Executives Will Want to use MBSE

The value of MBSE to a non-engineer

Loyd Baker – VP of Technology

3SL, Inc

Track 2: MBSE, M-8

The presenter,

Loyd Baker, is VP for Technology with 3SL Inc., with extensive experience teaching automated MBSE methods to major US corporations and government agencies such as NASA, FAA, and DoE.

Provides training for Cradle (https://www.**threesl.com***)* the systems engineering tool selected by NASA as their primary requirements management tool.

Past president of the Huntsville Chapter of International Council on Systems Engineering (INCOSE)

NASA Silver Snoopy Award winner for support of the Apollo missions, including Apollo 13.

What is MBSE (Model Based Systems Engineering) ?

- Model Based Systems Engineering (MBSE) is defined by the International Council on Systems Engineering (INCOSE) as follows:

  "The formalized application of **modeling** to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. MBSE enhances the ability to capture, analyze, share, and manage the information associated with the specification of a product." Taken from the INCOSE System Engineering Handbook.

- Your CEO, CFO, COO, VP of anything but Engineering **DOESN'T CARE about MBSE!**

Executives Will Want to use MBSE

- To a Systems Engineer the value of MBSE is as follows:
    - Enhanced knowledge capture and reuse of the information
    - Improved communications among project members and stakeholders
    - Enhanced ability to compare architecture specifications
- Dwight Eisenhower said, ***"Leadership is the art of getting someone else to do something you want done because he wants to do it."***
- How do you get an non-engineering executive to want MBSE and provide the budget for the time, training and tools needed to do it successfully?

WIFM - What's in it for Me ?

- CEO, GM, Program Manager
    - Brief visual communication verses long documents
    - Reduced cost
    - Remember – <u>How to</u> will provide needed support information –but should Not be your lead argument
- CFO, other financial lead
    - Reduced cost
    - More accurate budgeting of time and money

Understand the CEO's Point of View

1. Know where they came from

    •   Engineer that came through the ranks to the top exec

    •   Business guy that closed contracts or program manager to keep things running

    •   Founder, placed after a merger/buyout, ???

2. What are Big picture company goals

    •   What do the shareholders/stakeholders expect?

    •   How is the executive or manager evaluated/compensated

    •   How does MBSE support these

Understand the CFO's Point of View

- Cost savings – but in context with your business model
  - Does your business bill by the hour on a contract?
  - Fixed firm price contracts
  - Sell finished products verses services
- Accuracy of schedule and costs
  - Increasing predictability

So, What's the story MBSE tells?

- how does more visualization of information helps the product specification process?
  - Do not tell Executives how we create the visual models
  - Discuss the "value-Add" to the organization
    > For example, a graphical diagram shows in one picture what may take pages and pages of text to convey – things get missed by the 15th page, the graphical picture makes it obvious. The graphical picture with a textual description for each symbol.

What is the Problem we Want to Solve?

Problem:

When project information is spread across multiple documents, and captured as free form text, the lack of consistent traceability can result in labor intense activities when examining project data.
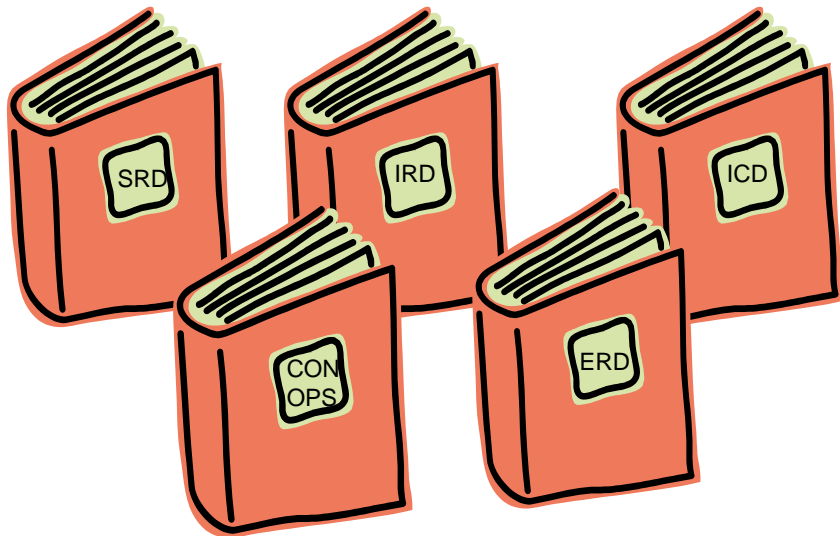
Systems Engineers Work with Pieces of Information So Maybe we should Manage the Pieces

Engineers utilize a large amount of different "pieces of information" to design, analyze, verify and validate a new system or modifications to an existing system

