

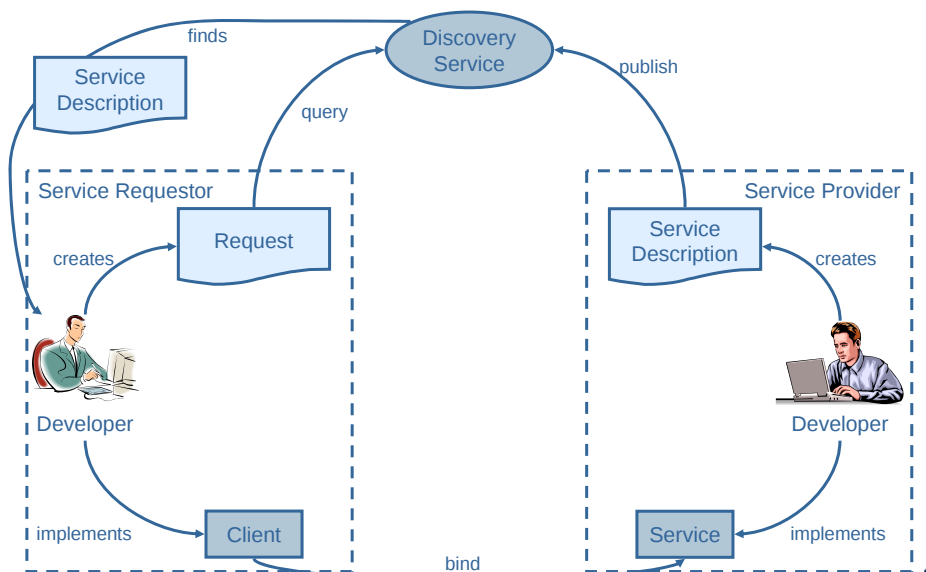


UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Visual Contracts: Applying Graph Transformations within Service-Oriented Architectures

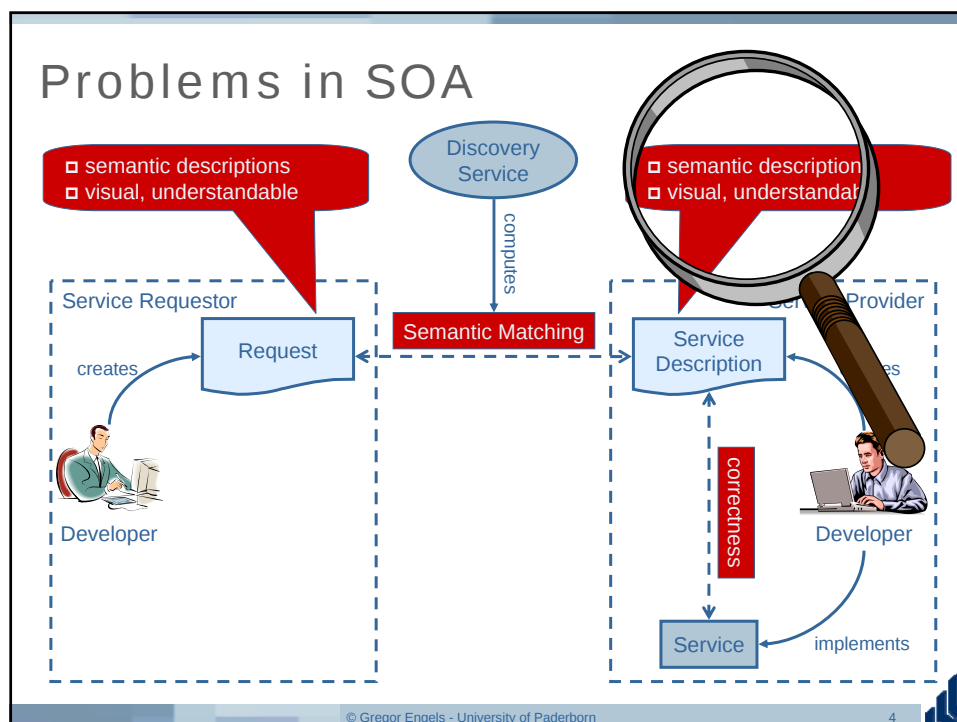
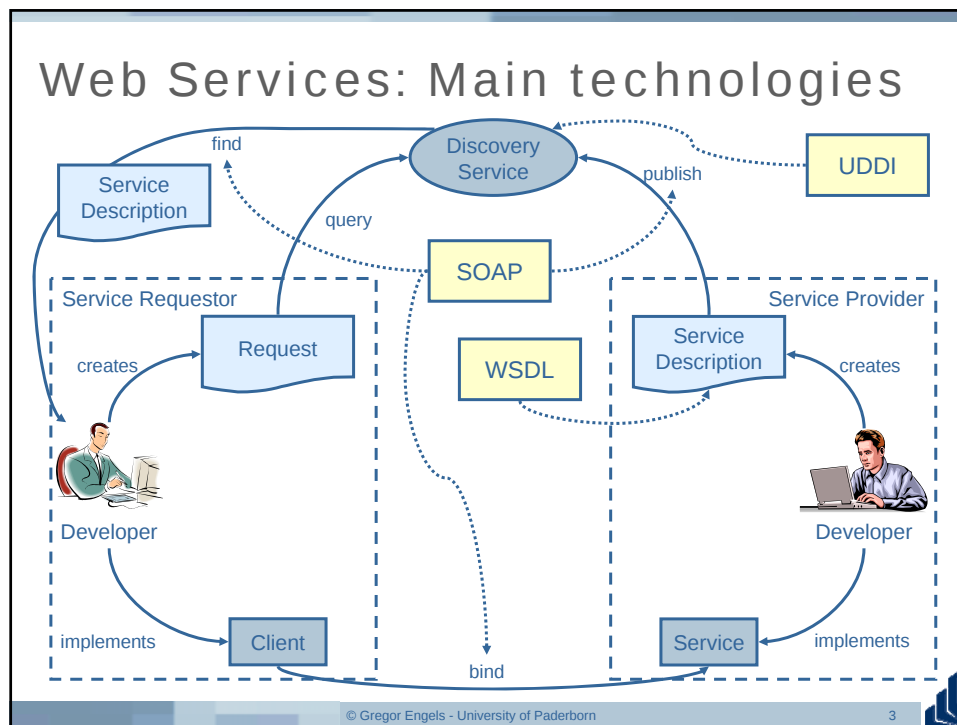
Gregor Engels, Marc Lohmann

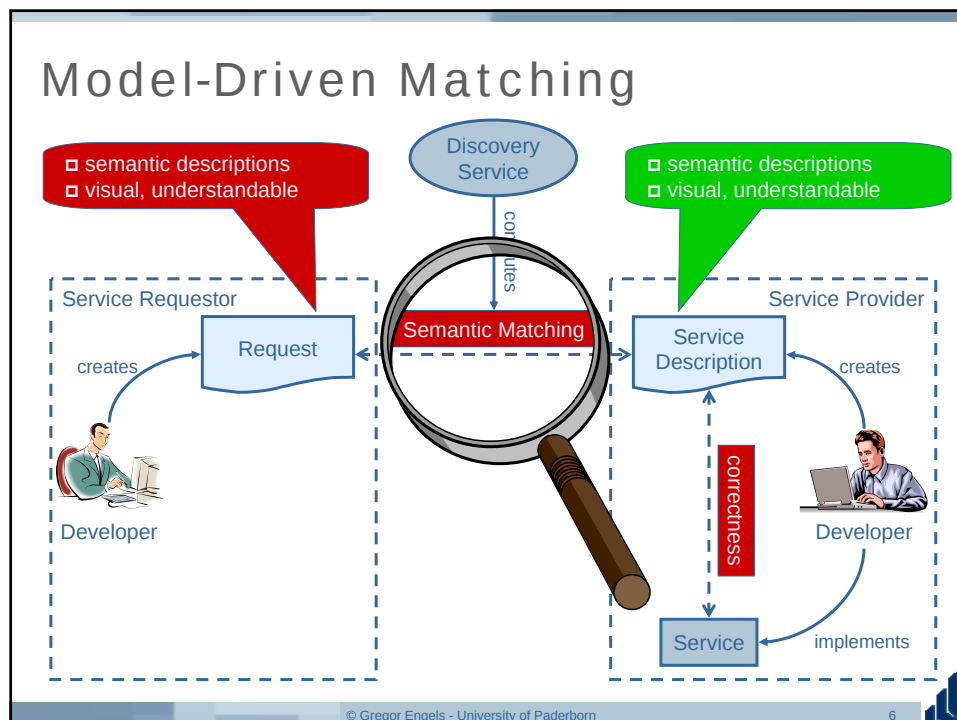
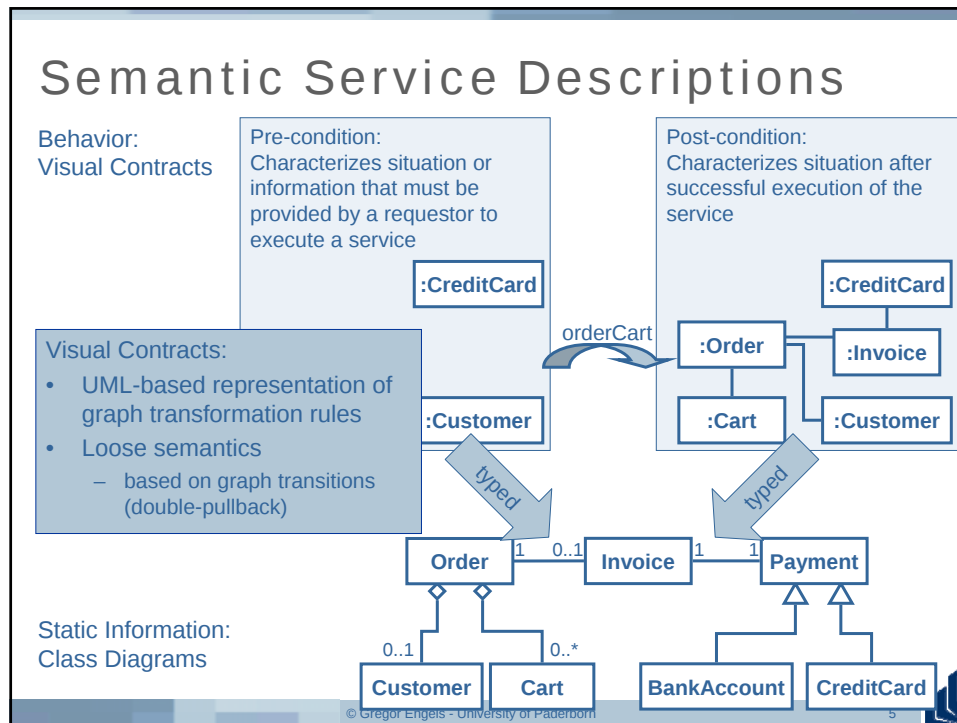
Service Oriented Architectures

