The Modeling Palette for Large Scale Systems and Enterprises

15 March 2007

Regina M. Gonzales, Ph.D.
Sandia National Laboratories
griegor@sandia.gov
(505) 844-7238

Sandia
National
Laboratories

A Department of Energy
National Laboratory

National Nuclear Security Administration

Modeling Palette for Large Scale Systems and Enterprises

What do we need to model?

Message Sequence/ Collaboration Diagram Protocol or Interfaces

State Diagram Modes / Maturity Events

Use Case Diagram Non-sequential Process

Structure (Class) Diagrams Things/Info/People

Activity Diagram Sequential Process
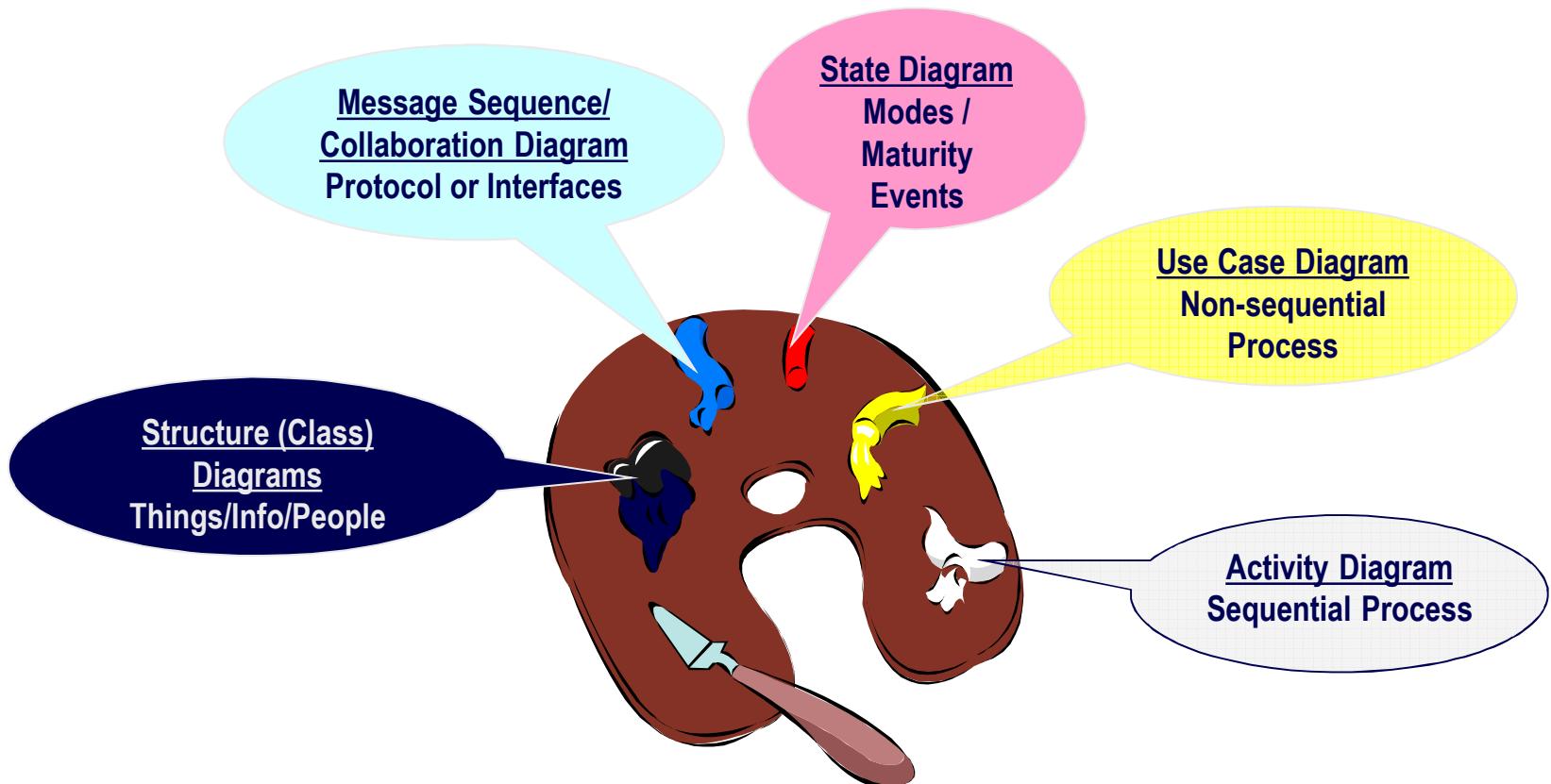
Why do we need to model?

Nature of Large Scale Systems and Enterprises

- **Concurrent**
- **Event-driven**
- **Non-sequential and sequential processes**
- **Layers of behavior within structure**
- **People within the context of the system as well as outside**
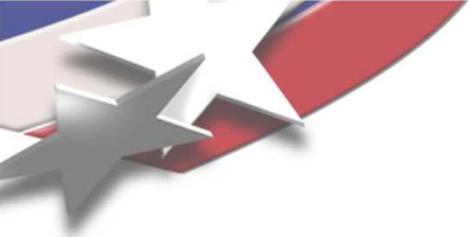
Purpose of Modeling

- **Communication tool for diverse stakeholders**
  - **Shared conceptual model**
  - **Shared semantic relationships**
  - **Abstracts for clear understanding**
  - **Flexible and allows domain language**
  - **Minimal notation, diagrams, and notational idiosyncrasies**
- **Vehicle for implementation**
  - **Models all necessary system concepts**
    - **Boundaries and Interfaces**
    - **Behavior and structure**
    - **Stakeholder relationships to the system**
  - **Rigorous not necessarily formal**
  - **Complete at the system level and shows entire context(s)**
  - **Allows first order behavioral analysis at the system level**

