52. Orthographic Software Modeling (OSM) with Single Underlying Model (SUM) - A 1-TS-Megamodel with Total Consistency

Prof. Dr. U. Aßmann

Technische Universität Dresden

Institut für Software- und Multimediatechnik

http://st.inf.tu-dresden.de/teaching/most

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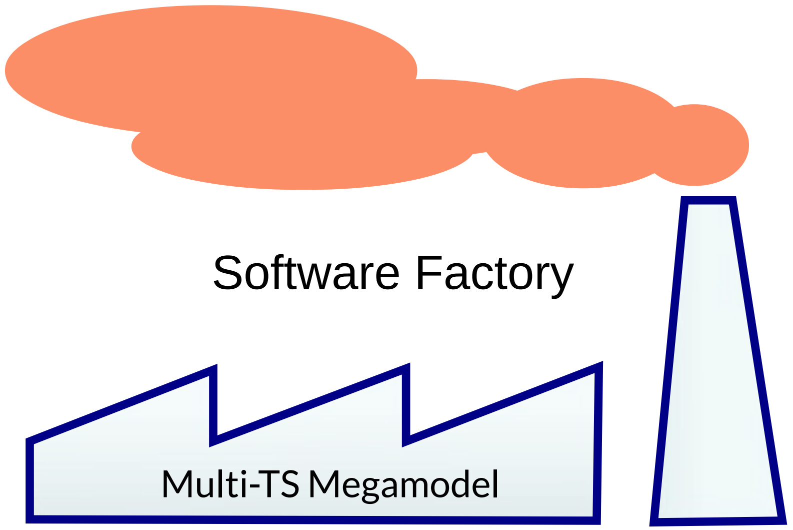
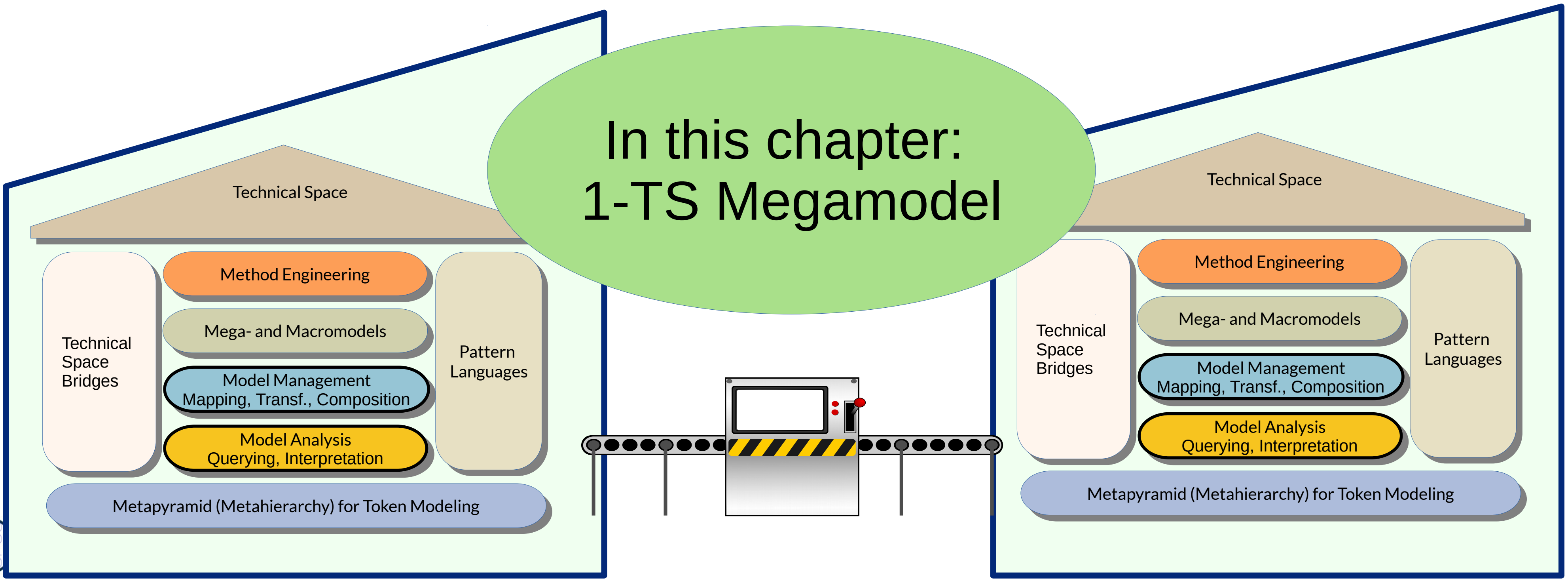
DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

Q11: A Software Factory's Heart: the Multi-TS Megamodel





References

- Zinovy Diskin and Yingfei Xiong and Krzysztof Czarnecki. From State- to Delta-Based Bidirectional Model Transformations: the Asymmetric Case. Journal of Object Technology, 2011, vol. 10, 6, pp. 1-25,
  - http://dx.doi.org/10.5381/jot.2011.10.1.a6
- J. Nathan Foster and Michael B. Greenwald and Jonathan T. Moore and Benjamin C. Pierce and Alan Schmitt. ombinators for Bi-Directional Tree Transformations: A Linguistic Approach to the View Update Problem, ACM Transactions on Programming Languages and Systems, Vol 29(3), pp. 17, 2007
  - http://www.cis.upenn.edu/~bcpierce/papers/newlenses-popl.pdf

Synchronization of Projective Views on a Single Underlying Model (A Orthographic Macromodel)

