Patterns of Business Software Applications In Model Driven Architecture

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Agenda

- Structural Patterns (13.30 – 14.50)
- Behavioral Patterns (14.50 – 16.05)
  - Coffee break (15.00 – 15.30)
- Model-Driven Architecture for Business Systems (16.05 – 17.00)

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About me

- Pavel Hruby
  - (pronounced ”ruby”; but call me Pavel, please)
- Work at Navision Software
  - Headquarters in Copenhagen, Denmark
  - Products: Navision (Attain), Axapta, C5
- Work at Microsoft Business Solutions
  - Microsoft has acquired Navision in July 2002
  - Products: + Great Plains, Solomon + more
  - www.microsoft.com/BusinessSolutions
- E-mail: phruby@acm.org

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Description of a Pattern

- Name
  - Proxy
- Context
  - Client is depending on services from another component. Direct access is technically possible, but may not be the best approach.
- Forces
  - Client needs to access services from another component
  - We do not want do hard-code a component’s physical location to its clients
  - Direct access may be inefficient or insecure
- Solution
  - Let client communicate with a representative (surrogate), rather than the component itself.

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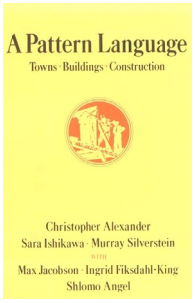
Pattern Definition

- Each pattern describes a problem that occurs over and over again in our environment,
- and then describes the core of the solution to that problem
- in such a way that you can use this solution a million times over without ever doing it the same way twice.

- Christopher Alexander



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Light on Two Sides of Every Room

- When people have a choice, they will always gravitate to those rooms which have natural light coming in from at least two sides.

- In designing a home, it's best to locate each room so that it has outdoor space on at least two sides, with ample windows to capture natural light in every room from more than one direction.

Source: A pattern language: towns, buildings, construction, by Christopher Alexander, Sara Ishikawa, Murray Silverstein, with Max Jacobson, Ingrid Fiksdahl-King, Schlomo Angel, New York, Oxford University Press, 1977.

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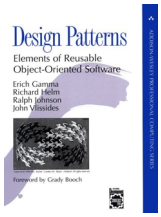
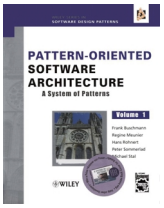
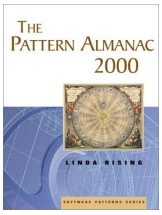
Patterns

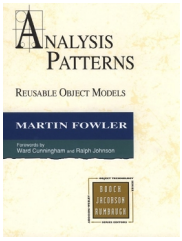
Design Patterns

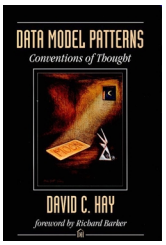


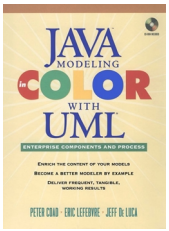




Business Patterns







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Patterns of Business Software Applications

- Business Relationships
- REA (Resources Events Agents)
- Contract
- Roles
- Business Transaction
- Account
- Identification
- Classification
- Due Date
- …

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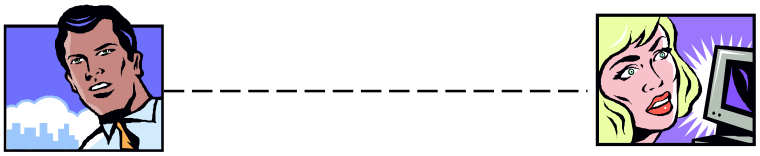
Part 1: Structural Patterns

Business Relationships
REA
Business Transaction
Contract
Roles
Business Component

Business Relationships: Business Problem



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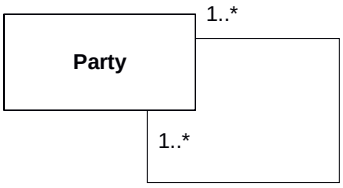
Business Relationships: Structure



- Unfortunately, reality is more complicated than this.

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Business Relationships: Forces

- You want to model the rules that apply to *all* economic systems
- You want to model things that are shareable and reusable across various application domains
- You want to build an extendable system, which can be extended by new concepts without changes to the foundations of the system.

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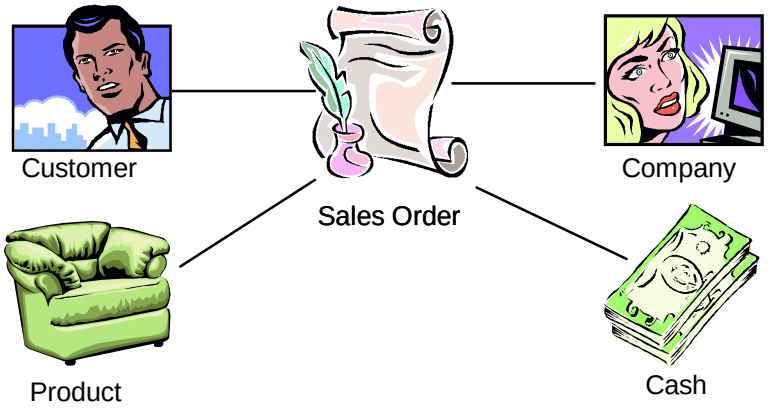
Example: Sales Order



