Proceedings of the 6th International Conference on Enterprise Information Systems (ICEIS 2004), p. 298-305: ICEIS Press, Porto (Portugal), April 14-17 2004.

# Advantages of UML for Multidimensional Modeling

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## Content

- Introduction
- MD Modeling based on the UML
- Advantages of UML for MD Modeling
- Conclusions

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- **Introduction**
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## Introduction

**Data warehouses**
(DW)
**Multidimensional databases**
(MDB)
**On-Line Analytical Processing**
(OLAP)

Multidimensional paradigm
↓
Facts
Measures
Dimensions
Attributes

Different approaches → **No standard**

## Introduction

- **Unified Modeling Language (UML)** → Standard object-oriented (OO) modeling language for describing and designing software systems
  - Widely accepted
  - General
  - Visual support
  - …

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## Introduction

- Our previous work:
  - A UML extension for MD modeling
  - Based on a three-layered schema
- In this work:
  - How our approach resolves important problems of MD modeling: multistar models, shared dimensions, multiple and alternative hierarchy levels, etc.

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- **MD Modeling based on the UML**
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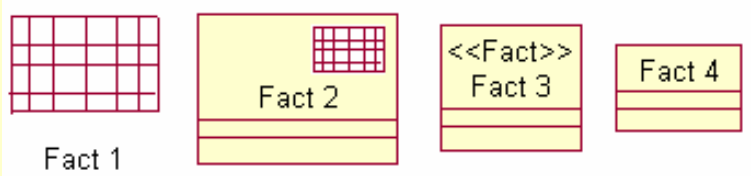
## MD Modeling based on the UML

- UML is a **general purpose** visual modeling language for systems
- **Extension mechanisms** allow the user to tailor it to specific domains
- Mechanisms:
  - **Stereotypes** → New building elements
  - **Tagged values** → New properties
  - **Constraints** → New semantics

## MD Modeling based on the UML

- Stereotype is the main mechanism:
  - Tagged values define stereotype properties
  - Constraints specify stereotype behavior
- Different representations of a stereotype:




Icon Decoration Label None

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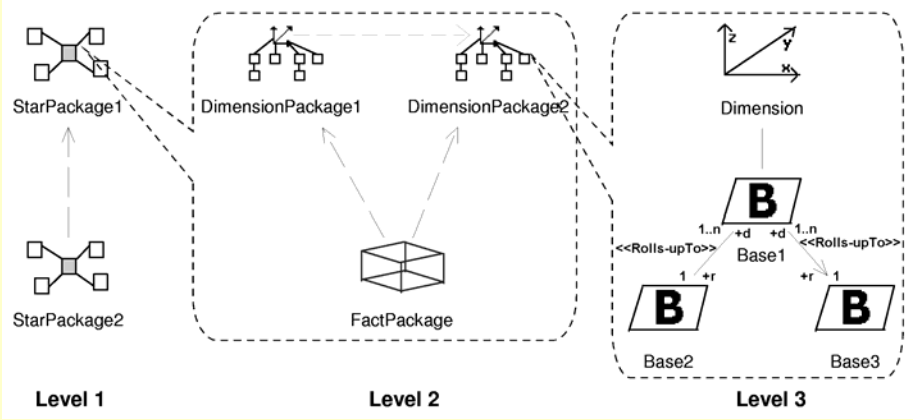


Model definition Star schema definition Dimension/fact definition

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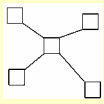
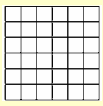
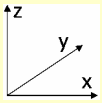
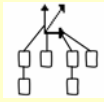
## MD Modeling based on the UML

| Package stereotypes | | Class stereotypes | |
|---|---|---|---|
|  | StarPackage (Level 1) |  | Fact (Level 3) |
|  | FactPackage (Level 2) |   | Dimension (Level 3) |
|  | DimensionPackage (Level 2) |   | Base (Level 3) |





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## Advantages of UML for MD Modeling

1. Multistar models
2. Support for different building perspectives
3. Shared dimensions
4. Shared hierarchy levels
5. Multiple and alternative classification hierarchies





## Advantages of UML for MD Modeling

6. Heterogeneous dimensions
7. Shared aggregation
8. Derivation rules
9. Computer-Aided Software Engineering (CASE) tool support