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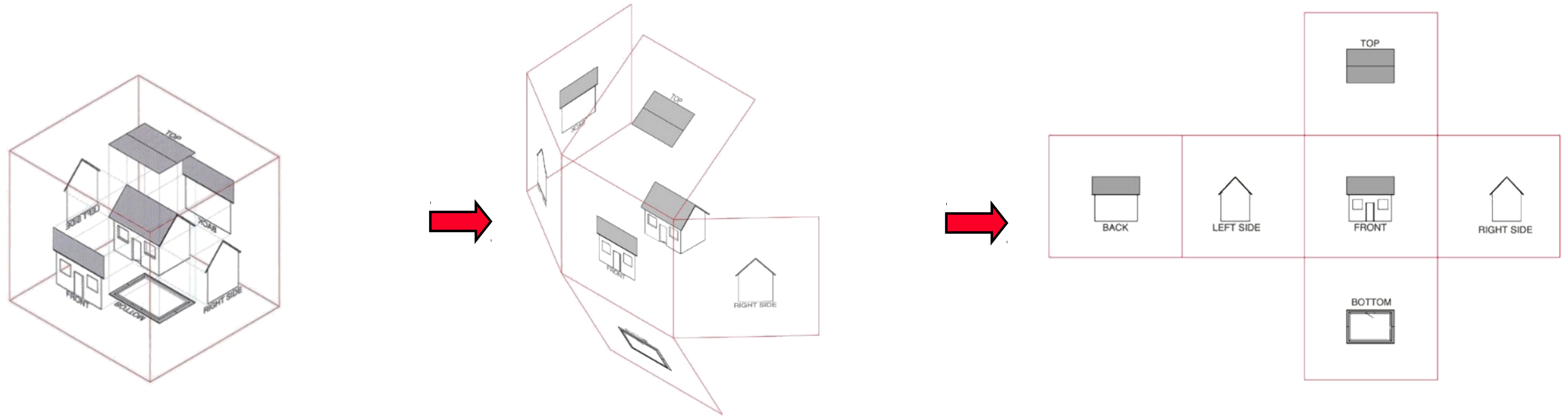
21 July, 2015

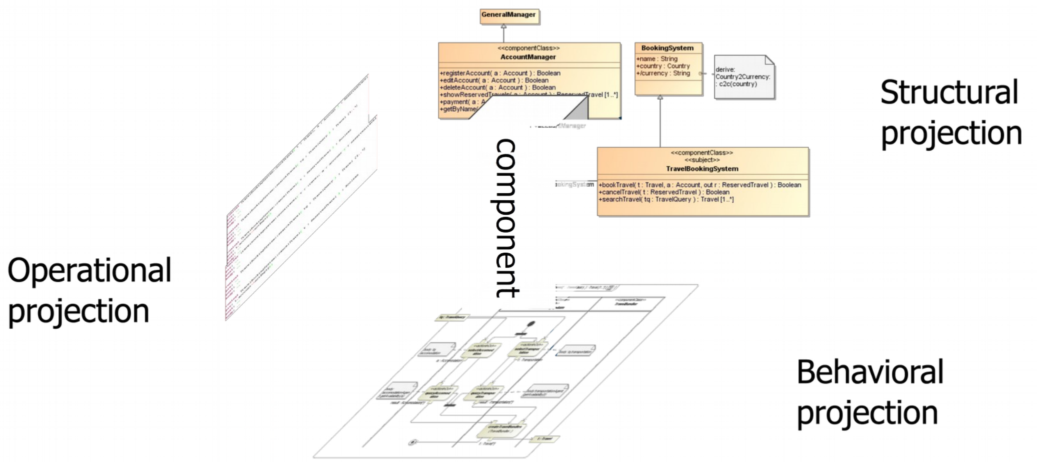
UNIVERSITÄT MANNHEIM

52.1 Orthographic Software Modeling (OSM)

- other engineering disciplines have a long and successful tradition of technical drawing - orthographic projection



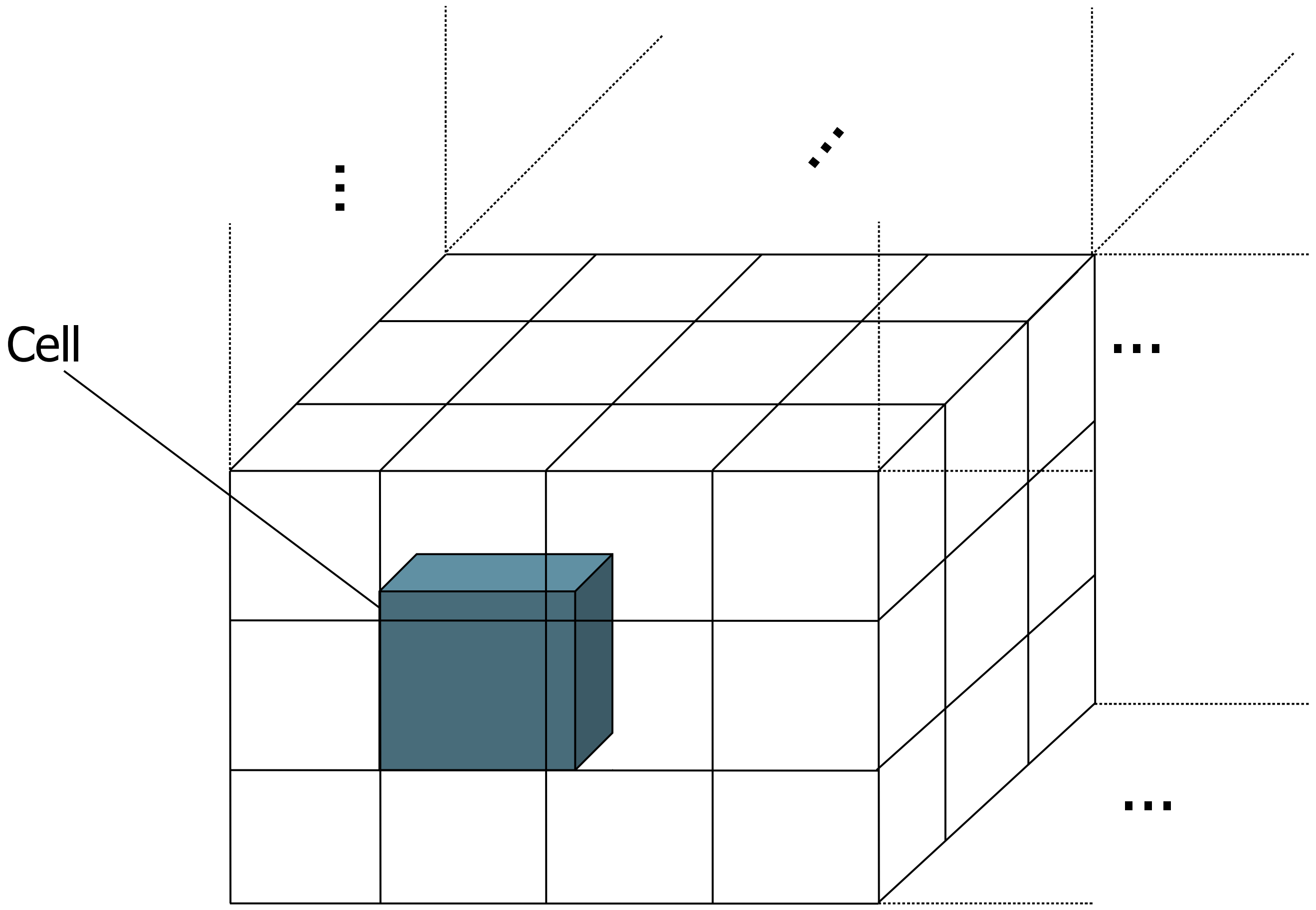
- so why don't we do this in software engineering?



