ParaMagic™ – Running the Numbers on SysML Models

Introduction to SysML Parametrics

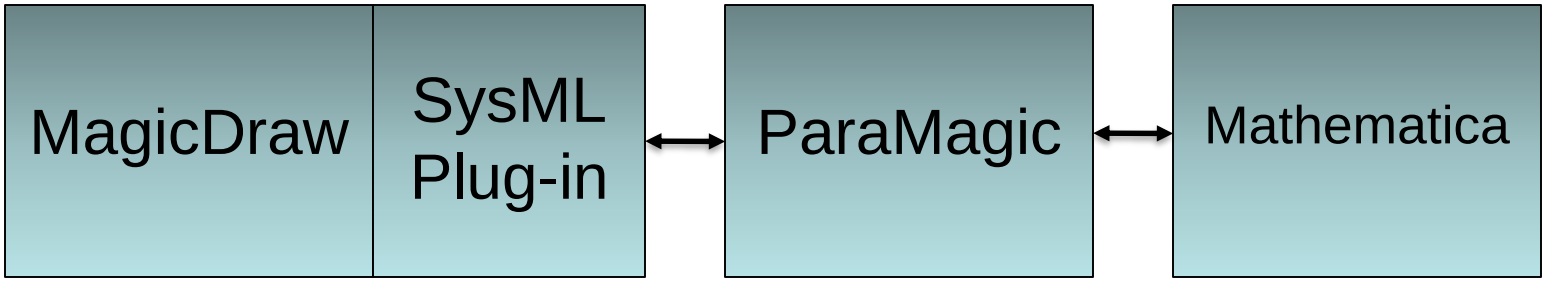
Parametrics – using the quantitative information and relationships inside a SysML model to test the model behavior/validity.

Parametrics + MagicDraw

↓

ParaMagic

Product Structure



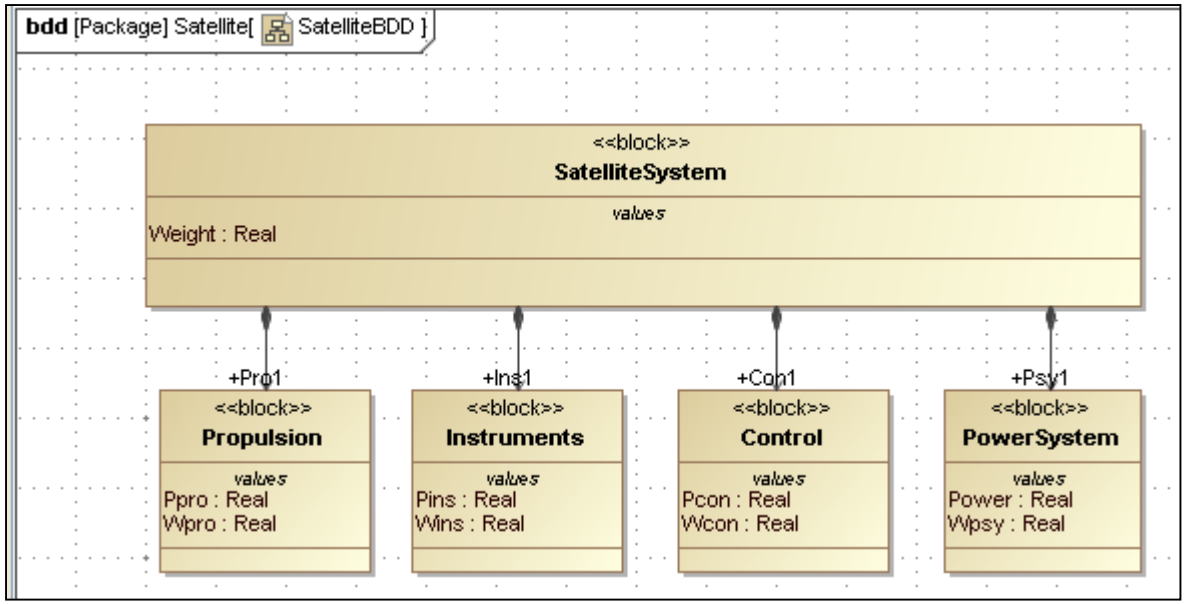
No Magic **InterCAX** **Wolfram Research**

Customers can make their models “live”

- Performance, cost and resources
- Trade-offs
- Optimization
- “What If?” scenarios

