

**Overview of the  
Multiscale Epidemiologic/Economic  
Simulation and Analysis (MESA)  
Decision Support System**

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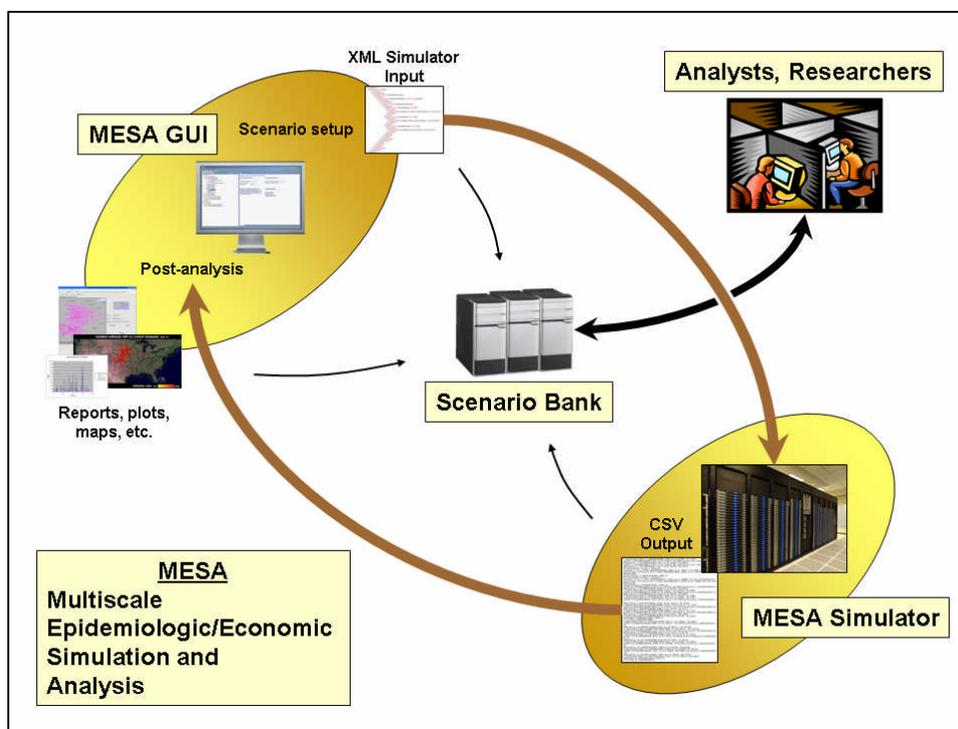
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## Overview of the Multiscale Epidemiologic/Economic Simulation and Analysis (MESA) Decision Support System

The Multiscale Epidemiologic/Economic Simulation and Analysis (MESA) Decision Support System (DSS) is the product of investments that began in FY05 by the Department of Homeland Security (DHS) Science and Technology Directorate and continue today with joint funding by both DHS and the US Department of Agriculture (USDA). The DSS consists of a coupled epidemiologic/economic model, a standalone graphical user interface (GUI) that supports both model setup and post-analysis, and a Scenario Bank archive to store all content related to foreign animal disease (FAD) studies (Figure 1).



**Figure 1 MESA Decision Support System Architecture**

The MESA epi model is an object-oriented, agent-based, stochastic, spatio-temporal simulator that parametrically models FAD outbreaks and response strategies from initial disease introduction to conclusion over local, regional, and national scales. Through its output database, the epi model couples to an economic model that calculates farm-level

impacts from animal infections, responsive control strategies and loss of trade. The MESA architecture contains a variety of internal models that implement the major components of the epi simulation, including disease introduction, intra-herd spread, inter-herd spread (direct and indirect), detection, and various control strategies (movement restrictions, culling, vaccination) in a highly configurable and extensible fashion.

MESA development was originally focused to support investigations into the economic and agricultural industry impacts associated with Foot-and-Mouth Disease (FMD outbreaks). However, it has been adapted to other FADs such as Highly Pathogenic Avian Influenza (HPAI), Classical Swine Fever (CSF) and Exotic Newcastle Disease (END). The MESA model is highly parameterized and employs an extensible architecture that permits straightforward addition of new component models (e.g., alternative disease spread approaches) when necessary.

