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Setting Priorities

Demonstrating Stakeholder Value Networks in SysML

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Presenting Authors

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James Hummell is an expert trainer for SysML, UML, and UPDM/UAF, currently working as chief consultant for MBSE Solutions, a tool gnostic (as opposed to tool agnostic) training and consulting company. Primarily focused on helping companies adopt MBSE ecosystems. He has been developing software and systems in model-based design engineering (UML and SysML) for over 20 years. He was a member of the RTCA SC-205 subgroup developing Do-178C model-based development and verification supplement, and has worked with the Object Management Group (OMG) and the International Council on Systems Engineering (INCOSE) on many specifications and working groups.

Matthew Sease

Matthew Sease is a Systems Engineering Technical Advisor for Cummins Corporate Research and Technology. In this role, he is identifying, exploring and demonstrating the most promising areas to improve the organization's competencies in Systems Engineering. Matthew holds license as a professional engineer in the state of Indiana and is a member of INCOSE. He received his Bachelors of Science in Mechanical Engineering from Purdue University in 2004. He received his Masters of Engineering in Systems Engineering from Cornell University in 2017.

Additional Authors

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Brian Smith is an Analysis Engineer for General Motors Global Propulsion Systems. In his current role, he supports engine controls and calibration using model-based techniques and engine system simulation. He received his Bachelor of Science in Mechanical Engineering from Michigan State University in 2011 and his Master of Engineering in Systems Engineering from Cornell University in 2016.

Daniel Selva, PhD

Daniel Selva is an Assistant Professor at the Sibley School of Mechanical and Aerospace Engineering at Cornell University, where he directs the Systems Engineering, Architecture, and Knowledge (SEAK) Lab. His research interests focus on the application of knowledge engineering, global optimization and machine learning techniques to systems engineering and architecture, with a strong focus on space systems. Prior to MIT, Daniel worked for four years in Kourou (French Guiana) as an avionics specialist within the Ariane 5 Launch team. Daniel has a dual background in electrical engineering and aeronautical engineering, with degrees from MIT (Ph.D., 2012), the Universitat Politecnica de Catalunya in Barcelona, Spain, and Supaero in Toulouse, France.

Customer asks for **Sharks** with **lasers** on their heads
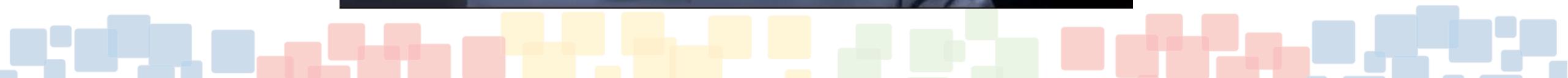
Seabass is what's being delivered

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 Mutated Seabass.
  - The Seabass shall have lasers installed on their heads.

Where is the failure (continued)

- The Government Stakeholder was considered a higher priority than the Customer
  - Who made that call.
  - Was money no object?
  - What obstacles were investigated to over come?
  - Where are all the trade offs documented?

- What was the customer Need?
  - Kill and eat an enemy to intimidate and conceal.

- 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.

