Development of an OCL-Parser for UML-Extensions

Closure of a Diploma Thesis

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Introduction

- Short explanation of the subject and its main technologies
- Introduction to the developed solution:
  - framework‘s architecture
  - model interface
  - parser, context checker, interpreter
  - MOF Bridge

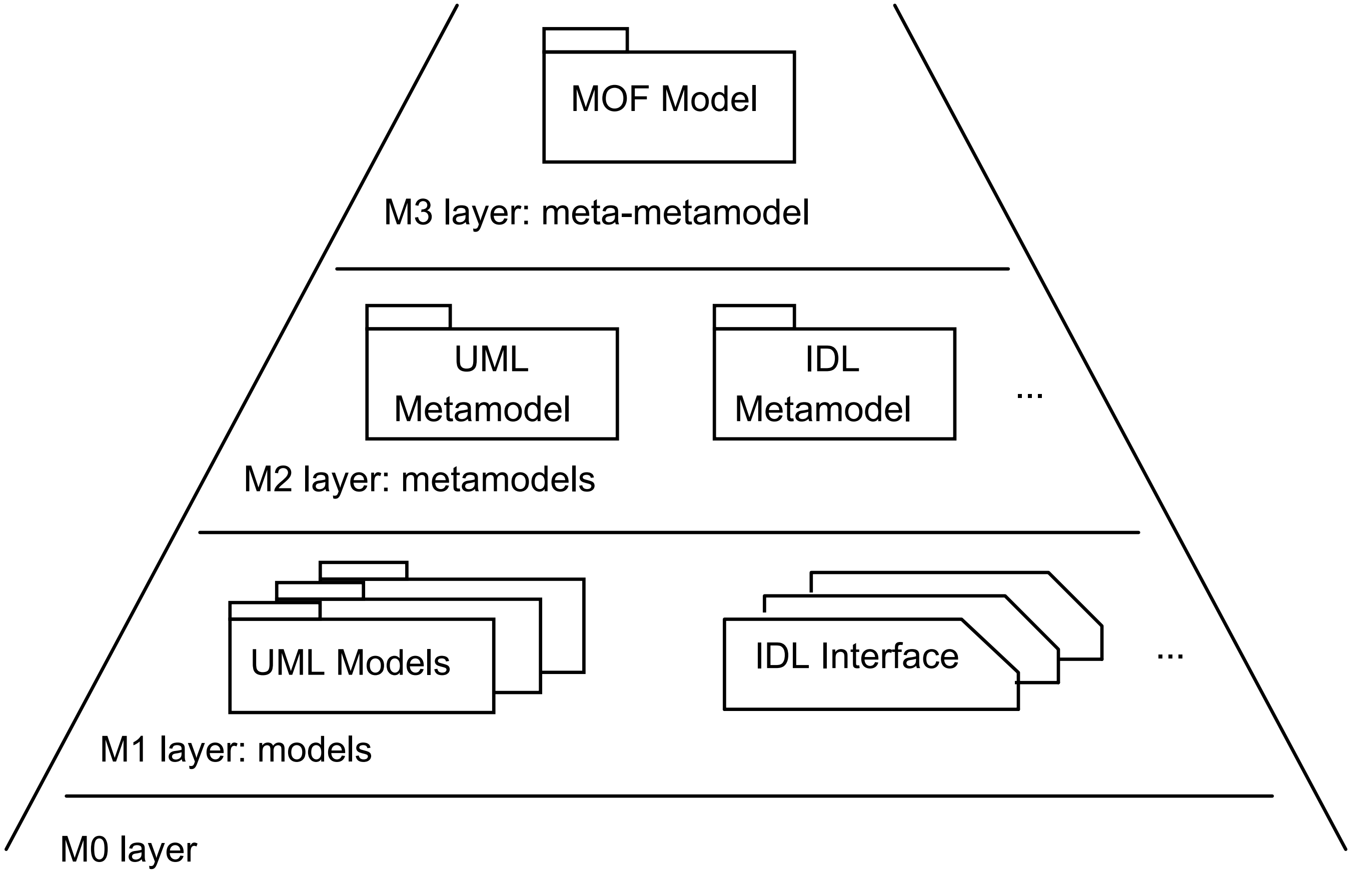
OCL

- Semiformal Constraint Language
- Part of the UML
- Supports invariants, pre and post conditions
- Constraints are defined for types / model elements:

```
context Company inv:
      self.numberOfEmployees > 50

context Person::income(d : Util::Date) : Integer
      post: result = 5000
```

