

Model Based Enterprise Simulation and Analysis

- A pragmatic approach reducing the burden on experts

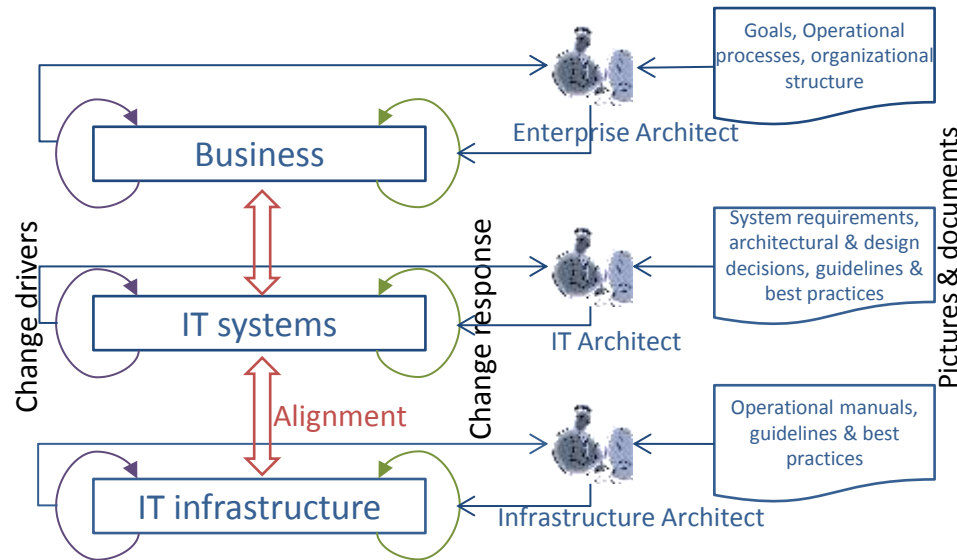
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Atlanta, USA

Problem

Enterprise information typically tacit, and when available, in descriptive text or pictures



Paradigmatically diverse languages, Non-interoperable tools, Excessive reliance on humans

Large number of interconnected systems, Multiple change drivers demanding quick response

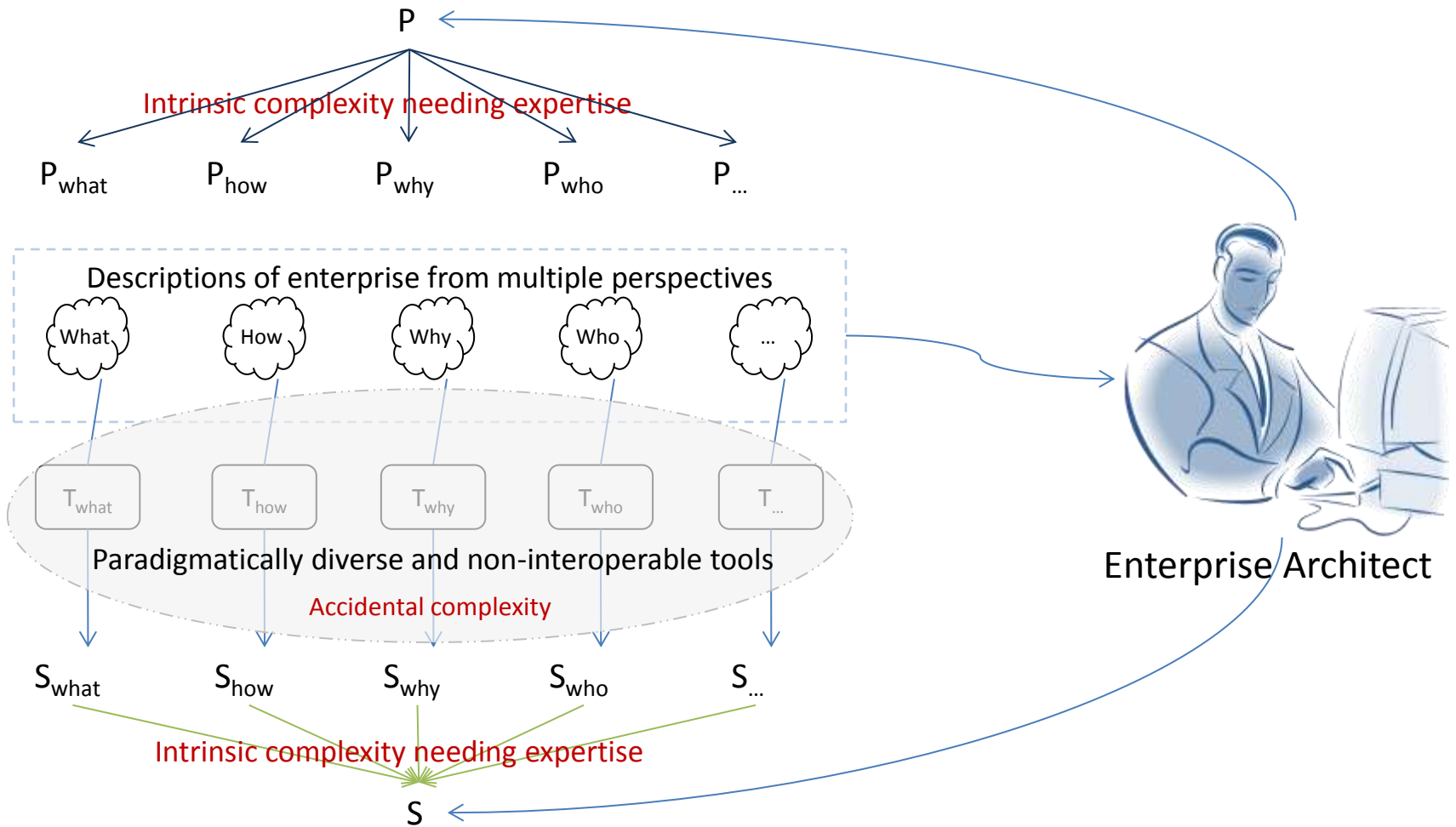
Imprecise idea of current state and possible to-be states, poorly defined path to the desired state

