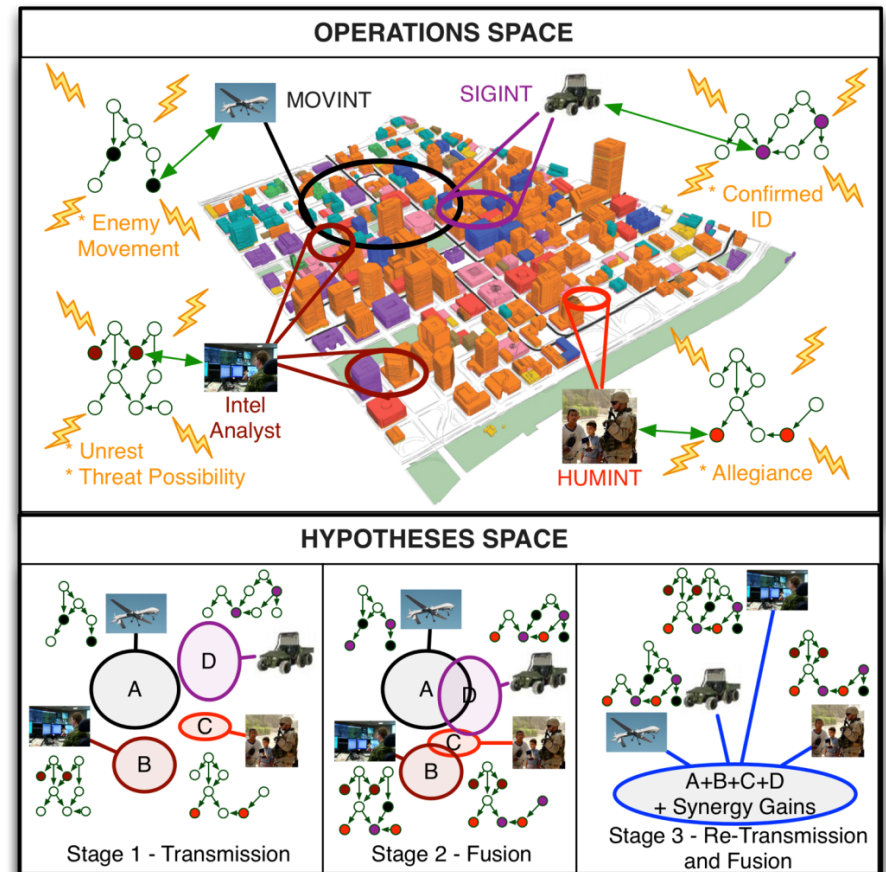
Systems of Systems

- Collections of disparate systems federated to satisfy new requirements

- Each participating system:
  - May itself be large and complex.
  - Is efficient at achieving its own specialized requirements
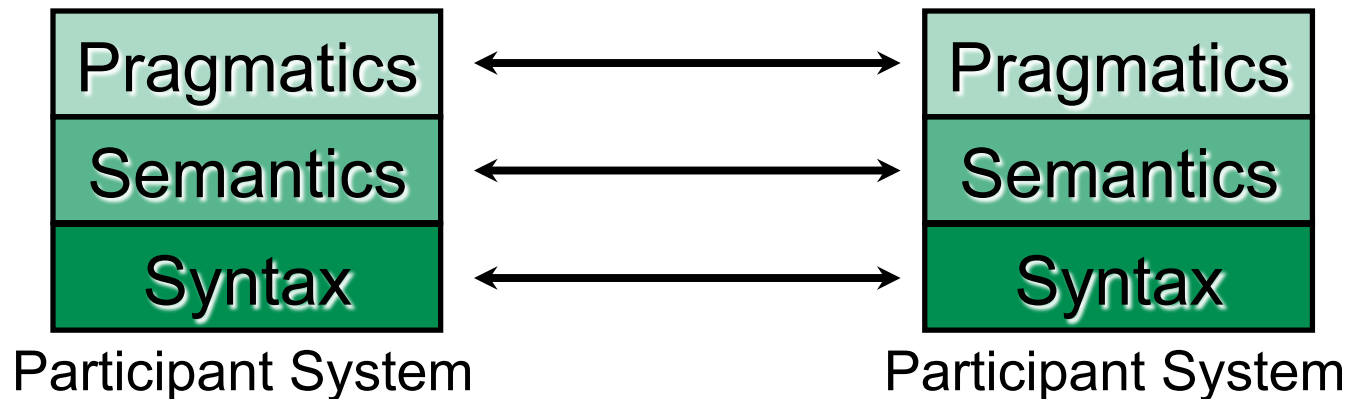 - Often adhere to idiosyncratic formalisms and development approaches

