Advanced Systems Engineering Methodologies and Tools for Gateway Selection and Configuration

15th Annual Systems Engineering Conference

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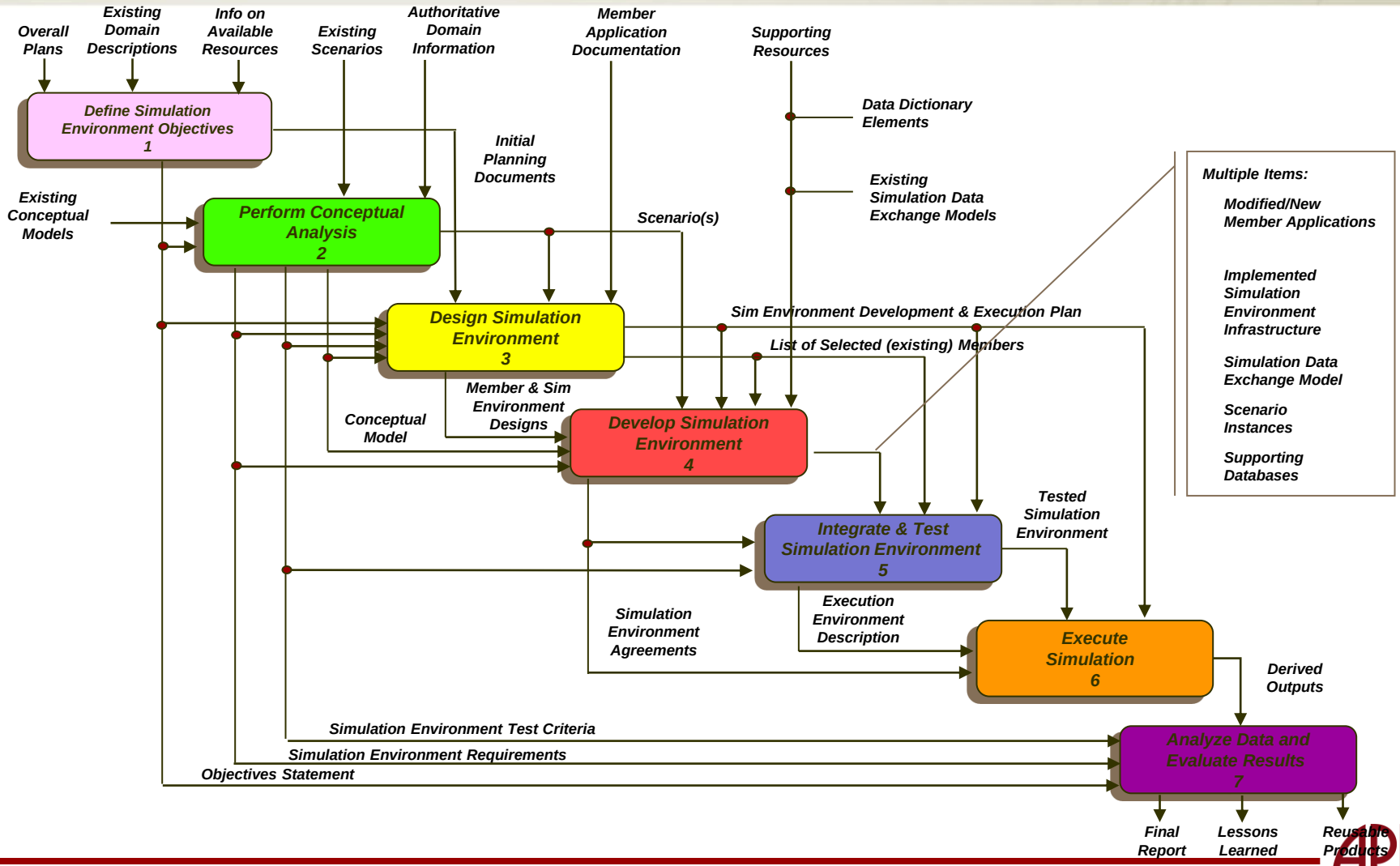
Introduction

- **System – a combination of interacting elements organized to achieve one or more stated purposes (Systems and Software Engineering - System Life Cycle Processes - ISO/IEC 15288)**
- **Under this definition, a model or simulation is a type of system**
  - Modular standalone M&S tools are composed of multiple software components interacting through well-defined interfaces
  - Distributed M&S environments use modern simulation architectures, middleware, and various infrastructure elements to allow multiple simulations to share information at runtime and interact coherently for some defined purpose
- **While system and software engineering principles are certainly relevant to M&S, much work has been done in recent years to tailor these principles to the M&S domain**