Over-burdened experts, poorly informed & ad hoc decision making

Current Practice

	Why	What	How	When	...
Stakeholder #1	<ul style="list-style-type: none">• Natural language descriptions<ul style="list-style-type: none">• Open to multiple interpretations• Manual interpretation guided by<ul style="list-style-type: none">• Past experience<ul style="list-style-type: none">• Extrapolation is not always possible• Knowledge<ul style="list-style-type: none">• Typically incomplete and could be incorrect• Partial modeling<ul style="list-style-type: none">• Goal modeling: <u>why</u> + what , qualitative• SD modeling: <u>what</u> + how, <u>simulation</u>, poor modularity• Process modeling: <u>how</u> + <u>who</u> + what, time & resource• Poor support for multi-level modeling• Multi-paradigmatic languages• Non-interoperable tools				
Stakeholder #2					
Stakeholder #n					

Consequences

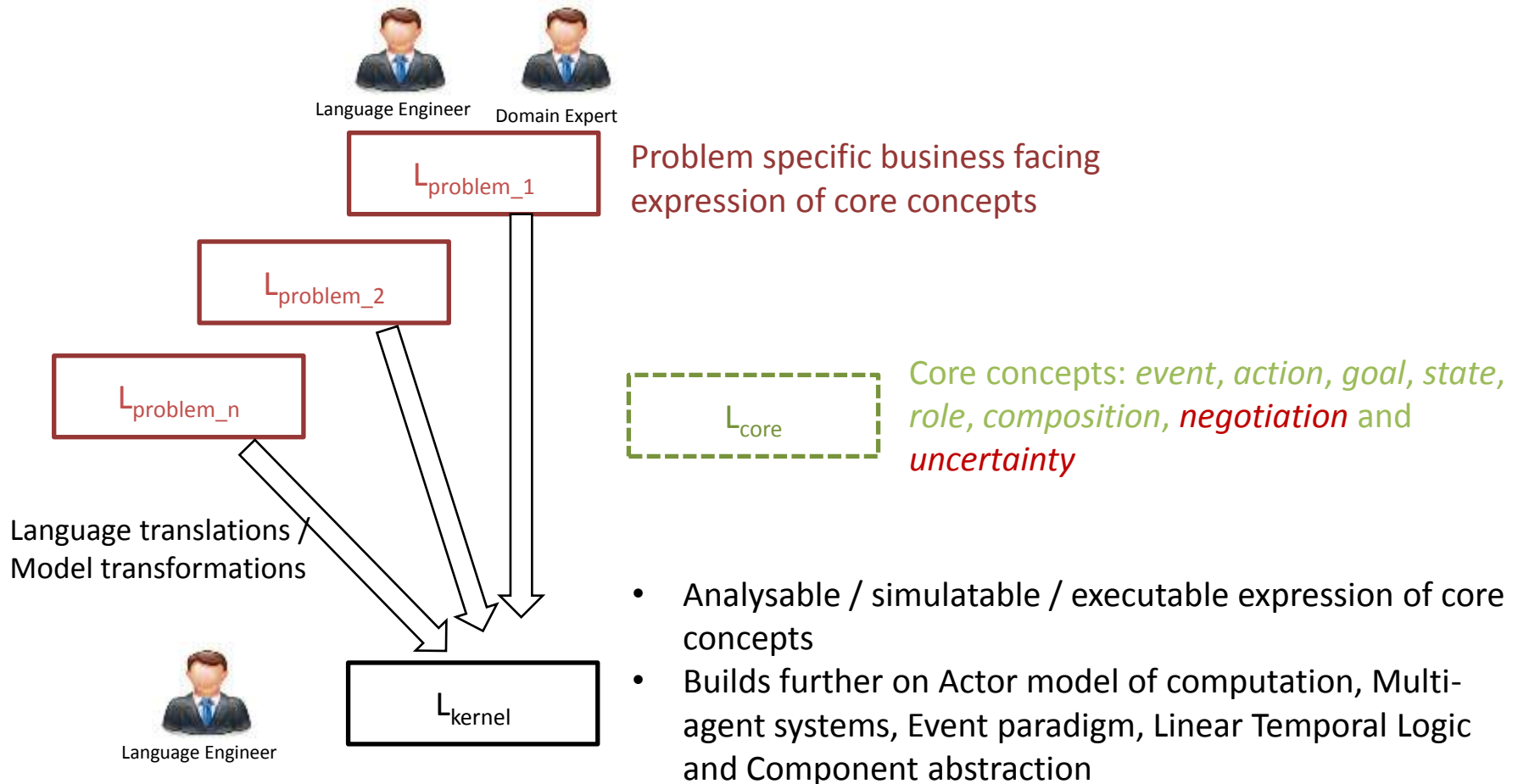


Poor ROI on tools → Over-burdened experts → Eventual dis-use of the tools

Tenets of proposed solution

- Organisation as something that raises and responds to events as it goes about achieving its stated objectives
 - Interface abstraction specifying *why* and *what*
- Organisation as a set of interacting business units each driven by individual goals
 - Abstract implementation of interface specifying *how* i.e. Component
- A business unit is also an organisation
 - Component abstraction to be first class as well as composable
- Organisation as machine manipulable specification
 - < Interface, Component > tuple
- Scenario playing based data-driven informed decision making
 - Simulation capable enterprise specification language

Platform Architecture



Simulating large organizations for

- What-if (i.e. what would be the consequences of such-n-action action)
- If-what (i.e. what action would have led to such-n-such consequence)