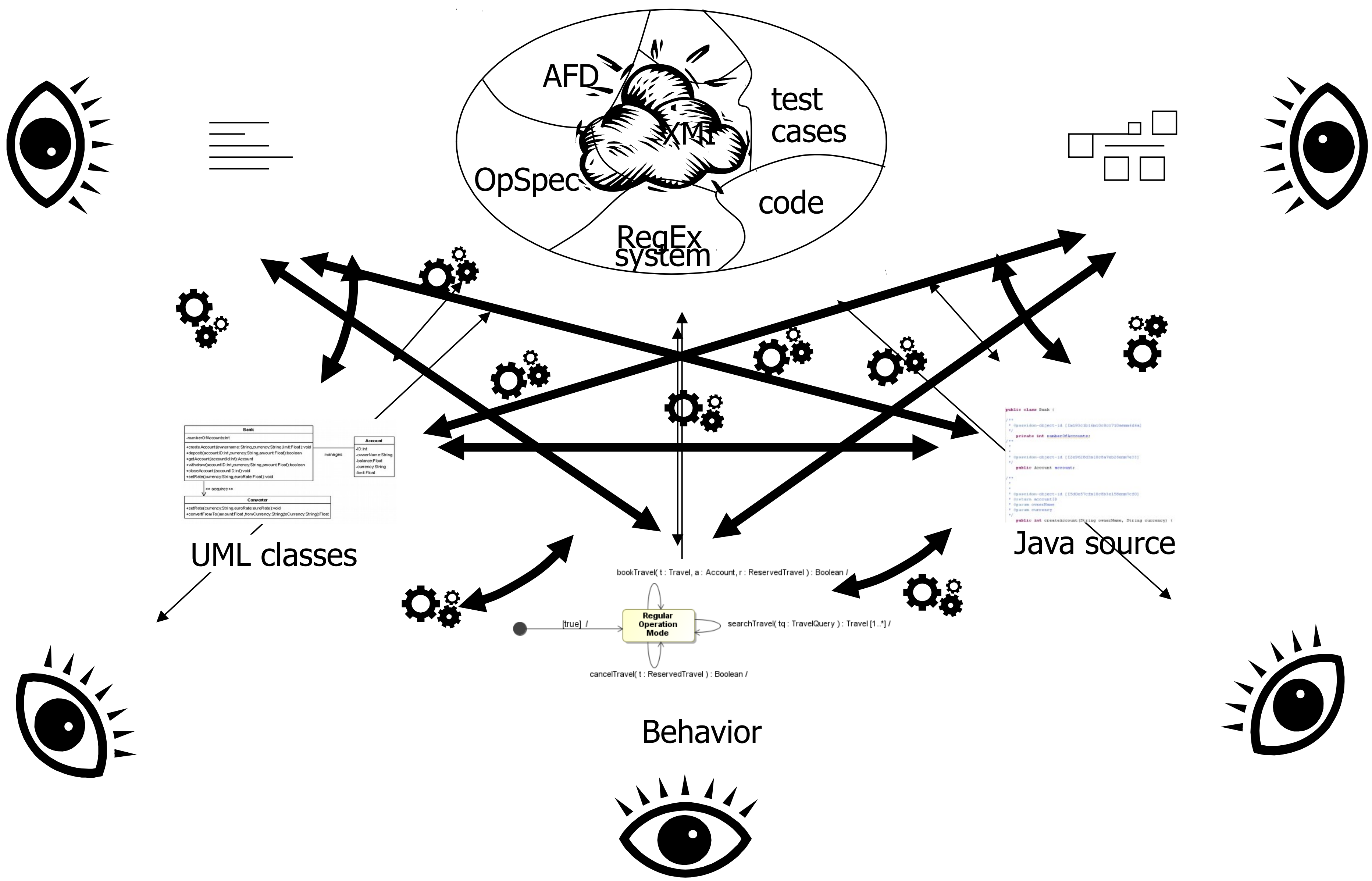
- On demand view generation (projective views)
- Dimension-based navigation
- View-based methodology

