

Defining KPIs for executable DSLs: a manufacturing system case study

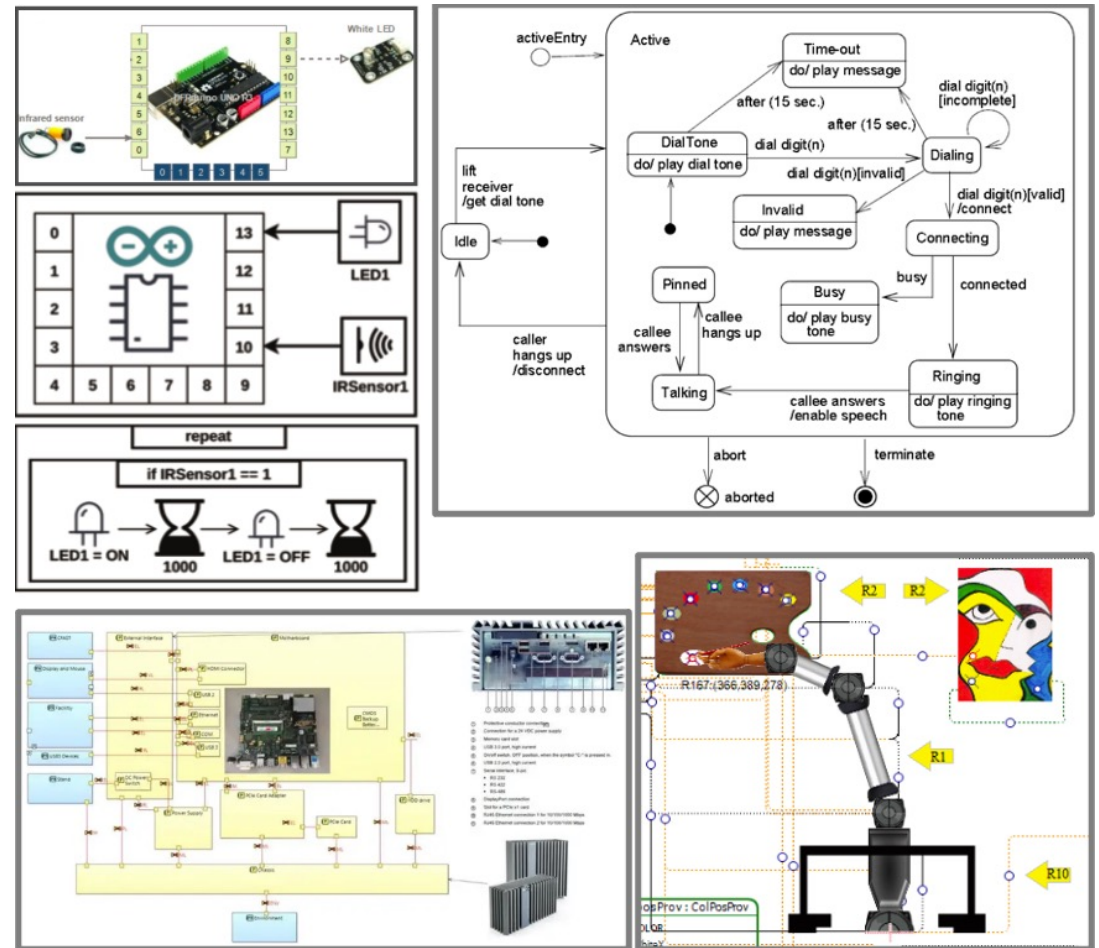
- Hiba Ajabri, Jean-Marie Mottu, Erwan Bousse
 - Nantes Université, IMT Atlantique, Ecole Centrale Nantes, CNRS, LS2N, UMR 6004, France.
-

Early performance evaluation is essential when designing systems

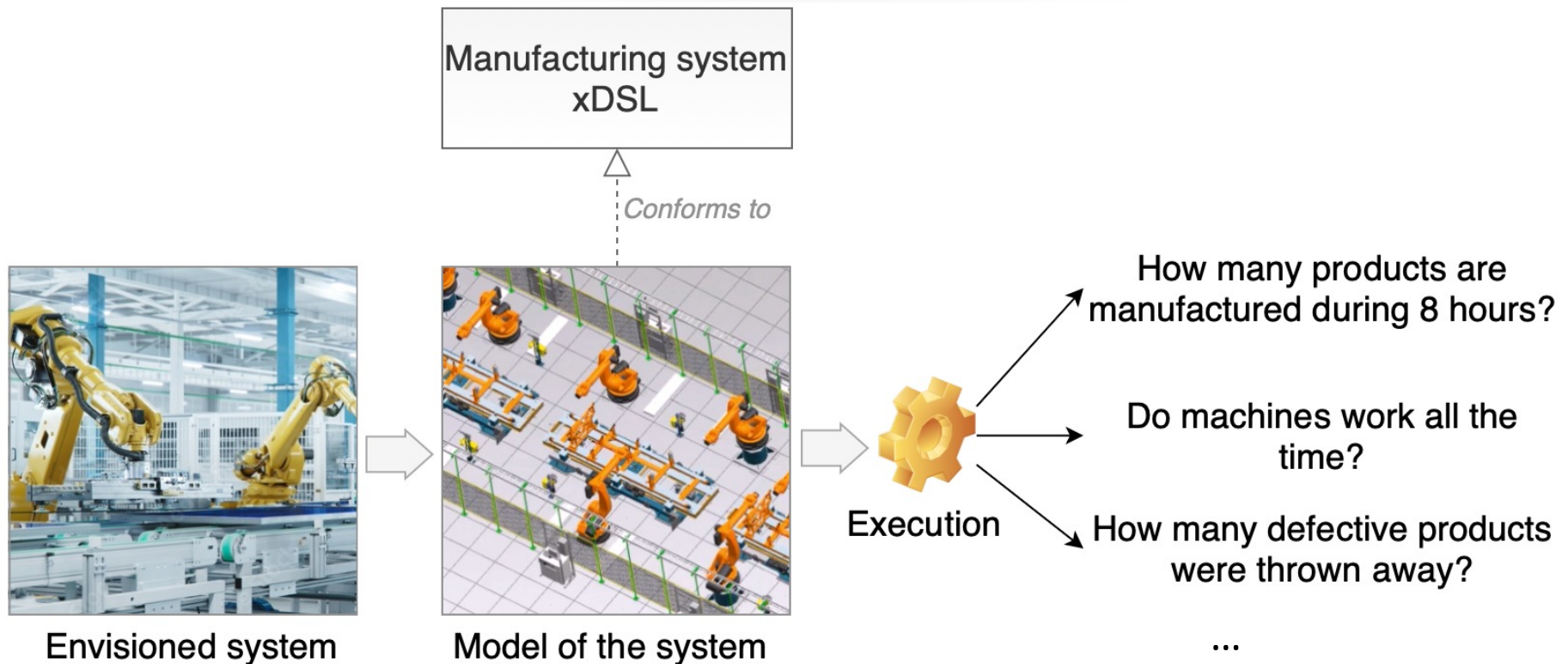
- Early performance evaluation requires:

- Modeling the behavior of systems.
- Simulating them before real implementation.

➔ Executable DSLs (xDSLs) are well suited for this endeavor.



Case study: early performance evaluation of manufacturing systems



Performance evaluation : KPI measurement

Key Performance Indicators (KPIs) :

Set of *metrics* used to evaluate the performance of a system.

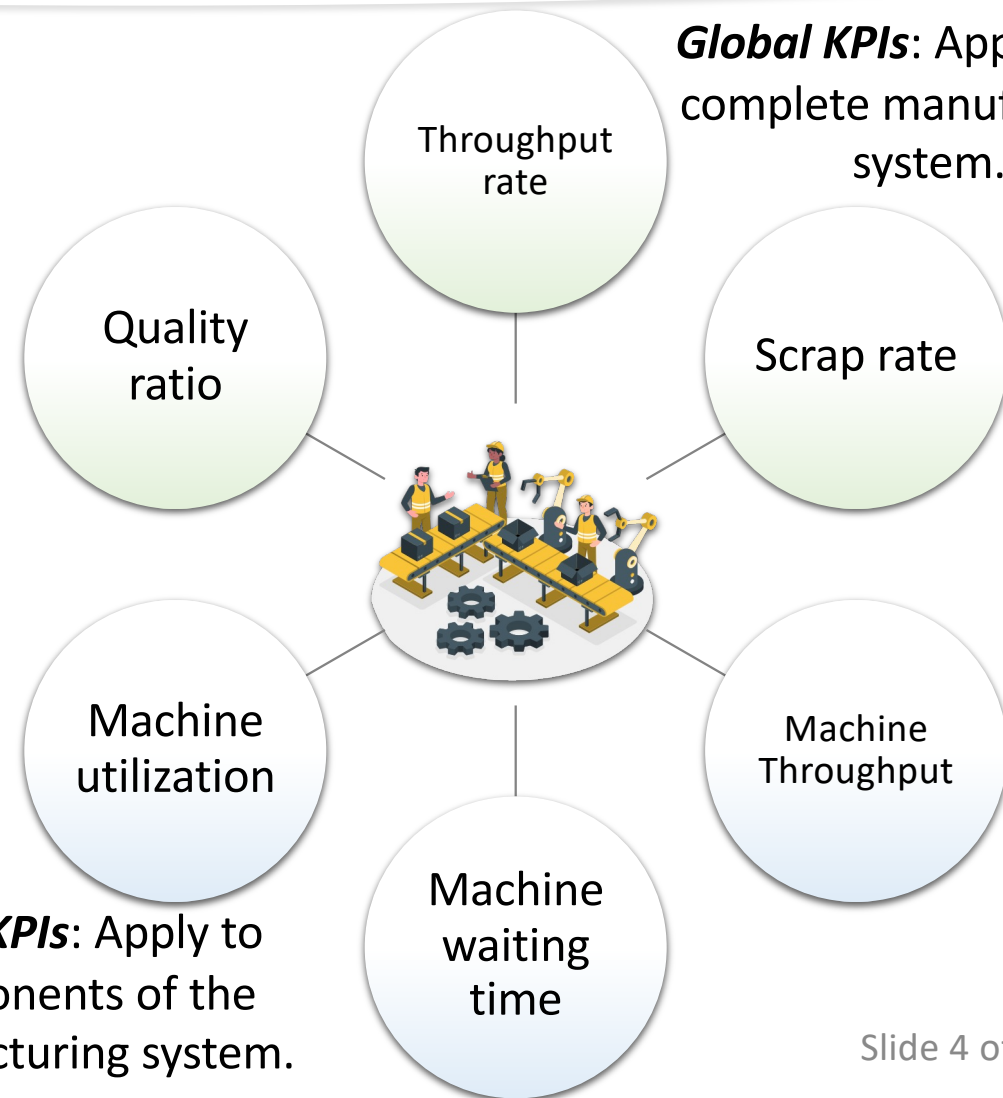
→ Measured on a real system during execution

→ Measured early on a modeled system during simulation

KPIs are **specific to the considered domain**.

Local KPIs: Apply to components of the manufacturing system.