The Theory

Stakeholder Value Network

# SVN Example (Sutherland, 2009)
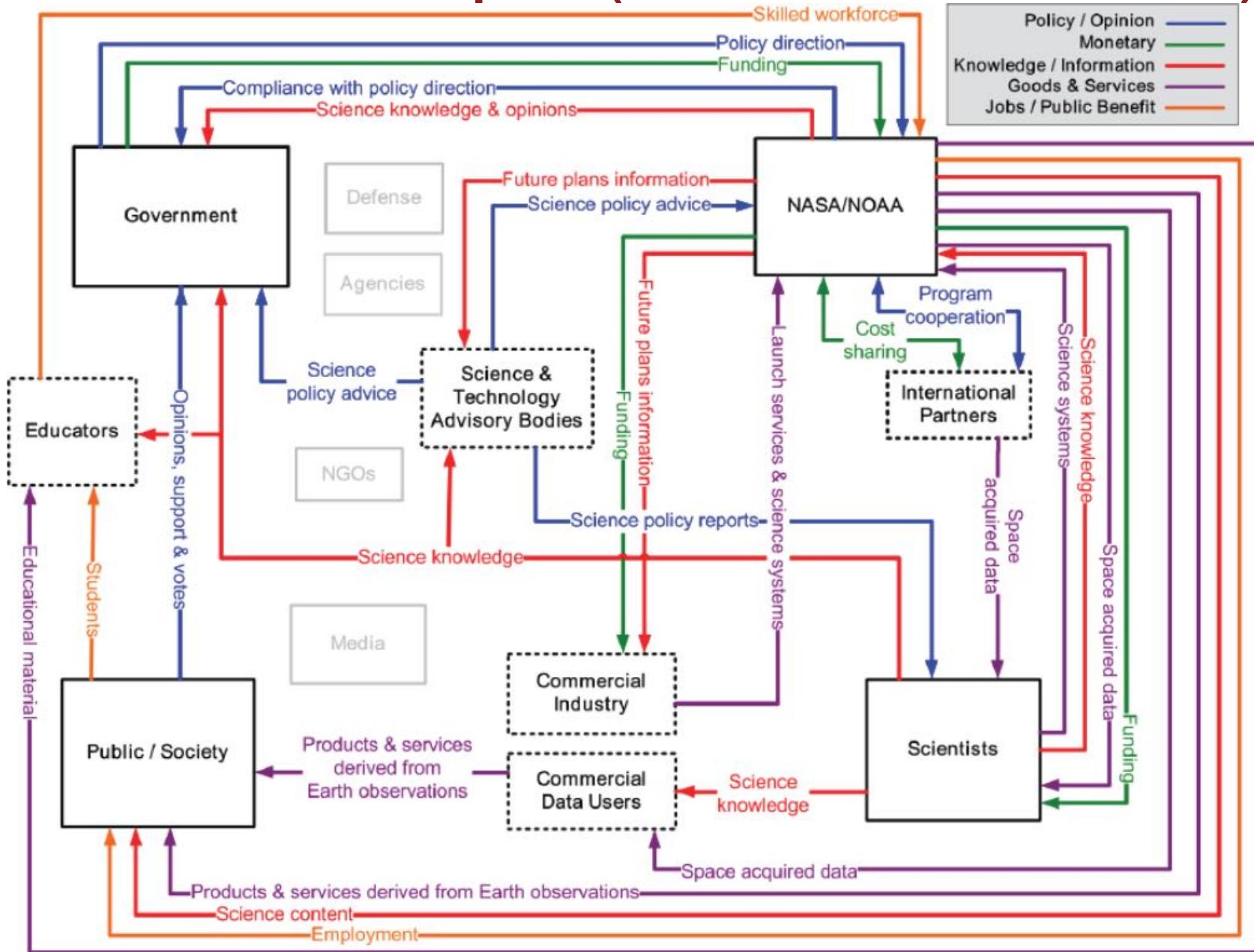
- <u>NASA/NOAA is the SOI</u>
- Stakeholders are the nodes
- Their needs flow in edges around a central project (or system)