Sandia National Laboratories

A Department of Energy National Laboratory

First Order Functional Partitioning of System from the Perspective of Stakeholders
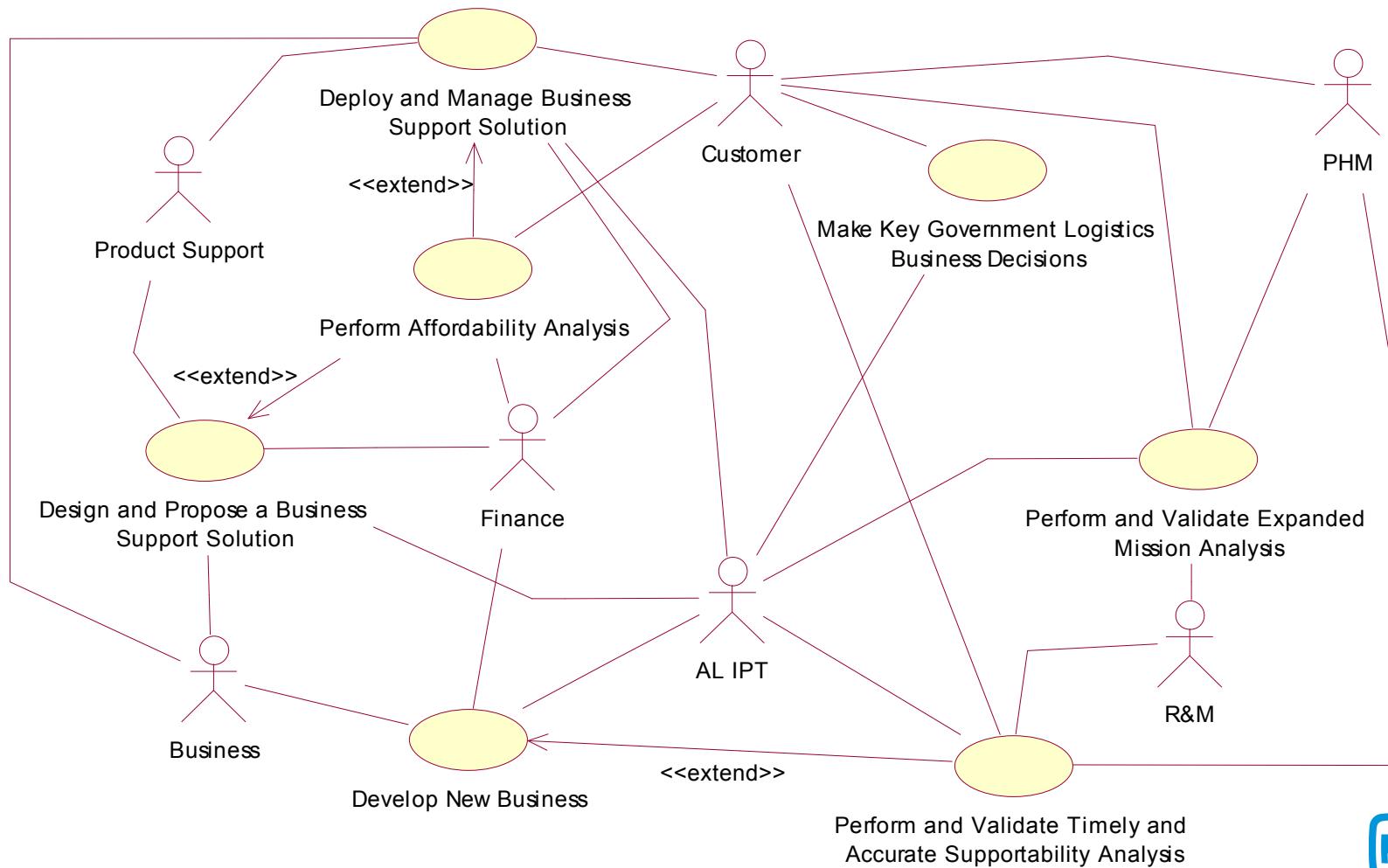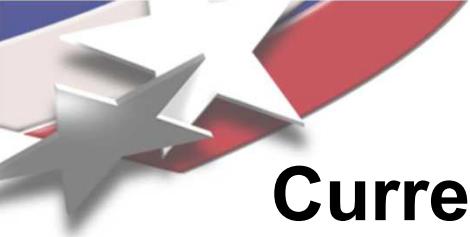
Current Methods (besides PowerPoint)

IDEF

- **Primarily hierarchical decomposition of sequential processes**
- **Provides some mechanism for parallel and non-sequential process**
- **Provides minimal representation of structure (i.e. nouns)**
- **Provides no representation of people (roles and responsibilities)**
- **Tools allow first order behavioral analysis**

SysML (UML 2.0)

- **Sequential processes (activity flow or MSC)**
- **Non-sequential processes (Use Cases)**
- **Event based behavior (state charts)**
- **System structure, hierarchical and relational**
- **Allow attribution of structural elements**
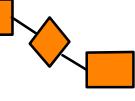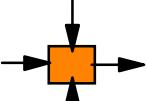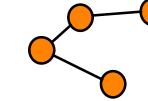- **Provides mechanism to view people in relation to each other and the system as well as roles and responsibilities**
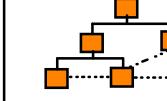
SysML Pillars
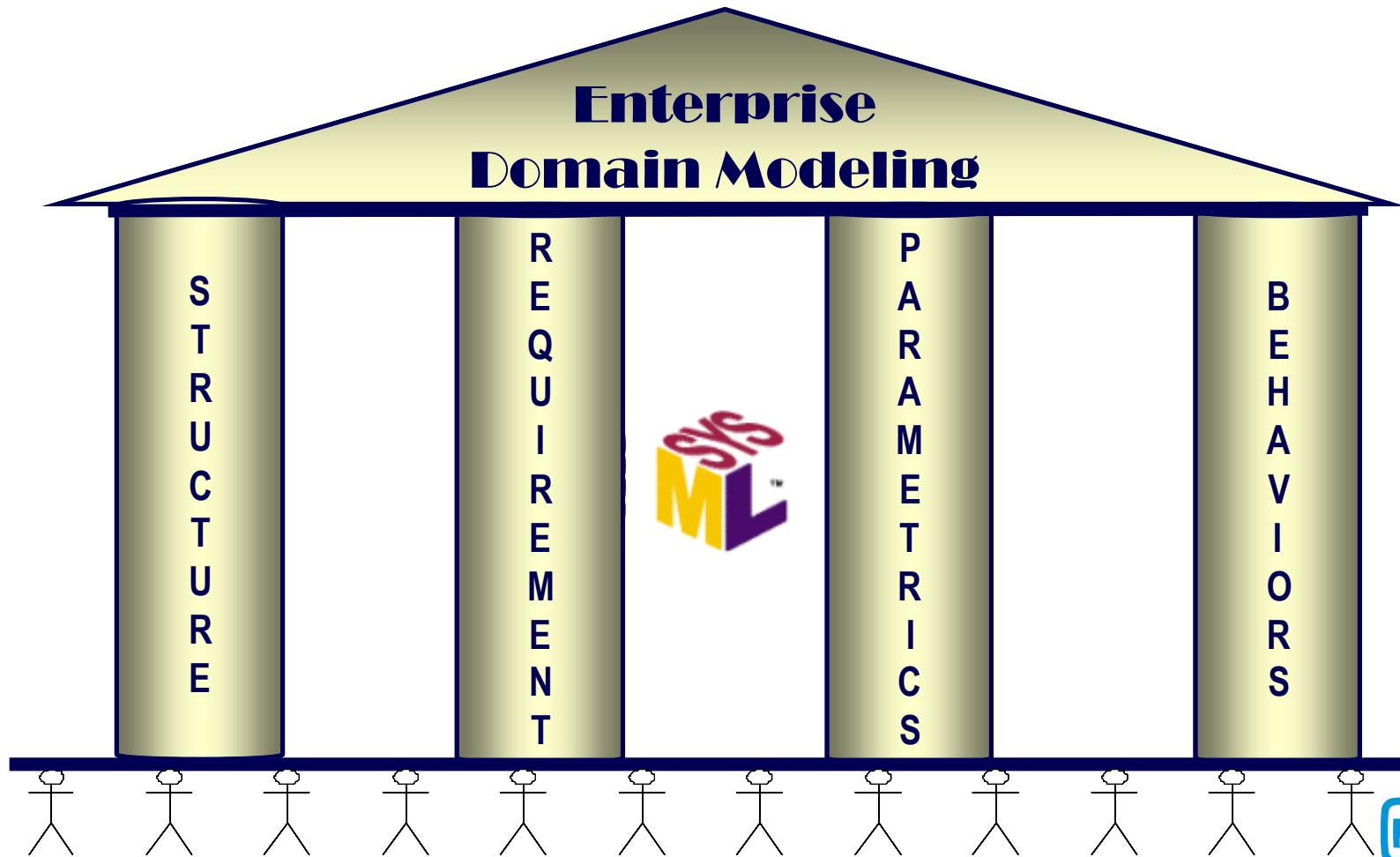
ENTERPRISE ARCHITECTURE - A FRAMEWORK ™

