Towards platform specific energy estimation for xDSMLs

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What's wrong with IT energy consumption ?

It's expensive

For every $1.00 spent on hardware, $0.50 is spent on power & cooling.

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This is expected to grow even more by 2030: up to 23% of total greenhouse emissions !

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Reducing energy consumption

Hardware level		Software level	
Clock gating	Adapt clock signal to circuit activity	CPU offloading	Offloads heavy calculations to cloud
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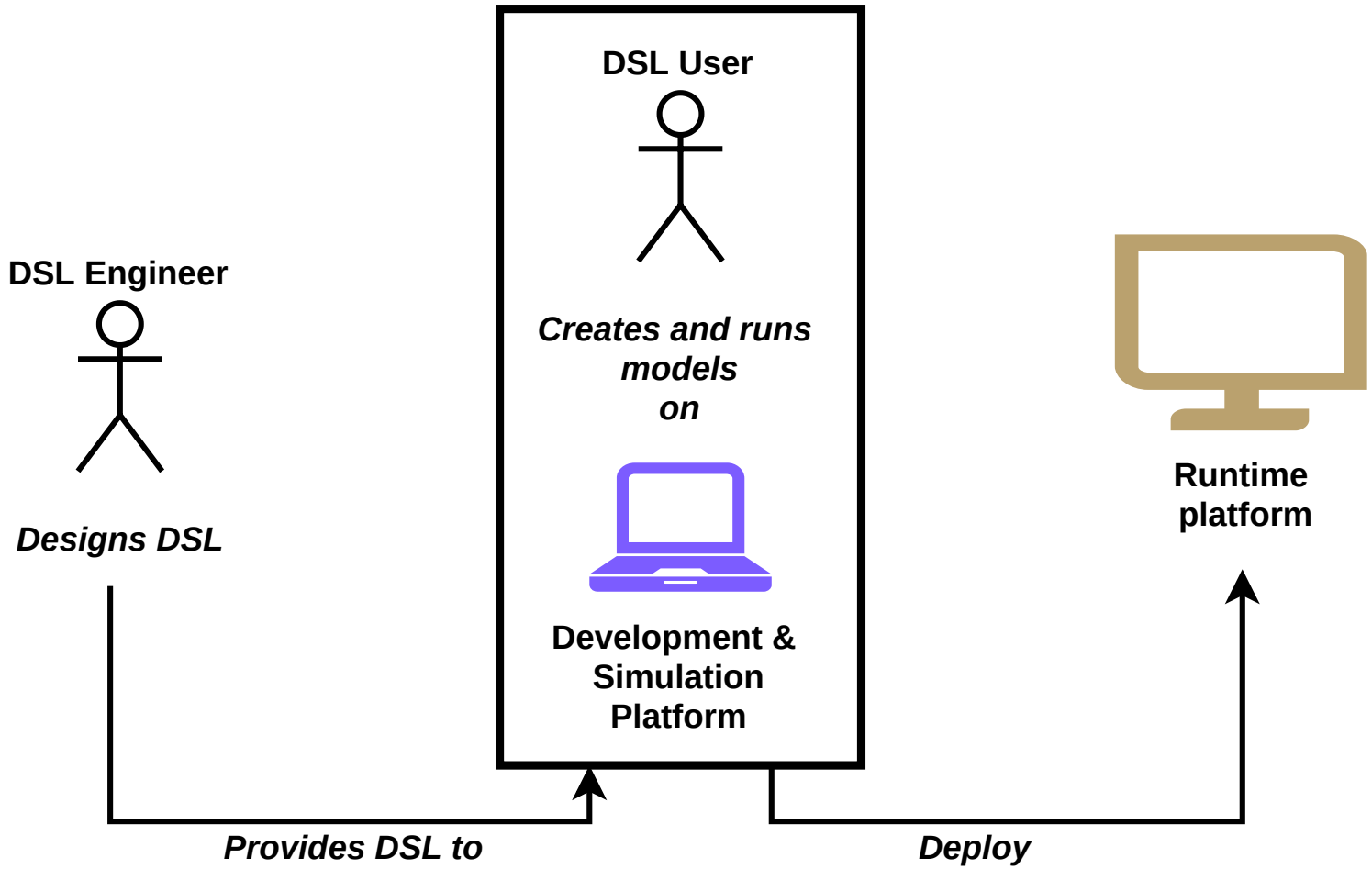
Hardware-level techniques are transparent to developers.

Software-level techniques require developer's implication!

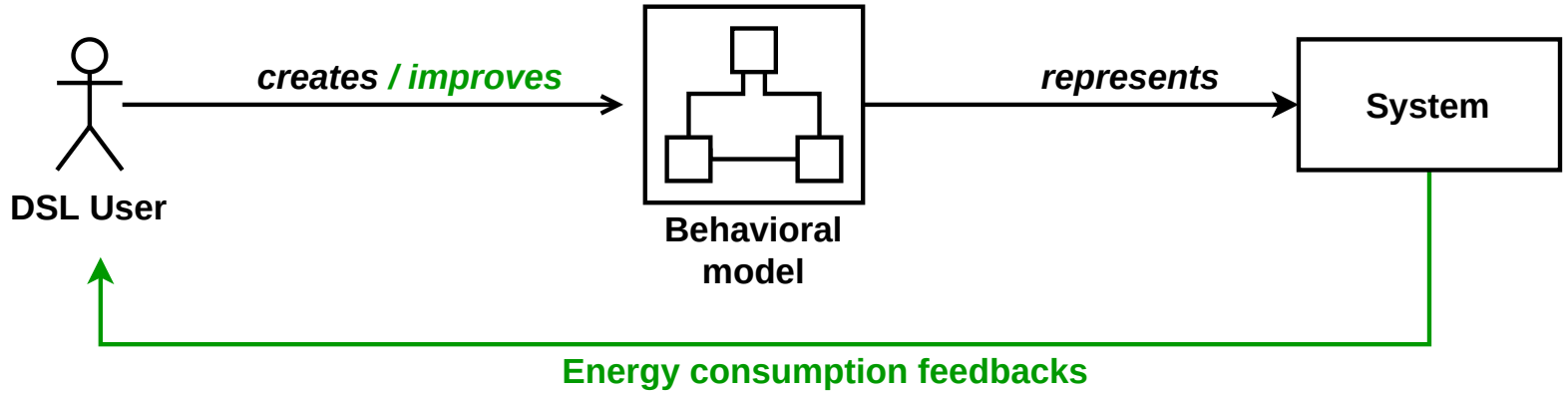
What about energy optimization for DSLs ?

Considered modeling scenario



Energy consumption and xDSMLs

The model describes the behaviour of the system. Improving the model can improve the system's energy consumption.



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- **Power-meters**

  Require heavy analysis for correlating metrics with a running programs.

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Providing energy consumption feedbacks requires the help of a specialist.