# Benefit & Supply Ranking

Benefit Ranking
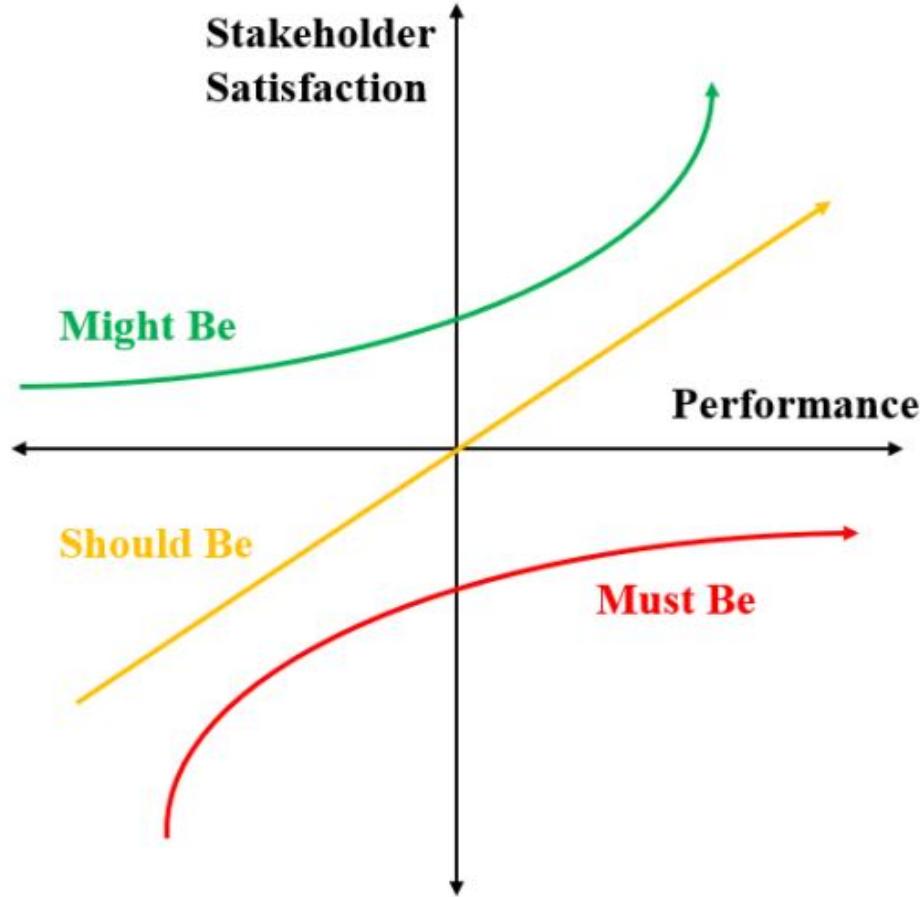
Supply Ranking

Low Availability of Alternatives → **High** Supply Ranking

High Availability of Alternatives → **Low** Supply Ranking
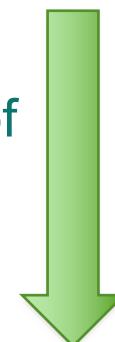
Value Path Scoring Rubric

Supply Importance		Might Be	Should Be	Must Be
	High	0.3	0.5	0.95
	Medium	0.2	0.4	0.8
	Low	0.1	0.2	0.4

Benefit Ranking

SVN Evaluation

- Value loop – Cumulative product of the value paths from a given loop.

> **Equation 1: Value loop quantification**
>
> $$s = p_1 \cdot p_2 \cdots p_n$$

- Stakeholder importance – The ratio of the sum of all the value loops that contain an individual stakeholder to the sum of all value loops.

> **Equation 2: Stakeholder importance quantification (Cameron B. G., 2007)**
>
> $$I(SH_i) = \frac{\sum_{l:SH_i \in l} s(l)}{\sum_l s(l)}$$

# SysML – Adding SVN profile

Meta Model

Entering Data

Association colorization and visualize value score

- Color pallet for associations based on calculated value (Benefit/Supply)