**Pieces of information**
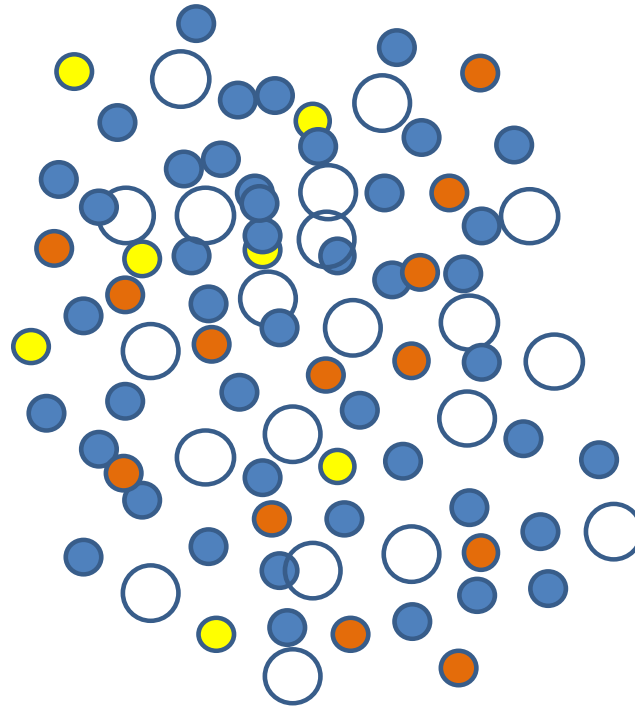
What do we do with the Dots?

Connect the Dots Together to Tell a Story

A Piece of Information by itself has limited value, but when associated with one or more other pieces of information via relationships (i.e., cross reference links), the information has more value to the project
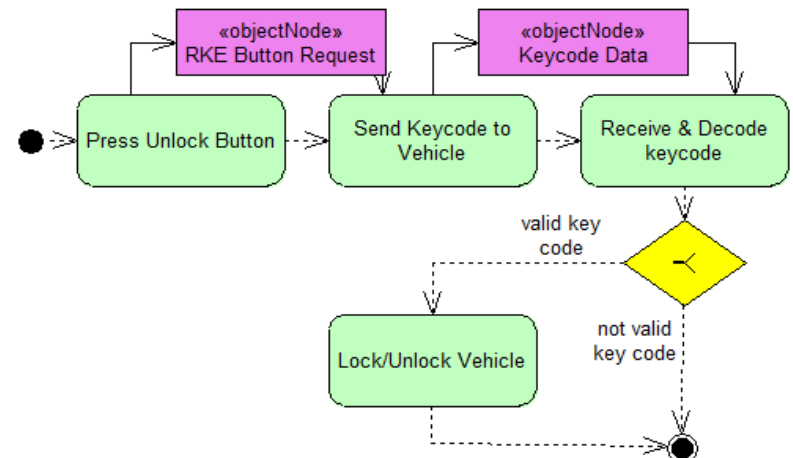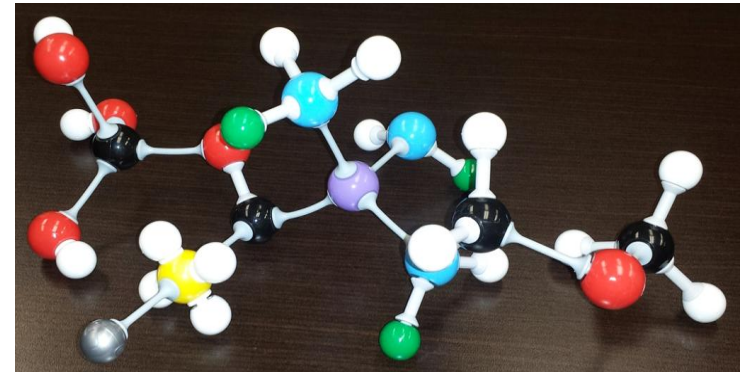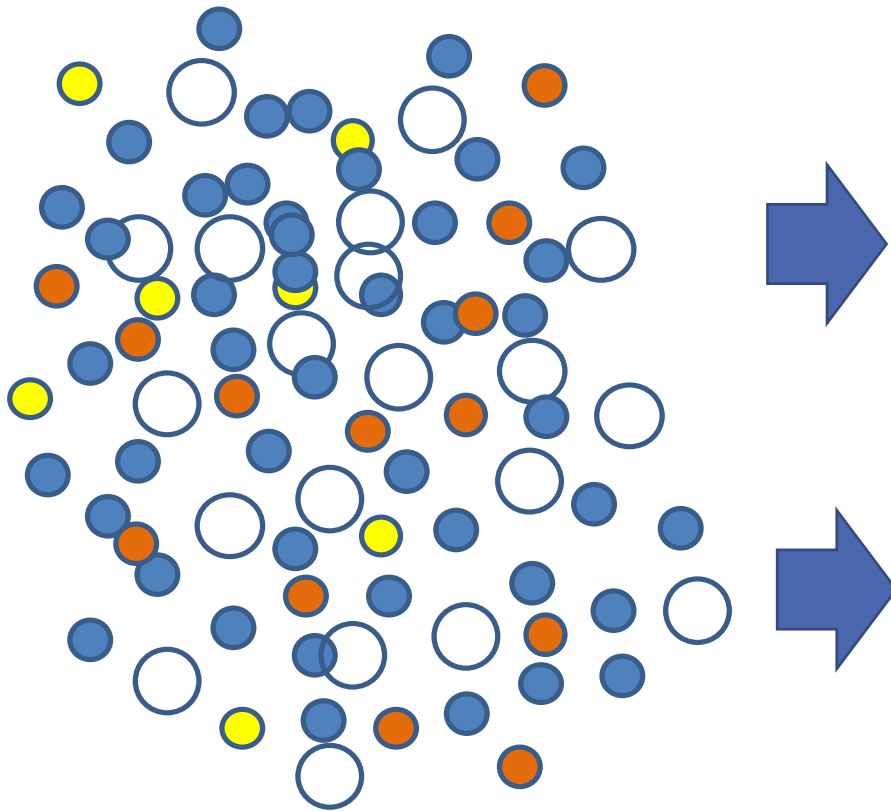
Connect the Dots using a defined Set of Rules and the result is a Structured Information-Model?

The information-Model consists of **elements**, **relationships** that establish traceability between elements, and **diagrams** (conceptual models). This information is stored in a Repository (i.e., database) that is accessible by computer-based tools.
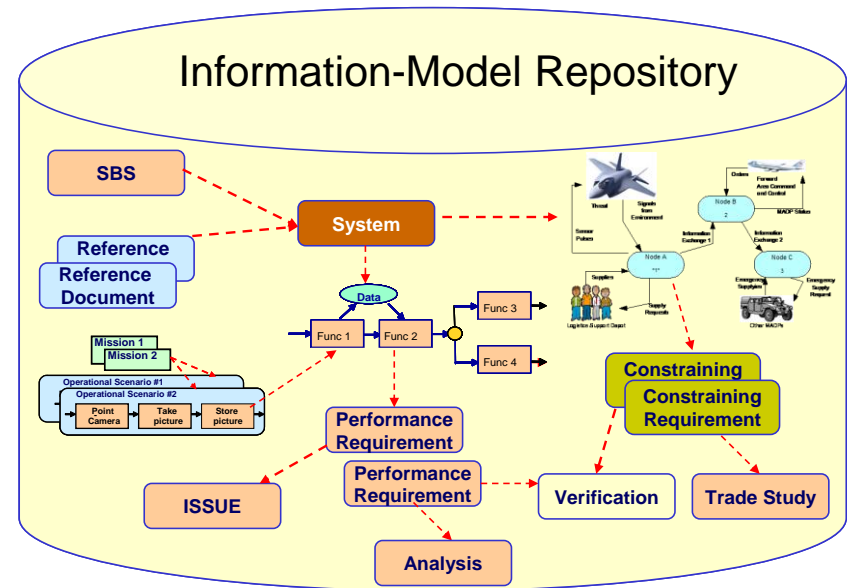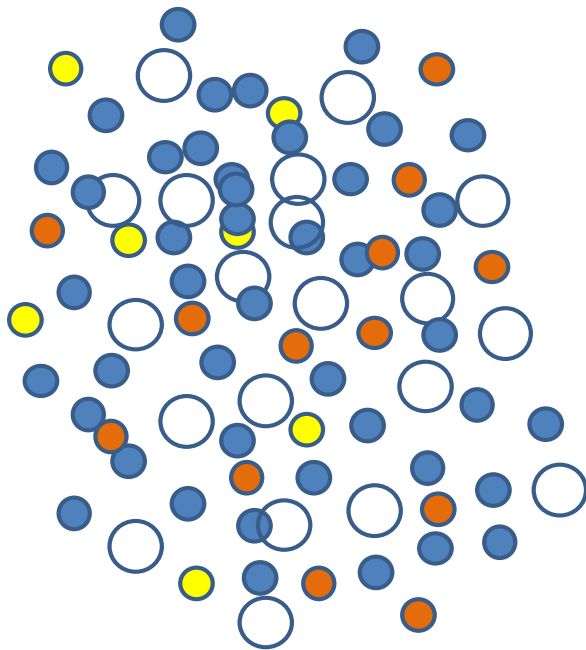
This type of structured approach is know as a Model-Based Systems Engineering (**MBSE**) Process. The process defines the rules to use to connect the dots.

Define Your Project's Model-Based Systems Engineering Process (MBSE)

Define the Project's Systems Engineering Process & Methods and then identify the Information-Model Element-Types and Diagrams-Types to be used on the project.
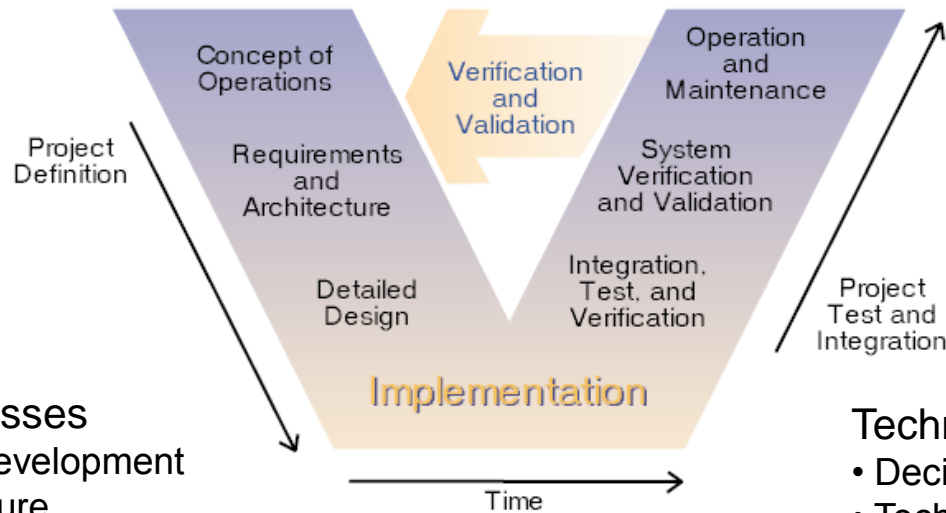
Technical Processes
- Requirements Development
- Logical Architecture
- Physical Architecture
- Design Solution
- Implementation
- Integration
- Verification
- Validation
- Transition

Technical Management Processes
- Decision Analysis
- Technical Planning
- Technical Assessment
- Requirements Management
- Architecture Management
- Risk Management
- Configuration Management
- Technical Data Management
- Interface Management
- Traceability Management

Summary - Benefits of MBSE

Project Activities	MBSE Methods	Document-Centric Methods	Best Method
Reviews (SDR, PDR, CDR)	Interrogate models following established traceability links	Read and interpret text and find related information manually. Labor intensive and time consuming.	MBSE built-in traceability
Communication	Stories described using established traceability links and known modeling rules mean less reader interpretation.	Read and interpret text to understand a specific story but because the information is free form text the understood story is based on reader perspective and is very subjective.	MBSE built-in traceability
Verification	Follow the built in traceability links to access all relevant information associated with a verification audio	Human must read the different documents to perform verification audio. Because there is no built in road map the next reviewer may miss something.	MBSE built-in traceability
Validation	Follow the traceability links through different views (e.g., customer's context, developers context, requirements view, etc)	Walk through document reviews based on reading the entire document and mentally linking relevant information together on the fly. Each reviewer must repeat the process	MBSE built-in traceability
Summary	Traceability of requirements to design to verification is built into the Information Model	Assuring accuracy of traceability of requirements to design to verification is labor intensive and very time consuming	MBSE built-in traceability

If the Executive gets excited and says, "show me examples of the kinds of models the team will build." Use Simple Example Diagrams like on the following slides.