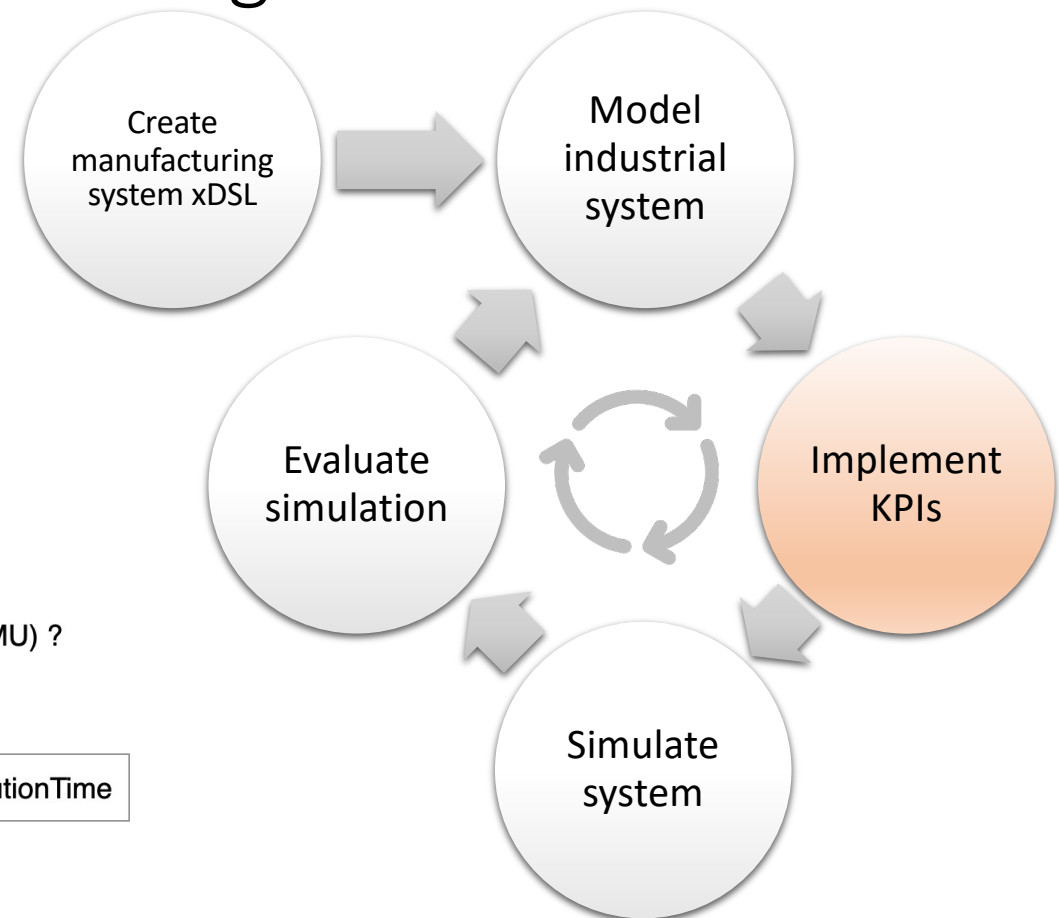
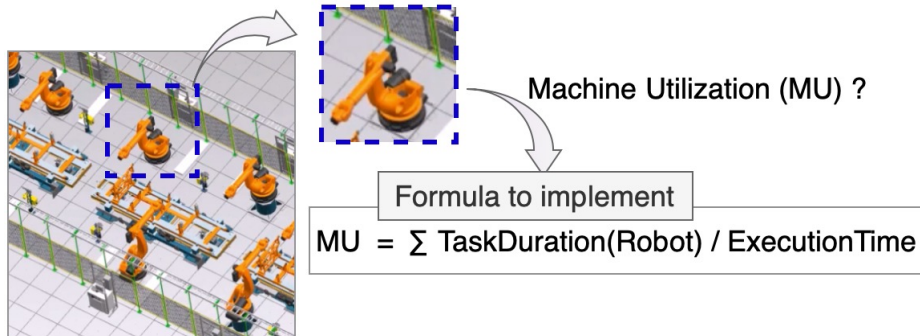
Global KPIs: Apply to the complete manufacturing system.



