

Unifying Systems Engineering Simulations

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Overview of Presentation

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Background

- The U.S. Department of Defense (DoD) relies on a multitude of fragmented simulations to assist in engineering new systems. The DoD recognizes the need for unified simulation environments to enhance the value of new models and help achieve its defense transformation goals; a major example of this is the U.S. Army's OneSAF program.
 - However, no plan exists to leverage the thousands of simulation models that remain idle on shelves.
 - Localized efforts by the government and its contractors to unify such models have been marginalized by a number of technical and non-technical hurdles, some of which are not obvious.
- Overall Goal: Field the best systems for the future military force in the shortest time using the fewest resources.

Definition of Unified Simulation

- Unified simulation is an ambitious goal for Systems Engineering that will be reached once the following criteria and capabilities are satisfied and delivered:
 - Interoperability standards allow any compliant simulation method to be incorporated (e.g., HLA, OneSAF)
 - All standalone simulation models can be integrated as pieces of a bigger puzzle (e.g., Matlab, Simulink, C++)
 - A global simulation picture provides the ability to “zoom in” on any level of detail ranging from systems to sub-components
 - System design feedback gets generated that accelerates feasibility testing of hardware and software

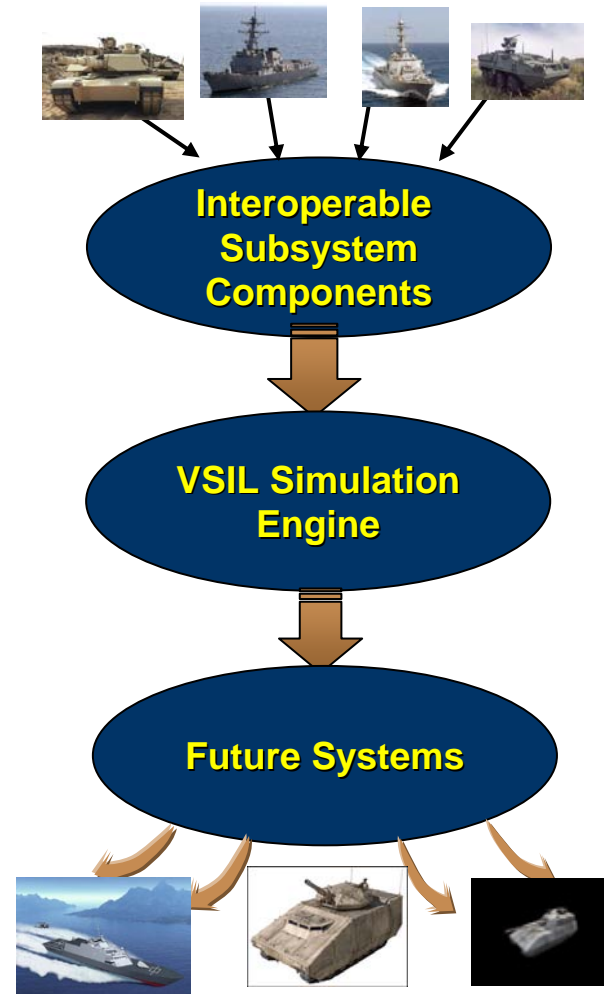
Real-life Example

- Virtual System Integration Lab (VSIL) for the U.S. Army Tank Automotive Research, Development & Engineering Center (TARDEC)
 - VSIL is a simulation suite for accelerating systems engineering
 - Tests prototype designs prior to committing to a physical prototype