Challenges for a SoS Framework

- How can global and local models be synchronized to maintain consistent states despite their differences in scope and purpose?

- How can global and local models be projected forward from their current states in a manner that does the best prediction possible while qualifying such predictions with meaningful uncertainty metrics?

Linguistic Levels of Information Exchange and Interoperability

Pragmatics	←→	Pragmatics
Semantics	←→	Semantics
Syntax	←→	Syntax

Participant System   Participant System

| Linguistic Level of Information Exchange	A System of Systems interoperates at this level if :	
Pragmatic – how information in messages is used	The receiver re-acts to the message in a manner that the sender intends (assuming non-hostility in the collaboration).	*Which format?*
Semantic – shared understanding of meaning of messages	The receiver assigns the same meaning as the sender did to the message.	*What is this about?*
Syntactic –common rules governing composition and transmitting of messages	The consumer is able to receive and parse the sender's message	*How can/should I respond?*

Probabilistic Ontologies

- Provide a principled means to represent a domain with uncertainty.

- Written in PR-OWL language, which is based on MEBN logic.

- Can support COP by providing the semantics "glueing" the local models.
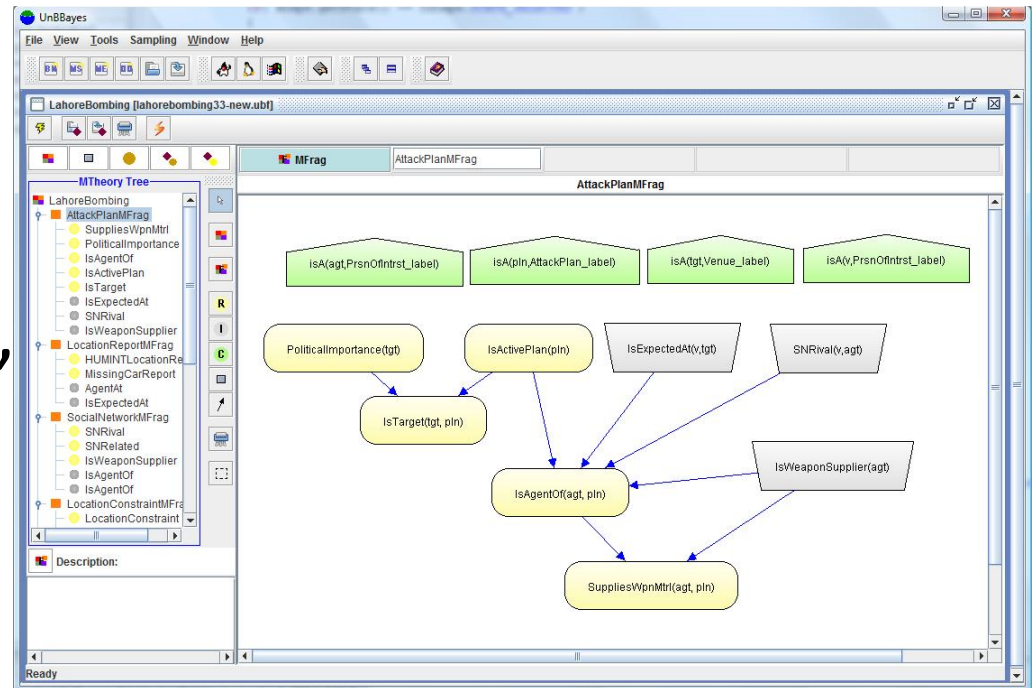
PR-OWL

- Upper ontology written in W3C recommended OWL ontology language.