Dimension Based Navigation

- views organized in a multi-dimensional cube
- one choice always “selected” from each dimension
- each cell represents a viewpoint



Traditional View-based Environment

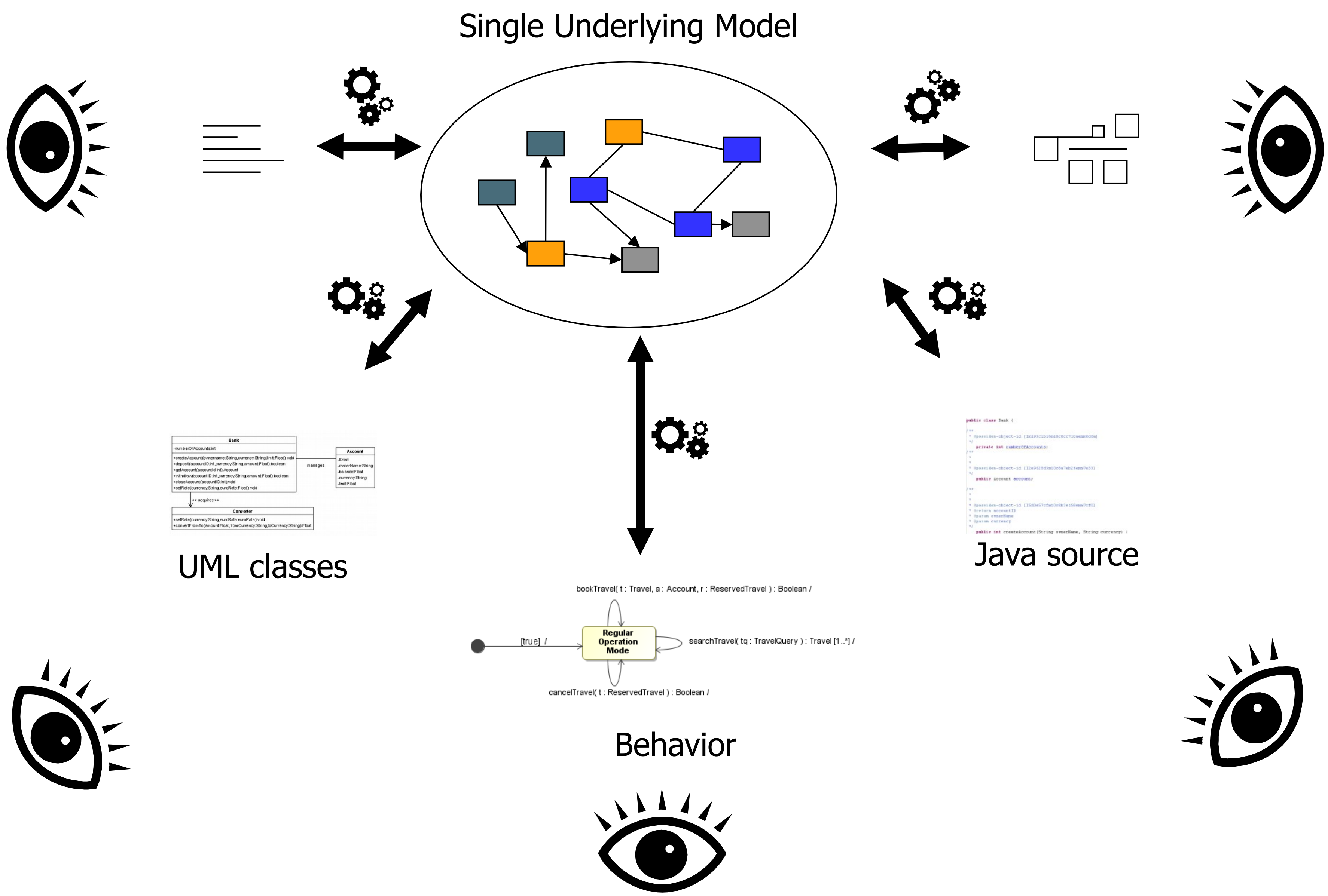

AFD
XMI
test cases
OpSpec
code
RegEx system
Bank
-numberOfAccounts:int
+createAccount(ownername:String,currency:String,limit:Float):void
+deposit(accountID:int,currency:String,amount:Float):boolean
+getAccount(accountId:int):Account
+withdraw(accountID:int,currency:String,amount:Float):boolean
+closeAccount(accountID:int):void
+setRate(currency:String,euroRate:Float):void
manages
Account
-ID:int
-ownerName:String
-balance:Float
-currency:String
-limit:Float
<< acquires >>
Converter
+setRate(currency:String,euroRate:euroRate):void
+convertFromTo(amount:Float,fromCurrency:String,toCurrency:String):Float
UML classes
Java source
bookTravel(t : Travel, a : Account, r : ReservedTravel) : Boolean /
[true] /
Regular Operation Mode
searchTravel(tq : TravelQuery) : Travel [1..*] /
cancelTravel(t : ReservedTravel) : Boolean /
Behavior

```
public class Bank {

/**
 * @poseidon-object-id [Im19]c1b16m10c8cc710mmmm6d6m]
 */
    private int numberOfAccounts;
/**
 *
 *
 * @poseidon-object-id [I2e9628d3m10c8m7eb26mmm7e33]
 */
    public Account account;

/**
 *
 *
 * @poseidon-object-id [I5d0e57cfm10c8b3e158mmm7cf0]
 * @return accountID
 * @param ownerName
 * @param currency
 */
    public int createAccount(String ownerName, String currency) {
```