Abstraction

Event Structure

Event Name
Pre condition in terms of Events
Post Condition in terms of Event

Goal Structure

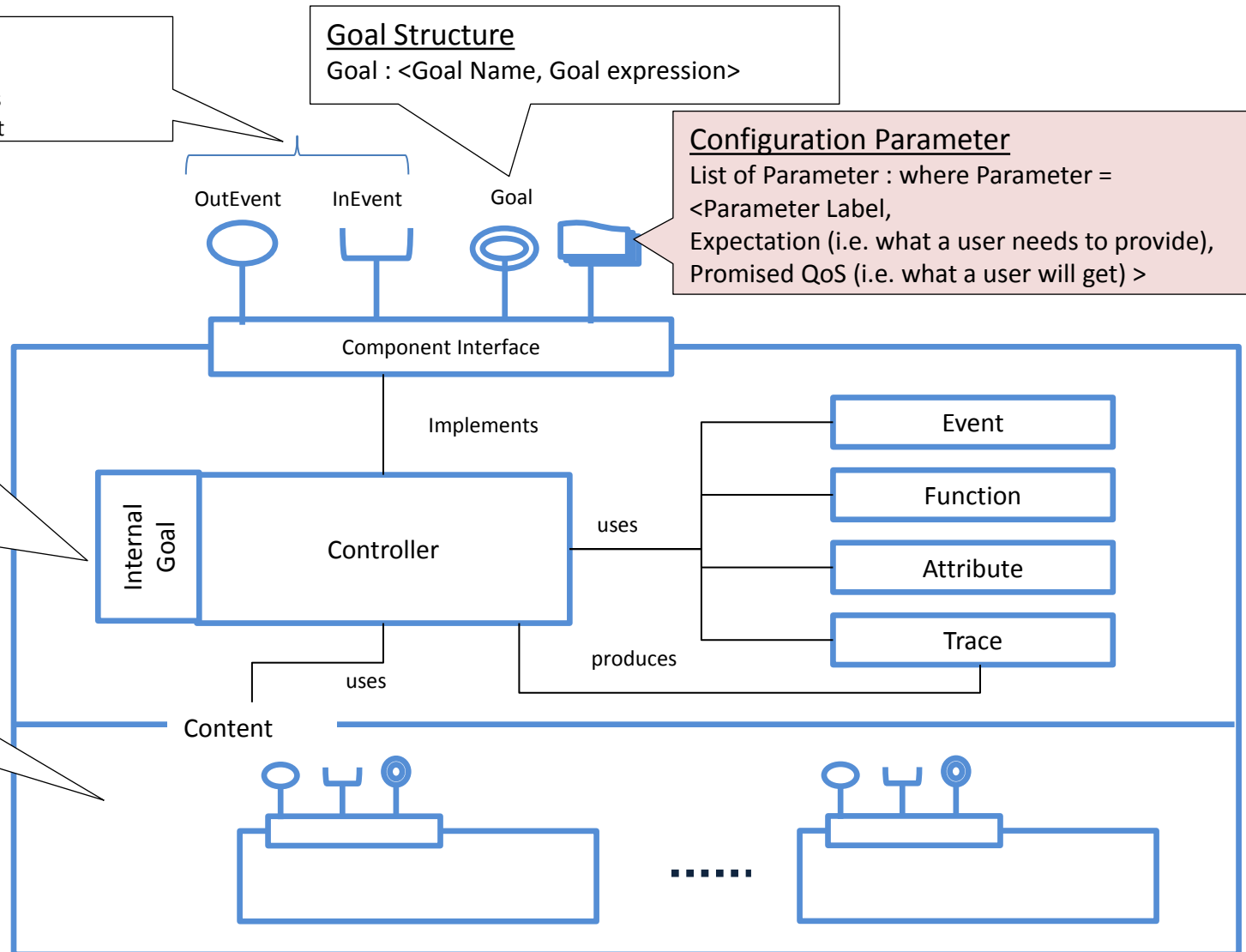
Goal : <Goal Name, Goal expression>

Configuration Parameter

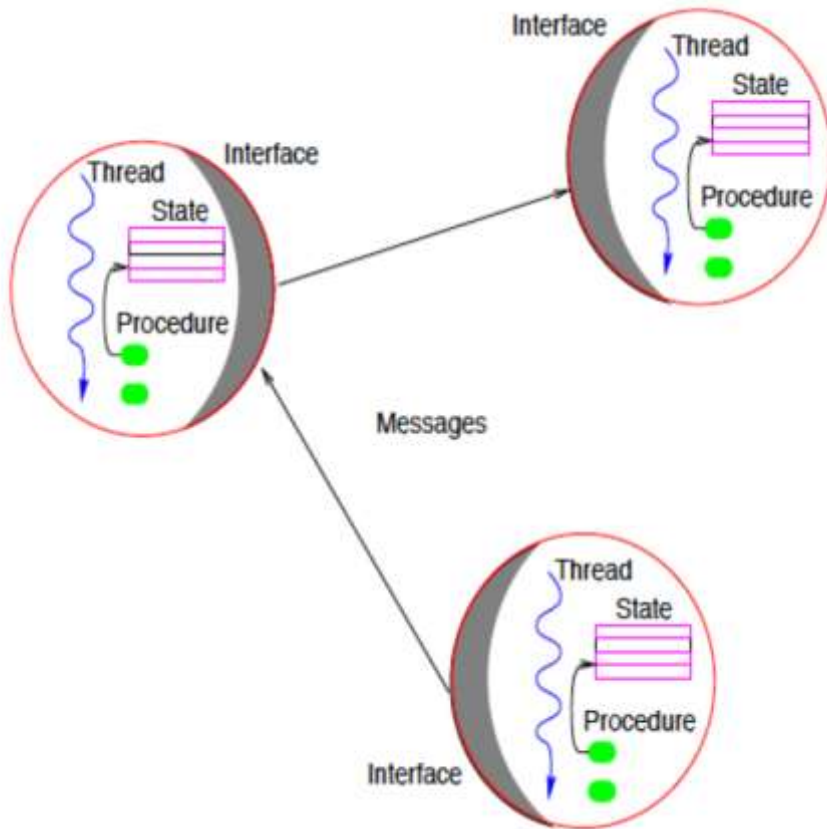
List of Parameter : where Parameter =
<Parameter Label,
Expectation (i.e. what a user needs to provide),
Promised QoS (i.e. what a user will get) >

External Goal is projection of Internal Goal. Internal goals are achieved by controller (through its own Attribute, Event and Traces) and External Goals of 'Content'.

Content Components conforms to a Relationship to achieve internal Goal.