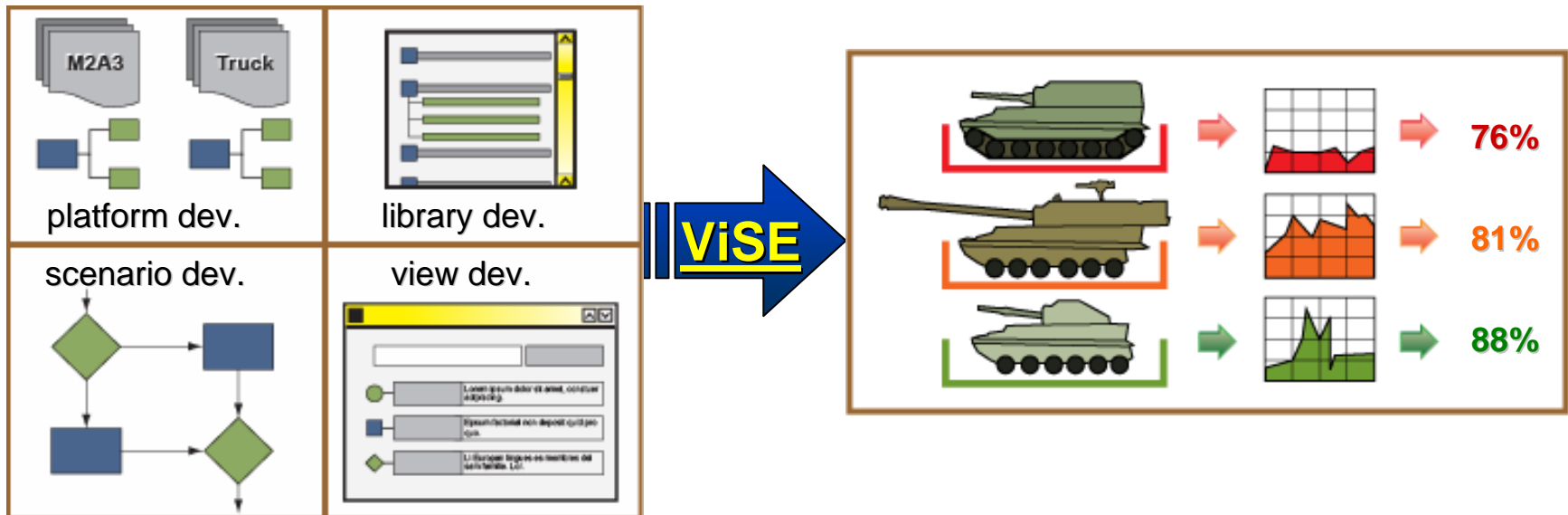


VSIL Objectives

- Enhance next-generation vehicle design and development
- Improve efficiency of simulation development
- Perform cost-benefit analysis on component models up to full deployments
- Transform development process so that new vehicle designs benefit from the development of all previous vehicles

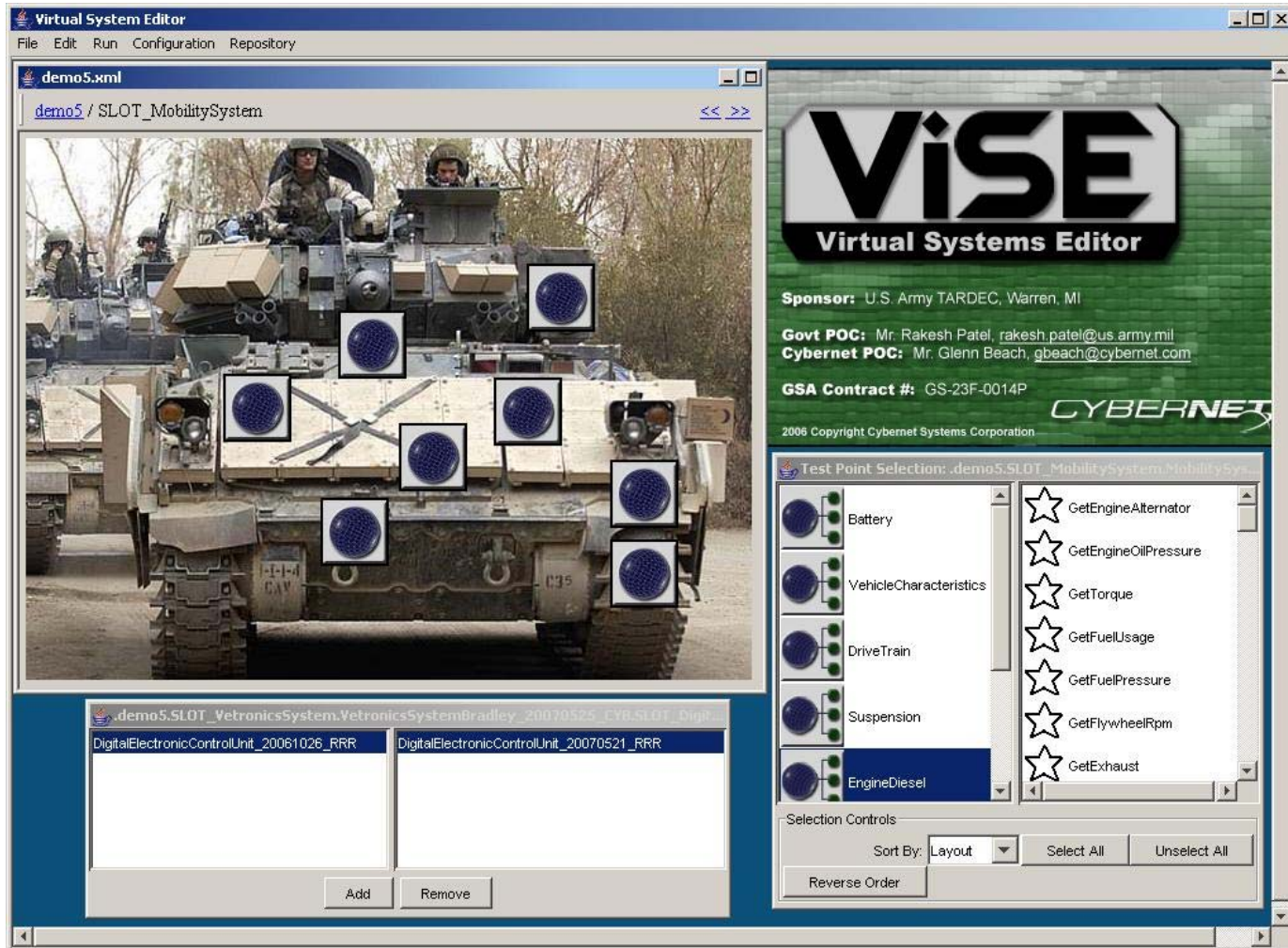


Result: Virtual Systems Editing



- Through the Virtual Systems Editor (ViSE), VSIL provides an integrated design, development, and simulation toolset to enable automated component trade-off analysis and requirements generation