- Represents probabilistic knowledge in XML-compliant format.

- Open-source, freely available solution for representing knowledge and associated uncertainty.

- Reasoner under development in collaboration with University of Brasilia
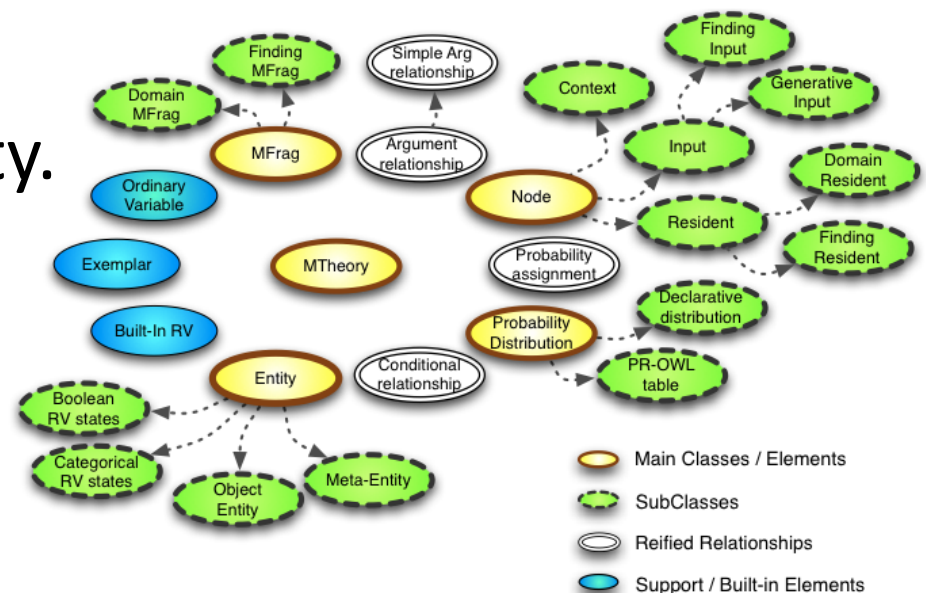
# DEVS-Based Modeling & Simulation
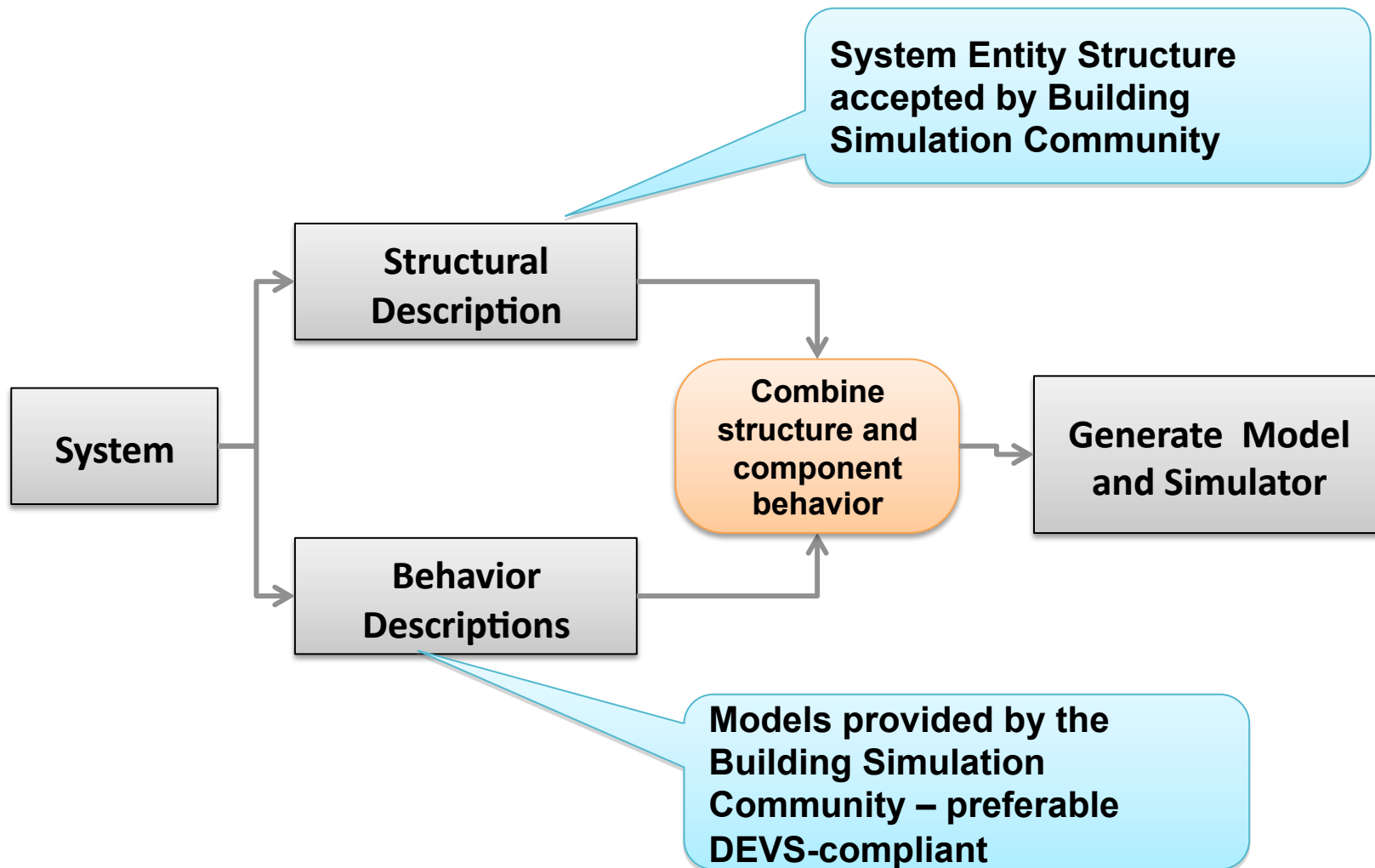
SES Formal Framework