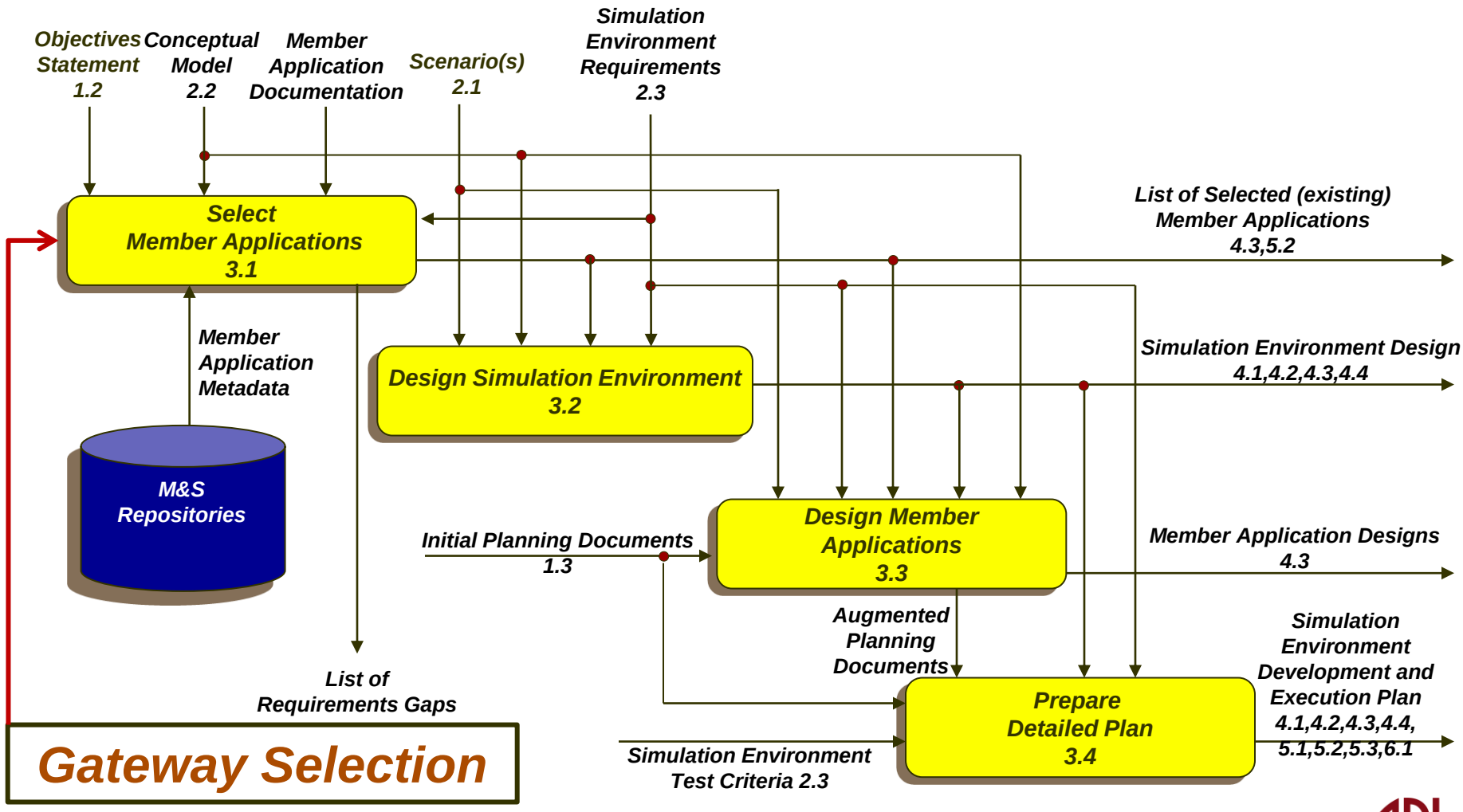
Distributed M&S Process Models

- Distributed interactive Simulation (DIS) - Exercise Management and Feedback (IEEE 1278.3)
- High Level Architecture (HLA) – Federation Development and Execution Process (IEEE 1516.3)
- Test and Training Enabling Architecture (TENA) – Logical Range Concept of Operations (TENA Architecture Reference Document)
- **Distributed Simulation Engineering and Execution Process – DSEEP (IEEE 1730)**
  - Published in January 2011
  - Reconciles differences among the architecture-specific process models and describes distributed simulation lifecycle process in architecture-neutral terminology