Define the Uses/Missions for the Proposed System

A Use Case Diagram displays a set of use cases (the mission/goals for the subject system) as well as the actors/stakeholders that invoke and participate in those use cases.

To understand a use case we tell stories. These stories cover how to successfully achieve the goal/mission, and how to handle any faults/problems that may occur.
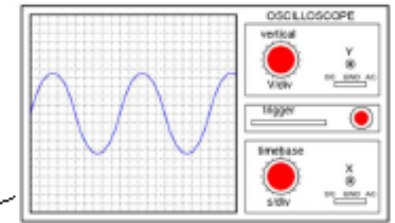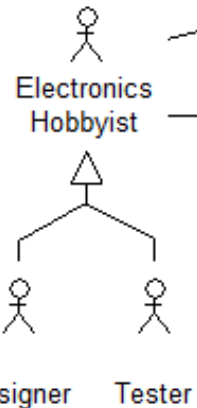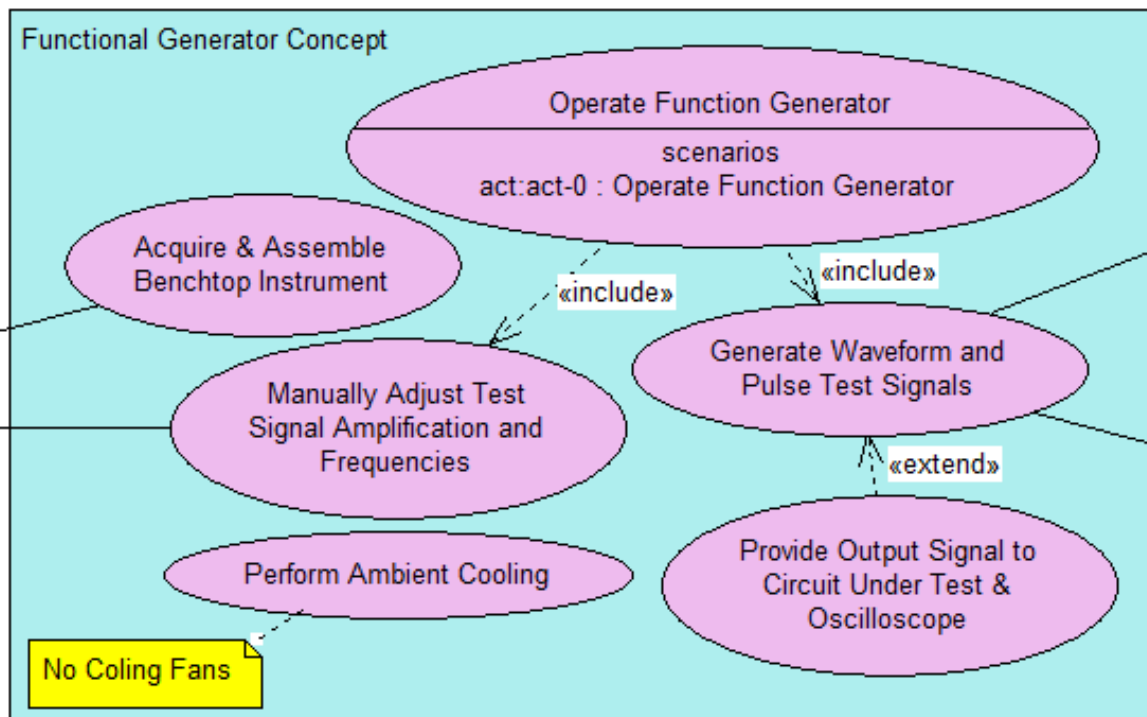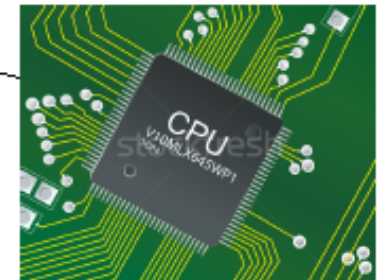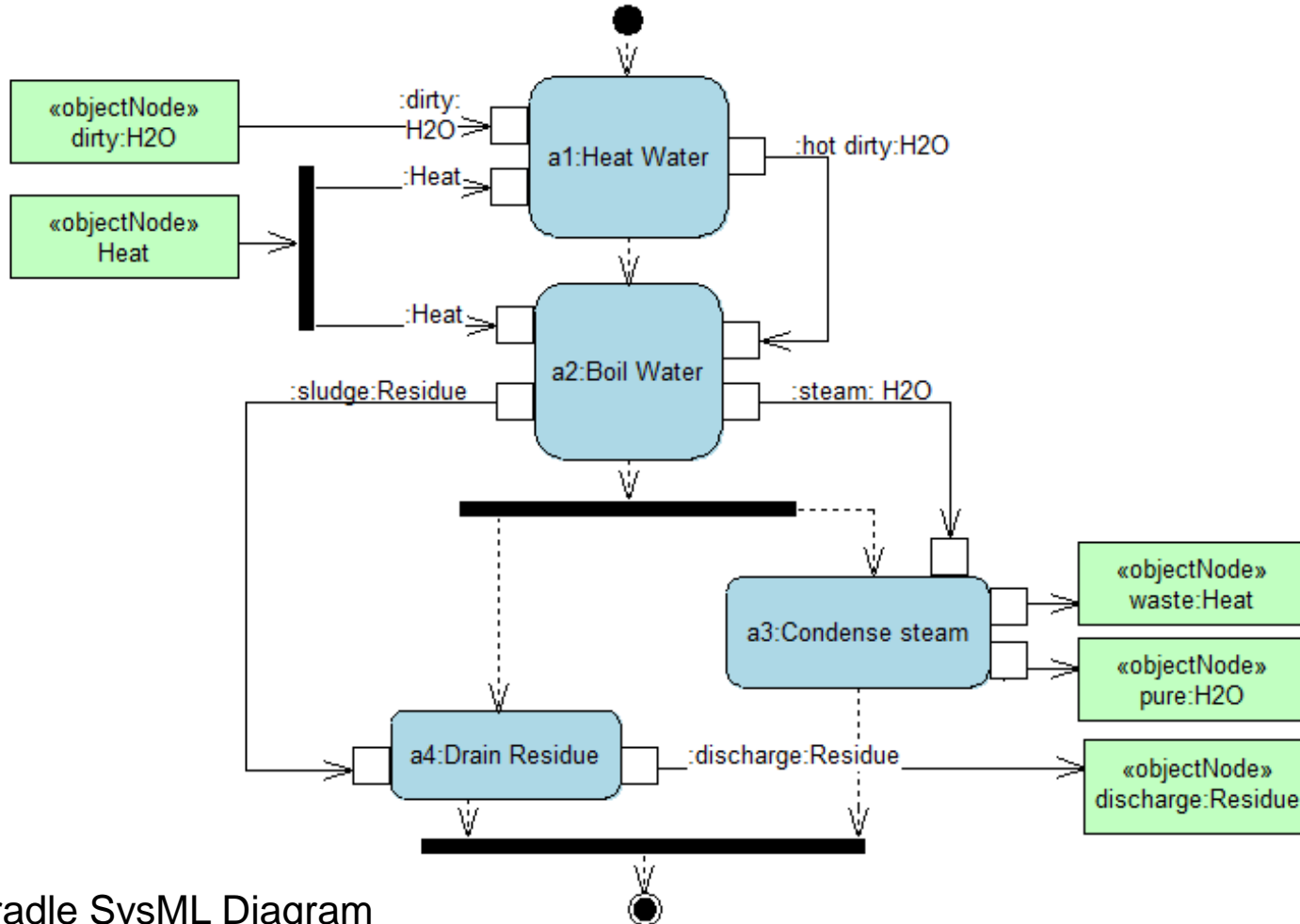

Cradle SysML Diagram

Describe Operational Scenarios for each Use case

This Activity Diagram (act) is used to specify the operational activities needed to accomplish the linked use case.

