Model Based Conceptual Design (MBCD)

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INCOSE GLRC10

Customer asks for Sharks with Lasers on their heads

Seabass is what's being delivered

Where is the failure

- Customer asked for Sharks with lasers on their heads.

- Systems engineer documented and wrote a requirement:
  - Their shall be a water feature installed in the main office.
  - In the water feature we shall have Sharks.
  - The Sharks shall have lasers installed on their heads.

- Because of environmental conditions of Sharks being endangered species a trade study was taken underway to determine a replacement.
  - What type of sharks was requested?
    - Customer is not available as he is chiro frozen.
    - Assume any type of shark will do.
    - Nurse sharks will fit nicely in the water feature.
    - What is the same size as Nurse sharks… Seabass are readily available.
    - We'll replace Sharks with seabass in the water feature.

- New Requirement:
  - In the water feature we shall have Seabass.
  - The Seabass shall have lasers installed on their heads.

Where is the failure continued

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- The system breaks down because the customer expectations are not captured anywhere.
- There are no Need statements to identify what is really needed.
  - If we knew there was a Need to kill and eat an enemy we wouldn't have selected seabass.
- There was no Goals that need to be achieved.
  - Goal is to kill an enemy in an elaborate way.
- There are no Objectives that can be measureable to know we achieved the goals.
  - Objective would be that we ensure a person put into the water feature will be killed and eaten.
- Most of engineering builds and designs to requirements.
- This make the requirements over specified details with out understanding the logic behind why it is written that way.

NASA\MBSE Solutions MBCD vs SESA

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MBCD (project based)

- ConOps and OpsCon
- Customer expectations
- Needs (Customer needs)
- Goals
- Objectives
- Ground rules
- Assumptions
- Constraints

- Product Vision
- Product objectively measurable attributes
- Product subjectively measurable attributes
- Boundary conditions
- Functions
- Interface descriptions

SESA (Systems Engineering Society of Australia)

- Stakeholder needs & refinement
- Explore ideas & technologies
- Feasibility concepts
- Propose solutions
- --- System interact action and interfaces ---
- Con-ops
- Measure of Effectiveness (MOE)
- Key Performance Parameters (KPP)
- System Conceptual Design
- Verification and Validation Criteria

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Additional concepts found in Concept Stage (ch 3.3.1)

- Technology Readiness Level (TRL)
- Research projects lead into actual project…
- Risk, Opportunity, Hazzards Analysis
- Alternative concepts

ConOps vs OpsCon

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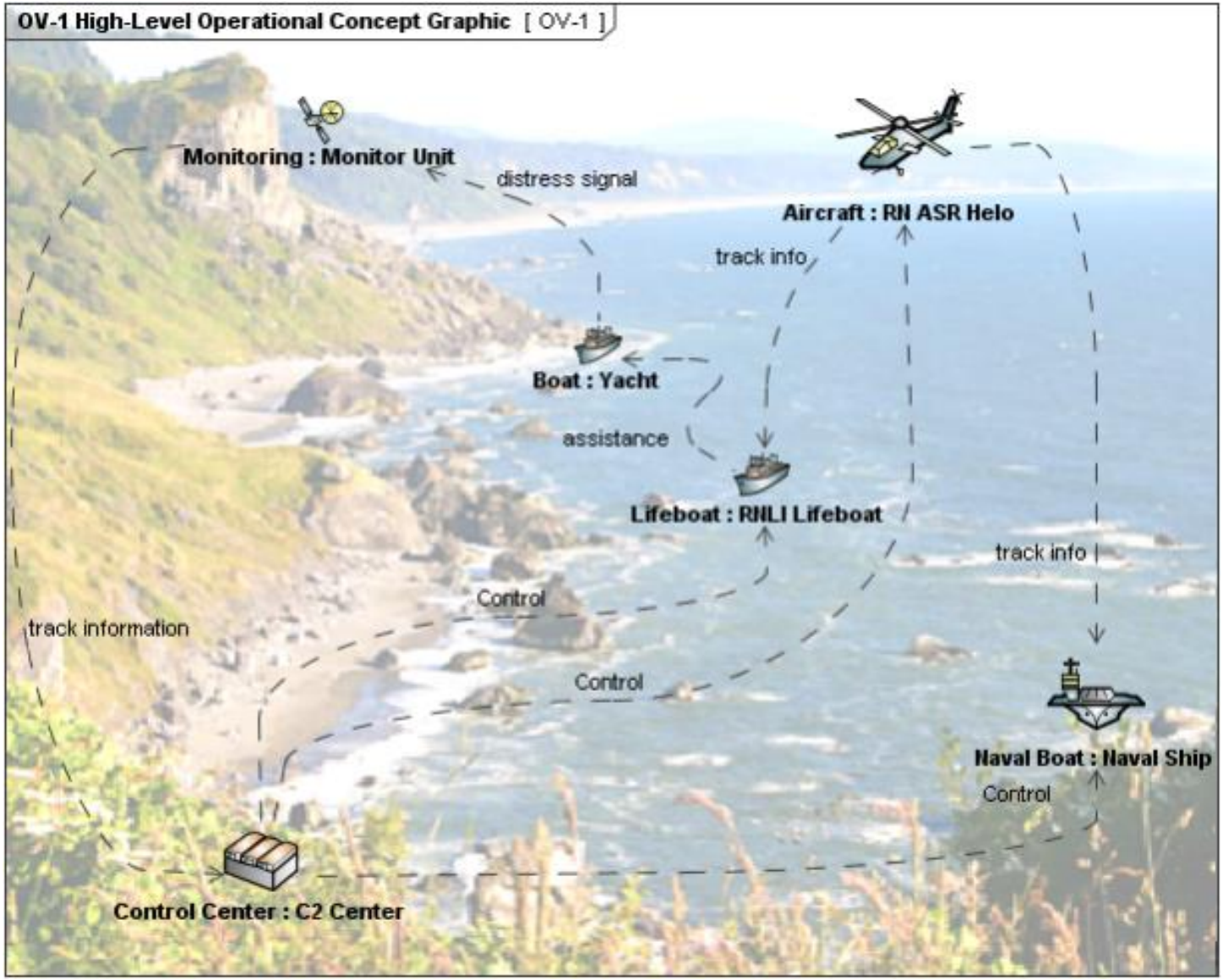
Concept of Operations

