Enhancing Command and Control (C2) Assessment through Semantic Systems

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Overview

Enabling true assessment of operations through dynamic semantic modeling of the operational environment, the operational plan, and the relationships between the two.

C2 – Current State

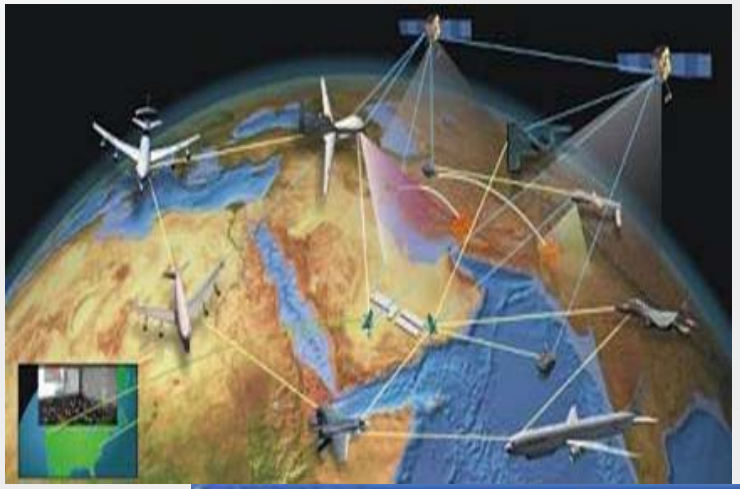
- Poor Cross-Domain Operational Planning, Execution, and Assessment
  - *"…no matter how impressive the conduct of [..] operations might be at the tactical level, there is* ***no guarantee that linkages will exist to the strategic and operational levels*** *without a considerable intellectual effort to think through the potential effects of policy decisions and strategy, or the possible contributions that tactical actions might make to achieving operational or strategic effects*."
    - Dr. Williamson Murray, *Thoughts on Effects-Based Operations, Strategy, and the Conduct of War*

C2 – Current State

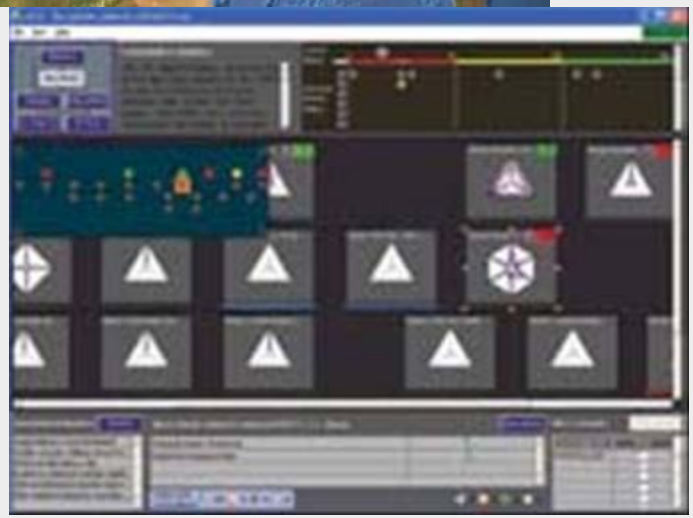
- Problematic Integration, Coordination and Visualization of Operational Plans and Operational Environment Knowledge
  - COP/UDOPs do not fully meet requirements
  - Lack of data sharing between coalition, joint, service, and federated partners

C2 – Current State

- Dislocated and Distributed C2



- Lack of Visualization supporting C2 Planning, Situational Awareness and Decision Making