Other examples: Service level agreement, invoice, phone call

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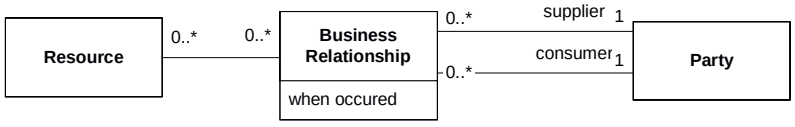
Business Relationship: Structure



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Business Relationships: Resulting Context

- Parties (agents, business partners) are ”never” directly related to each other.
- The pattern does not specify any additional constraints and rules.
- The pattern defines the fundamental infrastructure of the enterprise model, which can be extended by other patterns.

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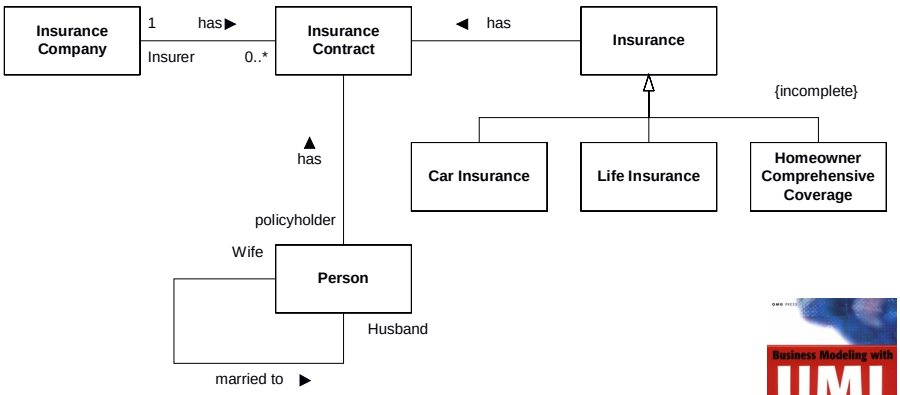
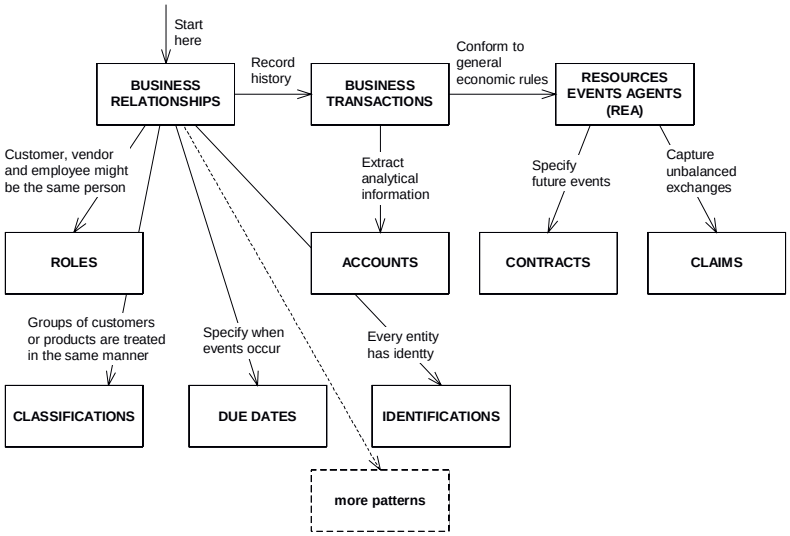
Exercise: Examine this Model



Source: Eriksson, Penker: Business Modeling with UML, Wiley, 2000

Pattern Language for Business Systems



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Business Transaction: Problem

Customer

Company

Record

Database

Term ”transaction” has two meanings:

- Communication involving two or more parties
- A record of business, especially a business agreement or exchange

I use the term transaction to mean the record of business.

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Business Transaction: Forces

- Record all relevant information about relationships between business partners
- An event that affects the business relationship might imply other events to occur.
  - For example, shipment of goods implies payment to occur.
- If user of the system made an error when making a record, there are often legal requirements for correction of the error.
  - The original (erroneous) information should often not just be deleted or overwritten, but instead a new record that eliminates the effect of the error should be made.