- **Middleware & Application-level energy monitoring**

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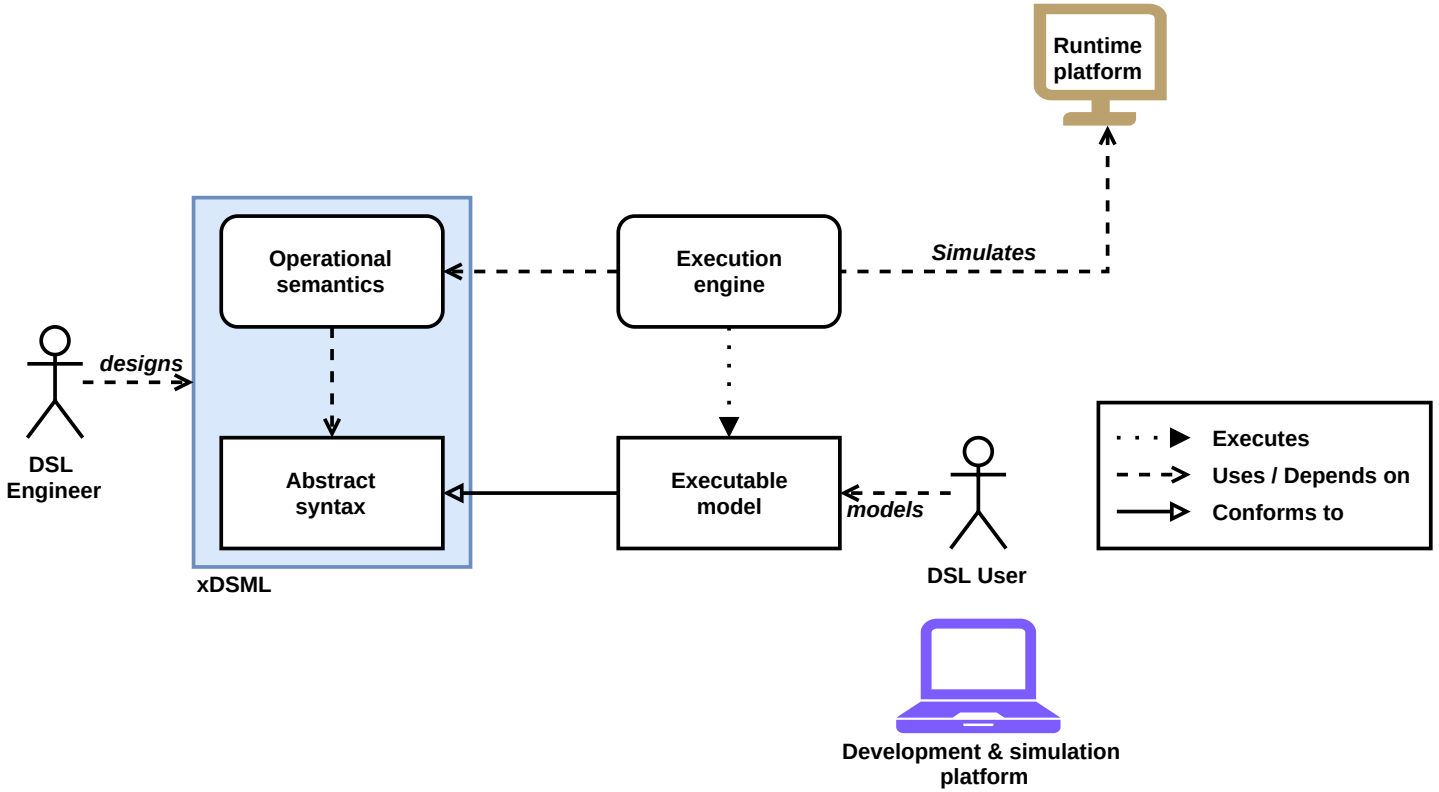
Research question

How to provide energy consumption feedbacks of runtime platform without energy measurement tooling and expertise?

Our contributions

1. A DSL for specifying energy-consumption estimation formulas.
2. An extension of the GEMOC modeling workbench to provide energy consumption estimations of runtime system to DSL Users.

Energy-consumption feedback for xDSMLs end-users



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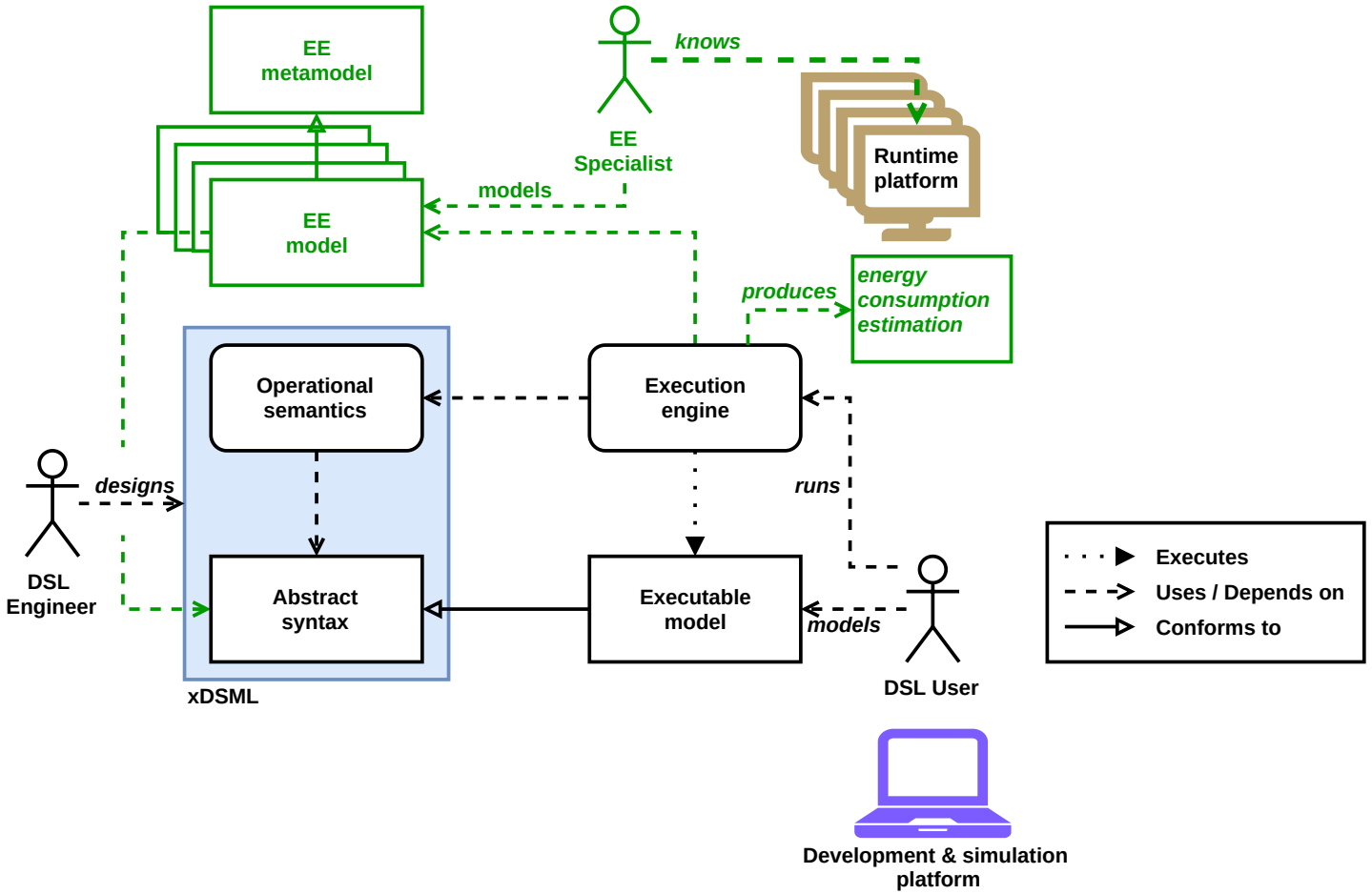
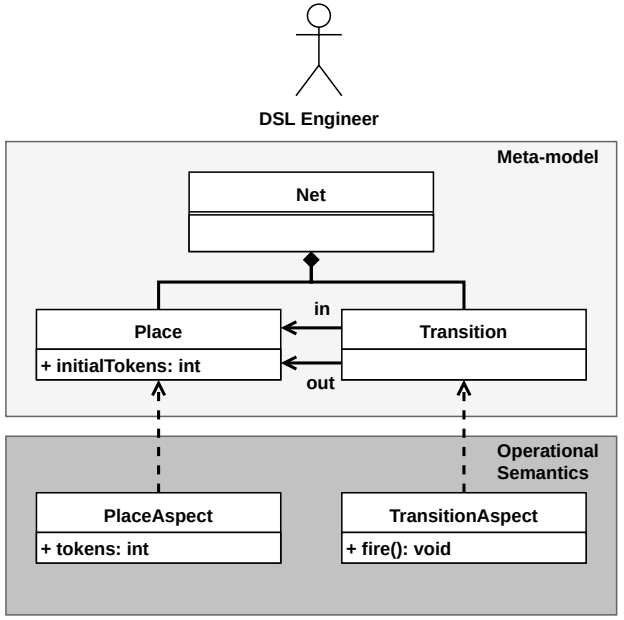
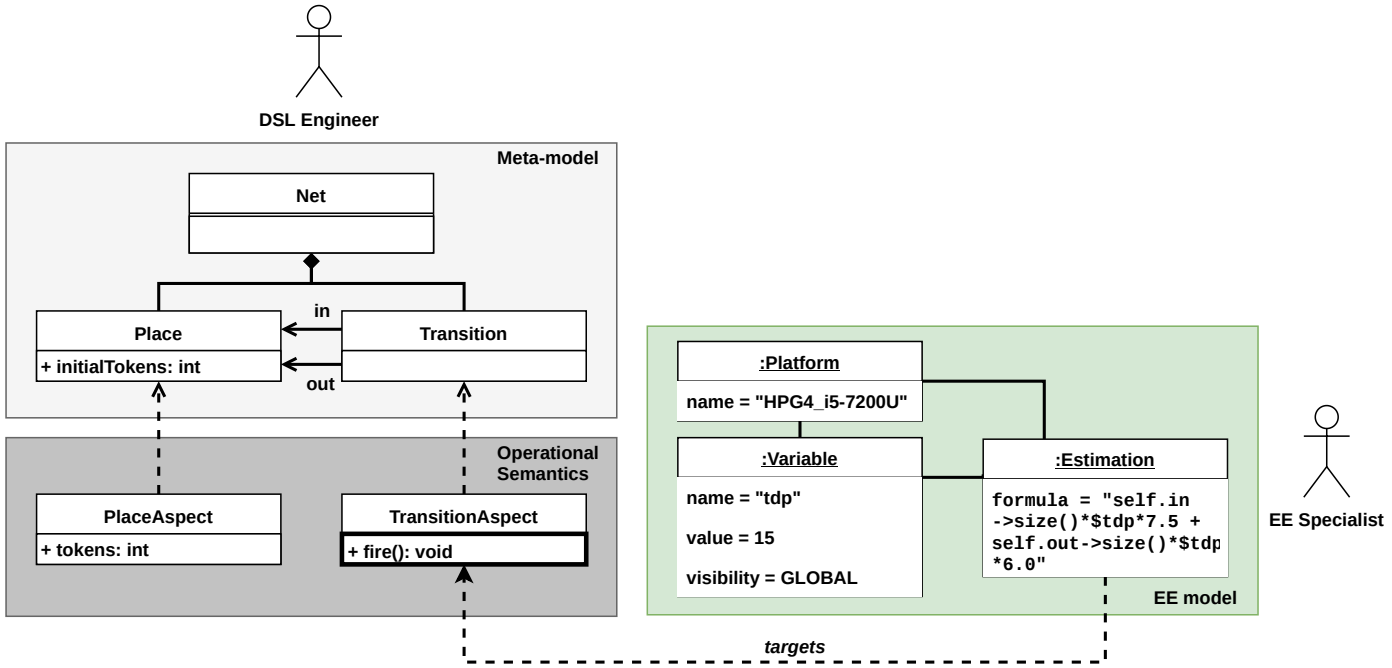