Since its inception, MESA has been developed with a requirement to enable simulation of the very large scale, nationwide disease outbreaks that are of special interest to DHS.. MESA has been developed at Lawrence Livermore National Laboratory (LLNL) and has benefited from the world-class experience in supercomputing application development held by LLNL staff as well as the best-in-class high performance computing infrastructure in place at LLNL. MESA incorporates novel architectural features that permit it to make efficient use of available compute cycles by dynamically increasing the fidelity of the simulation in spatial (geopolitical) regions where relevant activity is occurring and keeping other regions aggregated into a computationally simpler representation.

In addition to the MESA epi and economic models, the MESA DSS incorporates other key components. Integral to the parametric approach MESA employs to setup and define disease outbreak scenarios is a GUI that enables the MESA user to efficiently manage the thousands of parameters required by the simulator. The GUI provides individual parameter editors for groups of variables that support a common high level function, such as disease introduction, spread, control strategies, etc. It also provides a capability to

browse through multiple study projects and develop n-additional outbreak scenarios per project through successive refinement of existing scenarios. Finally, the MESA GUI links post-processing applications that permit extraction of key data from MESA raw output, generation of spreadsheets, and geospatial mapping of simulation results. The MESA GUI is a standalone application that normally runs on the user’s desktop, although its Java source code is portable and can execute under virtually any modern operating system.

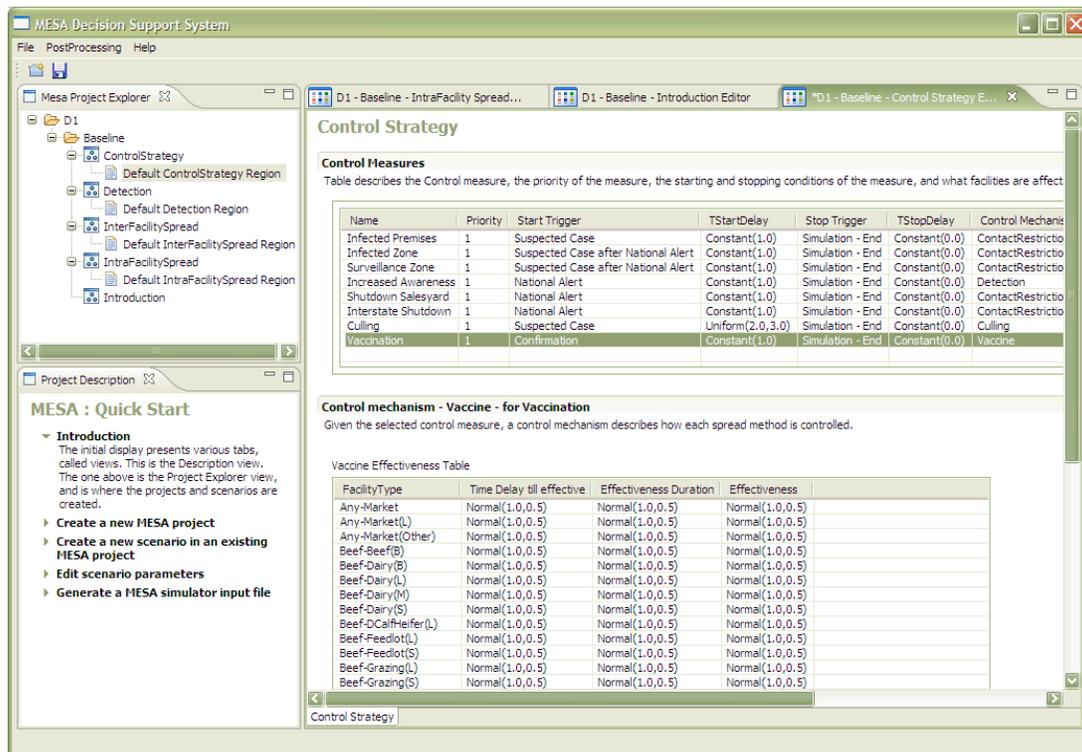


Figure 2 MESA GUI

The final major component of the MESA DSS is the Scenario Bank, which is a web-served archive of unclassified FAD study content. The Scenario Bank implements a hierarchy of spaces, structured primarily along organizational lines (e.g., “USDA”, “LLNL”, etc), that permits participants to store simulator inputs, outputs, analysis results, reports, etc. and explicitly control who among Bank users may access them. Documents can be shared within organizations or across organizations at the owner’s discretion. The Scenario Bank is intended to be the system of record for USDA and DHS sponsored FAD study efforts and as such will archive content from a variety of models employed by USDA and DHS-sponsored researchers and analysts.