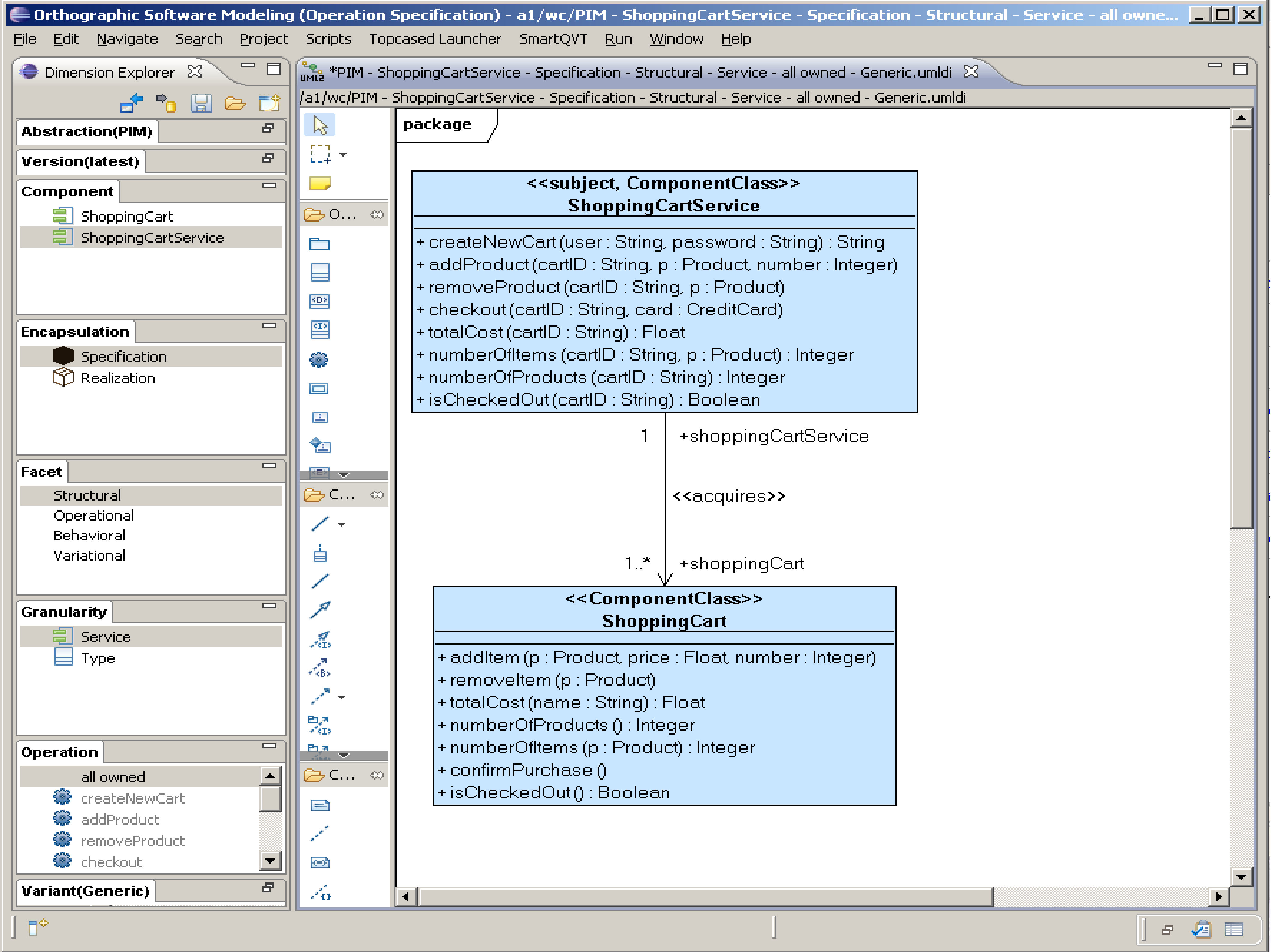
On-Demand View Generation


Single Underlying Model
Bank
-numberOfAccounts:int
+createAccount(ownername:String,currency:String,limit:Float):void
+deposit(accountID:int,currency:String,amount:Float):boolean
+getAccount(accountId:int):Account
+withdraw(accountID:int,currency:String,amount:Float):boolean
+closeAccount(accountID:int):void
+setRate(currency:String,euroRate:Float):void
manages
Account
-ID:int
-ownerName:String
-balance:Float
-currency:String
-limit:Float
<< acquires >>
Converter
+setRate(currency:String,euroRate:euroRate):void
+convertFromTo(amount:Float,fromCurrency:String,toCurrency:String):Float
UML classes
Java source
bookTravel(t : Travel, a : Account, r : ReservedTravel) : Boolean /
[true] /
Regular Operation Mode
searchTravel(tq : TravelQuery) : Travel [1..*] /
cancelTravel(t : ReservedTravel) : Boolean /
Behavior

```
public class Bank {

/**
 * @poseidon-object-id [Im193c1b16m10c8cc710mmm6d6a]
 */
    private int numberOfAccounts;
/**
 *
 *
 * @poseidon-object-id [I2e9628d3m10c8a7eb26mm7e33]
 */
    public Account account;

/**
 *
 *
 * @poseidon-object-id [I5d0e57cfm10c8b3e159mm7cf0]
 * @return accountID
 * @param ownerName
 * @param currency
 */
    public int createAccount(String ownerName, String currency) {
```



Orthographic Software Modeling (Operation Specification) - a1/wc/PIM - ShoppingCartService - Specification - Structural - Service - all owne...