Cradle SysML Diagram

# Create System Context Diagram to Identify external Systems

This bdd System Context Diagram is defining all relevant external systems the System under development must interact with.
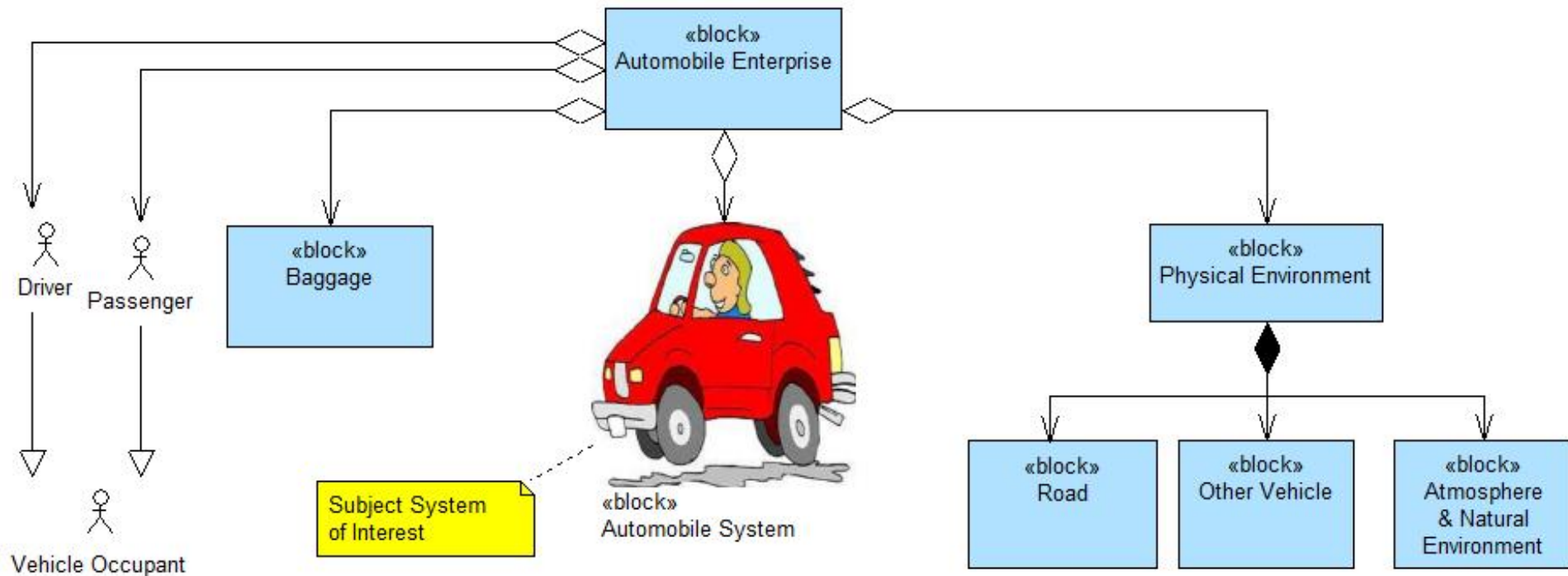
Cradle SysML Diagram

# Create System Context Diagram to Identify External Interfaces

This Internal Block Definition diagram (ibd) shows the internal structure of a high-level block and how the internal entities are interconnected, and what flows across the connections (i.e.. external interfaces).
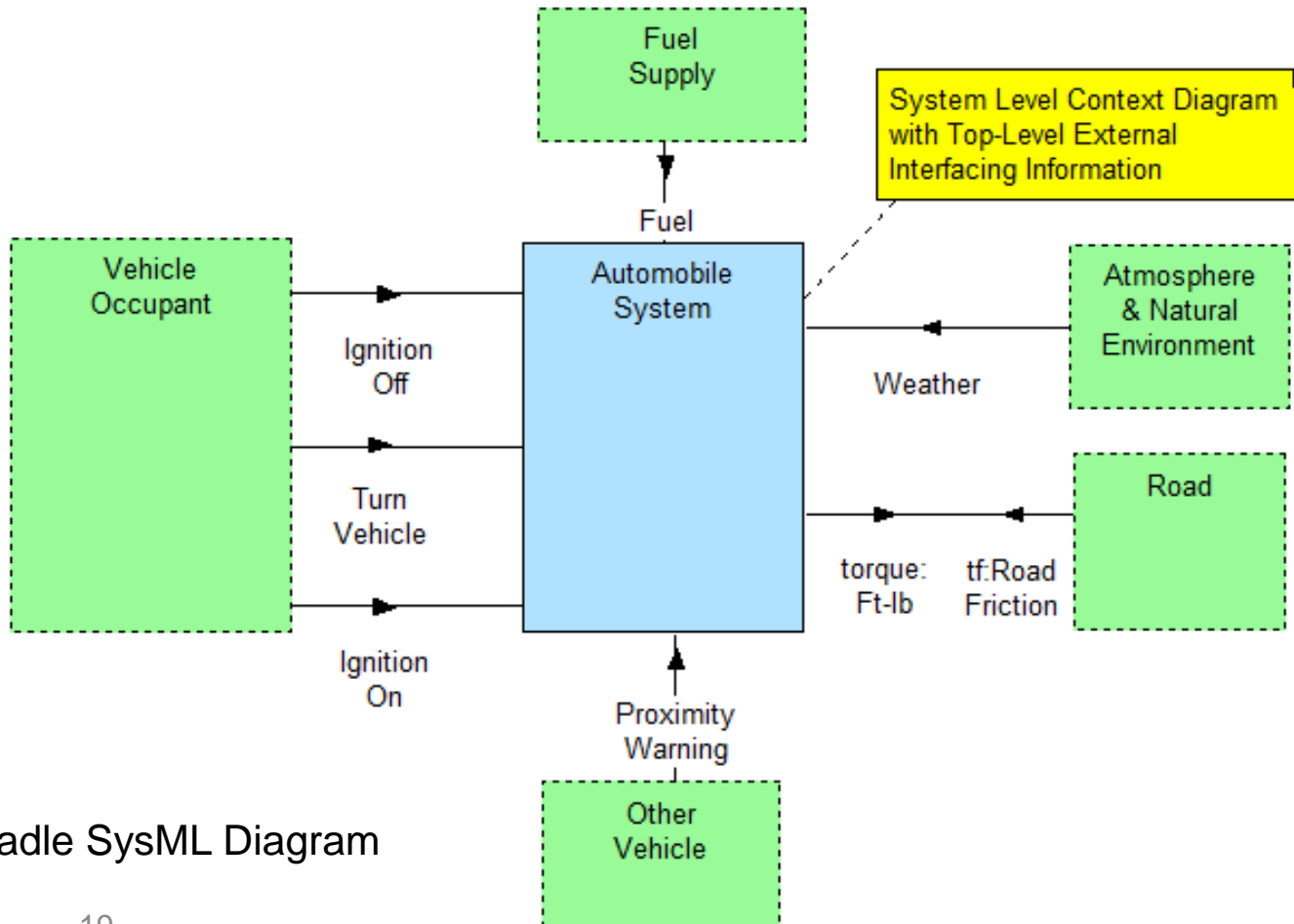
Cradle SysML Diagram