Problem: Cost of implementing KPIs

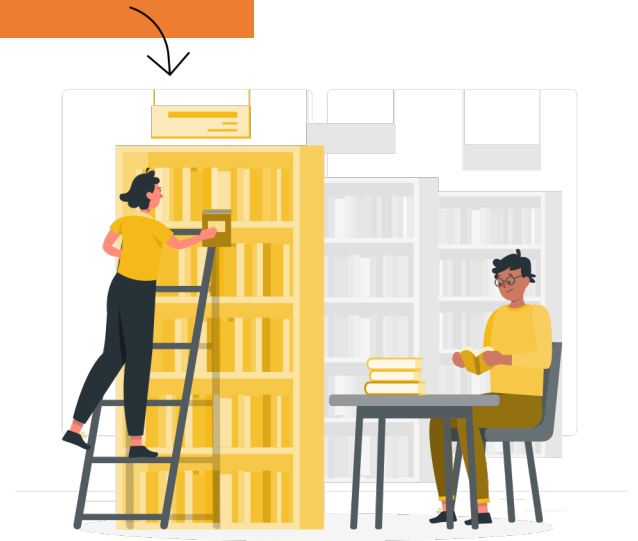
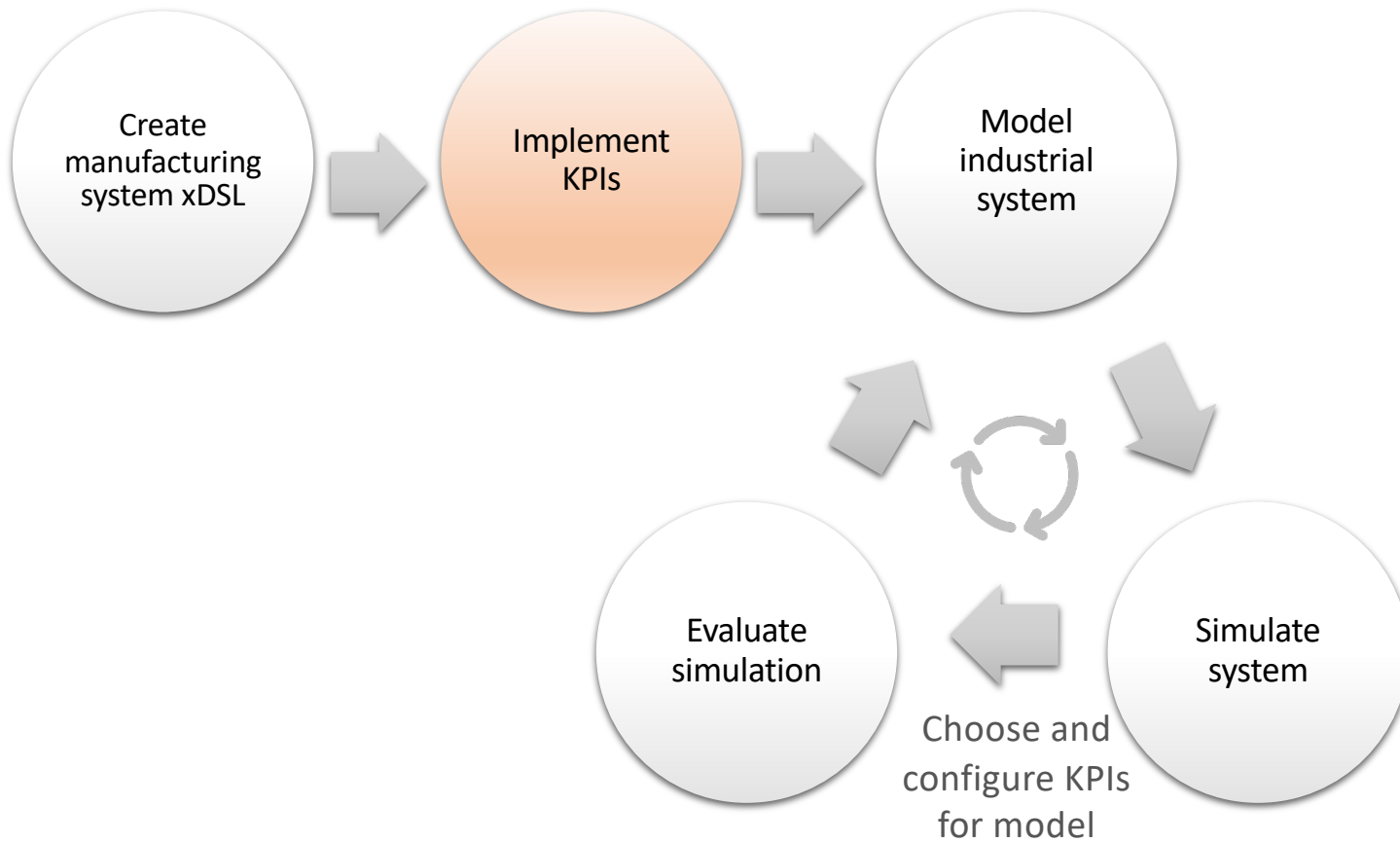
Even if KPIs are defined for a given domain, they must be **(re-)implemented for each new modeled system**