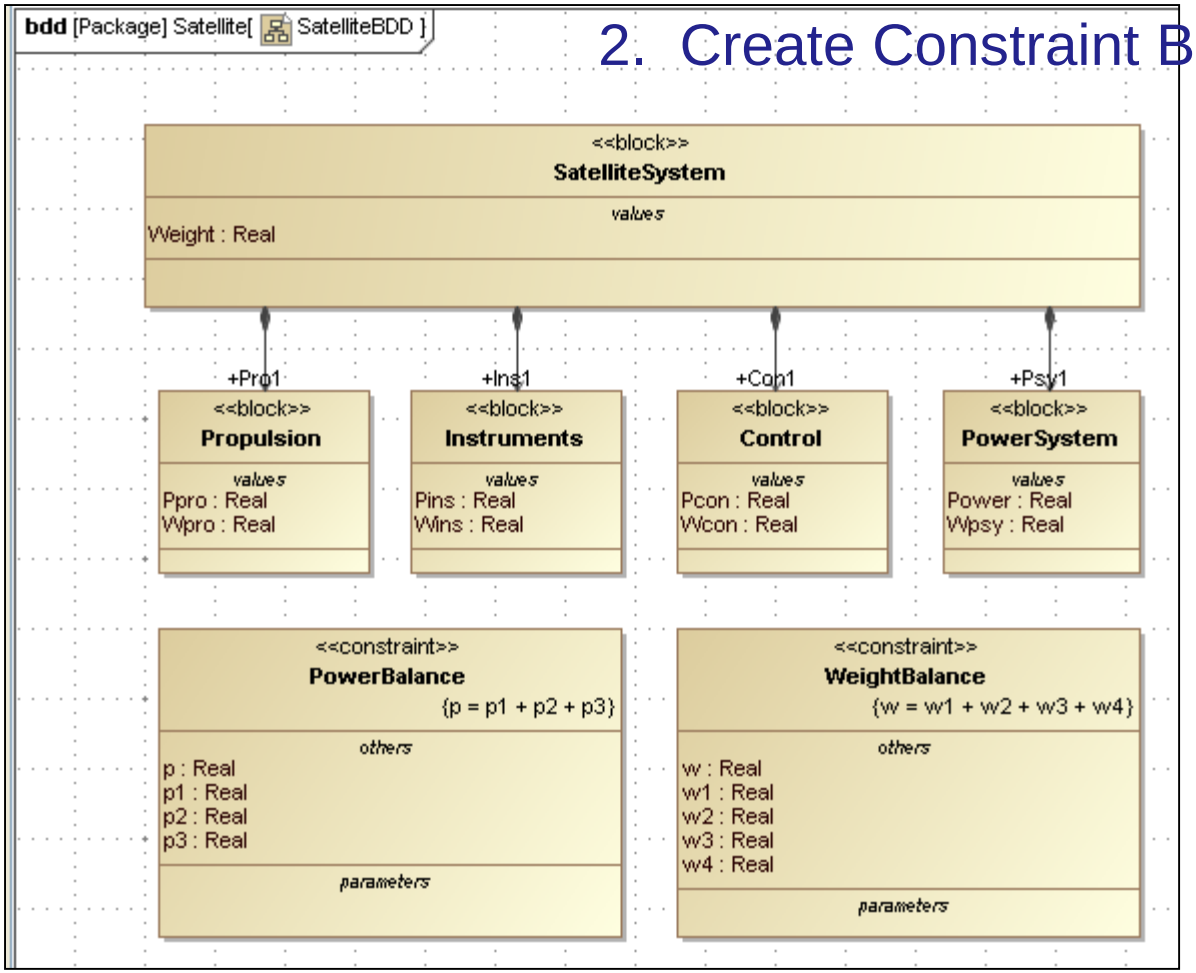
Building a SysML Model with Parametrics

1. Create Structural Model



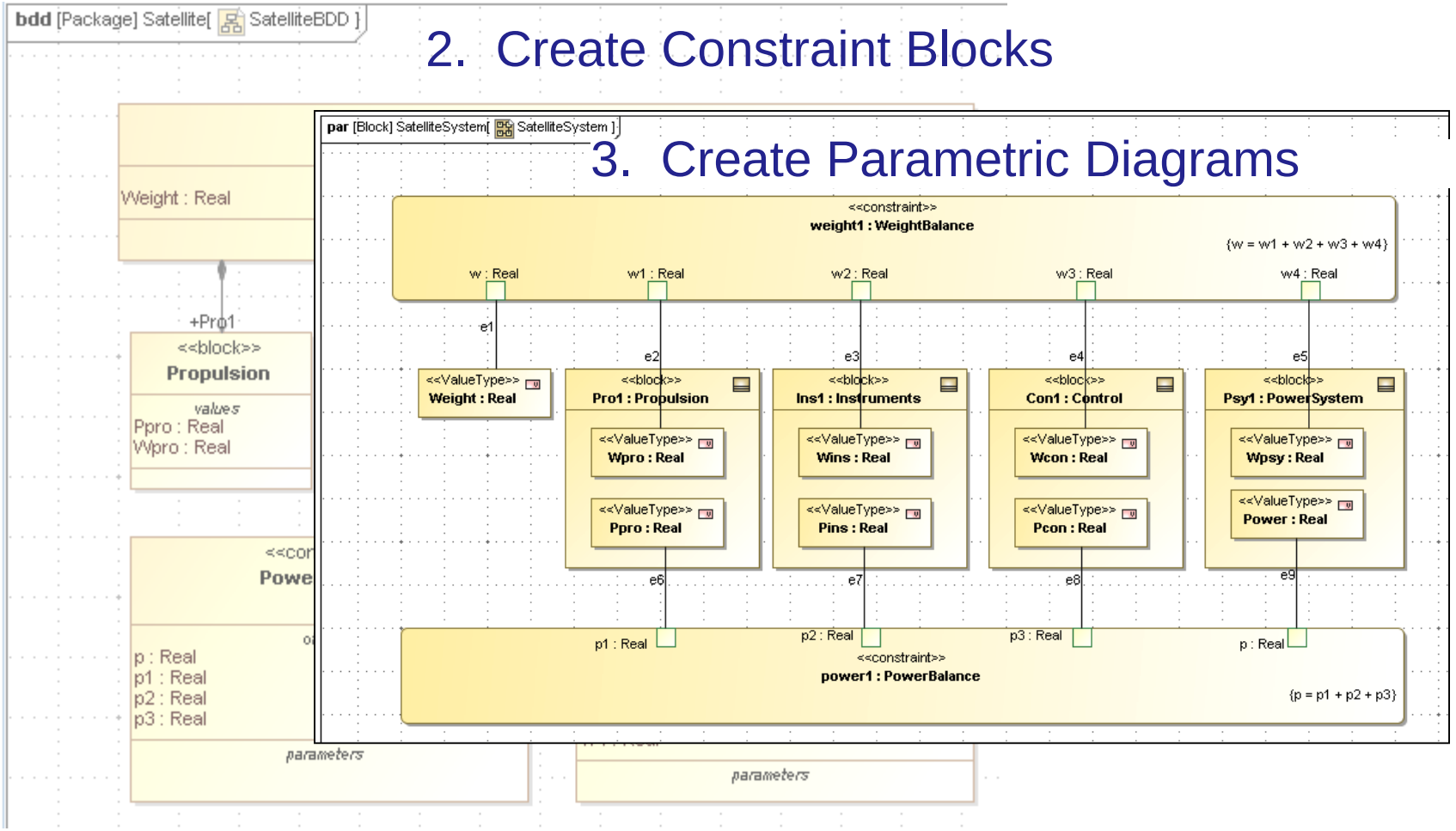
Satellite Model

1. Create Structural Model
2. Create Constraint Blocks



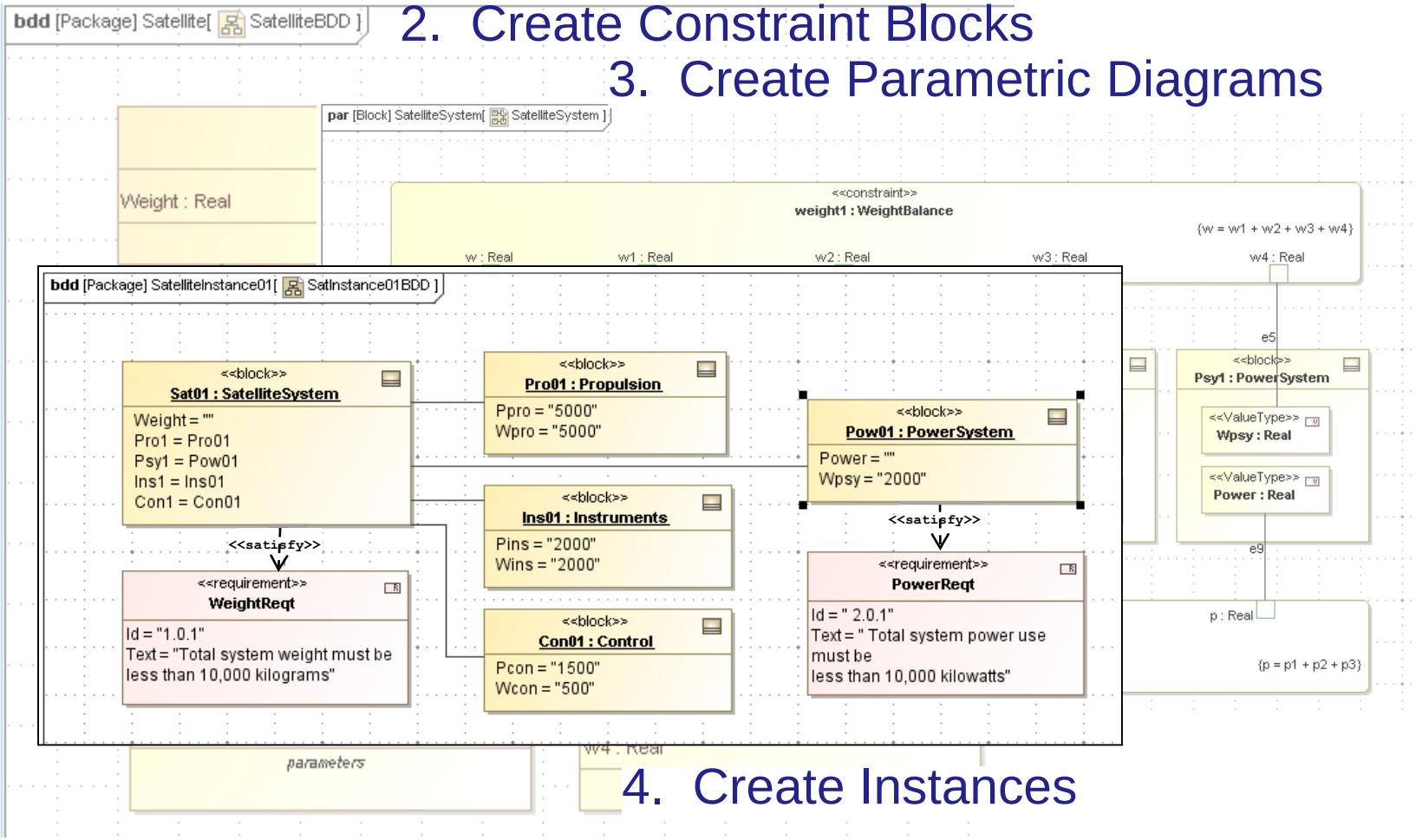
Satellite Model

1. Create Structural Model
2. Create Constraint Blocks
3. Create Parametric Diagrams



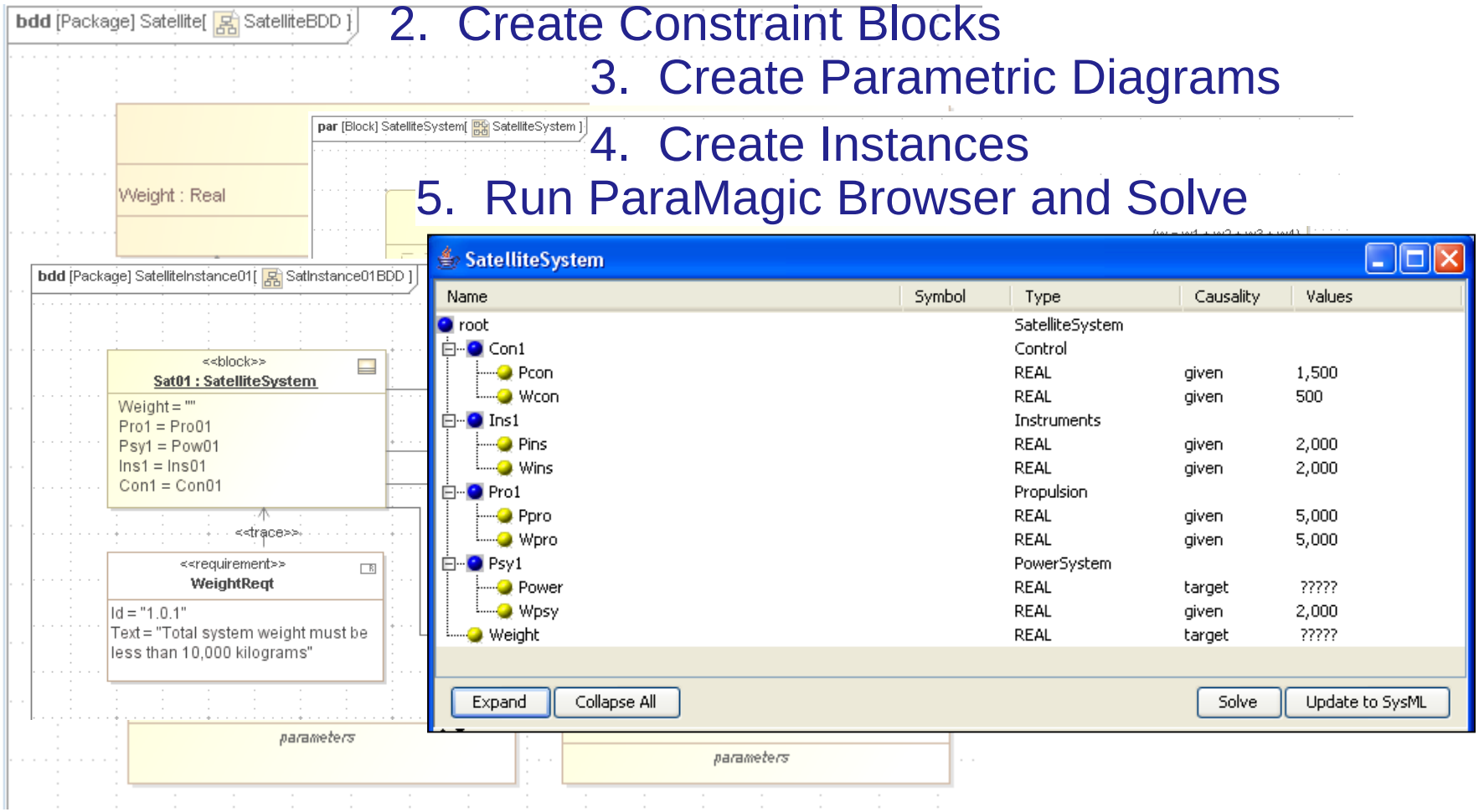
Satellite Model

1. Create Structural Model
2. Create Constraint Blocks
3. Create Parametric Diagrams
4. Create Instances



Satellite Model

1. Create Structural Model
2. Create Constraint Blocks
3. Create Parametric Diagrams
4. Create Instances
5. Run ParaMagic Browser and Solve



Demo Models

LittleEye – modeling system performance

Insurance – modeling business processes

Project Planning – modeling activities

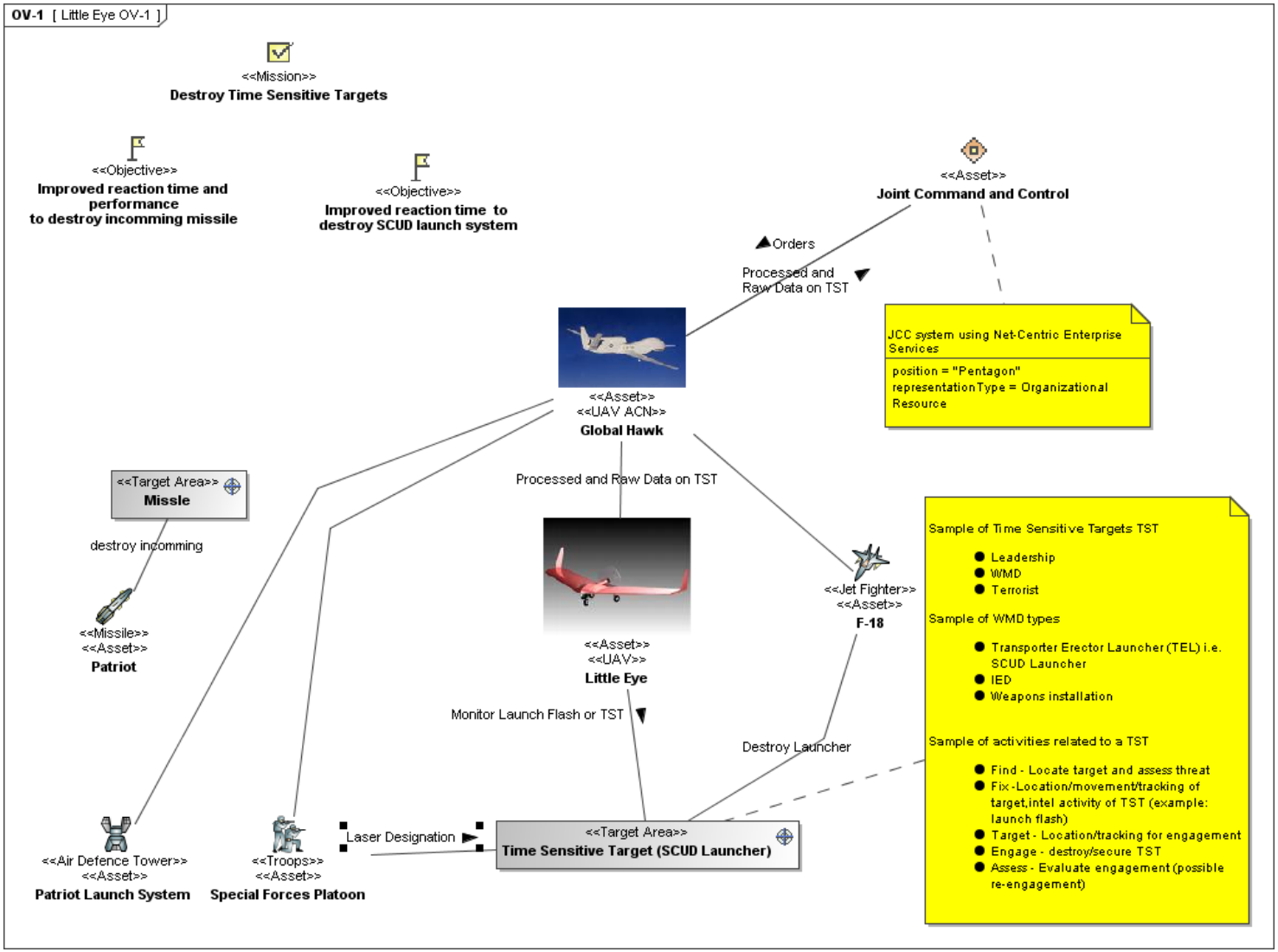