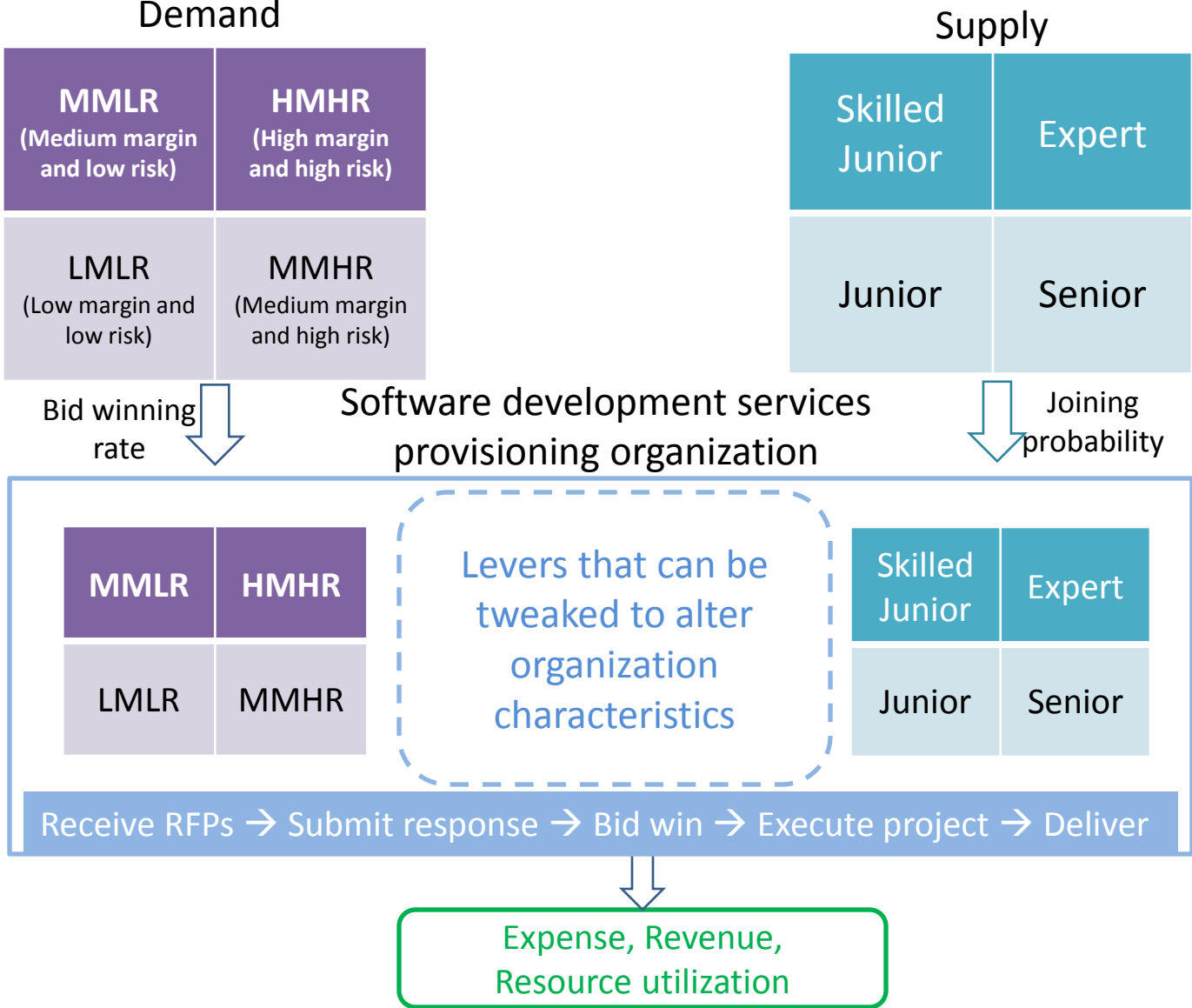


Kernel Language (ESL)