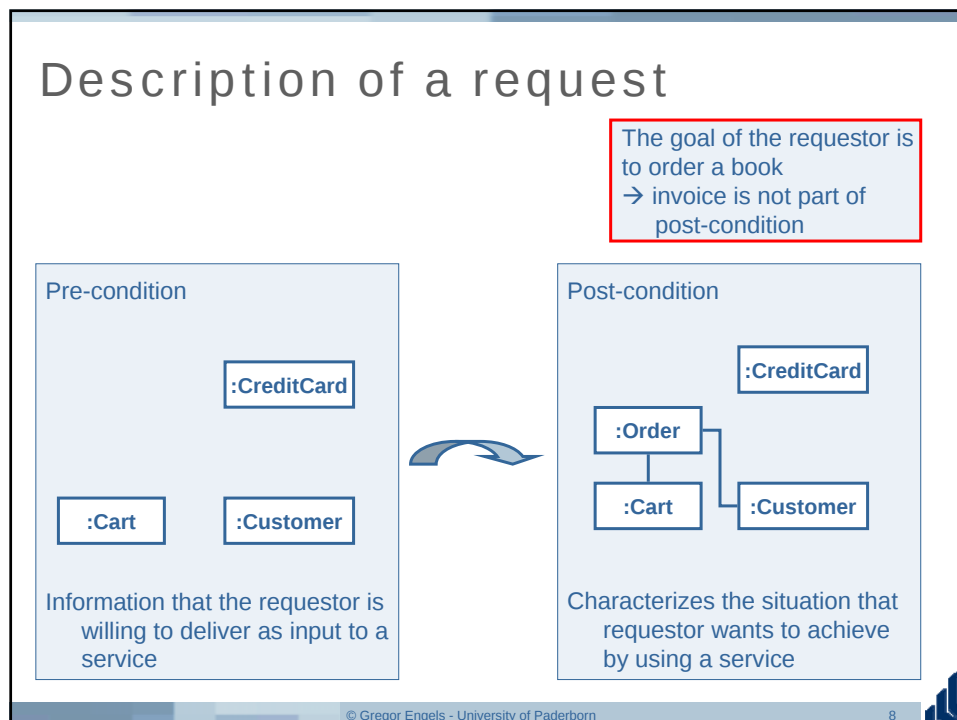
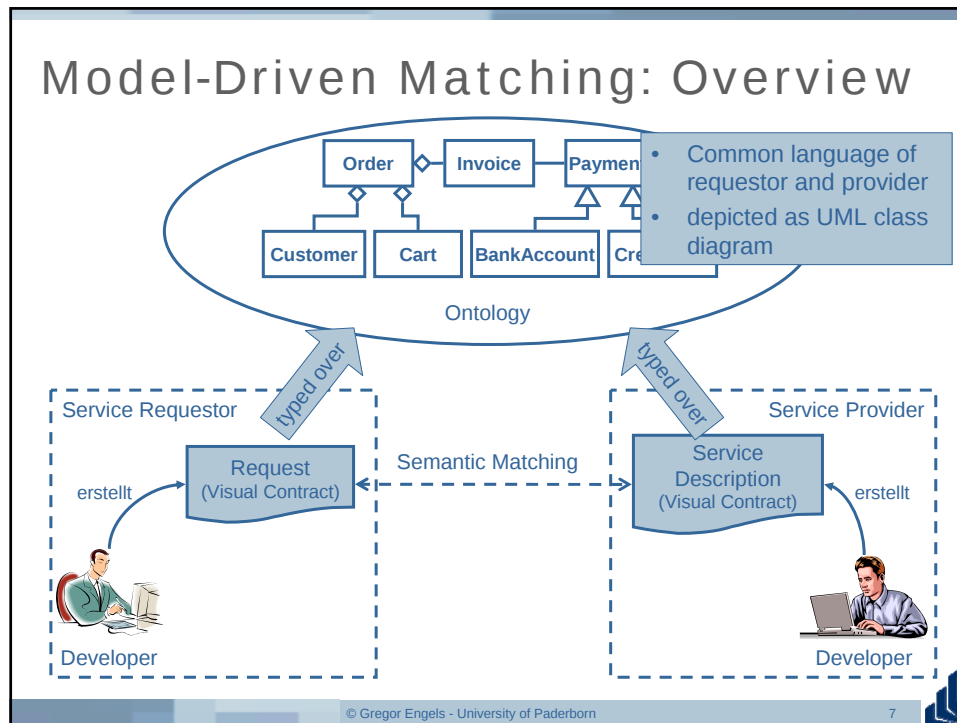