Trade Financing – modeling risk

Corporate Finance – modeling cash flow

Retail Banking – modeling market segmentation

CommNetwork – modeling network capacity

Demo - LittleEye



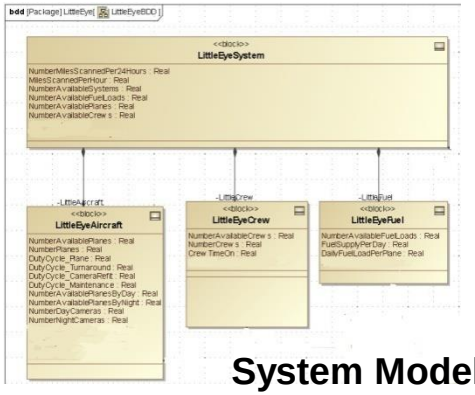
Demo - LittleEye

- LittleEye is an unmanned aerial vehicle used for highway reconaissance. A LittleEye base requires aircraft, crew and fuel to operate. Aircraft maintenance and crew schedules limit operations.

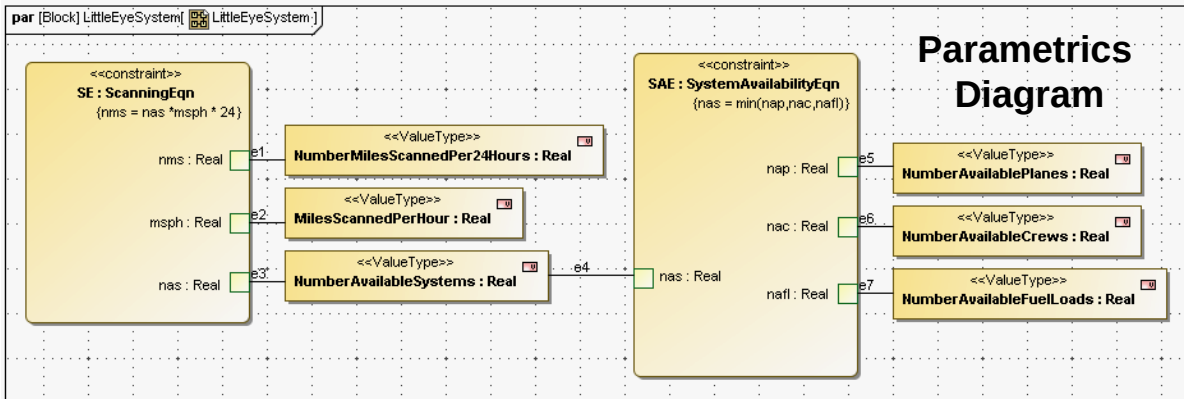
- Objective: How many miles of road can be covered per 24 hours by a LittleEye base with a given number of aircraft, crews, and fuel loads?

- Results: Instance 1 shows 2k miles scanned per day, limited by the four crews' availability. In Instance 2, an additional crew is added and base capacity rises to 2.3k miles per day, but now the number of aircraft is the limiting factor.