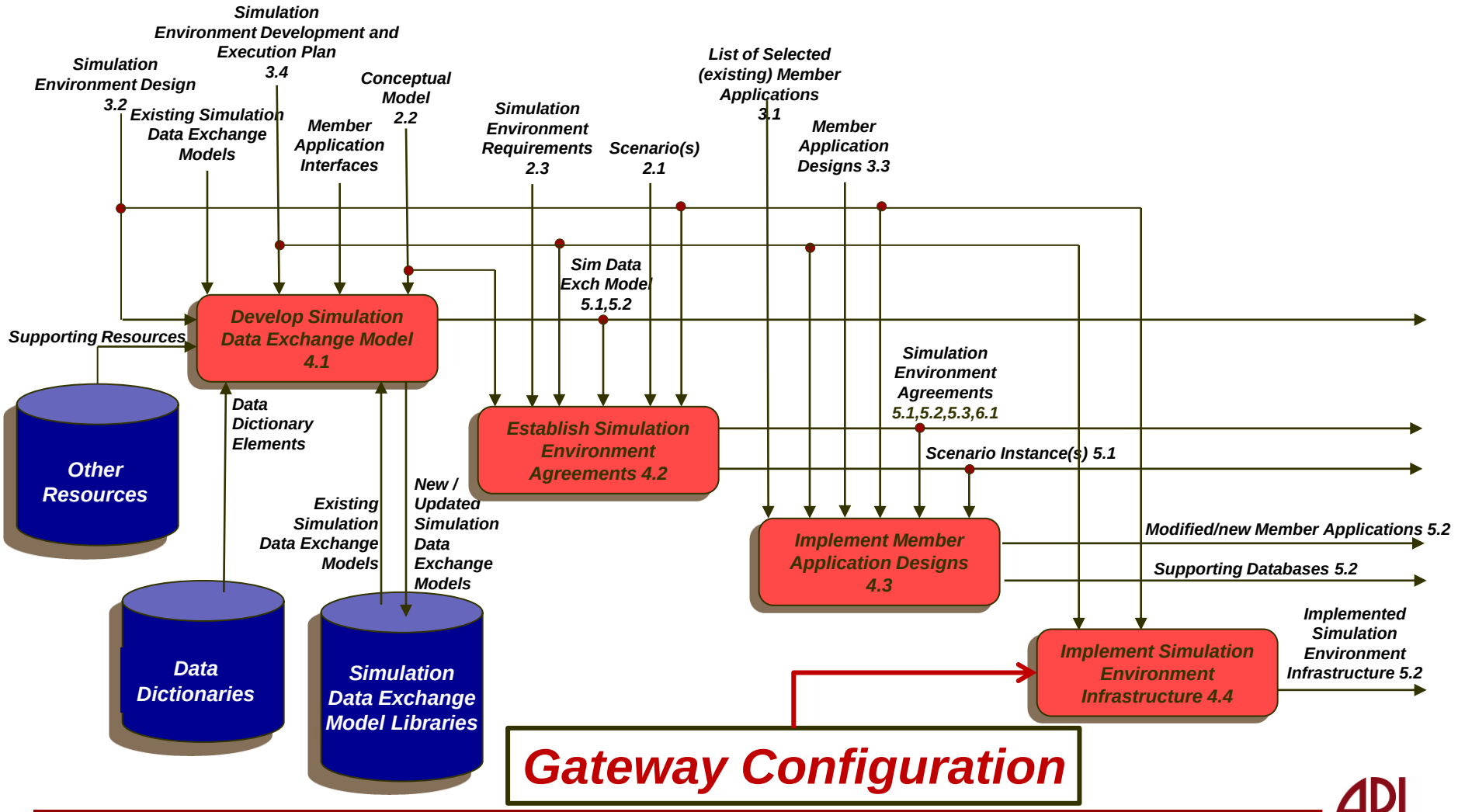
DSEEP – Top-Level View



Step 3 – Design Simulation Environment



Step 4 – Develop Simulation Environment



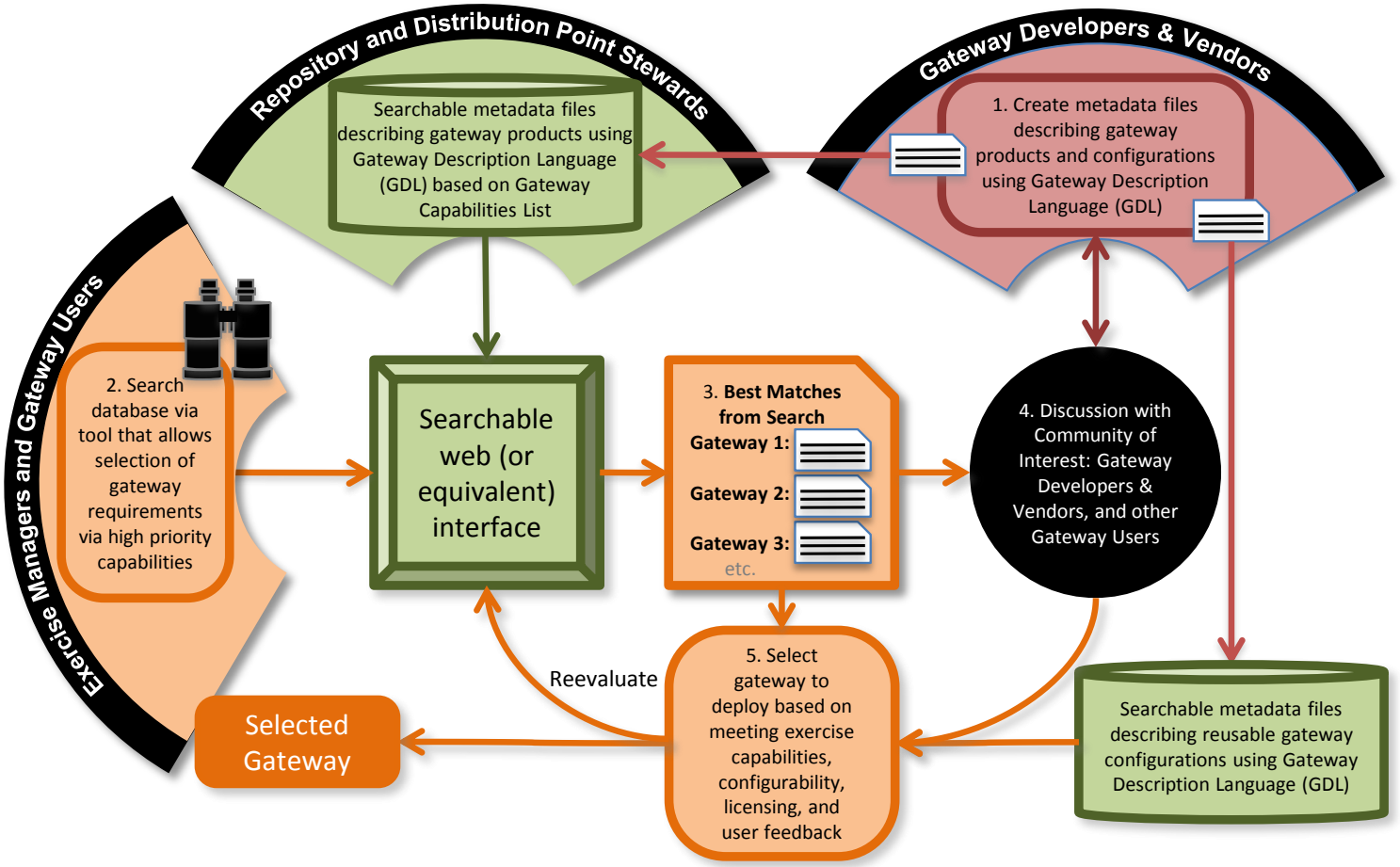
Gateway Challenges

- **Despite the many documented success stories associated with the use of gateways to facilitate LVC interoperability, there are also some significant issues that impact technical, schedule, and cost risk**
  - No central “marketplace” of gateways
    - Few mechanisms for user to determine what reuse opportunities are available
    - No mechanisms for direct comparisons of gateways
  - Gateways built for specific needs
    - Not built for reuse/not built for extensibility
    - Extensive duplication of existing gateway capabilities
  - Broad proliferation of gateways
    - Redundant maintenance costs
  - Many gateway configuration tasks are very time consuming and error-prone
    - Development of mappings (i.e., translations) among simulation data elements
    - Filters