High	0.3	0.5	0.95
Medium	0.2	0.4	0.8
Low	0.1	0.2	0.4
	Might Be	Should Be	Must Be
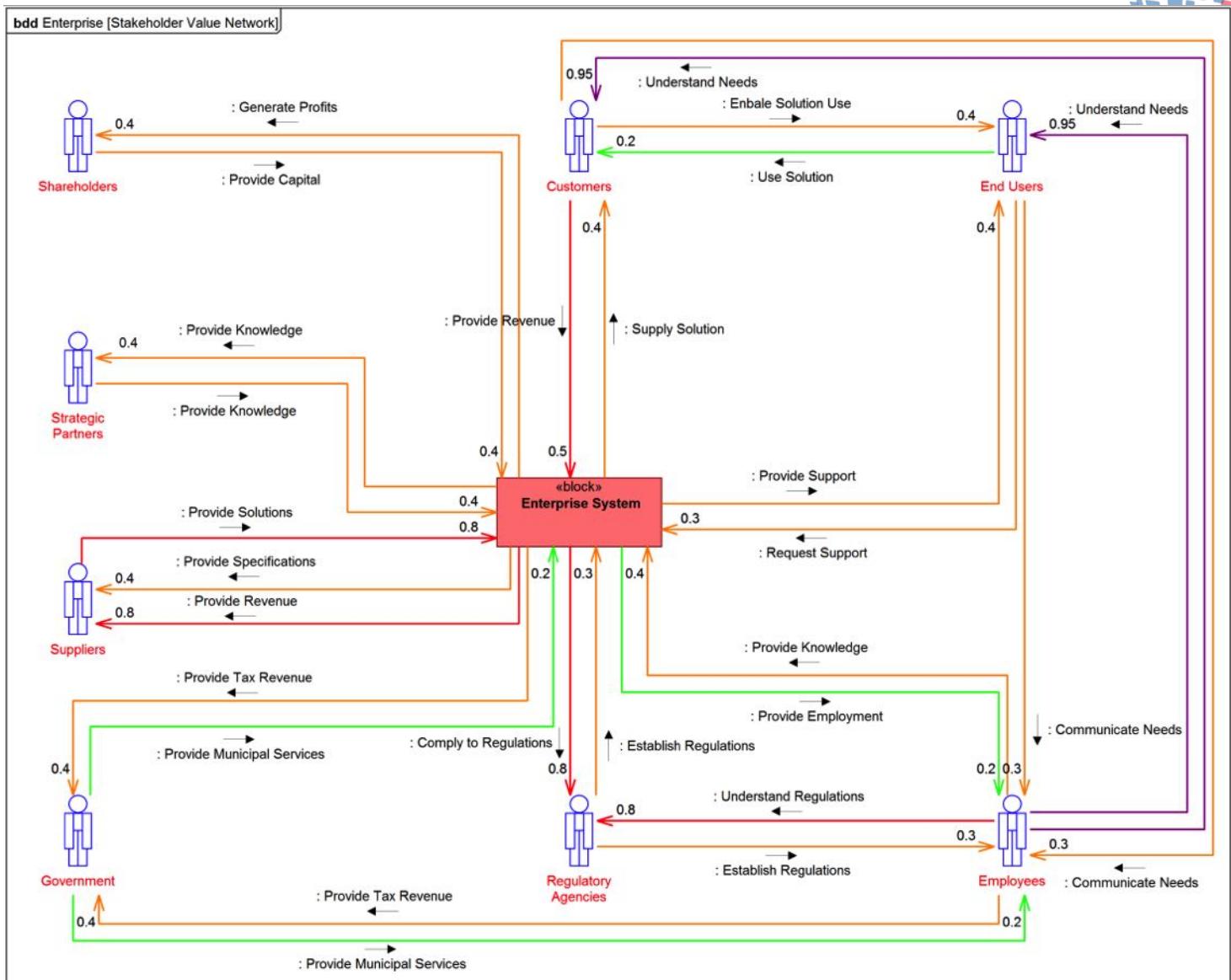
Value Paths – Partial Table

	High	0.3	0.5	0.95
	Medium	0.2	0.4	0.8
	Low	0.1	0.2	0.4
		Might Be	Should Be	Must Be

No.	Path Description	Value Description	Benefit Ranking	Supply Importance	Score
1	Shareholders to Enterprise	Provide Capital	Should	Medium	0.4
2	Enterprise to Shareholders	Generate Profits	Should	Medium	0.4
3	Strategic Partners to Enterprise	Provide Knowledge	Should	Medium	0.4
4	Enterprise to Strategic Partners	Provide Knowledge	Should	Medium	0.4
5	Suppliers to Enterprise	Provide Solutions	Must	Medium	0.8
…	…	…	…	…	…

Calculating the value loop

$$S = p_1 \ast p_2 \dots p_n = 0.2 \ast 0.95 \ast 0.2 \ast 0.5 = 0.019$$

bdd Stakeholder Value Network [Loop Example]