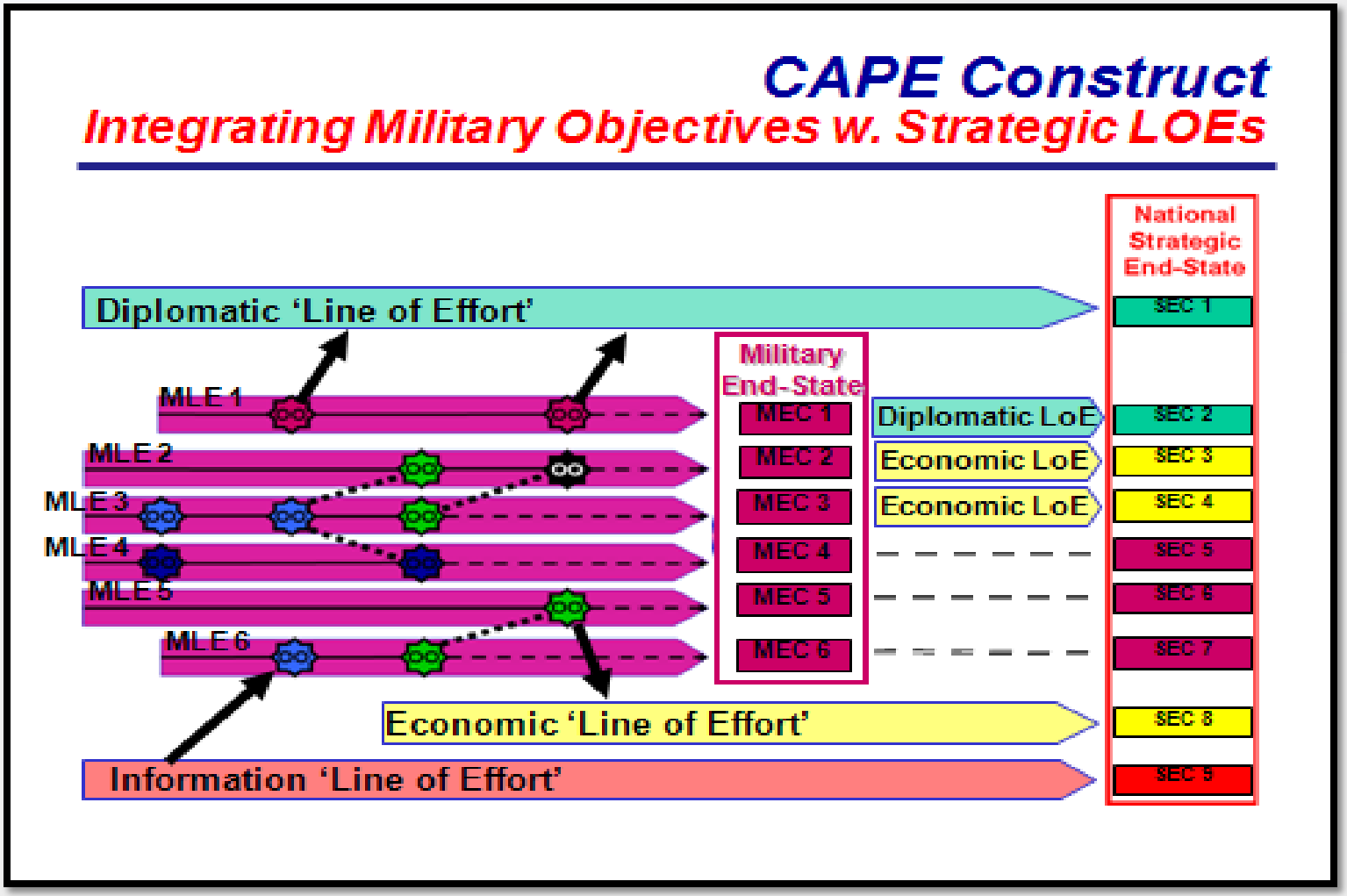
Unifying and Visualizing through Dynamic Modeling

- ‘Unifying’ Cross-Domain Planning, Execution, and Assessment
  - Comprehensive, Conditions-Based Approach needed
  - Key Elements
    - A holistic understanding of the OE
    - A focus on the required outputs of change in the OE

Unifying and Visualizing through Dynamic Modeling - CAPE

- Comprehensive Adaptive Planning and Execution (CAPE)
  - Captures unifying logic of operational plans across all domains
  - Employs the **Line of Effort** (LOE) concept,
    - Key construct element
    - Primary construct for logic-based visualizations