- System Concepts
  - This is used to bridge the gap between the product scope and the technical requirements.
- Usually becomes the system and sub system definitions
- This type of nomenclature leads directly to UPDM and UAF
  - Where we can define the Capabilities and the systems that will perform those capabilities
- SysML: System design Interfaces and Interactions

Operations Concepts – OV1 in DodAF terms

- Describes the Systems and their interactions…
- SysML: Use Cases to describe how the system will operate.

Sample OV-1


OV-1 High-Level Operational Concept Graphic [OV-1]
Monitoring : Monitor Unit
distress signal
Aircraft : RN ASR Helo
track info
Boat : Yacht
assistance
Lifeboat : RNLI Lifeboat
track info
Control
track information
Control
Naval Boat : Naval Ship
Control
Control Center : C2 Center

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Conceptual Items Described

Customer Expectations

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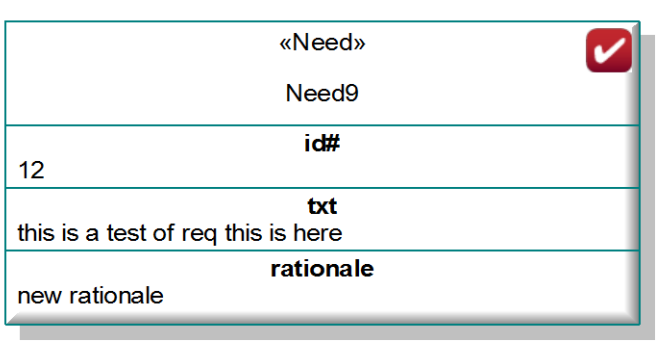
- The purpose of this is to capture expectations.
  - Sometimes a picture is worth a 1000 words and other time a 1000 words are more informative and concrete than a picture.

- …not sure how the prose aspect can be captured in a model, or even if it should. But what comes out of it can be captured as qualities (see below)
  - Objectively measurable qualities (weighted)
  - Subjectively measurable qualities

Needs

- What needs do people want your project to address?
  - Don't worry at this point whether your project actually can address these needs or whether it's the best way to address the needs. You're just trying to identify what is needed for this project.
- How do you know that the needs you identify are the real needs that people have for your project?
  - Determining people's real thoughts and feelings can be difficult. Sometimes they don't want to share them; sometimes they don't know how to express them clearly.
- Needs should have attributes of Id, Heading, Description, and Rationale



Determine the project Needs

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- When speaking with people to determine the needs your project should address, try the following techniques:
  - Encourage them to speak at length about their needs and expectations
    - Split expectations up separate from needs.
  - Listen carefully for any contradictions.
  - Encourage them to clarify vague ideas.
  - Try to confirm your information from two or more independent sources.
  - Ask them to indicate the relative importance of addressing each of their needs.