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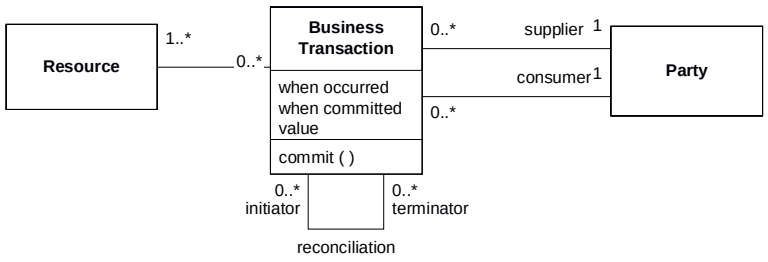
Business Transaction: Solution



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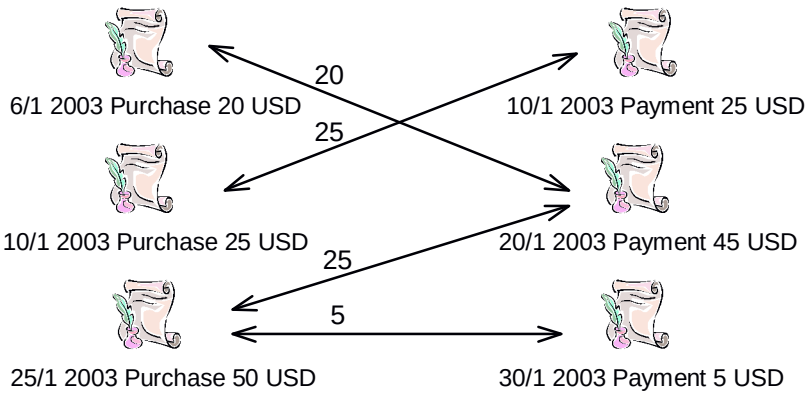
Reconciliation (Apply): Example



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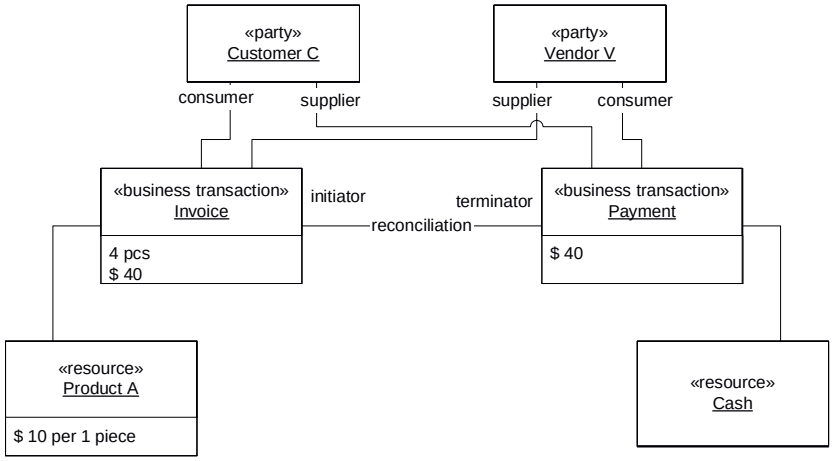
Business Transaction: Example



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Business Transaction: Resulting Context

- Special strategies for corrections of errors
- Business transaction (in the REA conceptual framework) does not have a navigable relationship to account.

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More Information

- Business transactions are part of the Transactions and Accounts pattern language, available at http://c2.com/cgi-bin/wiki?TransactionsAndAccounts
- Martin Fowler' paper Accounting Patterns has a concept of event that is close to business transaction. The paper is available at http://martinfowler.com/apsupp/accounting.pdf.

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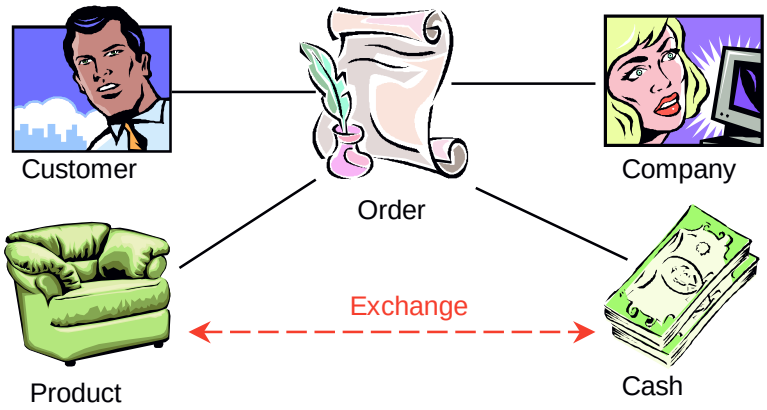
REA (Resources Events Agents): Problem



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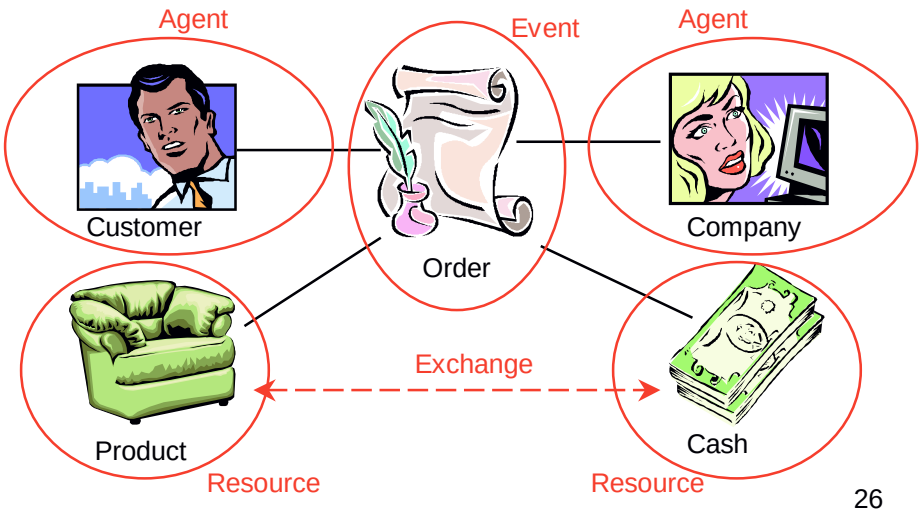
REA (Resources Events Agents): Problem



