Meta-Object Programming for MDA

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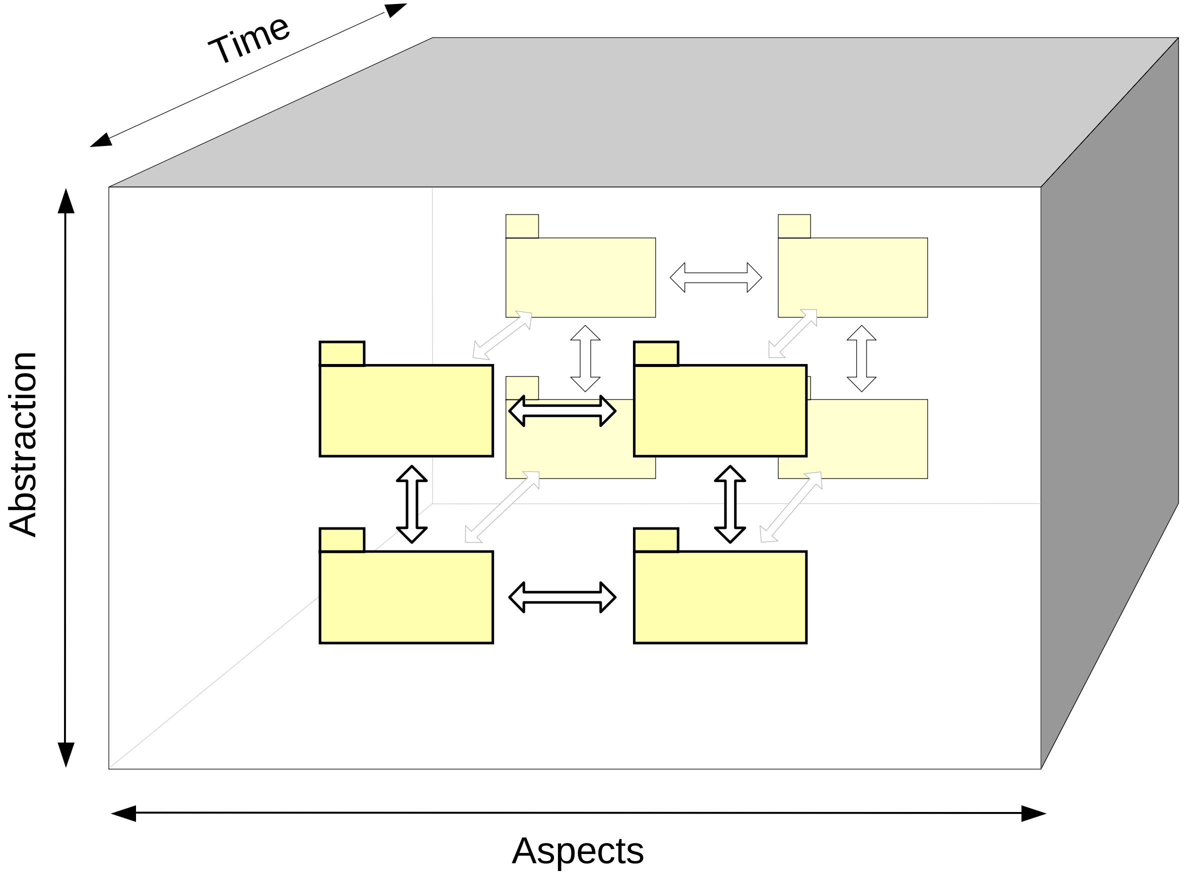
Model Driven Architecture