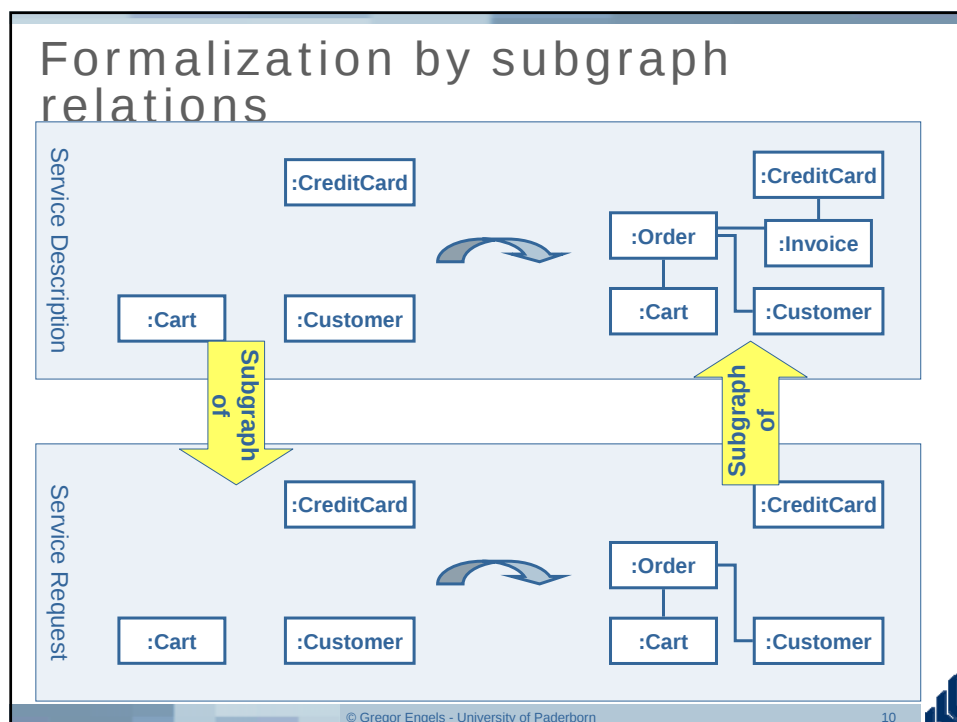
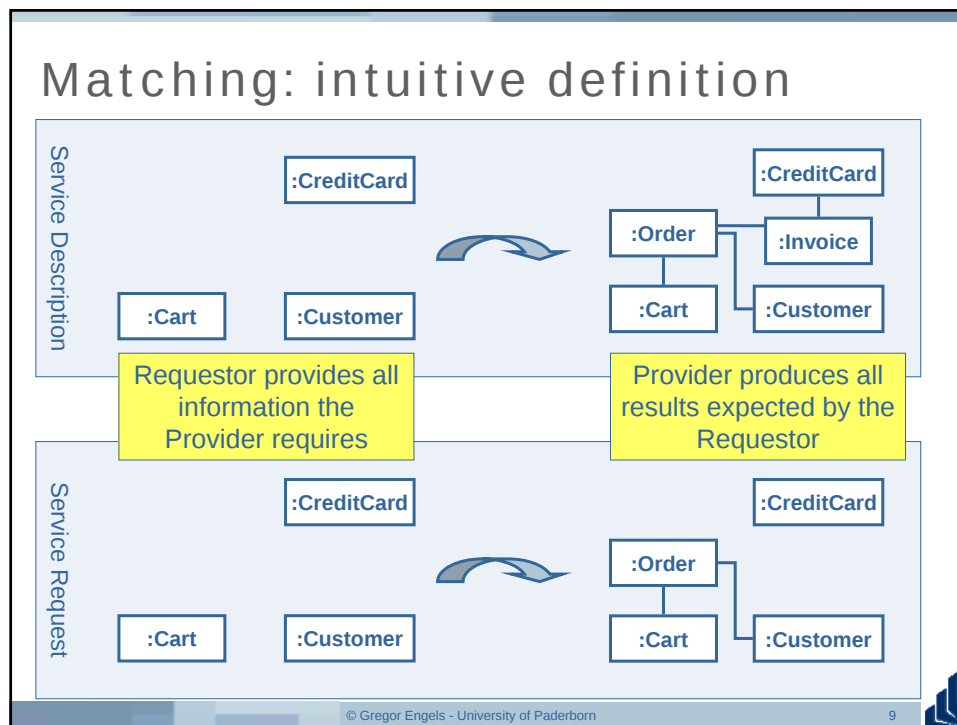
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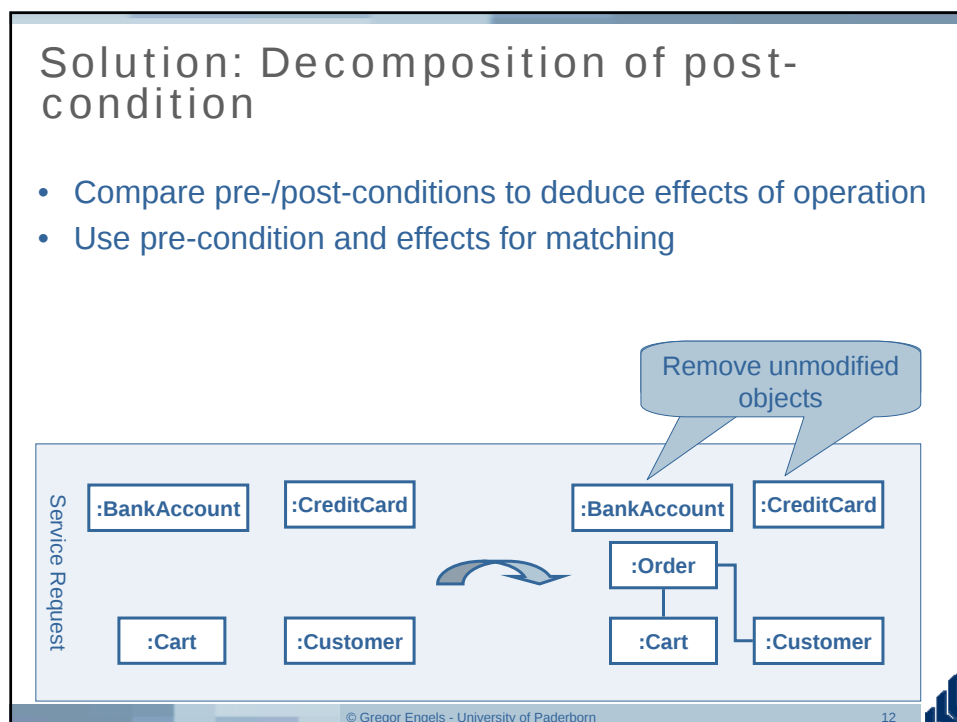
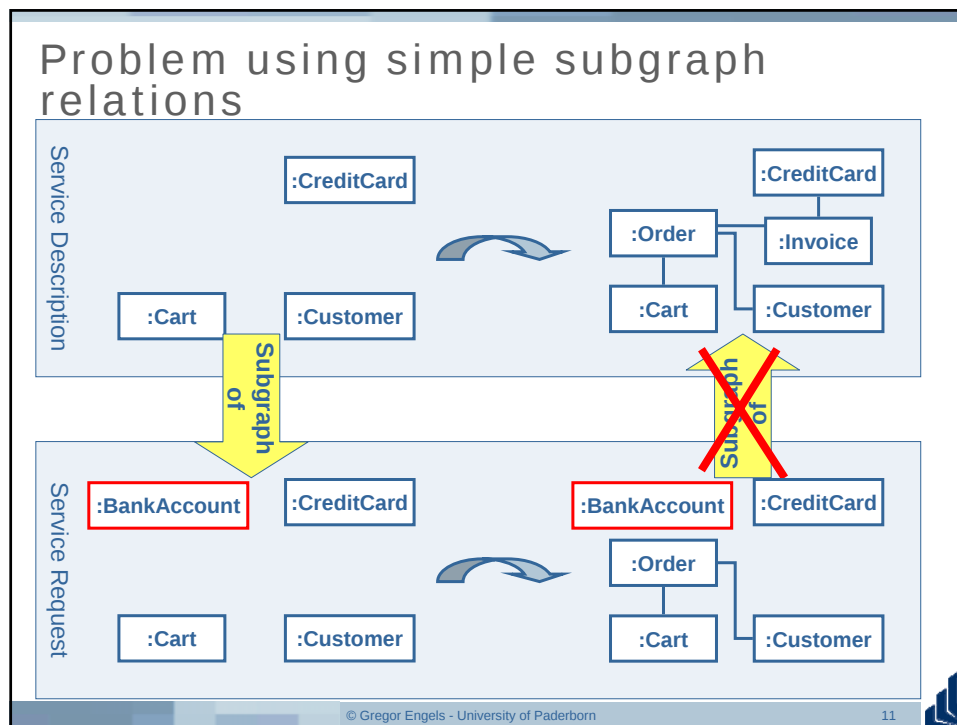
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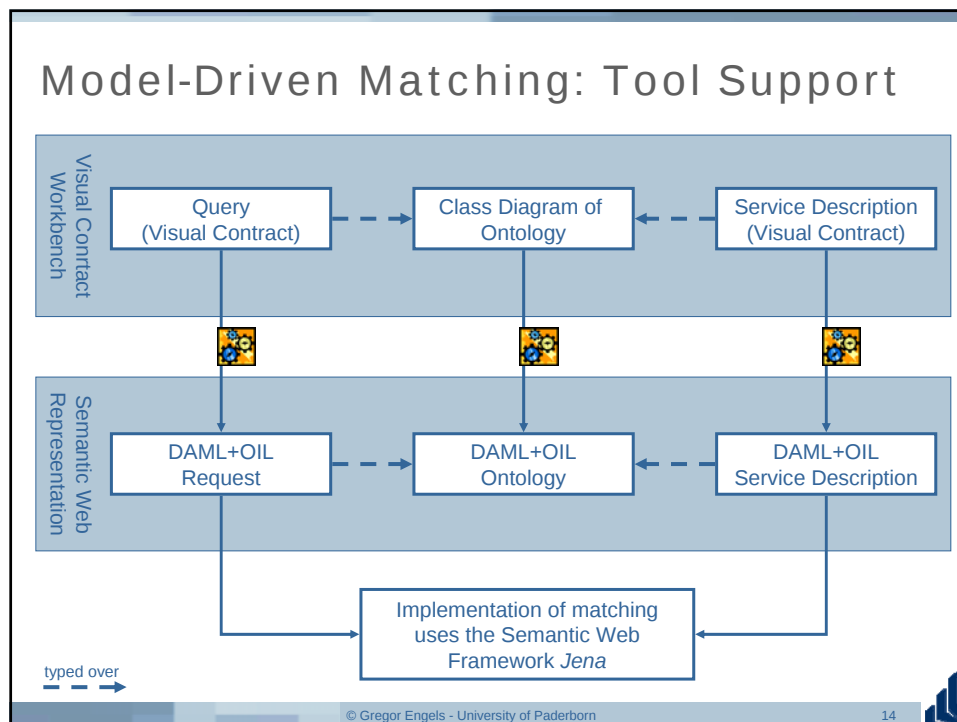
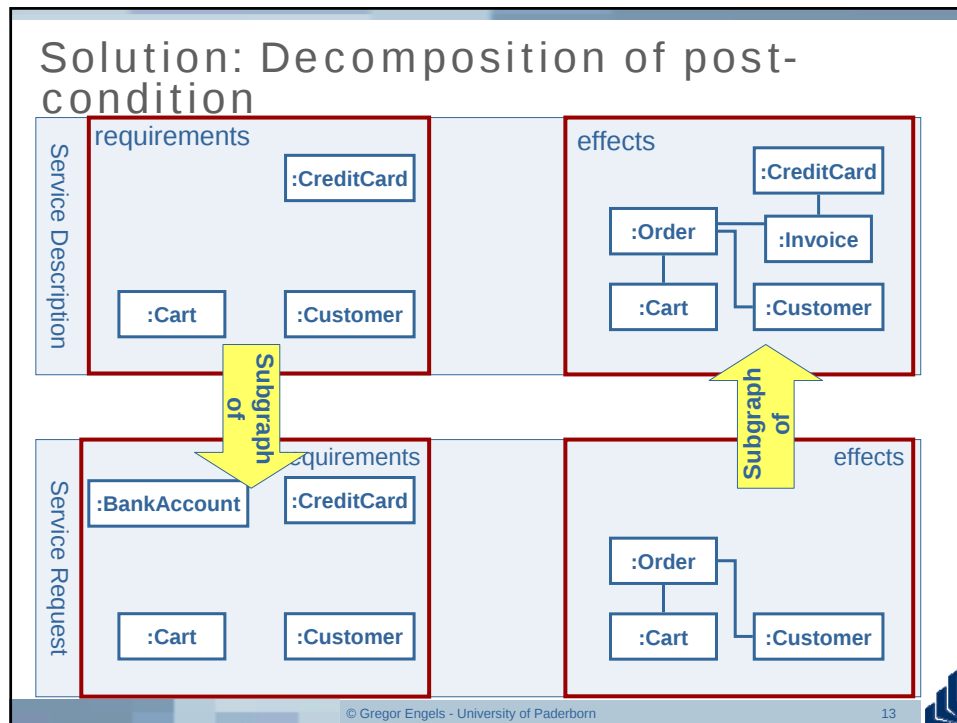












