



Goal Modeling Education with GRL: Experience Report

Daniel Amyot, University of Ottawa

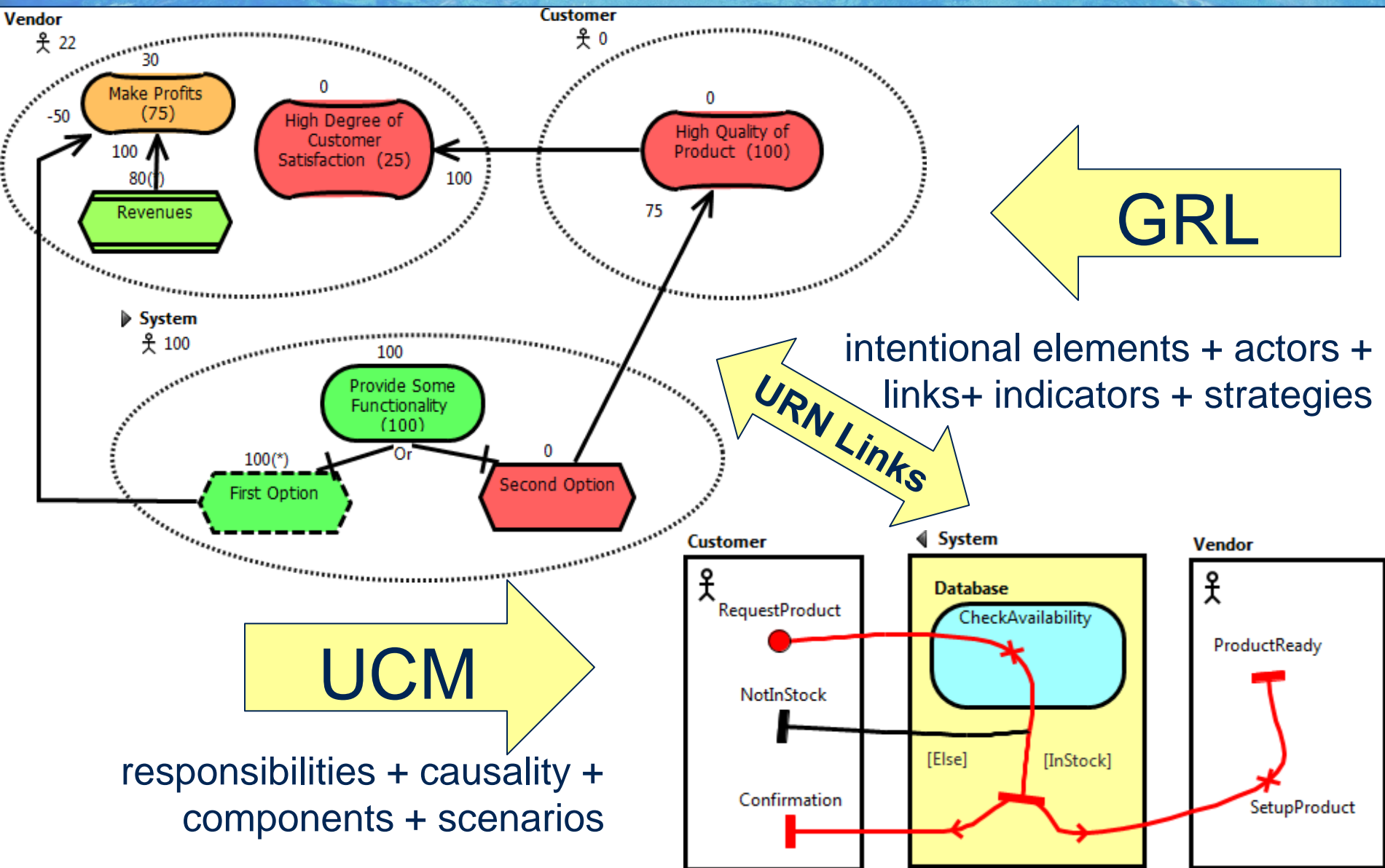
damyot@uottawa.ca

iStar'15, Ottawa, Canada

Overview

- Goal-oriented Requirement Language (GRL)
- Courses
- Teaching and Learning GRL Modeling
- Teaching and Learning GRL Analysis
- Observations
- Conclusions and Future Work

Bird's Eye View of the User Requirements Notation



responsibilities + causality + components + scenarios

Major Differences between GRL and i^*

- **What i^* has that GRL does not**
 - Types of actors (e.g., role, agent, position)
 - Types of relationships between actors (e.g., ISA, IsPartOf, Plays, Covers, Occupies, InstanceOf-INS)
 - Different types of diagrams (Strategic Dependency and Strategic Rationale)
 - Many constraints on what can be linked to what
- **What GRL has that i^* does not**
 - Indicators
 - Importance level of an intentional element to an actor
 - Evaluation strategies
 - Contribution overrides
 - URN links and metadata
 - Integration with Use Case Maps as part of URN
 - International standard (ITU-T Rec. Z.151, 2012)
- **GRL can be profiled to support i^* concepts**

Courses Taught

- **Introduction to Software Engineering (2003-2004)**
 - Undergraduate, 3rd-year, computer science program
 - Without tool support or labs.
- **Software Requirements Analysis (2005-2014)**
 - Undergraduate, 3rd-year, software engineering program
 - With tool support and labs.
- **Software Engineering (10 times during 2004-2015)**
 - Graduate, masters and Ph.D., computer science program
 - With tool support but no labs.
- Total audience of well **over 1,000 students** over the years.
- 3-hour lecture, plus 3-hour lab when available.

Teaching and Learning GRL Modeling

- From rationales to decision making to social modeling
- Rationale documentation: limitations of tables
- GRL syntax with an example
- GRL pattern leading to trade-offs
- Use of qualitative and quantitative scales
- Indicators to better root models in reality
- Connection to business process modeling
- Use of views (diagrams) to manage the complexity of large models
- Aspect-modeling and cross-cutting concerns at the goal level also covered at the graduate level

Teaching and Learning GRL Analysis

- *What-If* analysis with GRL strategies
- “Best” strategies... for whom (which actor)?
- *Trade-off* analysis with multiple strategies and means of comparing them
 - Strategy Diff; export to Excel
 - Strategy creation akin to test creation
 - Strategy inference (e.g. through constraint solving) not covered
- Semantics of links more precisely defined and illustrated
- OCL constraints and OCL-based metrics on goal models (for well-formedness and for result analysis) also covered in the graduate course

GRL Modeling: Rationale Documentation (1)

Question: Alternative Authentication Mechanisms?

References: Service: Authenticate

Decision: Smart Card + PIN

	Criteria 1: ATM Unit Cost	Criteria 2: Privacy
Option 1: Account number	+	-
Option 2: Fingerprint reader	-	+
Option 3: Smart Card + PIN	+	+

Qualitative version

GRL Modeling: Rationale Documentation (2)

Question: Alternative Authentication Mechanisms?