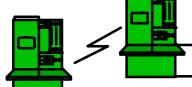|	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*	
SCOPE (CONTEXTUAL) *Planner*	List of Things Important to the Business ENTITY = Class of Business Thing	List of Processes the Business Performs Function = Class of Business Process	List of Locations in which the Business Operates Node = Major Business Location	List of Organizations Important to the Business People = Major Organizations	List of Events Significant to the Business Time = Major Business Event	List of Business Goals/Strat Ends/Means=Major Bus. Goal/Critical Success Factor	**SCOPE (CONTEXTUAL)** *Planner*
ENTERPRISE MODEL (CONCEPTUAL) *Owner*	e.g. Semantic Model Ent = Business Entity Reln = Business Relationship	e.g. Business Process Model Proc. = Business Process I/O = Business Resources	e.g. Logistics Network Node = Business Location Link = Business Linkage	e.g. Work Flow Model People = Organization Unit Work = Work Product	e.g. Master Schedule Time = Business Event Cycle = Business Cycle	e.g. Business Plan End = Business Objective Means = Business Strategy	**ENTERPRISE MODEL (CONCEPTUAL)** *Owner*
SYSTEM MODEL (LOGICAL) *Designer*	e.g. Logical Data Model Ent = Data Entity Reln = Data Relationship	e.g. "Application Architecture" Proc .= Application Function I/O = User Views	e.g. "Distributed System Architecture" Node = I/S Function (Processor, Storage, etc) Link = Line Characteristics	e.g. Human Interface Architecture People = Role Work = Deliverable	e.g. Processing Structure Time = System Event Cycle = Processing Cycle	e.g., Business Rule Model End = Structural Assertion Means =Action Assertion	**SYSTEM MODEL (LOGICAL)** *Designer*
TECHNOLOGY MODEL (PHYSICAL) *Builder*	e.g. Physical Data Model Ent = Segment/Table/etc. Reln = Pointer/Key/etc.	e.g. "System Design" Proc.= Computer Function I/O = Screen/Device Formats	e.g. "System Architecture" Node = Hardware/System Software Link = Line Specifications	e.g. Presentation Architecture People = User Work = Screen Format	e.g. Control Structure Time = Execute Cycle = Component Cycle	e.g. Rule Design End = Condition Means = Action	**TECHNOLOGY CONSTRAINED MODEL (PHYSICAL)** *Builder*
DETAILED REPRESEN- TATIONS (OUT-OF- CONTEXT) *Sub-Contractor*	e.g. Data Definition Ent = Field Reln = Address	e.g. "Program" Proc.= Language Stmt I/O = Control Block	e.g. "Network Architecture" Node = Addresses Link = Protocols	e.g. Security Architecture People = Identity Work = Job	e.g. Timing Definition Time = Interrupt Cycle = Machine Cycle	e.g. Rule Specification End = Sub-condition Means = Step	**DETAILED REPRESEN- TATIONS (OUT-OF-CONTEXT)** *Sub-Contractor*
FUNCTIONING ENTERPRISE	e.g. DATA	e.g. FUNCTION	e.g. NETWORK	e.g. ORGANIZATION	e.g. SCHEDULE	e.g. STRATEGY	**FUNCTIONING ENTERPRISE**
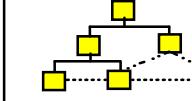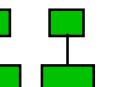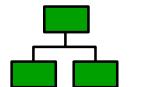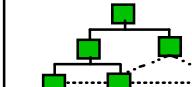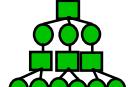
Zachman Institute for Framework Advancement - (810) 231-0531   Copyright - John A. Zachman, Zachman International
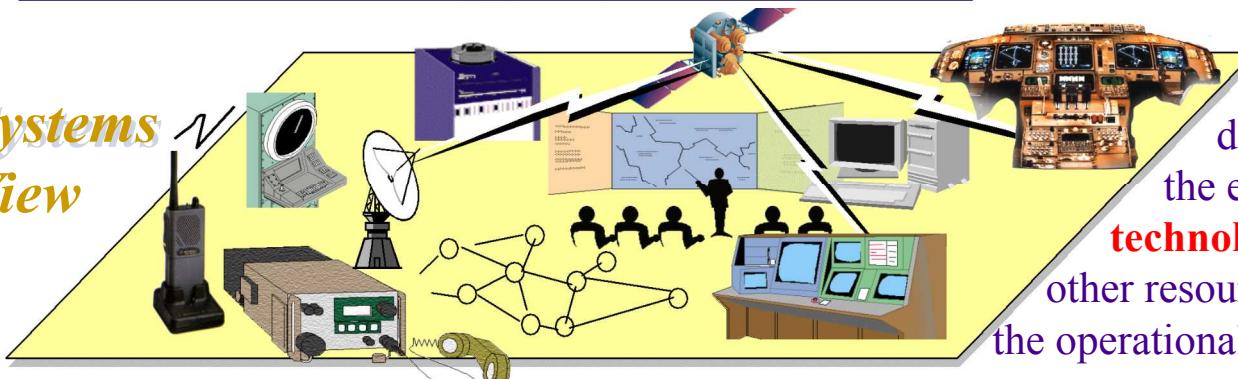
DoD Architecture Framework
One Architecture – Three Views

Operational View

The **Operational View** describes and interrelates the **operational elements**, **tasks** and **activities**, and **information flows** required to accomplish mission operations.