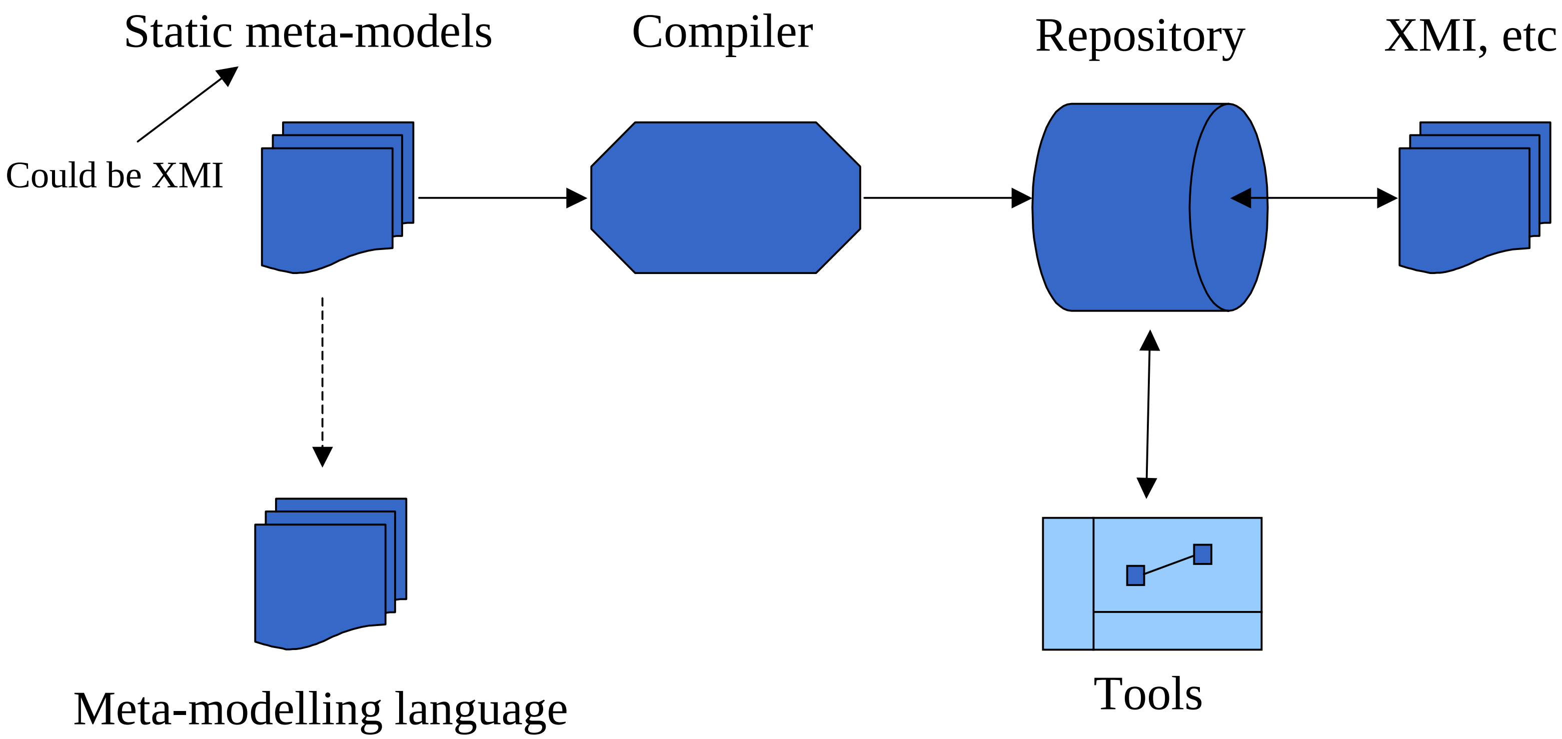
- MDA unifies multiple perspectives of the modeling space



MDA Tool Requirements

- Modelling languages becoming increasingly complex, diverse and semantically rich:
  - Software and non-software modelling.
  - Support for: model analysis, model checking, model execution, model transformation, …
  - Support for language related facilities: parsing, model interchange, model-management.
- MDA tools must provide full support for the modelling of semantically rich languages.
- Can only be achieved by full access to a sufficiently expressive meta-modelling language.

Traditional Meta-tools



Limitations

- Use of static meta-modelling language means that semantics of languages must be described at an implementation specific level, e.g. through repository API
  - Semantics cannot be viewed as being a part of the language definition.
- Meta-modelling language is not capable of expressing its own semantics:
  - Again, relies on platform specific implementation of semantics, e.g. new()
- Impact is to significantly reduce flexibility, interoperability and time to deployment of tools.