Metamodeling



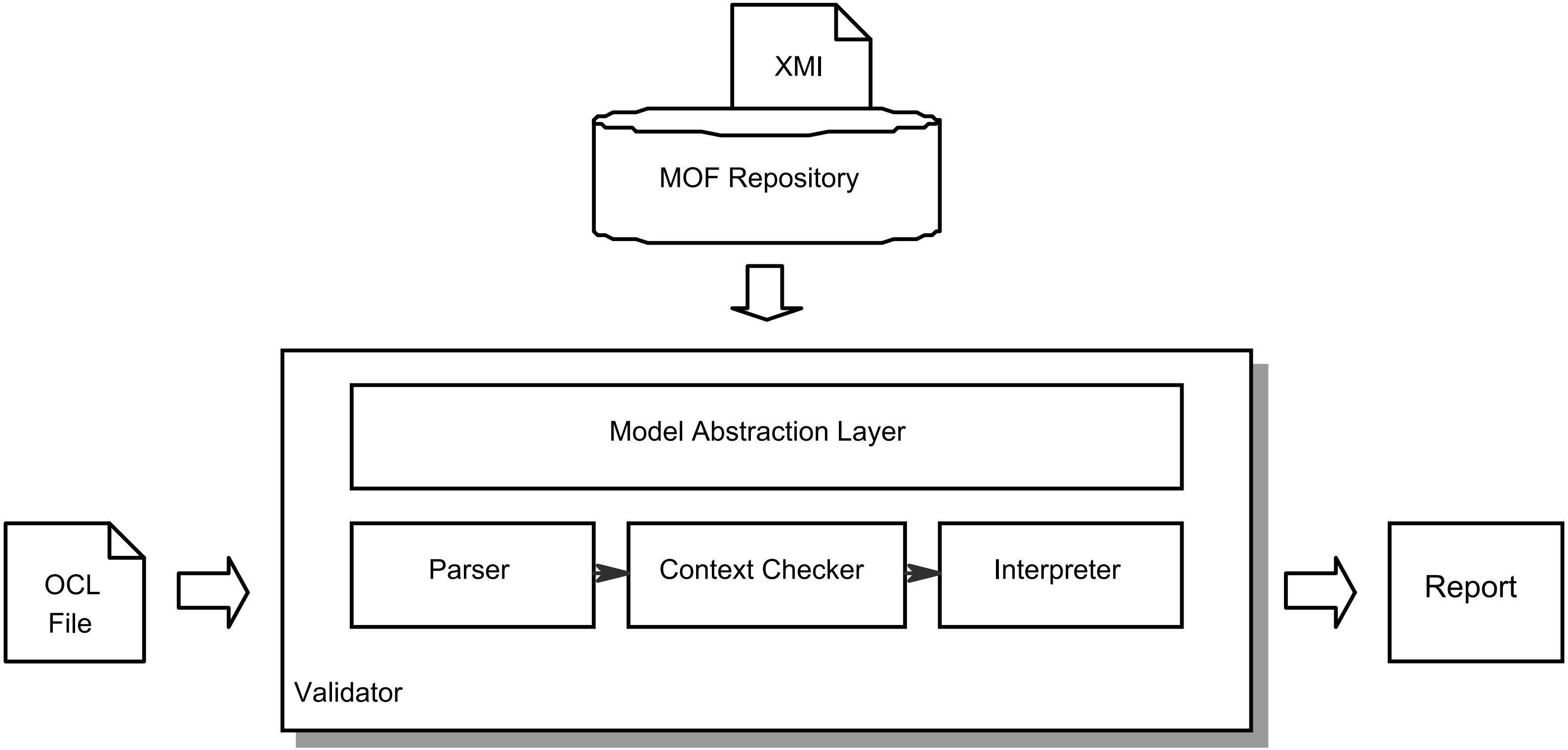
Connection: UML Profiles

- Extension system of UML
- Define additional constraints to the UML Metamodel
- Narrow models down to domain specific requirements
- Constraints described through OCL can be validated

Diploma Subject

- OCL expressions have to be interpreted in the context of UML Profiles and the UML-Metamodels 1.3 and 1.4.
- Therefore a „Parser“ has to be developed, which:
  - gets an UML model instance and an UML-Profile as input
  - and validates the adherence of the model to OCL constraints defined by the given UML-Profile