- Cumbersome,
- Costly job,
- Error-prone task

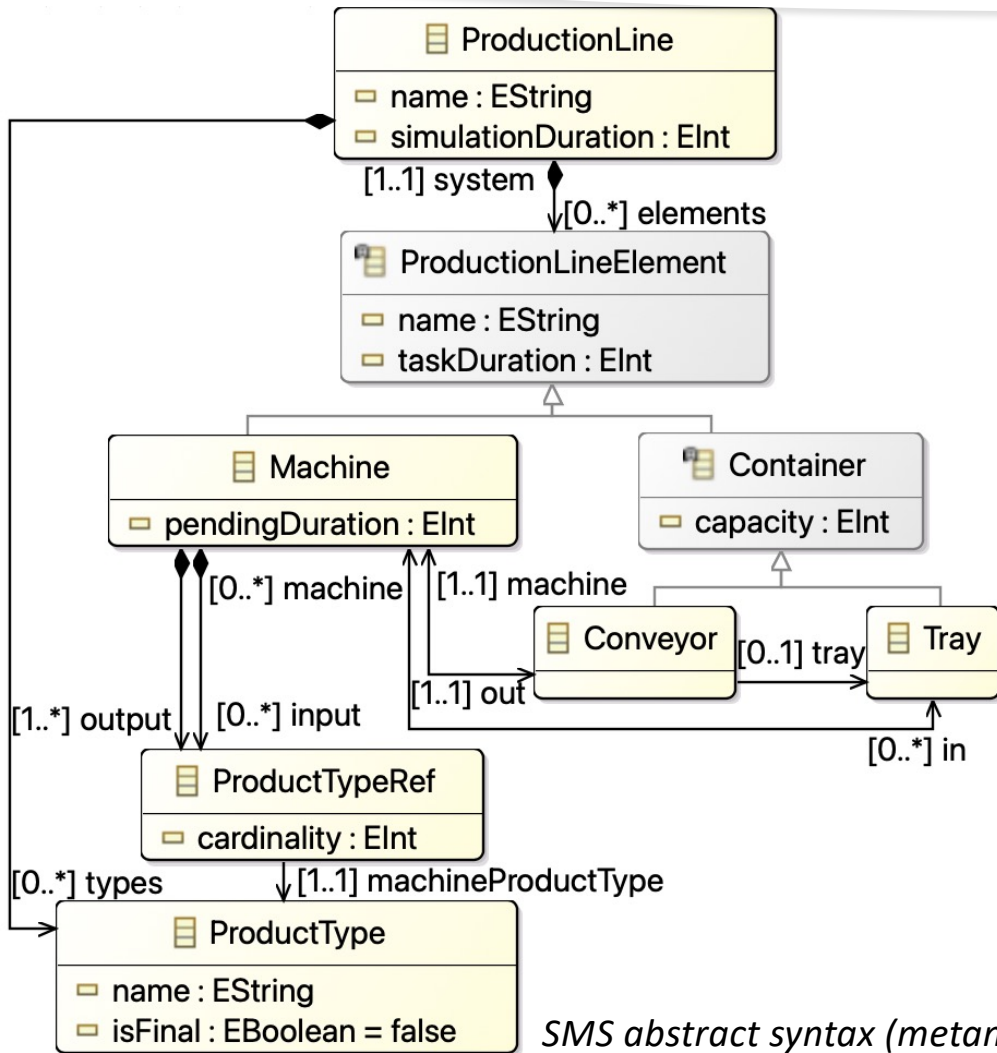


Proposal: Defining KPIs directly at the level of a DSL

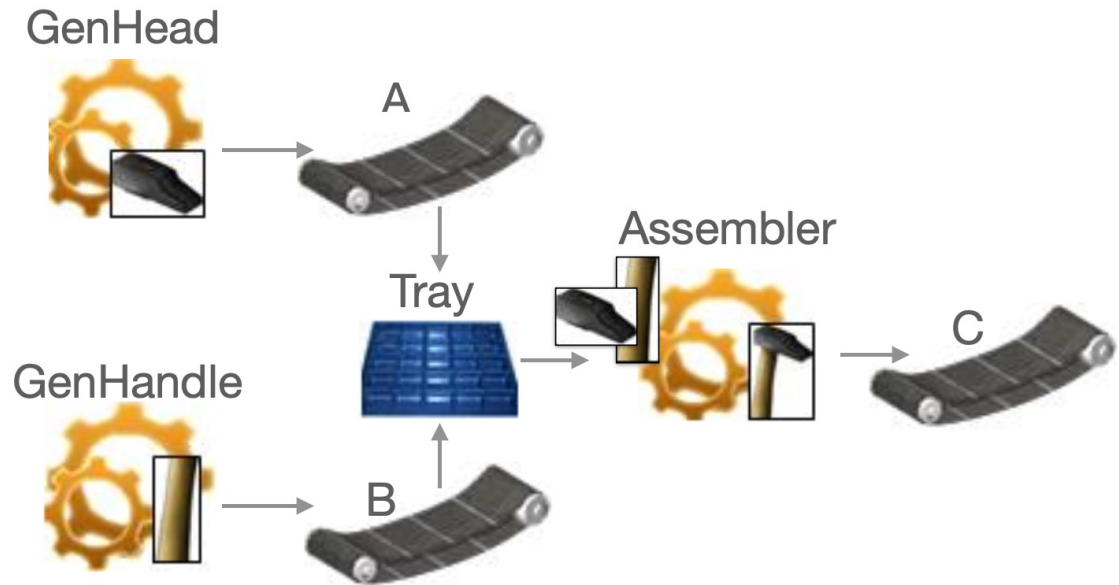
KPIs available on the model level, as if they were on a *library shelf*.