MOF

- OMG standard meta-modelling language.
  - Cornerstone of MDA standard.
- MOF 1.X/2.0 being extended to support richer modelling abstractions:
  - QVT (Query, Views, Transformations) RFP
  - Versioning and Lifecycle RFP
  - Facilities RFP
- Yet, still lacking full power to capture language semantics.

Solution - meta programming

- Key feature missing from MOF is: *executability*.
- Extend MOF with minimal set of executable primitives: create/delete object, slot update, sequential operator.
- Result:
  - MOF can express semantics of languages in a platform independent way.
  - MOF can express own semantics.
  - MOF becomes stand alone, highly flexible, executable language (programming language) for MDA tool development.

XOCL

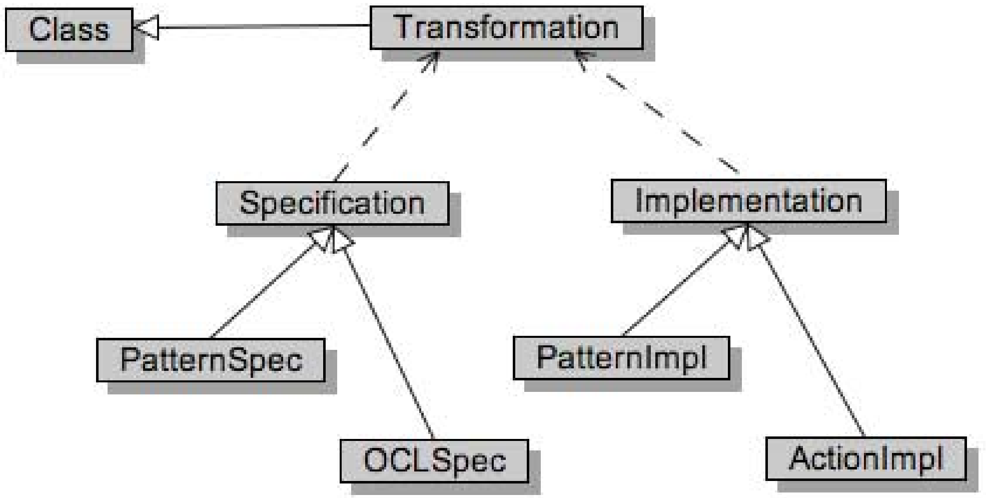
- Extends OCL with primitive action expressions:

```
context TransformationInstance::addMap(left,right)
let x := Map.new(left,right) in
 self.maps := self.maps ->including(x)
end

context Bank::addAccount(details)
let a = Account.new(details) in
  self.accounts := self.account -> including(a);
  self.transactions := self.transactions + 1
end
```

Example: meta-language definition and extension

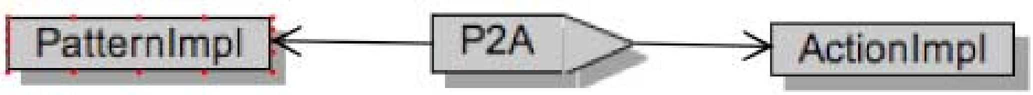
- Mappings:
  - An extension to the MOF meta-model



  - Has rich executable semantics: e.g. pattern matching mechanism has been widely proposed.

