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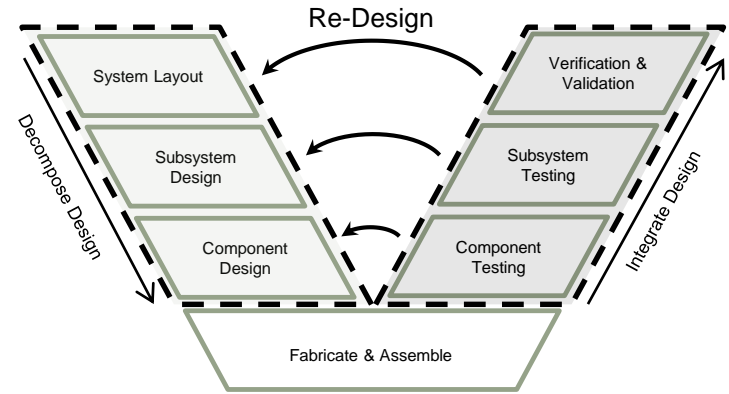
A satellite view of Earth is shown on the left side of the slide, with the top half showing the Americas and the bottom half showing the Pacific Ocean and Asia. A thick red horizontal band spans the width of the slide, containing the title text in white.

Trade Space Analytics: Enabling The Future of Systems Engineering

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Current Approach to Managing Complexity

- **MIL-STD-499A systems engineering process as employed today**
 - Un-modeled and undesired interactions lead to emergent behaviors during integration
 - Resulting architectures are single point designs
 - Conventional V&V techniques not scalable to highly complex or adaptable systems
- **Re-Designs become economically expensive and time consuming**
 - Point solutions not easily adaptable
 - Not feasible to consider large number of configurations

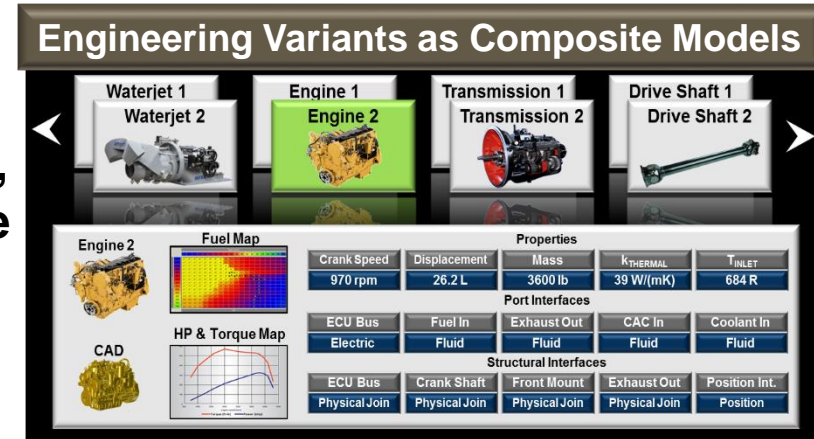


*Source: DARPA

Design of complex defense systems must be revolutionized

Digital Systems Model (DSM) Approach

- Models are used as a means of information exchange
- Component model library (CML) is required, for systems-level design to become feasible
 - CML contains models for an entire system, stretching across multiple design domains
 - CML requires a governance process to assure V&V of the models
- Domain ontologies can be used for CML to drive consistency in the way terms are defined
- Models must extend from the requirements through the factory