Customers

End Users

0.2

: Use Solution

: Provide Revenue

0.95

: Understand Needs

0.5

«block»
Enterprise System

0.2

: Provide Employment
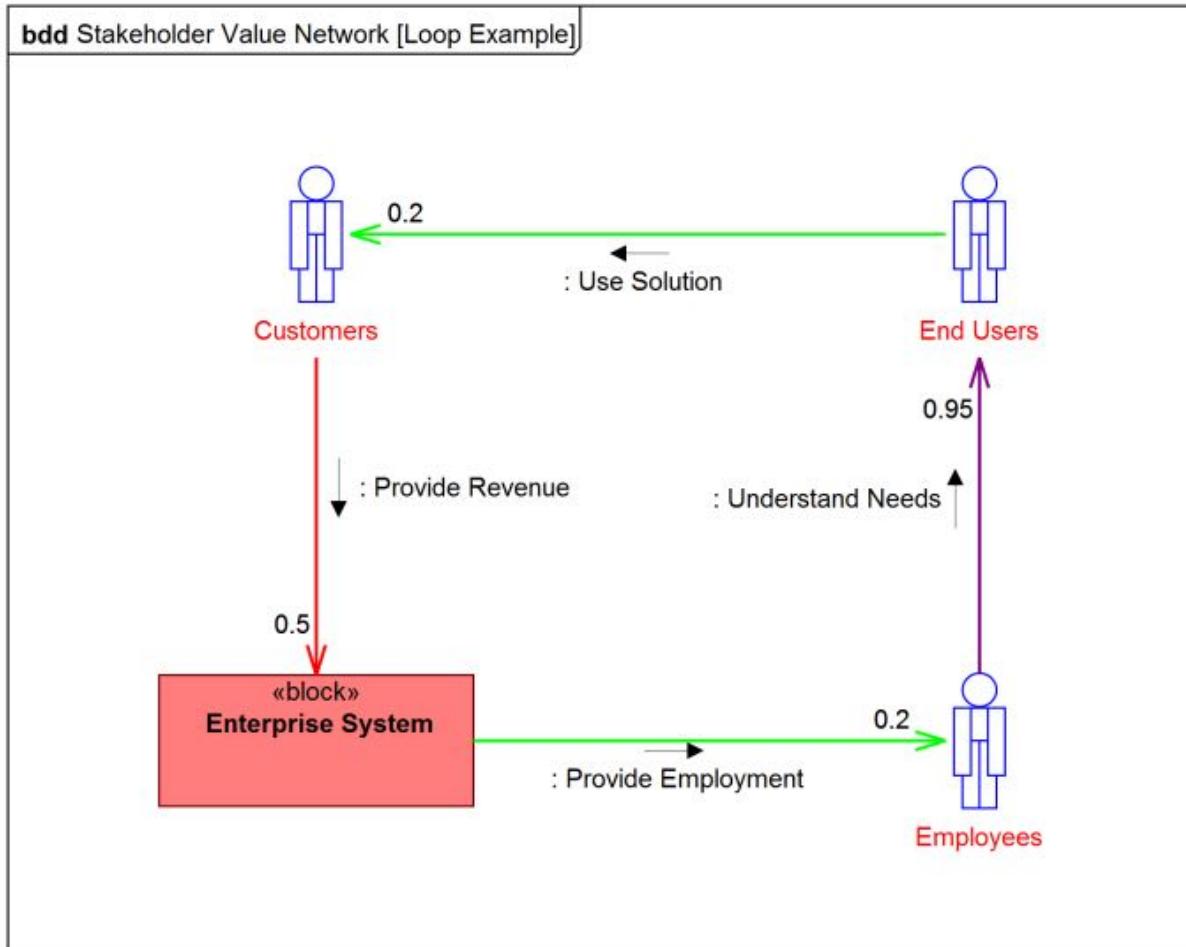
Employees

- Enterprise System -> Employees -> End Users -> Customers -> Enterprise System

Value Loops - Partial Table

$S = p_1 * p_2 \ldots p_n$

No.	Loop Description	Score
1	Enterprise -> Shareholders -> Enterprise	0.160
2	Enterprise -> Strategic Partners -> Enterprise	0.160
3	Enterprise -> Suppliers -> Enterprise (Specs)	0.320
4	Enterprise -> Suppliers -> Enterprise (Revenue)	0.640
5	Enterprise -> Government -> Enterprise	0.080
…	…	…

Prioritized Stakeholders

$$I(SH_i) = \frac{\sum_{l:SH_i \in l} s(l)}{\sum_l s(l)}$$

Rank	Stakeholder	Score
1	Suppliers	0.370
2	Employees	0.226
3	Customers	0.192
4	Regulatory Agencies	0.148
5	End Users	0.146
6	Shareholders	0.062
7	Strategic Partners	0.062
8	Government	0.049

Stakeholder Prioritization Applied

- Stakeholder value (SV)