Need prioritization

- Must: The project must address these needs, at the very least.
- Should: The project should address these needs, if at all possible.
- Nice to: It would be nice for the project to address these needs, if doing so doesn't affect anything else.

Goal and Objectives

- To have a successful project and definable deterministic conclusion it is necessary to define your projects Goals and Objectives.
- Goals are the “What” you want the project to have.
- Objectives are the “How” you are going to achieve the goal.
- Goals should trace to the Needs of the project

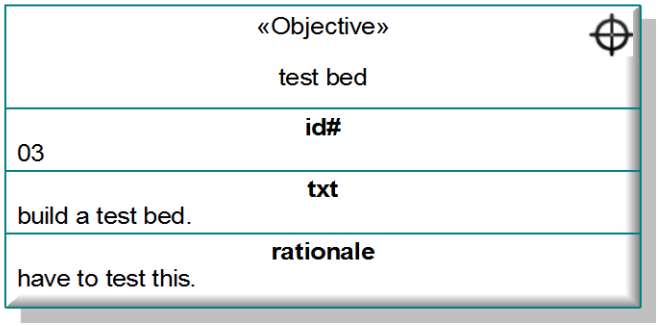
Goals

- Goals should be related to the need statements.
  - Use Traceability to ensure that Goals are tied to the needs of the project.
- Goals should be simply stated
- Give you the big picture of the final outcome to be

«Goal» 
Goal1
id#
G009
txt
Goal of this project is to complete
rationale
This goal exists because I will it into existence.

Objectives

- An objective is a performance measure that would lead to achieving the goal. An objective should be specific, concrete, measureable, and time framed. A goal may have one or several associated objectives. Keep in mind the following when developing objectives:
  - Who/What?
  - Expected outcomes (results of activities)
  - Measures
  - Criteria for achieving the expected outcomes
  - Timeframe



Goal and Objective Examples

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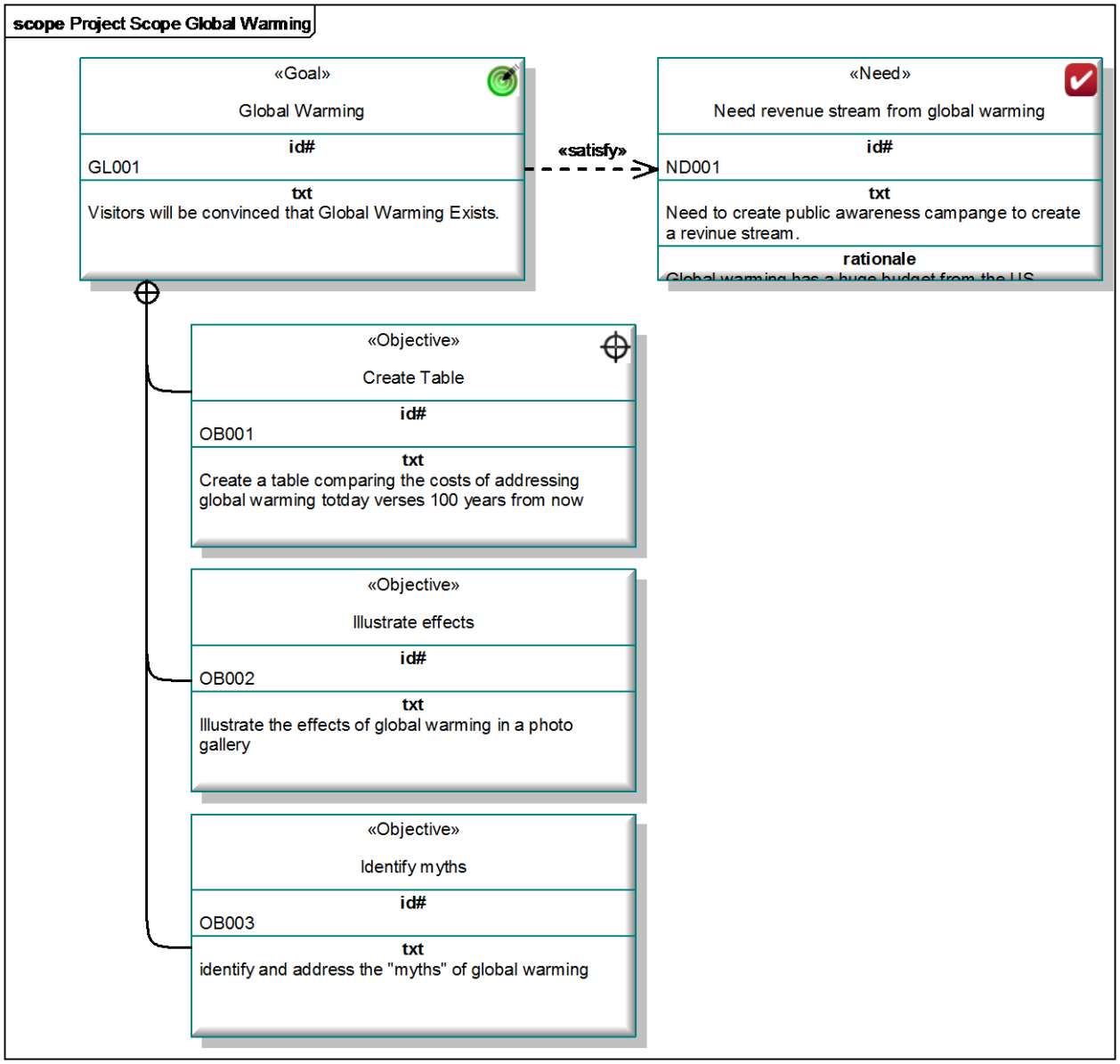
- Start an objective with an action verb. This will ensure the objective is measureable and end-results are addressed through the action of the objective.
- Each objective becomes a measureable milestone
- Example:
- Goal: Visitors will be convinced that global warming exists