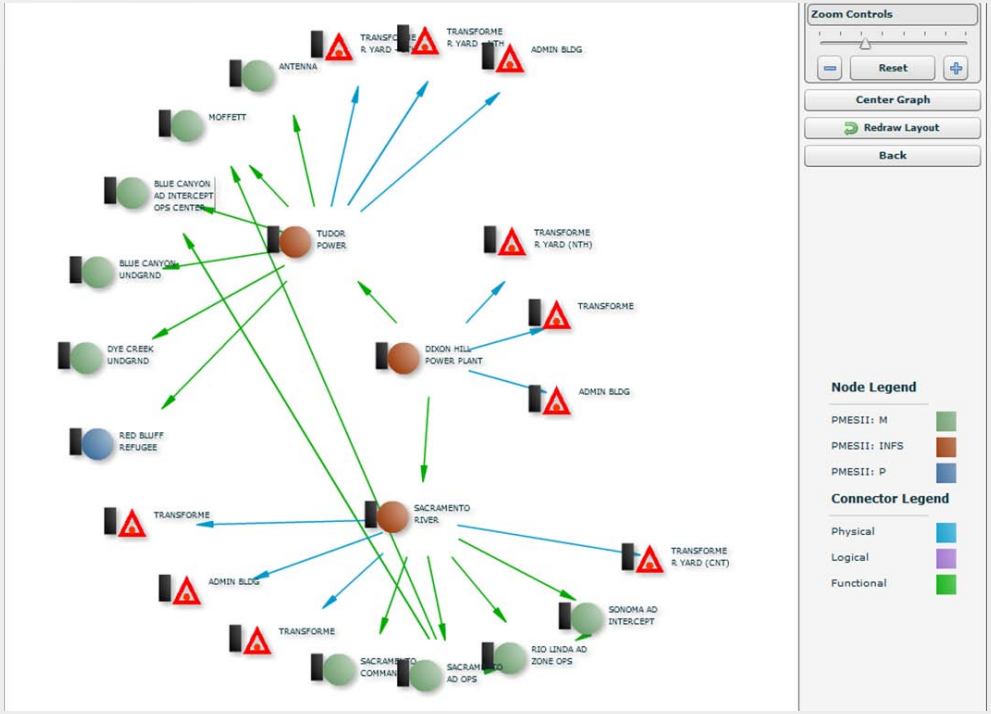
Unifying and Visualizing through Dynamic Modeling – CAPE (Continued)