- SV > 0.2   **Red**

- 0.1 > SV > 0.2   **Yellow**

- SV < 0.1   **Green**
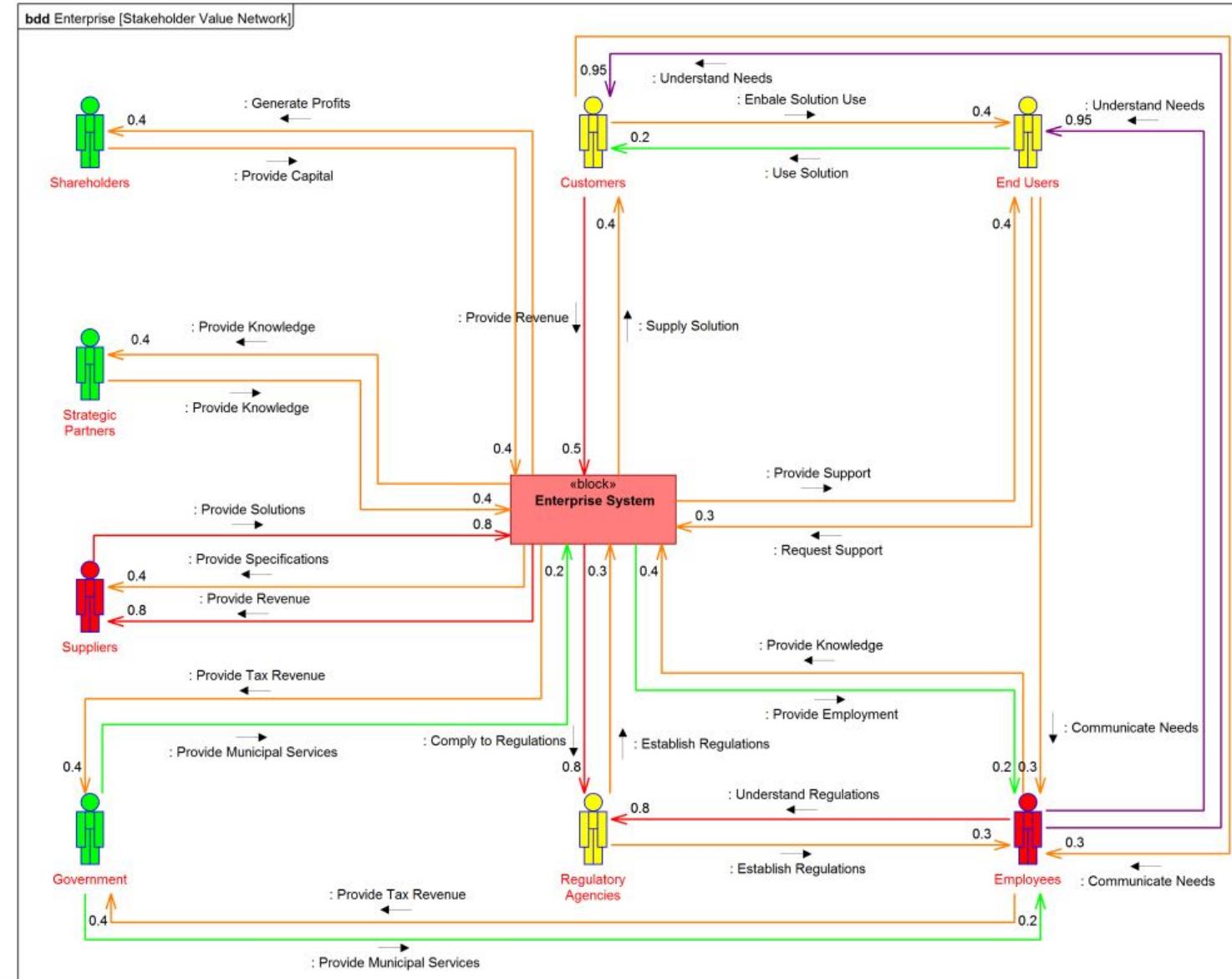
Needs -> Goals -> Objectives