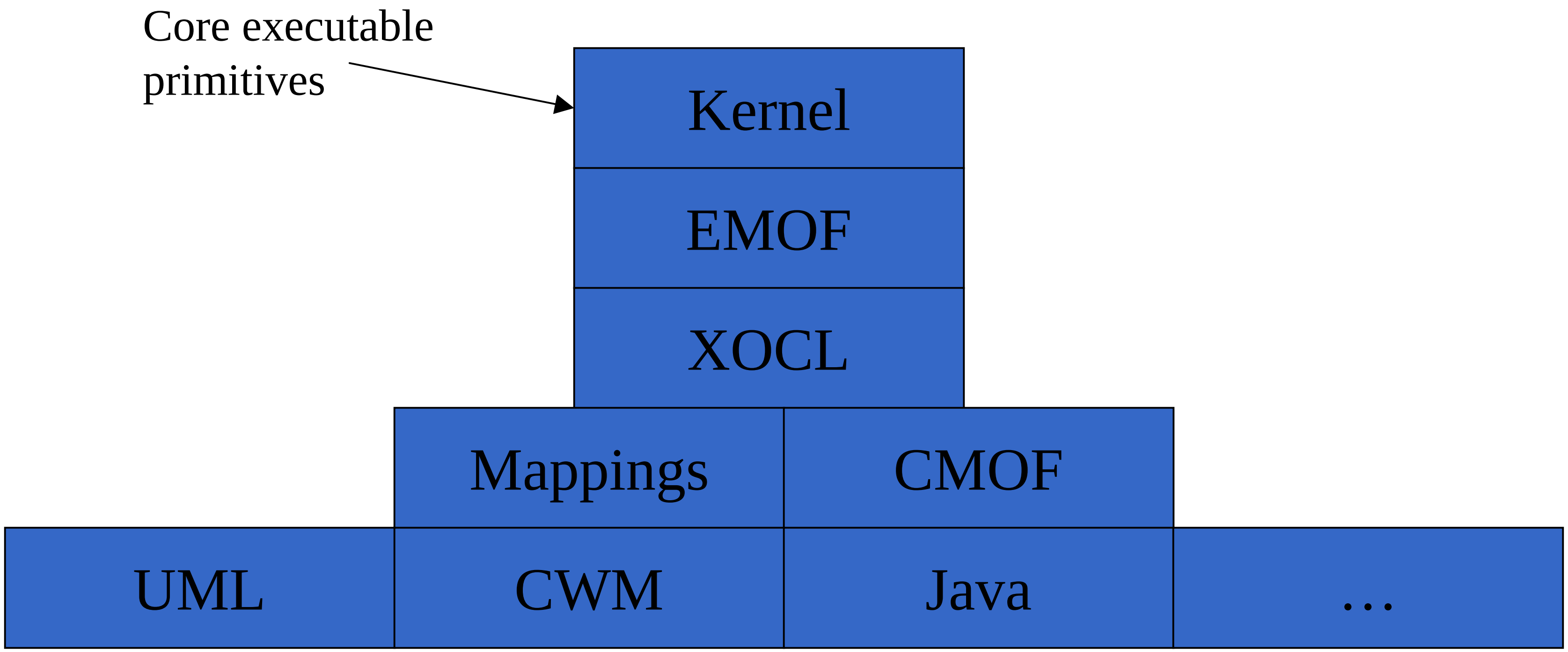
Pattern Matching

- Implement pattern matching mechanisms via mapping to action primitives

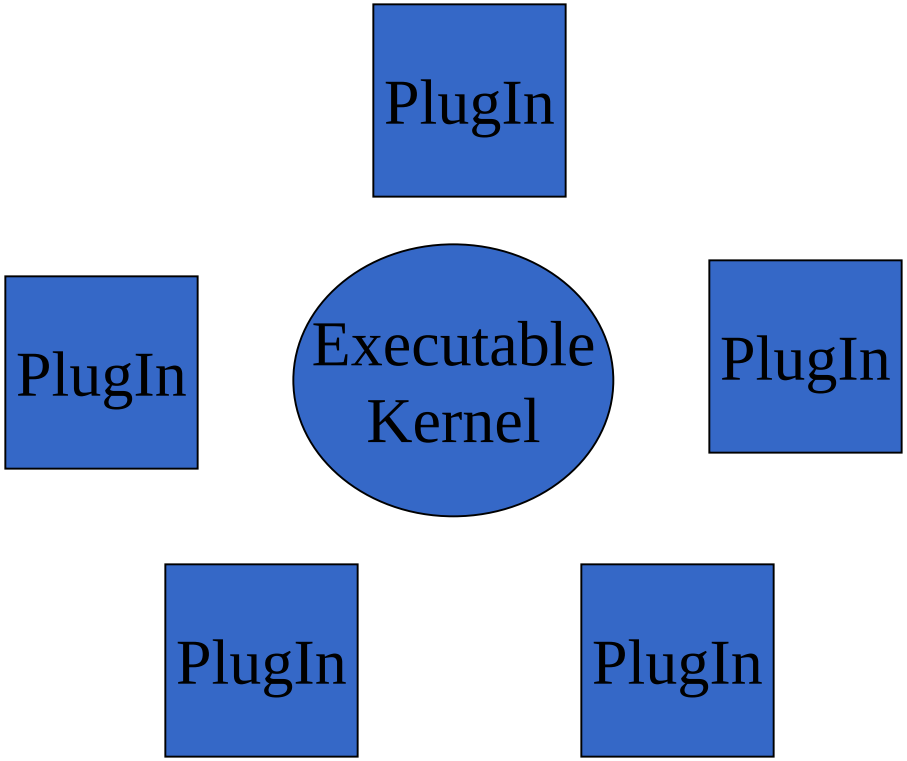


- Key benefits:
  - Platform independent description of semantics
  - Executable in an appropriate tool
  - Flexible: semantics can be readily changed and built up in layers to define multiple languages

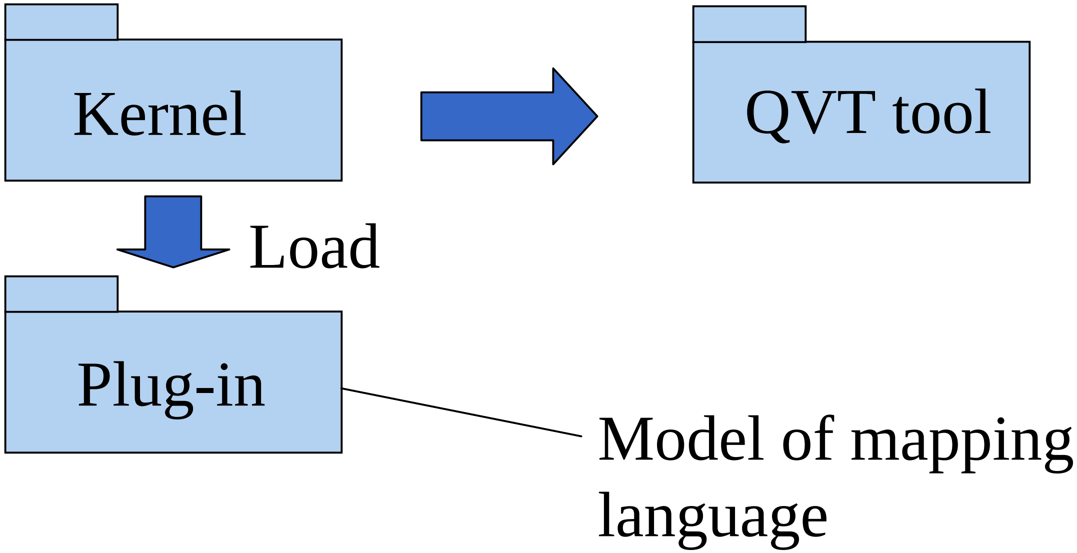
Executable Meta-tool Architecture



PlugIn Architecture



Extensibility



Kernel

QVT tool

Load

Plug-in

Model of mapping language

XMOF: an MDA Hub

- Enables rapid development of tools that can support the full spectrum of languages required for MDA
- Tools are *modelled* - giving maximum flexibility and interoperability:
  - Facilitates plug and play tool architecture
  - Tools can be exchanged as models (XMI documents) - ultimately breaks vendor dependence (tools become models, I.e. assets).

Summary

- MOF is currently not expressive enough to support modelling of semantically rich languages required for MDA
- Simple extension with execution is what is required
- MOF becomes a meta-programming environment (moves away from static, repository based approaches)
- Language definition is completely platform independent - a good basis for OMG specifications (imagine if you could download a spec and run it!)