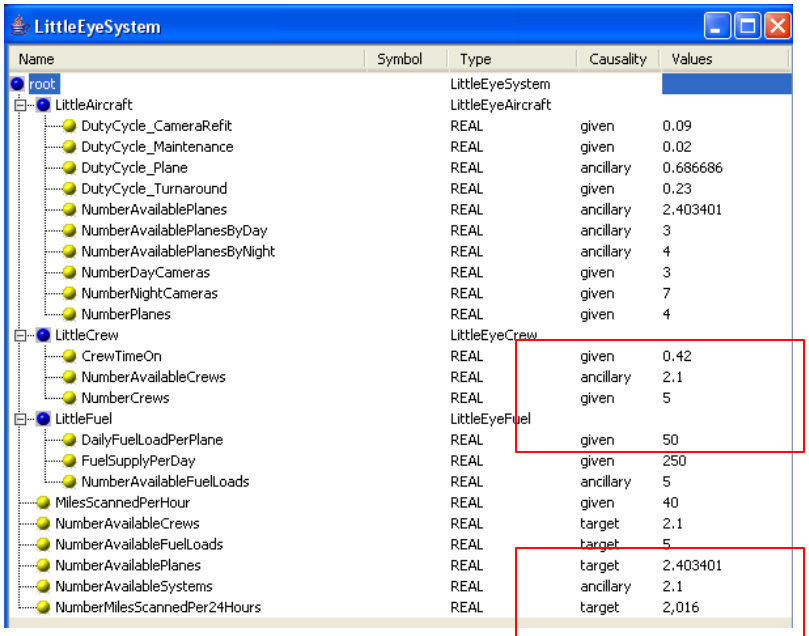
Demo - LittleEye



System Model

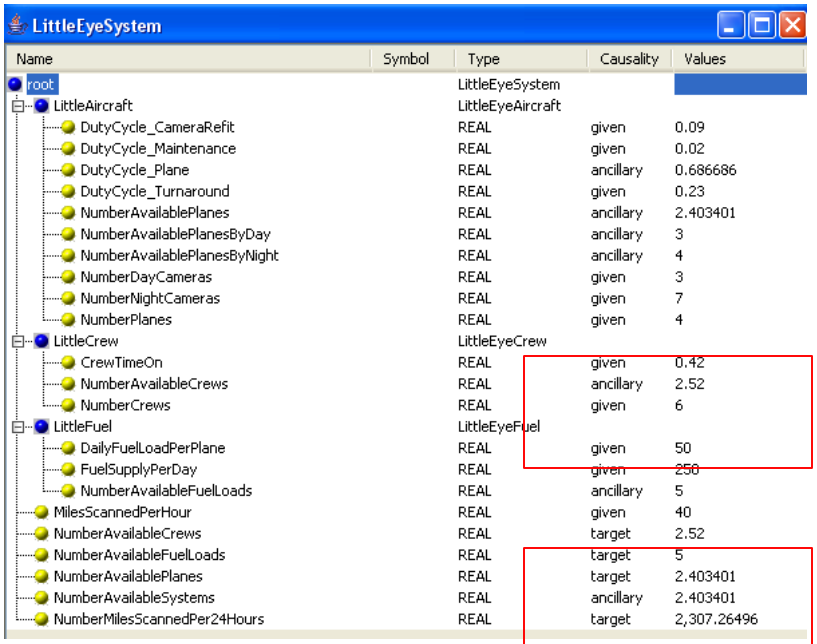


Parametrics Diagram



Name	Symbol	Type	Causality	Values
root		LittleEyeSystem		
LittleAircraft		LittleEyeAircraft		
DutyCycle_CameraRefit		REAL	given	0.09
DutyCycle_Maintenance		REAL	given	0.02
DutyCycle_Plane		REAL	ancillary	0.686686
DutyCycle_Turnaround		REAL	given	0.23
NumberAvailablePlanes		REAL	ancillary	2.403401
NumberAvailablePlanesByDay		REAL	ancillary	3
NumberAvailablePlanesByNight		REAL	ancillary	4
NumberDayCameras		REAL	given	3
NumberNightCameras		REAL	given	7
NumberPlanes		REAL	given	4
LittleCrew		LittleEyeCrew		
CrewTimeOn		REAL	given	0.42
NumberAvailableCrews		REAL	ancillary	2.1
NumberCrews		REAL	given	5
LittleFuel		LittleEyeFuel		
DailyFuelLoadPerPlane		REAL	given	50
FuelSupplyPerDay		REAL	given	250
NumberAvailableFuelLoads		REAL	ancillary	5
MilesScannedPerHour		REAL	given	40
NumberAvailableCrews		REAL	target	2.1
NumberAvailableFuelLoads		REAL	target	5
NumberAvailablePlanes		REAL	target	2.403401
NumberAvailableSystems		REAL	ancillary	2.1
NumberMilesScannedPer24Hours		REAL	target	2,016

Instance 1



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NumberAvailablePlanes		REAL	ancillary	2.403401
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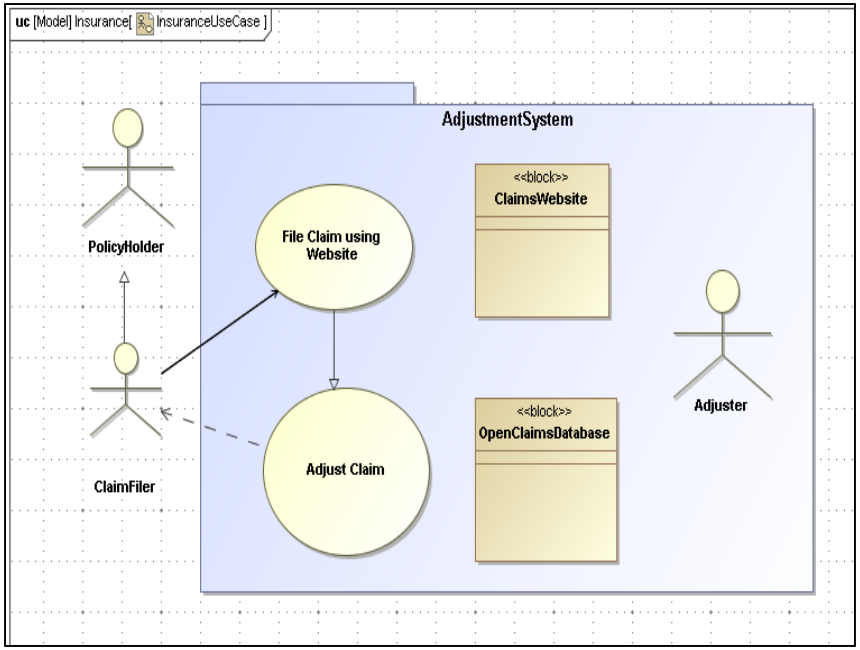
NumberDayCameras		REAL	given	3
NumberNightCameras		REAL	given	7
NumberPlanes		REAL	given	4
LittleCrew		LittleEyeCrew		
CrewTimeOn		REAL	given	0.42
NumberAvailableCrews		REAL	ancillary	2.52
NumberCrews		REAL	given	6
LittleFuel		LittleEyeFuel		
DailyFuelLoadPerPlane		REAL	given	50
FuelSupplyPerDay		REAL	given	250
NumberAvailableFuelLoads		REAL	ancillary	5
MilesScannedPerHour		REAL	given	40
NumberAvailableCrews		REAL	target	2.52
NumberAvailableFuelLoads		REAL	target	5
NumberAvailablePlanes		REAL	target	2.403401
NumberAvailableSystems		REAL	ancillary	2.403401
NumberMilesScannedPer24Hours		REAL	target	2,307.26496