References: Service: Authenticate

Decision: Smart Card + PIN

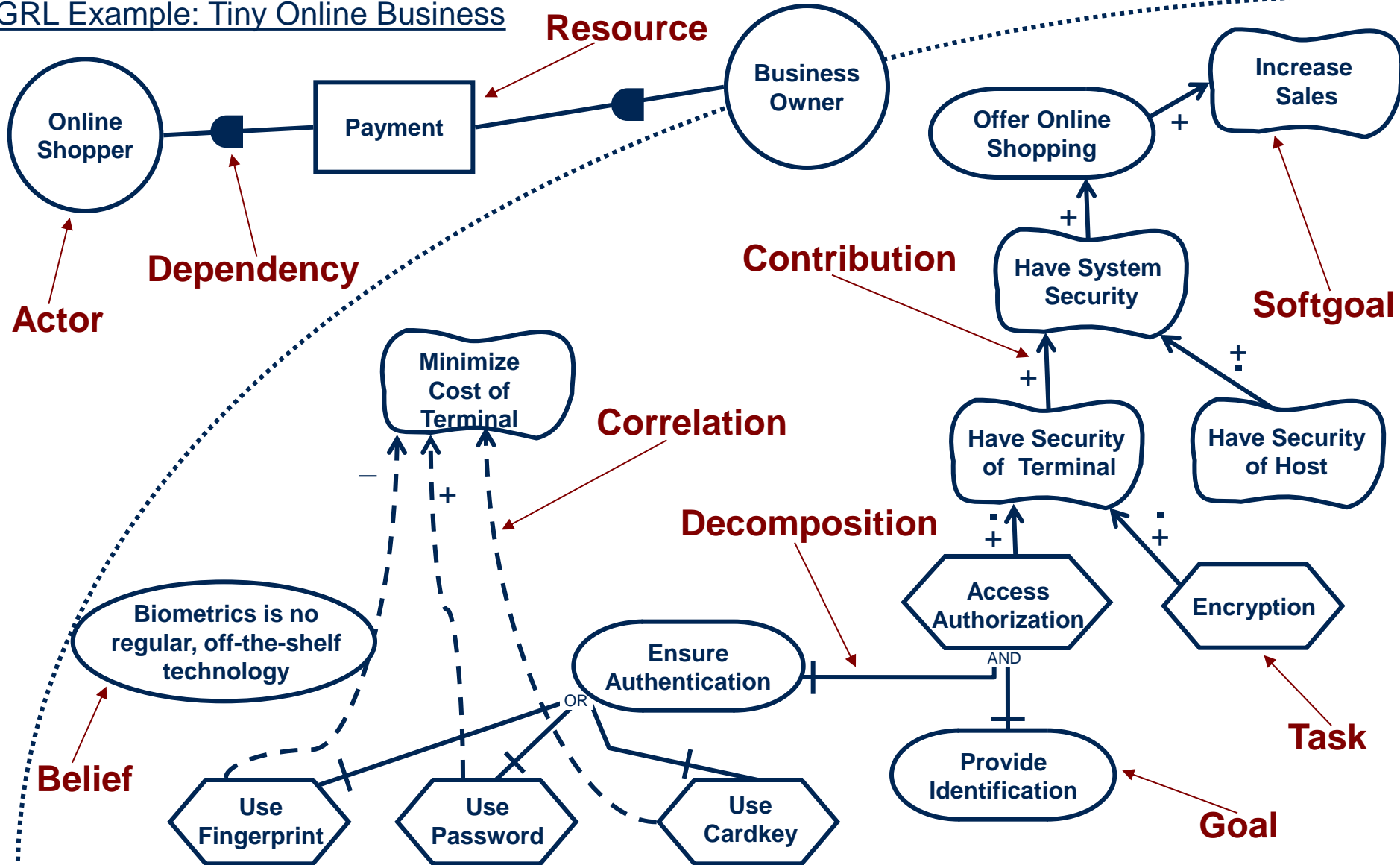
	Criteria 1: ATM Unit Cost	Criteria 2: Privacy
Option 1: Account number	1	20
Option 2: Fingerprint reader	4	30
Option 3: Smart Card + PIN	2	40

Quantitative version

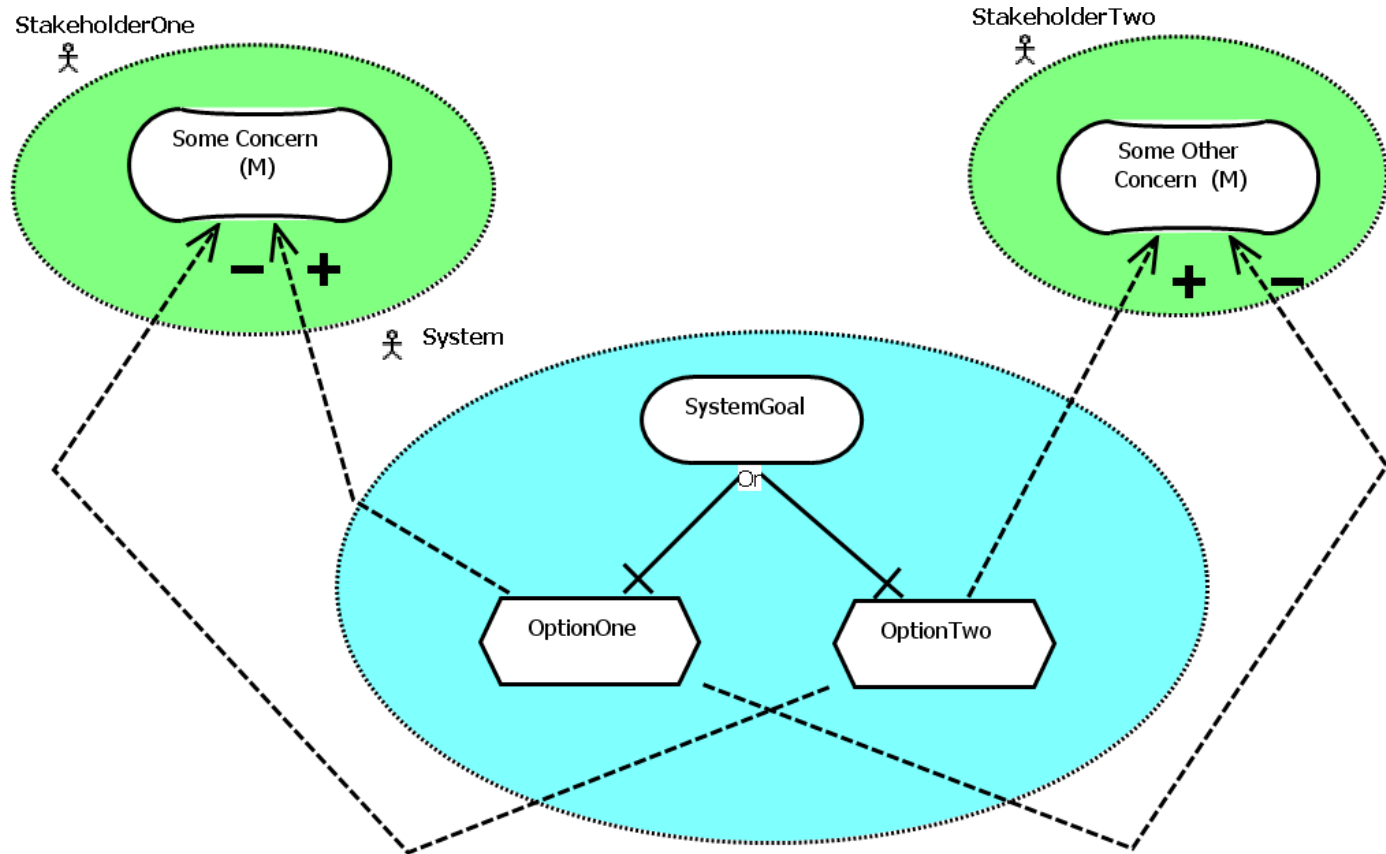
*Questions: Relationships between criteria? Scalability?
Stakeholders?... Can we do better than a simple table?*