## Advantages of UML for MD Modeling

- Running example: a simplified version of the warehouse example from Kimball's *The Data Warehouse Toolkit*:
  - **Inventory snapshot**: measures the inventory levels in a regular period of time
  - **Delivery status inventory**: tracks the disposition of all the items in a delivery
  - **Transaction inventory**: every change of status of delivered products is recorded throughout the delivery flow

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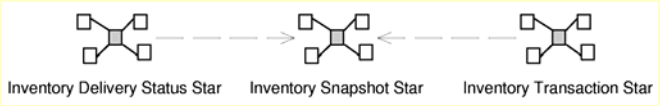
## Advantages of UML for MD Modeling

1. Multistar models:
   - Fact constellation
   - A single MD model has multiple facts → Multiple star schemas

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## Advantages of UML for MD Modeling

2. Support for different building perspectives:
   - Top-down: DW → data marts
   - Bottom-up: data marts → DW

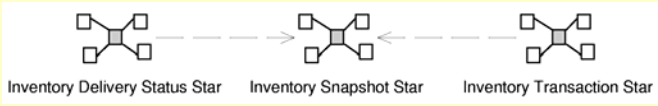




## Advantages of UML for MD Modeling

3. Shared dimensions:
   - Two or more star schemas can share some dimensions
   - Benefits:
     - Reduces the development time
     - Drill-across
     - Avoids inconsistency

## Advantages of UML for Multidimensional Modeling

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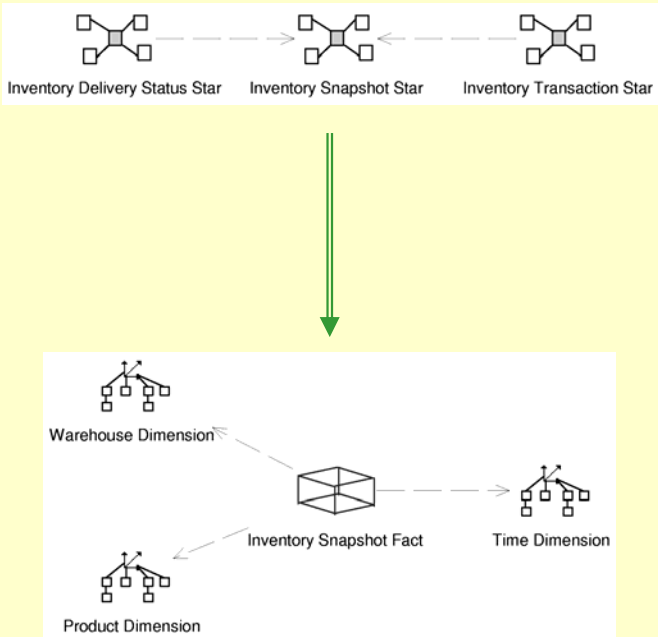
## Advantages of UML for Multidimensional Modeling

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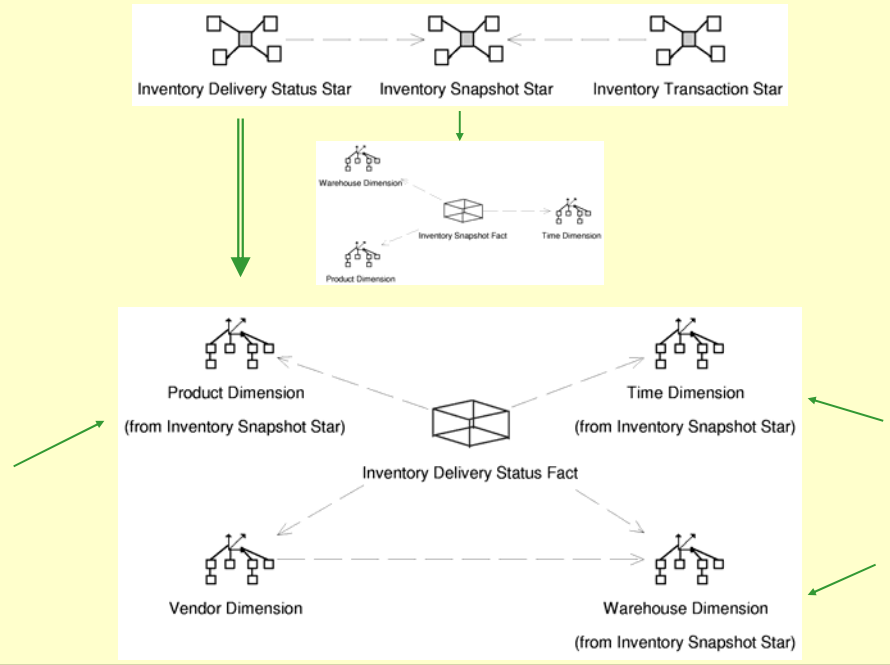
## Advantages of UML for Multidimensional Modeling