Generated DAML+OIL Code: Overview

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:daml="http://www.daml.org/2001/03/daml+oil#"
  xmlns:xsd="http://www.w3.org/2001/03/XMLSchema#"
  xmlns:dex="http://www.daml.org/2001/03/daml+oil-ex#"
  xmlns:exd="http://www.daml.org/2001/03/daml+oil-ex-dt#"

  xmlns="file:///D:/shopOntology.xml#"
>
<daml:Ontology rdf:ID="shopOntology">
  <daml:versionInfo>1.0</daml:versionInfo>
  <rdfs:comment>An ontology for selling products</rdfs:comment>
  <daml:imports rdf:resource="http://www.daml.org/2001/03/daml+oil"/>
</daml:Ontology>
...
```

DAML+OIL extends RDF with some concepts like associations or cardinalities etc.

Namespace for ontology

Define name of ontology

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15

Generated DAML+OIL Code: Overview

```
...
<!-- Class Order -->
<daml:Class rdf:ID="Order">
  <!-- use association oinv -->
  <rdfs:subClassOf>
    <daml:Restriction>
      <daml:onProperty rdf:resource="#oinv"/>
      <daml:toClass rdf:resource="#Invoice"/>
      <daml:minCardinality>0</daml:minCardinality>
      <daml:maxCardinality>1</daml:maxCardinality>
    </daml:Restriction>
  </rdfs:subClassOf>
</daml:Class>
...

<!-- Association: oinv -->
<daml:ObjectProperty rdf:ID="oinv">
  <rdfs:domain rdf:resource="#Order"/>
  <rdfs:range rdf:resource="#Invoice"/>
</daml:ObjectProperty>
...
```

- Define class *Order*.
- Concept of classes in DAML+OIL is similar to concept of classes in UML.

Reference association

Define cardinality

Define association



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16

Generated DAML+OIL Code: Overview

How to instantiate classes from ontology?

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:daml="http://www.daml.org/2001/03/daml+oil#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:xsd="http://www.w3.org/2000/10/XMLSchema#"
  xmlns="file:///D:/shopOntology.xml#">
```

Use ontology as default namespace

...

```
<CreditCard rdf:ID="cc"></CreditCard>
<Cart rdf:ID="c"></Cart>
<Customer rdf:ID="cu"></Customer>
```

Define identifier

...

```
</rdf:RDF>
```

Reference elements (classes) from standard namespace

cc:CreditCard

c:Cart

cu:Customer

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17

How to compute subgraphs with DAML+OIL?



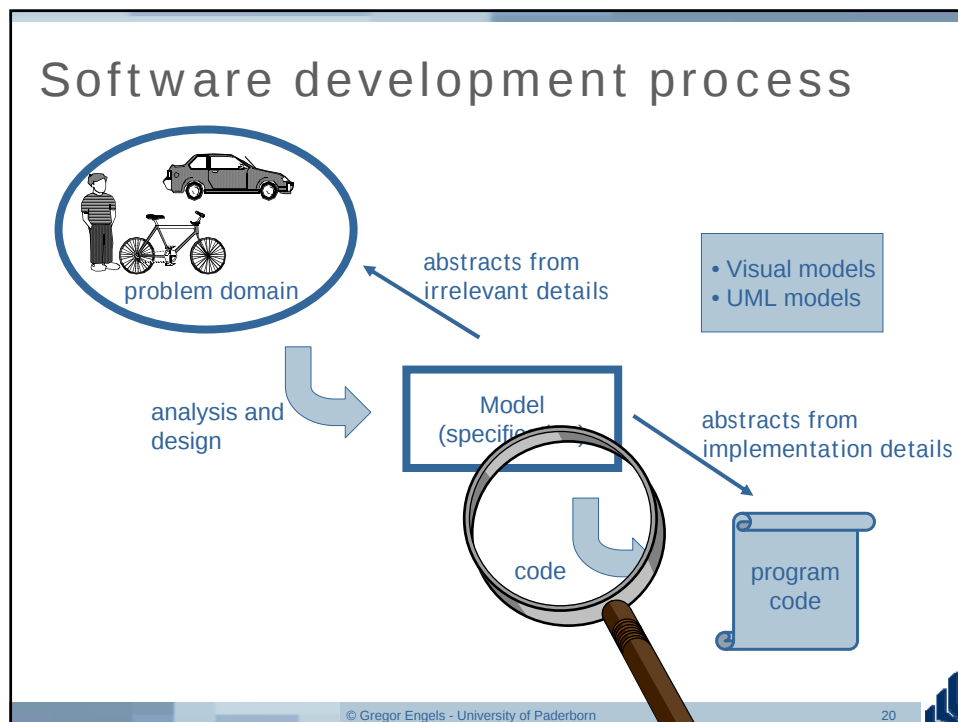
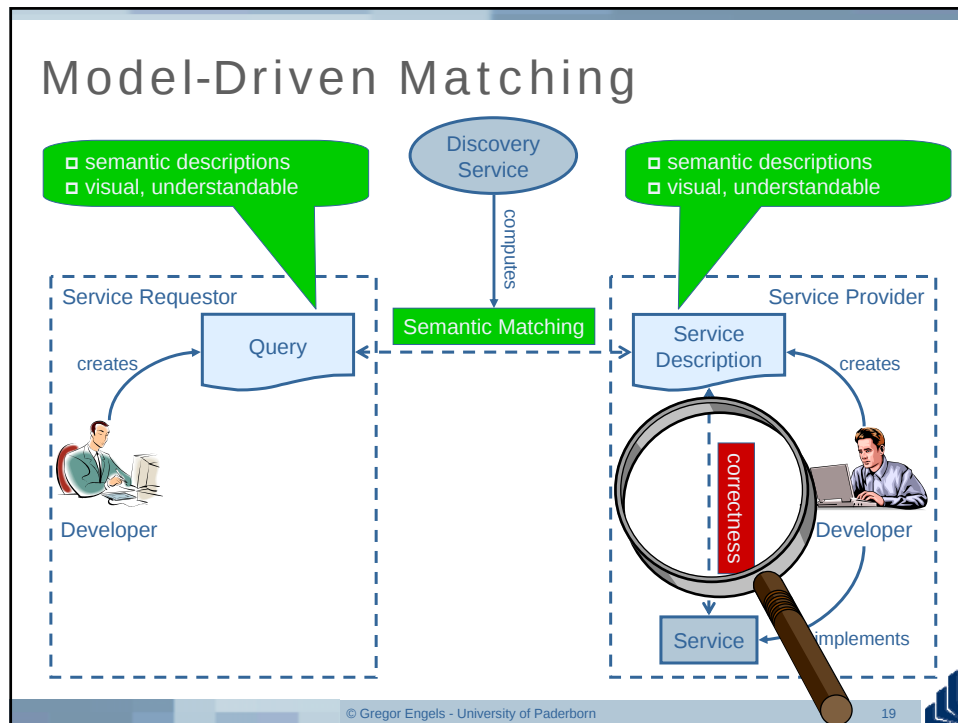
RDQL: RDF Data Query Language