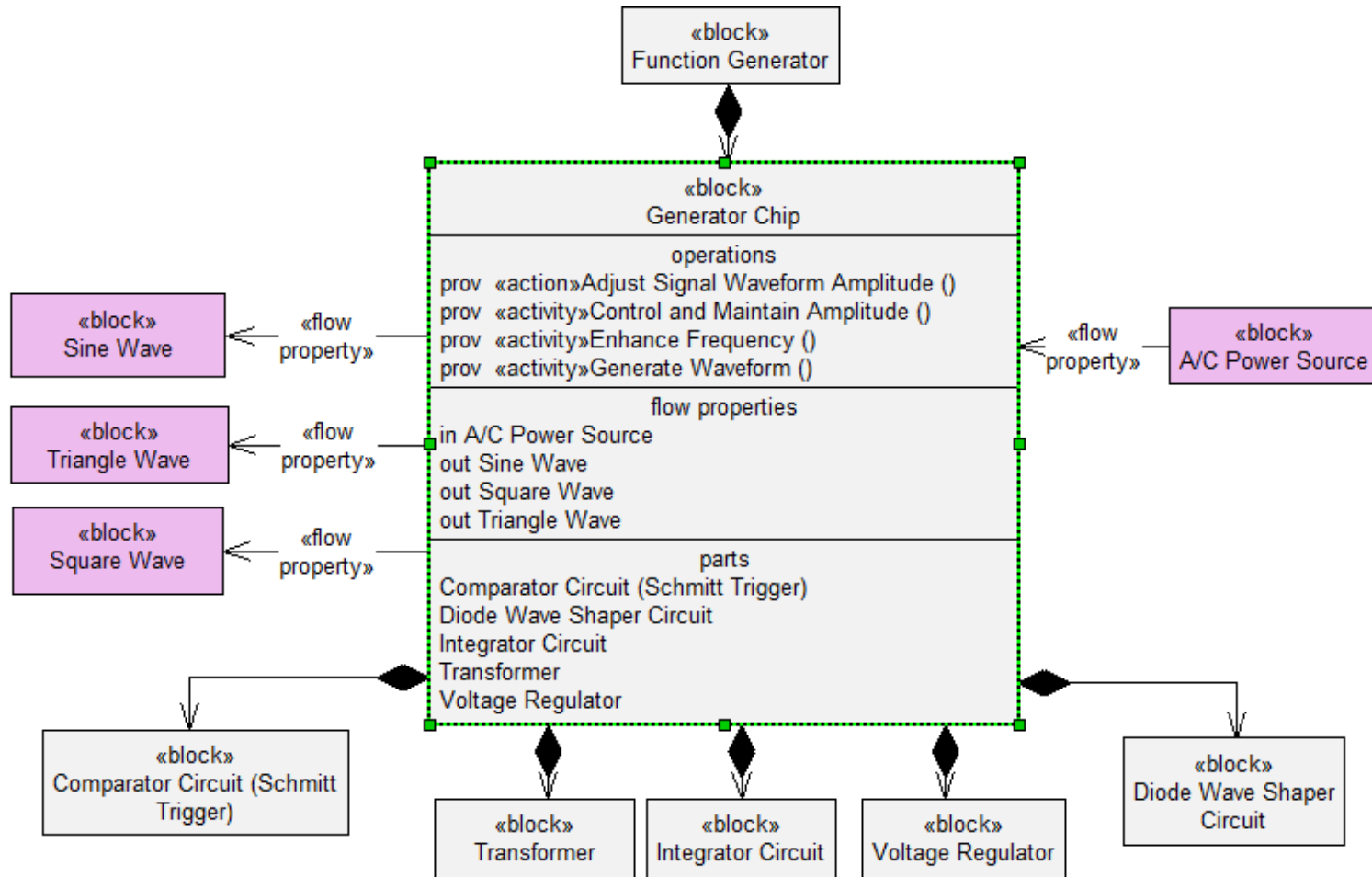# Define the System Hierarchical Structure (Level by Level)

This 'bdd' shows the structure of the proposed System (i.e., component parts). A block represents a type of 'thing' (e.g., system, subsystem, light, report, organization, human, etc).
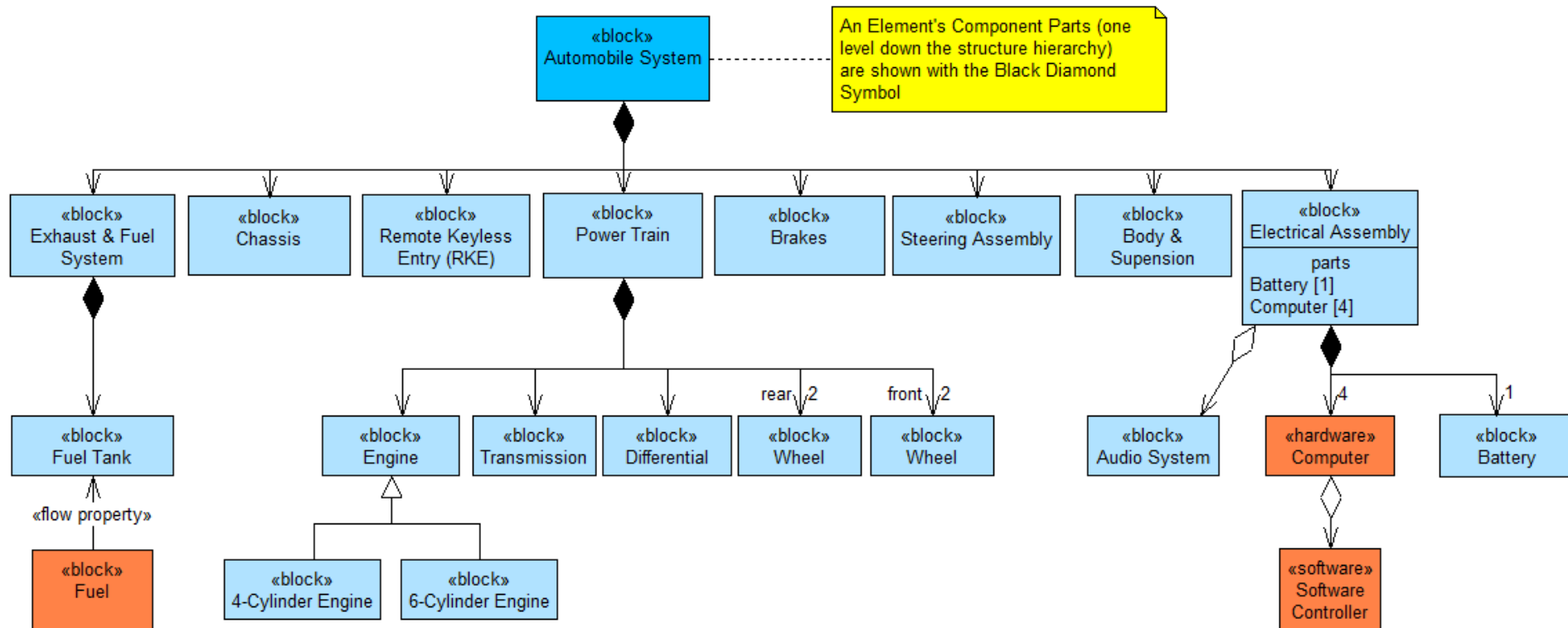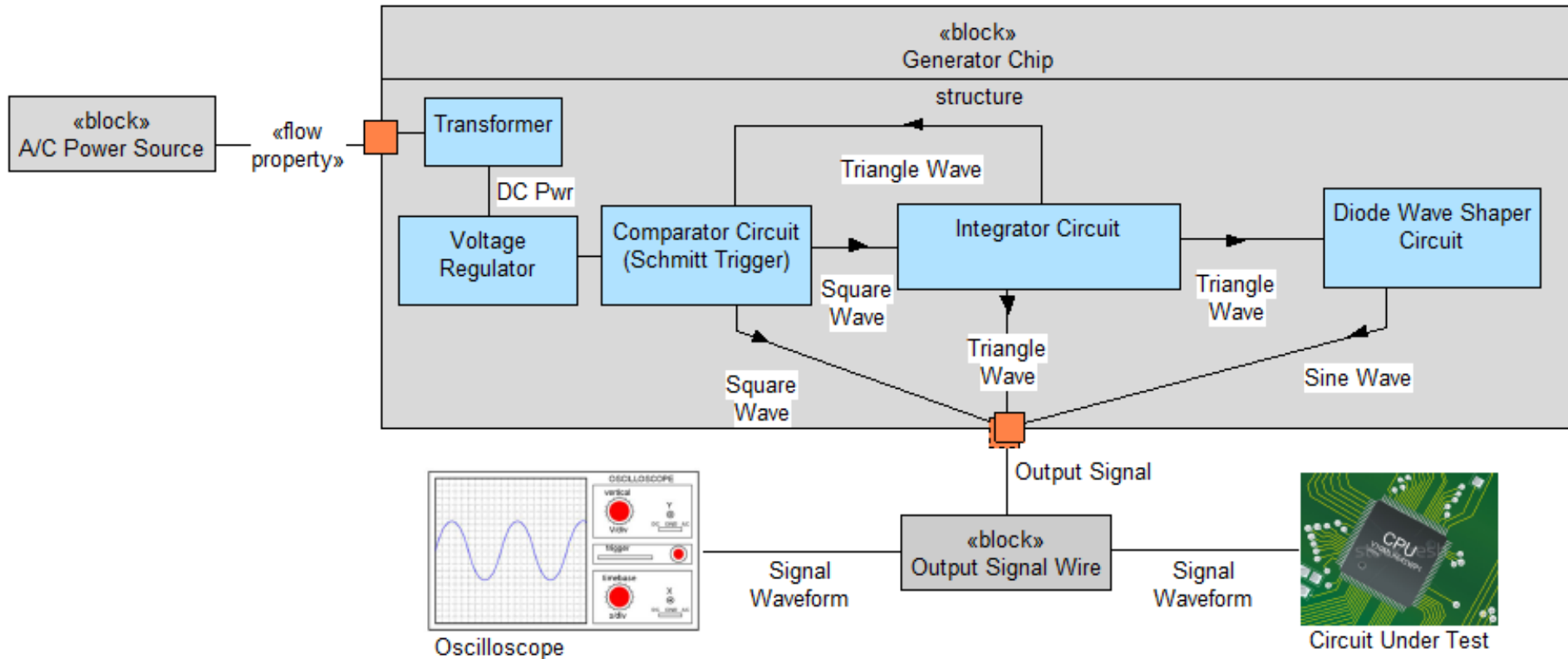