Example: Petri net modeling scenario



Example: estimating Petri Net energy consumption



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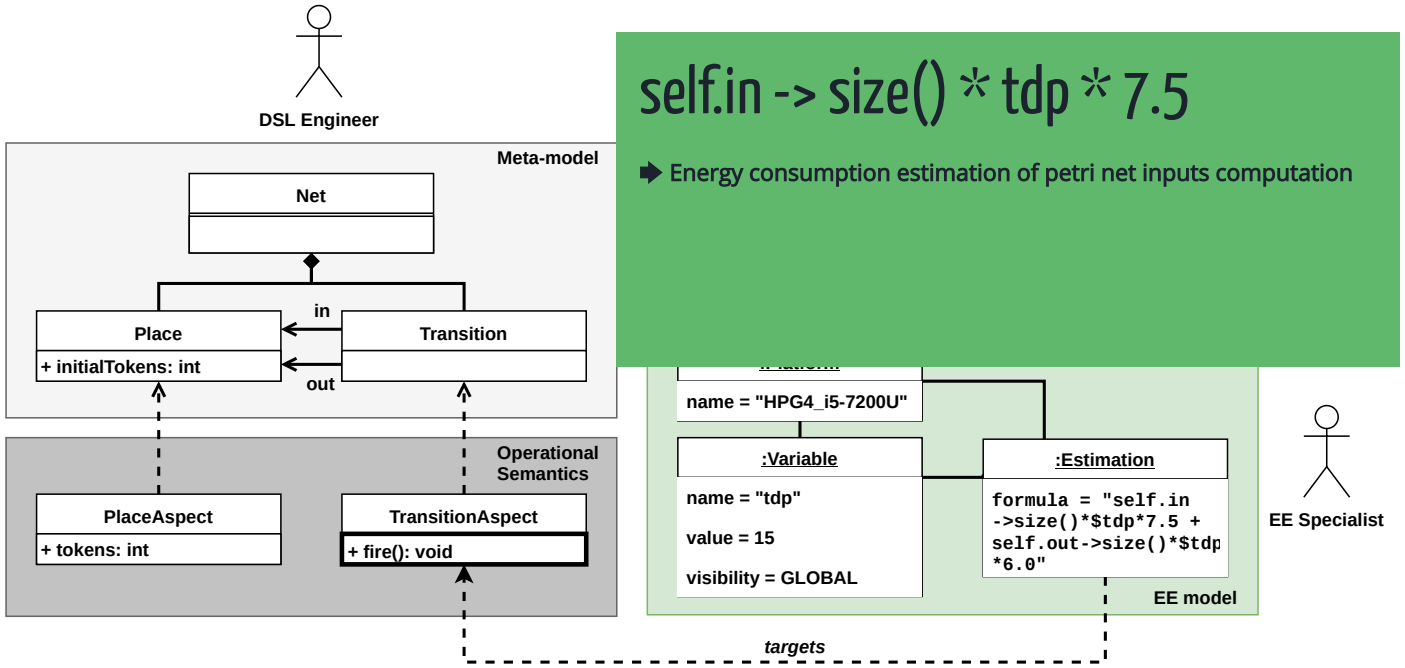