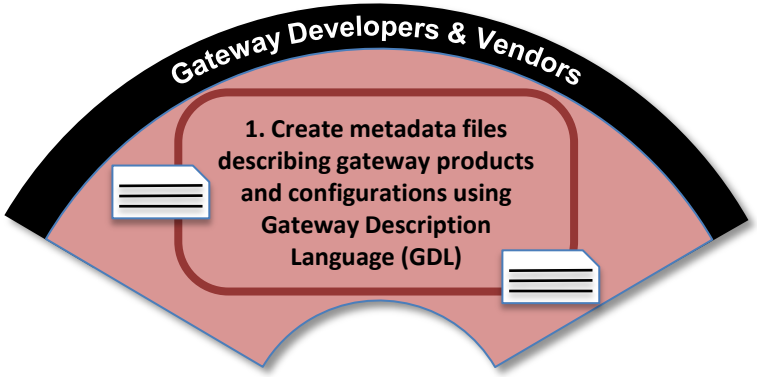
Live-Virtual-Constructive Architecture Roadmap (LVCAR)

- **The Live-Virtual-Constructive Architecture Roadmap (LVCAR) was established in the Spring of 2007, continuing for approximately sixteen months**
  - Intended to examine the differences among the major simulation architectures from a technical, business, and standards perspective, and to develop a time-phased set of actions to improve interoperability within multi-architecture simulation environments in the future
  - Resulted in a final report and supporting documentation that collectively totaled over a thousand pages
- **LVCAR technical recommendations included numerous actions to create new products that help to increase the efficiency and effectiveness of LVC simulation environment developments**
  - Spanned many areas, including needed improvements to gateway selection and configuration practices
- **The implementation of LVCAR recommendations began in the Spring of 2009**