  Objectives:
  - Create a table comparing the costs of addressing global warming today verses 100 years from now
  - Illustrate the effects of global warming in a photo gallery
  - Identify and address the “myths” of global warming

Goal and Objectives Example



Ground Rules & Assumptions (GR&As)

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- From NASA study on ESAS Exploration Systems Architecture Study. It suggests that Ground Rules and Assumptions go together hand in hand.

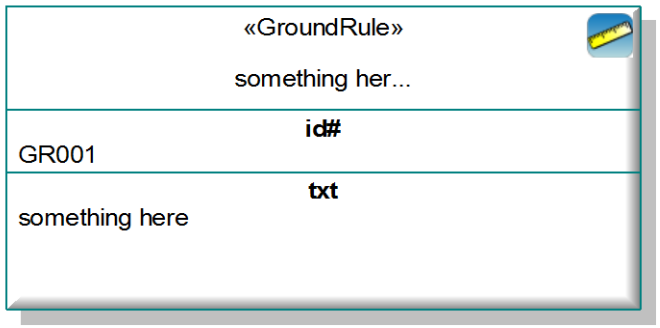
- The study listed multiple levels of GR&As
  - Safety and Mission Assurance
  - Operations
  - Technical
  - Cost
  - Schedule
  - Testing
  - Foreign Assets

- ✓ I wouldn't combine Ground Rules with Assumptions as they are different beasts. However I appreciate the distinction of seeing the levels of ground rules and Assumptions.

- ✓ This needs to be looked into to see if there is value added information in knowing a "type" of Ground Rule. (i.e. grouping like types)

Ground Rules

- From a Project Level POV
- Ground rules are policies and guidelines which a group establishes consciously to help individual members decide how to act.
- To be effective, ground rules must be clear, consistent, agreed-to, and followed.
- Team ground rules define a behavioral model which addresses how individuals treat each other, communicate, participate, cooperate, and support each other in joint activities.
- Attributes of a Ground Rule should contain ID, Heading, Text



Typical Ground Rule Items to be addresses

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- Team Location - this will determine what network infrastructure will be needed to run the project. When the team members can access information and sharing.
- Project duration – think about the duration to define the urgency of how to get the project implemented. The customer wants this project completed by this date…

Ground Rules Example

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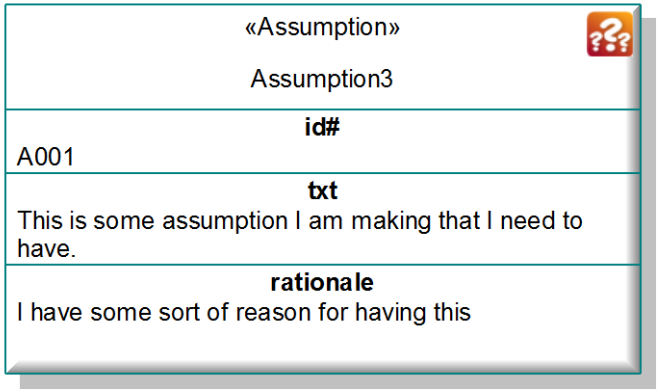
- Ground Rule for Project meetings:
  - Be on time
  - Team lead create and disseminate agendas for each meeting
  - Team leader must create and disseminate minutes after each meeting
  - Attend full duration of all team meetings except for emergencies
  - Avoid informal social talking during meetings
  - Build in brief informal social talk before and after meetings
  - Be patient with alternative viewpoints
  - ….