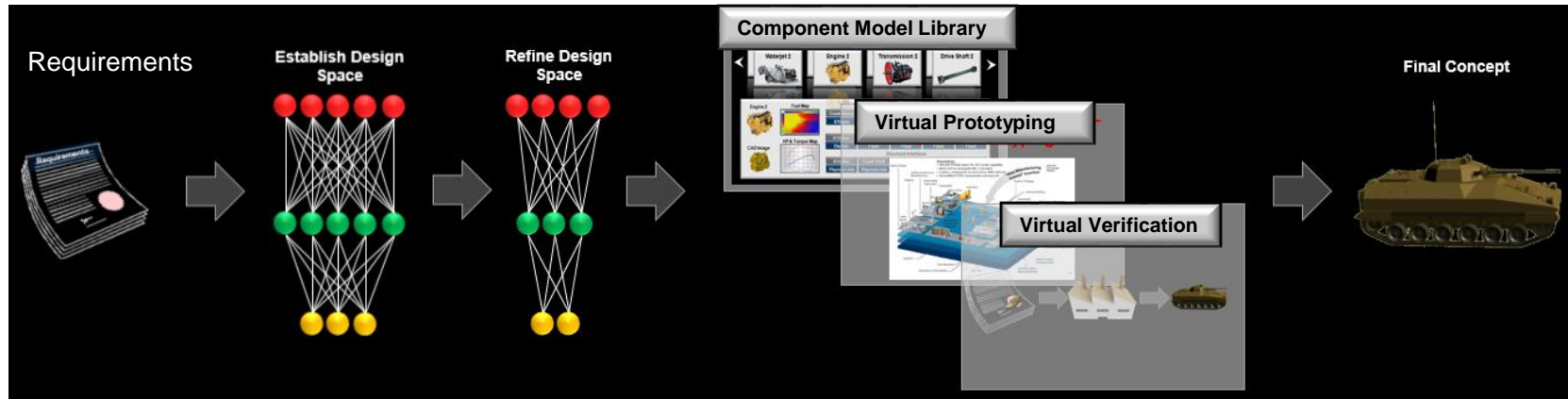


Component model library from DARPA AVM program

Domain ontologies are critical to Digital Systems Model

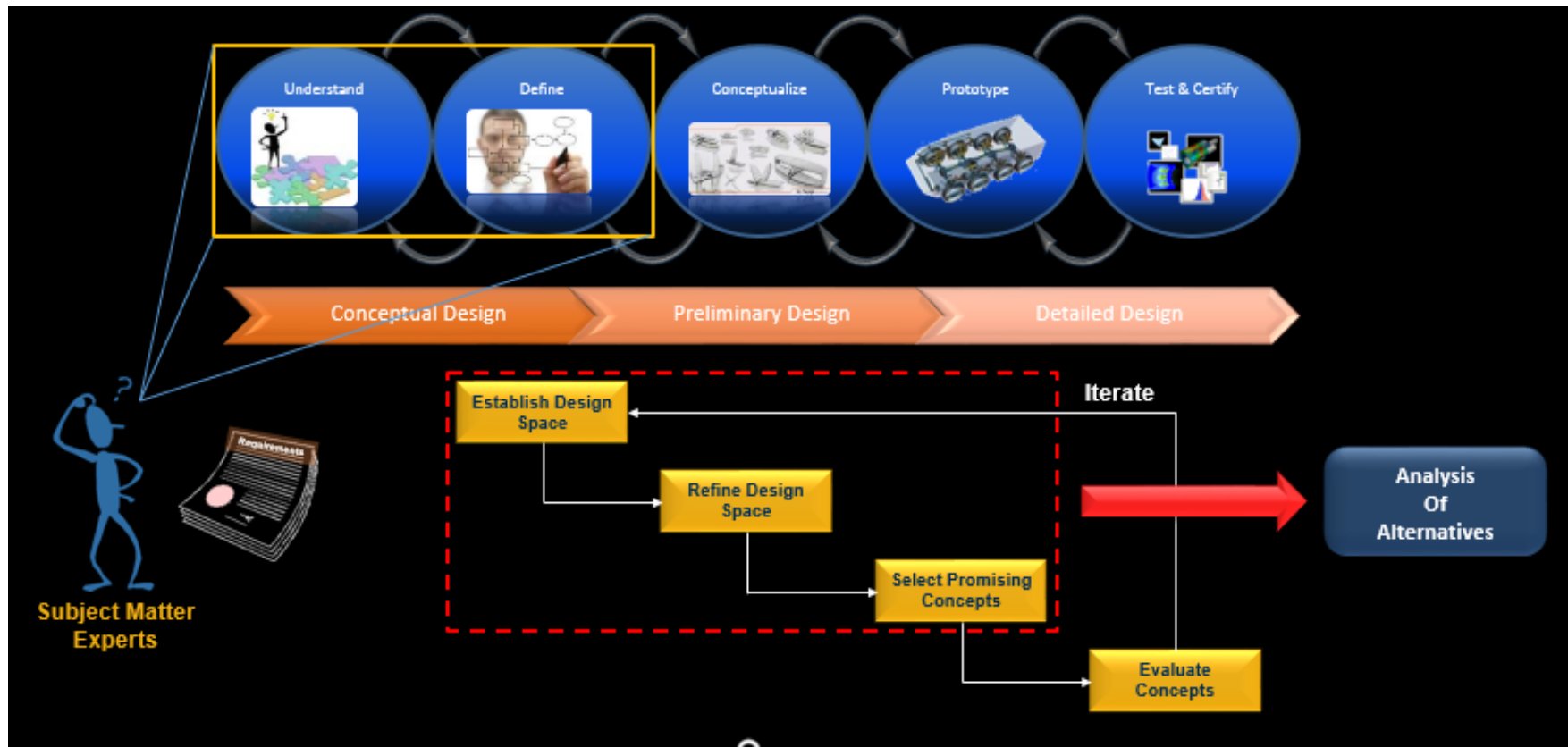
DSM Approach

- **Virtually design, manufacture, and verify complex defense systems**
 - Multi-fidelity models
 - Increase adaptability of design process
- **One of the goals is to enhance design space exploration**
 - Consider wider variety of designs to achieve the design requirements



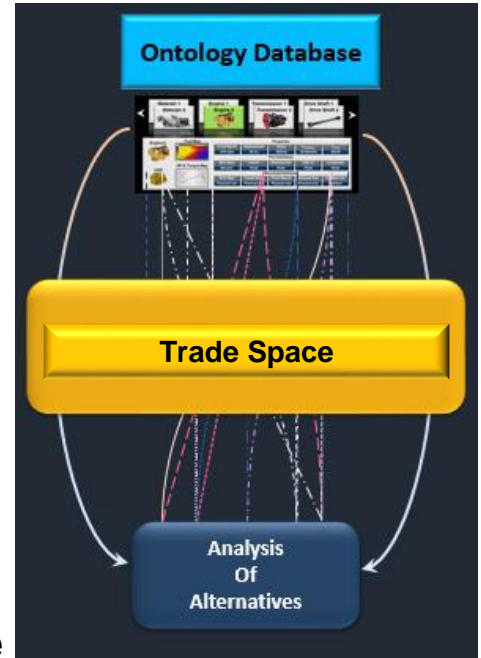
Trade Space for the entire product development process