Systems Engineering Approach to Gateway Selection

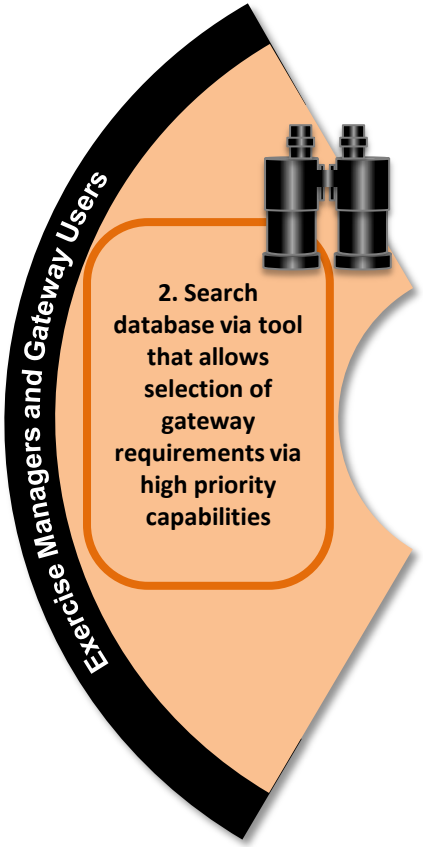


Step 1: Create Gateway Descriptions

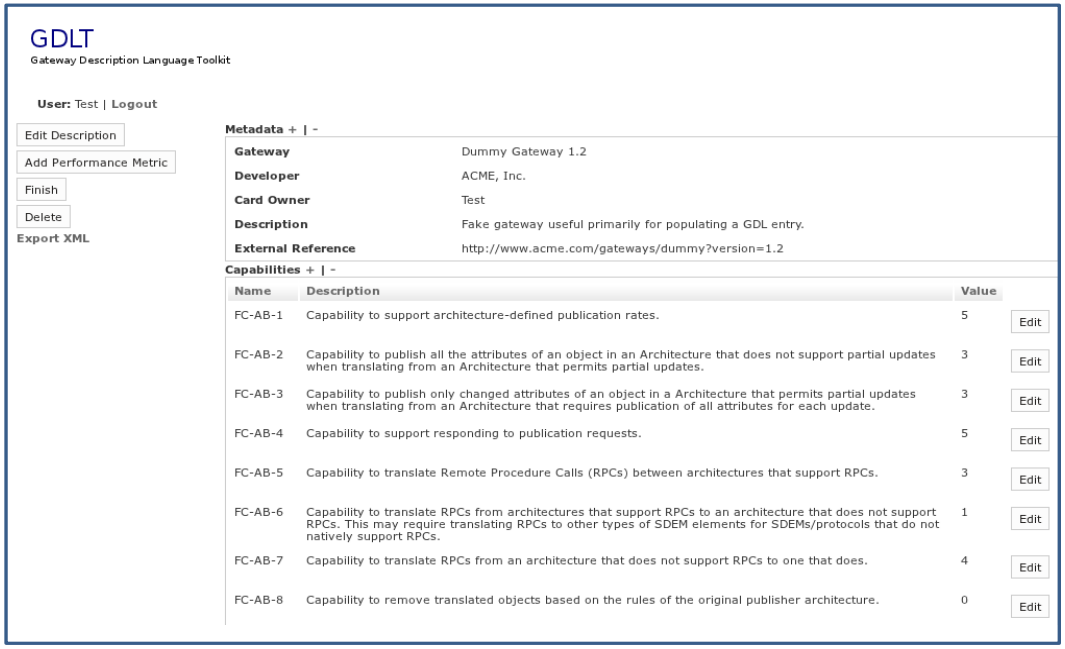


- ***Gateway developer describes the capabilities the gateway provides in a common file format and stores the file in an on-line repository***
- ***Supporting gateway products:***
  - *Gateway Capability Description (GCD) - Delineates the various capabilities that individual gateways can offer to user programs, along with specific levels of implementation for each unique capability*
  - *Gateway Performance Benchmarks (GPB) - Identifies specific gateway performance measures, along with use cases that describe how and where these measures should be applied*
  - *Gateway Description Language (GDL) - A common XML-based, machine-readable format/syntax for describing both user gateway requirements and the capabilities that individual gateways can offer to users*

Step 2: Identify User Requirements

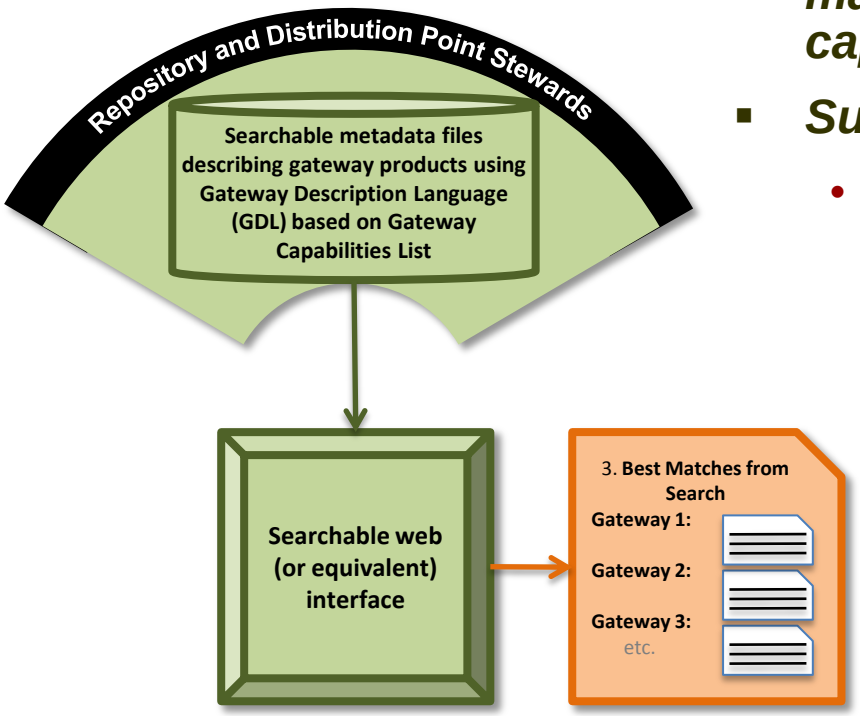


- ***Gateway user defines the gateway requirements for their LVC application in a common file format (GDL)***
- ***Supporting gateway products:***
  - *GDL Editor – Software tool for creating and editing a GDL file*



