UNIVERSITÄT KOBLENZ · LANDAU

(Towards) a megamodel of the ATL model transformation language and toolkit

Ralf Lämmel
Software Languages Team, University of Koblenz-Landau
Joint work with Jean-Marie Favre (Visiting Researcher at Softlang)
and Martin Leinberger, Thomas Schmorleiz, and Andrei Varanovich

http://softlang.wikidot.com/

Preamble

Ralf Lämmel introduced

- W3 Professor of CS at University of Koblenz-Landau
- Leader of the Software Languages Team @ Koblenz
- Co-founder of SLE conference series
- Co-founder of GTTSE summer school series
- *Previous jobs*: MSFT, VU (A'dam), CWI, Uni Rostock
- *Interests*: languages, grammars, software language engineering, software linguistics, transformations, automation, lambdas, programs, technologies, understanding, ...

Topics for collaboration

- Megamodeling (today)
- API analysis and migration
- Software language comprehension
- Software technology comprehension

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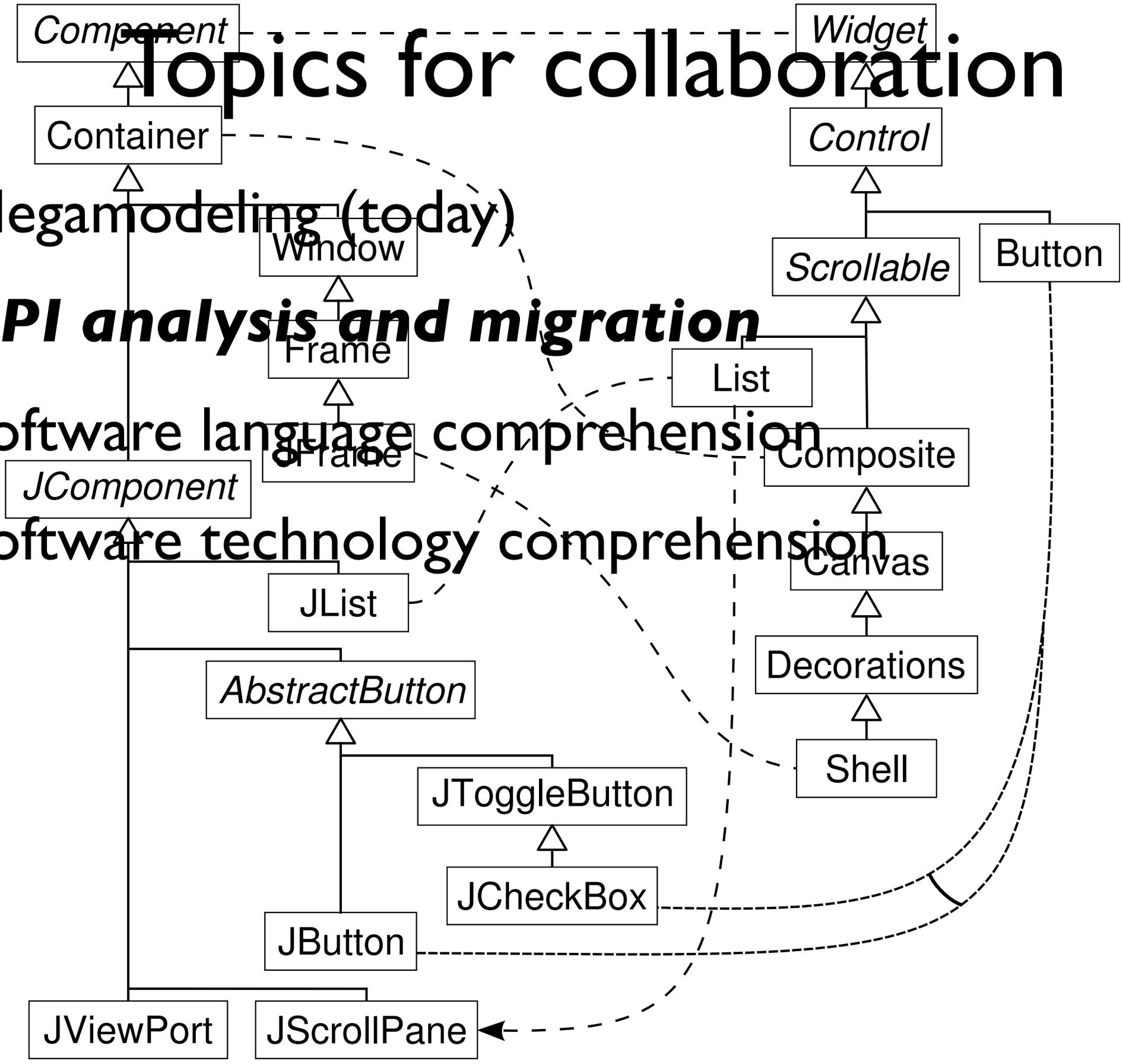
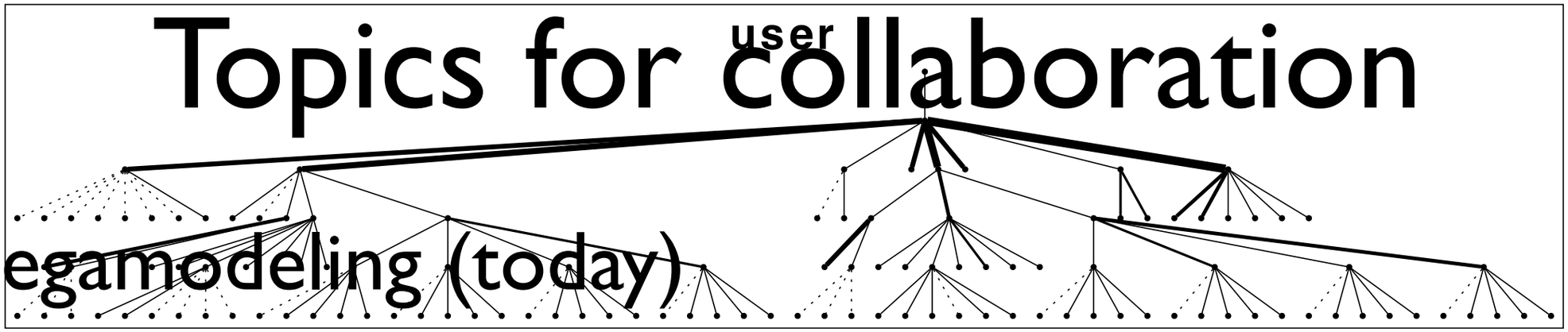


Topics for collaboration



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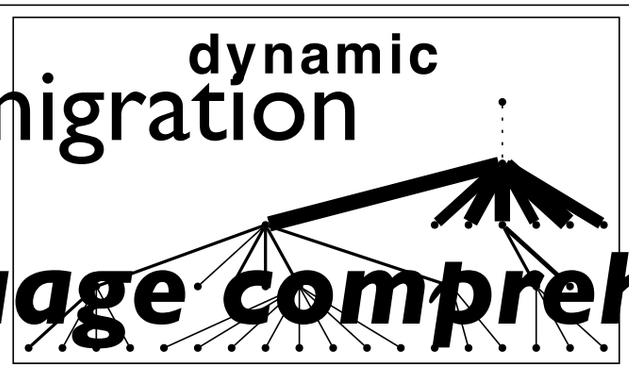
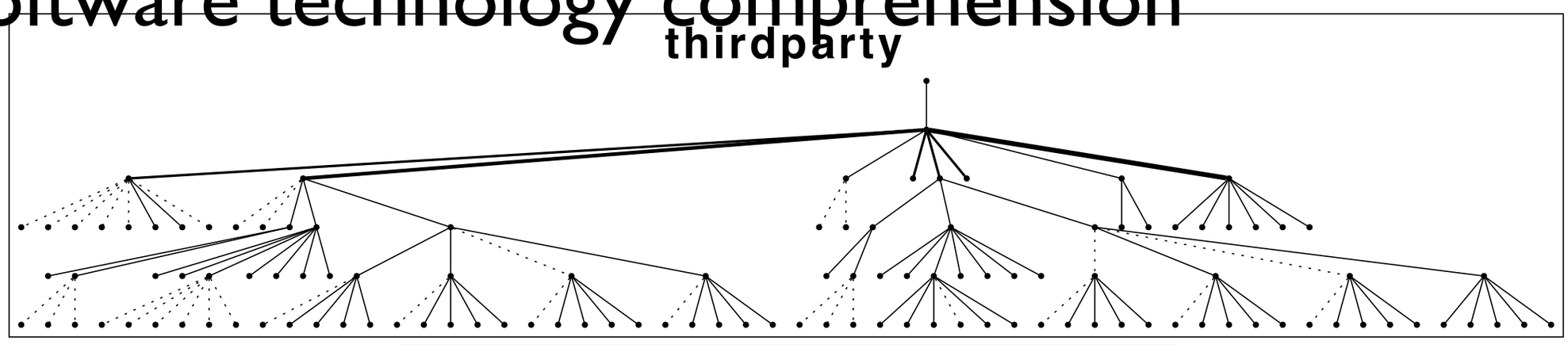
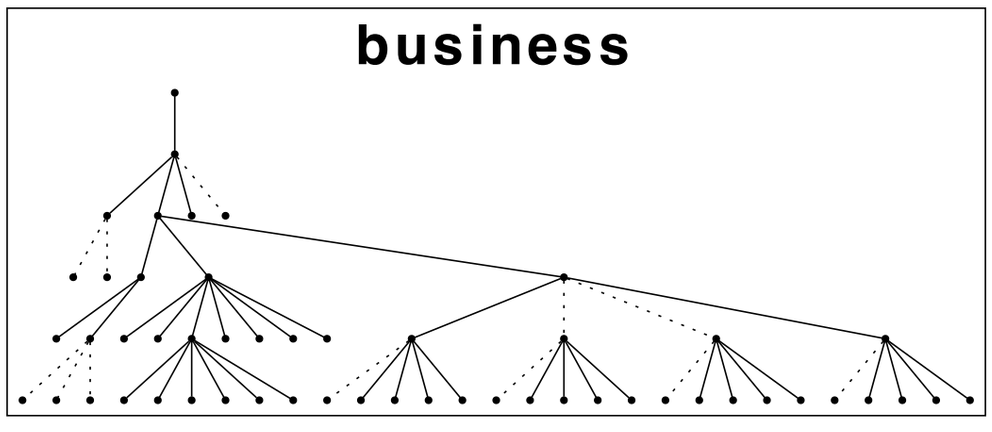


- ***Software language comprehension***
- Software technology comprehension





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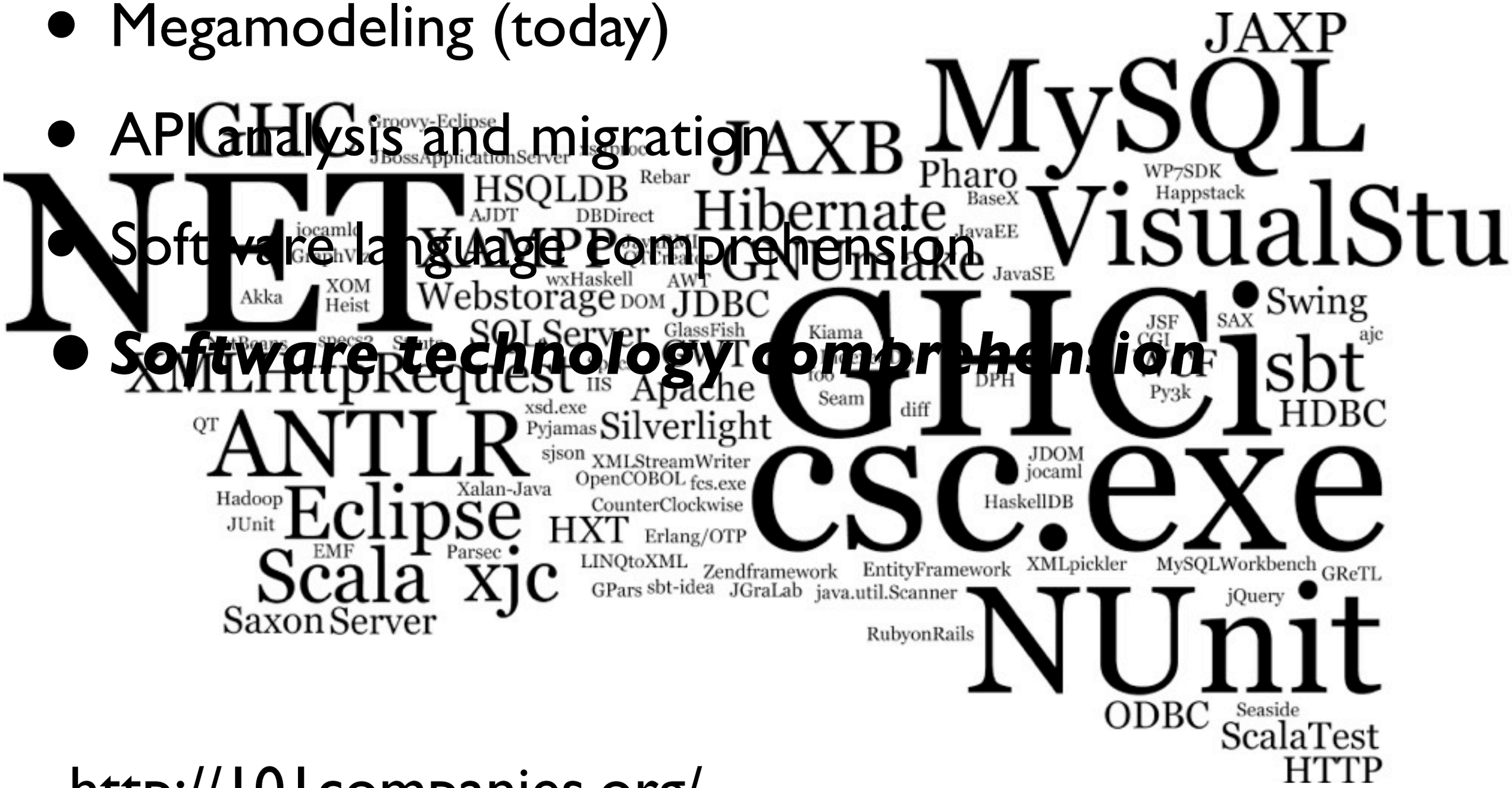

http://101companies.org/

Collaboration indicators

```
$ pwd
/Users/laemmel/projects/misc/talks/120215-nantes/dl
$ ls
BridgingEclipseMicrosoftModeling.pdf      MoScript.pdf
ComparisonOfModelMigrationTools.pdf       ModelRefinmentByTransformation.pdf
CorrectATL.pdf                            OnModelTyping.pdf
GeneralCompositionSemantics.pdf           TraceabilityWebApplications.pdf
ImprovingHigherOrderInATL.pdf             TypingArtifactsInMegamodeling.pdf
IncrementalExecutionATL.pdf               TypingInModelManagement.pdf
LazyATLPaperModels2011.pdf
```