Case Study: Simple Manufacturing System (SMS) xDSL

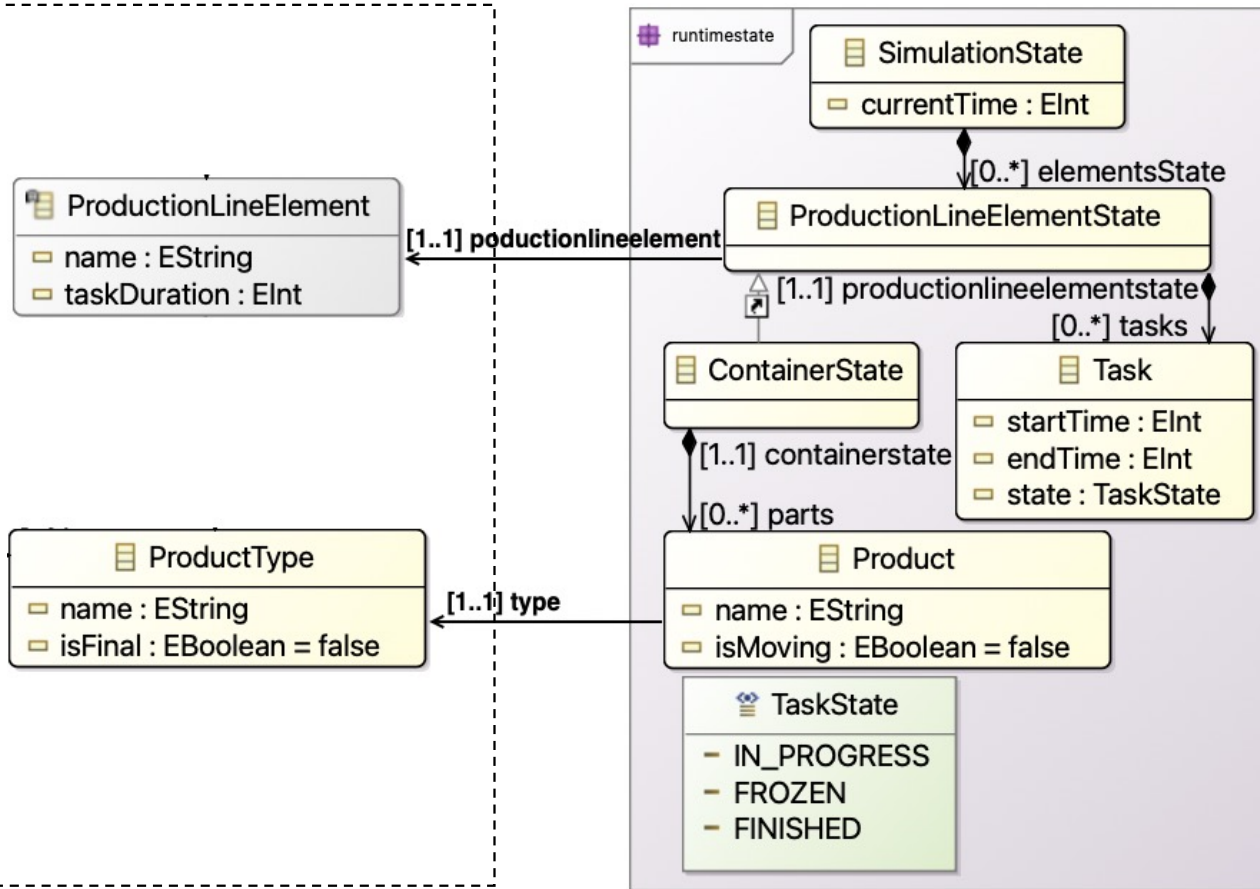


SMS abstract syntax (metamodel)



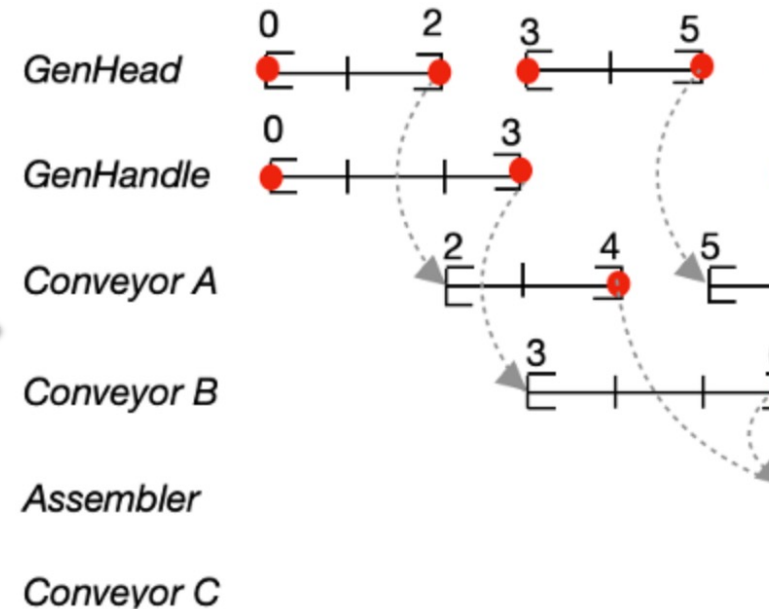
Example of an SMS Model : Hammer Production Line

Operational semantics (simulator)



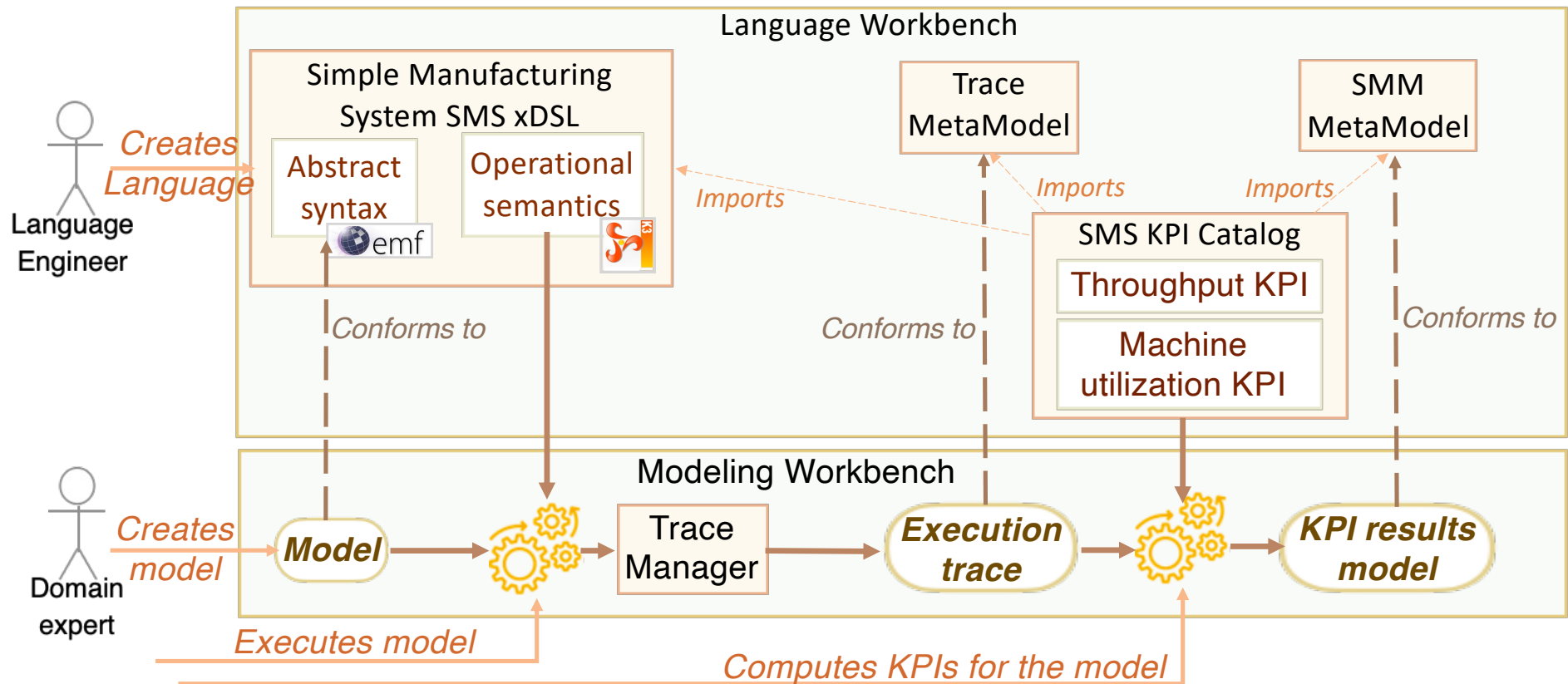
Extract from the abstract syntax

RuntimeState package



Time advancement based on discrete event simulation of the Hammer Production Line SMS Model