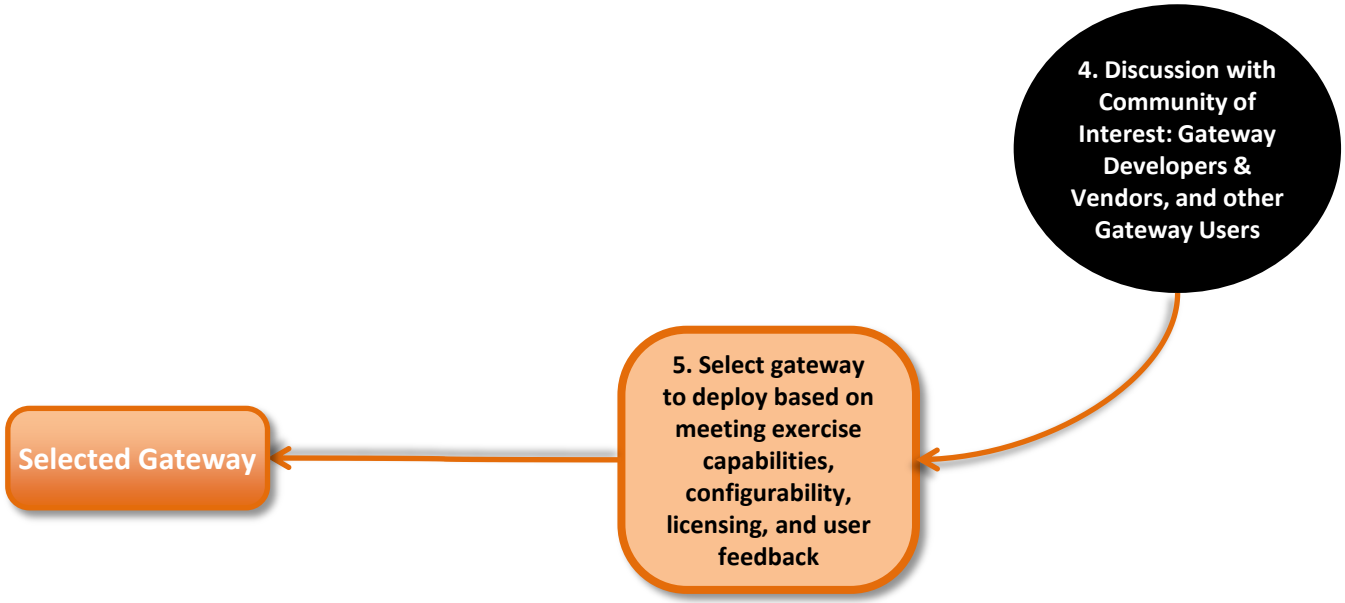
GDL Editor Interface

Step 3: Match Requirements to Capabilities



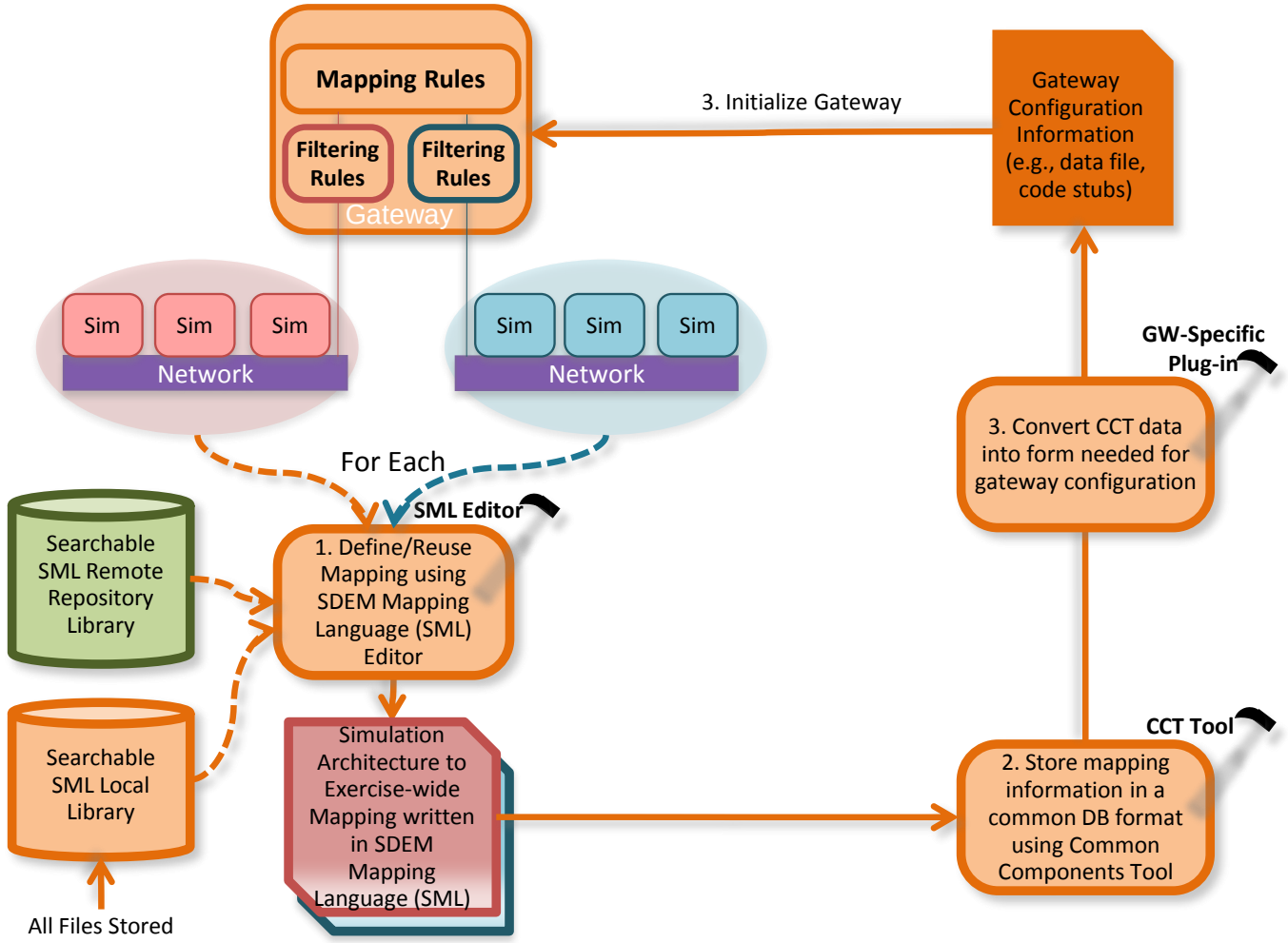
- ***Gateway user employs GDL Editor to match requirements to gateway capabilities stored in GDL Repository***
- ***Supporting gateway products:***
  - *GDL Repository – Gateway-specific element of a larger LVCAR Asset Reuse architecture which includes the Enterprise Metacard Builder Resource (EMBR) Portal. Provides search and discover capabilities*