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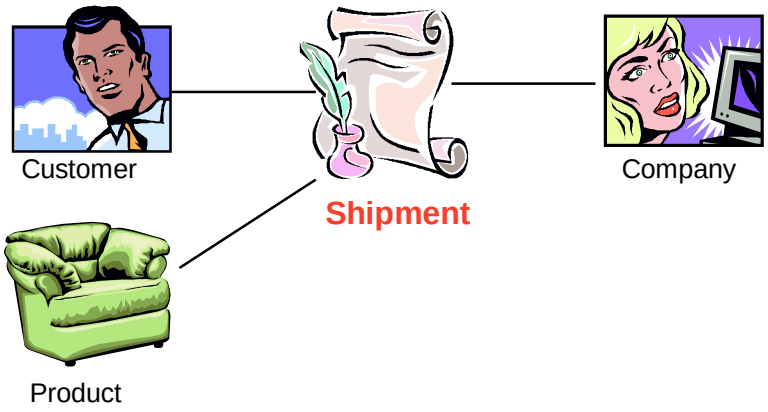
In Fact, there are Two Economic Events



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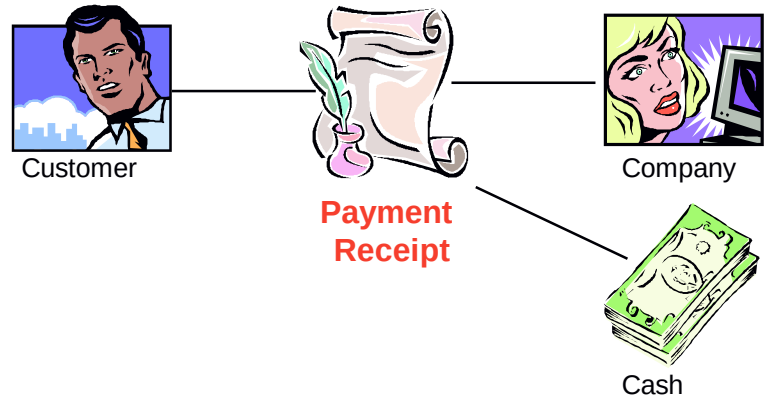
In Fact, there are Two Economic Events



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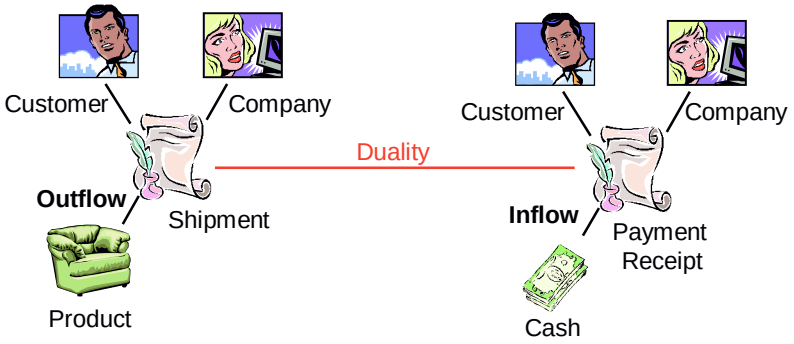
REA (Resources Events Agents): Problem



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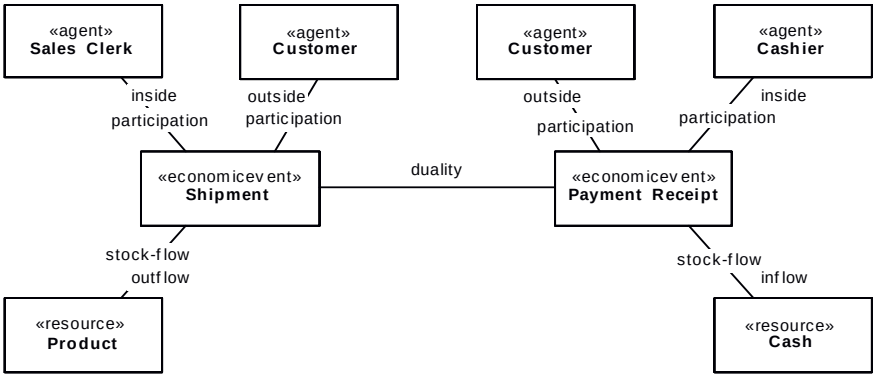
REA (Resources Events Agents): Example



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REA (Resources Events Agents): Axioms

- At least one inflow event and one outflow even exist for each economic resource; conversely, inflow and outflow events must affect identifiable resources
- All events effecting an outflow must be eventually paired in duality relationships with events effecting and inflow and vice-versa
- Each exchange needs an instance of both the inside and outside parties.