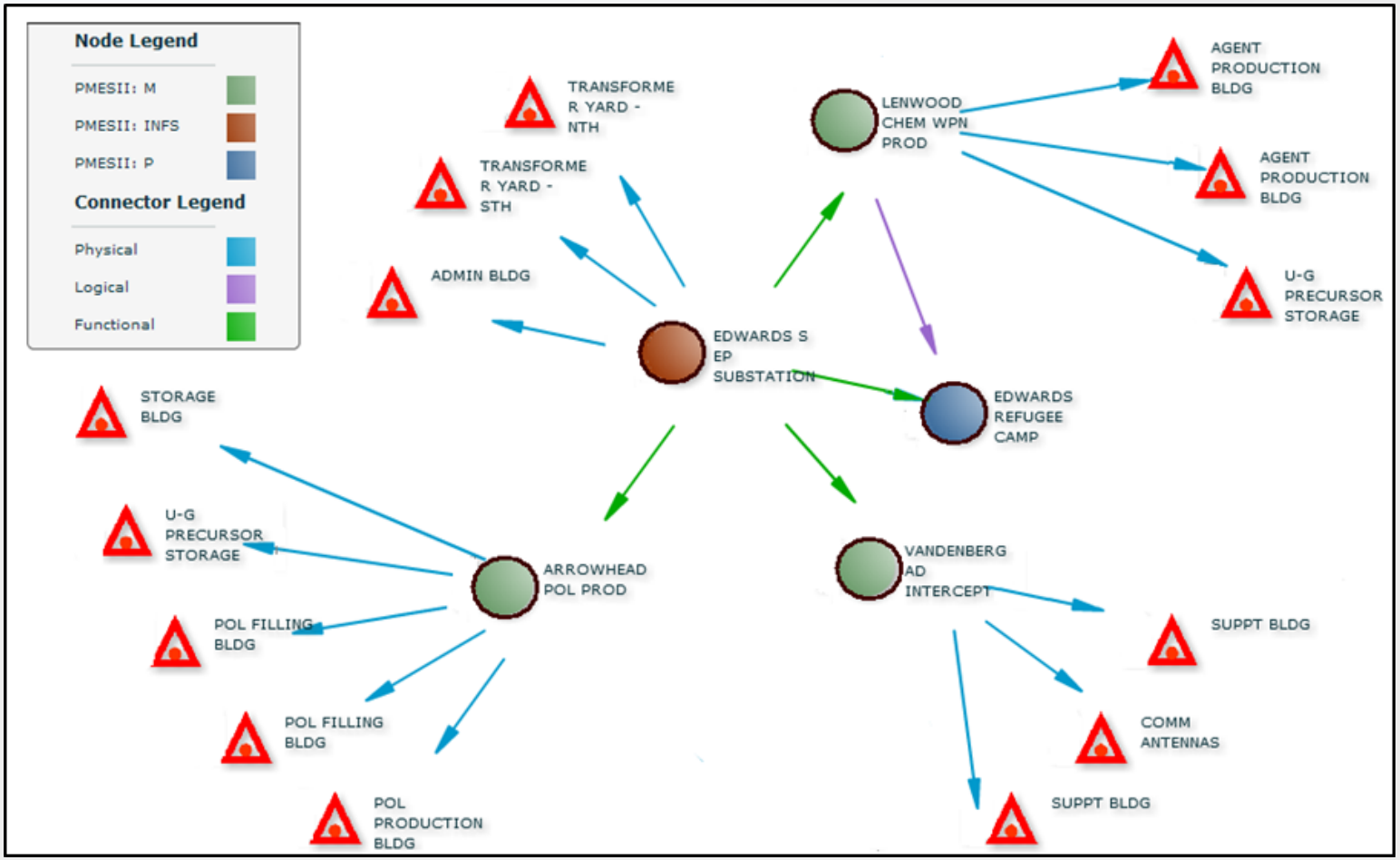
Integrating Operational Knowledge through Dynamic Modeling

- Automated creation of dynamic, user-defined Operational Environment Models (OEMs)