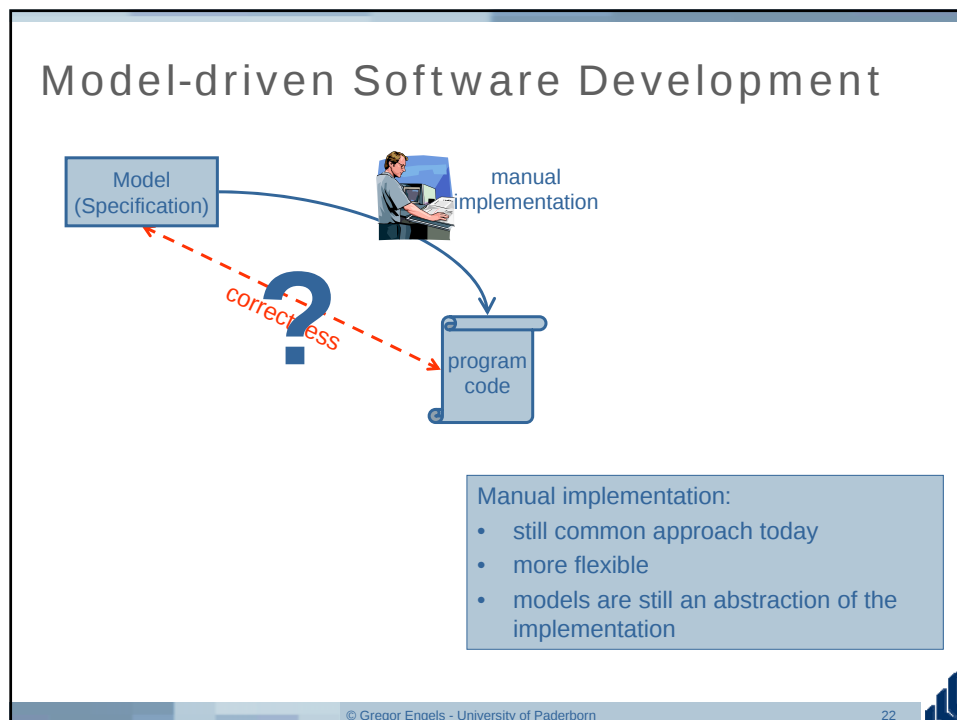
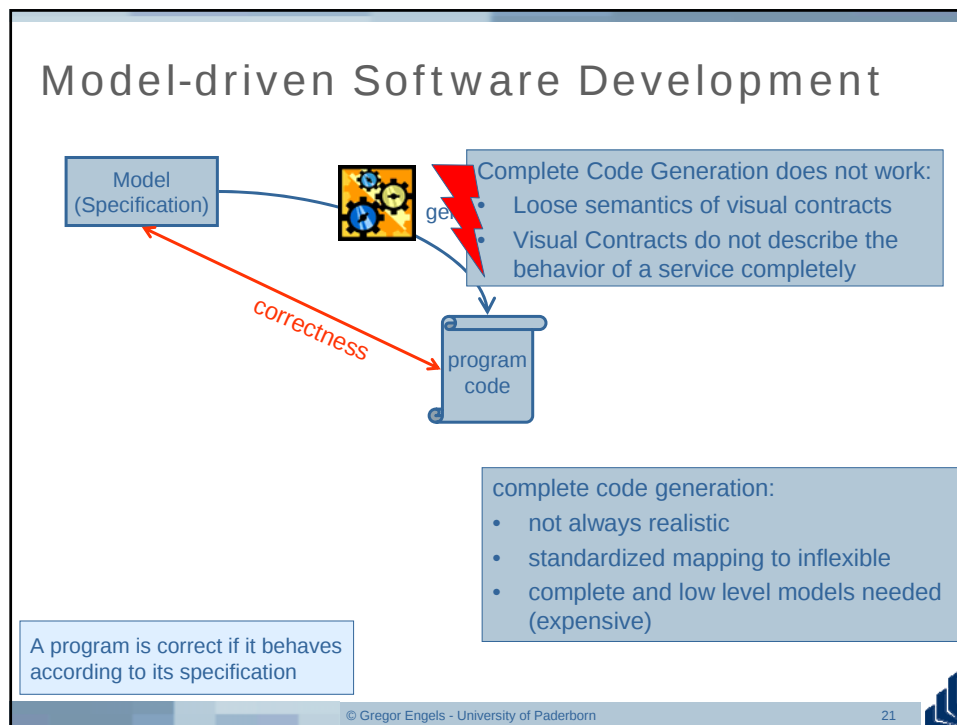
Simple RDQL Query:

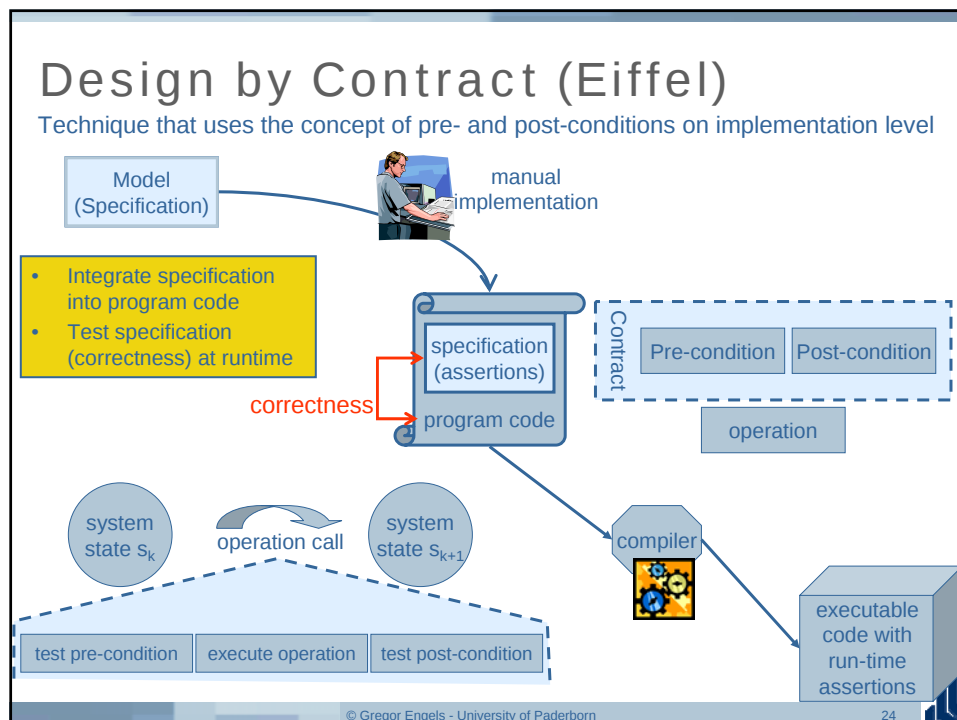
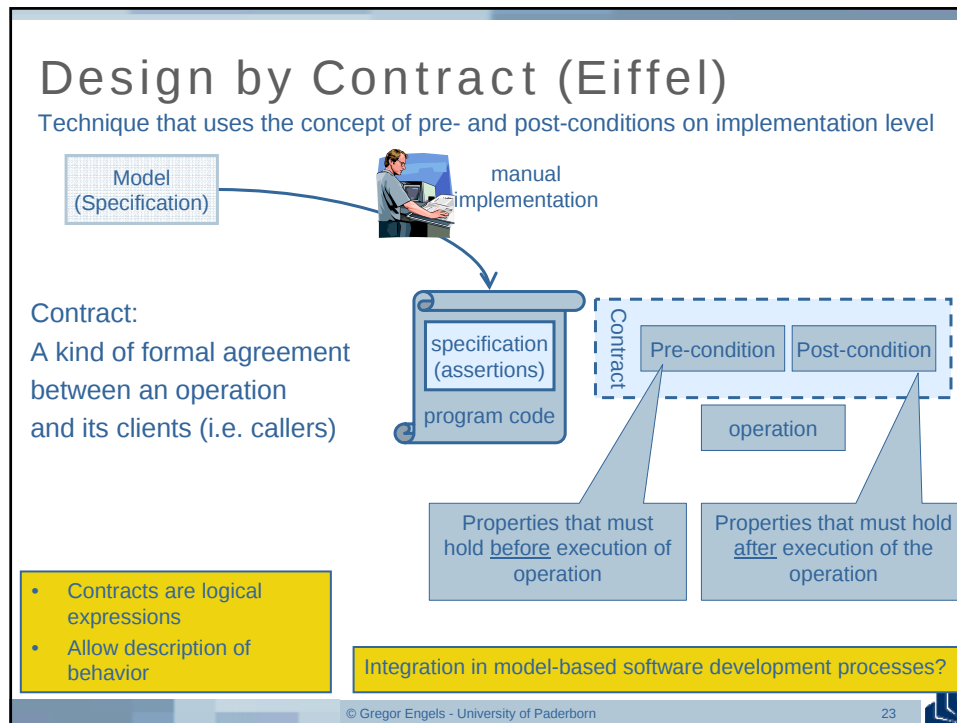
```
SELECT ?cc, ?c, ?cu
WHERE
(?cc, <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
  file:///D:/shopOntology.xml#CreditCard>),
(?c, <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
  <file:///D:/shopOntology.xml#Cart>),
(?cu, <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>,
  <file:///D:/shopOntology.xml#Customer>)
```