ViSE Version 0.5



Hurdles to Unified Simulation

- The VSIL team encountered the following hurdles during its joint simulation efforts with TARDEC:
 - The availability of models
 - The usability of simulation construction tools
 - The creation of reference architecture
 - The complexity of simulation results
 - The automation of repetitive integration tasks
 - The verification & validation of component models

Hurdles Explained

- The availability of models
 - Credibility of M&S is tied to the availability and fidelity of component models of interest (e.g., Mobility, Suspension)
 - Populating a useful model library from scratch is a lengthy task that requires vast domain expertise
- The creation of Reference Architecture (RA)
 - RA defines interfaces required by models to be leveraged into a unified simulation (e.g., RA for vehicle electronics component)
 - Creating RA is an exhausting task. A mature RA requires constant re-factoring over time.

Hurdles Explained

- The verification & validation of simulation models
 - True validation of models is only possible by using real data taken from the component or system being modeled, or by using the most high-fidelity models available
 - Requires definitions for “high-fidelity” models and tiers of model fidelity
- The complexity of simulation and results
 - Need better analysis tools to process output data faster
 - Takes more time to execute simulations – the cost of accuracy

Hurdles Explained

- The usability of simulation construction tools
 - Impacts the efficiency of model verification & validation
 - User-friendly tools encourage more use, reduces anxiety, and builds confidence
- The automation of repetitive integration & analysis tasks
 - Automated model wrapping for common formats is highly desired
 - Need to automate the formatting and analysis of output data

Conclusions for Military Simulation

- Simulation-based engineering is a vital but expensive enterprise.
- Unified simulation is an ambitious goal that will accelerate innovation and make systems engineering more viable in the long run.
- Govt. leadership will help overcome the hurdles to unifying military systems engineering simulations.
- The DoD is the only organization that can truly unify systems engineering simulations for military use. Relying solely on industry and non-profits like SISO to accomplish the task will not achieve this goal in the long term without Govt. mandate.

Recommendations to Maximize Simulation Reuse across DoD

- To establish a unified approach to maximize simulation reuse, the DoD needs to mandate a standard response from industry. The DoD's mandate must include provisions for three broad areas:
 - 1. Model Sufficiency
 - Are high-fidelity models available?
 - Are they compliant with interoperability standards?
 - 2. Tool Usability
 - Need tools that highly automate the M&S process
 - Software tools must be easy to use, easy to learn, and fast
 - 3. Process Adoption
 - Need usage to get credibility and continuous improvement
 - Write model deliverables into contracts
 - Make model repositories easily searchable

Recommendations to Maximize Simulation Reuse across DoD

- Mandate wider deployments of existing efforts. The adoption of simulation-based processes and toolsets in the defense space will gain the most traction when mandated with ongoing efforts.
 - For example, existing programs such as OneSAF should publish their plan how they will interoperate with new models. The next evolution of OneSAF should incorporate higher fidelity simulations of FCS models, which may already exist.
 - Since OneSAF is expected to be a platform for other services if it continues to be successful, this should trigger a number of action items including: discovering needed models, identifying interoperability protocols, and designing necessary extensions to incorporate OneSAF into new programs.

Recommendations to Maximize Simulation Reuse across DoD

- Employ a bottom-up approach to unifying simulations.
 - Experience shows that a bottom-up approach to unifying simulations is superior to a top-down approach.
 - For example, the expansive JSIM project that preceded OneSAF failed due to the management burdens of operating as a joint-service project.
- Account for ongoing simulation interoperability efforts.
 - A unified approach relies on simulation interoperability.
 - Consider how ongoing infrastructure developments in the DoD community will fit in, including HLA, BOMS, SEDRIS, and MSDL.
- Populate government-owned model repositories. Let industry maintain proprietary repositories with interface-based model access.
 - Interface with decentralized repositories based on service agreements
 - Provide real data for Govt. engineers and support contractors to use

Recommendations to Maximize Simulation Reuse across DoD

- Establish a validation program for simulation models.
 - A program is necessary to verify the adequacy of simulation models.
 - Can be run by a university center, similar to the way Johns Hopkins was contracted to perform HLA RTI compliance testing.
- Invest in a standard simulation design environment.
 - Investing in a standard simulation design environment will enable the DoD to send a tangible mandate to its PEOs and contractors.
 - Identify a software toolset that is easy to use, accurate, useful, & flexible.
- Require the delivery of component models developed under contract.
 - Govt. & Industry need standardized tools to handoff and evaluate models
 - The DoD needs more automated M&S capabilities and should buy better tools to effectively manage M&S.

Question & Answer

- Please address questions after the conference to Kevin Tang:
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