Step 4: Select Gateway

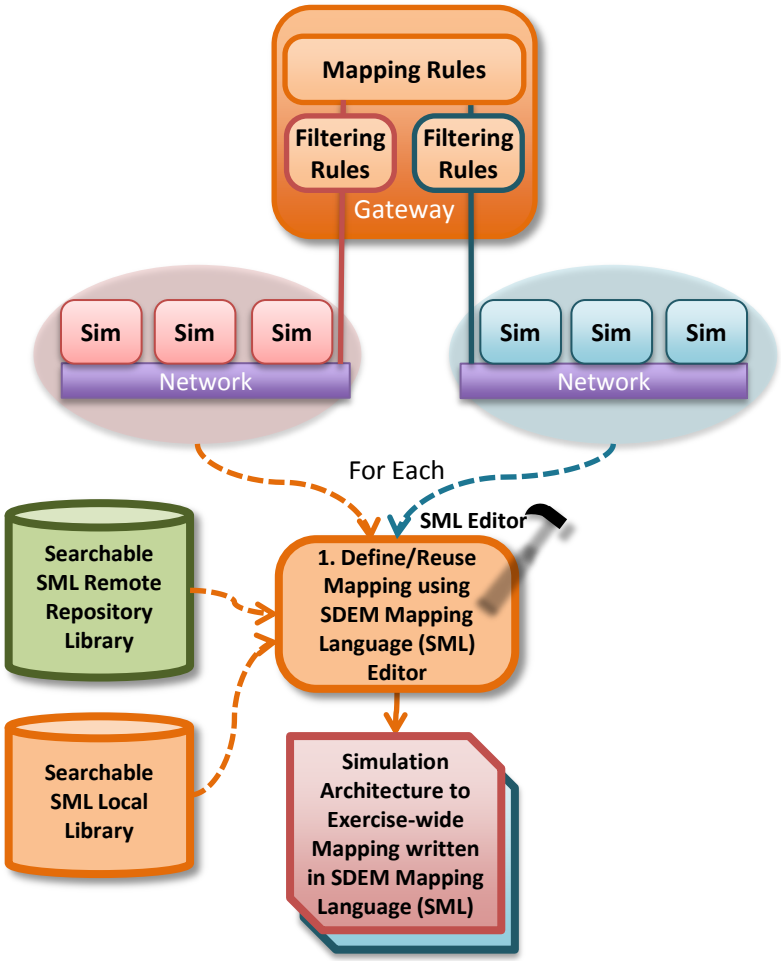


- ***Gateway user leverages matching results and other relevant information to make informed gateway decision***