Architecture

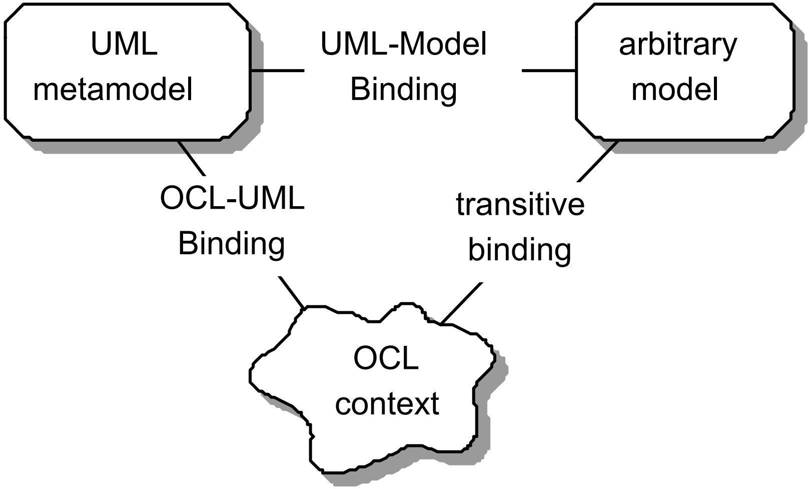


Model Interface

- Abstraction Layer to interpret OCL constraints in context of arbitrary models
- Designated to be implemented for MOF compliant metamodels
- Enables support of different versions of the UML Metamodel

The Interface‘s Basic Idea

- OCL is defined in the context of UML
- OCL augments its type system through model types via UML concepts (e.g. UML Classifier, Properties etc.).
- Description of these concepts in a model define the model‘s OCL semantics



Structure of the Model Interface

Facade describes the model on its:

- Type level:
  - Packages
  - Classifiers
  - Properties
- Instance level:
  - Instances
  - Reflective Properties for OCL meta level Operations

Parser

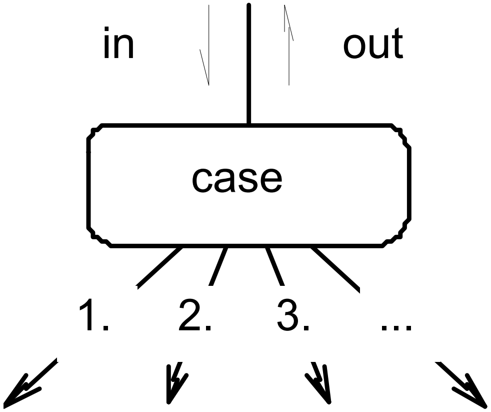
- OCL Grammar does not produce a LR-Language
- Changes to the grammar are necessary
- Choice of parser generator: SableCC
- Enlargement of the language is circumvent by concrete syntax
- New grammar is LALR(1), the parser accepts the same language

Context Checker

- OCL type system consists of predefined and model types
- Java Interfaces describe predefined types.
  - Instances implement these interfaces
  - Java Reflection API resolve the interface‘s properties.
  - This allows later changes to the OCL type system to be reflected
- Model types and their properties are resolved through the model interface

Visitor Pattern

- SableCC generates Parser and Visitors.
- When a Visitor visits a node in three phases:
  - – in … is called when entering a node
  - – case … lets the visitor visit the node‘s children
  - – out … is called when leaving a node



Type check

- Implementation of a static type check
- Usage of the Visitor-Pattern
- AST is traversed bottom-up from left to right by overriding out methods.
- Exceptions of this order are implemented by redefining case methods.
- Types are determined at the bottom of the tree and used in the parent nodes until the root is reached

Interpreter

- Corresponding to the type system there are predefined and model instances
- Predefined instances are implemented on the basis of the type interfaces
- Model instances delegate to the model interface

