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Use of Plugin Architecture and Full Source Licensing in the Deployment and Support of the Conflict Analysis & Simulation Tool (CAST)

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Overview

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- Plugin Architecture
  - What problems are solved by plugin architecture
  - How it is accomplished
- Embedded Python
  - Key enabler for plugin architecture
  - Other benefits of embedding Python
- Full Source Licensing
  - End user benefits
  - Vendor benefits

Context

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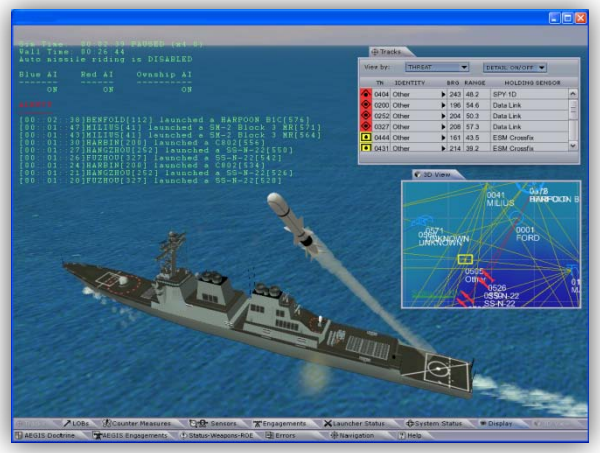
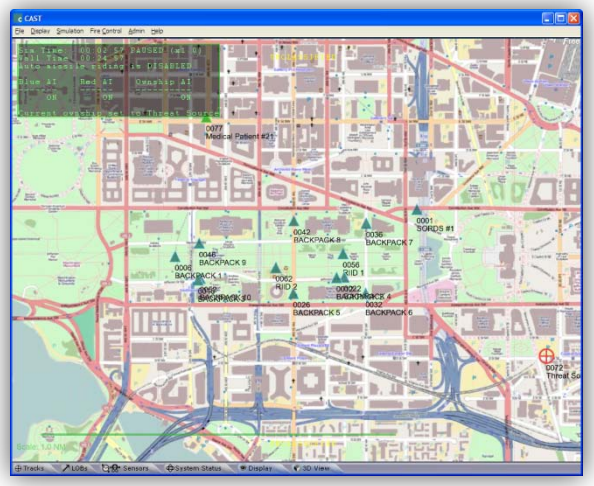
- The Conflict Analysis & Simulation Tool (CAST) was developed by ManTech to provide a MS&A framework to rapidly simulation and visualize conflict scenarios for:
  - mission effectiveness analysis
  - requirements analysis
  - trade studies
  - technology assessment
  - tactics/CONOPS development
- CAST is commercially available, but has also been employed on support contracts with Government customers.
- Modularization through a plugin architecture is required to support a disparate client base and problem domains.





Framework Description

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- The CAST framework provides the core components which are used to create, run, and analyze simulations.
- The CAST framework is extended to develop system models and scenarios specific to the client's problem domain.
  - DHS DNDO: Radiation Detection
  - DoD: Naval Warfare
  - International: Air Warfare