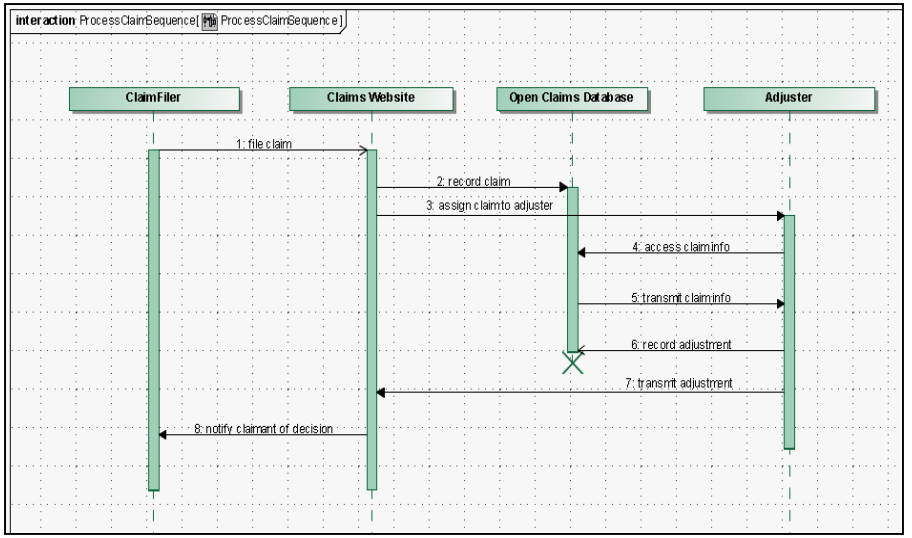
Instance 2

Insurance

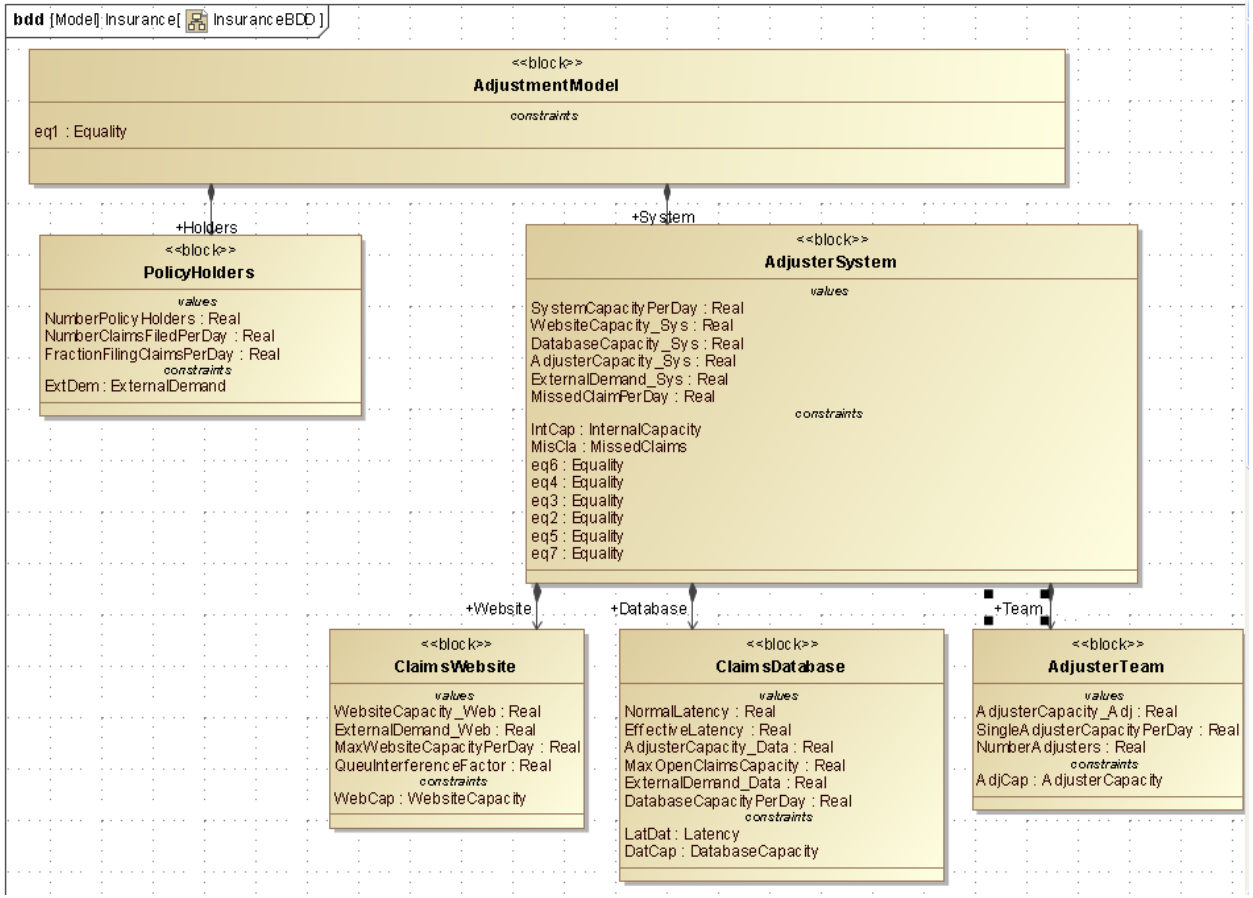
An insurance company wants to set up a web-based claim filing system, combining a website, a team of adjusters, and an open claims database.

Question: How many claims per day are not accepted because of system limitations?





Insurance


bdd [Model] Insurance [InsuranceBDD]
<<block>>
AdjustmentModel
constraints
eq1 : Equality
+Holders
+System
<<block>>
PolicyHolders
values
NumberPolicyHolders : Real
NumberClaimsFiledPerDay : Real
FractionFilingClaimsPerDay : Real
constraints
ExtDem : ExternalDemand
<<block>>
AdjusterSystem
values
SystemCapacityPerDay : Real
WebsiteCapacity_Sys : Real
DatabaseCapacity_Sys : Real
AdjusterCapacity_Sys : Real
ExternalDemand_Sys : Real
MissedClaimPerDay : Real
constraints
IntCap : InternalCapacity
MisCla : MissedClaims
eq6 : Equality
eq4 : Equality
eq3 : Equality
eq2 : Equality
eq5 : Equality
eq7 : Equality
+Website
+Database
+Team
<<block>>
ClaimsWebsite
values
WebsiteCapacity_Web : Real
ExternalDemand_Web : Real
MaxWebsiteCapacityPerDay : Real
QueueInterferenceFactor : Real
constraints
WebCap : WebsiteCapacity
<<block>>
ClaimsDatabase
values
NormalLatency : Real
EffectiveLatency : Real
AdjusterCapacity_Data : Real
MaxOpenClaimsCapacity : Real
ExternalDemand_Data : Real
DatabaseCapacityPerDay : Real
constraints
LatDat : Latency
DatCap : DatabaseCapacity
<<block>>
AdjusterTeam
values
AdjusterCapacity_Adj : Real
SingleAdjusterCapacityPerDay : Real
NumberAdjusters : Real
constraints
AdjCap : AdjusterCapacity

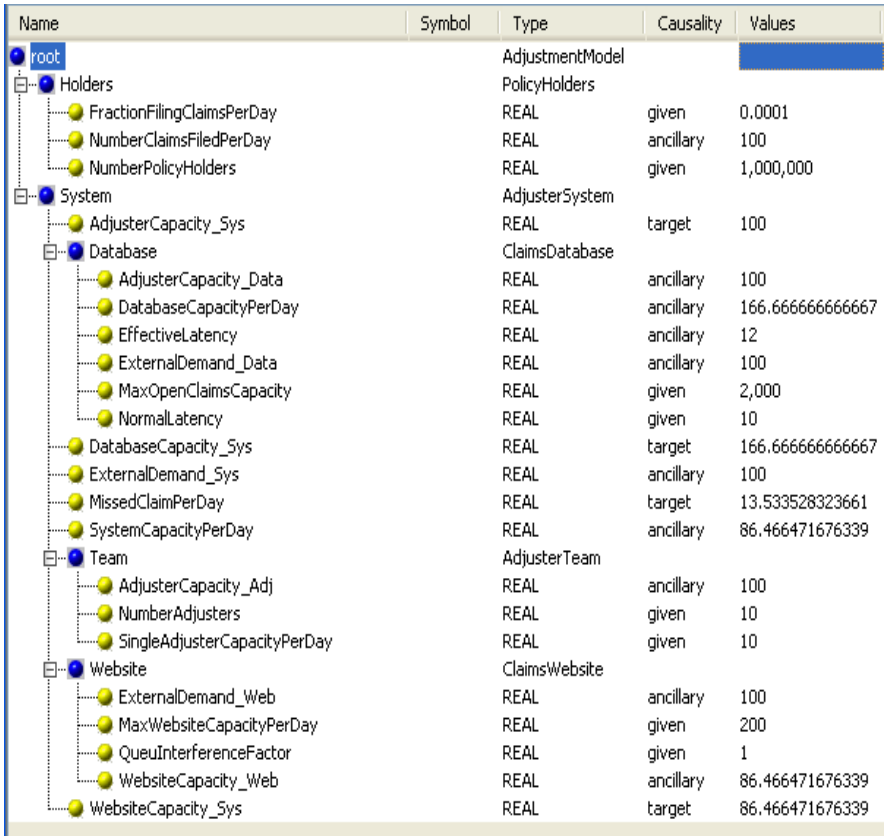
Insurance

- Instance 01 – Given a team of seven adjusters and a customer demand to file 100 claims per day, how many claims cannot be handled?

  Result: 30 claims per day are “missed”, limited by adjuster capacity of ten claims per day each.

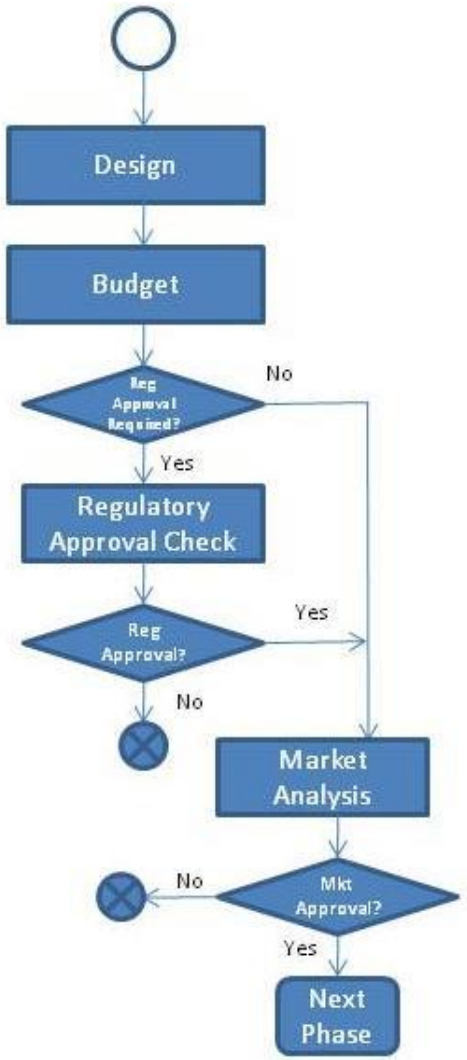
- Instance02 – If we increase the number of adjusters to ten, can we handle all the claims?
- Result: No, website capacity becomes the bottleneck. We still miss an average of 13.5 claims per day.