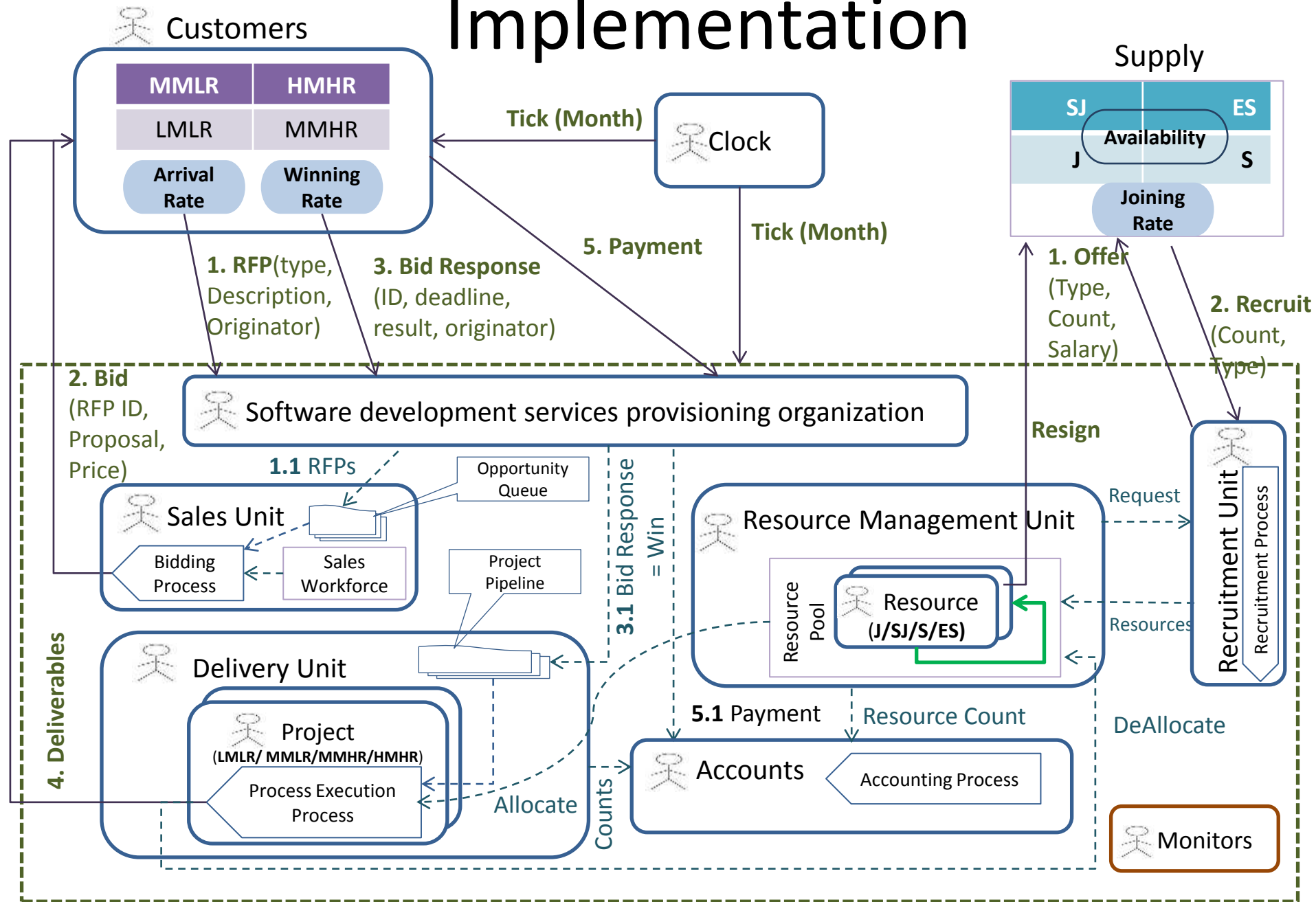


- System is a set of **Actors**
- Actor
 - Autonomous
 - Local goals and policies
 - Private state as well as trace
 - Listens to, processes and raises events
 - Exchanges messages with other actors
 - Understands time
 - Can be decomposed into a set of interacting actors
- Simulatable
 - What-if (forward)
 - If-what (backward)

Validation



Implementation



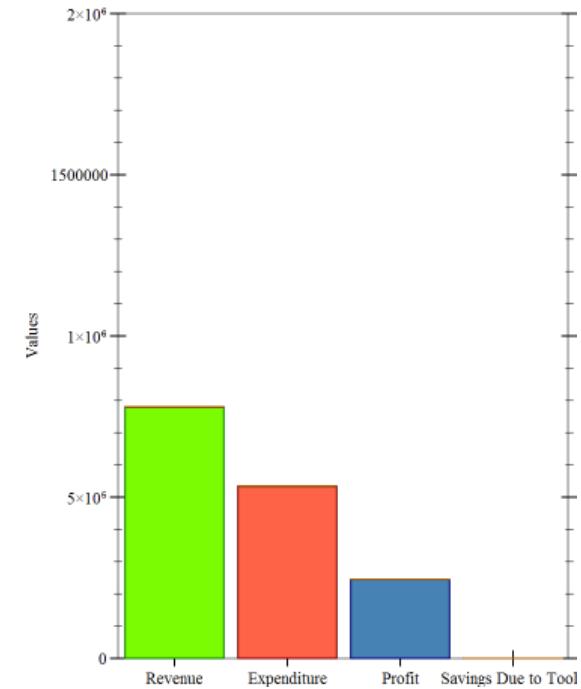
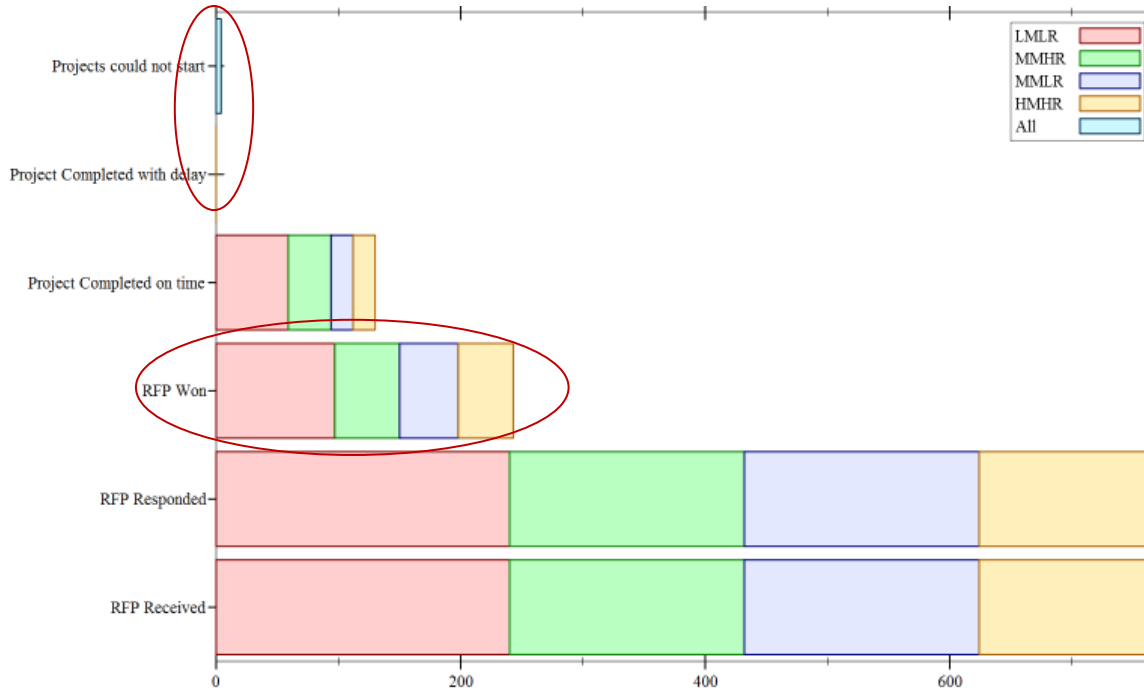
Legends