Process: Defining KPIs at the language level

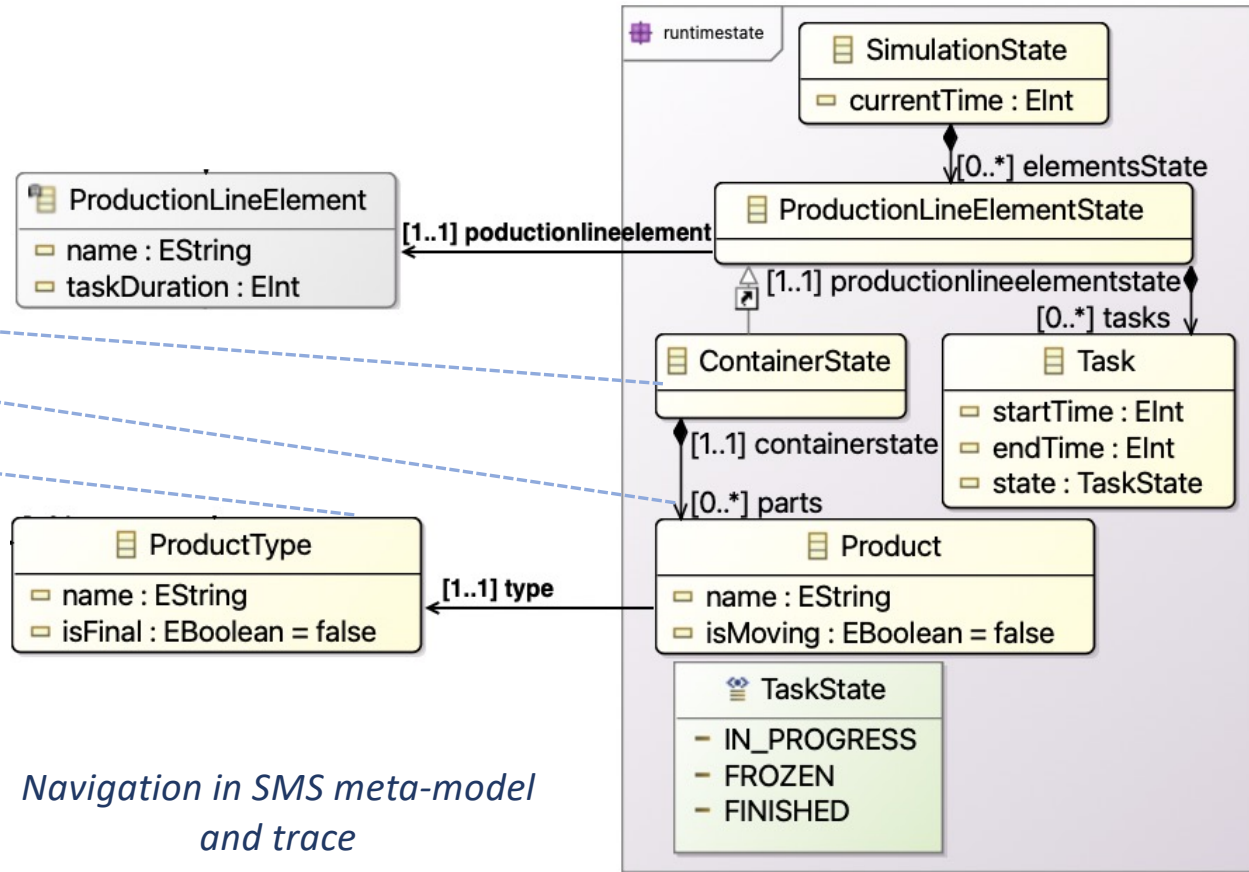


Example of KPI implementation for the SMS xDSL

Algorithm Throughput KPI formula

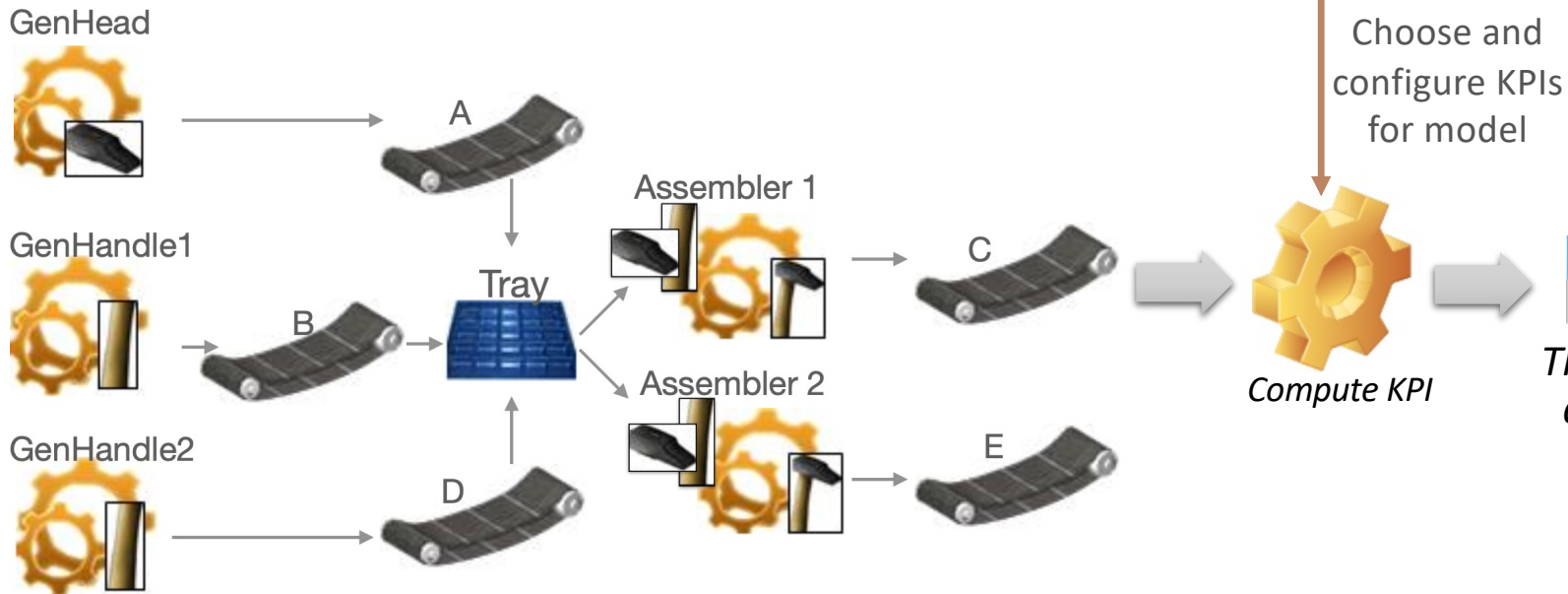
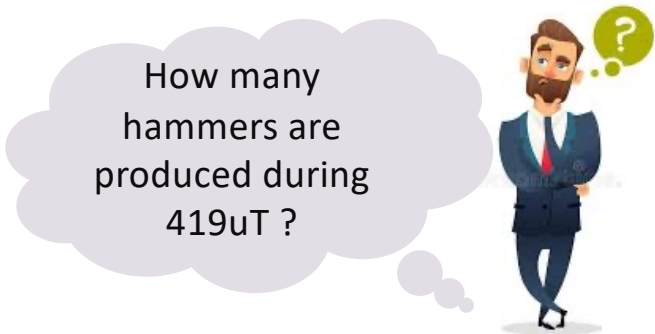
```

begin
  SMMmodel ← initializeSMMmodel();
  S ← executionTrace.states.last.currentTime;
  N ← 0;
  foreach
    container ∈ ExecutionTrace.finalState do
      count ← 0;
      foreach part ∈ container.getParts() do
        if part.getType().equals(type) then
          | count ++;
        end
      end
      if count > 0 then
        | N ← N + count;
      end
    end
  storeComputedKPIValue(SMMmodel, N/S);
end
  
```



This formula can be used off-the-shelf on any SMS model

Example of KPI computation on SMS model



Name	Throughput
Value	0.329355608

Throughput ≈ 0.3 number de Hammer /simulation duration

Reconfiguration of Hammer Production Line Model

Implementation



- Development environment: Gemoc Studio
 - EMF to create the abstract syntax of the xDSL .
 - K3 to code the executions rules of the xDSL.
 - KPIs implemented using Java Project
- <https://gitlab.univ-nantes.fr/rodic/simpleplsdsl>

The screenshot shows the Eclipse IDE interface for Gemoc Studio. The top toolbar contains various icons for file operations and execution. The 'Project Explorer' on the left shows a project structure with folders for 'pls_Models', 'gemoc-gen', and 