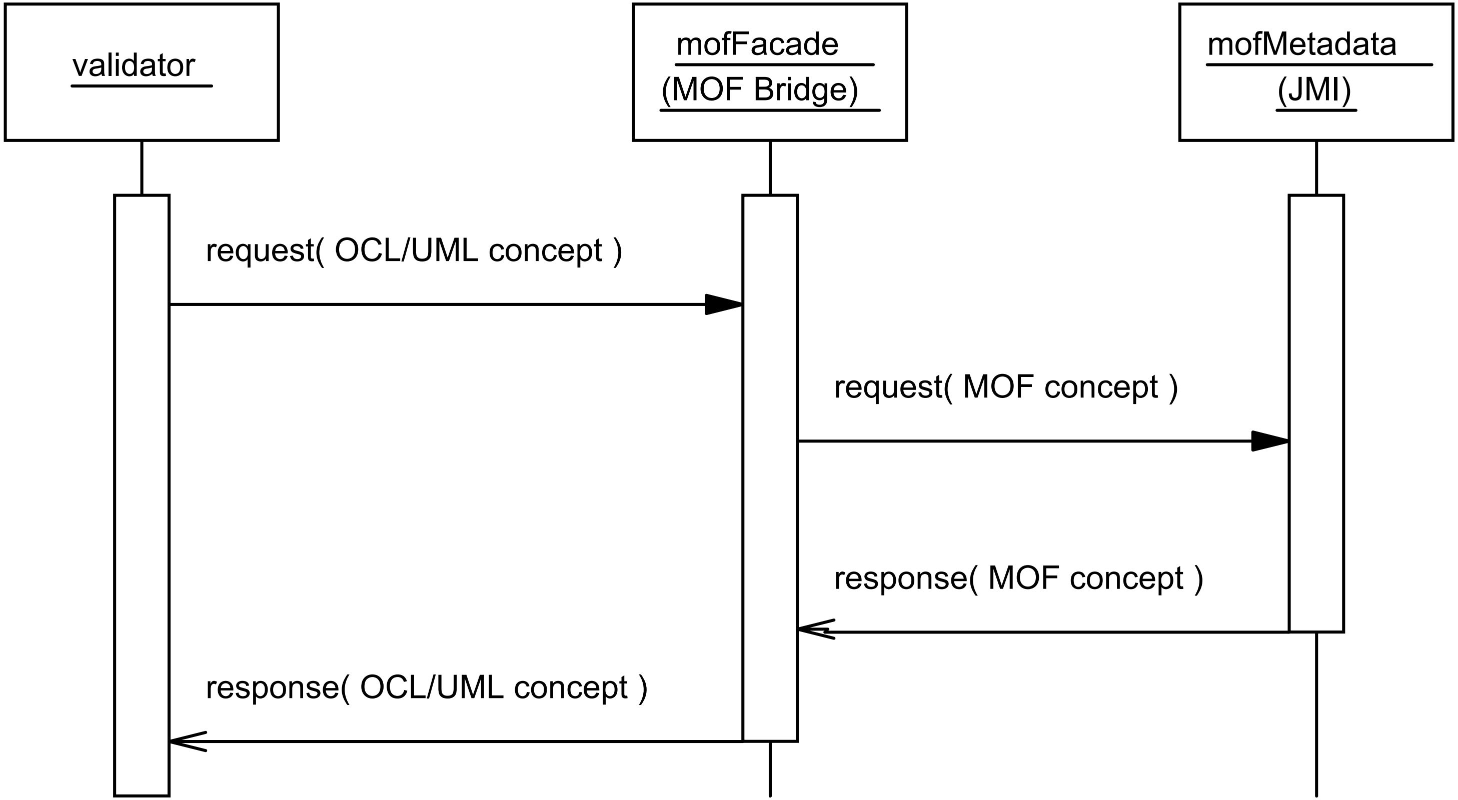
Evaluation

- Values are evaluated bottom-up from left to right.
- Constraints must be evaluated for every instance of a type
- The respective constraint holds if the root node evaluated to true

MOF Bridge

- Java Metadata Interface (JMI)
  - MOF Mapping for Java
  - MDR implementation supports import of metamodel over XMI
- JMI enables access to MOF compliant metamodels
- MOF Bridge connects the model interface with JMI

Sequence


validator
mofFacade
(MOF Bridge)
mofMetadata
(JMI)
request(OCL/UML concept)
request(MOF concept)
response(MOF concept)
response(OCL/UML concept)

What did we actually achieve?

- Concrete JMI technologies (e.g. MDR) represent the UML Metamodels 1.3 and 1.4 and its instances
- This representation is translated by the Abstraction Layer of the framework:
  - MOF to UML by the MOF Bridge
  - UML to OCL by the model interface and the framework
- OCL semantics are stipulated for the UML Metamodels.
- Constraints can now be validated by the framework

By-Products

The Abstraction Layer of the framework facilitates:

- Support of OCL for arbitrary models
- Support of OCL for MOF compliant metamodels
- The definition of a general OCL tool interface

Conclusion: Summary 1

- Presentation of UML Profiles and the subject of the diploma thesis
- Model interface
  - Basic Idea
  - Type and instance level
- Parser
  - Changes to the grammar, LALR(1)

Conclusion: Summary 2

- Context Checker
  - Implementation of the type level
  - Description of the static type check algorithm
- Interpreter
  - Implementation of the instance level
  - Description of the evaluation algorithm
- MOF Bridge
  - JMI