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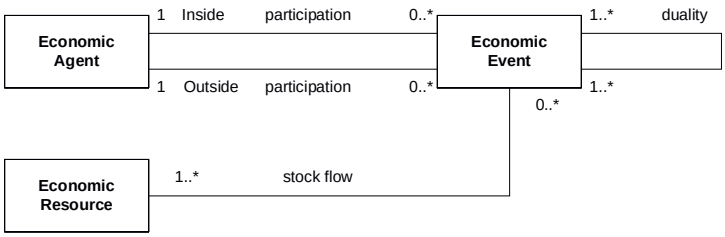
REA (Resources Events Agents): Structure



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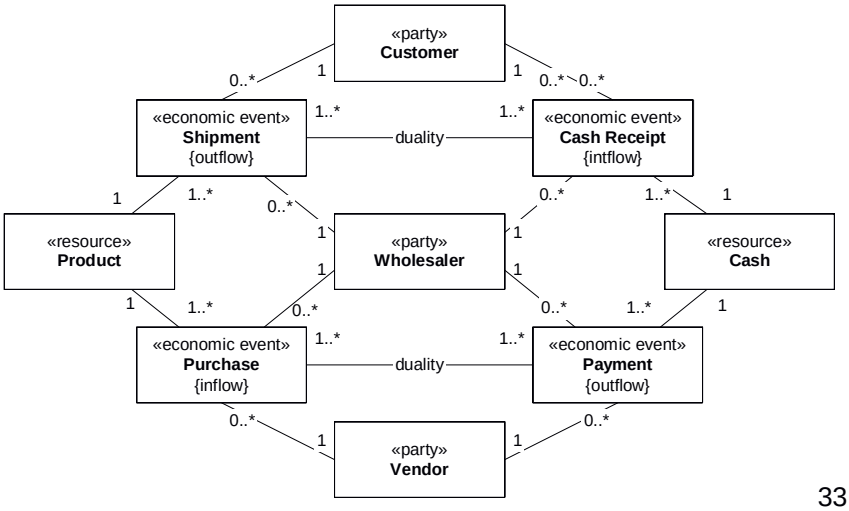
REA: Wholesale Example



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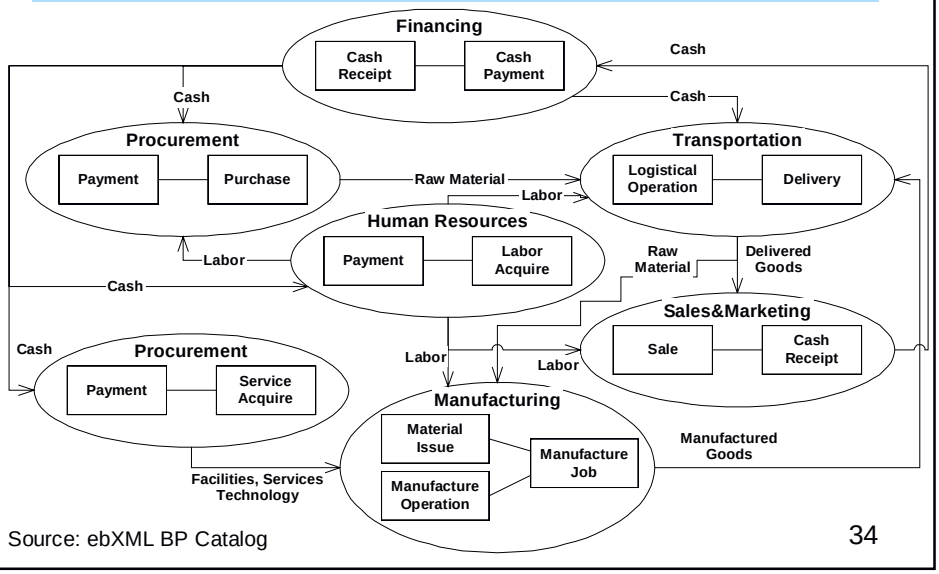
REA: Supply Chain Example



Source: ebXML BP Catalog

34

REA: More Information

- W E. McCarthy: The REA Accounting model: A generalized framework for accounting systems in a shared data environment. The accounting review (July) pp. 554-578, 1982.
- Geerts, G.: "Augmented Intensional Reasoning in Knowledge-Based Accounting Systems,The Journal of Information Systems,1995
- Jesper Kiehn, Model REAL World, VikingPLoP 2002, for details see www.plop.dk/vikingplop
  - This paper describes REA in the pattern form.