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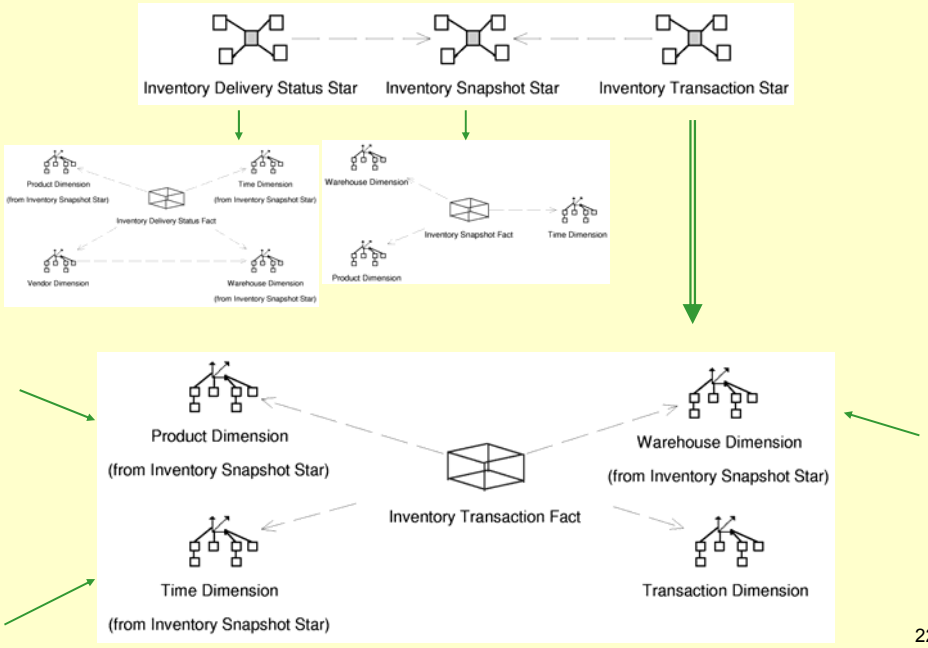
## Advantages of UML for Multidimensional Modeling

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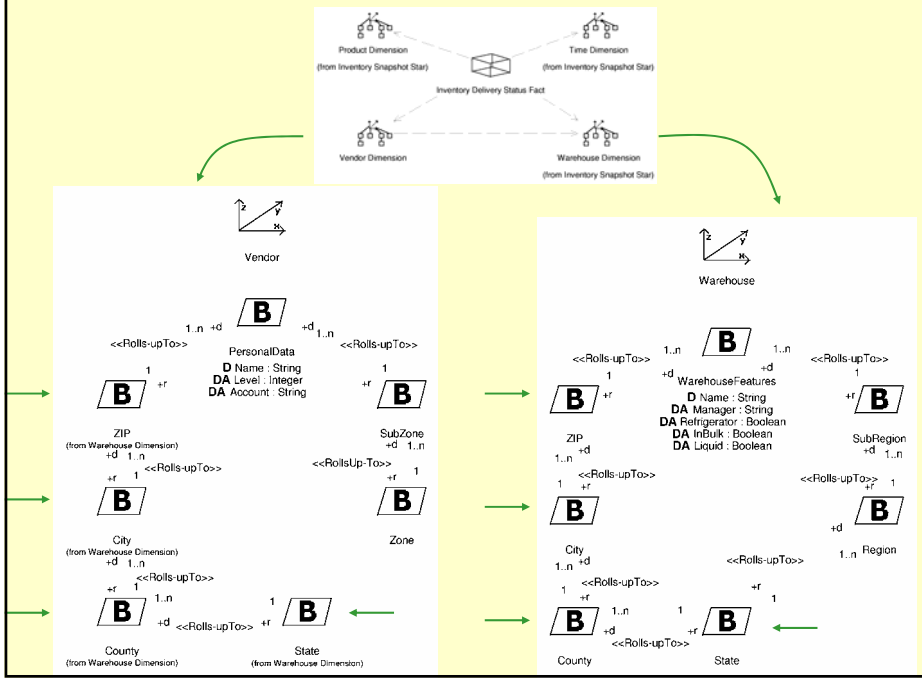
# Advantages of UML for MD Modeling