Model

- Definitions
 - Small and Large (in kloc), Simple and Complex (in COCOMO variables)
 - Junior and Senior (in years of experience), skilled and expert (as tags)
- Independent variables
 - Productivity of J, SJ, S, E (as multiple of standard productivity as per COCOMO)
 - Productivity of J, SJ, S, E with tool
 - Operating cost of J, SJ, S, E (in USD/month)
 - Recruitment cost of J, SJ, S, E (in USD/person)
 - Attrition rate of J, SJ, S, E (in percentage)
 - Tool procurement cost (in USD)
 - Tool license cost (in USD/year)
 - Tool training cost LMLR, MMLR, MMHR, HMHR (in USD/project)
 - Bidding cost for LMLR, MMLR, MMHR, HMHR (in USD/bid)
 - Project setup cost for LMLR, MMLR, MMHR, HMHR (in USD/project)
 - Total number of current resources
 - J:SJ:S:E distribution of current resources
 - Desired bench strength (in the same distribution)
 - Bid winning rate for LMLR, MMLR, MMHR, HMHR (in percentage)
 - Joining probability for J, SJ, S, E (in percentage)
- KPIs
 - Total expenditure (per month)
 - Total revenue (per month)
 - Project delivery time (elapsed time in months)

Current state KPIs



Organization is operating in comfort zone
and there exists an opportunity to do more

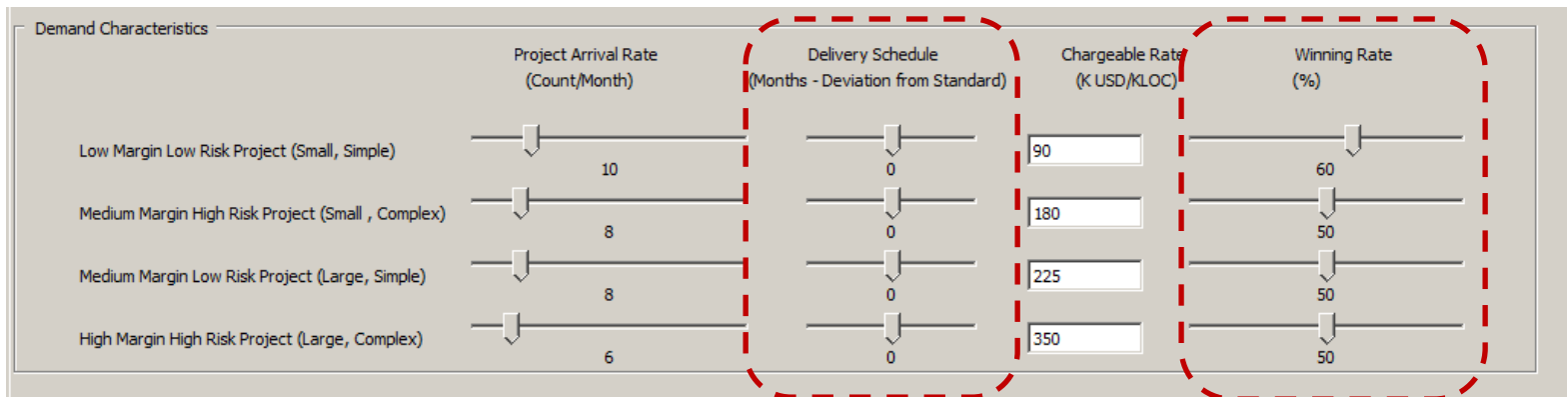
Scenario playing as decision-making aid

- Aim is to improve revenue
 - How far can one go by removing existing slack (without violating any policies)?
 - By winning more bids
 - Reduce price, or Reduce delivery time, or Both
 - How far can one go with existing workforce distribution (J:SJ:S:ES)?
 - By improving workforce productivity
 - Better training, or Productivity tools, or both
 - For this organization settings, what's the best workforce distribution possible i.e. locally optimal situation
 - How does one sustain this distribution?
 - What's the globally optimal situation?
 - What if one decides to focus only on high margin projects?
 - What's the best workforce distribution in this scenario?
 - What is the impact of scarcity of a certain kind of resource?