Systems View

The **Systems View** describes and interrelates the existing or postulated **technologies**, **systems**, and other resources intended to support the operational requirements.
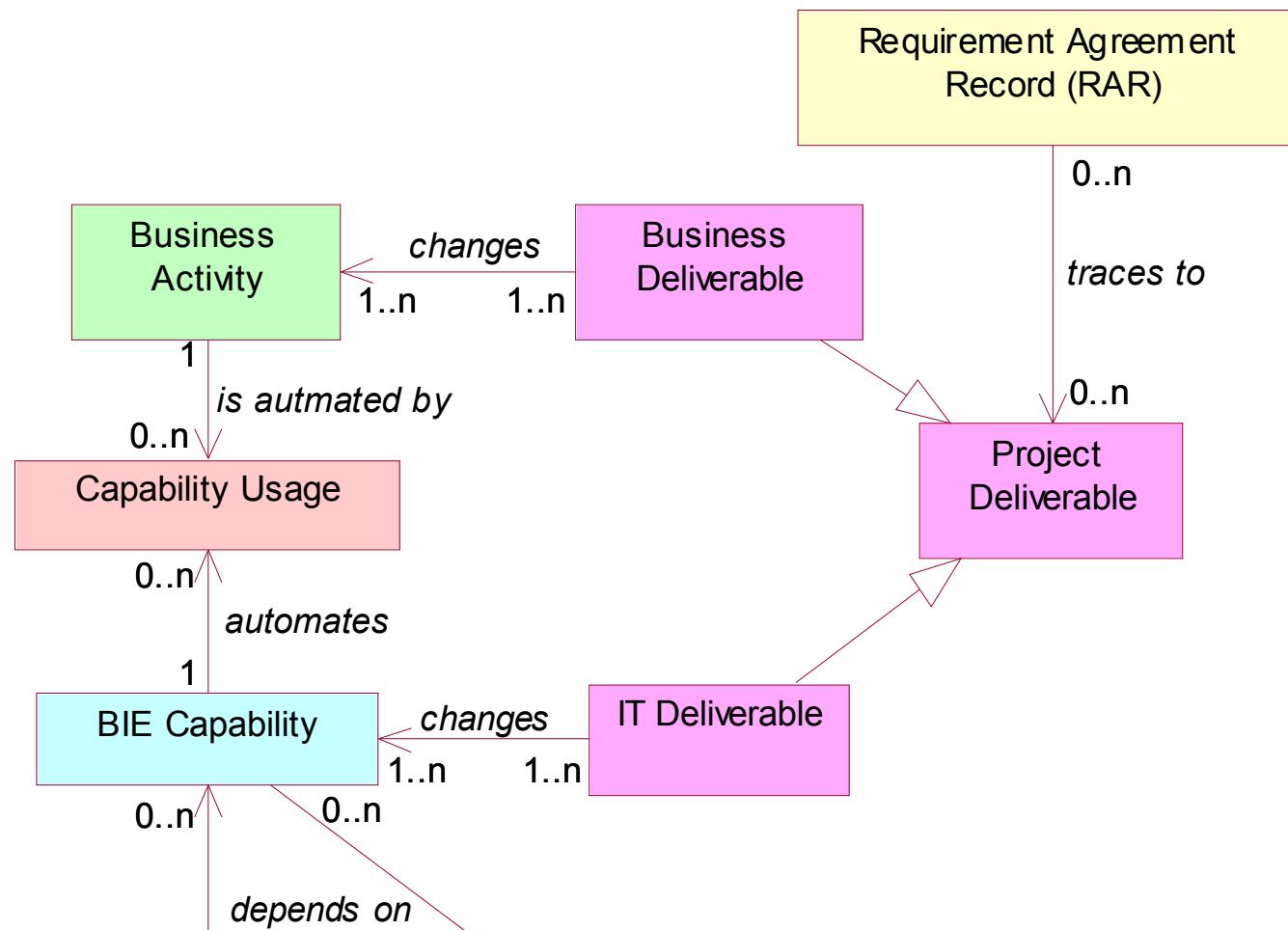
Technical View