File Edit Navigate Search Project Scripts Topcased Launcher SmartQVT Run Window Help

Dimension Explorer

Abstraction(PIM)

Version(latest)

Component
- ShoppingCart
- ShoppingCartService

Encapsulation
- Specification
- Realization

Facet
- Structural
- Operational
- Behavioral
- Variational

Granularity
- Service
- Type

Operation
- all owned
- createNewCart
- addProduct
- removeProduct
- checkout

Variant(Generic)

*PIM - ShoppingCartService - Specification - Structural - Service - all owned - Generic.umldi

/a1/wc/PIM - ShoppingCartService - Specification - Structural - Service - all owned - Generic.umldi

package

<<subject, ComponentClass>>
ShoppingCartService

```
+ createNewCart (user : String, password : String) : String
+ addProduct (cartID : String, p : Product, number : Integer)
+ removeProduct (cartID : String, p : Product)
+ checkout (cartID : String, card : CreditCard)
+ totalCost (cartID : String) : Float
+ numberOfItems (cartID : String, p : Product) : Integer
+ numberOfProducts (cartID : String) : Integer
+ isCheckedOut (cartID : String) : Boolean
```

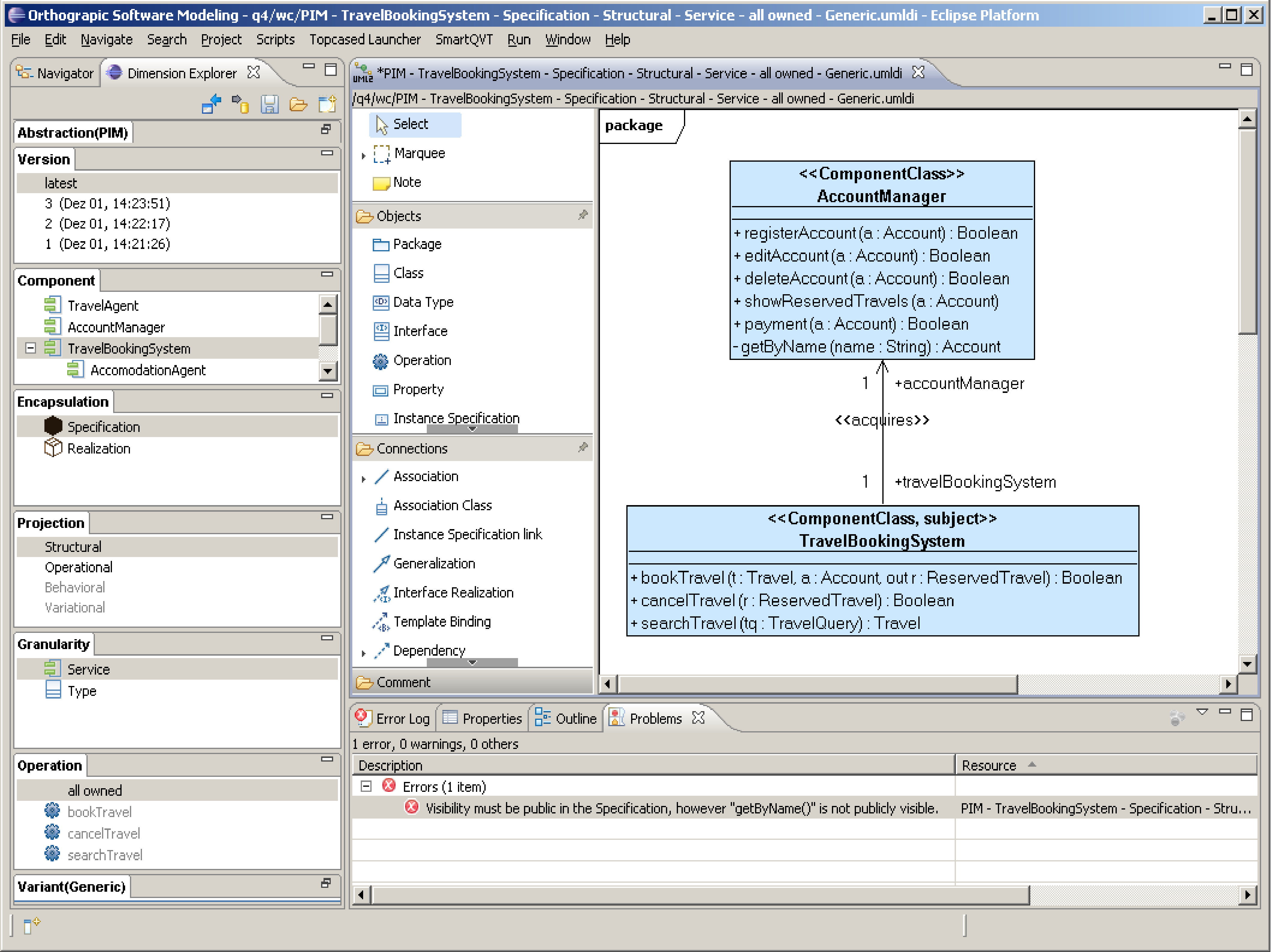
1 +shoppingCartService

<<acquires>>

1..* +shoppingCart

<<ComponentClass>>
ShoppingCart

```
+ addItem (p : Product, price : Float, number : Integer)
+ removeItem (p : Product)
+ totalCost (name : String) : Float
+ numberOfProducts () : Integer
+ numberOfItems (p : Product) : Integer
+ confirmPurchase ()
+ isCheckedOut () : Boolean
```