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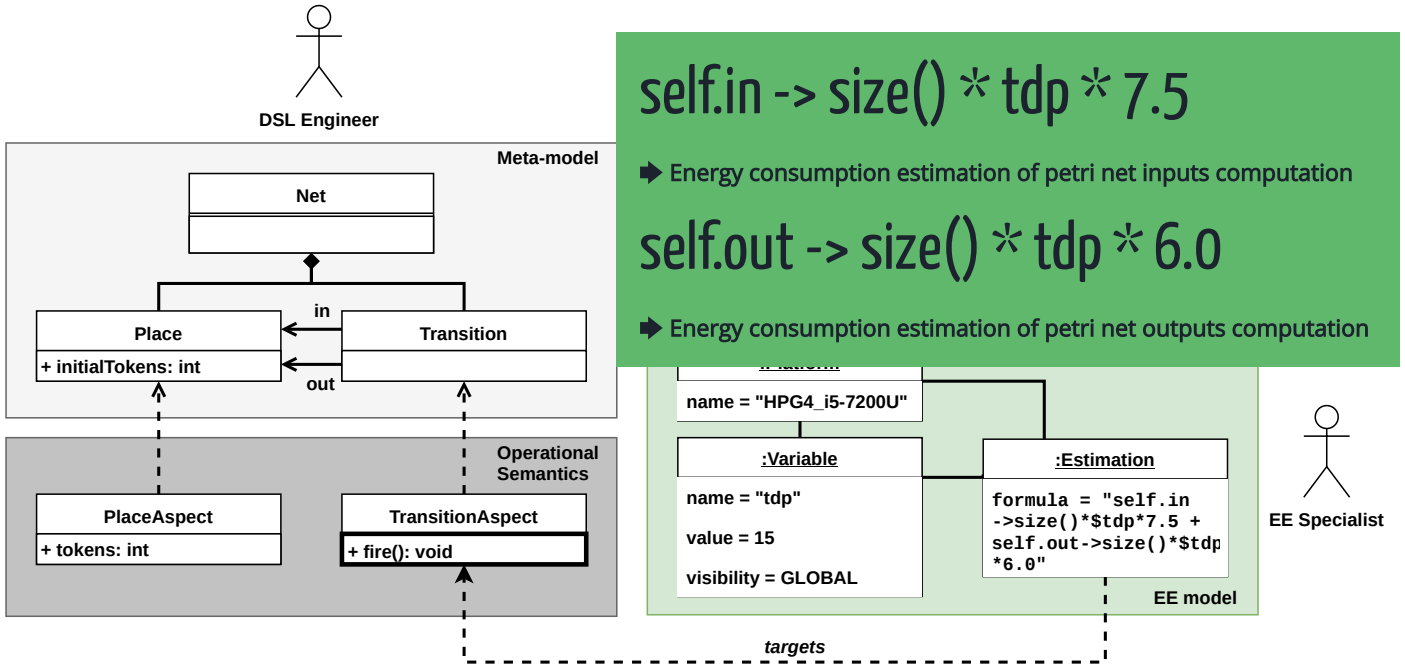

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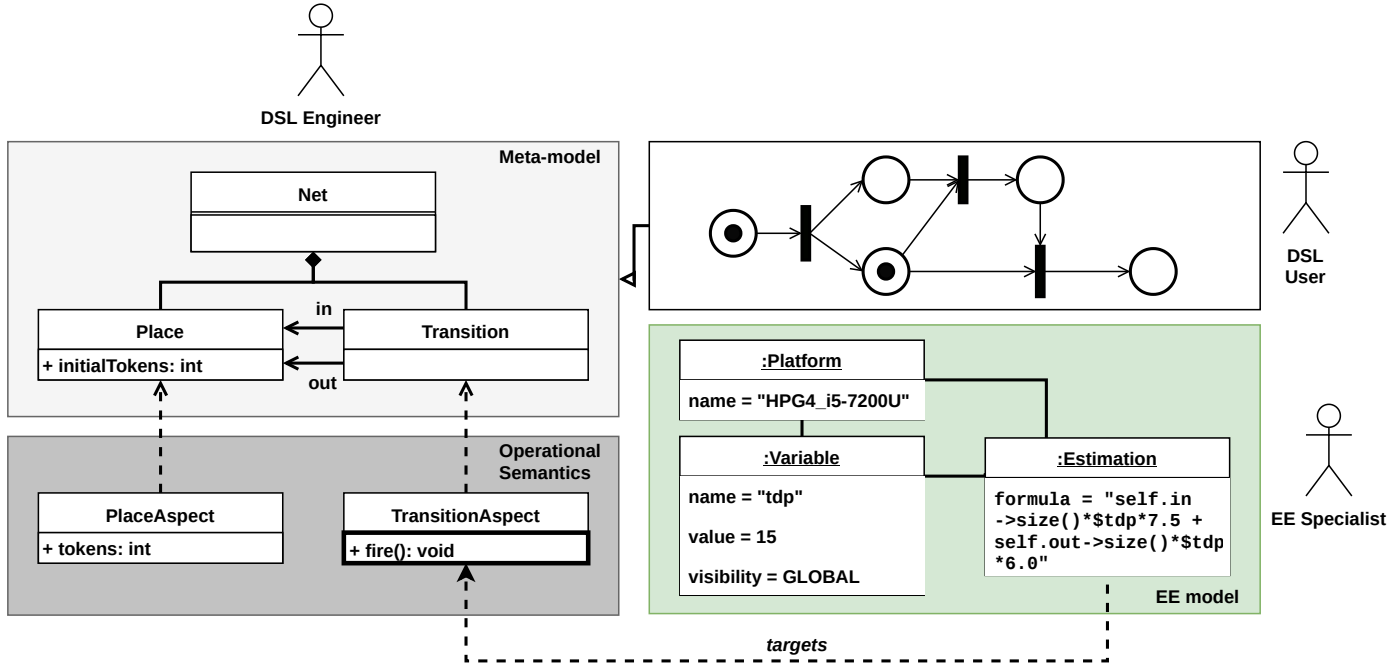
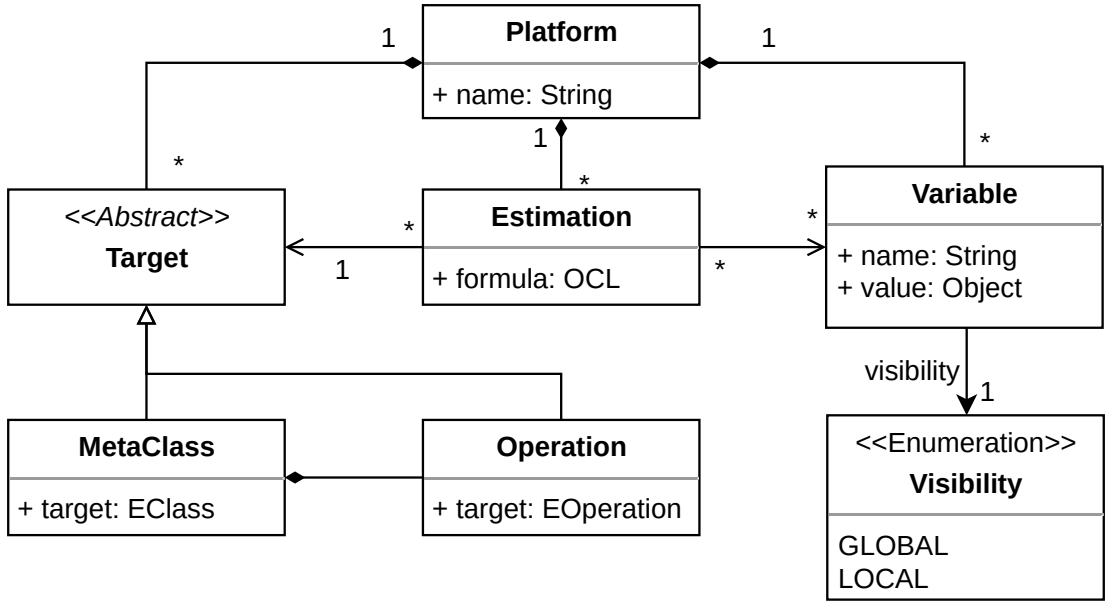


Defining energy estimation formulas

- Role of the Energy Estimation specialist.
- Requires a thorough study of the operational semantics.
- Can be inferred from multiple model executions with energy consumption measurements.