- OEMs provide more than a snapshot in time of friendly, neutral and enemy systems



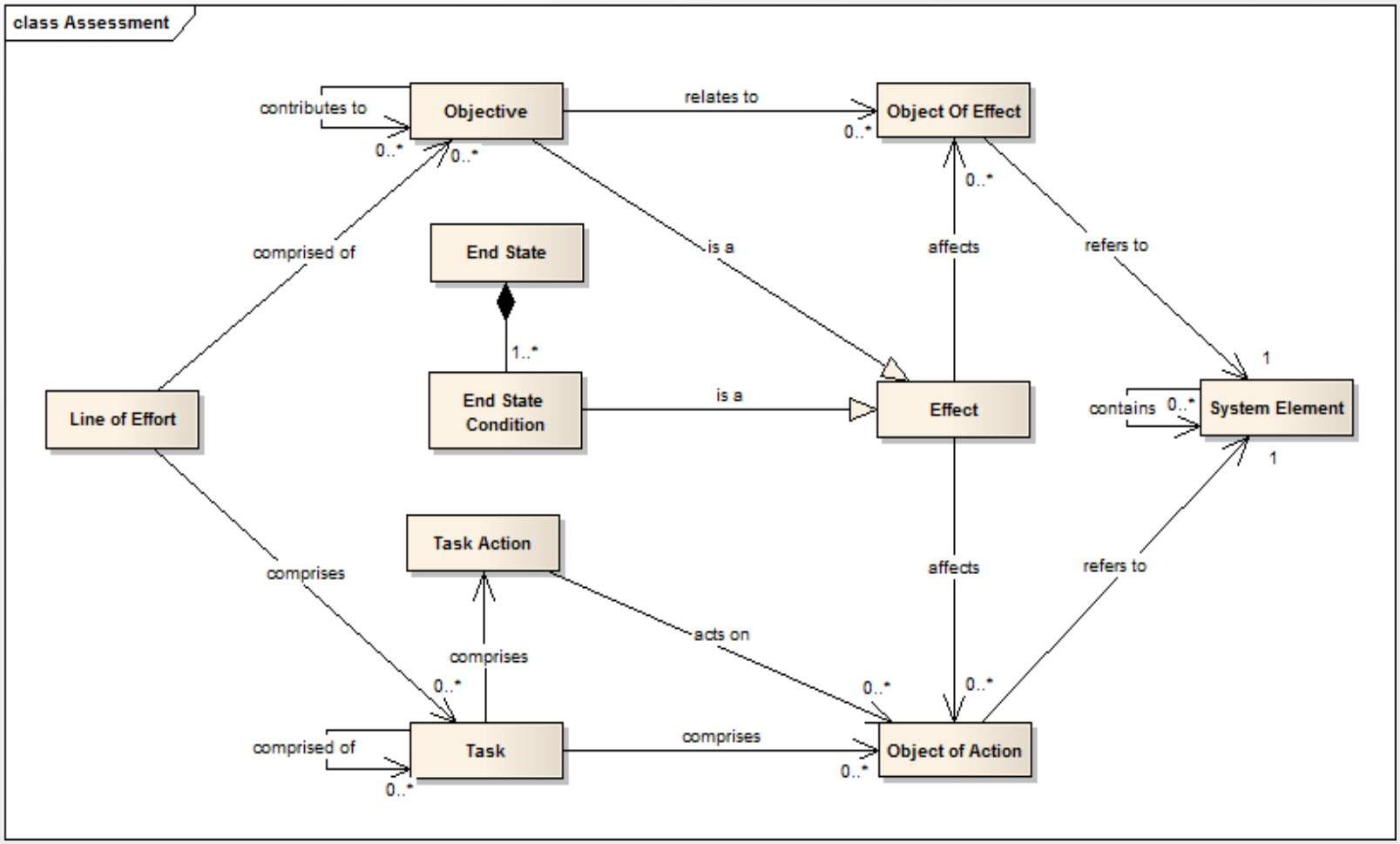
Integrating Operational Knowledge through Dynamic Modeling