Meta Model

PD SVN Profile Diagram
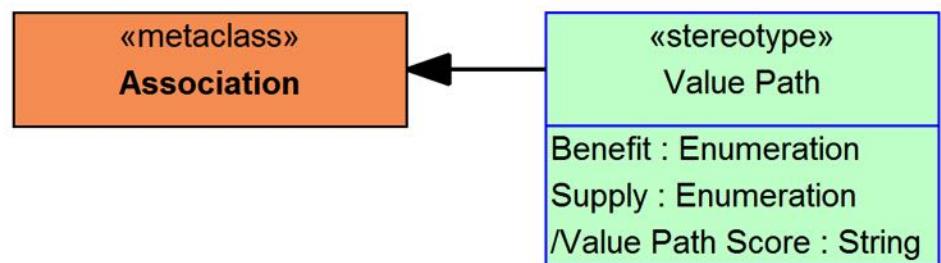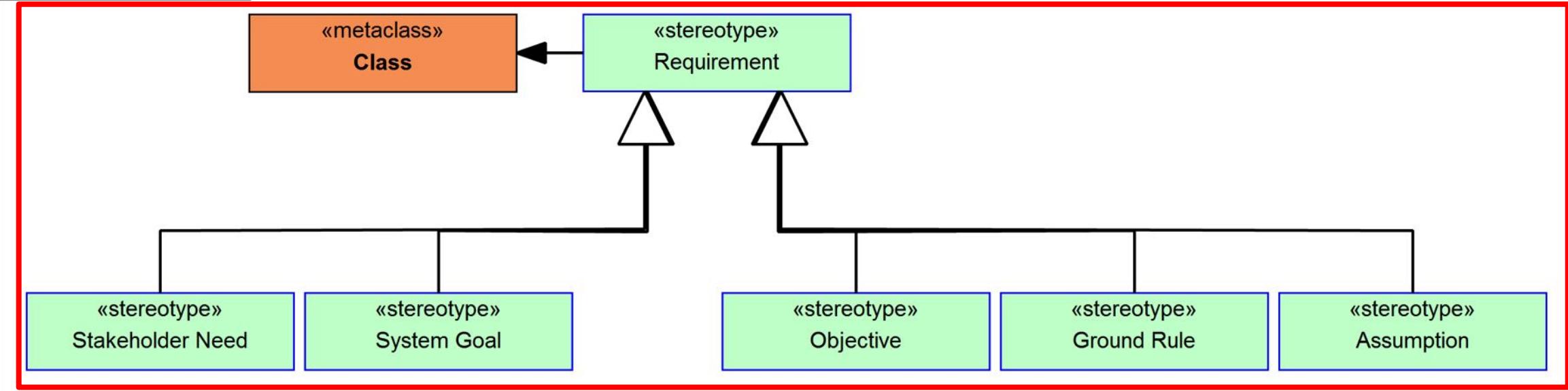
«metaclass» **Class** ← «stereotype» Requirement

«stereotype» Stakeholder Need

«stereotype» System Goal

«stereotype» Objective

«stereotype» Ground Rule

«stereotype» Assumption

«metaclass» **Association** ← «stereotype» Value Path

Benefit : Enumeration
Supply : Enumeration
/Value Path Score : String

+Stakeholder Value Network Analysis
«→» +Benefit Ranking
«→» +Supply Importance
«→» +Stakeholder Need
«→» +System Goal
+Supply
+Benefit
+Rank