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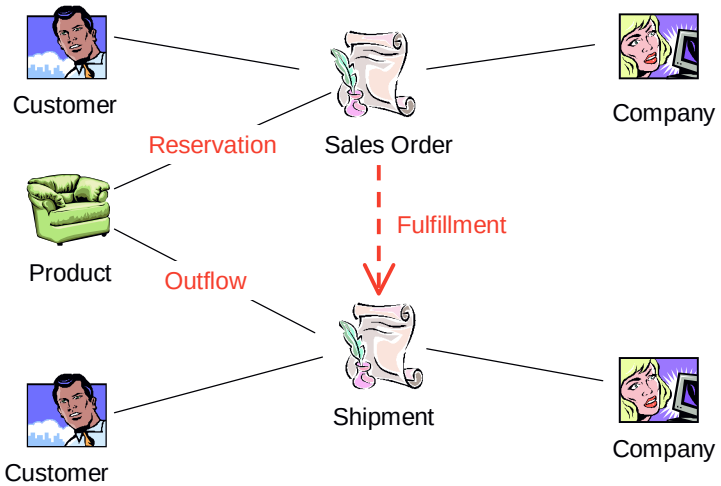
Commitment: Business Problem



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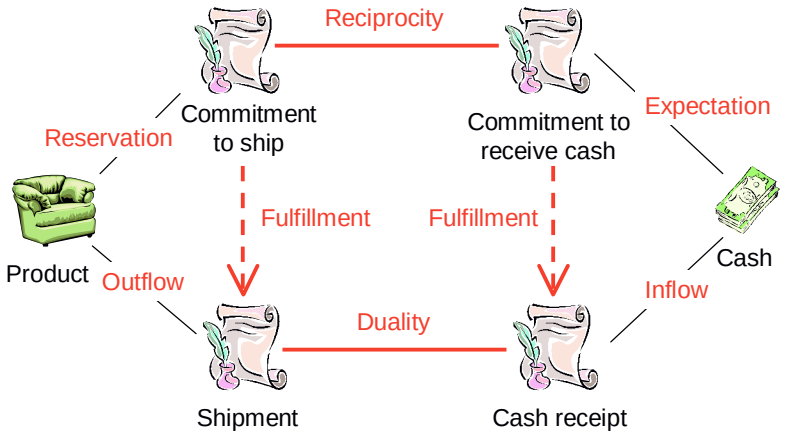
In Fact, there are Two Commitments



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Commitment: Forces

- Most economic events do not occur unexpectedly. They have been agreed between business partners beforehand. You would like to have a mechanism specifying details about the commitments of economic events.
- If a party commits itself to give resources away (to pay for a product or accept a purchase order), the party would like to be informed about whether it will actually have the resources available at the time specified by the commitment.

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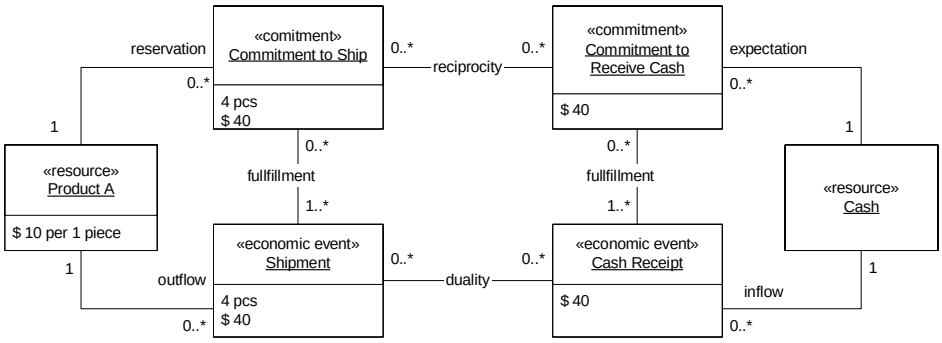
Commitment: Example



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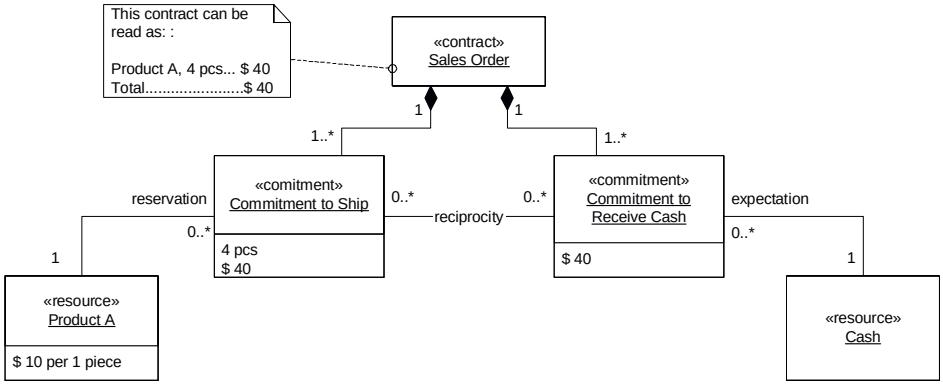
Contract as a Bundle of Commitments