Integrating Operational Knowledge through Dynamic Modeling

- Logical abstractions of CAPE used to develop complete operational planning, execution, and assessment ontology
  - Allows an Operational Plan Model (OPM) to be built and maintained on the fly.
  - Defines semantic relationships between OE system nodes and CAPE plan elements

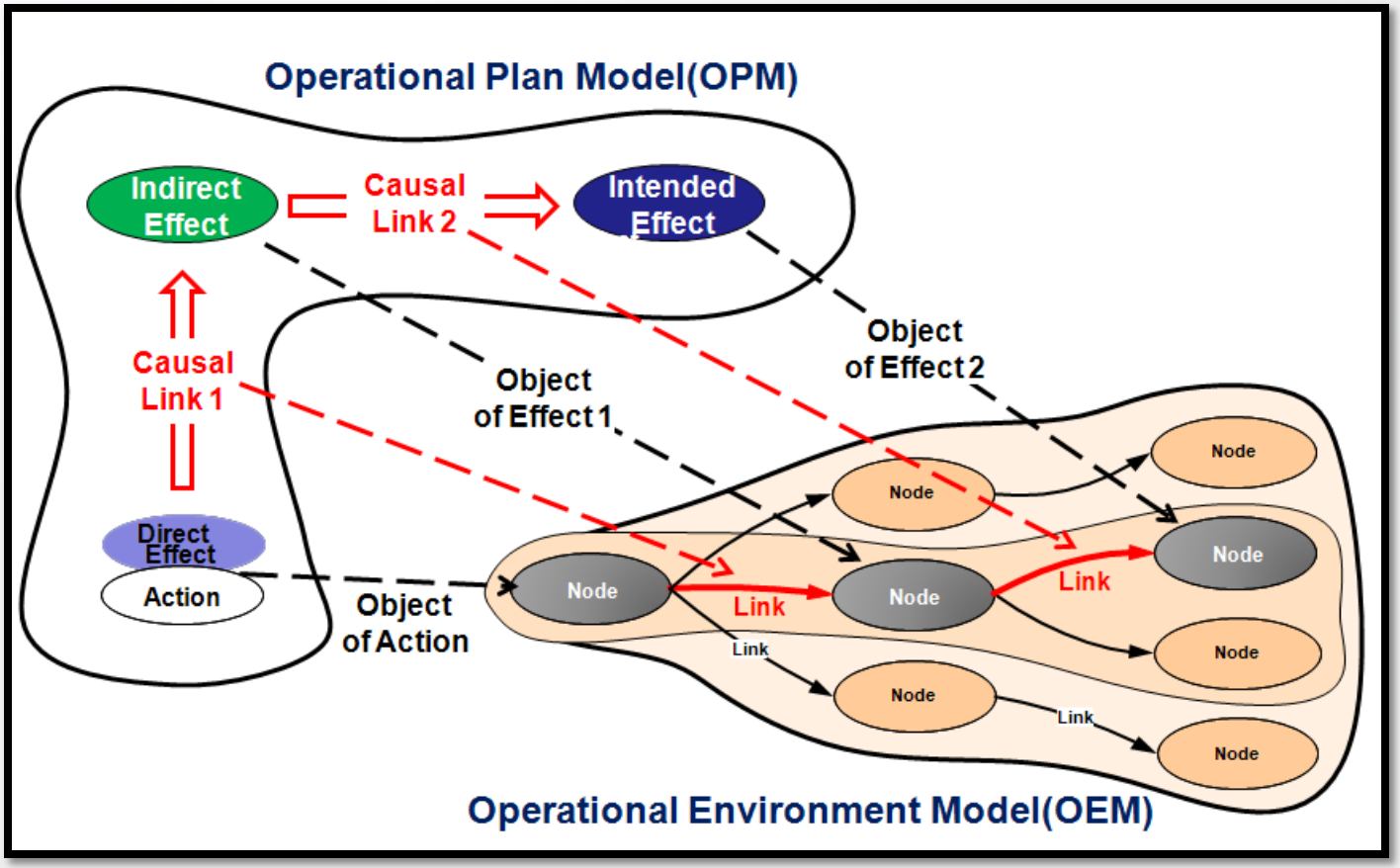
Integrating Operational Knowledge through Dynamic Modeling



Integrating Operational Knowledge through Dynamic Modeling

- Two logical bridges between OEM and OPM
  - Object of Action/Object of Effect
    - Objects within the OPM are entities within the OEM
    - Enables interactions between models
  - Causal Link (CL)
    - Deduced during operational design and planning
    - Operational Plan CLs instantiated within the OPM
      - Relate to some form of physical, functional, or logical link
    - CLs exist between entities in the OE

Integrating Operational Knowledge through Dynamic Modeling



Inter-connections between OPMs and OEMs

Generating and Integrating Semantic Models

- Semantic Model: a data modeling technique to define the meaning of data within the context of its interrelationships with other data
  - Formalizes knowledge in a machine readable format
  - Can be reasoned over to support explanation & prediction
  - Semantic models may be constructed using various techniques
    - Ontology constructs are the primary implementation
    - Maintained using the Web Ontology Language (OWL)
    - For this effort, the term semantic model and ontology are synonymous