<<ComponentClass>>
AccountManager

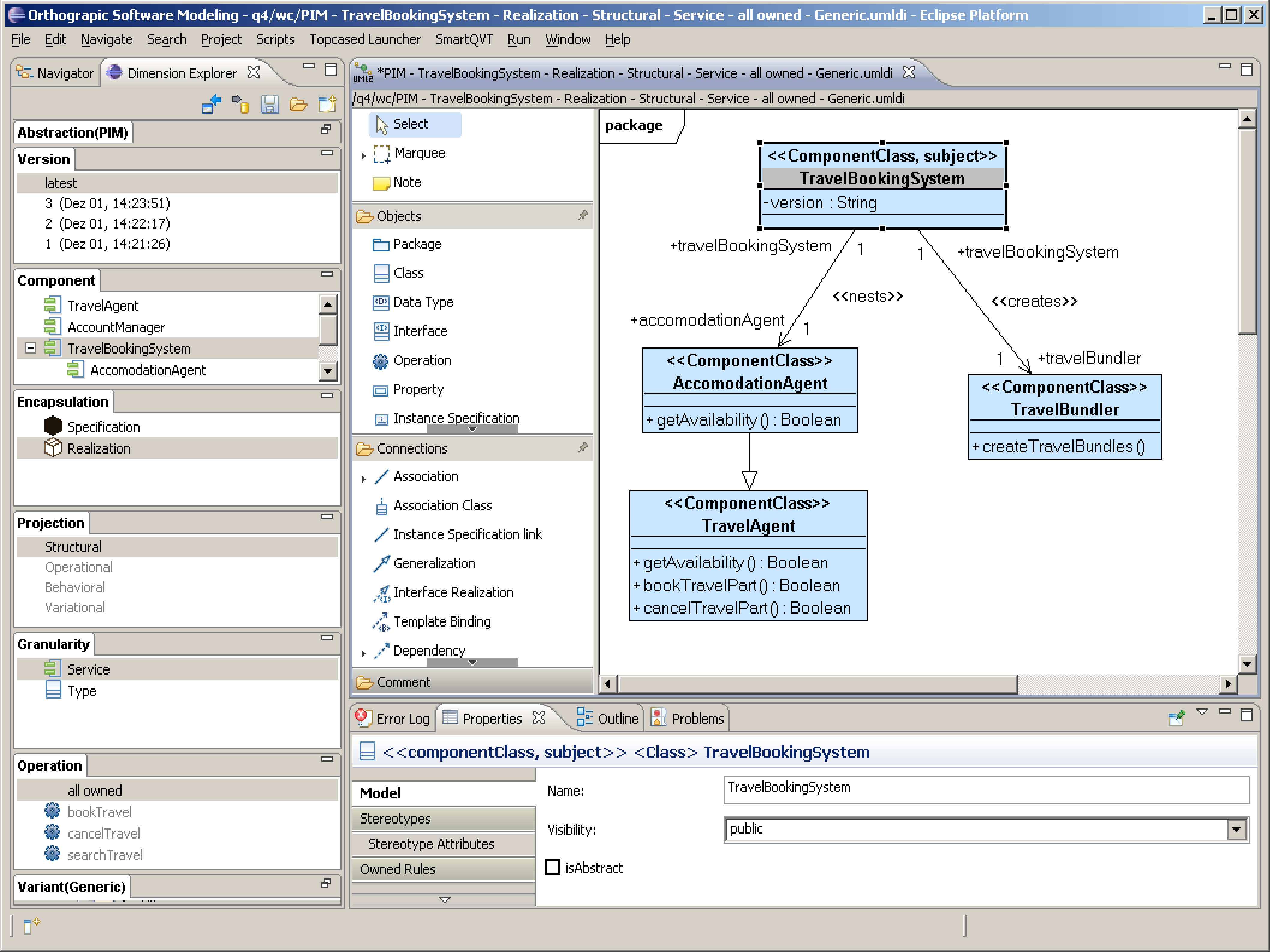
+ registerAccount (a : Account) : Boolean
+ editAccount (a : Account) : Boolean
+ deleteAccount (a : Account) : Boolean
+ showReservedTravels (a : Account)
+ payment (a : Account) : Boolean
- getByName (name : String) : Account

<<ComponentClass, subject>>
TravelBookingSystem

+ bookTravel (t : Travel, a : Account, out r : ReservedTravel) : Boolean
+ cancelTravel (r : ReservedTravel) : Boolean
+ searchTravel (tq : TravelQuery) : Travel

1 error, 0 warnings, 0 others

Description	Resource
Errors (1 item)	
Visibility must be public in the Specification, however "getByName()" is not publicly visible.	PIM - TravelBookingSystem - Specification - Stru...



Name: TravelBookingSystem

Visibility: public

☐ isAbstract

Scalability and Applicability

- An approach needs to be applicable to more than just a toy example
- An approach must scalable for the chosen field of applicabilty
- Simple minded implementation approach –
  - uni-directional transformations (SUM-to-view, view-to-SUM)
  - create a new (version of the) view whenever there is a change in the SUM
  - create a new (version of the) SUM whenever there is a change in a view
- Would work but -
  - not scalable (inefficient)
  - transformation more complex than necessary
  - too large grained

⇒ Delta-based bidirectional lenses

52.2 Delta-Based Lenses

- Lenses (Pierce et al. 2007) are bidirectional transformations based on put and get operations
  - axioms for *well-behaved lenses*