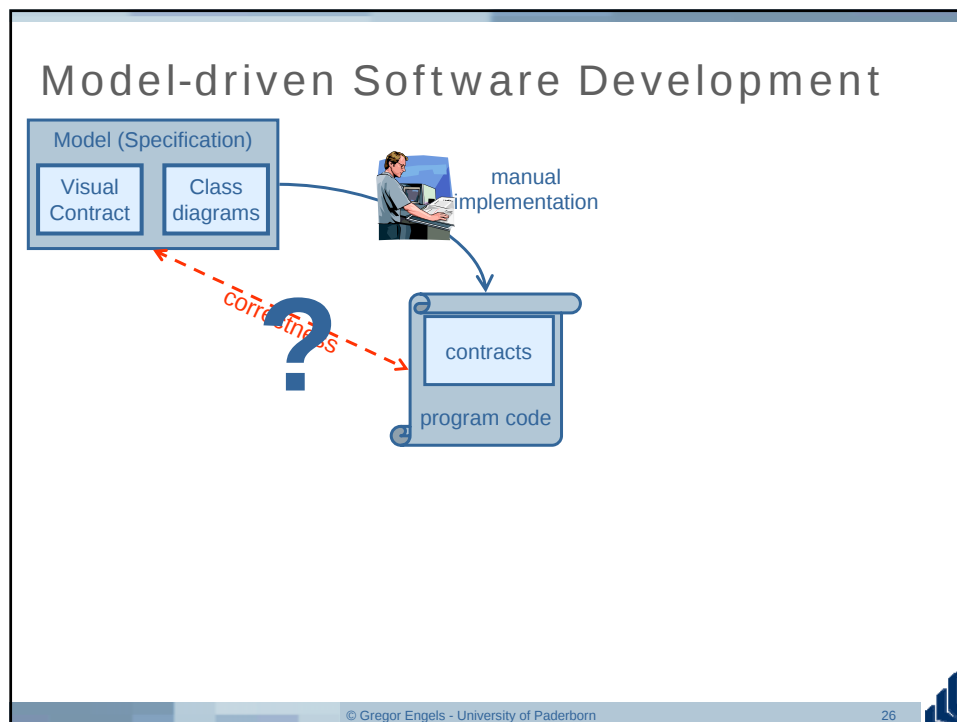
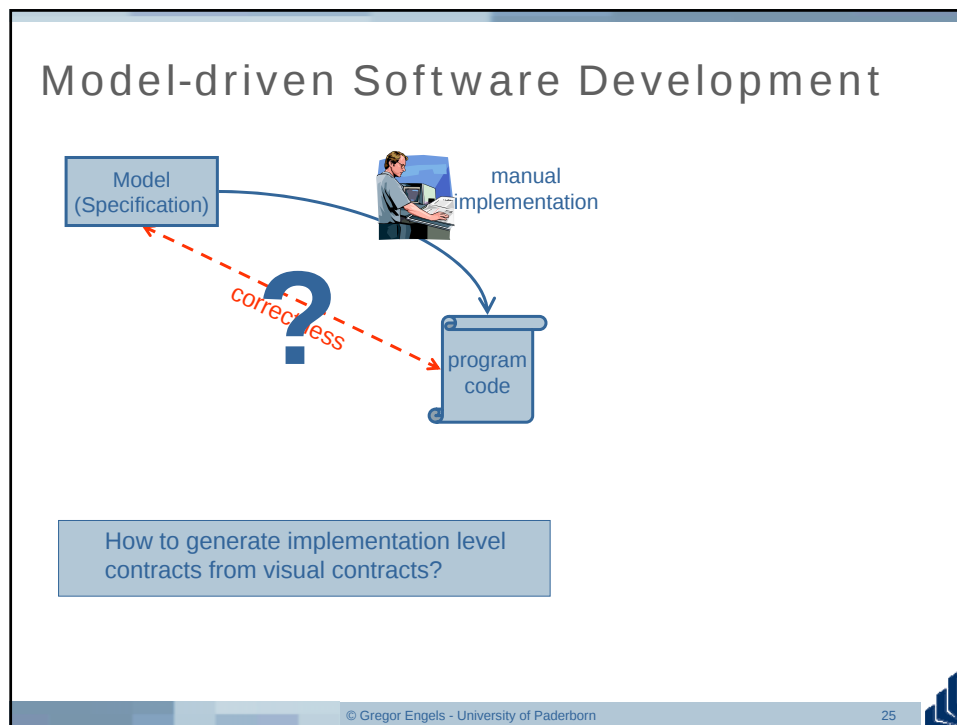
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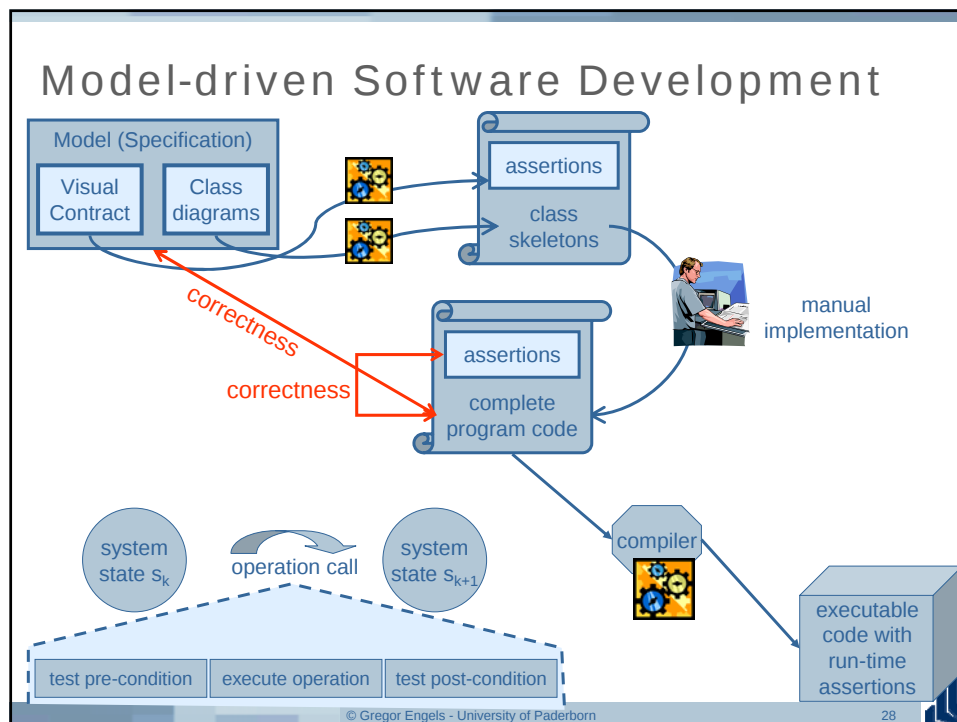
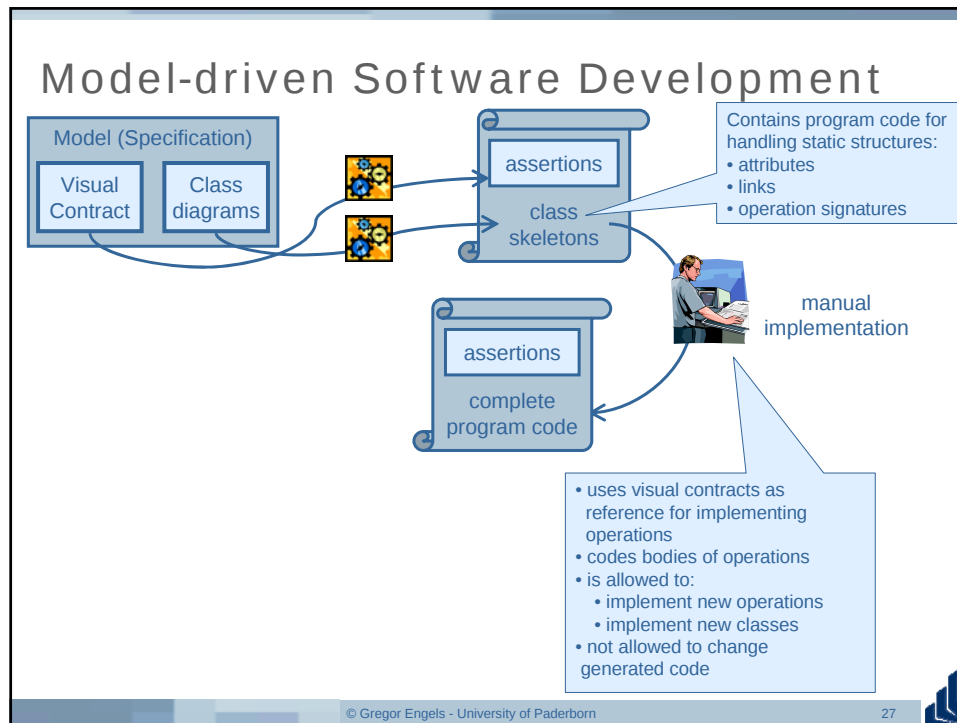
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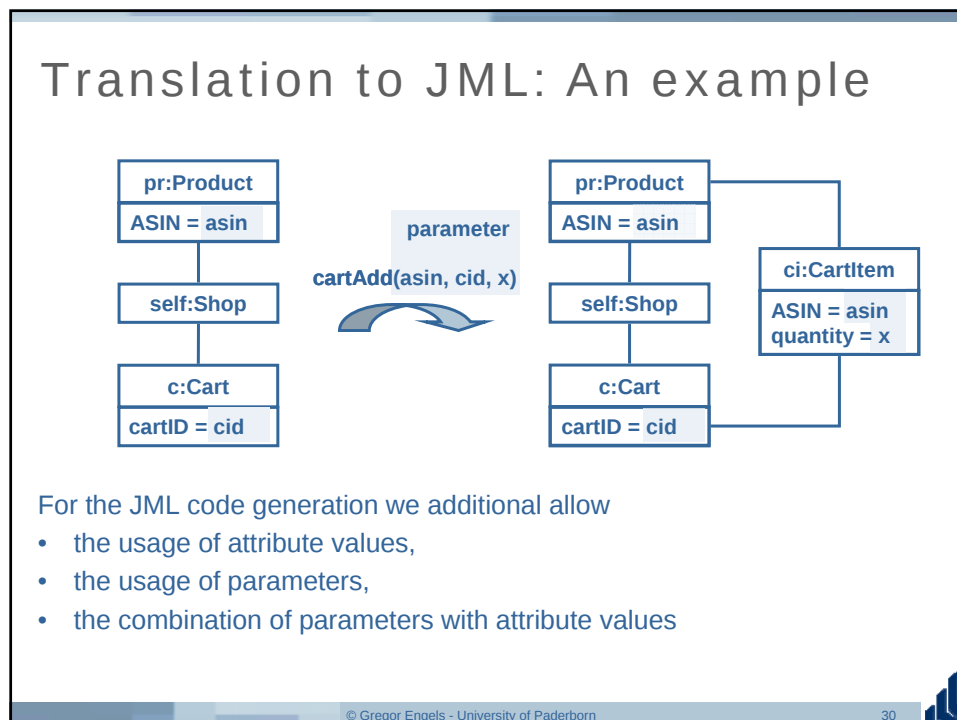
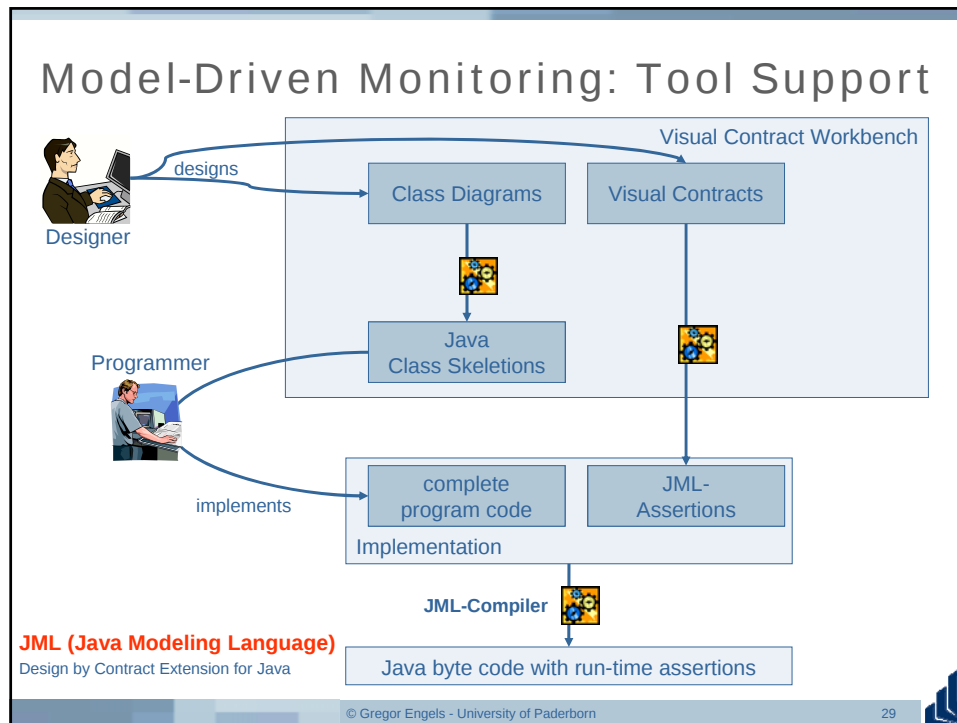