Generating and Integrating Semantic Models

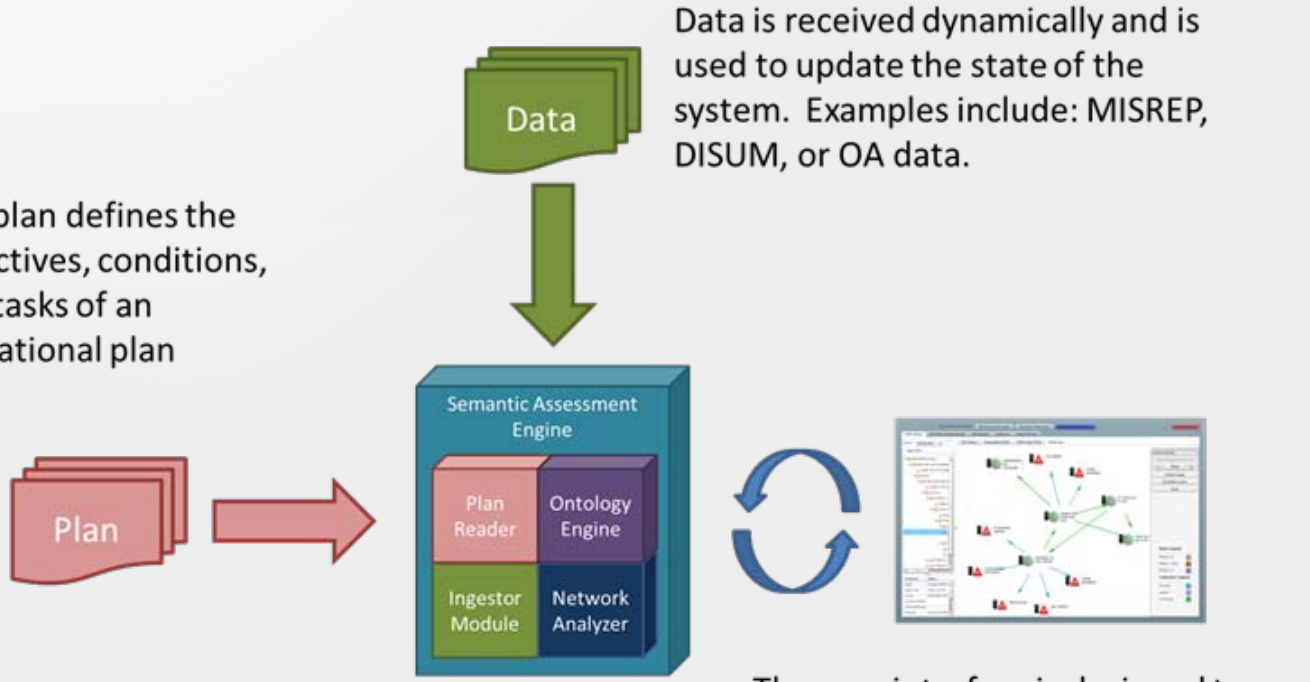
- Semantic Modeling of Cross-Domain Plans and the Operational Environment
  - Formalization of strategy, plans, execution, and assessment within an operational environment
  - Semantic models can change dynamically to accommodate growth of domain or new knowledge
  - OEMs include taxonomies ranging from facilities, equipment, and organizations to an OEs “soft” factors (political, cultural, and social)

Generating and Integrating Semantic Models

- Stereotypical OEM
  - Modeled after widely used databases and artifacts (e.g. MIDB)
  - Classified by type then semantically defined using patterns
  - Enables users to reason about and make inferences towards the state of specific objects and related objects
- Instantiated OEM
  - Provides adversary and/or campaign specificity to the stereotypical OEM
  - Populated as instances of the stereotypical constructs
  - Related to OPM to complete a comprehensive semantic model