The **Technical View** describes the profile of rules, **standards**, and **conventions** governing systems implementation and **forecasts** their future direction.
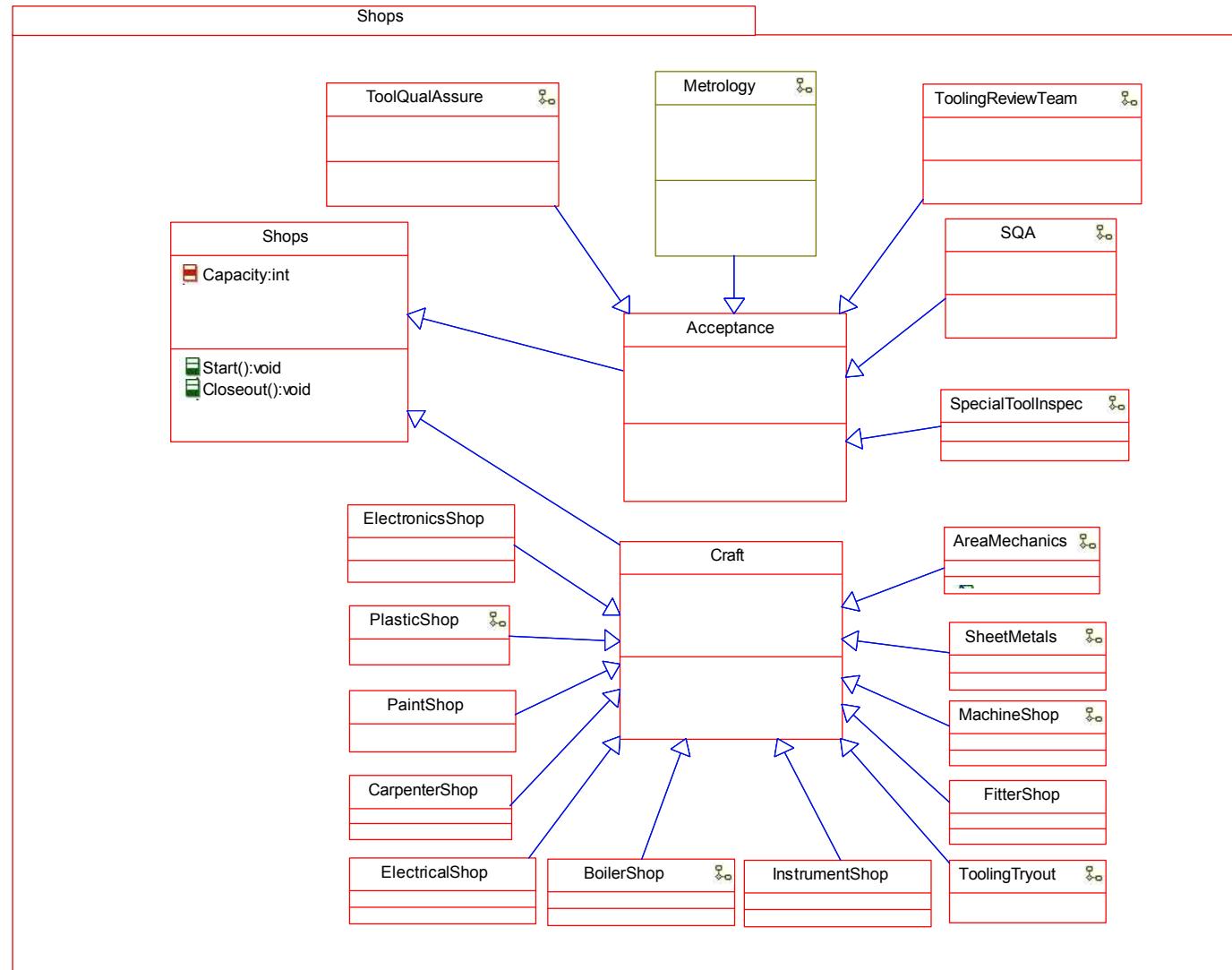
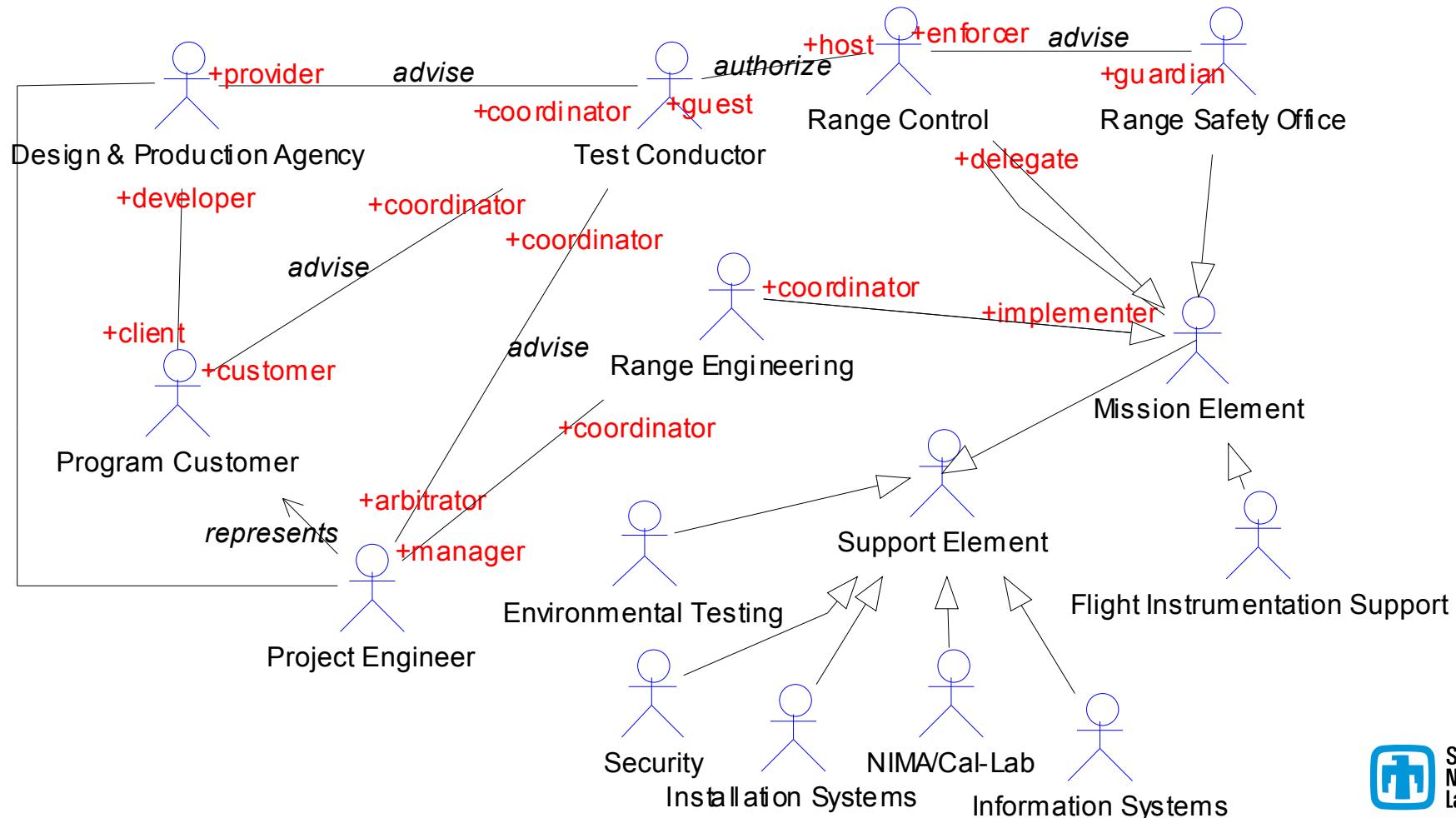Sandia National Laboratories