GRL Modeling: Notation

GRL Example: Tiny Online Business



GRL Modeling: Recurring Pattern in GRL



Typical GRP pattern:

- The system (actor) has several functional goals, with various alternative ways of performing them (shown with tasks)
- There are several stakeholders (actors) involved, with their own concerns, often non-functional (captured with softgoals)
- There are side-effects from the potential solutions to the softgoals

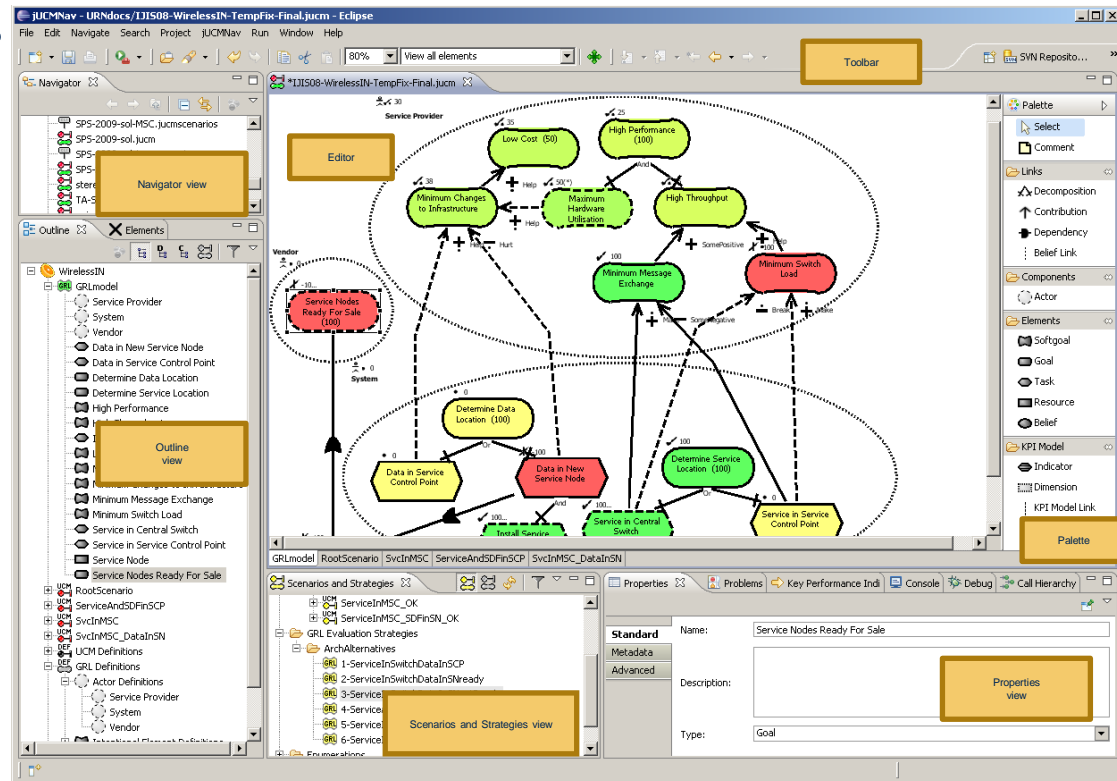
Observations about Students (1)

- Students generally understand that a **qualitative** scale ({Break, ..., Make}, {Denied, ..., Satisfied}) is used in the early modeling steps, when little information is available, and that a **quantitative** scale (e.g., [0..100]) can be used later as we gain better information and understanding.
- The pattern highlights the fact that most decisions involve **trade-offs**, and that there is value in making them explicit.
- Students understand the limitations of common tables for decision making and rationales
- Little attention is paid in class and in models to some details (contribution vs correlation, goal vs softgoal...) or concepts (beliefs and resources)
- More emphasis on **strategic rationale** (SR) type of models (easier to sell) than a strategic dependency (SD) view
- Little interest in learning more than one goal language

GRL Modeling: jUCMNav (Eclipse Plug-in)

- Features for GRL

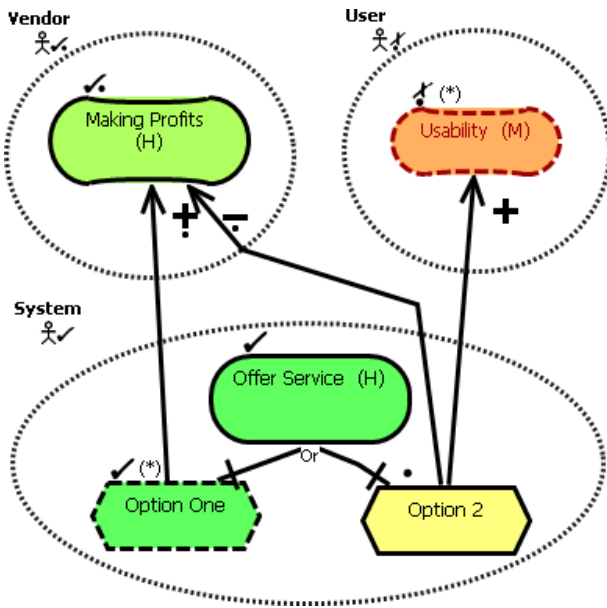
- 7 GRL evaluation algorithms, with color highlight
- One model, multiple diagrams
- Various import/export mechanisms
- OCL constraints/metrics
- DOORS integration
- ...



GRL Analysis: Strategies in jUCMNav

The screenshot shows the jUCMNav interface. On the left, the 'Scenarios and Strategies' view displays a tree structure of GRL Evaluation Strategies, including 'Cardkey' and 'Password' folders, each containing three GRL strategies. A red circle highlights the GRL icons in the toolbar. On the right, the 'Properties' view shows the 'Info' tab for a selected strategy, with the following table:

Property	Value
description	Situation where we have a cardkey but no trainin...
id	928
name	Cardkey_noTraining_noEncrypt
Metadata	[click to edit]
Miscellaneous	[click to edit]
author	Jean-François Roy
Scenario / Strategy	