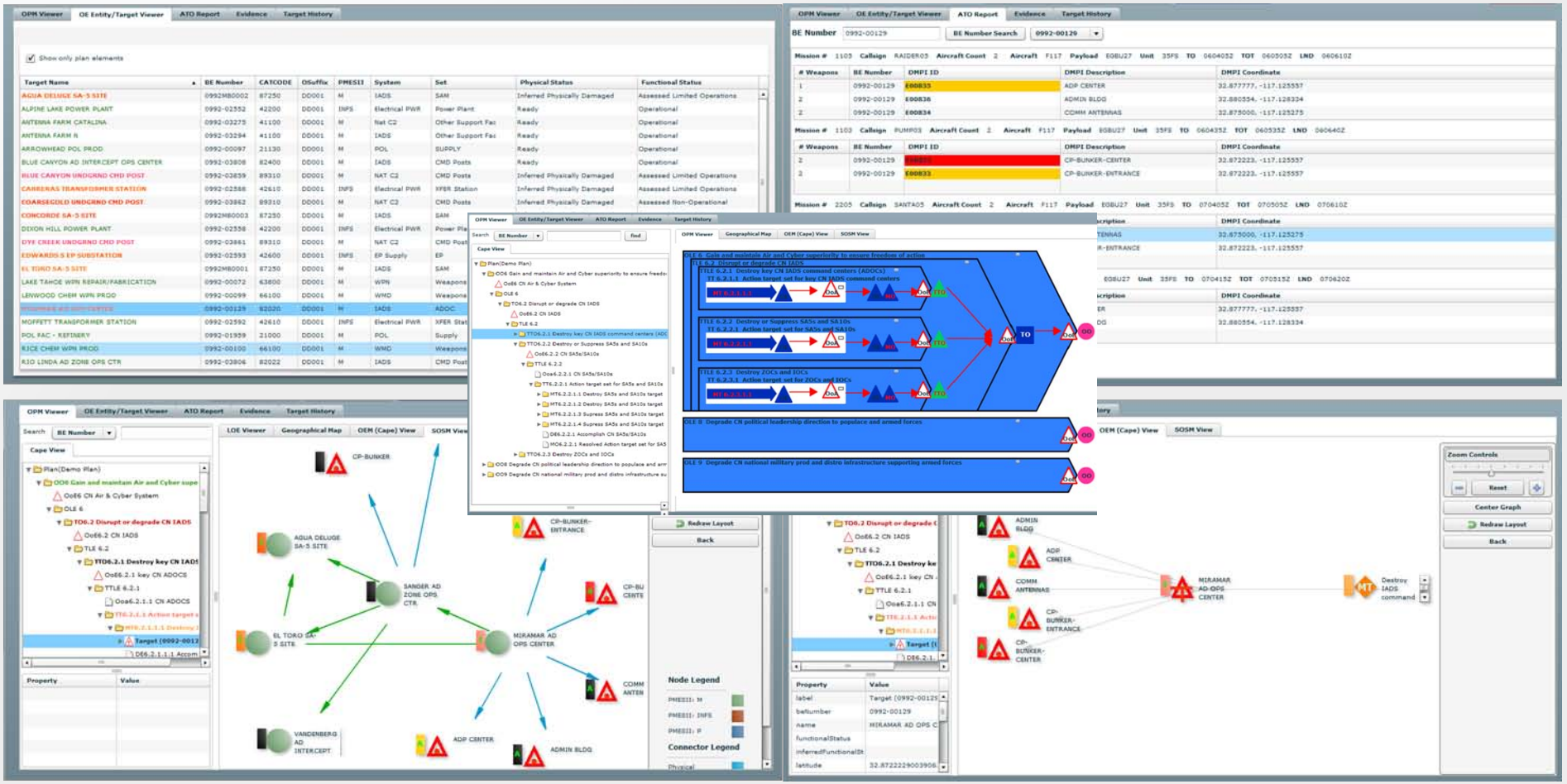
CAPE Realization

- Semantic Assessment Engine (SAE)



CAPE Realization

- CAPE Visualization



Dynamic Tactical Assessment

- "Over a decade of lessons learned from conflicts since DESERT STORM emphasize that the traditional concepts, practices, organizations, and tool sets constituting traditional "battle damage assessment" (BDA) do not meet warfighters' needs for assessment…"
  - AFDD 3-60 (formerly 2-1.9)

- "How do we view the enemy as a system vice counting all the specifics that are out there? …I think that's the direction that we want to head to in the future."
  - OIF Lessons Learned: Army Brig. Gen. Robert W. Cone, director, Joint Center for Lessons Learned, U.S. Joint Forces Command, 10/2/03

Dynamic Tactical Assessment

- Plan and OE Element Relationships
  - Any structured plan seeking to affect change can be represented by OPM and OEM interactions
  - Models dynamically updated as information becomes available

- Data Gathering and Correlation
  - Automated correlation/processing of information
  - Allows users to concentrate on higher-level cognitive tasks

Dynamic Tactical Assessment

- Evidence Evaluation
  - SAE extracts data from incoming messages and makes that data available to the core engine and users
  - Results are available against individual or a group of targets

- Information Visualization
  - Semantic relationships maintained in the OPM and OEM make options for visualizing data almost limitless
  - Analysts can search models for effects or allow the SAE to assist in reporting effect indications

Conclusion

- Enables the realization of ‘living’ plans - through the constant interaction of the ‘living’ OPM of the ever changing plan with streaming and changing outputs from the ‘living’ OEM

- Analysis engine to reason across the models provides clear potential to assist C2 planning, execution, and assessment in any domain.