Instance02 – ParaMagic Browser



Name	Symbol	Type	Causality	Values
root		AdjustmentModel		
Holders		PolicyHolders		
FractionFilingClaimsPerDay		REAL	given	0.0001
NumberClaimsFiledPerDay		REAL	ancillary	100
NumberPolicyHolders		REAL	given	1,000,000
System		AdjusterSystem		
AdjusterCapacity_Sys		REAL	target	100
Database		ClaimsDatabase		
AdjusterCapacity_Data		REAL	ancillary	100
DatabaseCapacityPerDay		REAL	ancillary	166.666666666667
EffectiveLatency		REAL	ancillary	12
ExternalDemand_Data		REAL	ancillary	100
MaxOpenClaimsCapacity		REAL	given	2,000
NormalLatency		REAL	given	10
DatabaseCapacity_Sys		REAL	target	166.666666666667
ExternalDemand_Sys		REAL	ancillary	100
MissedClaimPerDay		REAL	target	13.533528323661
SystemCapacityPerDay		REAL	ancillary	86.466471676339
Team		AdjusterTeam		
AdjusterCapacity_Adj		REAL	ancillary	100
NumberAdjusters		REAL	given	10
SingleAdjusterCapacityPerDay		REAL	given	10
Website		ClaimsWebsite		
ExternalDemand_Web		REAL	ancillary	100
MaxWebsiteCapacityPerDay		REAL	given	200
QueuInterferenceFactor		REAL	given	1
WebsiteCapacity_Web		REAL	ancillary	86.466471676339
WebsiteCapacity_Sys		REAL	target	86.466471676339

Project Planning

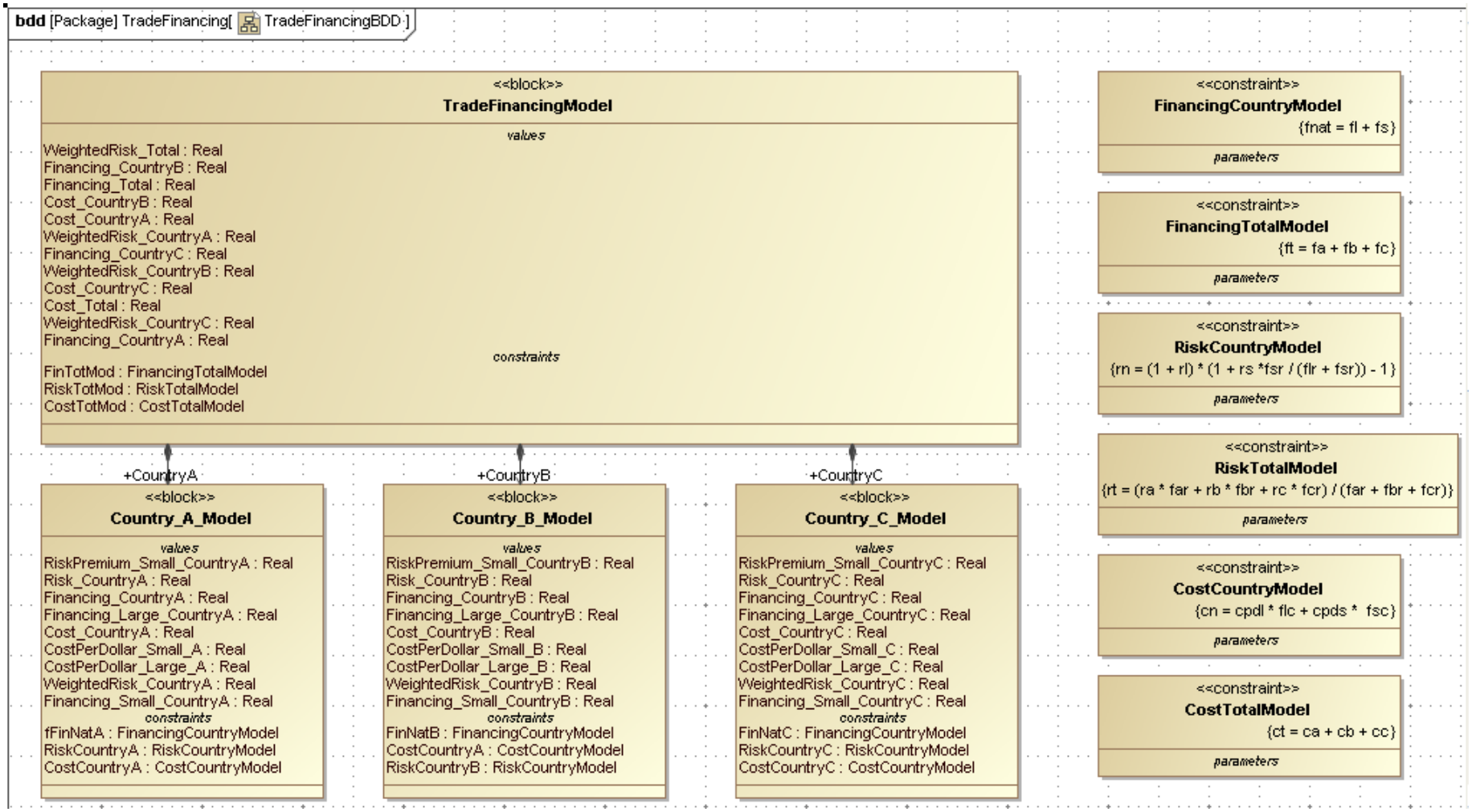


- Objective: estimate the time and resources required to complete the initial phase of a project?
- Parametrics diagrams use If…Then statements to reflect decision nodes.
- Budget and Market Analysis activities can link to cost and sales models, so project profitability can be one of the model outputs.

Trade Financing

- A trade financing company arranges payment for international buying and selling.
  - They have to monitor the amount of financing extended, the overall risk, and the associated costs.
  - They work in multiple countries with different risk and cost structures.
  - They have risk specialists and country specialists that must pool their expertise to create a realistic model.
- Instance01
  - What is the total financing extended, the weighted risk and the total cost for the current status?
- Instance02
  - If we need to lower weighted risk to 15%, what is the maximum financing for small accounts in high risk Country C?

Trade Financing

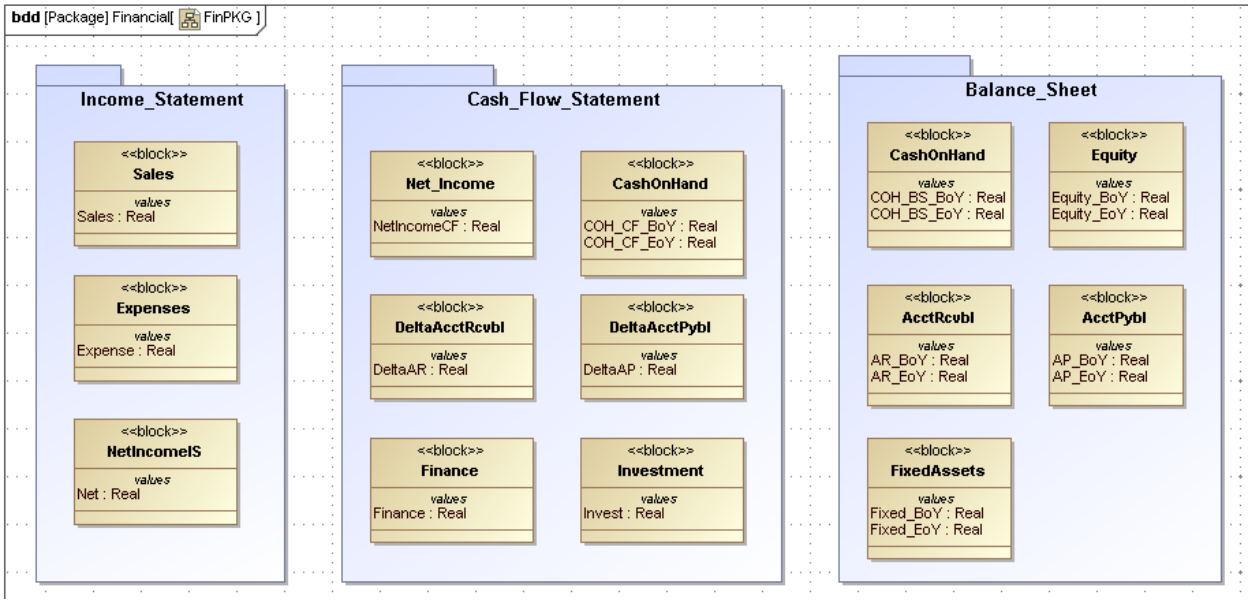


Financial Projections

- A financial analyst wants to project three years pro forma financial statements, especially cash flow, for a new business.
- Instance01 – Given projected sales, expenses and outside financing, how much cash will the company have at the end of each year?
- Instance02 – Given a requirement to have $50 million cash on hand at the end of each year, how much outside financing will be required?