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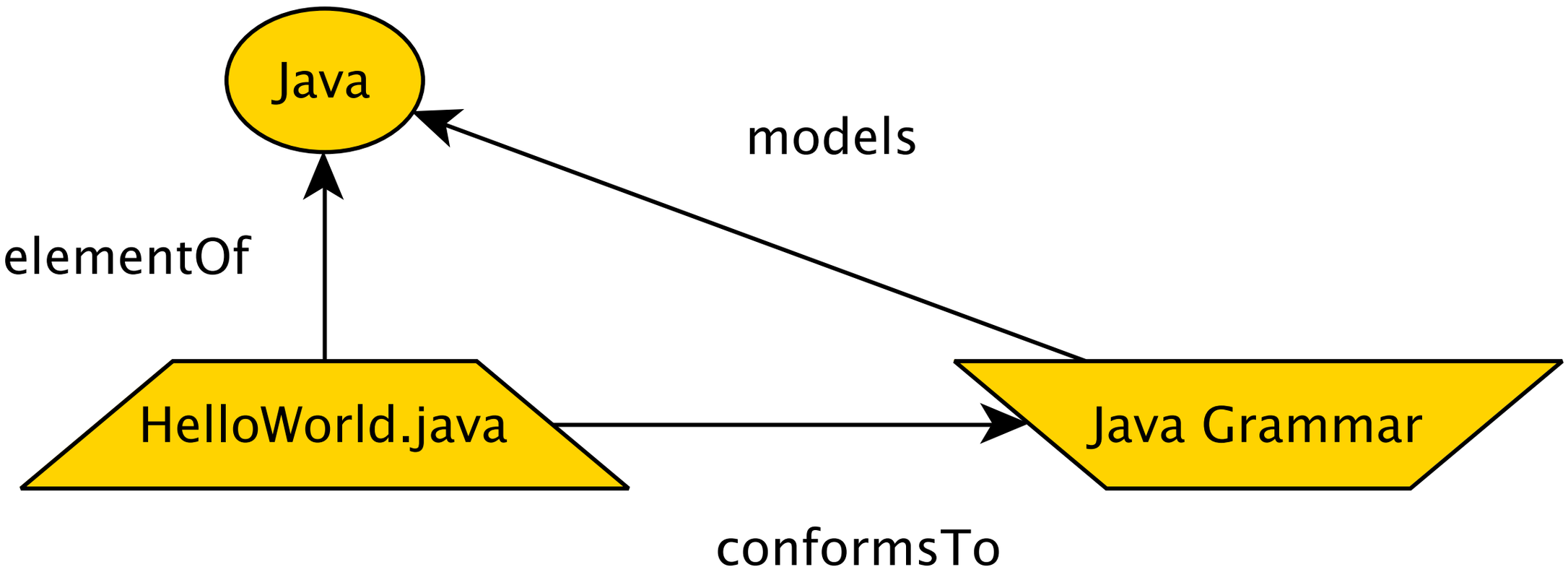
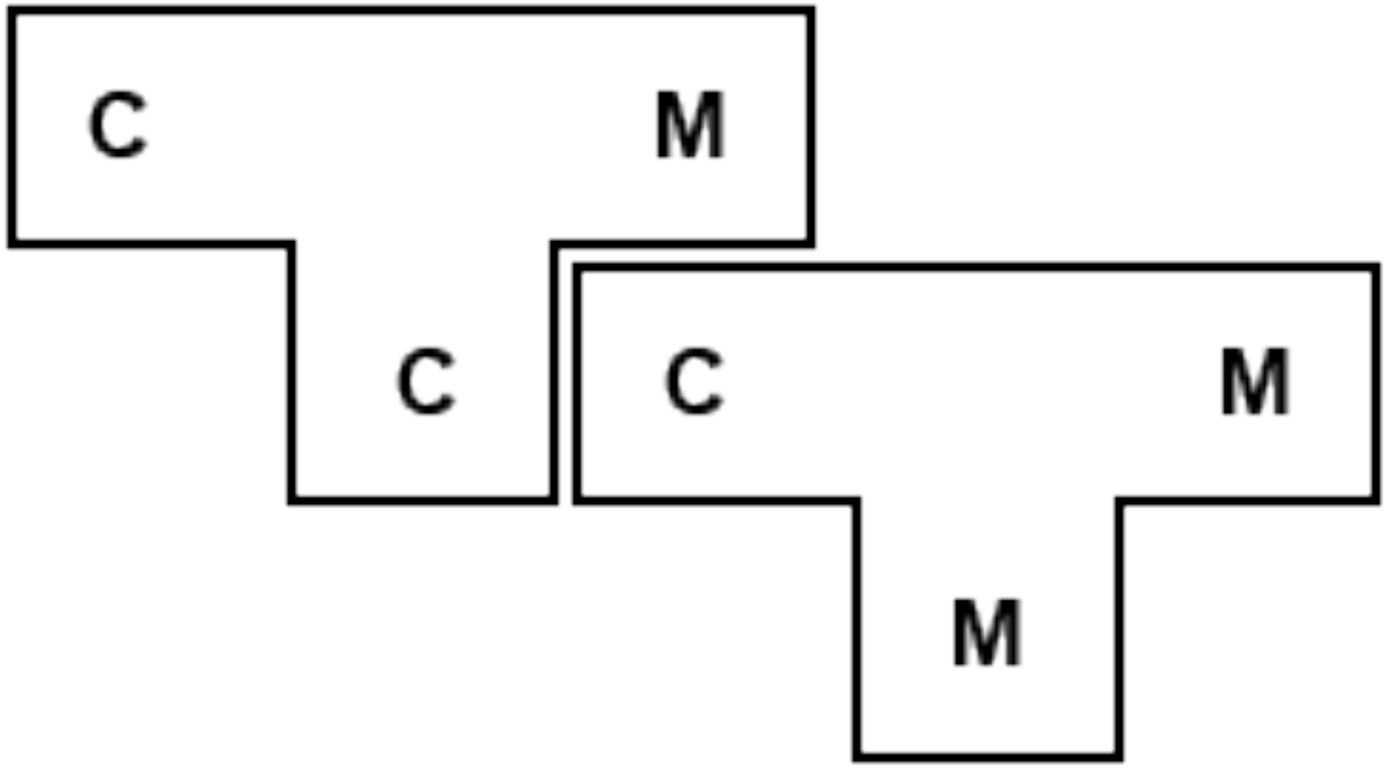
What's a megamodel?



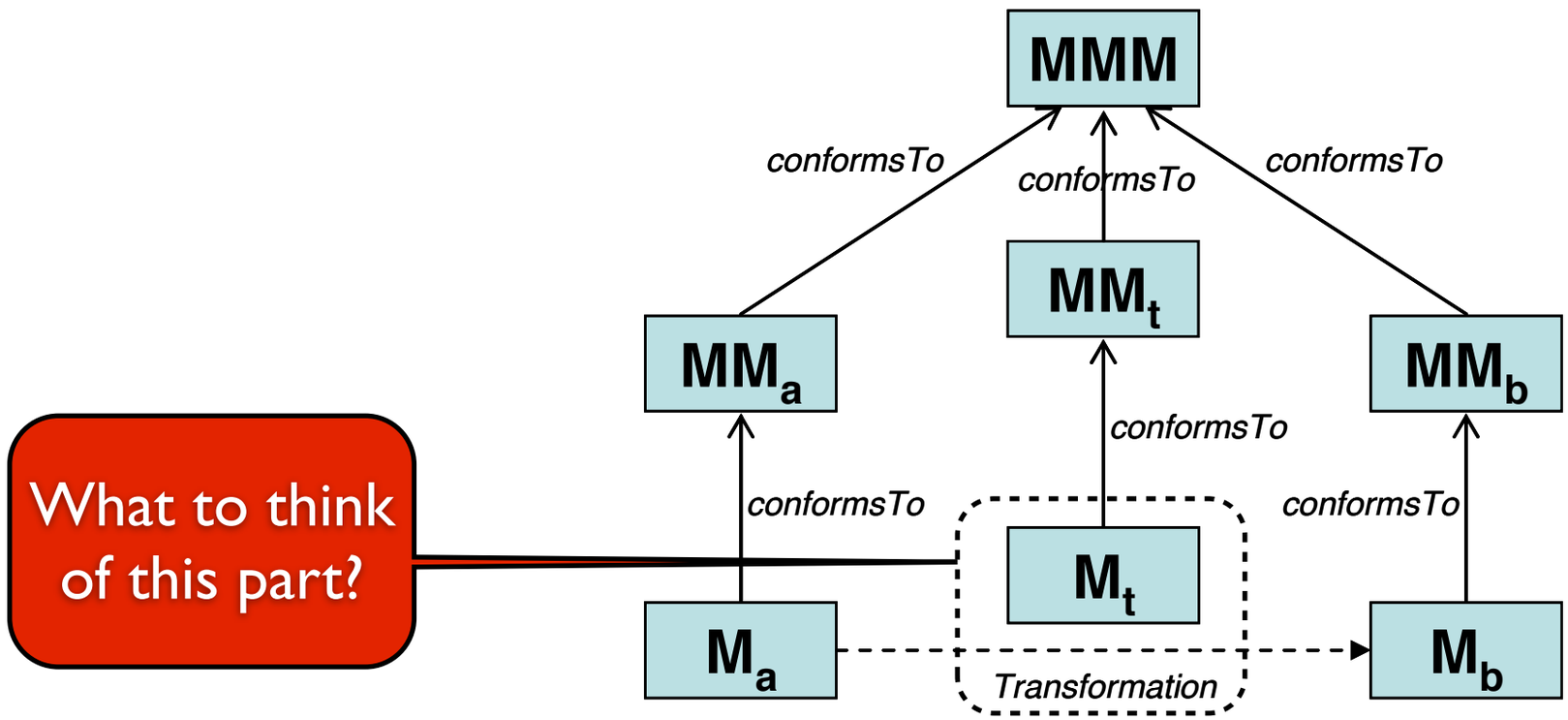
JMF style; see the pyramids papers.

That's a megamodel, too!



http://en.wikipedia.org/wiki/Tombstone_diagram

Yet another megamodel!

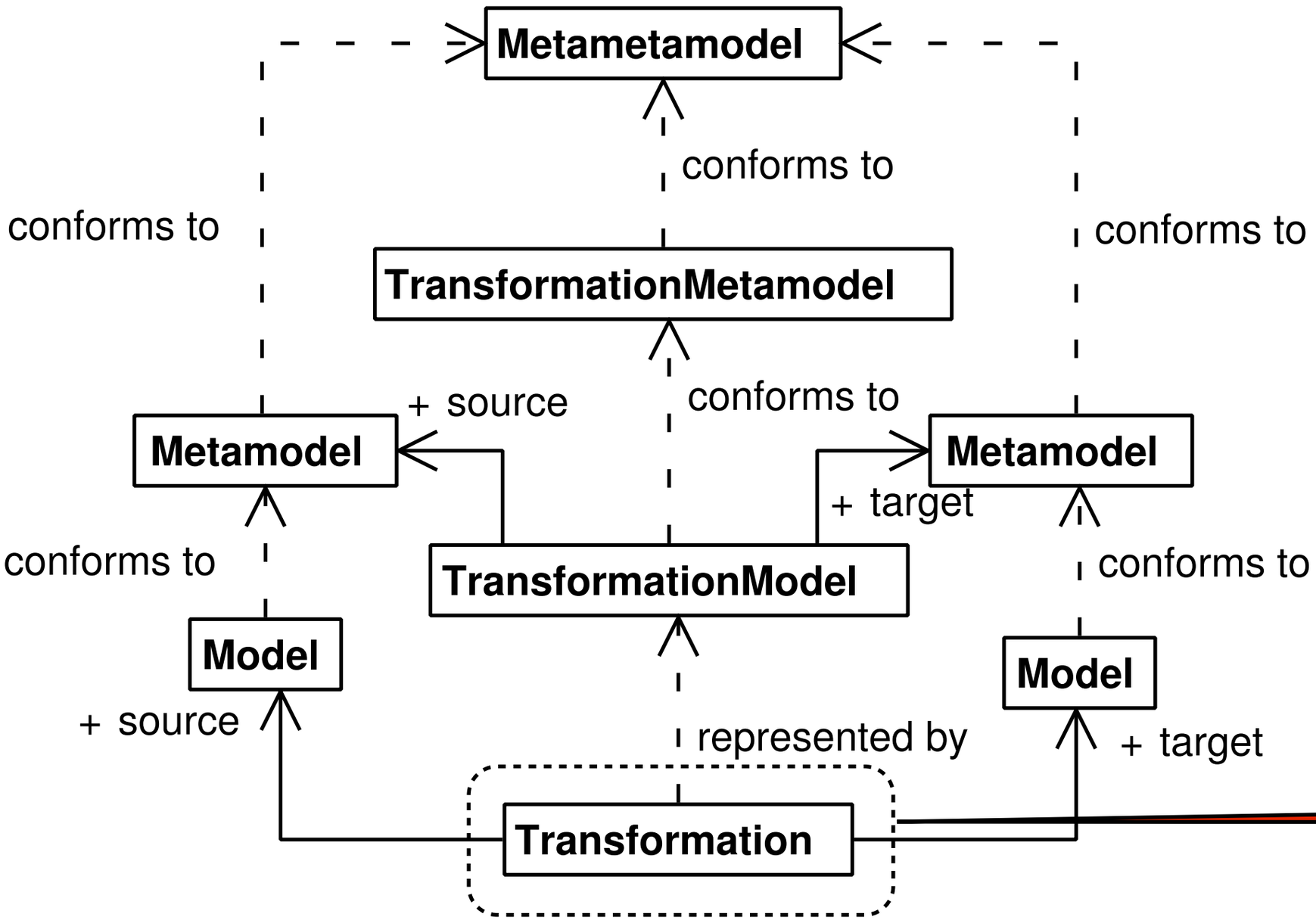


What to think of this part?