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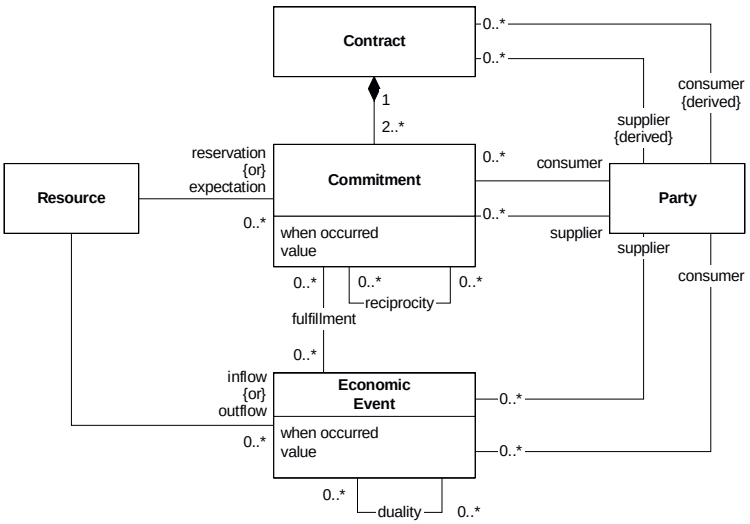
Commitment: Structure



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Commitments: Axioms

1. Each commitment must be related to a resource. For example, a sales order line must specify the goods to be sold.

2. Each commitment must have two relationships to parties that agree on the future exchange of resources. The customer and vendor, the employer and employee are the examples of parties related in contractual relationship.

3. Each commitment must have the fulfillment relation to at least one economic event. For example, the purchase order line specifying the goods must be related to the shipment of these goods.

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Commitments: Resulting Context

- Prognosis of future events, for example budgeting, is not covered by this pattern. Budgeting is addressed by classification / grouping pattern.
- There might be a hierarchy of contracts: order, service level agreement, government regulations … Higher level contracts specify policies for lower level contracts

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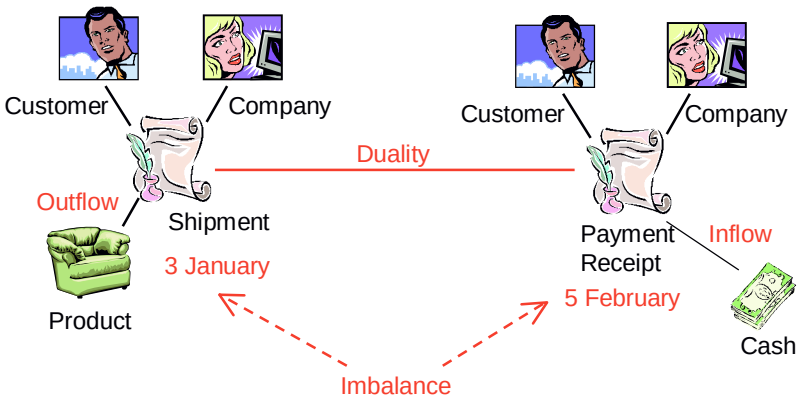
Claim: Business Problem



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Claim: Context

- When a vendor ships goods, it usually does not receive customer payments at the very same moment.
- Outflow and inflow economic events usually do not occur simultaneously, and the duality relationship between the economic events is out of balance for certain period of time.
- In this case, a common practice is to send an invoice, a requirement to the business partner to settle the owed amount.

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Claim: Forces

- Exchange of economic resources must be fair, that is, agreed by both parties.
- Business partners do not know the exact unbalanced value of the exchanges.
- Legal reasons might require a document specifying the unbalanced value. For example, VAT (value added tax) in Denmark is calculated as a percentage from the invoiced amount.

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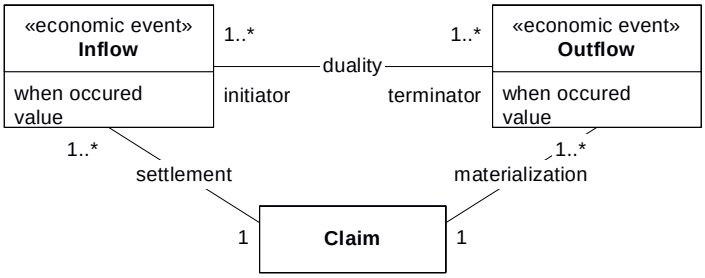
Claim: Solution



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Claim: Examples

- Invoice is a claim: pays us the money for the goods or services we provided to you.
- Library's late notice that is sent out to you is a claim: bring back those books you owe us!

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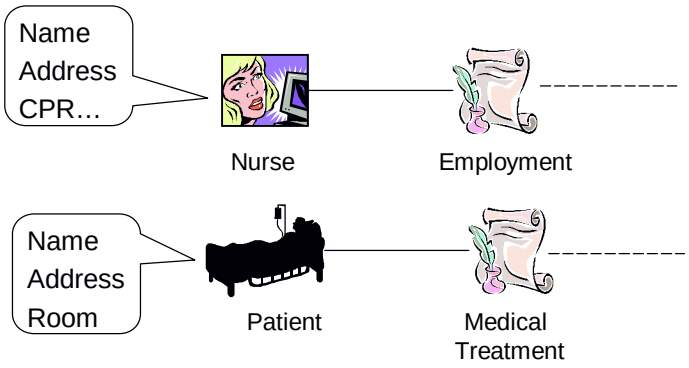
Roles: Business Problem



If nurse becomes a patient, wouldn't it be nice to reuse data already existing in the system?