Financial Projections

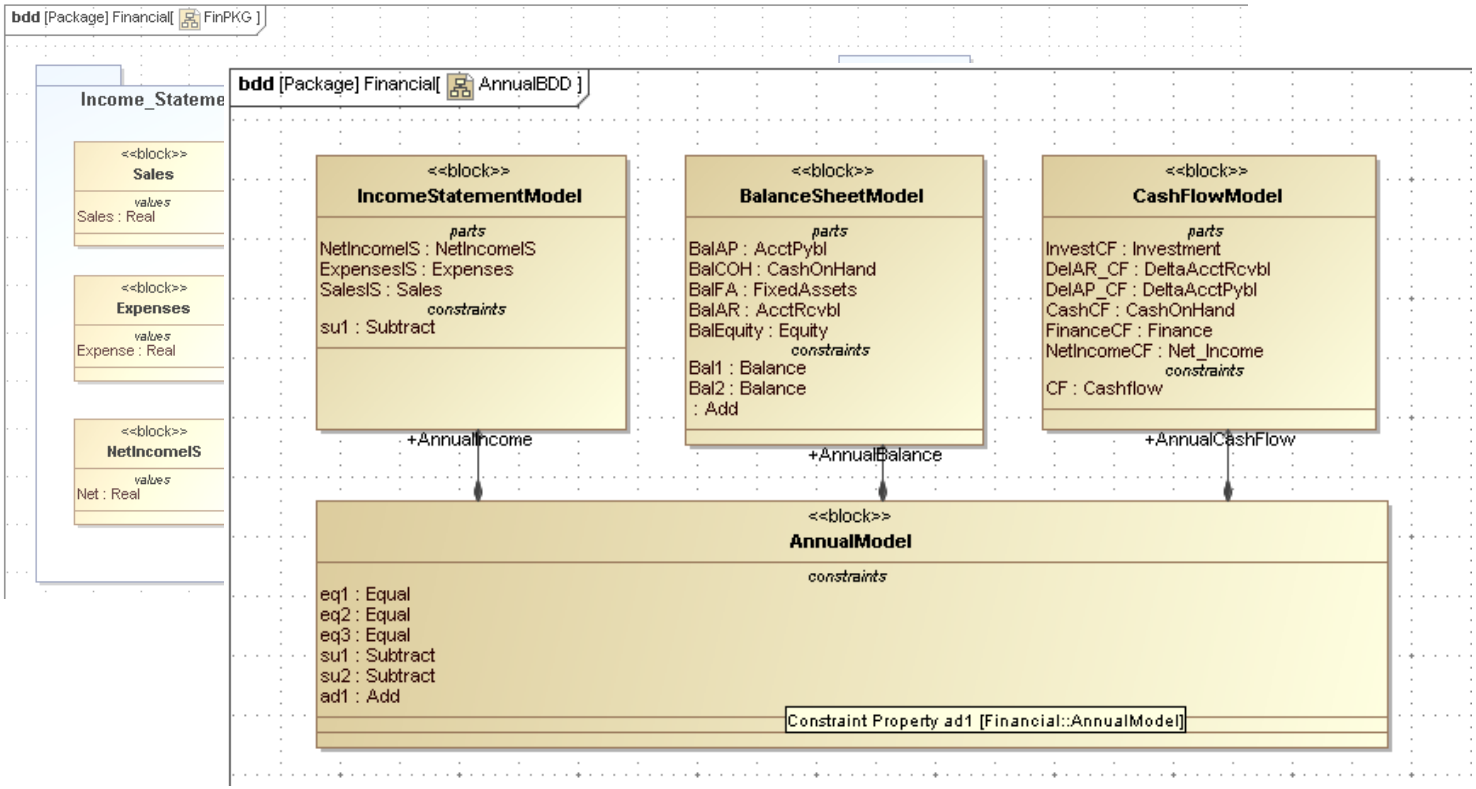
Accounts are part of financial statements



Financial Projections

Accounts are part of financial statements

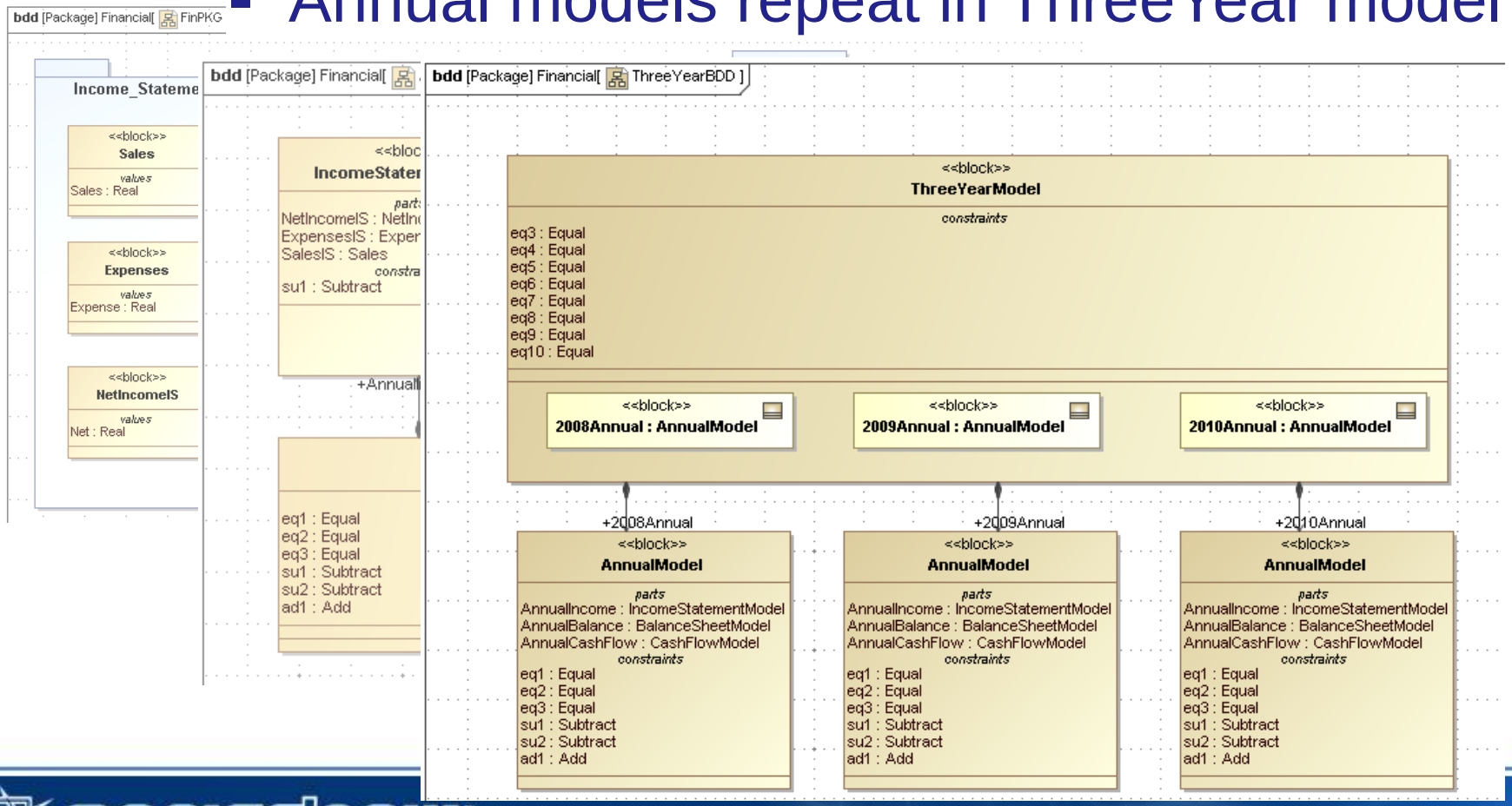
- Financial statements are part of annual model