    $\mathrm{get}(\mathrm{put}(v, s)) = v$ *PUTGET invariant rule*

    $\mathrm{put}(\mathrm{get}(s), s) = s$ *GETPUT invariant rule*

  - axiom for *very well behaved lenses*

    $\mathrm{put}(v', \mathrm{put}(v, s)) = \mathrm{put}(v', s)$ *PUTPUT rule*

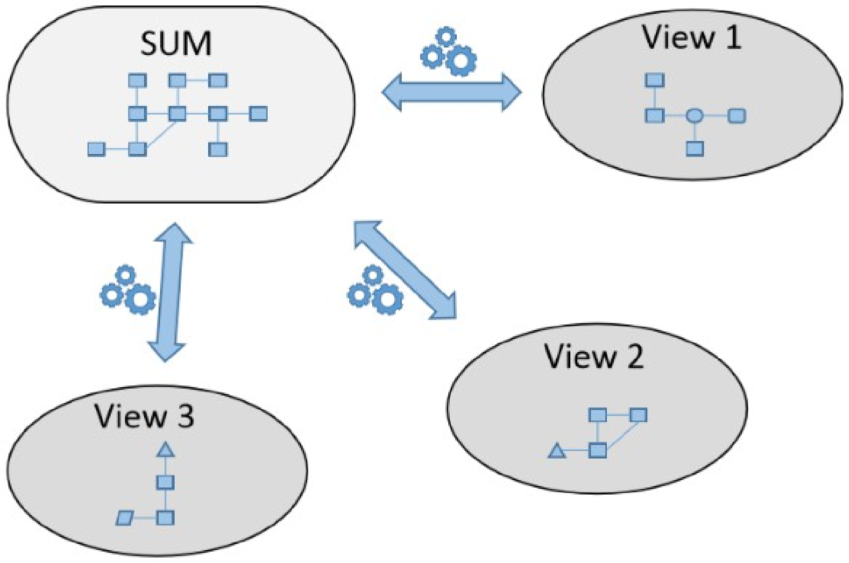
- Delta-based Lenses (Diskin et al. 2011)
  - dput and dget operations driven by the changes to the views
  - avoids problems with the *PUTPUT* rule

    if $\Delta s = \mathrm{dput}(\Delta v, s)$, then $\mathrm{dget}(\Delta s) = \Delta v$ $\equiv$ *DeltaPUTPUT rule*

  - much more fine-grained and scalable

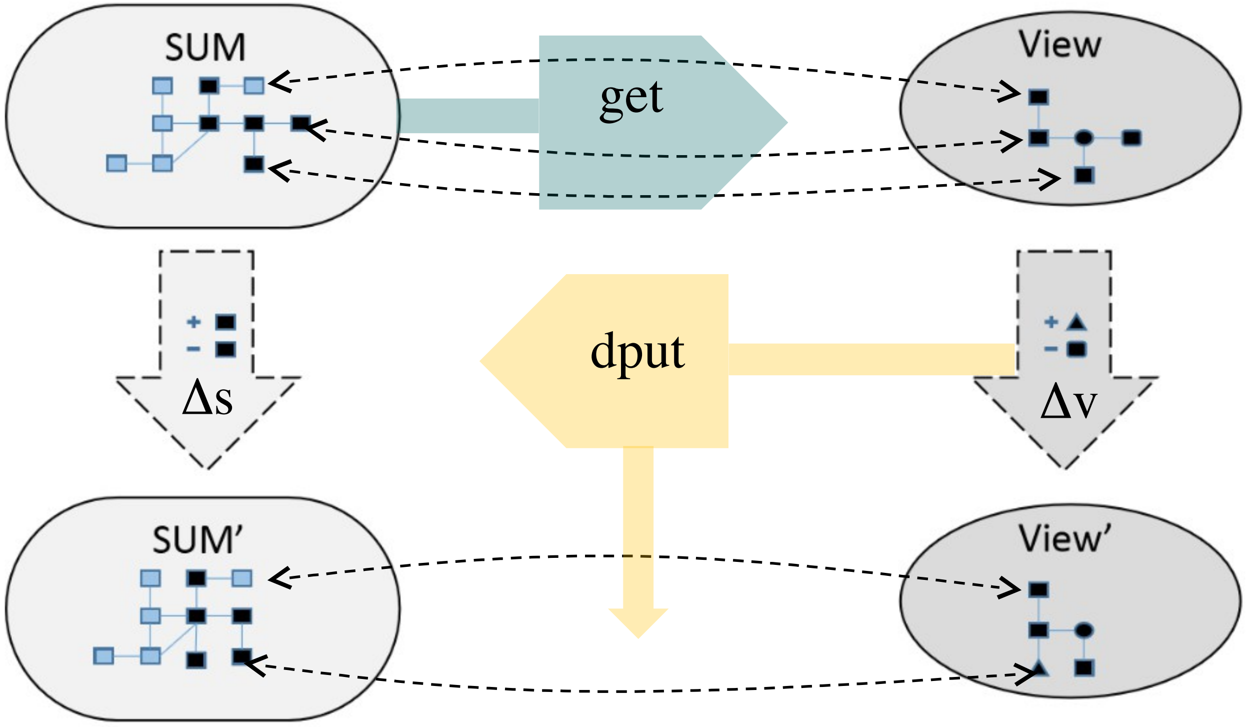
OSM Context

- The SUM is much larger than the views
  - the views are relatively small and compact
- Views can be updated concurrently
  - axioms only applicable locally (i.e. to one view at a time)
- Usually have one-to-one correspondences between view elements and SUM elements
  - changes can conveniently be traced to the affected element
- View elements cannot be changed just locally
  - for example, cannot delete an element from just the view, but not the SUM



Hybrid Approach

- use ***get*** to create views from the SUM
- use ***dput*** to update the SUM when a view is changed



Pros and Cons

- **Traces** allow affected SUM elements to be efficiently identified
  - can be generated most mainstream transformation engines
- Traces also allow the open views impacted by a change to be identified
  - must be updated dynamically a la MVC pattern
- Use of ***get*** to create views reduces the complexity of the transformation with little extra overhead
  - no need to update trace information
- Use of ***dput*** to update the SUM greatly enhances the efficiency of updating SUM
  - the SUM is only ever updated via changes to views
- However, it increases the amount of information that needs to be stored on the server
  - part of the SUM?

Conclusion

- Work in progress…. !
- Related work
  - Inclusion of correspondences suggests connection to Triple Graph Grammars (definition of completeness, correctness etc.)
  - Vitruvius (change objects, projectional scope …)
- Challenges
  - determine appropriate laws in a multi-view context -
    - e.g. when does PUTPUT make sense?
  - accommodate many-to-many correspondences
- Possible enhancements
  - extend correspondence information with layout information to allow retainment of layout between view updates
  - allow local editing and manipulation of views
    - e.g. domain specific rendering