Assumptions

- Assumptions are circumstances and events that need to occur for the project to be successful, but are outside the total control of the project team. Assumptions are accepted as true and are always without proof or demonstration



Assumptions Example

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- A Situation on the project – Program Management requires and approval on design artifacts from the customer during the course of the project. Project can not move forward with out approval.
- Project Assumption – “After submitting design artifacts approval will come back with in 2 weeks.”
- Other System examples:
- "assumption: it will take 6 months to make the widget"
- "assumption: all widget components will be off-the-shelf"
- These clearly come with associated risk. Therefore we should tie **Risks** with assumptions.

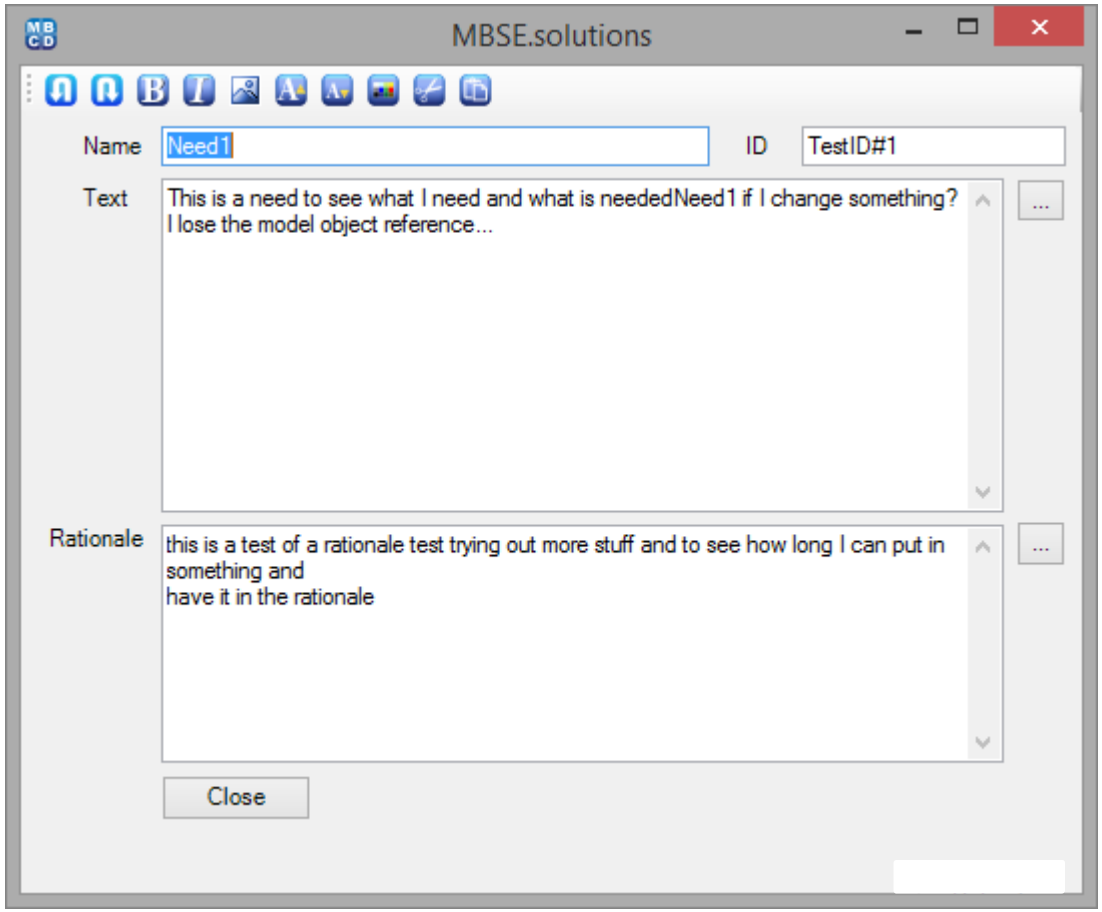
Constraints

- Constraint is a limitation or restriction.
- Typical constrains include cost, schedule, or other things like “reuse the existing widget from project X”.
- Constraints are things that might restrict, limit, or regulate the project.
- Use the current SysML Constraint item.
- However these constraints should be directly tied to each system element they are constraining as attributes of the system. This may change the nature of how constraints are viewed in the system.

MBCD easement in tooling

- In order to get these items in tooling it is suggested to create a form that when selecting specific items related to conceptual design a form like the image will help users enter information.

- ID's are auto-generated with the following prefix
  - Ground Rule (GR)
  - Objective (OB)
  - Assumption (AS)
  - Need (ND)
  - Goal (GL)



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