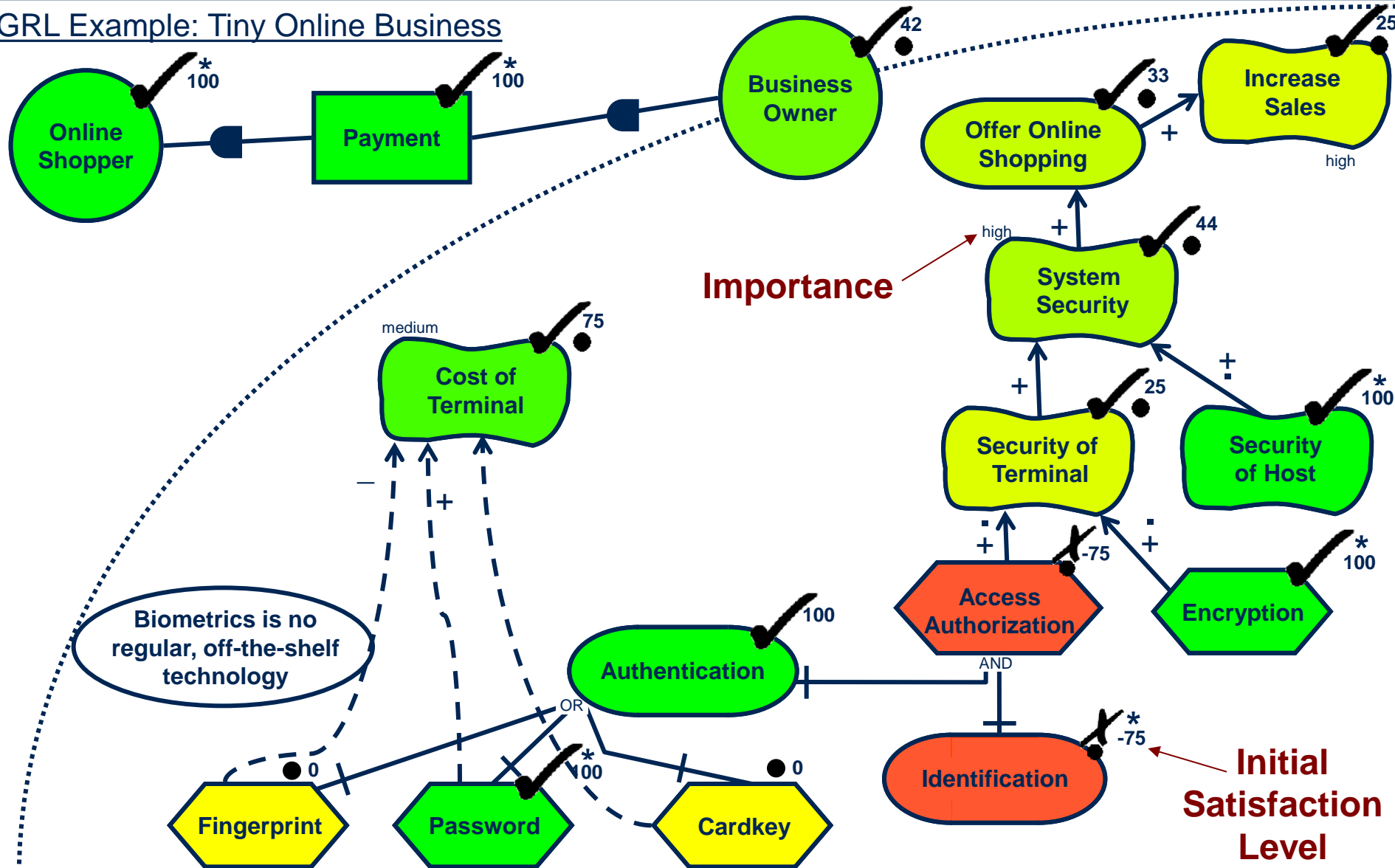


A star () indicates an initial value part of a given strategy (element also shown in dashed lines).*

All the others are evaluated through a propagation algorithm. Dashed red lines are overridden values (could be computed)

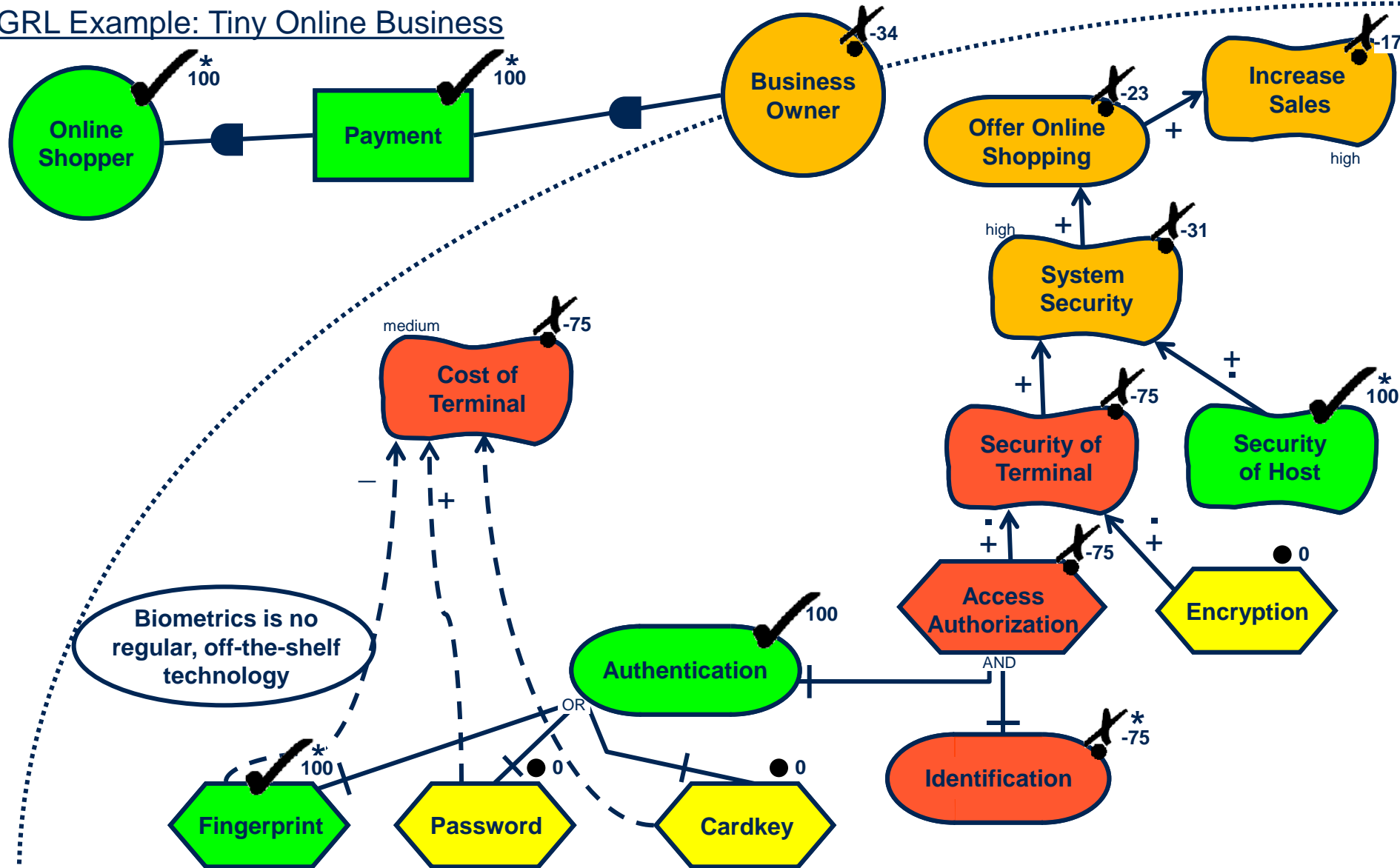
GRL Analysis: Strategy Execution (Strategy 1)

GRL Example: Tiny Online Business



GRL Analysis: Strategy Execution (Strategy 2)

GRL Example: Tiny Online Business



Observations about Students (2)