Energy estimation meta-model



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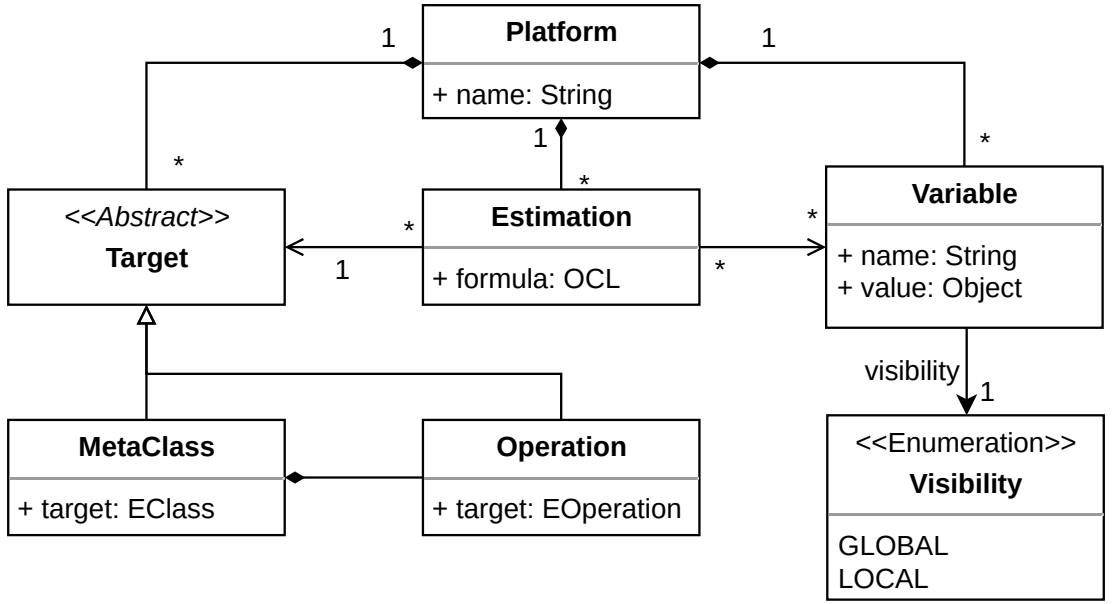

- Formulas are associated to meta-elements of a xDSML.
- They should only focus on one specific platform.

- Written as OCL Queries, applied to elements of an executable model that conforms to the decorated xDSML.

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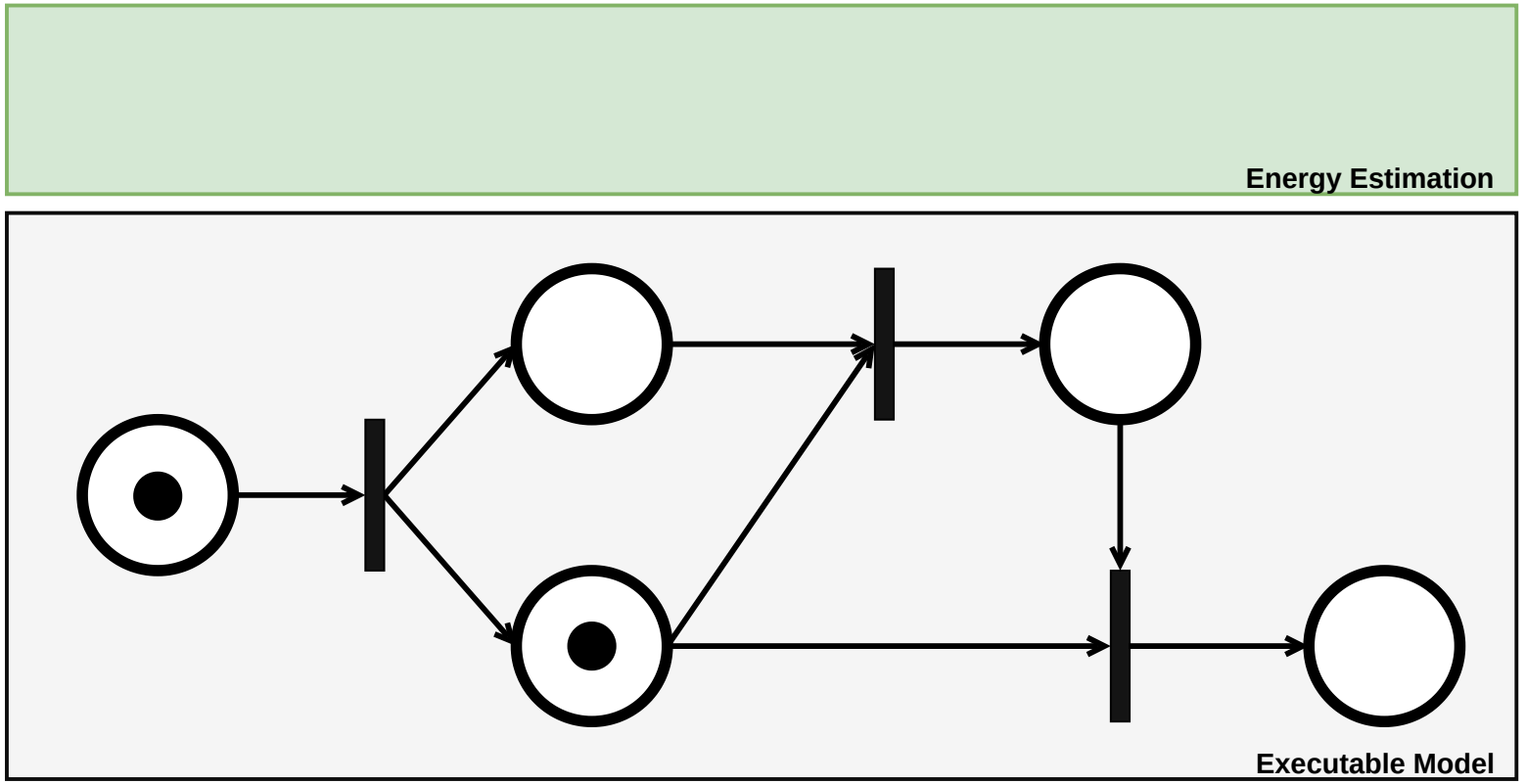