Cradle SysML Diagram

View a Block's Properties

This 'bdd' shows the optional compartments of a block that can be displayed.
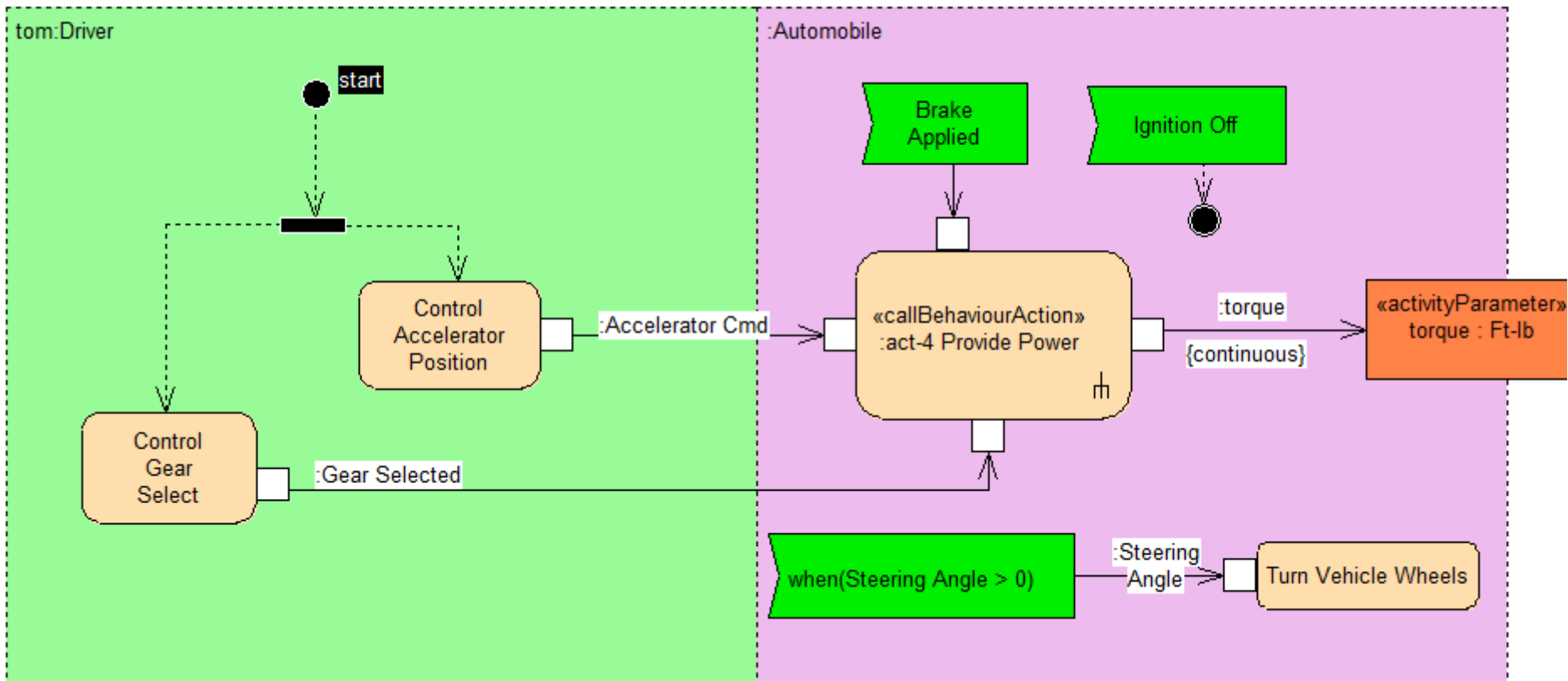

Cradle SysML Diagram

View a Block's Component Parts and their Interactions
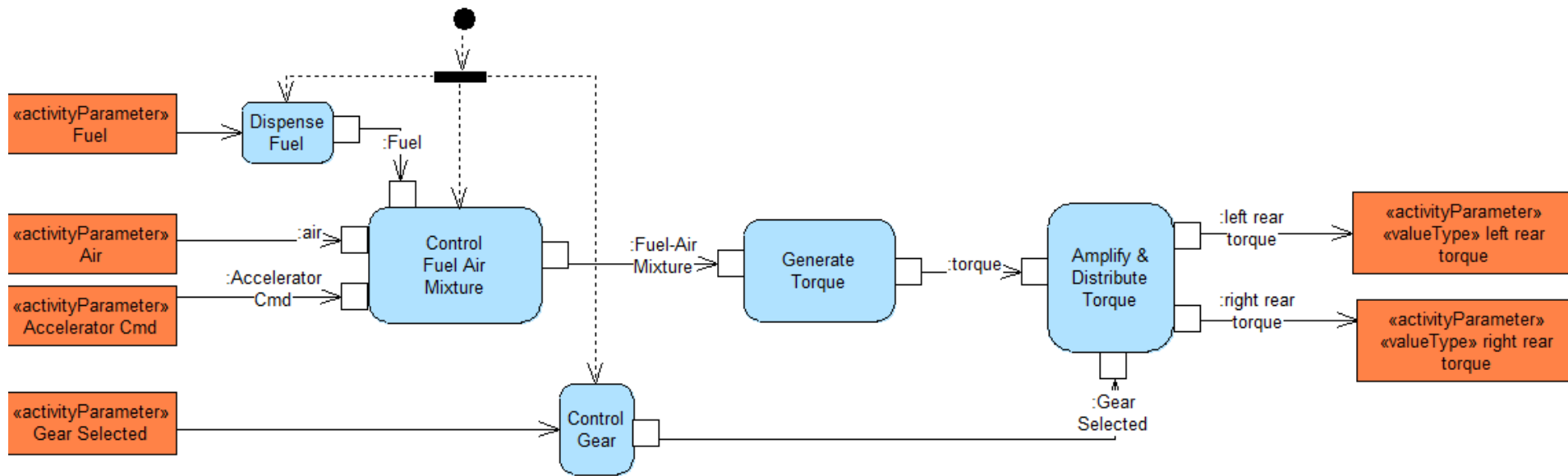