Relationship of the 'What'
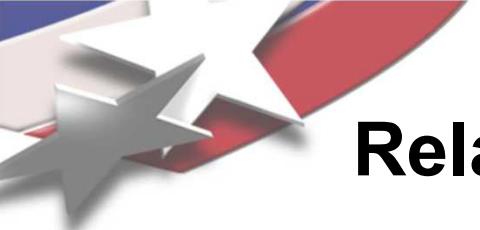
Representation of the "How" and Responsibilities
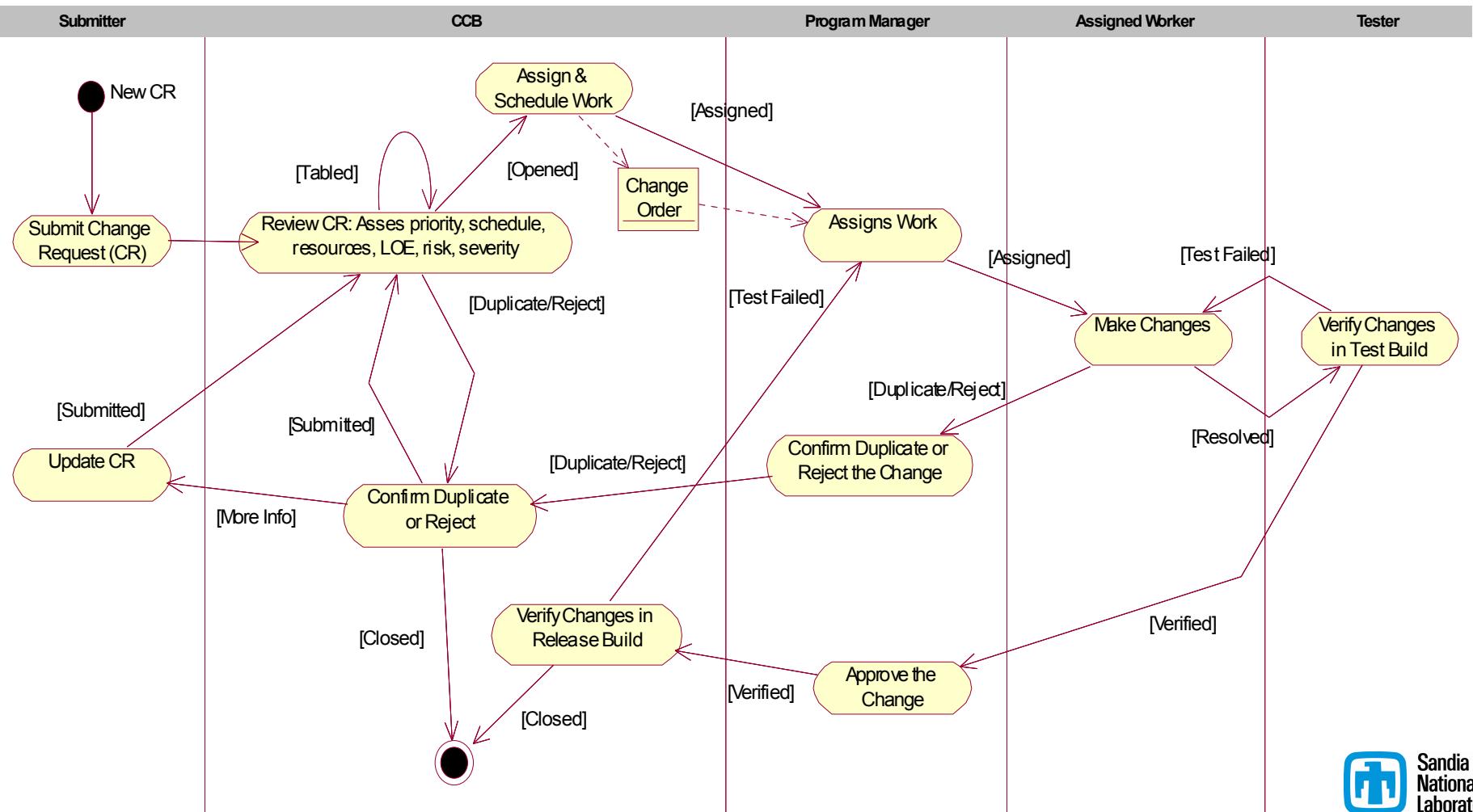