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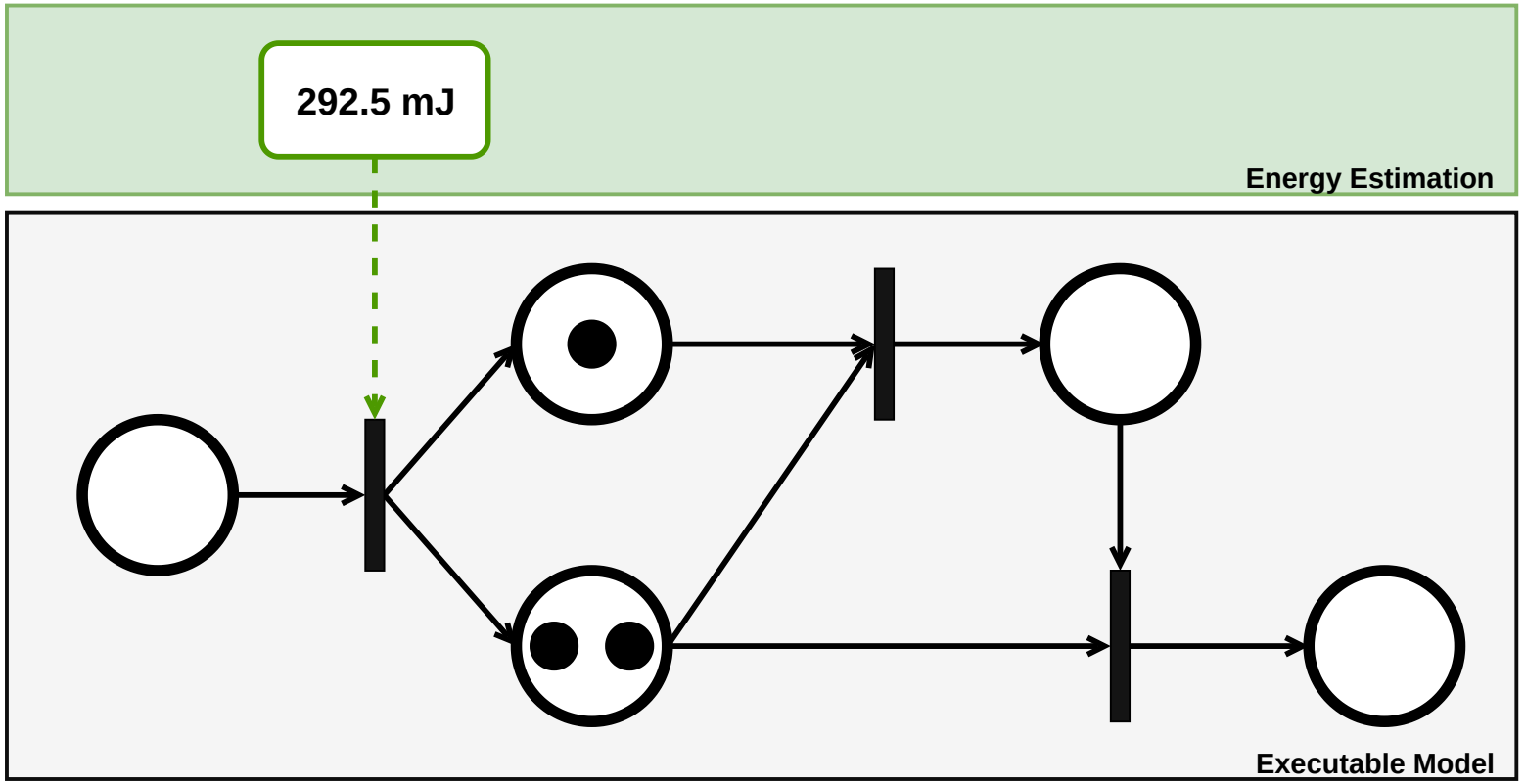

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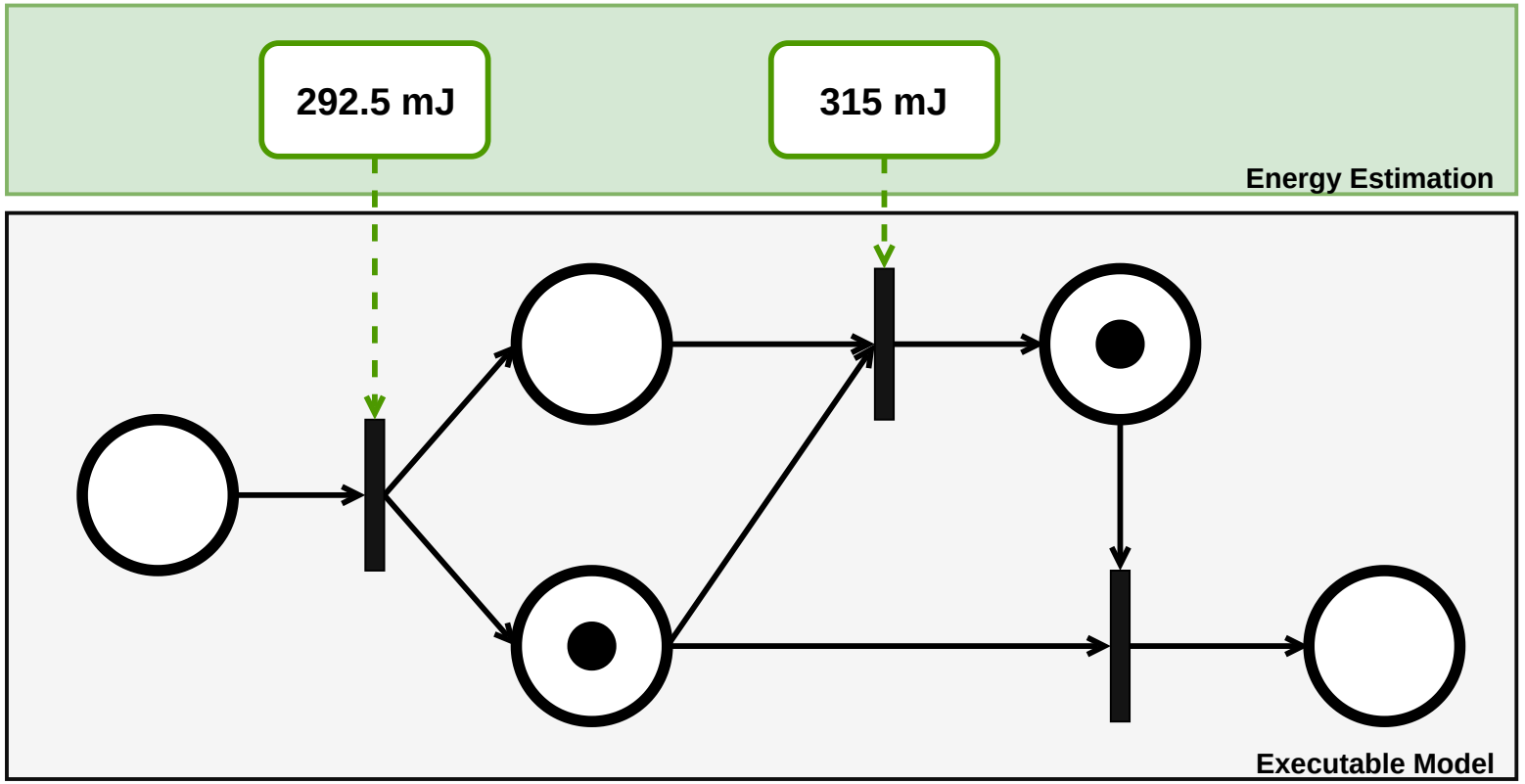