Cradle SysML Diagram

Describe the Functional Behavior of a Block or Process

The behavior (represented by an Activity Diagram) specifies the transformation of inputs to outputs through a controlled sequence of time ordered actions/functions.
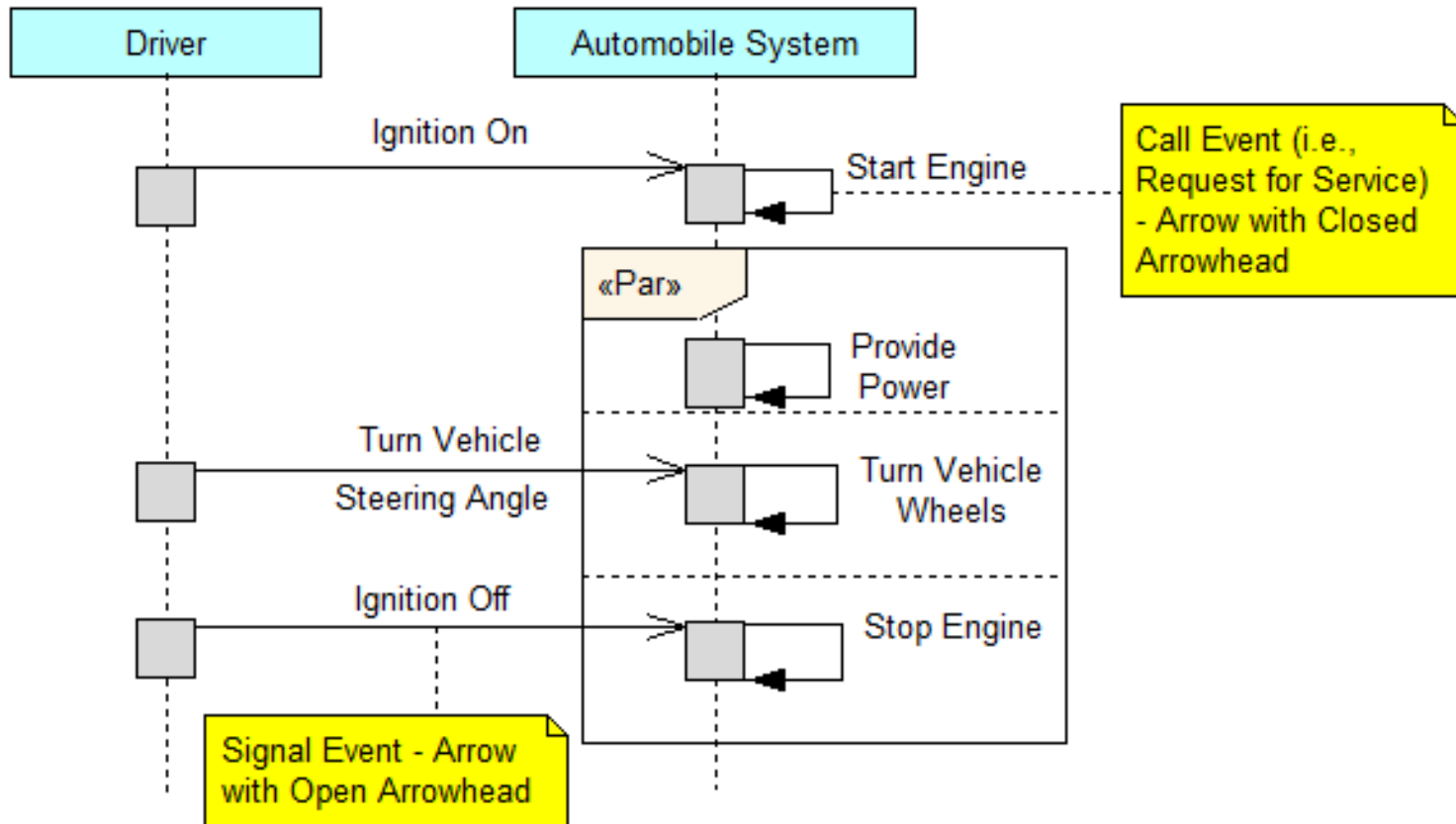

Cradle SysML Diagram

Describe the Functional Behavior of a Block or Process :2


Cradle SysML Diagram

Describe the Events/Messages Exchanged by Different Blocks

The Sequence Diagram (sd) is used to represent the interaction between structural elements (parts) of a block, as a sequence of message exchanges.
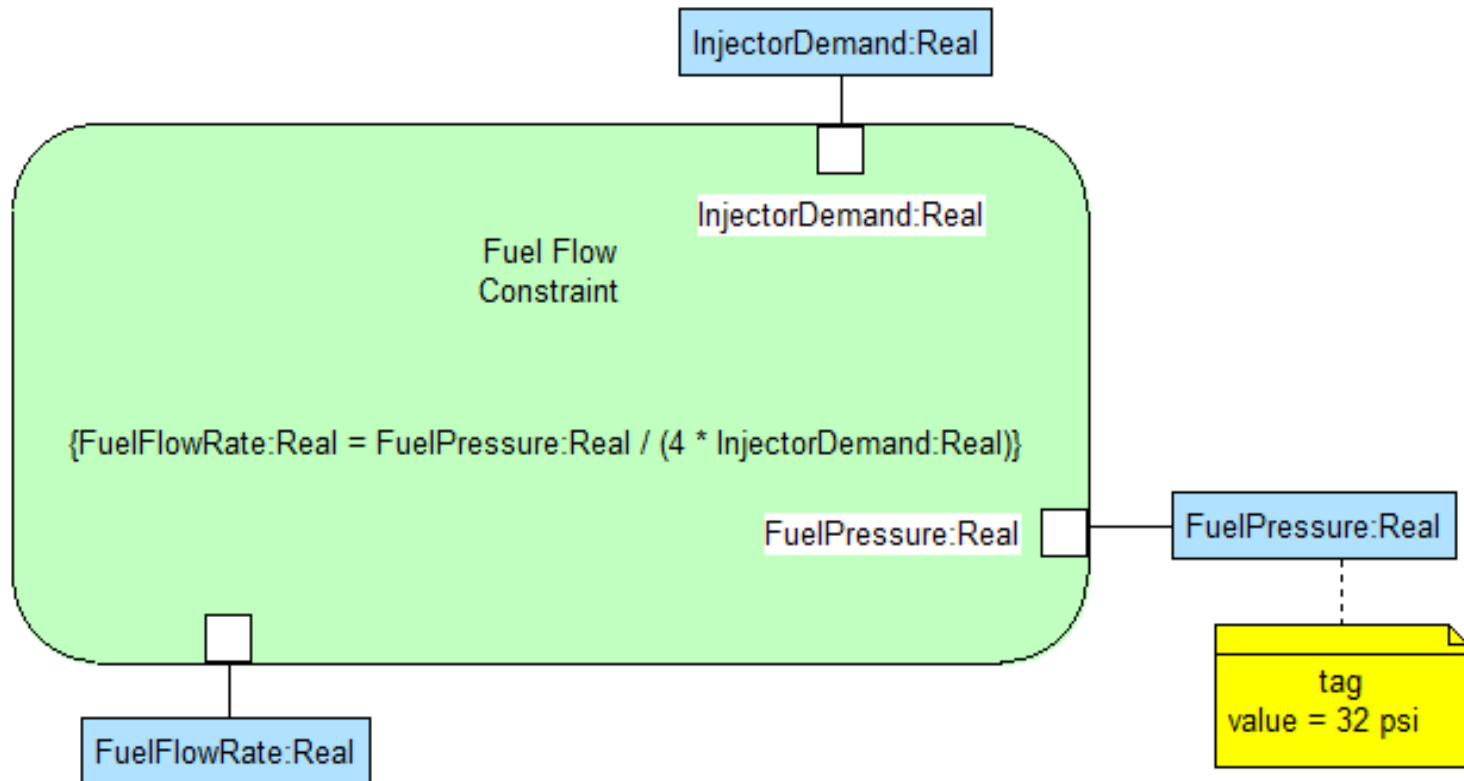

Cradle SysML Diagram

Describe a Block's States and Transitions

A State Machine Diagram is used in SysML to describe the state-dependent behavior of a block throughout its life cycle in terms of its states and the transitions between them. This diagram type is an alternative method to the activity diagram to describe behavior.