Financial Projections

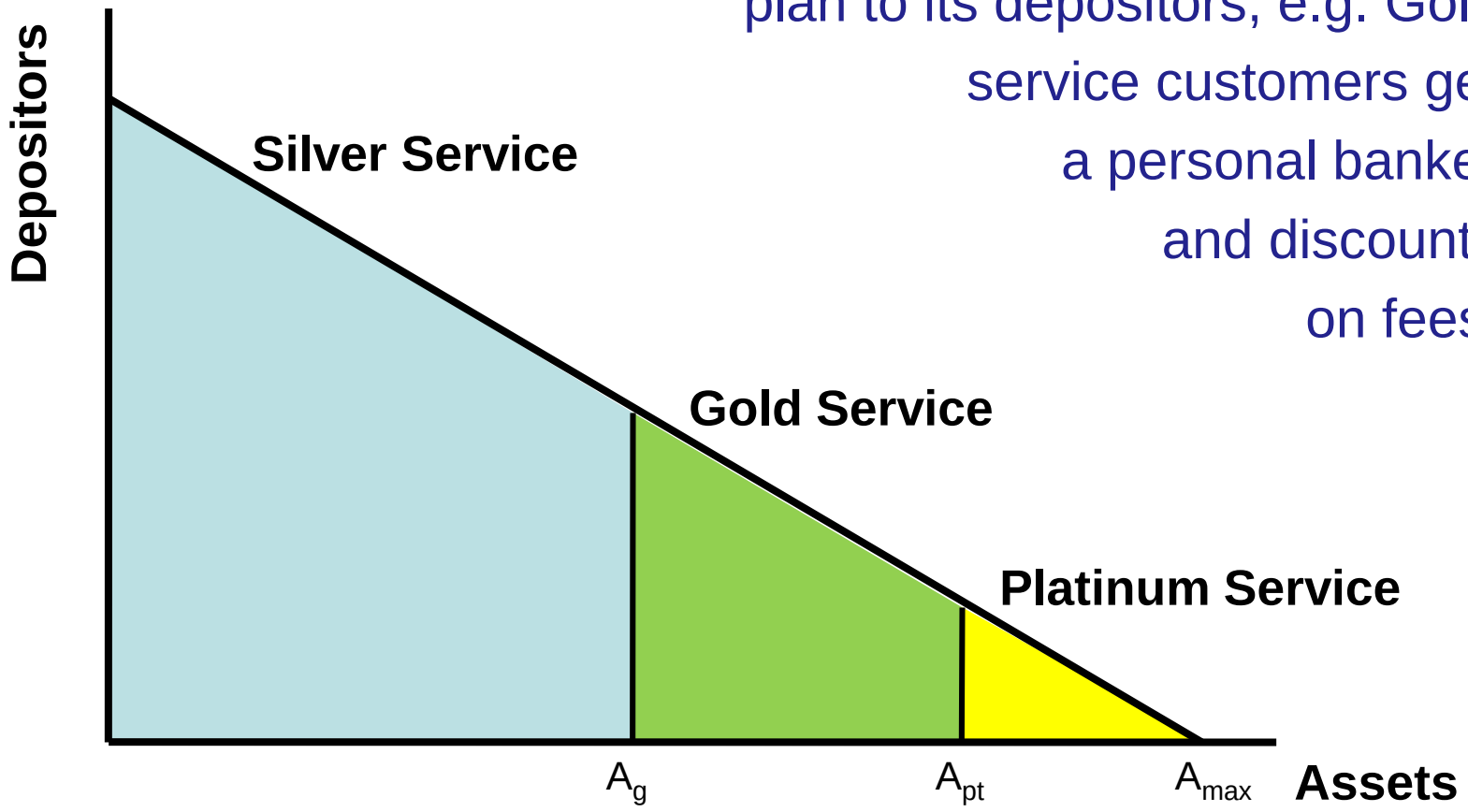
Accounts are part of financial statements

- Financial statements are part of annual model
- Annual models repeat in ThreeYear model



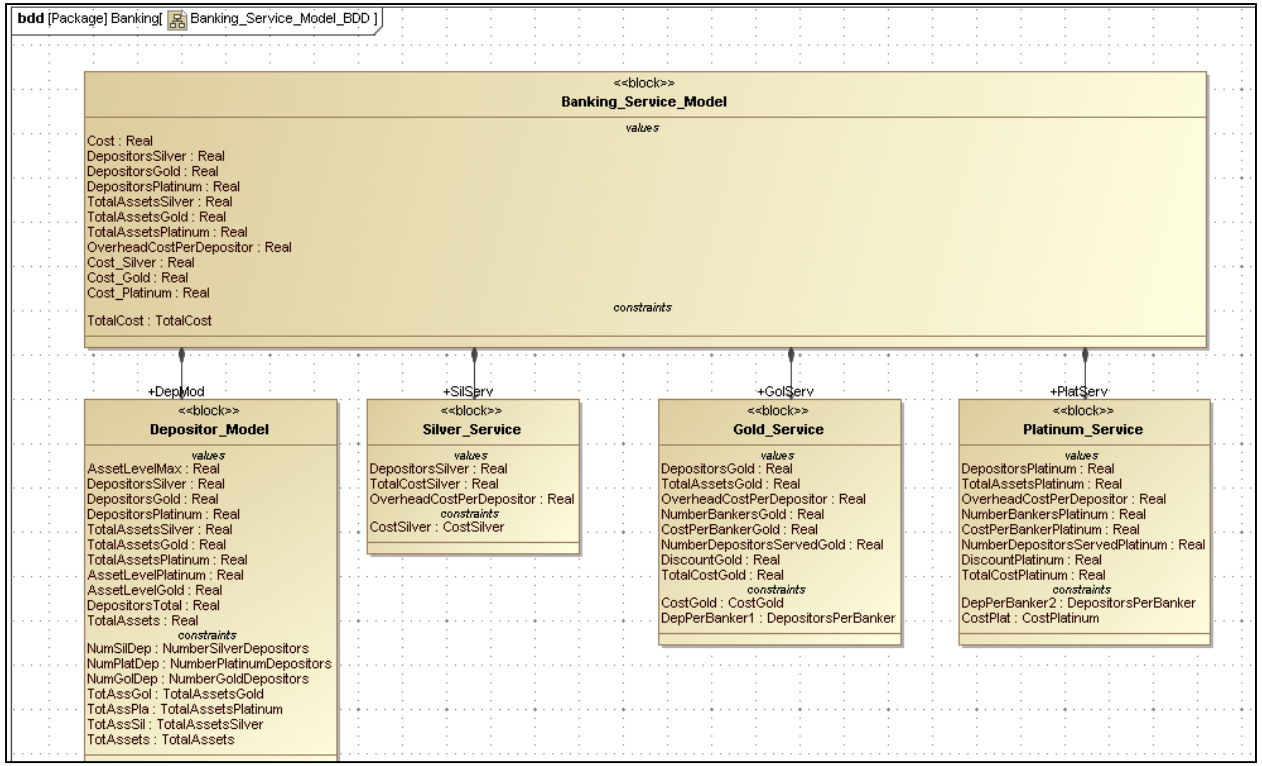
Retail Banking

A bank wants to offer a tiered service plan to its depositors, e.g. Gold service customers get a personal banker and discounts on fees.



Retail Banking

- Objective: model the depositor population and the cost structure of the different service levels



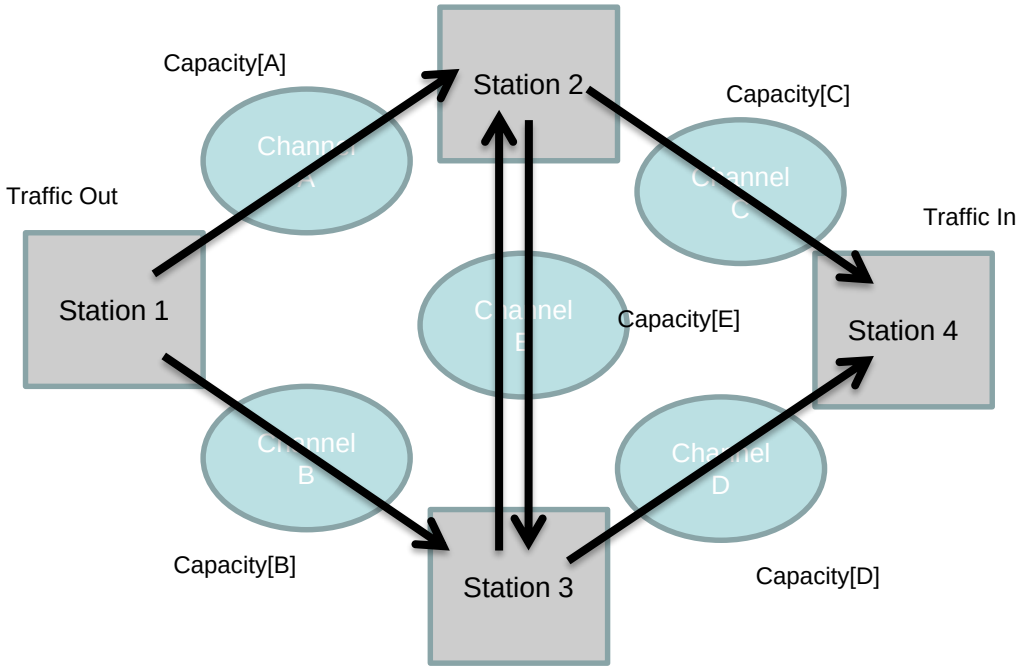
Instance 01:

Given the depositor population and service levels at $500k and $750k assets, what is the total cost of this new service?

How many assets in each tier?

CommNetwork

A communications network has four stations (nodes) and five connecting channels. Nodes split message traffic between channels depending on channel capacity. Transmission through a channel degrades as traffic increases.



We have a node model and a channel model. We use each model multiple times and wire them together into a network using parametric diagrams.

Instance01 – Given a level of message traffic through Station 1 of 10 (thousand messages per second), how much is received by Station 4?

Caution

This presentation contains simplified models for purposes of demonstration. These models are not intended to accurately simulate the behavior of real defense, financial or business systems.

Any feedback on the models would be much appreciated.

It should be sent to sales@nomagic.com