- The System Entity Structure (represents a design space via the elements of a system and their relationships in hierarchical and axiomatic manner

**Aspect :** labeled decomposition relation between the parent and the children

Specialization :labeled relation that expresses alternative substitutions for a component

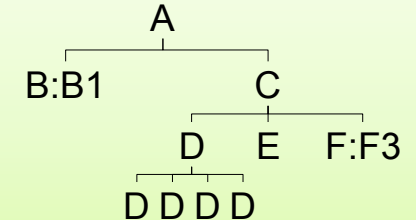**Multi-aspects:** aspect for which the components are all of the same kind.

Pruning: cuts off structure in a SES that is not needed to meet particular objectives *Selects from a family of possible architectures*
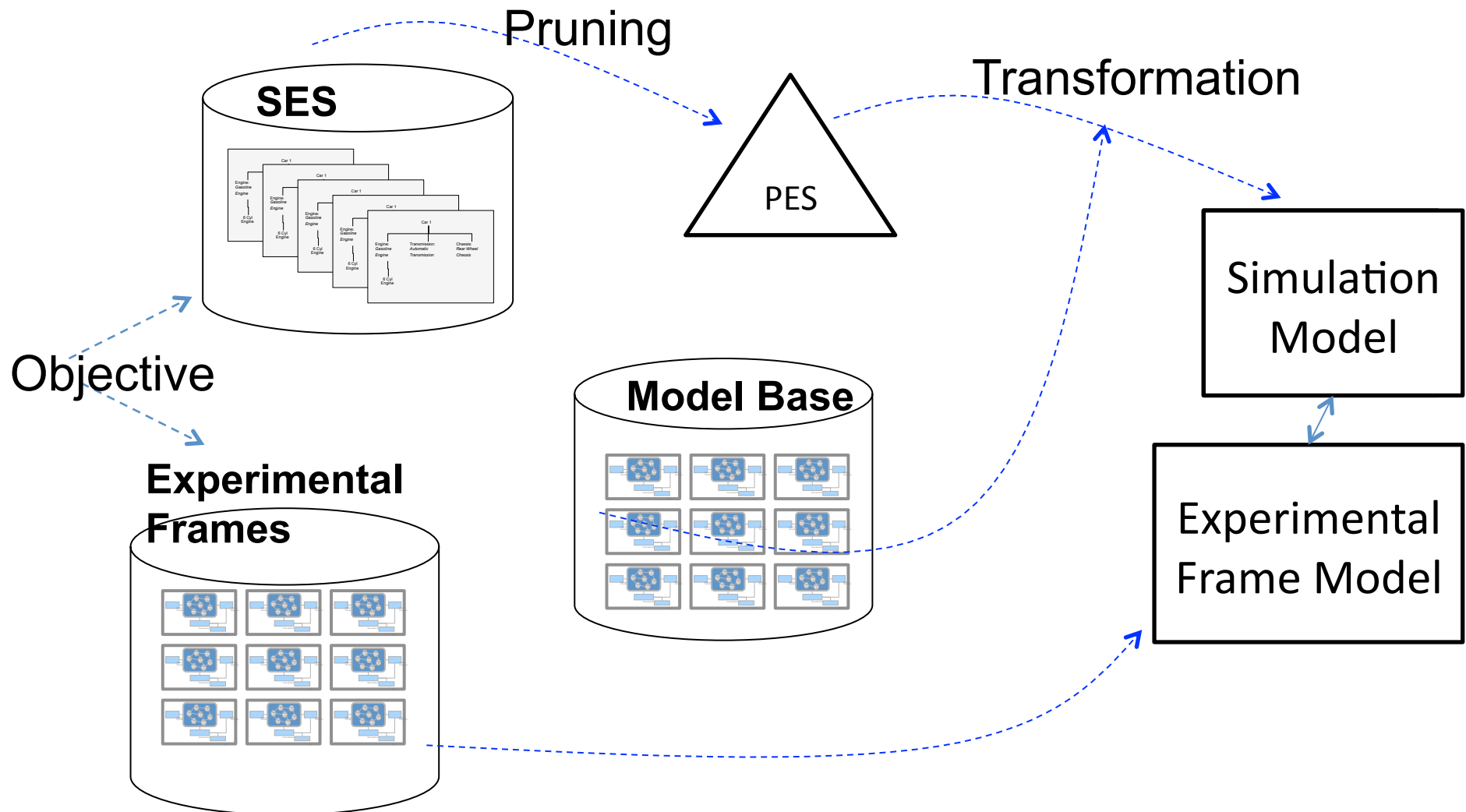