Stakeholder Needs Relationship Diagram
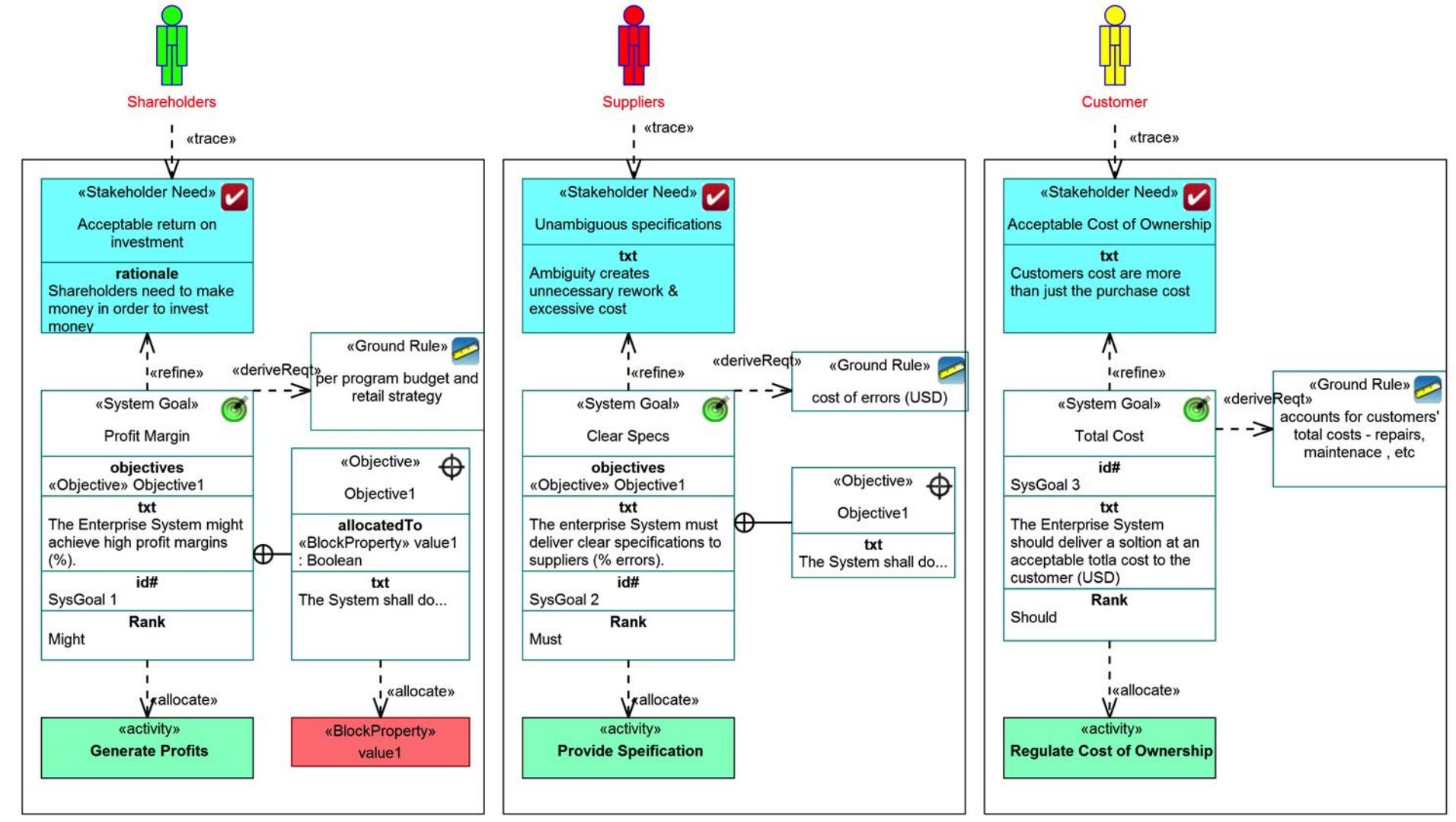
- System Goals have a Rank value (Might, Should, Must)

Stakeholder 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

«Need»	✔
Need9	
id#	
12	
txt	
this is a test of req this is here	
rationale	
new rationale	

Determine the project Needs

- 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 will have a Rank (**Might**, **Should**, **Must**)

«System Goal»	
Profit Margin	
id#	
SysGoal 1	
Rank	
Might	
objectives	
«Objective» Objective1	
txt	
The Enterprise System might achieve high profit margins (%).	

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

«Objective»	
test bed	
id#	
03	
txt	
build a test bed.	
rationale	
have to test this.	

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
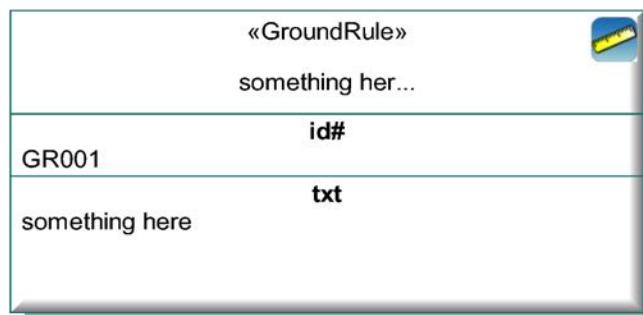
Assumptions

- 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

Stakeholder Needs Relationship Diagram

- System Goals have a Rank value (Might, Should, Must)

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