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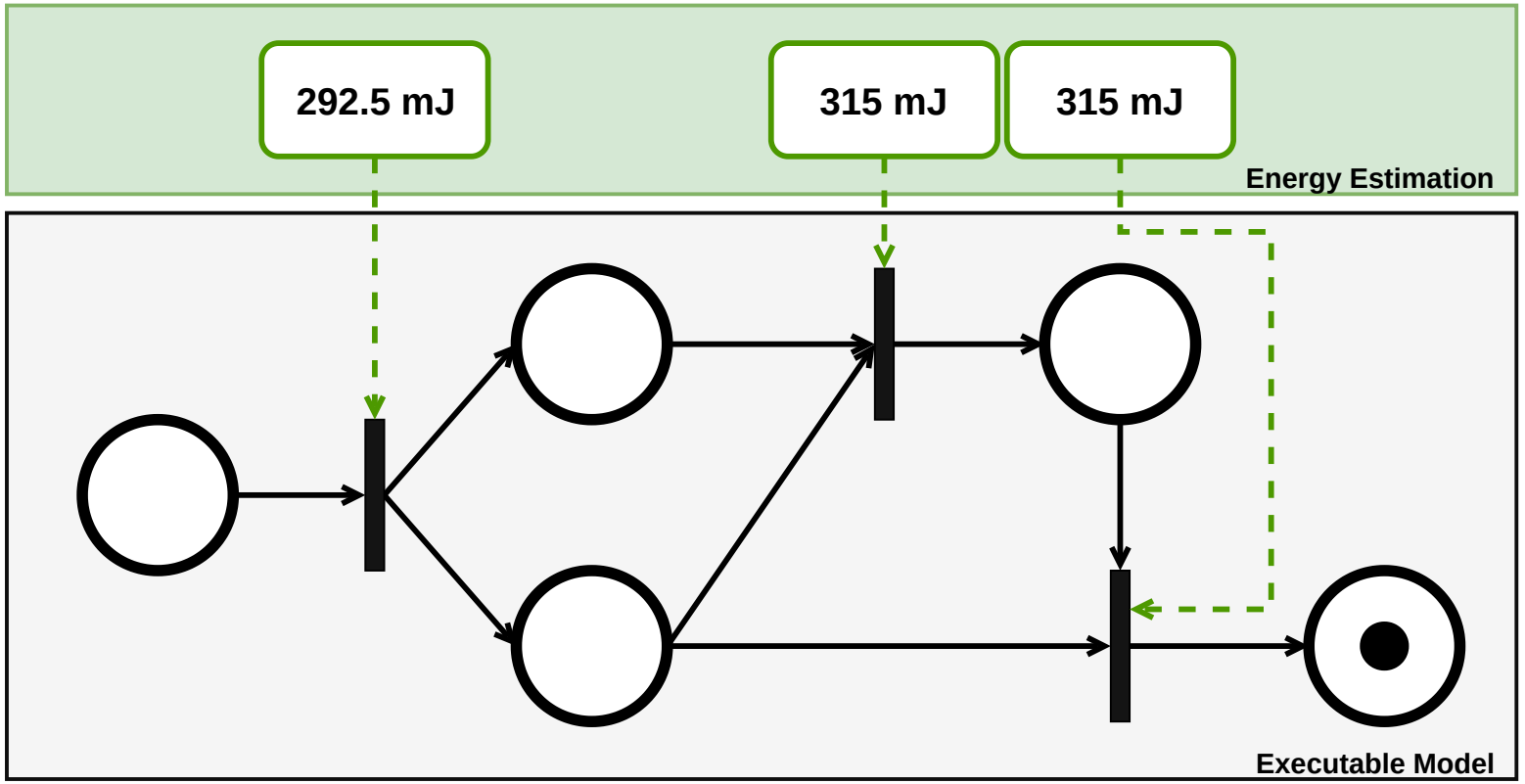
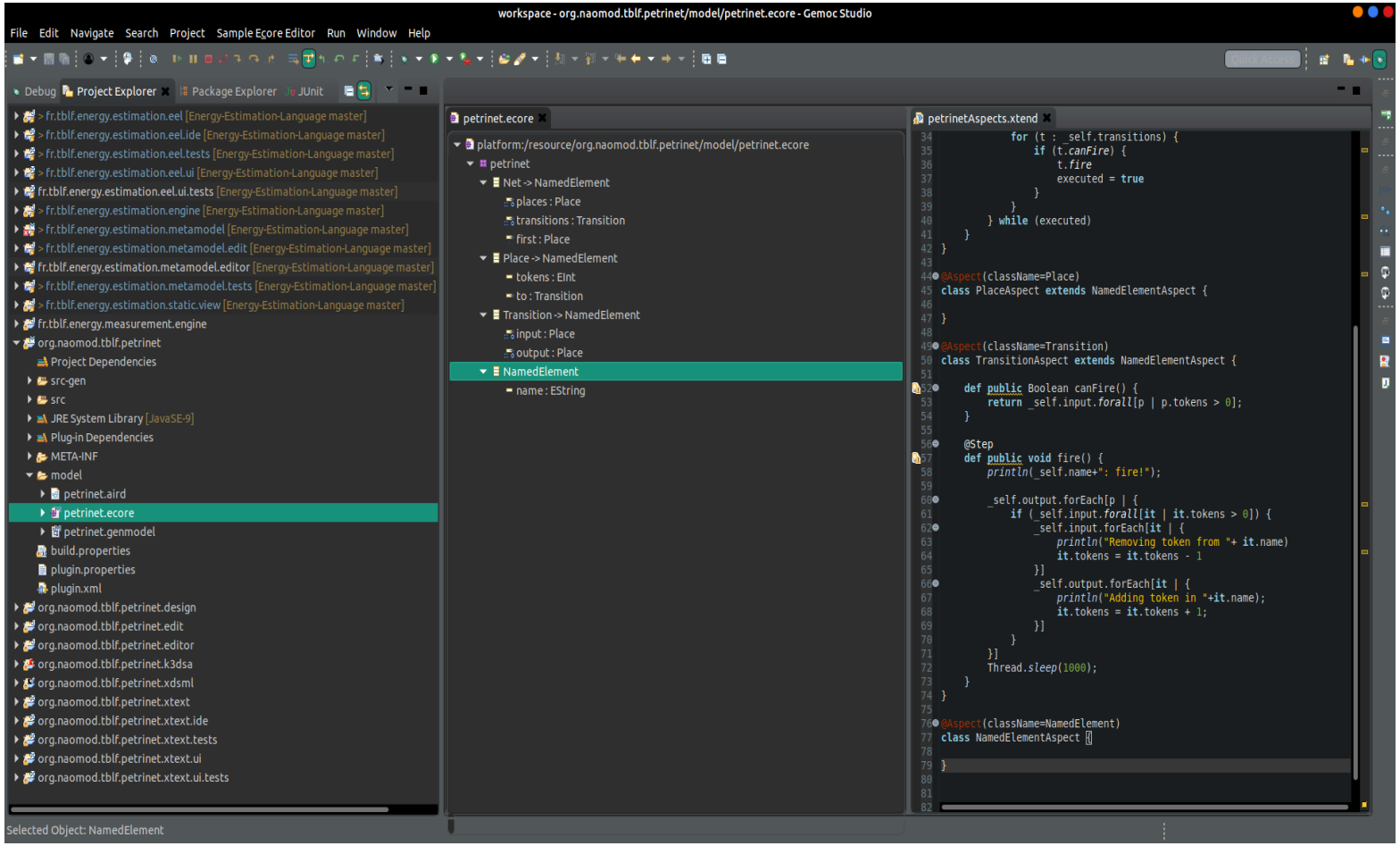