Model transformations with ATL

http://wiki.eclipse.org/ATL/Concepts#Model_Transformation

That's nearly the same megamodel.

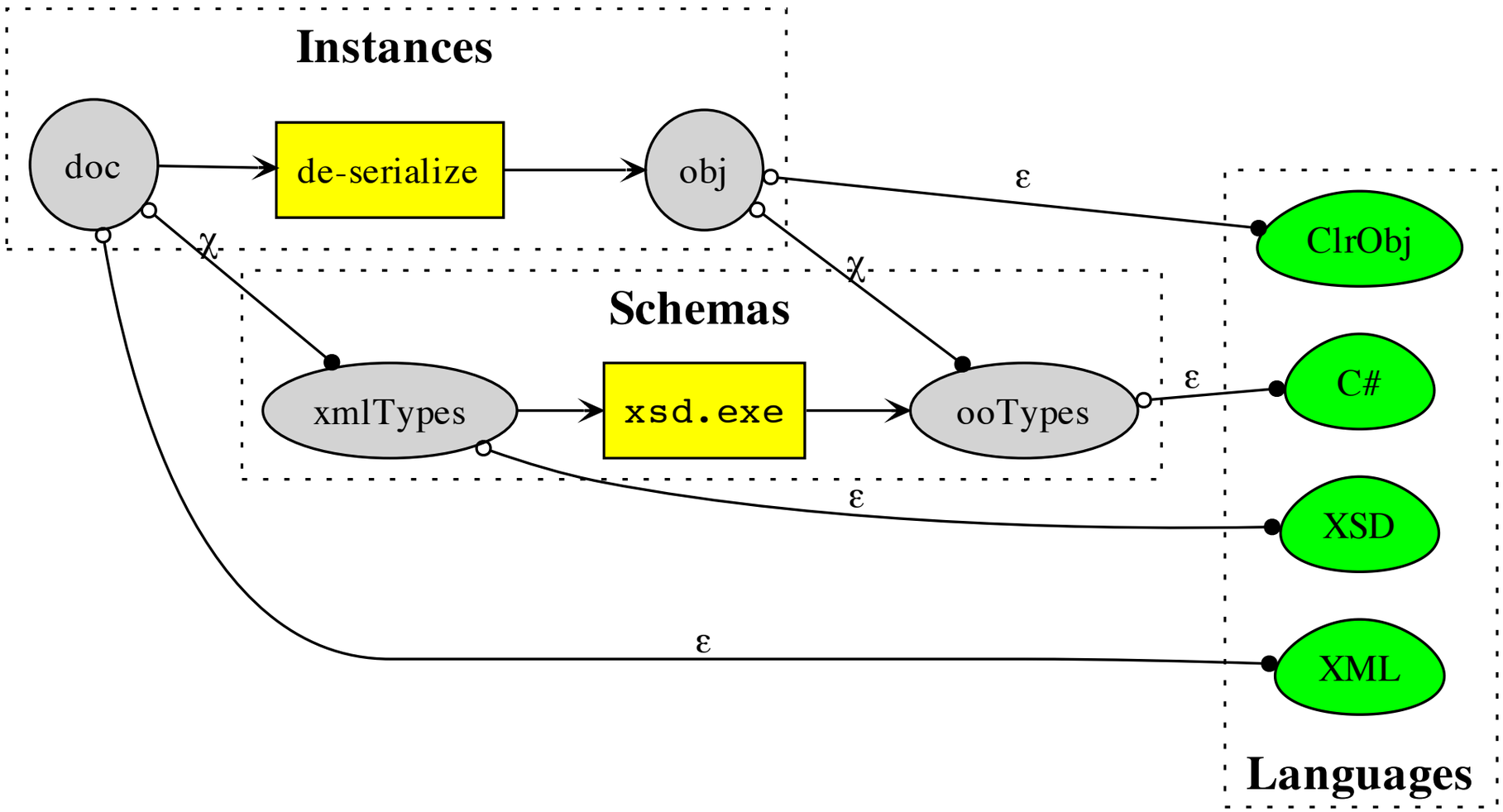


Model transformations

Is this is a function or an application thereof?

Bas Graaf: *Model-Driven Evolution of Software Architectures*, Dissertation, Delft University of Technology, 2007.

Different example. Different notation.



Object/XML mapping with xsd.exe

http://softlang.uni-koblenz.de/mega/

Research questions

- Can we do ***heavy lifting*** with megamodeling?
- Does a ***general megamodeling language*** exist?
  - What are the ***entities*** of linguistic architecture?
  - What are the ***relationships*** of interest?
  - (What is a good visual syntax?)
- How to ***validate megamodels***?

Heavy lifting with megamodeling

Claim by this speaker:

Megamodeling lifts heavily once it can explain, for example, ***Object/Relational/XML mapping*** *at a high level of abstraction in a comprehensible and falsifiable manner.*

More generally, megamodeling must help with managing diversity and heterogeneity of software technologies.

Thanks to Jean-Marie Favre for this cool slide*!*

We have a problem.

XPATH TXL Sesame JPA
Jena Rose JDBC EMF.gen XText
jDOM JAXB Jersey RDF(S) UTF8 Jena ODM
MOF
XSD JeanBeans Teneo
UML VLDB
Stratego BNF
xerces GWT SLE2010 Json
OCL sax Ralf
RDFS OWL saxon OWL
Ecore
Rest
MySQL XMI ORACLE RDF Jean OMG
JMI EMF JMF
XSD ArgoUML
xalan ODBC SparQL XMLSpy Yacc RDFa
LALR Prolog
XSLT JAXP Protegé
CFG SBVR DOM Java ATOM ER
SQL DDL Dragan SQL
Antlr QVT
TENEO XLST
Awk DTD
sed Saxon TCS
grep ASCII XSD
Hibernate XQuery

Issues with software technologies

- **Silos of knowledge**
- **Combining technologies**
- **Complexity of technologies**
- **Entering a new space**
- **Teaching technologies**

Issues with software technologies

- **Silos of knowledge**
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In need of ...

- **analogies**
- **examples**
- **abstractions**

Analogies, examples, abstractions

	Modelware	*XMLware*	*Ontoware*	*Tableware*	*Grammarware*
Meta language	MOF	XSD	RDFS	SQL.DDL	EBNF
Navigation	OCL	XPath			
Query		XQuery	SPARQL	SQL	
Transfo.	QVT	XSLT			TXL ASF
Toolkit	ArgoUML Rose	XMLSpy VS-XML	Protégé Topbeard	MySQL Oracle	MetaEnv.
Conferences	MoDELS ECMDA	XML VLDB	ICSW ESWC	VLDB SIGMOD	CC POPL

Analogies, **examples**, abstractions

Total salaries

Cut salaries

```
company "meganalysis" {
    department "Research" {
        manager "Craig" {
            address "Redmond"
            salary 123456
        }
        employee "Erik" {
            address "Utrecht"
            salary 12345
        }
        employee "Ralf" {
            address "Koblenz"
            salary 1234
        }
    }
    department "Development" {
        manager "Ray" {
            address "Redmond"
            salary 234567
        }
```

Persist companies

Parallelize operations

•••

Analogies, examples, **abstractions**

- What's the taxonomy of technologies?
- What's the **essence** of technology *xyz*?

This is where megamodeling kicks in!

Towards a general megamodeling language

Entities of megamodels

- Sets
  - Languages
  - Domains
  - Relations
    - e.g., meanings of models
    - Functions
      - e.g., meaning of tools
- Elements
  - Strings, trees, graphs
  - Models (values, instances)
  - Metamodels (types, schemas)
  - Pairs (related elements)
- Singletons
  - Tools
  - Other "black boxes"

Relationships of megamodels

- Membership ("elementsOf")
- Conformance ("conformsTo")
- Modeling ("models" / "representationOf")
- Correspondence ("correspondsTo")
- Reference ("refersTo")
- ...

The black hole of modeling.

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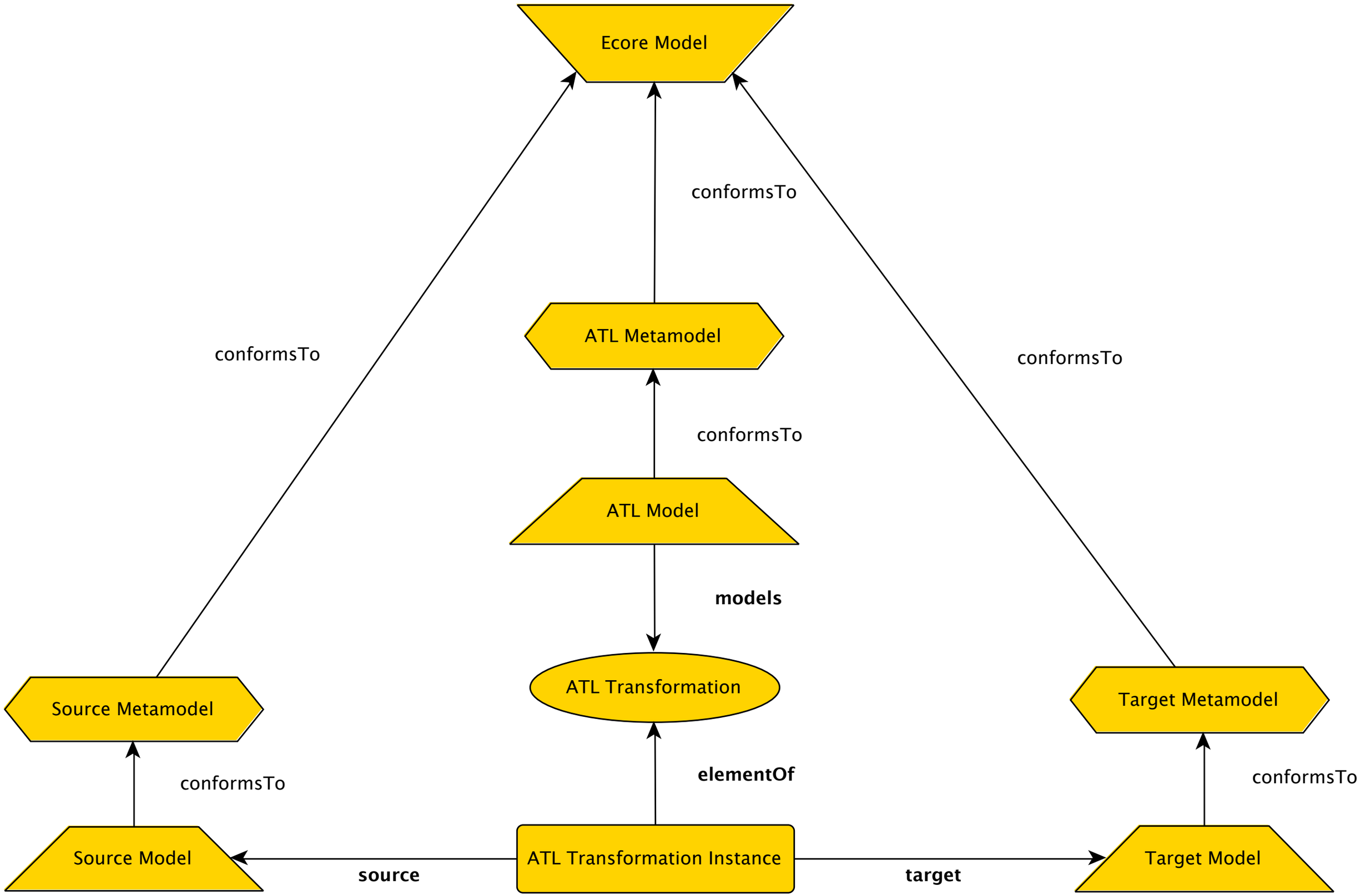
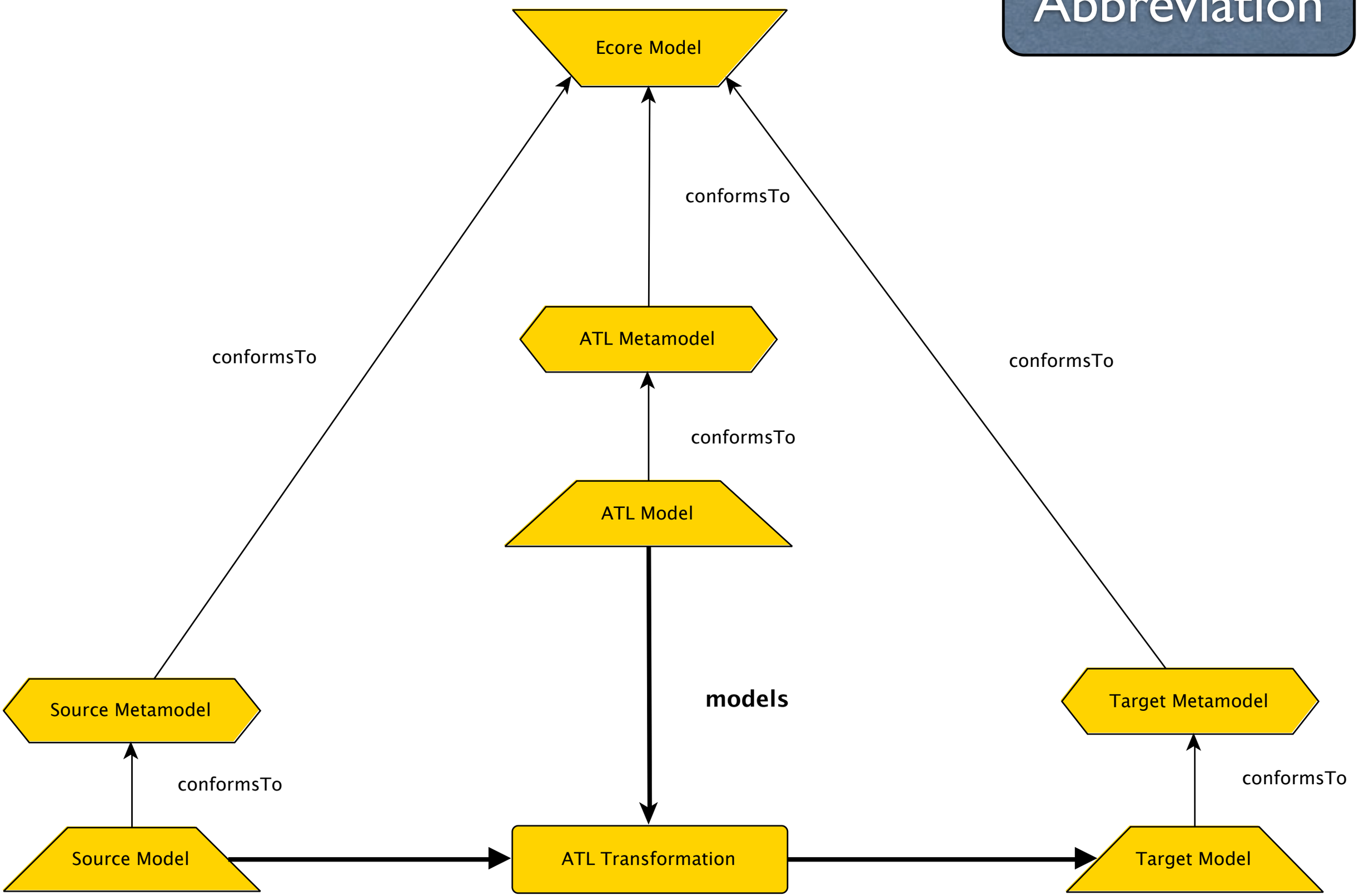
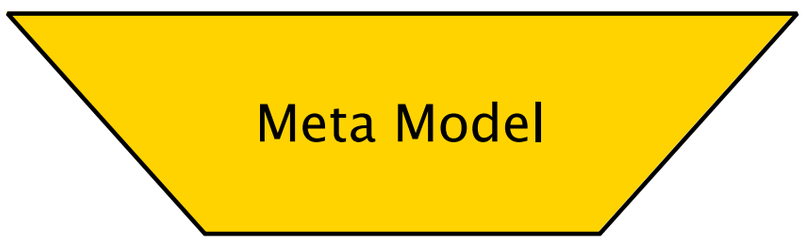
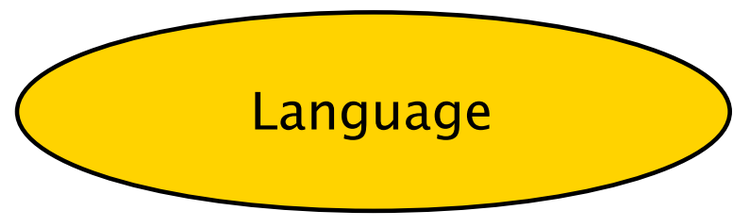