Design Space Refinement Technique



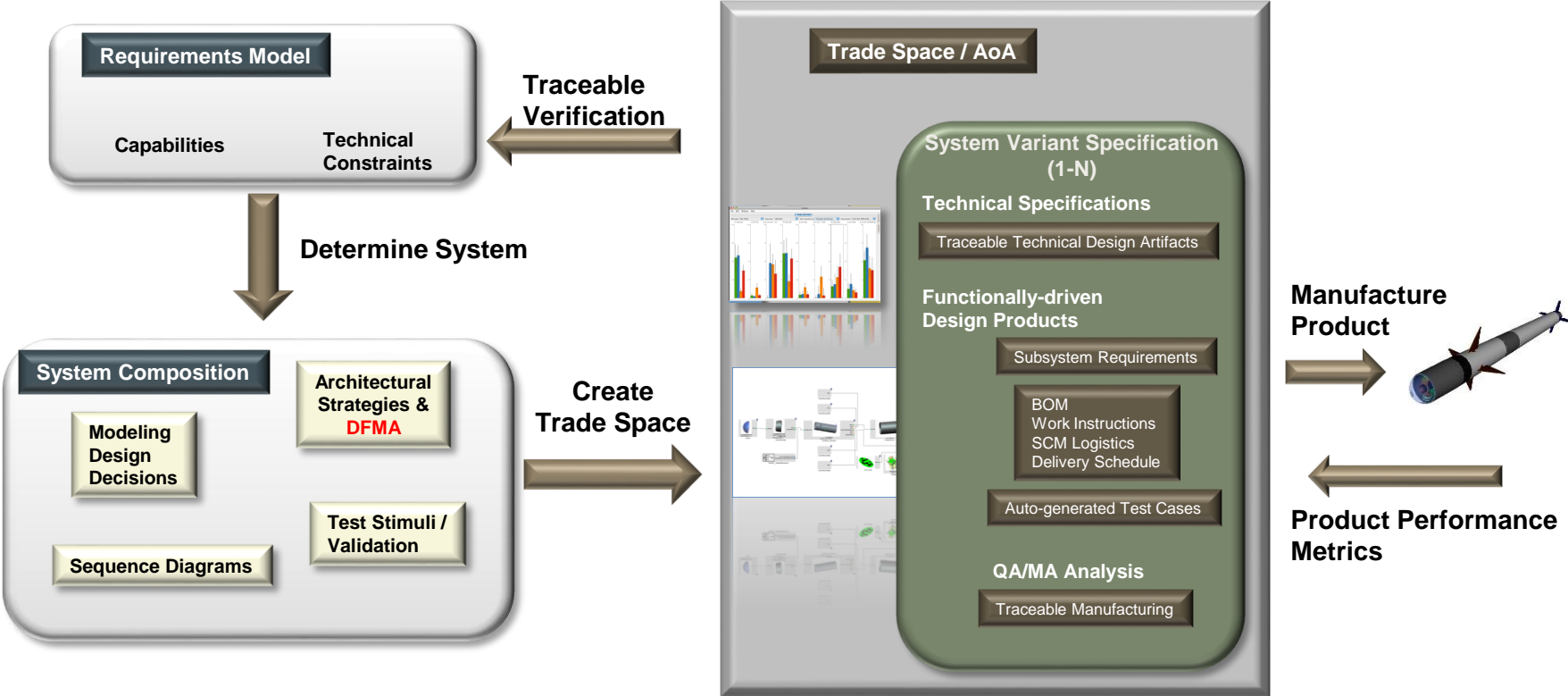
Trade Space Automation

- **Objective:**
 - Automating the process of extracting the functional decomposition and relationships of a system from a domain ontology, and importing that information to a design space
- **Key challenges:**
 - Storing functional decomposition and relationships (incompatibilities) of a system within an ontology
 - Development of a process to extract the necessary information from the ontology
 - No built-in feature within ontological development software to accomplish this
 - Information must be reformatted for use in a design space

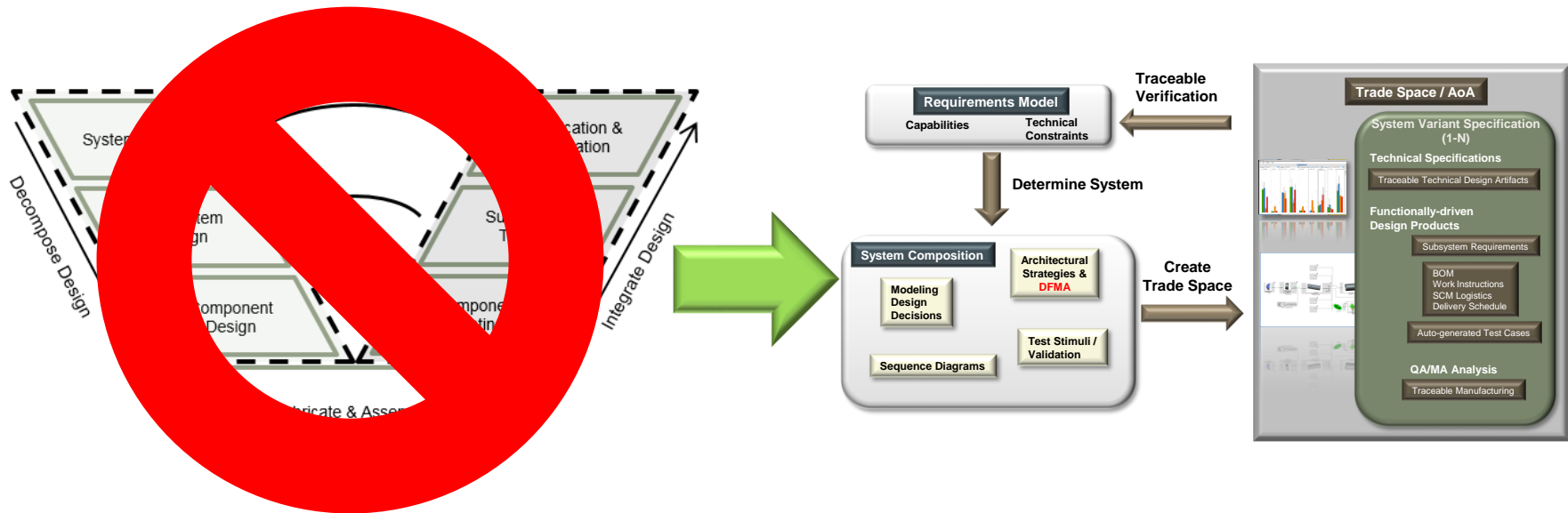


Governance and curation of models is required

DSM End-to-End Process



DSM-based Trade Space is SE



Future of DSM Trade Spaces

- **What needs to be developed?**
 - Domain ontologies
 - Uniform trade space environment
- **Obstacles**
 - Cultural resistance
 - Lack of uniform model descriptions
 - Development of domain ontologies is time intensive
- **What is the path forward?**

Questions?