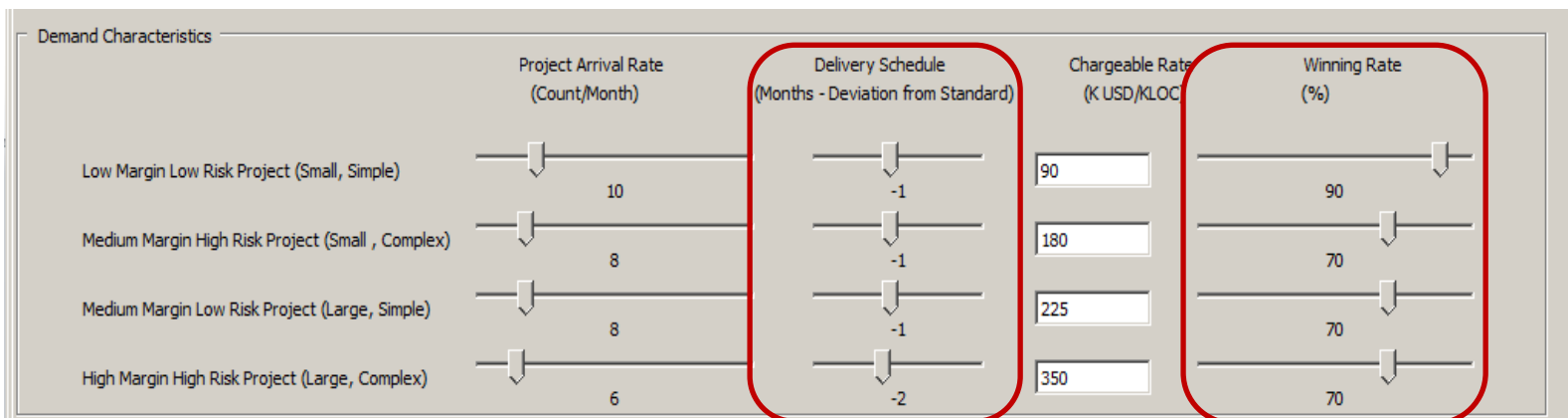
Get the most out of existing workforce

- Reduce price as well as delivery time to improve winning rate

Current

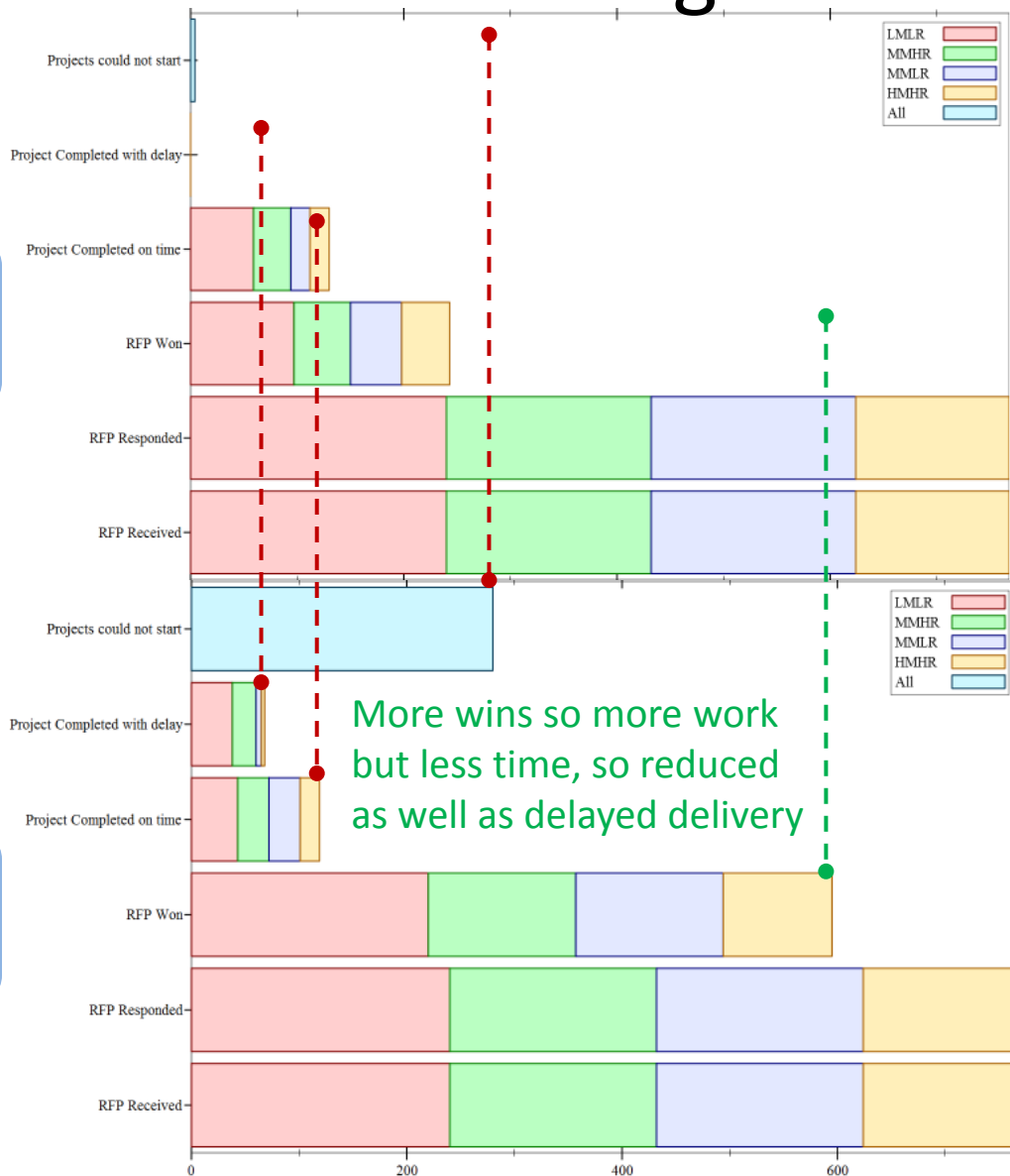


To-be candidate

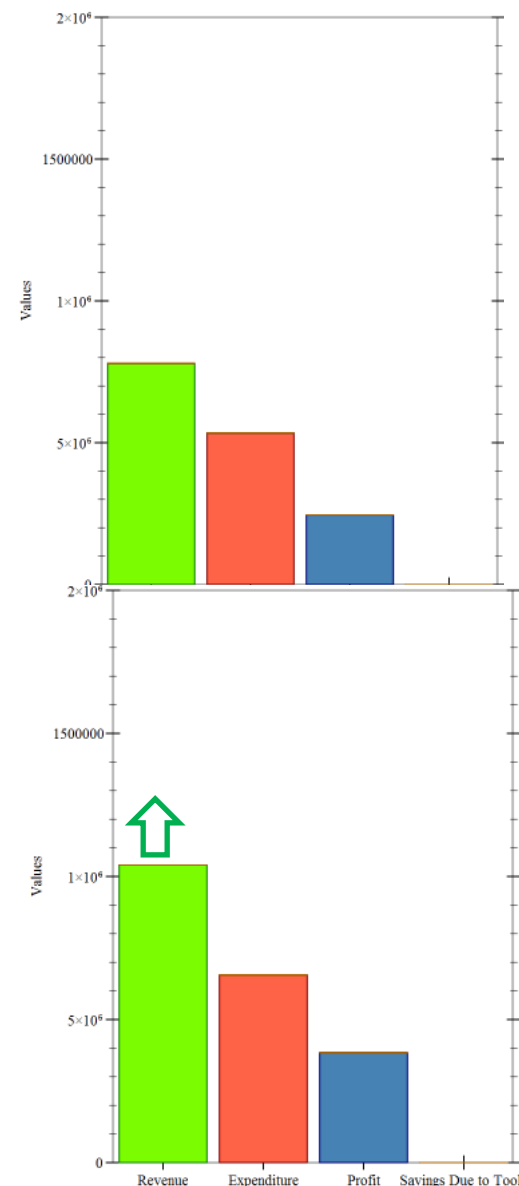


Reduce price and delivery time to improve winning rate - I

Current



To-be candidate



Comparative Evaluation

Excel

- Captures relationships between variables in terms of algebraic equations
- No support for temporal aspects
 - How a variable changes over time
 - How relationship between a set of variables changes over time
- Good for data computations only but not for decision making