Systems Engineering Approach to Gateway Configuration and Use

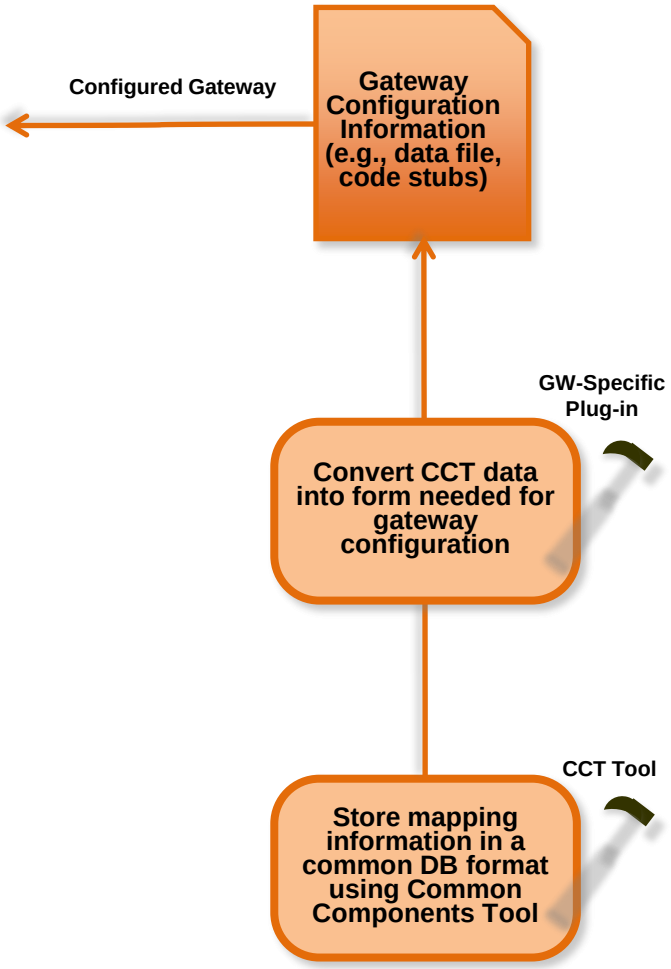


Step 5: Define Simulation Data Element Mappings



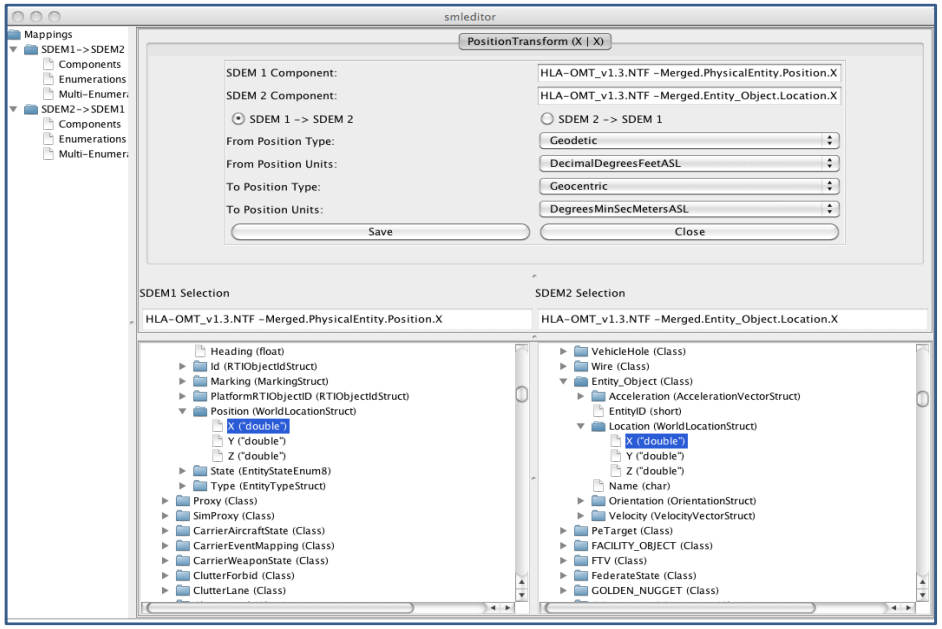
- ***Gateway developer describes the capabilities the gateway provides in a common file format, and stores the file on an on-line repository***
- ***Supporting gateway products:***
  - *SDEM Mapping Language (SML): An XML-based, machine-readable format/syntax for describing architecture/SDEM element mappings and any necessary transforms (e.g., units, coordinate systems)*
  - *SML Editor – Software tool for creating and editing an SML file*

Step 6: Perform Gateway Configuration



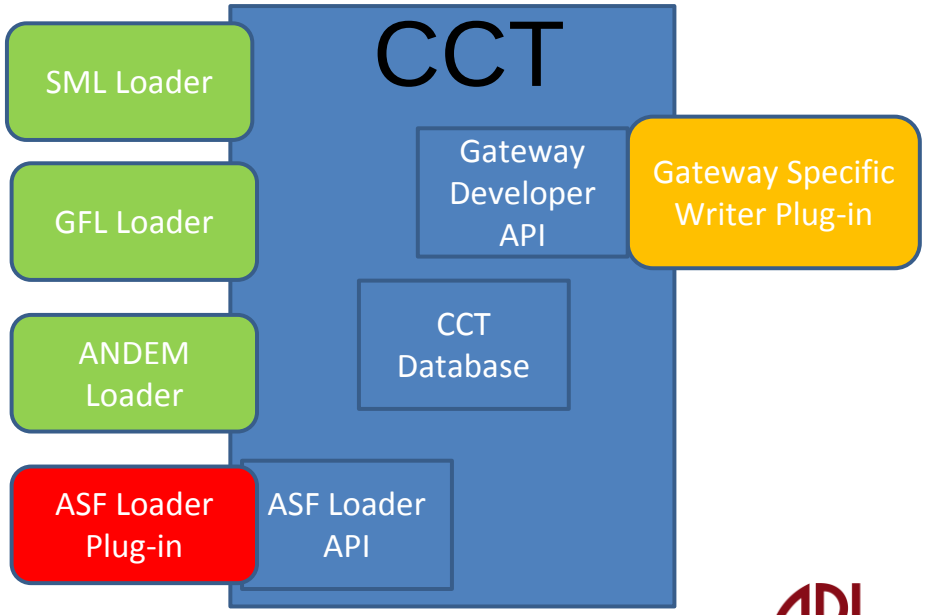
- ***Gateway developer describes the capabilities the gateway provides in a common file format, and stores the file on an on-line repository***
- ***Supporting gateway products:***
  - *Gateway Filtering Language (GFL): Common XML-based language for describing gateway message traffic filters*
  - *Common Components Tool (CCT): Software Tool that ingests gateway configuration information (SDEMs, GFL files, SML files) and stores in a common database format*
  - *Gateway-Specific Plug-ins: Converts CCT data into the format needed for configuration of specific gateways (e.g., files, code)*

Gateway Configuration Tools



SML Editor Interface

CCT Architecture



LVCAR-I Gateways Effort – Summary

- **LVCAR identified a general need for systems engineering rigor in the way LVC environment developers select, configure, and employ gateways**
- **LVCAR-I has produced a process model for gateway selection/configuration that streamlines the development of LVC environments (particularly multi-architecture LVC environments)**
- **Numerous products have been produced to enable this process for practical use**
  - Specifications (e.g., language specifications, performance benchmarks)
  - Tools (e.g., GDL Repository, SML Editor, CCT)
- **LVC community outreach will be a strong emphasis in 2013 to engage developers in product revisions and to help gateway users take advantage of this work**
- **Many LVCAR-I gateway products produced to date are available via this website:**
  - https://msenterprise.jhuapl.edu/drupal/?q=node/37#overlay-context