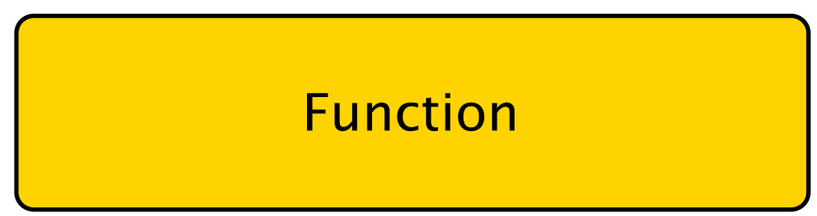
Abbreviation

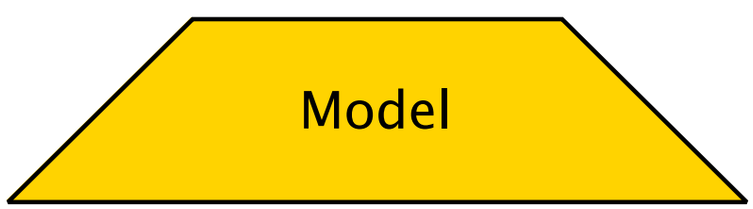


Legend





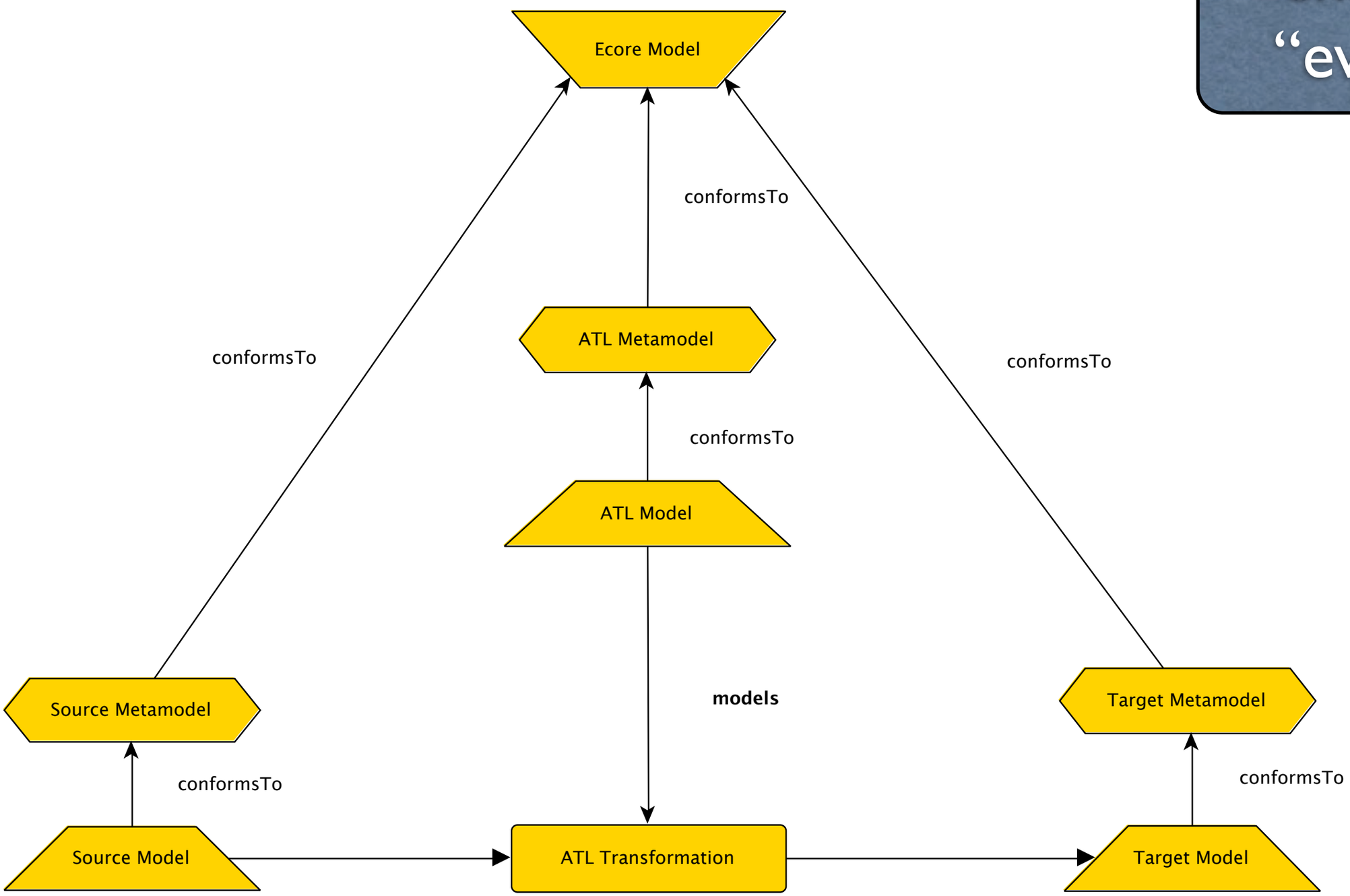


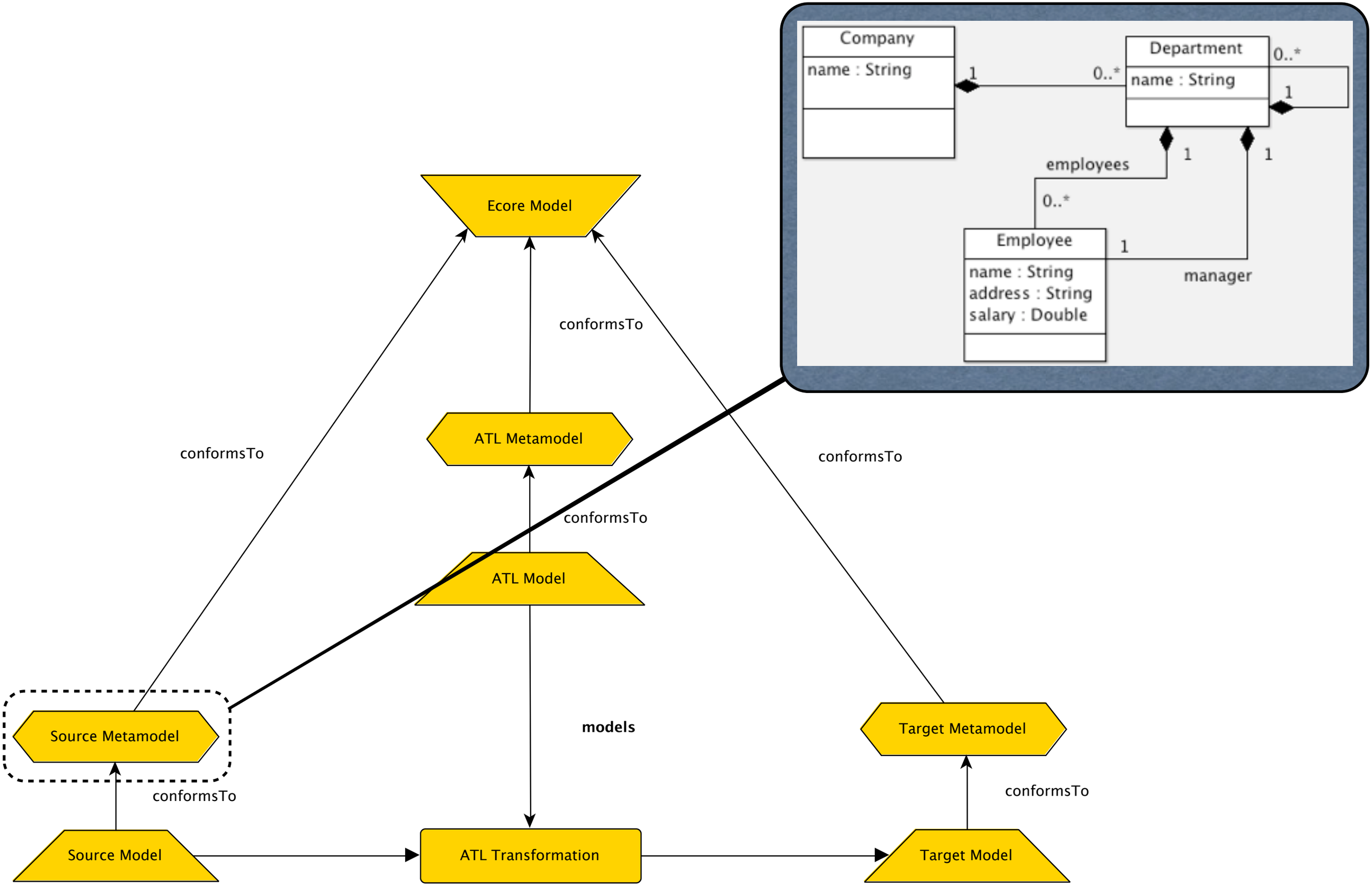


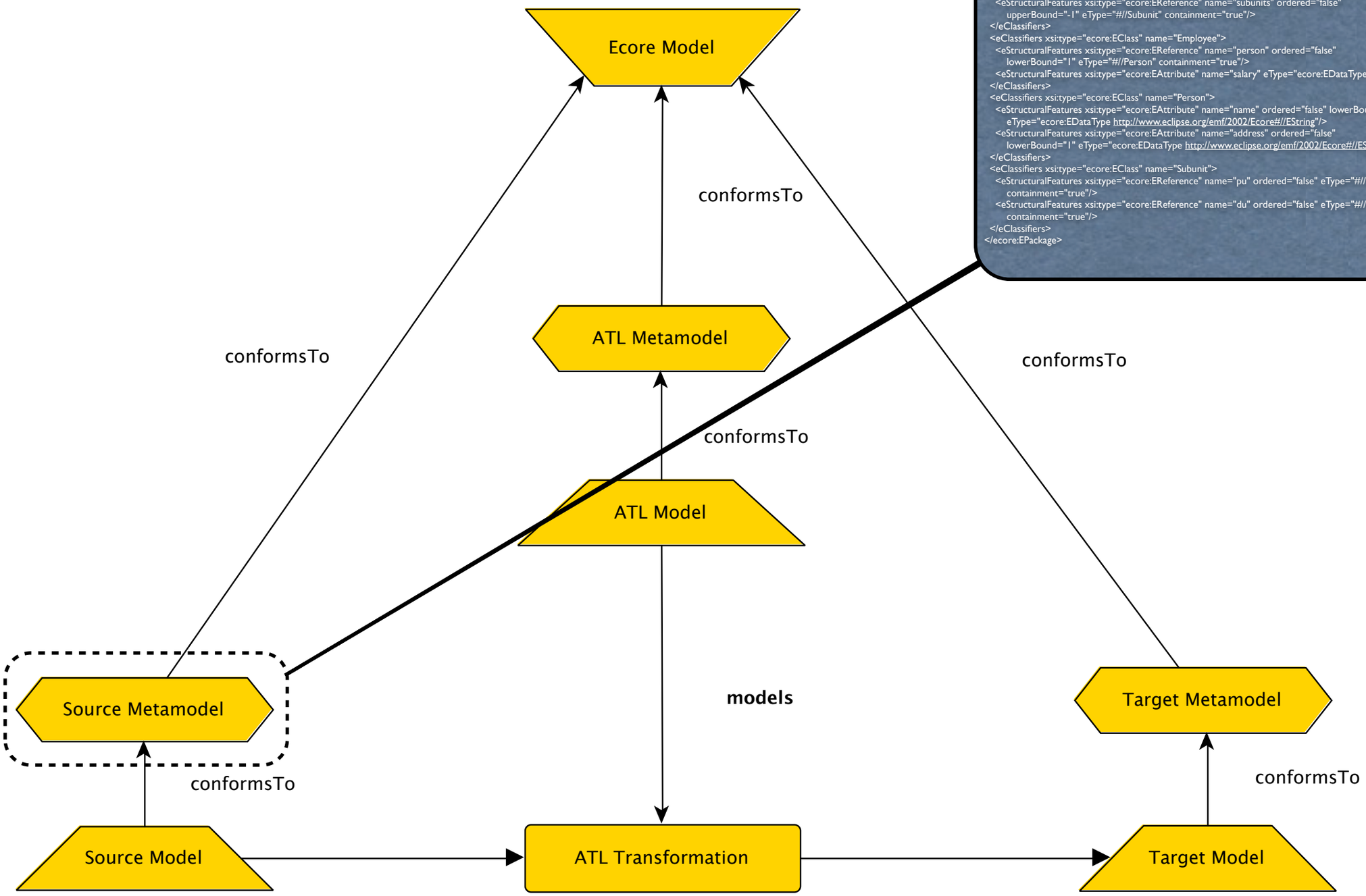
Validation of megamodels:

How to know that we understand?