System dynamic model

- Specified in terms of stocks, flows, controllers and variables
- Supports time
 - How a variable changes over time
- Good for generic models
 - Specialization lead to model size explosion
- Poor modularity
- Poor support for multiple levels of abstraction
- Identical stable state results, but, journey is far more interesting

Limitations

- Model is correctly depicting the obvious behaviour
 - Can be made richer
- However, need more complex case-study to check whether the approach can,
 - Throw counter-intuitive inferences
 - Demonstrate tipping points
 - Illustrate Actor-based nature even more prominently

Further On Case Study

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Adaptation

- Actor is in fact a set of actors each encoding a specific strategy
- 'becomes' the appropriate variant in response to adaptation event

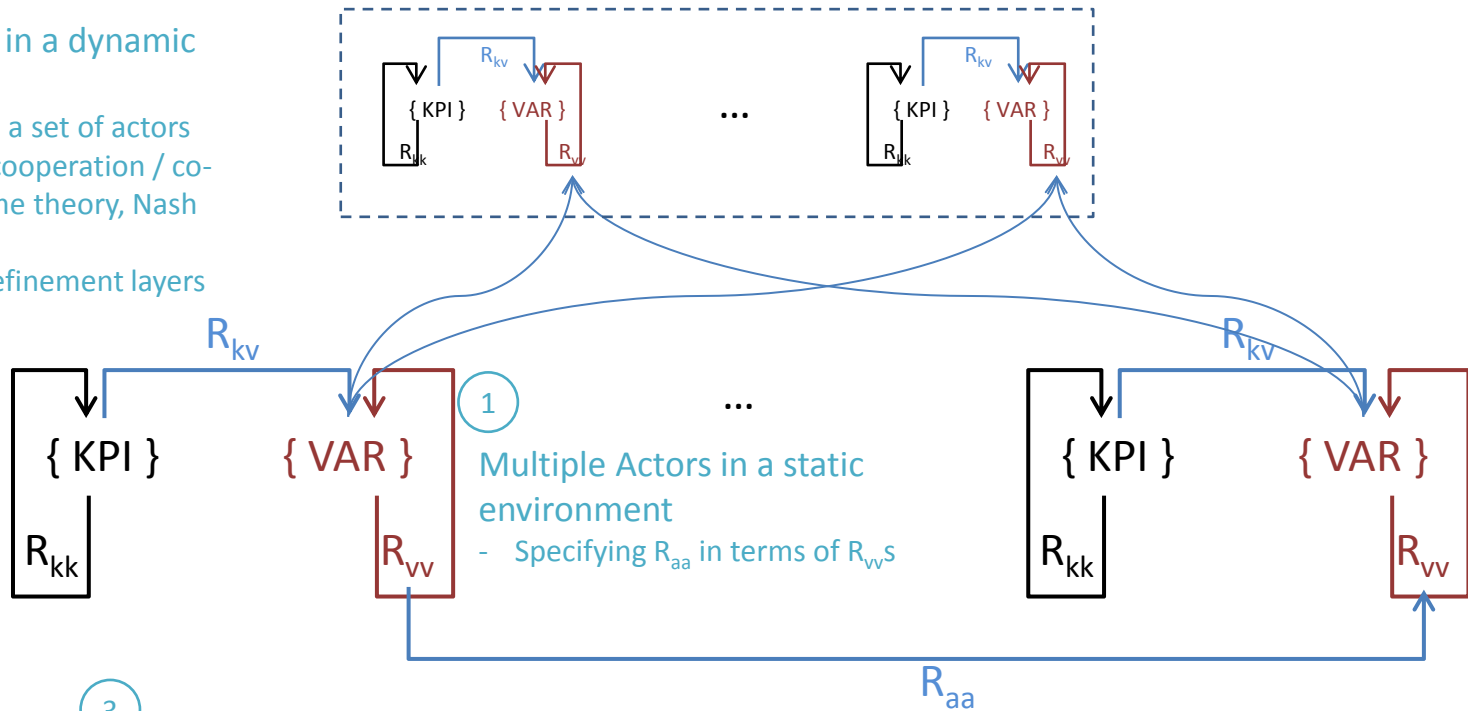
Self-adaptation

- Meta rule to add / modify / delete existing rules

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Multiple Actors in a dynamic environment

- Environment as a set of actors
- Competition / cooperation / co-optition → Game theory, Nash equilibrium
- Actors across refinement layers



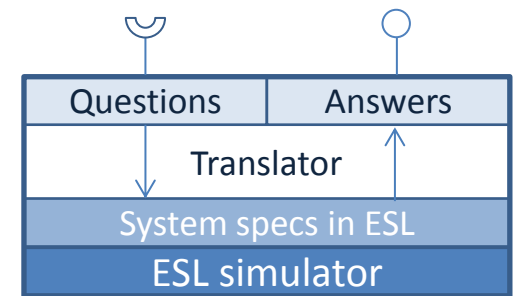
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Uncertainty and risk

- Incorporating probability in value of a variable as well as influence on other variables
- Risk is the consequence of uncertainty in the 'value' delivered

Future Research

- Usability
 - Guided navigation towards solution i.e. when to change which controllable variable and how
 - DSMLs for specifying questions and visualizing results of simulation
 - Graphical notation for ESL and translator
 - Composing Actors from a repository of Facts, Variables, Behaviour, Goals, Therbligs etc
 - Platform architecture
 - Debugging
- Engineering
 - Simulator scaleable to real-life enterprise models
 - DSL – a business-facing ESL
 - DSL to ESL automated transformation
 - Model discovery from available information
- New Concepts
 - Memory
 - Negotiation
 - Planning
 - Multiple levels of abstraction



Questions?

Suggestions, critic, inputs welcome

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