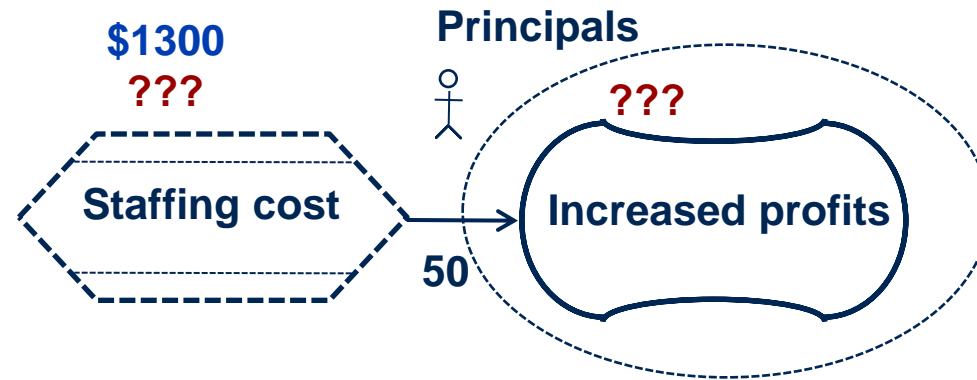
- Students learn to have models on which stakeholders **disagree sooner** than with verbose text.
- Better understanding of how propagation algorithms work leads to a better and more consistent selection of GRL relationships (e.g., decomposition versus contributions) by students.
- Students in these courses enjoy *automated* analysis with immediate feedback and have little interest in manual or interactive propagation.
- Students realize the challenge in choosing appropriate contribution weights

Inclusion of Measures in Goal Models

- Need to better relate observations about the real world to the goal model, with domain-specific units such as:
 - Currencies (e.g., revenues in \$)
 - Durations (e.g., waiting time in a hospital, in hours)
 - Counts (e.g., number of new students admitted in SEG)
- GRL supports this kind of information, and integrates it in the rest of the goal model
 - *Key Performance Indicator* (KPI)
- KPIs help **measure** goals and NFRs with quantifiable metrics
- GRL KPIs can also be fed from external sources (monitoring)

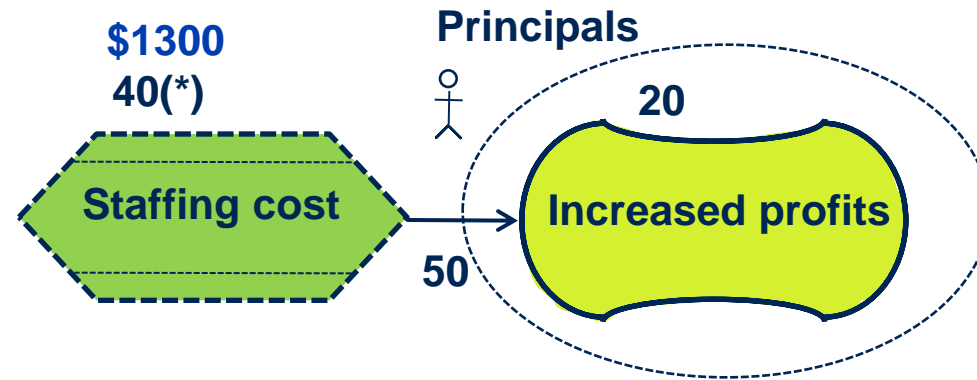


Indicators: From Current to Satisfaction Value



Attribute	Value	GRL Satisfaction
Target	\$1000	100
Threshold	\$1500	0
Worst-case	\$2500	-100
Current	\$1300	???

Indicators: From Current to Satisfaction Value



Attribute	Value	GRL Satisfaction
Target	\$1000	100
Threshold	\$1500	0
Worst-case	\$2500	-100
Current	\$1300	40

Integration with UCM for BPM

UCMNav - EclipseTest33/Documents/paper-based process-OH-Thesis-DOORS - linux v8.jucm - Eclipse Platform

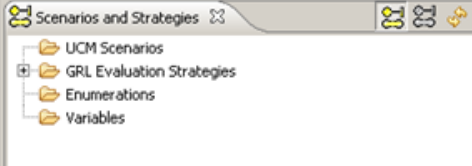
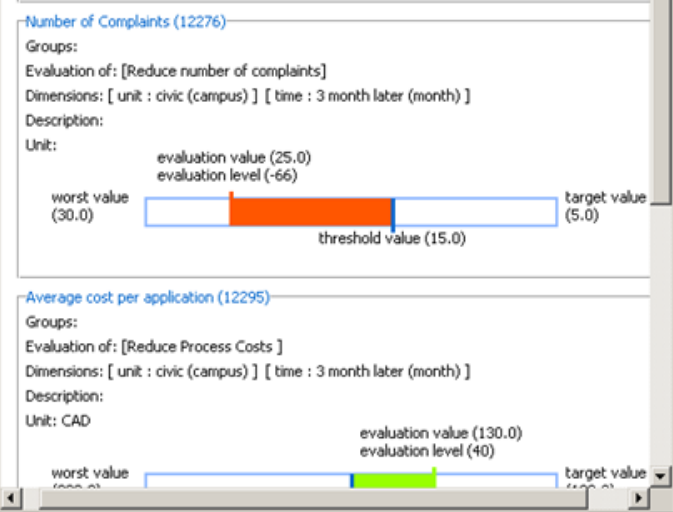
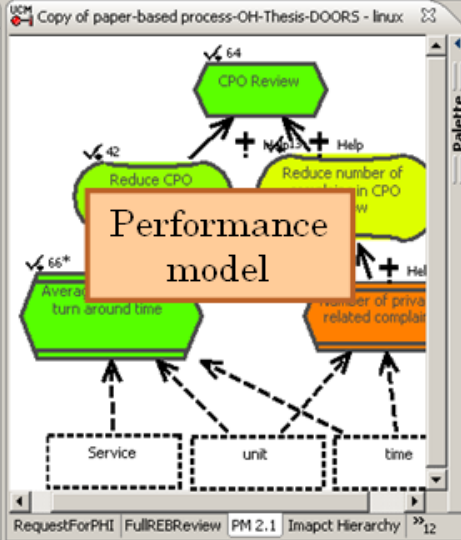
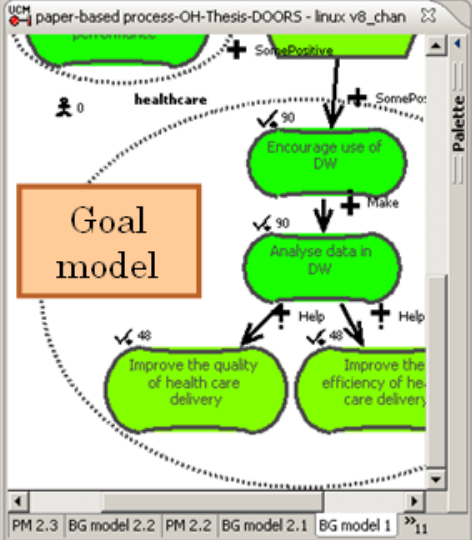
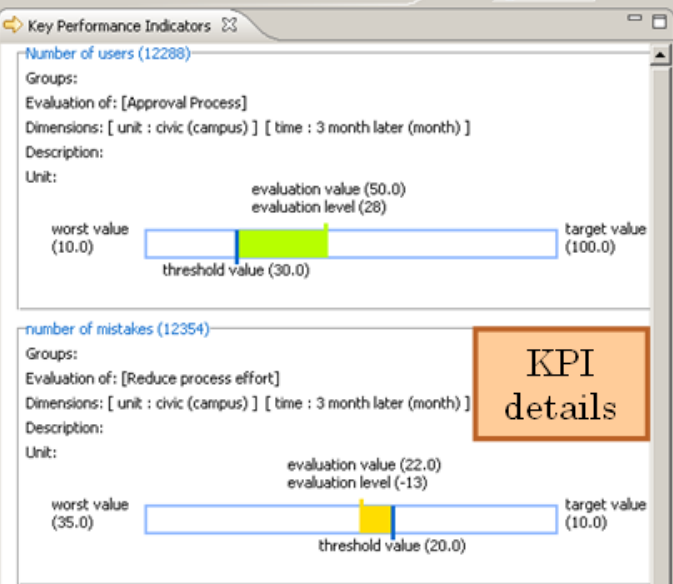
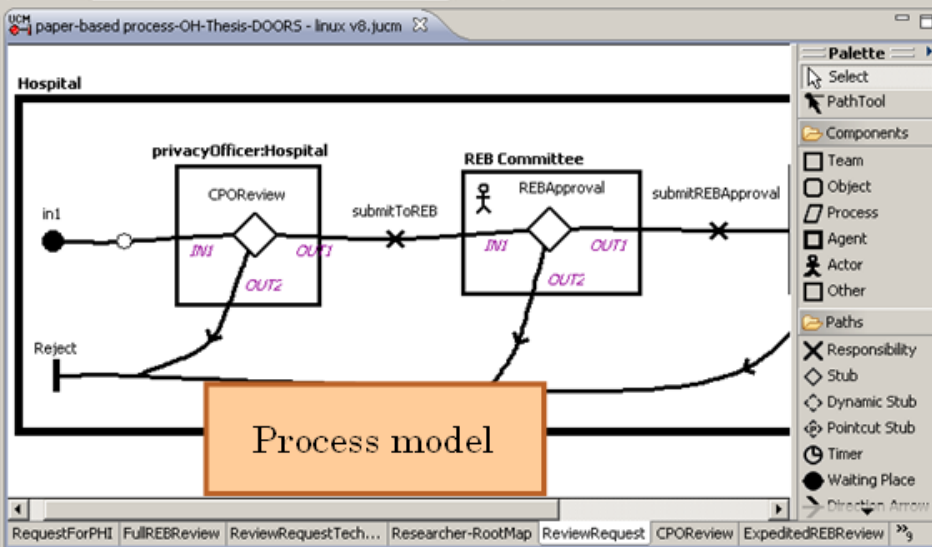
File Edit Navigate Search Project UCMNav Run Window Help