4. Shared hierarchy levels:
   - Two or more dimensions share some hierarchy levels
   - Similar benefits to shared dimensions: reduces development time, avoids inconsistency, etc.
   - Salient feature: two dimensions do not need to share the whole hierarchy → Higher level of flexibility







# Advantages of UML for MD Modeling

5. Multiple and alternative classification hierarchies:
   - Classification hierarchies provide the basis for the subsequent data analysis
   - **Multiple**: when a dimension has two or more classification hierarchies
   - **Alternative**: where two or more classification hierarchies converge into the same hierarchy level

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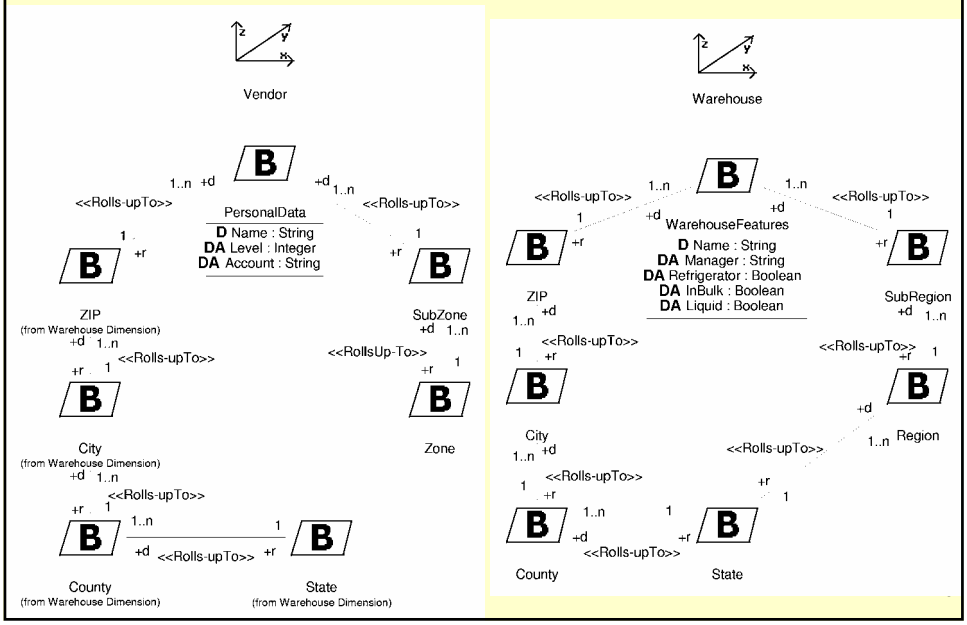
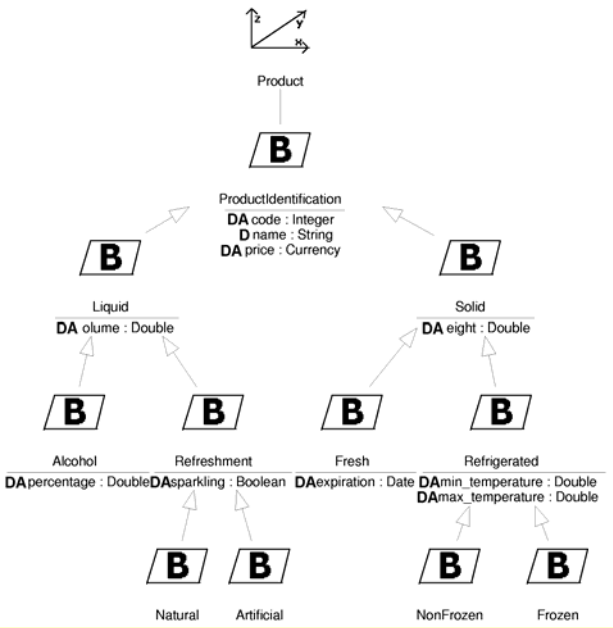