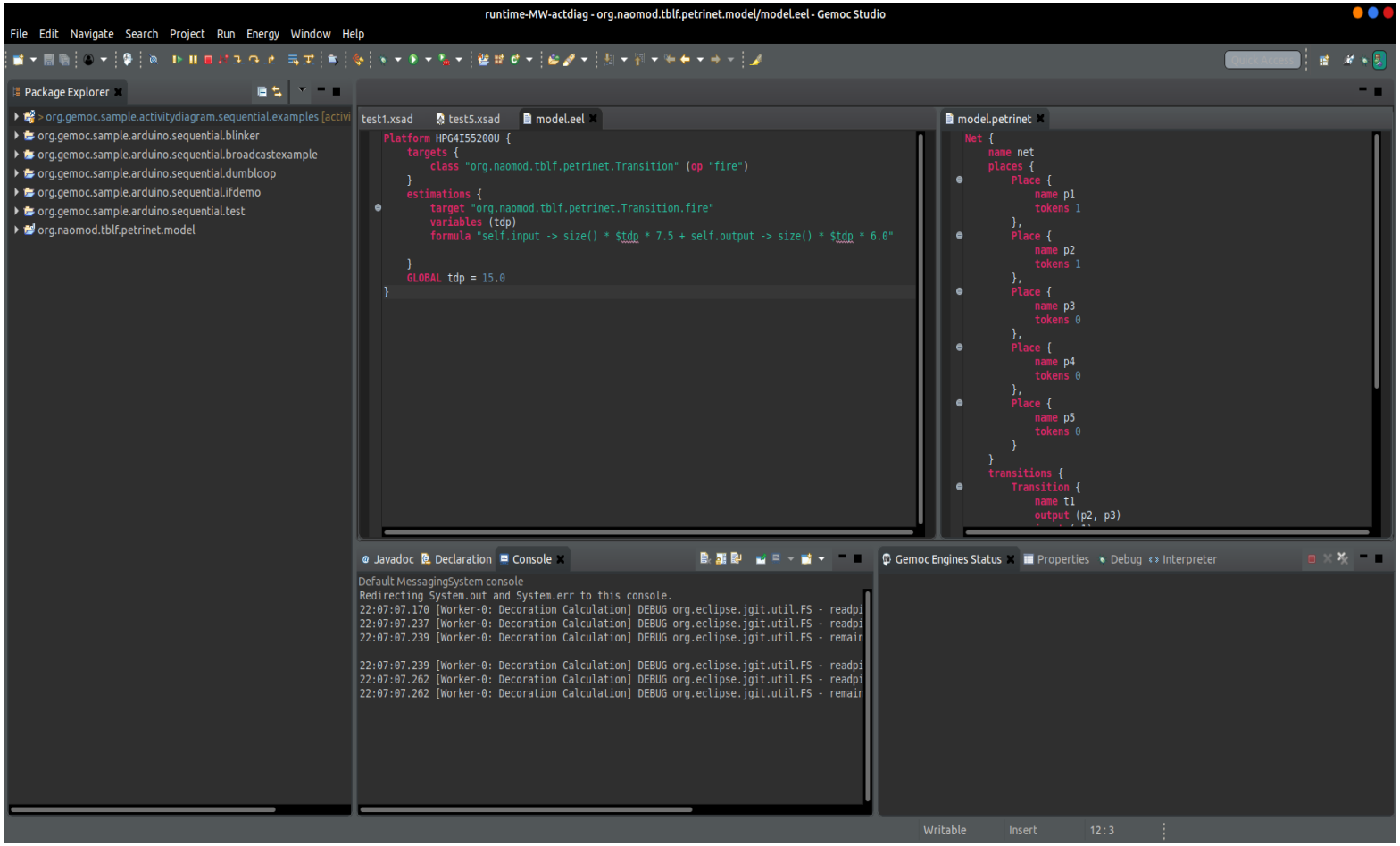
Extension of the GEMOC modeling workbench

1. Takes an energy estimation model as an extra input.
2. An additional execution listener performs energy estimation during the simulation:
   - OCL EE formulas are executed on the elements of the model.
3. The energy estimation is given as a report to the DSL User.
4. Now s/he can improve the executable model in order to reduce the energy consumption of the target runtime system.

Implementation: Language workbench



Implementation: Modeling workbench



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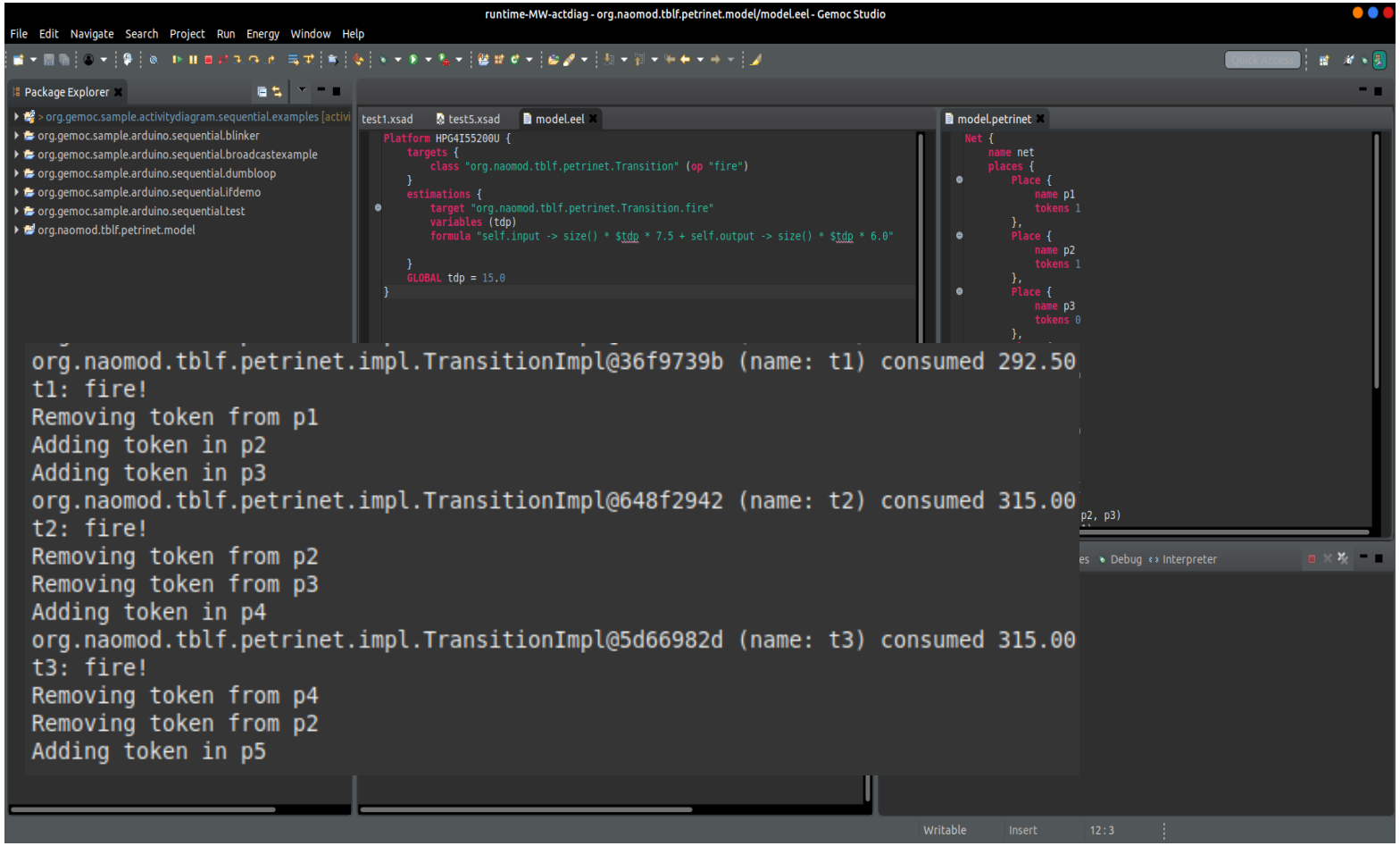

Conclusion:

- A meta-model for estimating the energy consumption of xDSMLs.
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- First step towards a better energy awareness among xDSMLs users.

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Future work:

- Empirical evaluation of the approach
  - Various xDSMLs
  - Various platforms
- Modelling the energy estimations with a dedicated meta-model.
- More research on the automation of the energy-estimation formulas generation.

Thanks !

Contact:

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https://github.com/atlanmod/energy-estimation-language