System Entity Structure
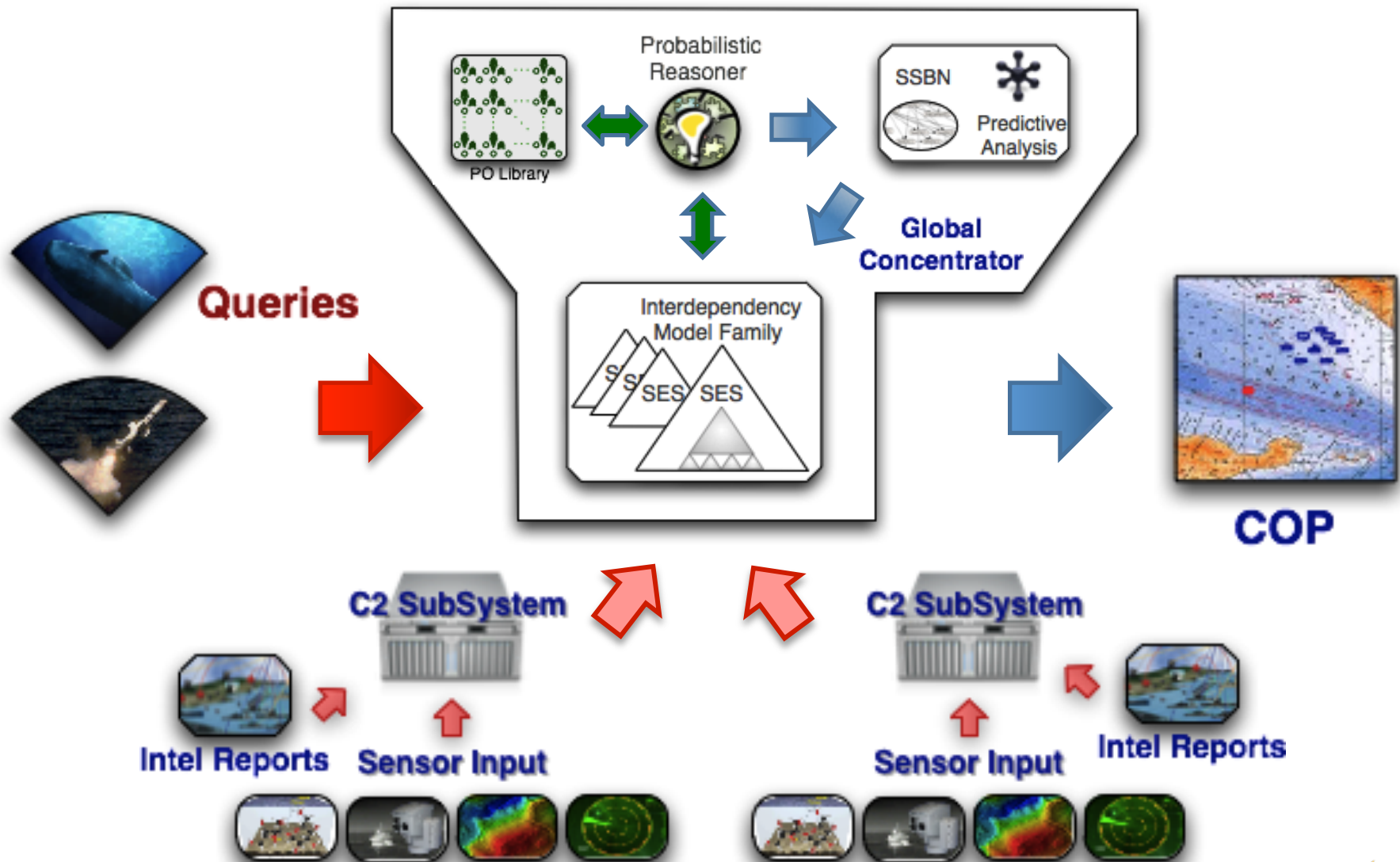
Pruning
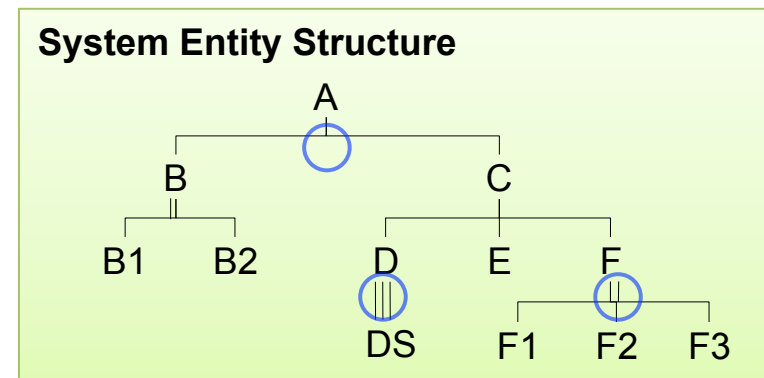
Pruned Entity Structure 1
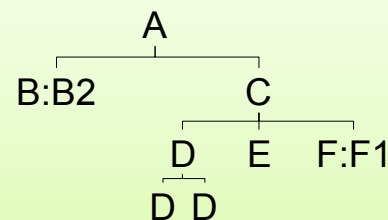
Pruned Entity Structure 2

Basic Infrastructure

The COP framework

Questions?