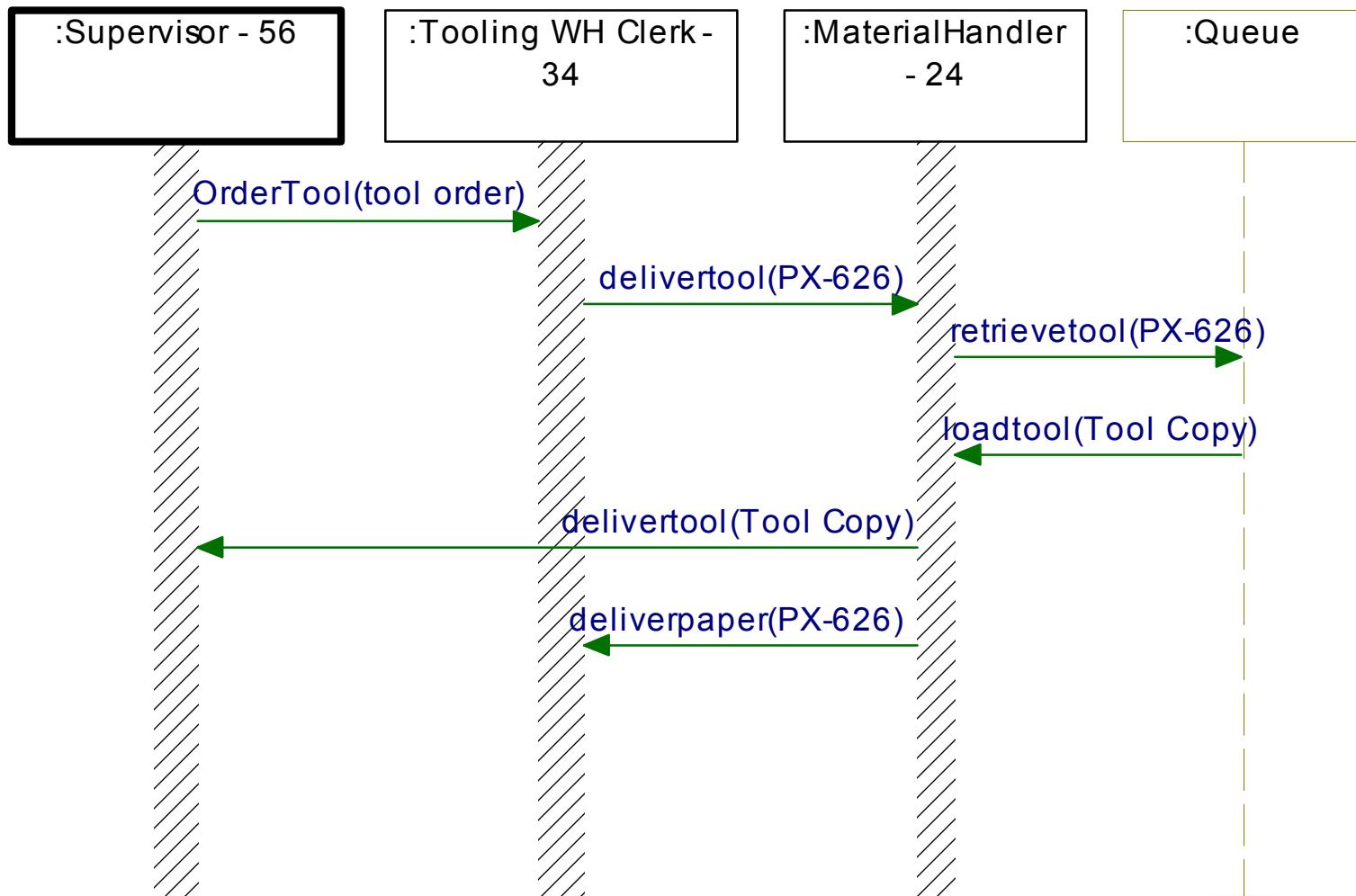# Structure of the "Where" – Layered Behavior
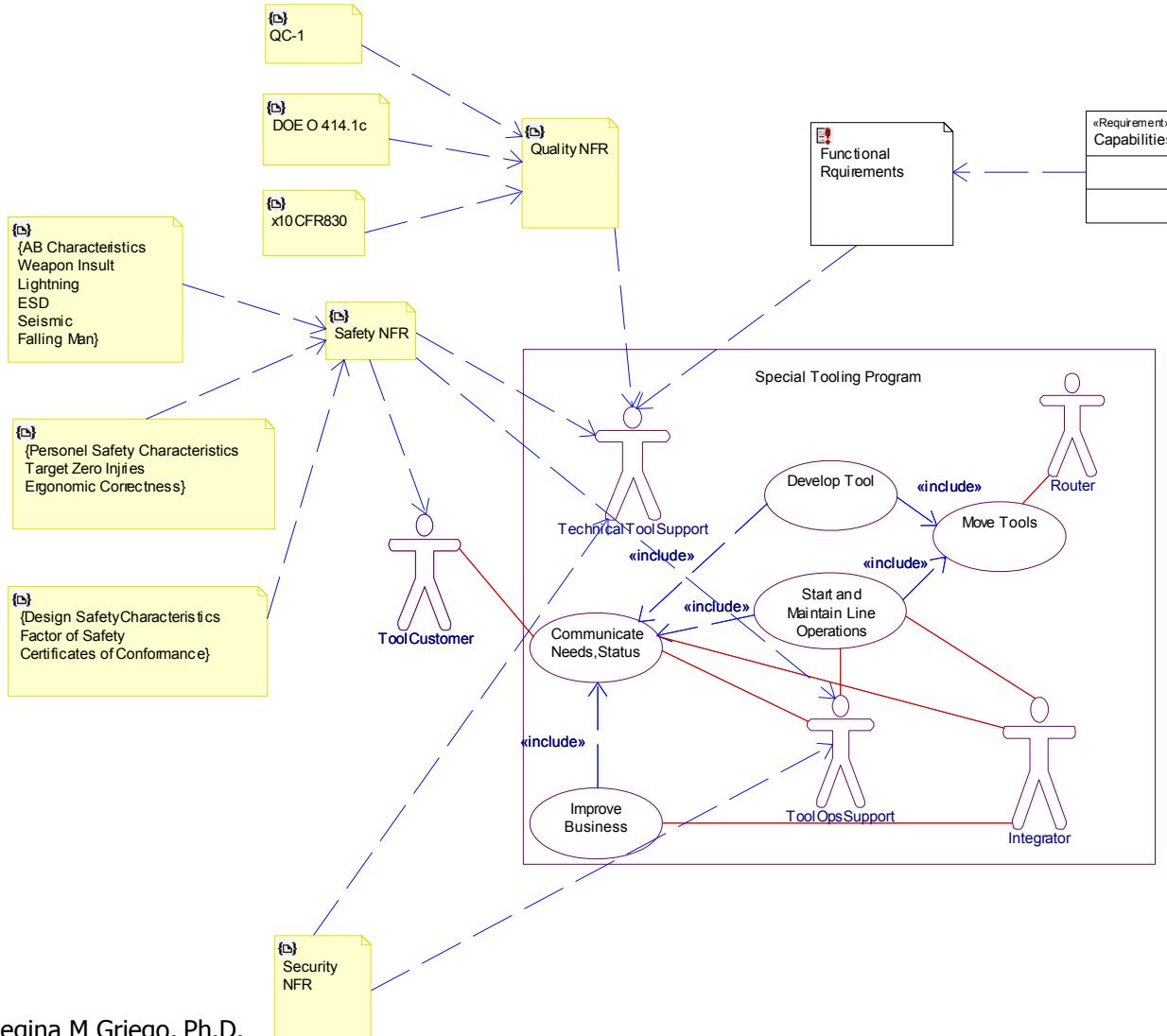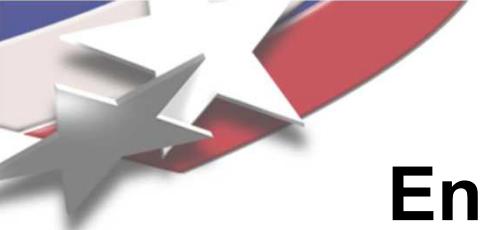
Relationship of the "Who"