'Model_Hammer'. The 'Model Explorer' in the center shows a 'Resource Set' with a tree view of production line components like 'Conveyor A', 'Machine Assembler', and 'Product Type Hammer'. The 'Properties' view on the right shows a table of properties for the selected 'Direct Measurement Throughput' object, including 'Base Measurement1 From', 'Description', 'Value', and 'Short Description'.

Property	Value
Base Measurement1 From	
Base Measurement2 From	
Base Measurement From	
Break Value	
Description	
Equivalent From	
Equivalent To	
Error	
Measurand	Production Line
Name	Throughput
Ranking From	
Recursive From	
Recursive To	
Refinement From	
Refinement To	
Requested Observations	
Rescale To	
Short Description	
Value	0.3293556085918

Selected Object: Direct Measurement Throughput

Future work roadmap

01 SMS

SMS xDSL : case study



02 KPIs

KPIs definition on language-level and Computation



03 xDSL annotation

Facilities for annotating any given xDSL with performance concepts



04 Performance Language

Performance facilities for any given xDSL



05 Performance Framework

Integrated framework for performance evaluation for xDSLs



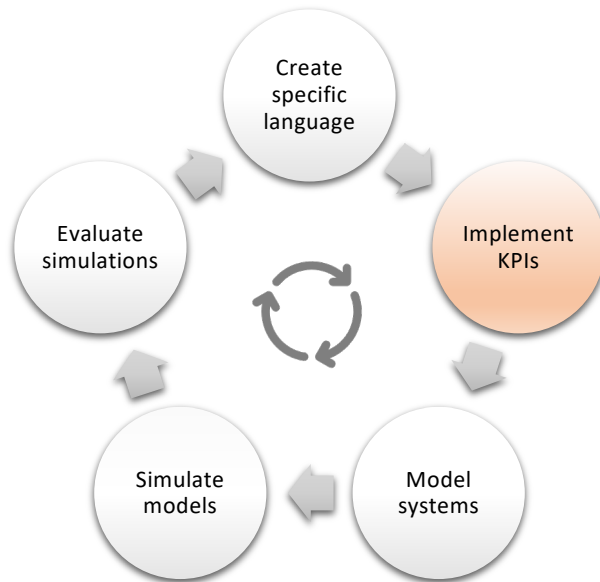


Defining KPIs for executable DSLs: a manufacturing system case study

Thank you for your attention

Question : reusable KPI implementations across different xDSLs ?

Problem: Redundancy in KPI definition ☹️



One-time KPI definition 😊