Associate each entity with "evidence".








```
<?xml version="1.0" encoding="UTF-8"?>
<ecore:EPackage xmi:version="2.0"
    xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore" name="company"
    nsURI="http://www.company.com" nsPrefix="">
  <eClassifiers xsi:type="ecore:EClass" name="Company">
    <eStructuralFeatures xsi:type="ecore:EReference" name="depts" ordered="false"
        upperBound="-1" eType="#//Dept" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Dept">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name" ordered="false" lowerBound="1"
        eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="manager" ordered="false"
        lowerBound="1" eType="#//Employee" containment="true"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="subunits" ordered="false"
        upperBound="-1" eType="#//Subunit" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Employee">
    <eStructuralFeatures xsi:type="ecore:EReference" name="person" ordered="false"
        lowerBound="1" eType="#//Person" containment="true"/>
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="salary" eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EDouble"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Person">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name" ordered="false" lowerBound="1"
        eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="address" ordered="false"
        lowerBound="1" eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Subunit">
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        containment="true"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="du" ordered="false" eType="#//Dept"
        containment="true"/>
  </eClassifiers>
</ecore:EPackage>
```

```
<?xml version="1.0" encoding="UTF-8"?>
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    xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore" name="company"
    nsURI="http://www.company.com" nsPrefix="">
  <eClassifiers xsi:type="ecore:EClass" name="Company">
    <eStructuralFeatures xsi:type="ecore:EReference" name="depts" ordered="false"
        upperBound="-1" eType="#//Dept" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Dept">
    <eStructuralFeatures xsi:type="ecore:EAttribute" name="name" ordered="false" lowerBound="1"
        eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="manager" ordered="false"
        lowerBound="1" eType="#//Employee" containment="true"/>
    <eStructuralFeatures xsi:type="ecore:EReference" name="subunits" ordered="false"
        upperBound="-1" eType="#//Subunit" containment="true"/>
  </eClassifiers>
  <eClassifiers xsi:type="ecore:EClass" name="Employee">
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        lowerBound="1" eType="#//Person" containment="true"/>
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        eType="ecore:EDataType http://www.eclipse.org/emf/2002/Ecore#//EString"/>
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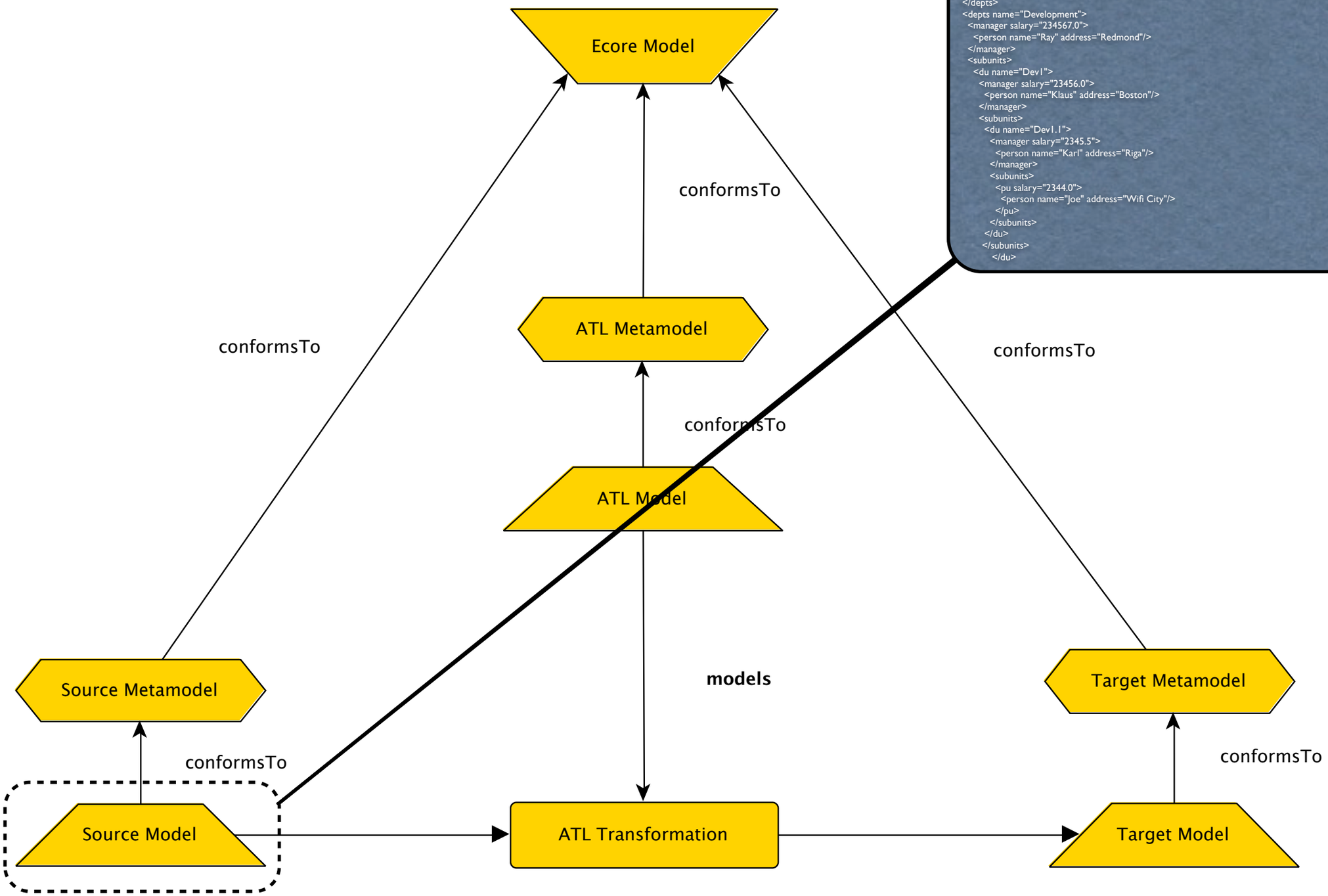
```




```
<?xml version="1.0" encoding="ISO-8859-1"?>
<Company xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI" xmlns="http://www.company.com">
 <depts name="Research">
  <manager salary="123456.0">
   <person name="Craig" address="Redmond"/>
  </manager>
  <subunits>
   <pu salary="12345.0">
    <person name="Erik" address="Utrecht"/>
   </pu>
  </subunits>
  <subunits>
   <pu salary="1234.0">
    <person name="Ralf" address="Koblenz"/>
   </pu>
  </subunits>
 </depts>
 <depts name="Development">
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   <person name="Ray" address="Redmond"/>
  </manager>
  <subunits>
   <du name="Dev1">
    <manager salary="23456.0">
     <person name="Klaus" address="Boston"/>
    </manager>
    <subunits>
     <du name="Dev1.1">
      <manager salary="2345.5">
       <person name="Karl" address="Riga"/>
      </manager>
      <subunits>
       <pu salary="2344.0">
        <person name="Joe" address="Wifi City"/>
       </pu>
      </subunits>
     </du>
    </subunits>
     </du>
```

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<?xml version="1.0" encoding="ISO-8859-1"?>
<Company xmi:version="2.0" xmlns:xmi="http://www.omg.org/XMI" xmlns="http://www.company.com">
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      </pu>
    </subunits>
    <subunits>
      <pu salary="1234.0">
        <person name="Ralf" address="Koblenz"/>
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    </subunits>
  </depts>
  <depts name="Development">
    <manager salary="234567.0">
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    </manager>
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        </manager>
        <subunits>
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            <manager salary="2345.5">
              <person name="Karl" address="Riga"/>
            </manager>
            <subunits>
              <pu salary="2344.0">
                <person name="Joe" address="Wifi City"/>
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            </subunits>
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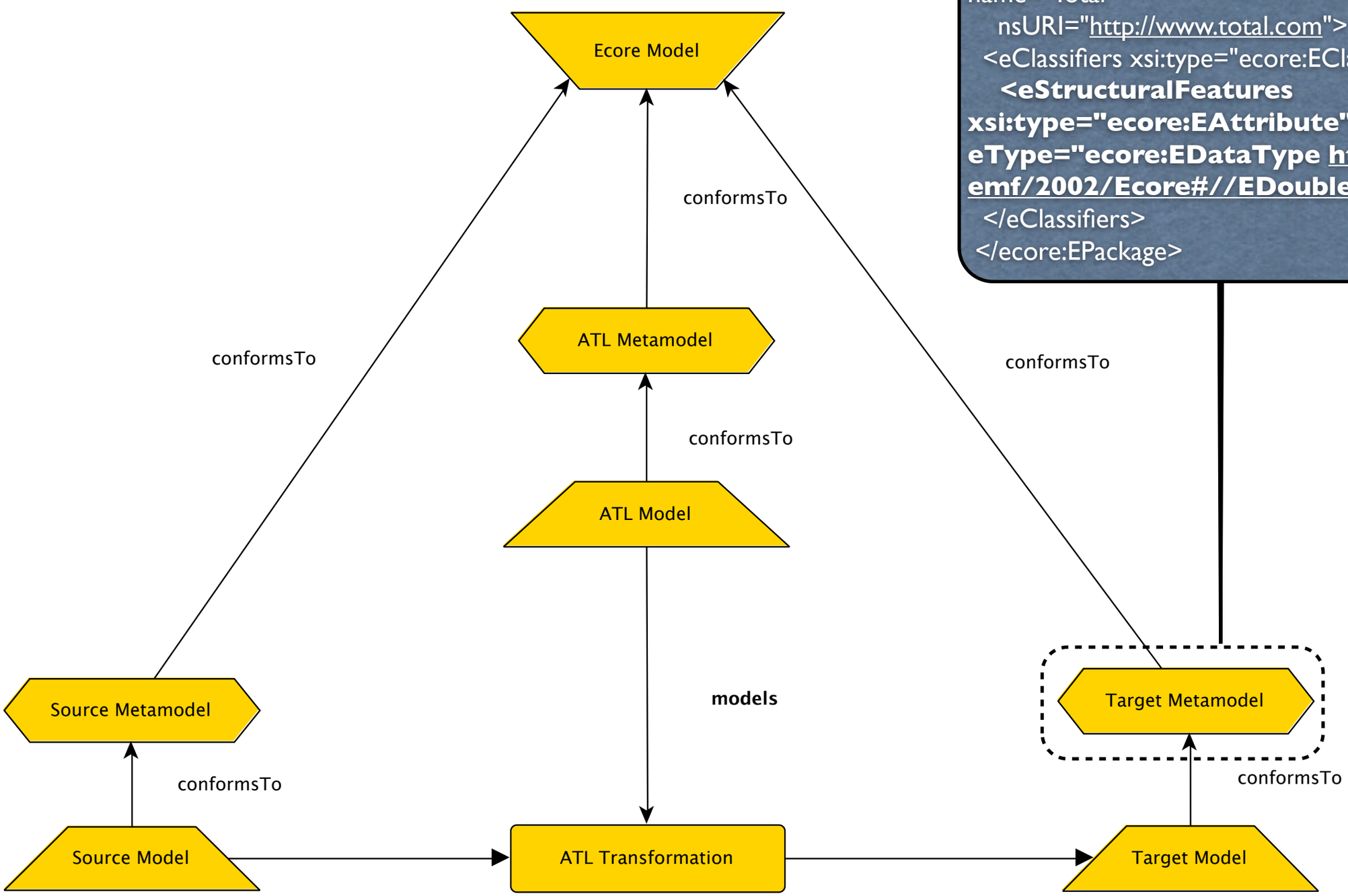
        </subunits>
      </du>
    </subunits>
  </depts>
</Company>
```