# Advantages of UML for MD Modeling

6. Heterogeneous dimensions:
   - A dimension that describes a large number of heterogeneous items with different attributes
   - Different categorization levels thanks to generalization/specialization hierarchies







# Advantages of UML for MD Modeling

7. Shared aggregation:
   - Allows us to represent many-to-many relationships between Fact and Dimension
   - Named relationships allows us to define more than one relationship between two classes

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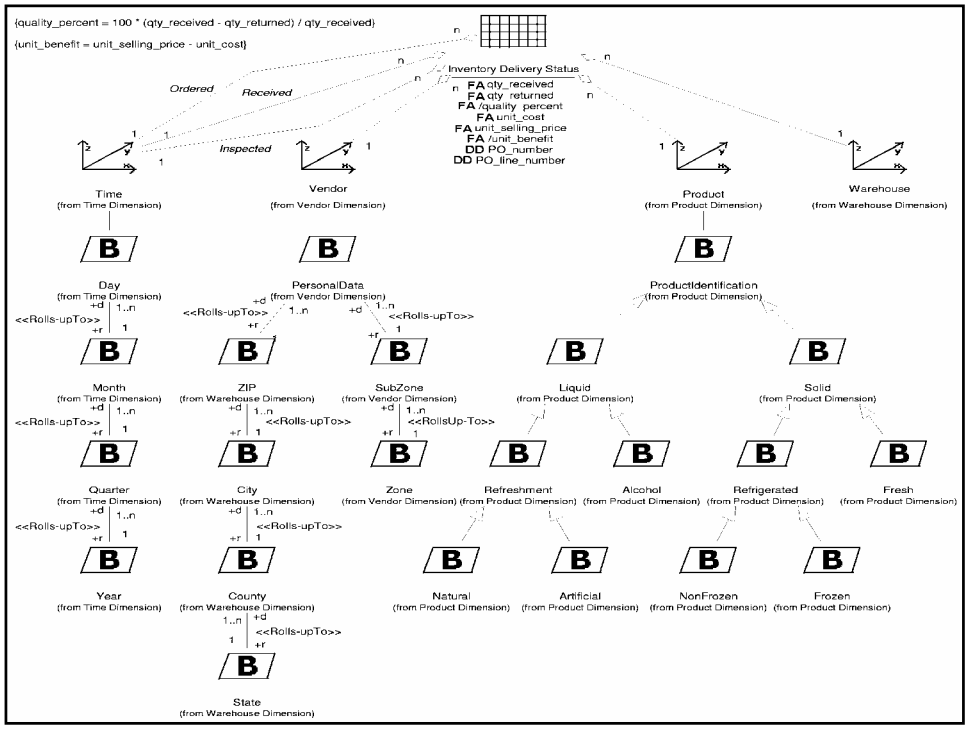