100% View all elements

UCMNav

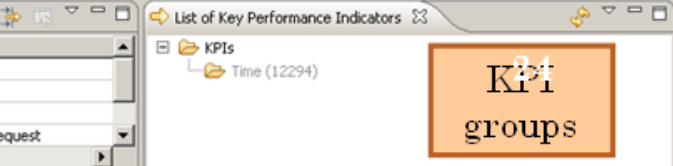
Outline

- URNSpec
 - UCM RequestForPHI (41)
 - UCM FullREBReview (66)
 - UCM ReviewRequestTechnically (3195)
 - UCM Researcher-RootMap (3059)
 - UCM ReviewRequest (3195)
 - DW Administrator :HIC (3197)
 - Hospital (3197)
 - privacyOfficer:Hospital (10034)
 - REB Committee (10034)
 - Approved (3202)
 - Reject (3237)
 - OrJoin (3596)
 - OrJoin (4961)
 - submitREBApproval (552)
 - submitToREB (5319)
 - in1 (3200)
 - CPOReview (3221)
 - REBApproval (4917)
 - technicalReview (3487)
 - DirectionArrow (11942)
 - DirectionArrow (3597)
 - DirectionArrow (8214)
 - EmptyPoint (14742)
 - CPOReview (4908)
 - ExpeditedREBReview (5195)
 - BG model 2.3 (13009)
 - PM 2.3 (13345)
 - BG model 2.2 (12980)
 - PM 2.2 (13331)
 - BG model 2.1 (12951)
 - BG model 1 (12901)
 - PM 1 (13094)
 - PM 2.1 (13188)
 - Impact Hierarchy (14894)
 - UCM Definitions
 - Component Definitions
 - Resource Definitions
 - Responsibility Definitions
 - GRL Definitions
 - Actor Definitions
 - Intentional Element Defir
 - KPI Information Element
 - Service (15699)
 - time (12458)
 - unit (12464)