```
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<ecore:EPackage xmi:version="2.0"
    xmlns:xmi="http://www.omg.org/XMI" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance"
    xmlns:ecore="http://www.eclipse.org/emf/2002/Ecore"
name="Total"
    nsURI="http://www.total.com">
  <eClassifiers xsi:type="ecore:EClass" name="TotalWrapper">
    <eStructuralFeatures
xsi:type="ecore:EAttribute" name="total"
eType="ecore:EDataType http://www.eclipse.org/
emf/2002/Ecore#//EDouble"/>
  </eClassifiers>
</ecore:EPackage>
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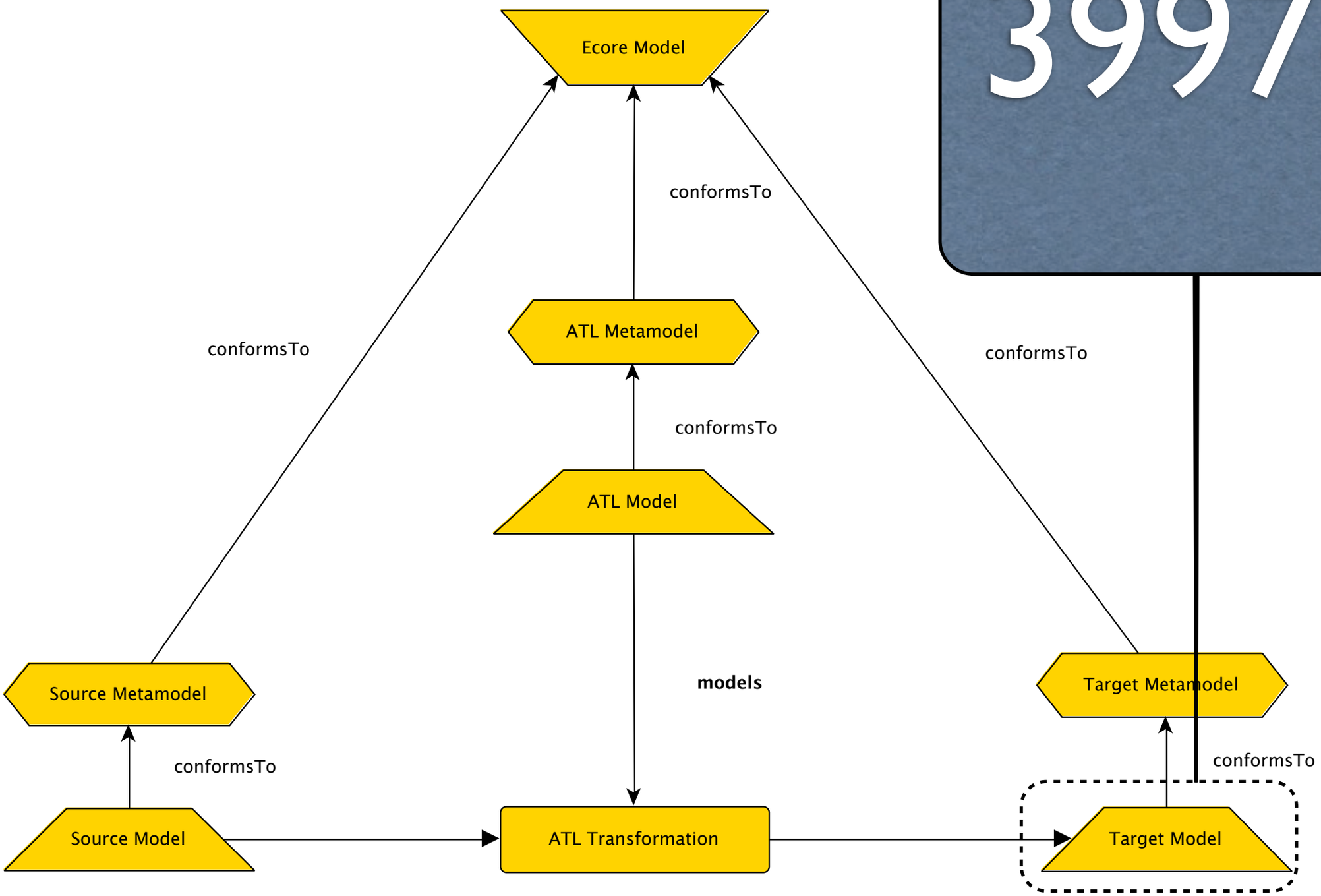
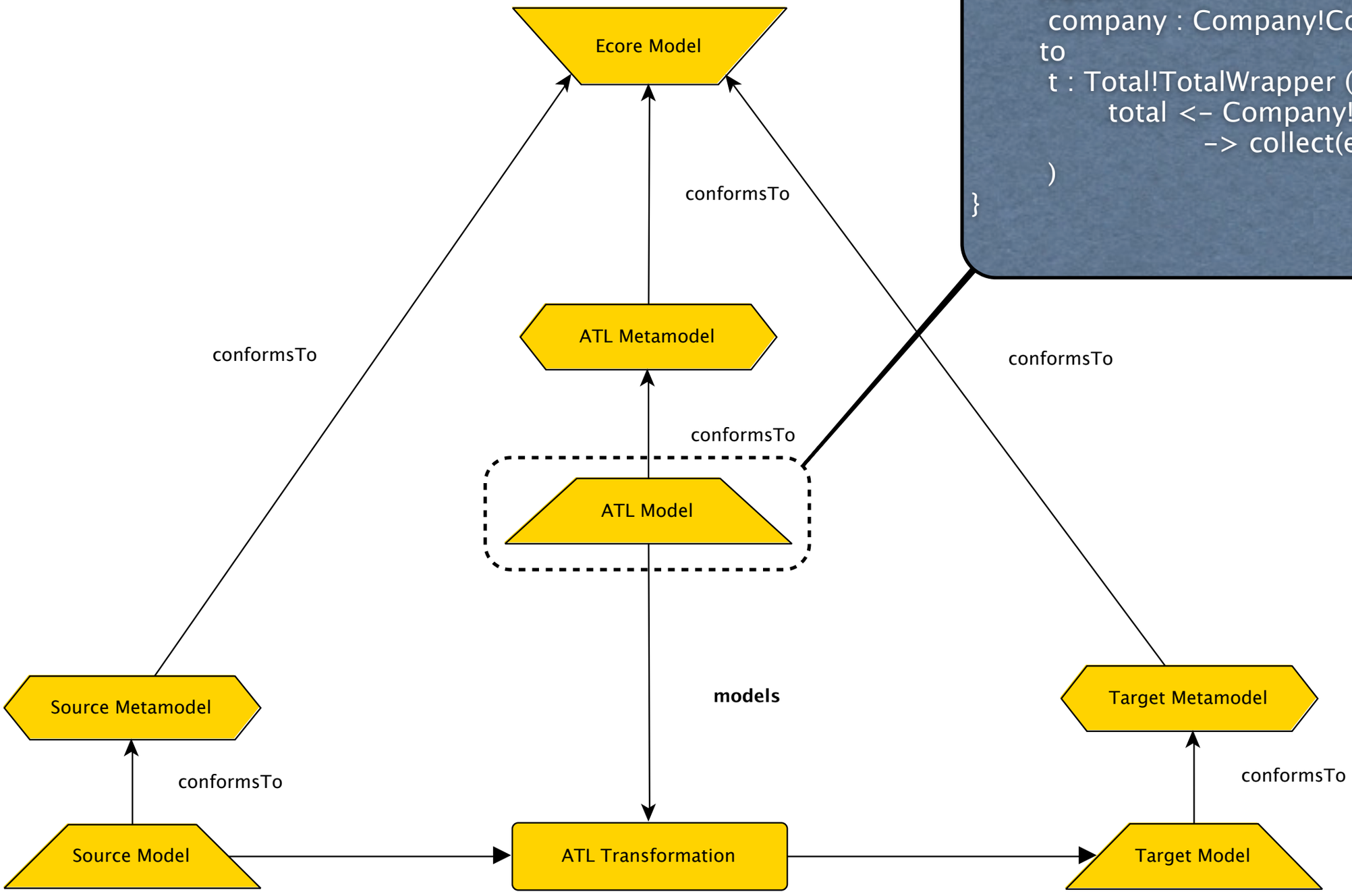