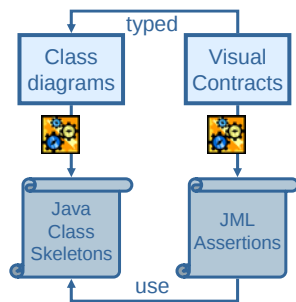






Translation to JML: An example

JML Assertions are based on Java expressions



```

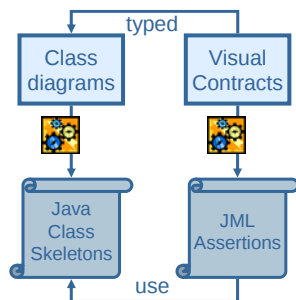
/*@ public normal_behavior
@ requires (\exists Product pr;
@   getProducts().values().contains(pr);
@   pr.getASIN().equals(asin)
@   && (\exists Cart c;
@     getCarts().values().contains(c);
@     c.getCartID().equals(cid)));
@
@
@ ensures (\exists Product pr;
@   getProducts().values().contains(pr);
@   pr.getASIN().equals(asin)
@   && (\exists Cart c;
@     getCarts().values().contains(c);
@     c.getCartID().equals(cid)
@   && (\exists CartItem citem;
@     c.getItems().values().contains(citem);
@     item.getASIN().equals(asin)
@     && citem.getQuantity() == x));
@
@*/
public String cartAdd (String asin, String cid, int x);
  
```

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31

Translation to JML: An example

JML Assertions are based on Java expressions



```

/*@ public normal_behavior
@ requires (\exists Product pr;
@   getProducts().values().contains(pr);
@   pr.getASIN().equals(asin)
@   && (\exists Cart c;
@     getCarts().values().contains(c);
@     c.getCartID().equals(cid)));
@
@
@ ensures (\exists Product pr;
@   getProducts().values().contains(pr);
@   pr.getASIN().equals(asin)
@   && (\exists Cart c;
@     getCarts().values().contains(c);
@     c.getCartID().equals(cid)
@   && (\exists CartItem citem;
@     c.getItems().values().contains(citem);
@     item.getASIN().equals(asin)
@     && citem.getQuantity() == x));
@
@*/
public String cartAdd (String asin, String cid, int x);
  