Customization through Plugin Architecture

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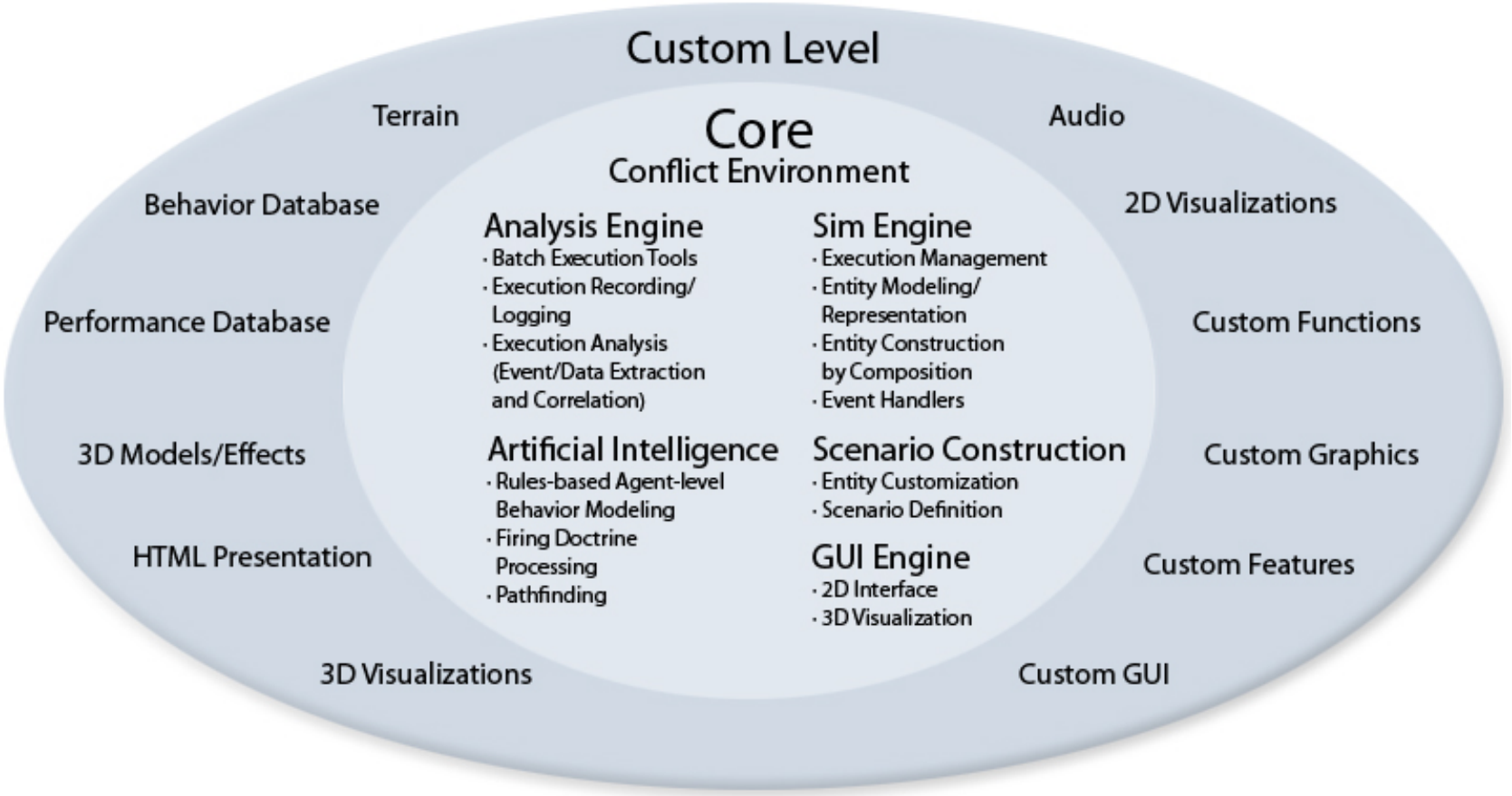

Core framework extended and customized by adding features via plugin architecture

Problems Solved by Plugin Architecture

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- Plugin architecture provides clear separation for
  - Security/classification
  - Export control
  - Source code funding streams
  - Intellectual property
- Specific models and scenarios cannot be shared
  - These models can exist completely within the plugin
- Deployment is simplified
  - End user’s configuraation management can focus on the plugin-level

Variety of Customizations

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- Simulation framework must be flexible to support a variety of customizations to occur at the plugin level
  - Graphical User Interface (GUI)
  - Visualization
  - System models
  - Data inputs
  - Analysis outputs
  - Agent behaviors