Properties

Property	Value
Info	
description	
id	3195
name	ReviewRequest

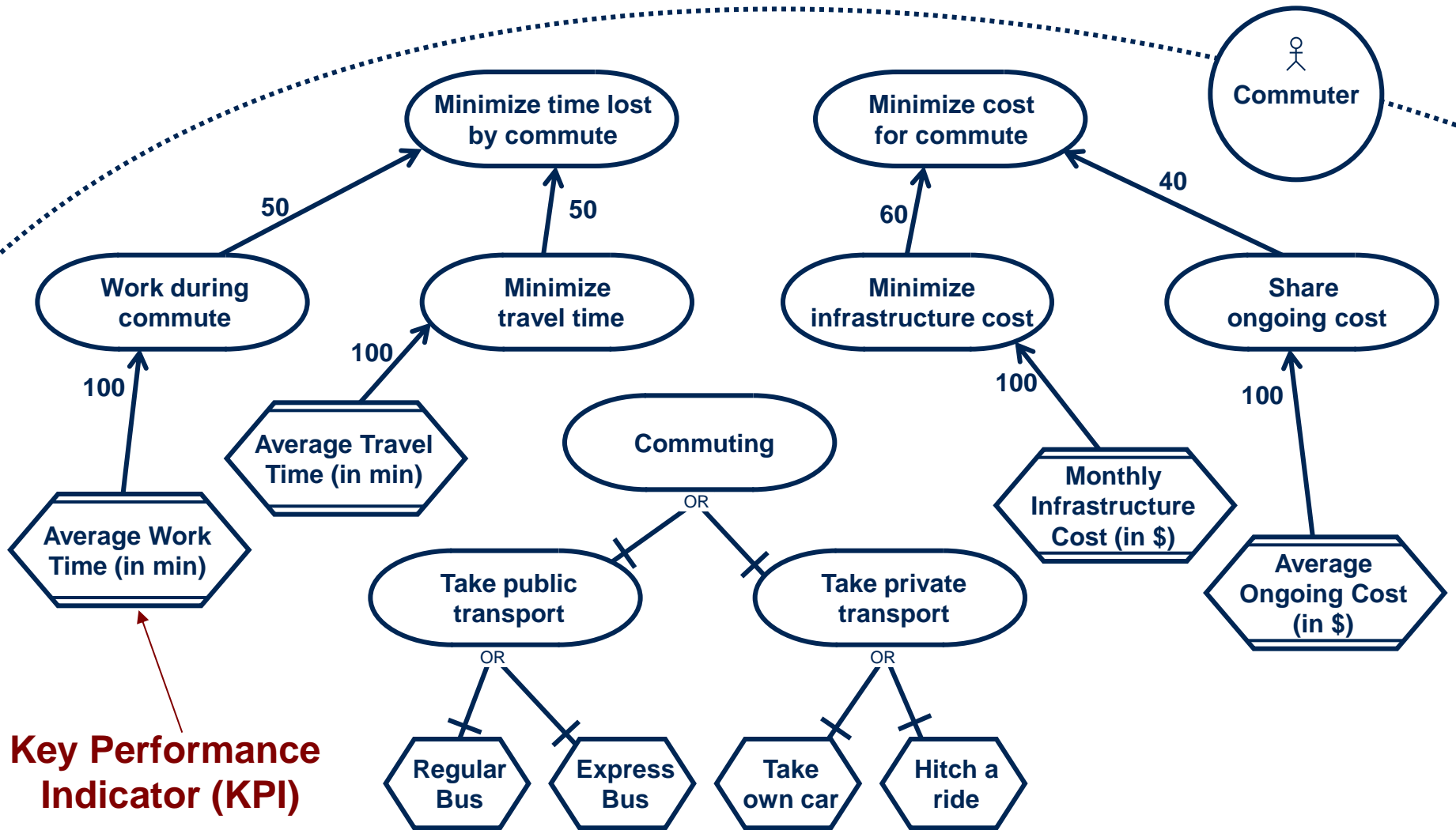


Models

KPI groups

KPIs: Commuting Example (from G. Mussbacher)

Example: Commuting



Key Performance Indicator (KPI)

From Real World Values to Model Values

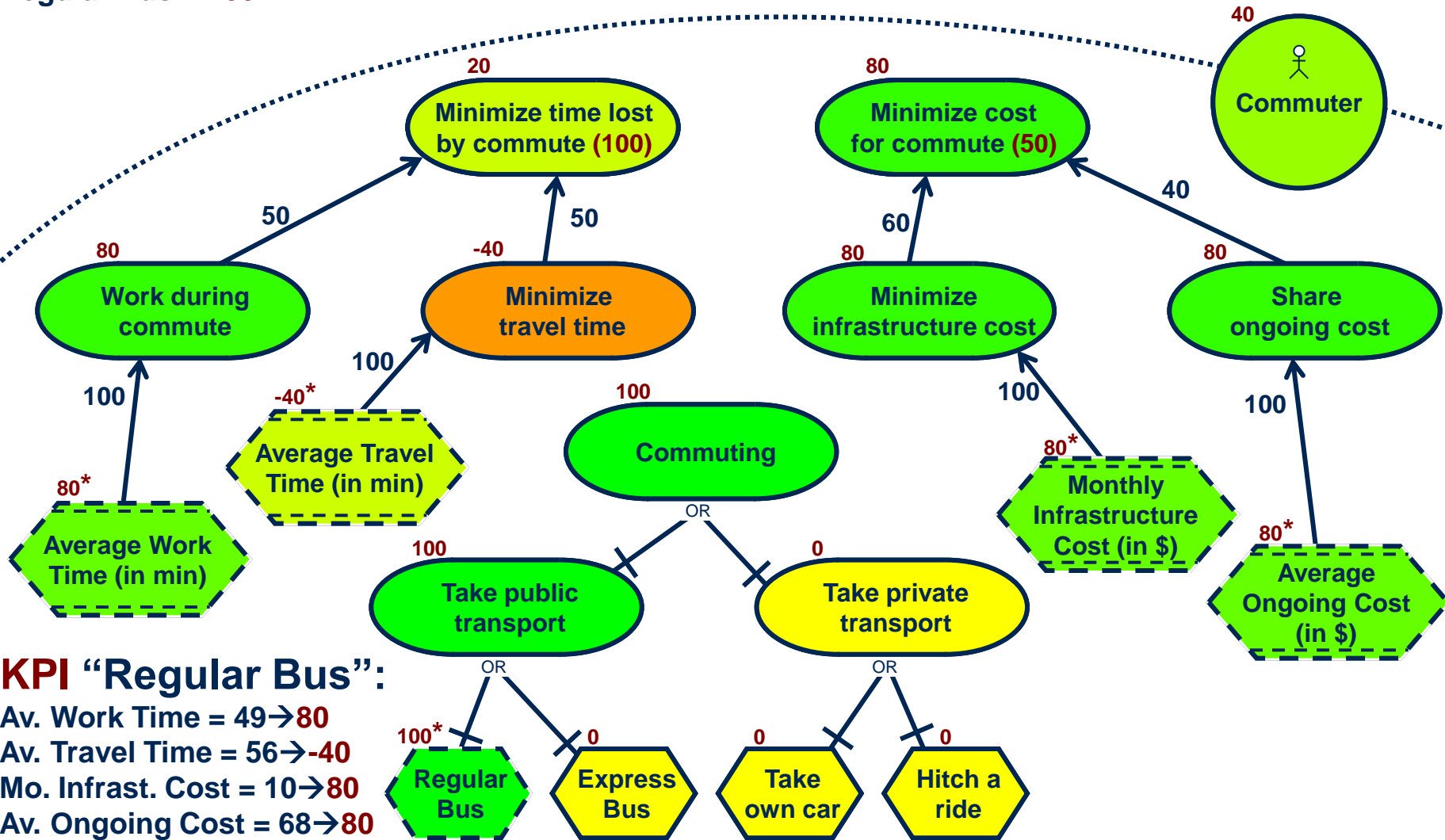
Real World Value	Model Value (Satisfaction Value)		Regular Bus	Express Bus	Take own car	Hitch a ride
Target Value	> 100					
	100	Average Work Time (in min)				
		Target Value (60)	49	29.75	4.5	4.5
Threshold Value	0	Threshold Value (5)	↓	↓	↓	↓
		Worst Value (0)	80	45	-10	-10
Worst Value	< -100					
	-100	Average Travel Time (in min)				
		Target Value (20)	56	52	24	24
		Threshold Value (40)	↓	↓	↓	↓
		Worst Value (80)	-40	-30	80	80
		Monthly Infrastructure Cost (in \$)				
		Target Value (0)	10	10	455	140
		Threshold Value (50)	↓	↓	↓	↓
		Worst Value (500)	80	80	-90	-20
		Average Ongoing Cost (in \$)				
		Target Value (60)	68	76	120	92
		Threshold Value (100)	↓	↓	↓	↓
		Worst Value (200)	80	60	-20	20

Strategy Execution with KPIs (1/2)

Example: Commuting

Strategy "Regular Bus":

Regular Bus = 100



KPI "Regular Bus":

Av. Work Time = 49 → 80

Av. Travel Time = 56 → -40

Mo. Infrast. Cost = 10 → 80

Av. Ongoing Cost = 68 → 80

type filter text

- General
- Ant
- ATL
- CDO
- Ecore Diagram
- Ecore Tools Diagram
- EMF Compare
- Help
- Install/Update
- Java
- JET Transformations
- jUCMNav
 - AutoLayout Preferences
 - Color Preferences
 - GRL Strategy Evaluation
 - KPI Monitoring Preferen
 - Metrics Preferences
 - Outline Preferences
 - Reference/Definition Pre
 - Report Generation Prefe
 - Scenario Export Prefere
 - Static Semantics Checkin
 - UCM Scenario Traversal
- Model Validation
- Plug-in Development
- Run/Debug
- Tasks
- Team
- Teneo
- UML2 Diagrams
- Usage Data Collector
- Validation
- XML
- Xtend/Xpand
- Xtext
- Xtext Languages

Static Semantics Checking Preferences

Show rule description in the rule violation report

Rules defined:

OCL Constraints (Graduate)

Edit a rule

Rule Name:

Context:

OCL query expression for collecting all objects to be checked:

OCL constraint expression:

Description:

Report as Warning instead of Error

New Edit Delete

OK Cancel

Example of a constraint definition

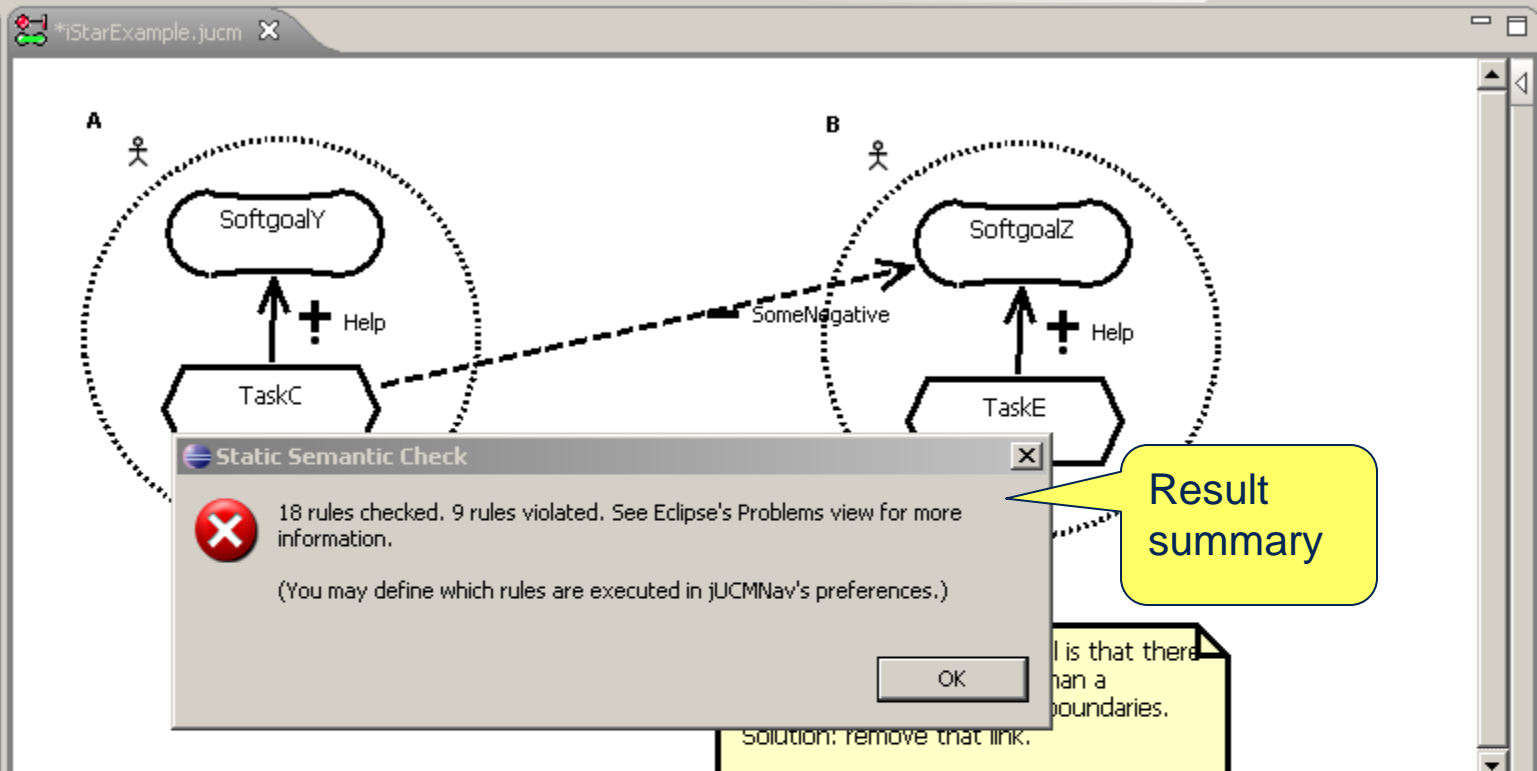
ld not be the dest...
 position links shoul...
 composition (mean...
 association should ...
 rams should be ta...
 y links in an SR mo...
 ks that cross actor...
 tion of a Contribu...
 ion links must not ...
 ion links must not ...
 alization) must be ...
 association must be...
 ociation must be fr...
 s association must...
 ociation must only ...
 y links must never ...
 y links in an SD mo...

Restore Defaults Apply

OK Cancel

Outli Elem

- Actor Definitions
 - A
 - AnotherSubactor
 - B
 - MyAgent
 - SomeRole
 - SubActor
 - SuperActor
- Intentional Element Definition
 - Dependee
 - Depender
 - Goal1
 - Goal3
 - Goal6
 - GoalY
 - Resource5
 - Softgoal2
 - Softgoal7
 - SoftgoalX
 - SoftgoalY
 - SoftgoalZ
 - SomeGoal
 - SomeOtherTask
 - SomeSoftgoal
 - SomeTask
 - Task4
 - Task8



SomeGRLGraph SD model SR model SR-Crossing SR Missing Dependum

Problems

6 errors, 7 warnings, 1 other

Description	Location	Type
Errors (6 items)		
The destination of a Contribution must be a Softgoal (SoftgoalAsContributionDestination)	Contribution50	Problem
Decomposition links must not have softgoals, resources or beliefs as a destination. (DecompositionLinkForbide	Decomposition74	Problem
Decomposition links must not have softgoals, resources or beliefs as a destination. (DecompositionLinkForbide	Decomposition77	Problem
Decomposition links must not have softgoals, resources or beliefs as a destination. (DecompositionLinkForbide	Decomposition95	Problem
SD models must not have links other than dependency and actor association links (SDmodelsRestrictedLinks)	SD model	Problem
Dependency links must never completely be inside of an actor boundary (NoDependencyInsideActor)	grl.impl.LinkRef...	Problem
Warnings (7 items)		
AND decomposition links should only have tasks as destinations (TasksAsDestOfAndLinks)	Decomposition74	Problem

Errors and warnings generated

Observations about Students (3)

- Students learn that by combining GRL with UCM, they can provide a rationale for the structure of business processes (the **why** aspect, added to the what/where/when/who)
- A dual view (goal/scenarios) also enable
 - Dealing with different types of stakeholders (goals for managers, scenarios for people in the trenches) during RE activities
 - Consistency and completeness analysis
- They also learn that indicators can help make models more precise and falsifiable
- Graduate students learn that OCL constraints can be used to enforce a specific style of modeling and detect customized categories of issues

Conclusions and Future Work

- Brief overview of my experience teaching GRL in various courses
- In addition to an assignment, undergrad students have an additional 3-hour tutorial/lab that contributes positively to the learning.
- Undergrad students have a semester-long project where many teams choose to use GRL to model goals and stakeholders, with traceability to scenarios and requirements via IBM DOORS
- Graduate students have a project in teams of 2 people on a tool comparison, and several express their goals and do their evaluation with GRL (nobody used indicators so far...)
- Need to introduce goal modeling with language subsets first
- What would help is a set on online/YouTube lectures and tutorials, with online exercises.

Dilbert on Goals



Dilbert.com DilbertCartoonist@gmail.com



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