```

operation

cartAdd(asin, cid, x)

pr:Product

ASIN = asin

self:Shop

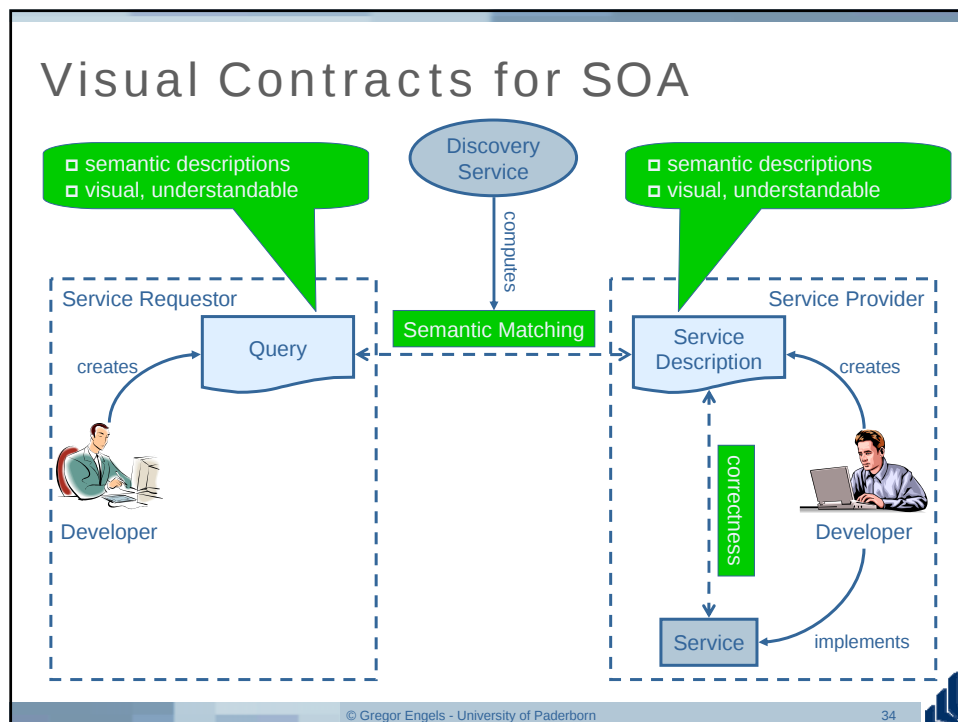
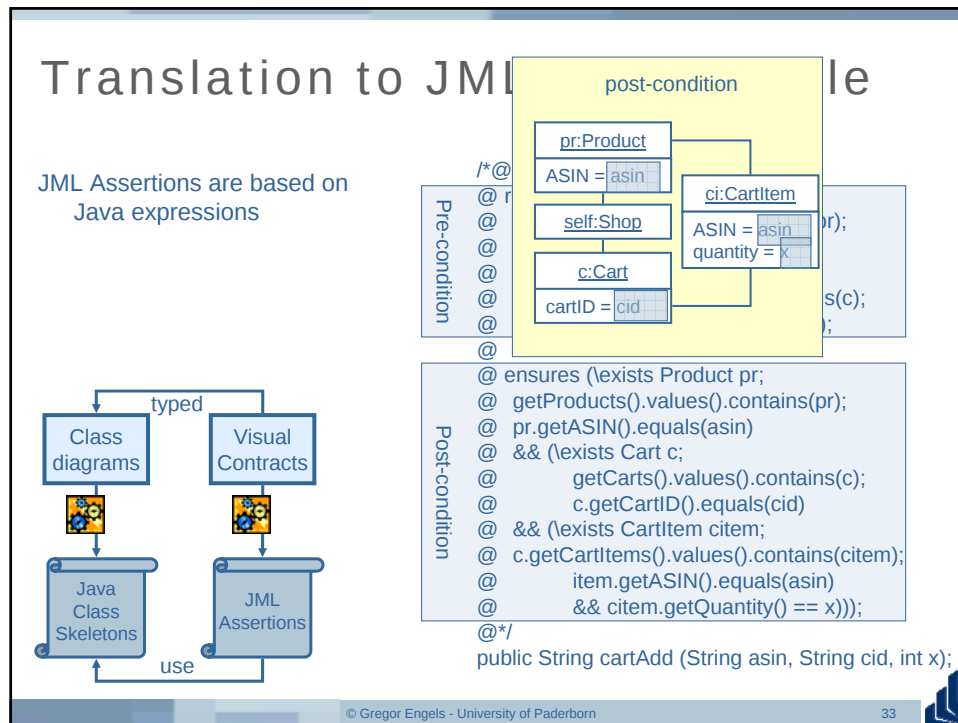
c:Cart

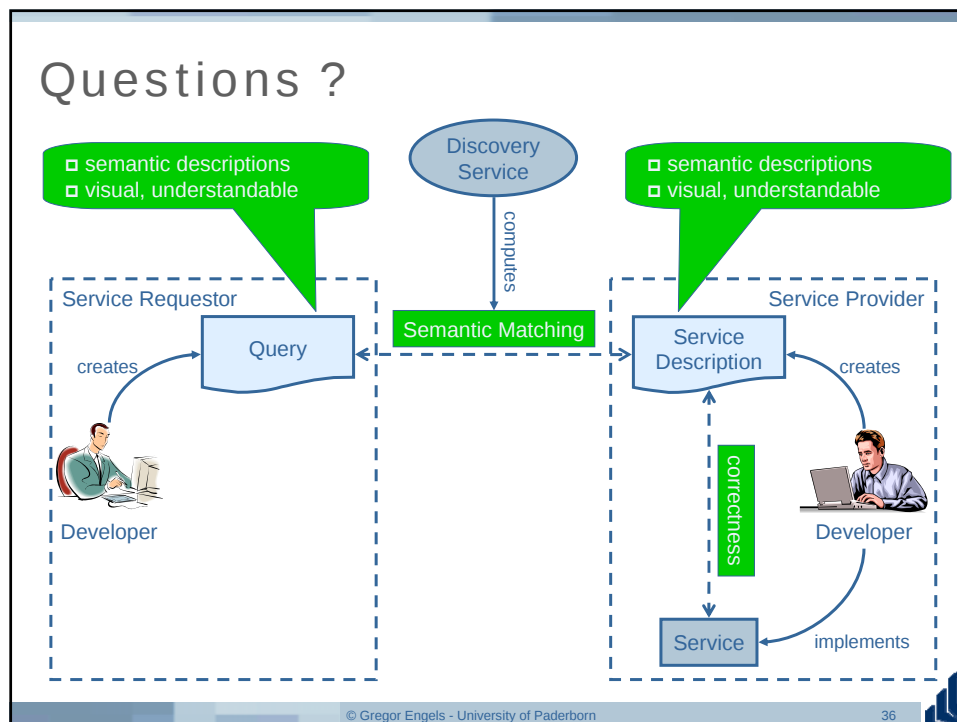
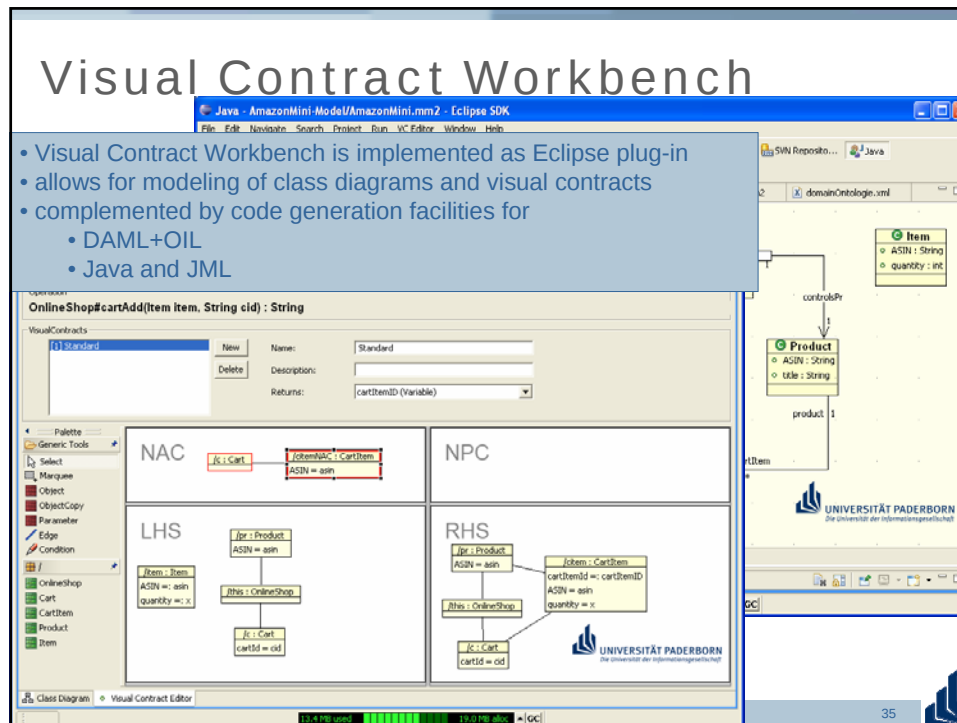
cartID = cid

pre-condition

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32





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- M. Lohmann, S. Sauer, G. Engels, *Executable Visual Contracts*, 2005 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC'05), 2005.
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- J. H. Hausmann, R. Heckel, M. Lohmann, *Model-based discovery of Web Services*, IEEE International Conference on Web Services 2004 (ICWS'04), 2004.