Cradle SysML Diagram
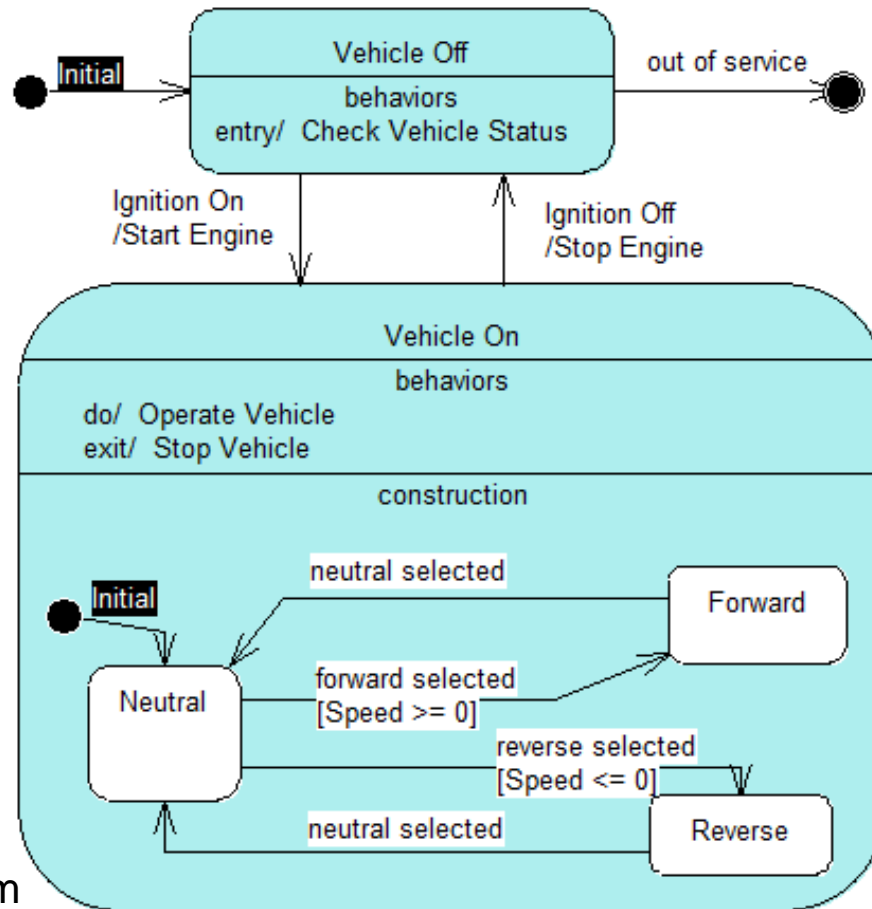
# Identify a Performance Constraint for a System Block

A Parametric Diagram shows performance constraint equations, defined in constraint blocks mapped to the system's component parts, with a graphical mapping of each constraint equation parameter to a specific value property of the component part.

Cradle SysML Diagram

Present Requirements Flow-Down Traceability

Requirements Diagrams are used to graphically depict hierarchies of Stakeholder Needs, Requirements and Test Cases, and show end-to-end traceability to any model element.

Cradle SysML Diagram
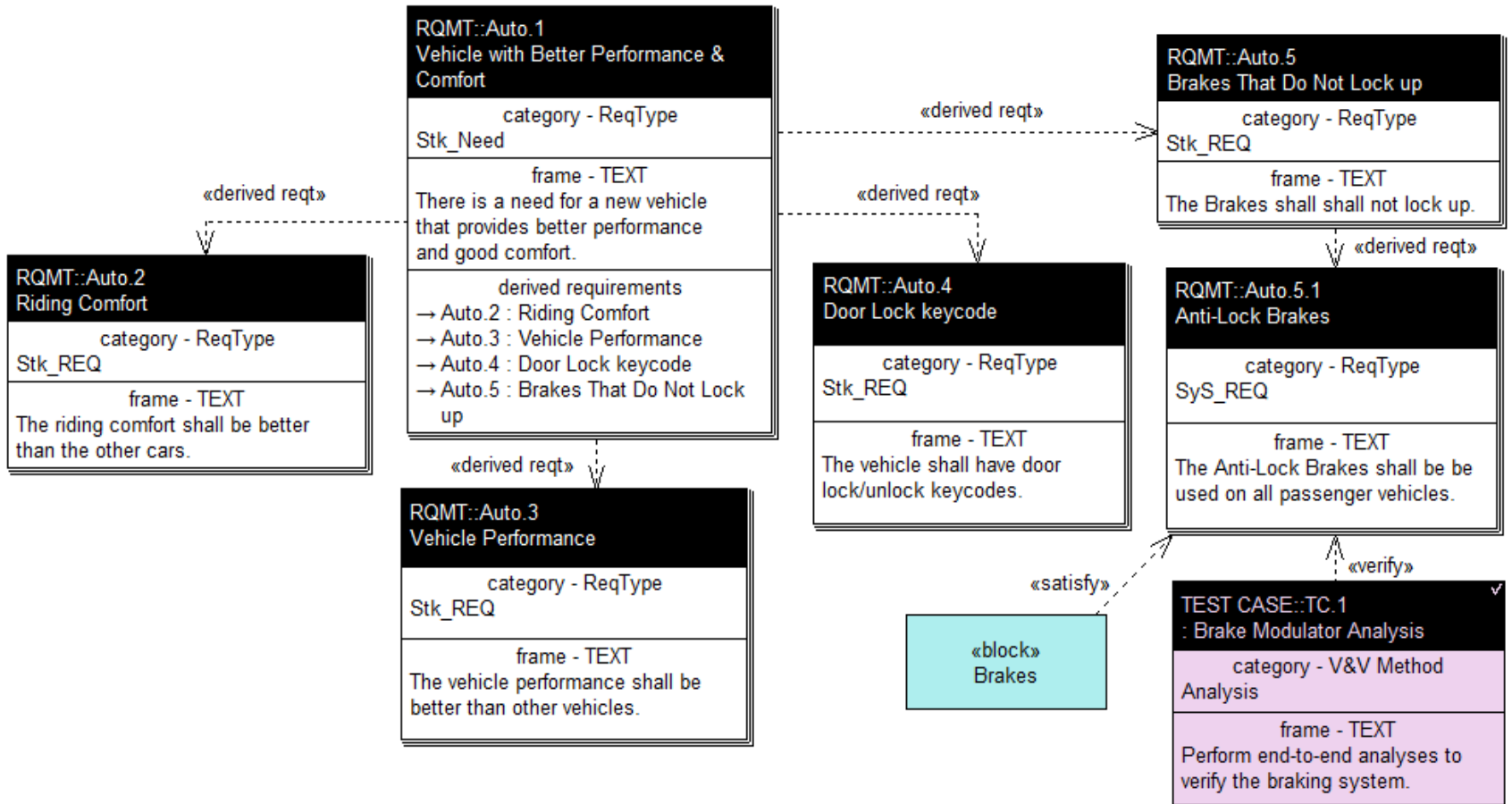
Show Requirements Flow-Down Traceability :2

Requirements Traceability Tables are Commonly used on most projects.

	StK NEEDs	Identity	Name	Text	Stakeholder REQs				
						Type	ID	Name	Text
Previous...									
1	Stk_Need	Auto.1.1	Vehicle with Better Performance & Comfort	There is a need for a new vehicle that provides better performance and good comfort.		Stk_REQ	Auto.2	Riding Comfort	The riding comfort shall be better than the other cars.
						Stk_REQ	Auto.3	Vehicle Operating Performance	The vehicle operating performance shall be better than other vehicles.
						Stk_REQ	Auto.4	Vehicle Lock & Unlock Remote Capability	The vehicle shall have remote door lock/unlock capability.
						Stk_REQ	Auto.5	Brakes That Do Not Lock up	The Brakes shall not lock up.
2	Stk_Need	Auto.1.2	Remote Keyless Entry (RKE) Need	There is a need for a Remote Keyless Entry (RKE) capability to minimize car theft.		Stk_REQ	Auto.4	Vehicle Lock & Unlock Remote Capability	The vehicle shall have remote door lock/unlock capability.

Need-Stk_REQs

Cradle Requirements Traceability Table