# Advantages of UML for MD Modeling

8. Derivation rules:
   - Derived attribute → /
   - Derivation rules are explicitly defined

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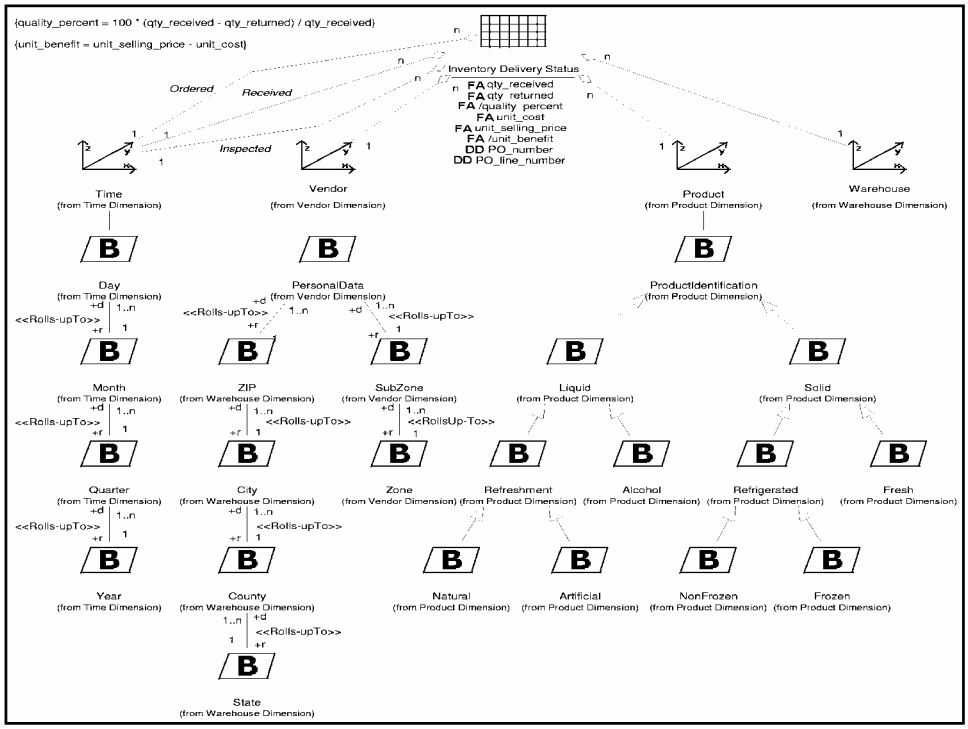
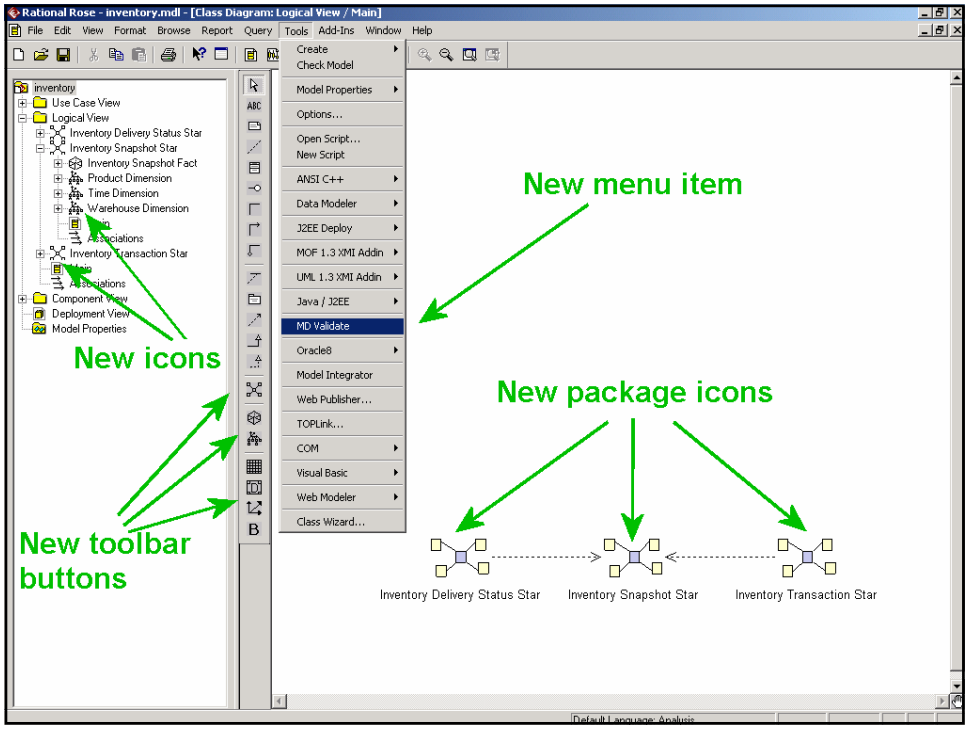


## Advantages of UML for MD Modeling

9. Computer-Aided Software Engineering (CASE) tool support:
   - Add-in for Rational Rose 2002
   - A well-known CASE tool available in the market
   - We do not have to develop our own CASE tool from scratch





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## Conclusions

- UML packages: clean MD design of huge and complex systems
- UML importation mechanism:
  - Simplifies the models
  - Avoids redundancy, inconsistency, and ambiguity

## Conclusions

- Future work:
  - Implementation of MD models → ORDB and OODB
  - Different implementation strategies: snowflake, constellation, etc.
  - Incorporate UML use cases into MD conceptual modeling





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