399747.0




```
module Total;
create OUT: Total from IN: Company;

rule Company2Total {
        from
         company : Company!Company
        to
         t : Total!TotalWrapper (
                total <- Company!Employee.allInstances()
                        -> collect(e | e.salary) -> sum()
         )
}
```

```
module Total;
create OUT: Total from IN: Company;

rule Company2Total {
        from
         company : Company!Company
        to
         t : Total!TotalWrapper (
                total <- Company!Employee.allInstances()
                  -> collect(e | e.salary) -> sum()
         )
}
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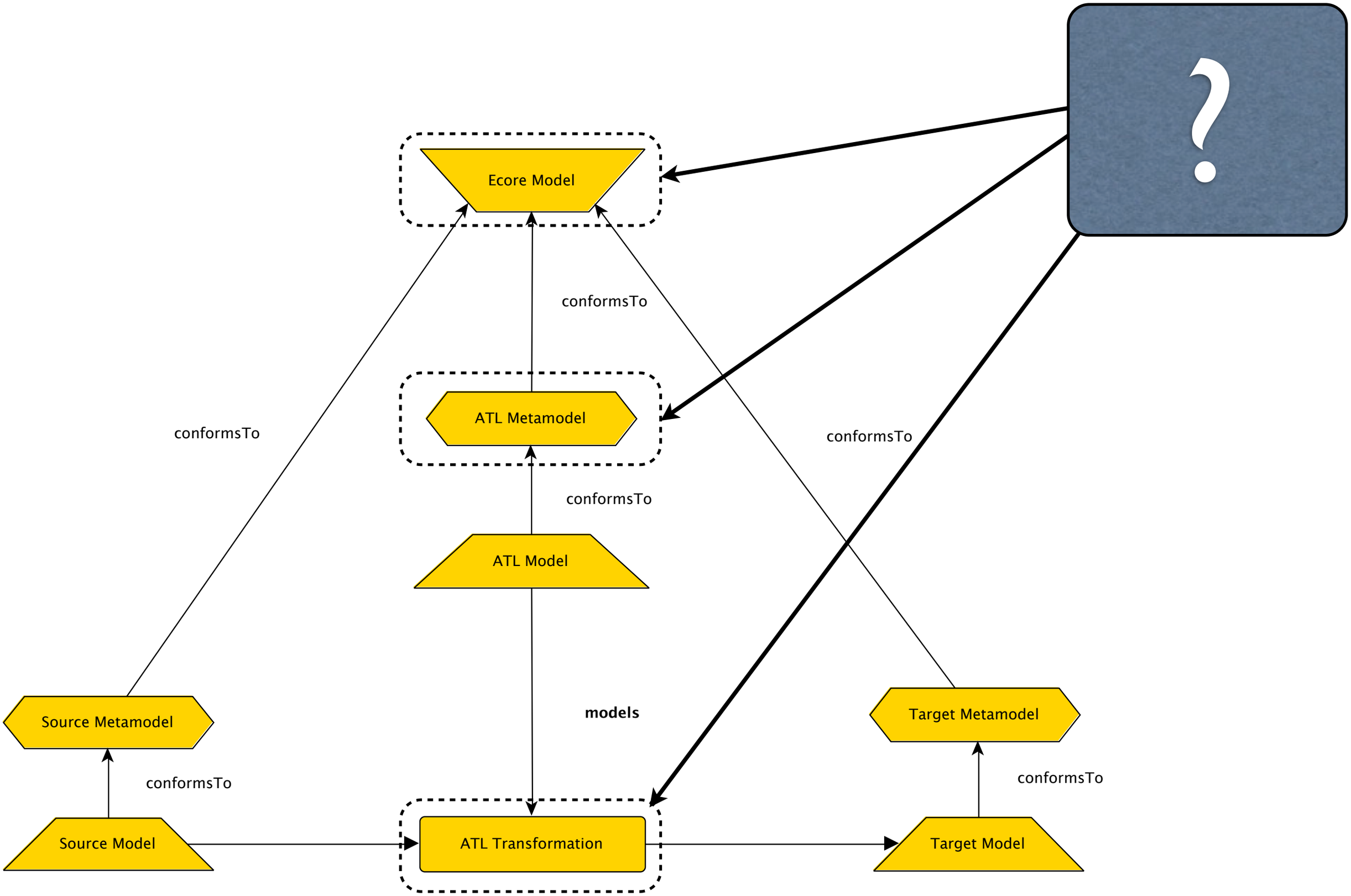
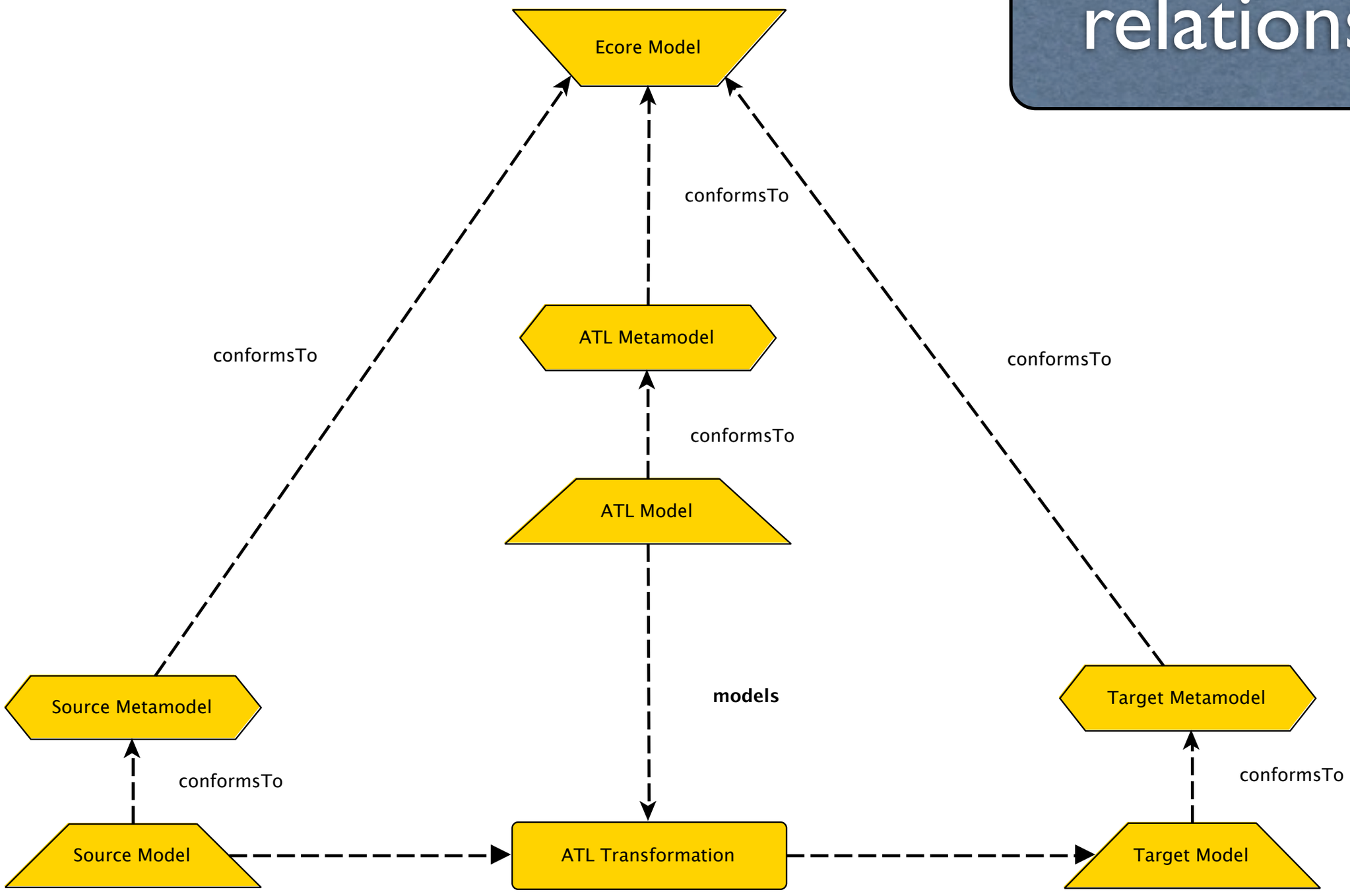


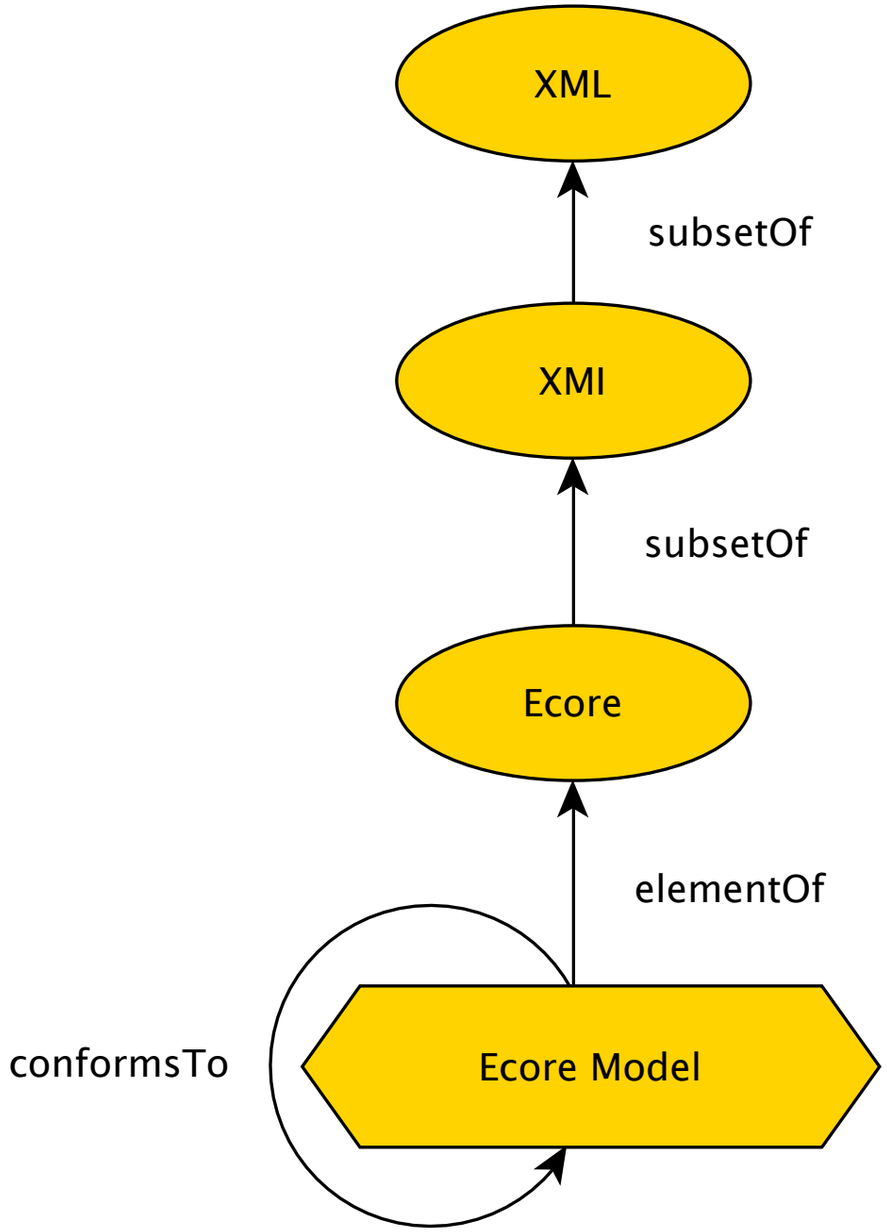
What about the relationships?



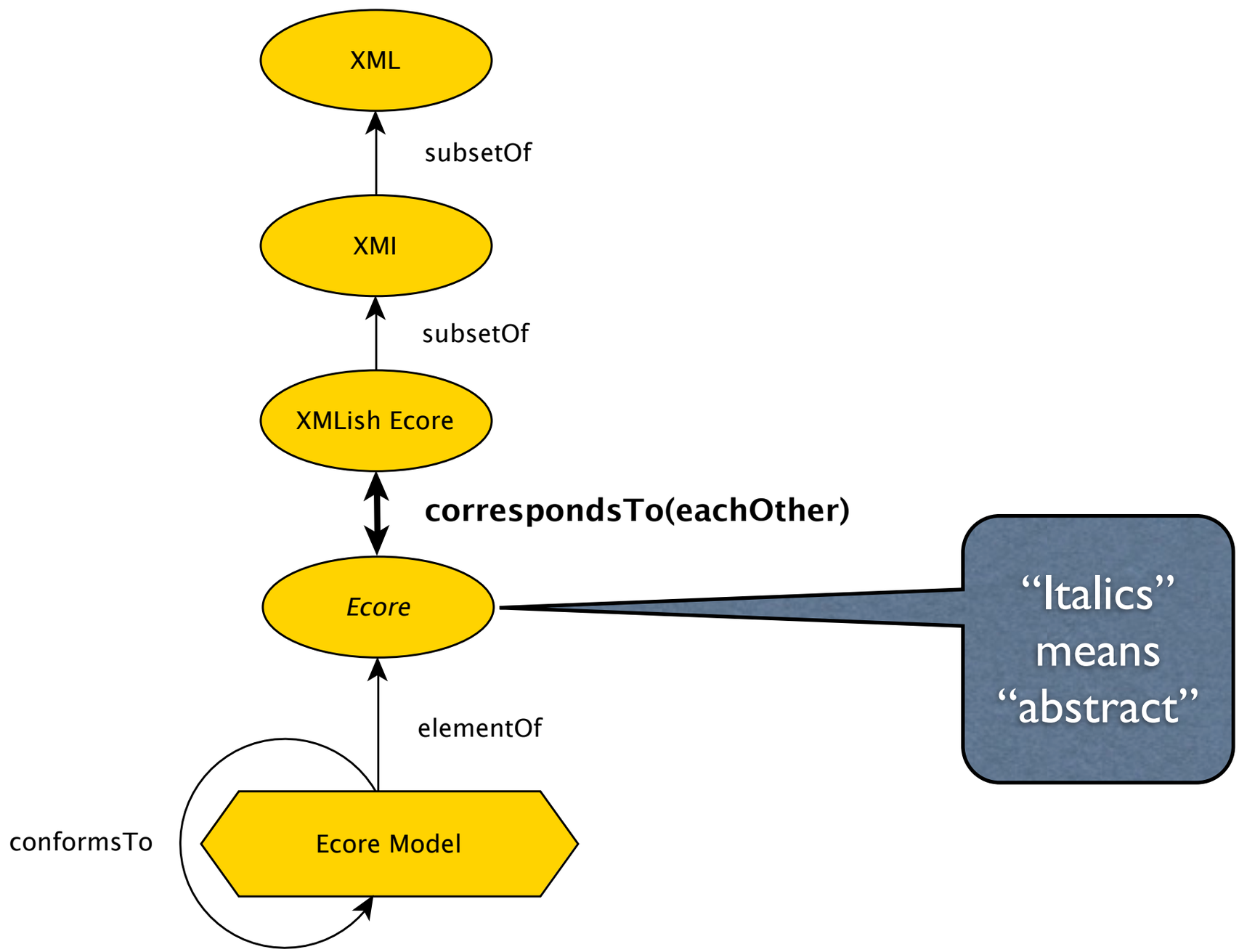
Leveling expectations:
By no means, we are ATL experts.

Slogan for the rest:
Please help me to get these slides right
(so that I can publish a great paper some day).

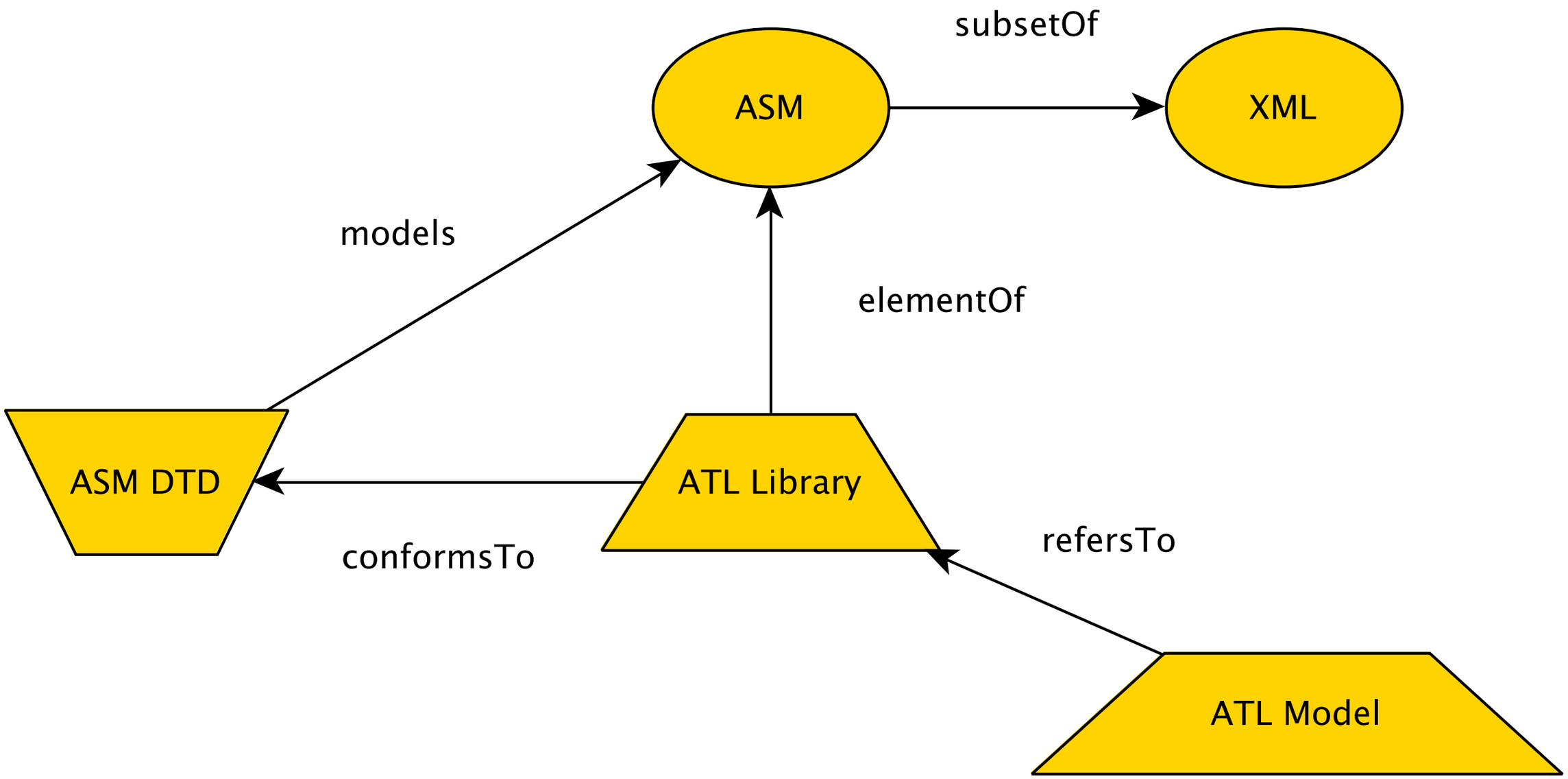