Aspects of a Plugin Architecture

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- Successful plugin architecture requires:
  - Flexible architecture
    - Object-oriented design
    - Composition versus inheritance
    - Runtime configuration
  - Data driven approach
  - Use of open standards

Object-oriented Design

- Code organized into a hierarchical structure of classes
- Data and associated code are grouped together
- Hierarchy of classes supports generalization where common aspects exist at higher levels and unique aspects are kept at lower levels
- In object-oriented design, inheritance is a rigid compile-time constraint that cannot be changed at runtime

Composition versus Inheritance

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- To improve flexibility, object composition is a technique that can be used to specialize objects at runtime.
- This can be thought of as “has a” (composition) versus “is a” (inheritance).
- The ability to compose behavior or functionality lies in creating interfaces.
- An example of kinematic motion for entities
  - Inheritance would dictate a hierarchy of classes for each entity with specialized movement algorithms (Vehicle, Ship, Aircraft, Airplane, Helicopter)
  - Composition provides an interface for movement and encapsulates the movement algorithms into a component attached to the base entity (Vehicle class with movement functors)

Runtime Configuration

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- To provide a flexible runtime architecture, framework must provide the ability to be configured at runtime.
- Runtime configurability plays nicely with an embedded scripting language capability (more detail later)
- Example of selecting system models with different fidelity
  - Object-oriented design with composition allows different fidelity models to be attached to entities at runtime, likely driven by data input

Data Driven Approach

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- Runtime configuration driven by data inputs
  - Execution changes based on inputs
  - Dynamic selection of runtime components versus hard-coded or static single-choice execution
- Data driven system modeling
  - Algorithm versus data
  - Requires algorithms to be selectable and initialized at runtime
  - This approach doesn't work for all system models, in which case, design falls back to traditional methods

Use of Open Standards

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- Use of Extensible Markup Language (XML) for data
  - Easy to parse
  - Human readable
  - Numerous tools exist for data entry and manipulation
  - Schema can be developed to enforce data structure
- Use of existing best of breed cross-platform Open Source libraries
  - OpenSceneGraph
  - osgEarth
  - wxWidgets
  - Allows users to find support within those open source communities for advanced customizations

Embedded Python

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- Embedded scripting language is a key enabler for plugin architecture
  - Python is a popular scripting language, others include Lua, Ruby, and JavaScript
  - Python scripts are text files which can be treated as input data
  - Interpreted nature of Python language allows for flexible initialization of runtime environment as opposed to hard-coded initialization
  - Example: CAST scenarios are implemented as Python scripts to construct and initialize entities

Other Benefits of Embedding Python

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- Rapid prototyping without recompile
  - Exposure of C++ code within CAST framework via SWIG (Simplified Wrapper Interface Generator)
  - Allows development of new system model prototypes quickly
  - Once satisfied with prototype, system model can be implemented in C++
- Allows user to execute Python code while simulation is running
  - This feature can be used to inspect the state of the simulation by accessing simulation objects
  - Can also be used to alter the state of the simulation which is helpful for debugging and testing

Full Source Licensing

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- End user is empowered to dig into the internals of the simulation framework
  - No “black box” barrier
- Similar benefits to Open Source licensing
  - Ability to see source code to get deeper understanding of framework’s internals
  - Ability to modify source code to create advanced customizations
  - Ability to debug into framework’s source code to identify cause of potential issues

Full Source Licensing

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- End users can set the level of software support they require
- Over time end user increases familiarity with codebase source code
  - Initially very hands on: Vendor heavily involved in customization efforts (training, consulting, maintenance)
  - As end user develops proficiency with codebase requires less vendor involvement (maintenance)

Vendor Benefits from Full Source Licensing

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- Enforces robust configuration management and software engineering best practices
  - Required in order to support multiple customers with multiple released versions
  - Separation of work-for-hire from core CAST development
- Provides a level of transparency to the customer because source code is not hidden

Questions?