Relative Timing ("When") of Event Transaction
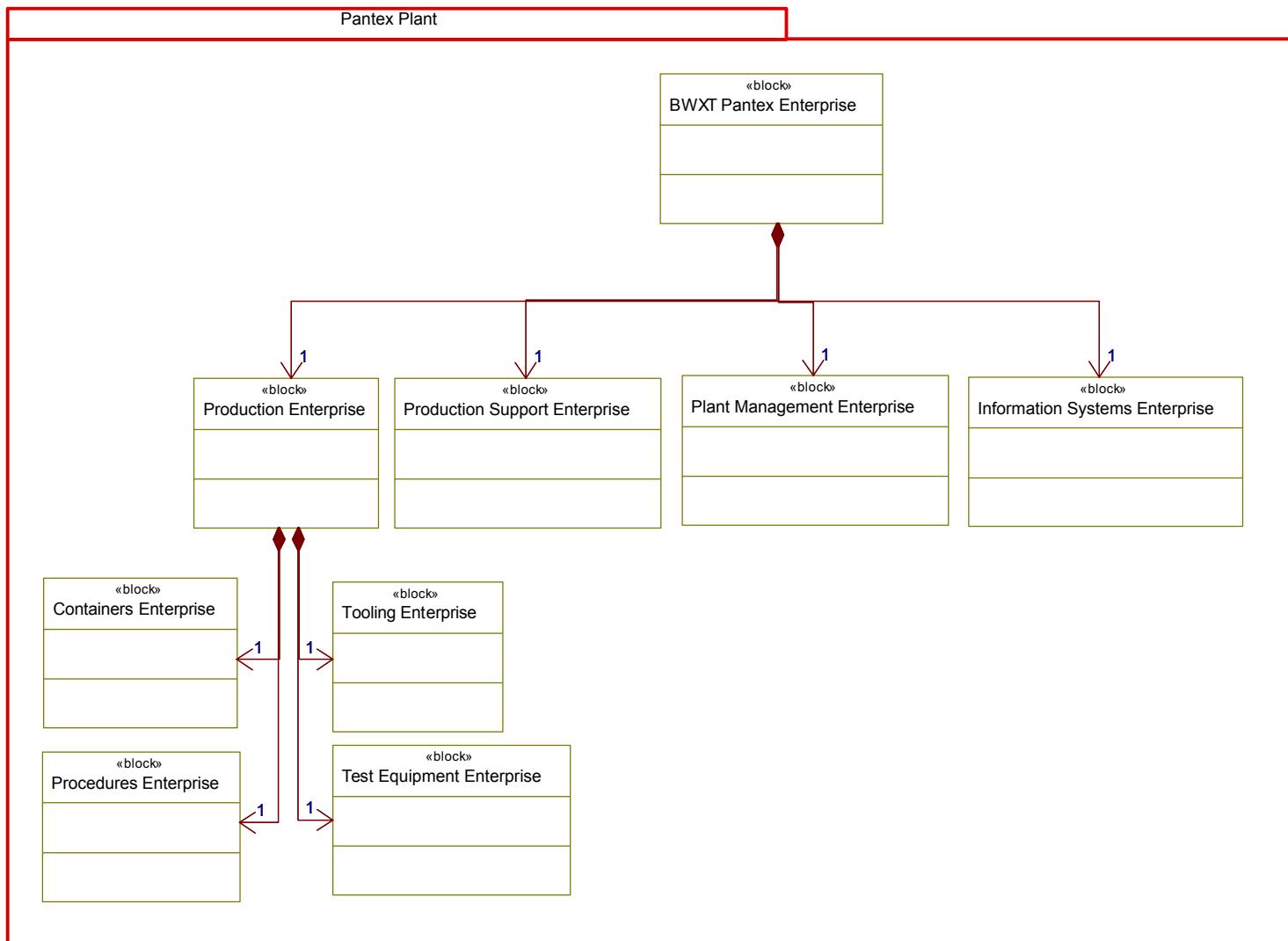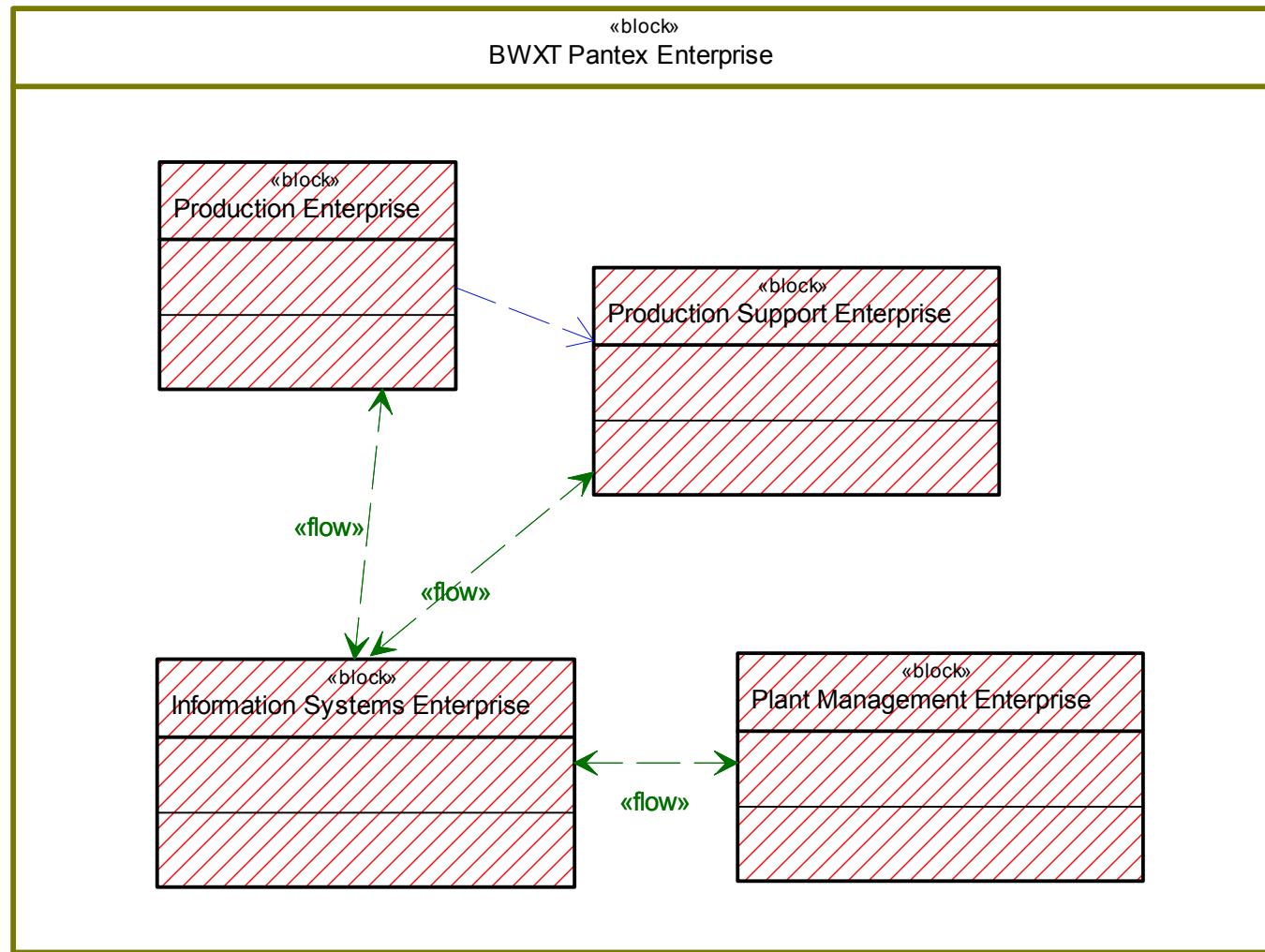
System Context with Stakeholders

Enterprise Breakdown Structure

Enterprise Relationship Structure

Conclusions

- **Apply modeling rigorously and with the necessary level of completeness**
  - **Shared conceptual model**
  - **Assists in developing complete and consistent requirements**
  - **Provides a way of framing, partitioning, and 1st order assessment the technical effort**
- **IDEF is early '80s technology when we were not modeling the scale of complexity in behavior and structure**
- **SysML (UML 2.0) provide mechanisms for the necessary modeling of Large Scale Systems and Enterprises, but a minimalist approach in necessary**
- **In all cases the modeling effort should be planned and engineered**