Discussion:
The complex nature of Ecore



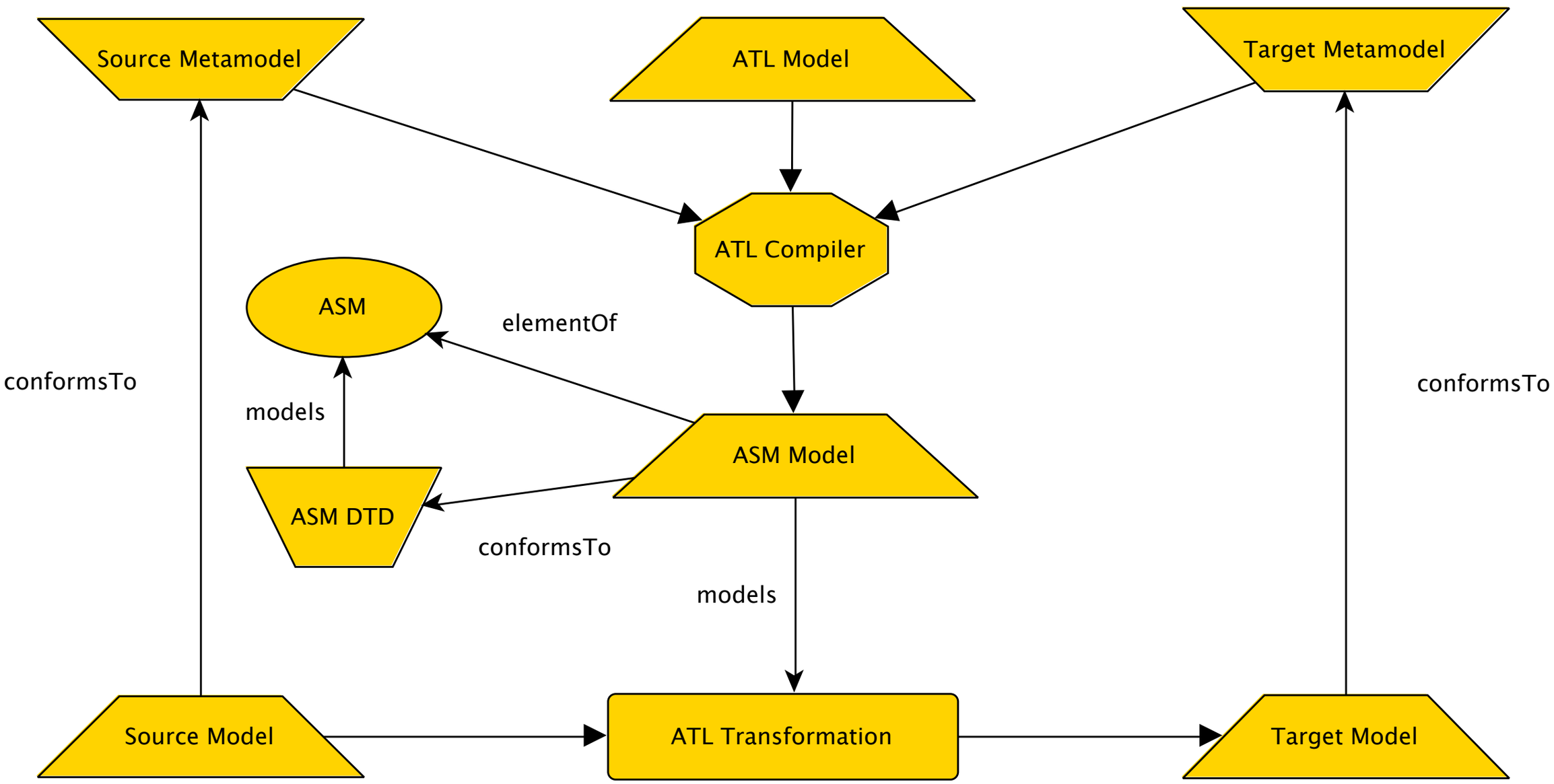
Discussion:
The complex nature of Ecore



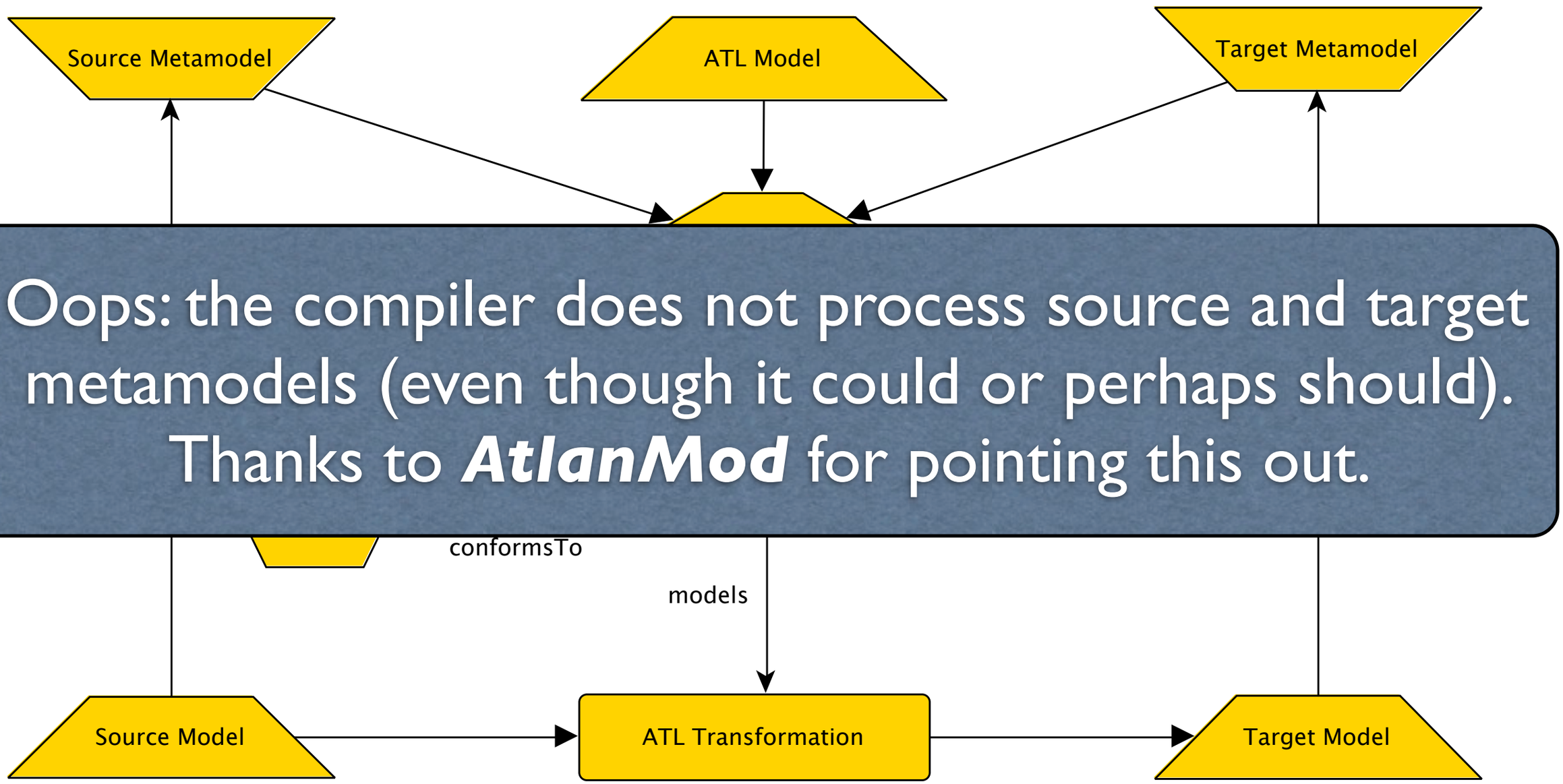
Discussion:
The role of ASM



Discussion:
The issue of compilation

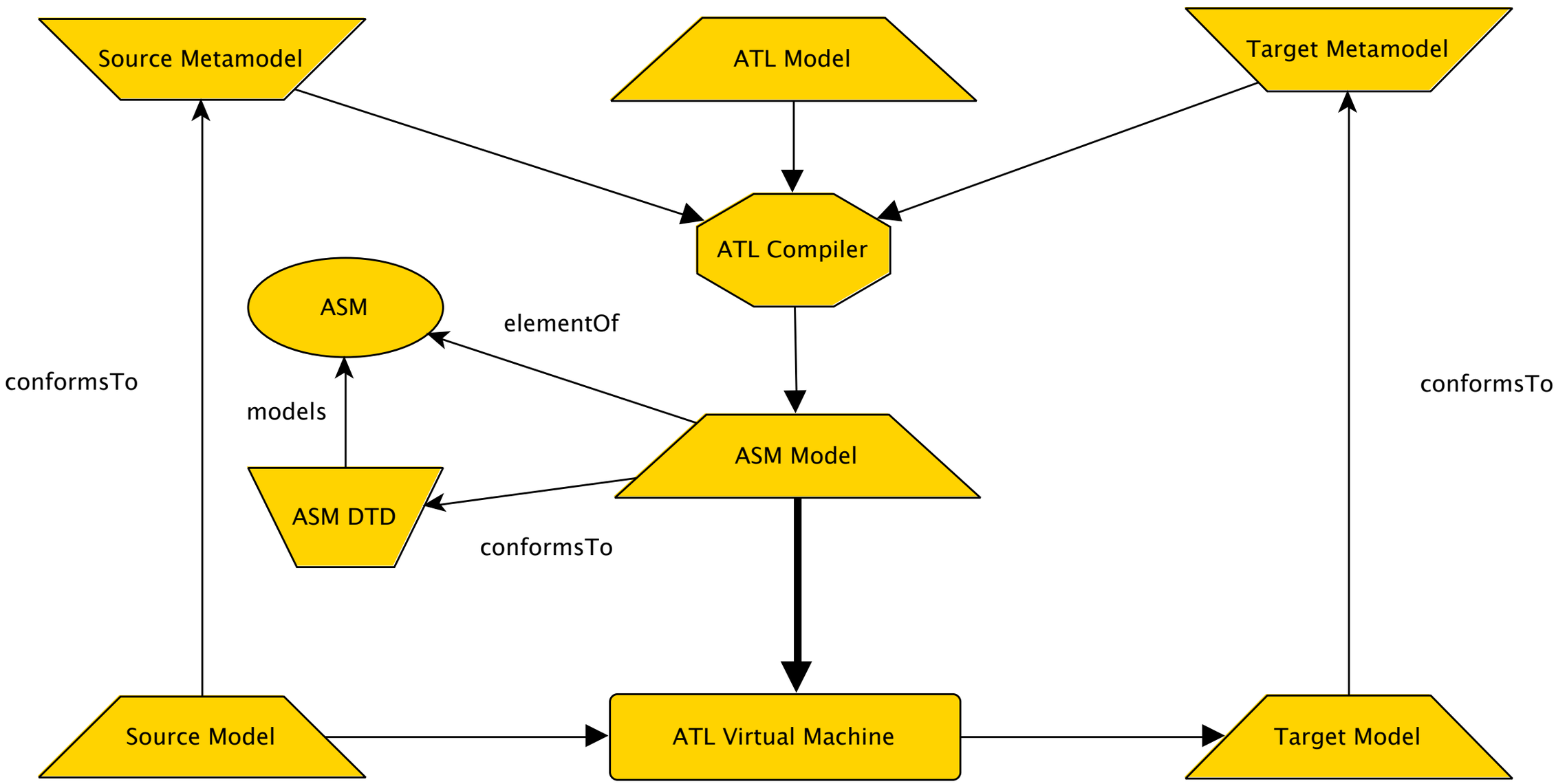


Discussion:
The issue of compilation

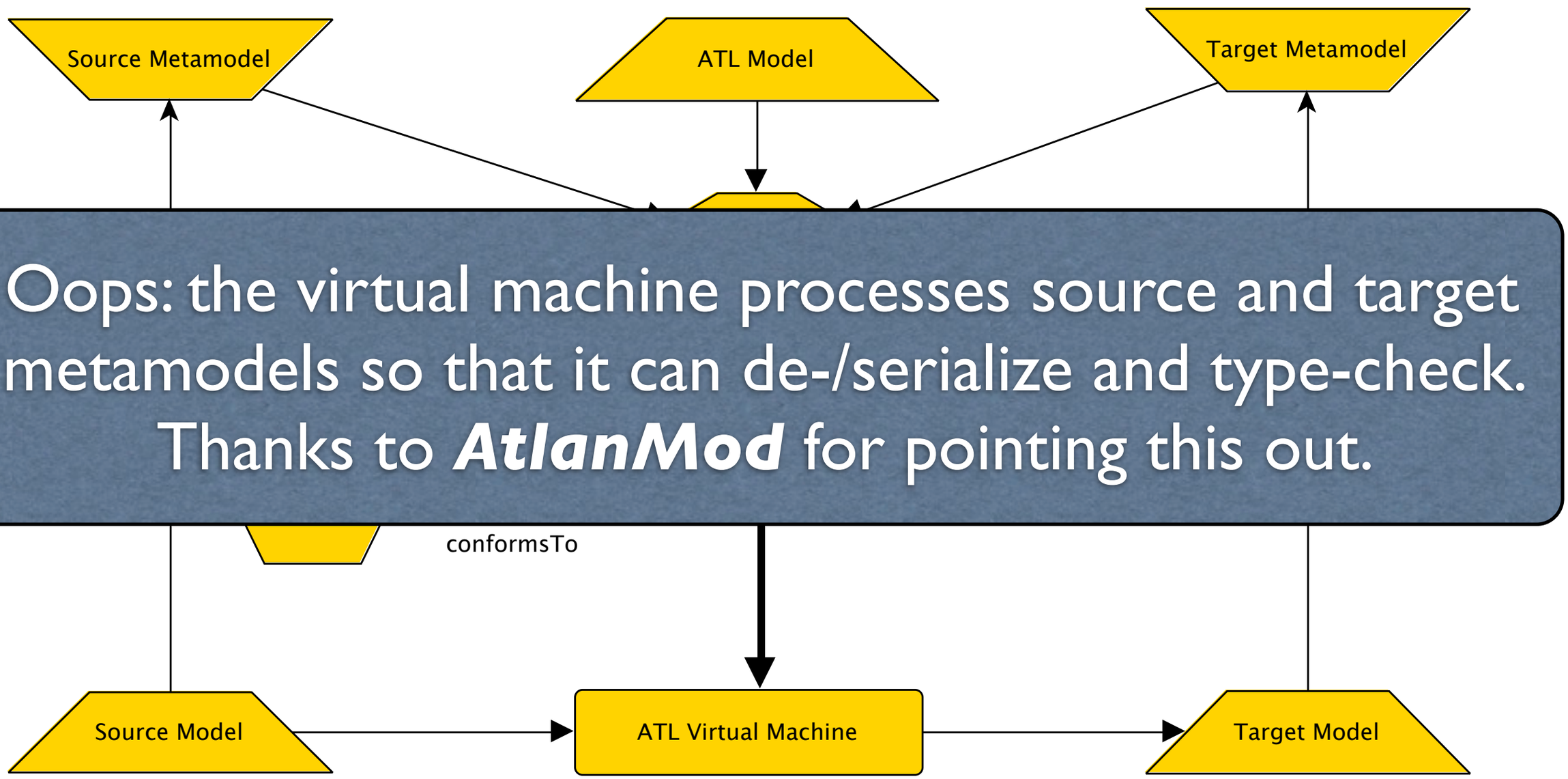


Oops: the compiler does not process source and target metamodels (even though it could or perhaps should). Thanks to ***AtlanMod*** for pointing this out.

Discussion:
The issue of interpretation



Discussion:
The issue of interpretation



Oops: the virtual machine processes source and target metamodels so that it can de-/serialize and type-check. Thanks to ***AtlanMod*** for pointing this out.

Further discussion topics

- KM3
- Compiler internals
- Eclipse support
- ...

Conclusion

- Megamodels model linguistic architecture.
- ATL requires a non-trivial megamodel.
- First ideas for such a megamodel were presented.
- Let's work on the ultimate ATL megamodel.

Thanks!
Questions?