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Roles: Context

- The same physical entity participates in different types of business relationships
- Agents
  - Customer, employee, vendor
- Resources
  - Work in progress, raw material, finished goods

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Roles: Forces

- The same physical entity participates in different types of business relationships
- Entity has different properties when participating in different business relationships.
  - For example, the default ship-to-address is relevant on a party related to the sales order, but not on the party related to the employment contract.
- You want to capture the information that customers, vendors and employees can be, in the real world, the same physical entity.

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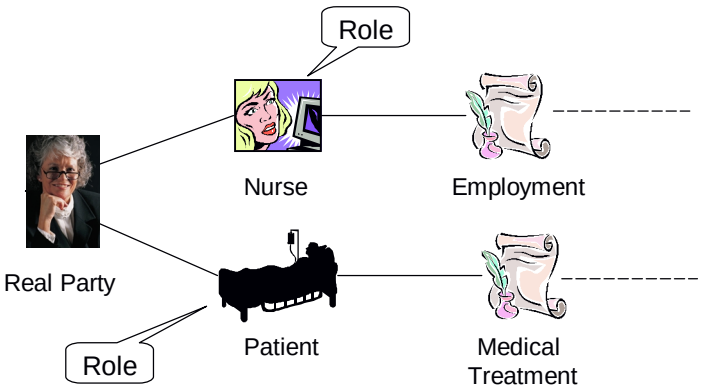
Roles: Solution



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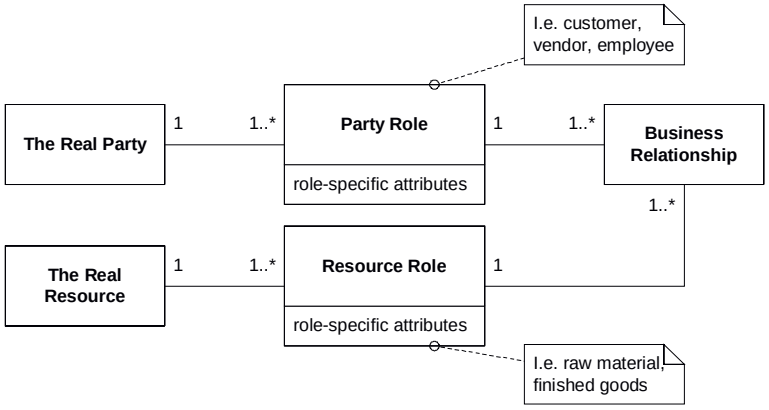
Roles: Solution in UML



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Roles: Resulting Context

- The roles pattern adds flexibility and extensibility to the model. Information can be shared, not duplicated.
- However, this is not always the desired behavior.
  - Security and legal issues

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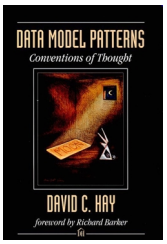
Roles: More Information

- Martin Fowler: Dealing with roles
  - Implementation considerations in Java.
    http://www.martinfowler.com/apsupp/roles.pdf

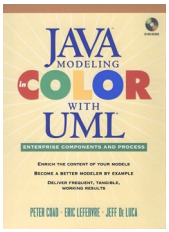
55

Business Component

- David C. Hay: Data Model Patterns: Conventions of Thought, Dorset House Publishing, 1996.



- Peter Coad, Eric Lefebvre, Jeff De Luca: Java Modeling in Color with UML, Prentice Hall, 1999



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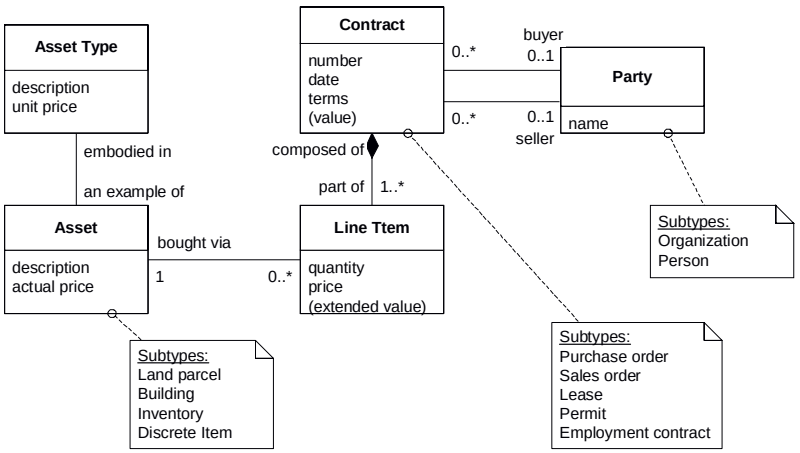
David Hay's Contract Pattern



Adapted from David C. Hay: Data Model Patterns: Conventions of Thought

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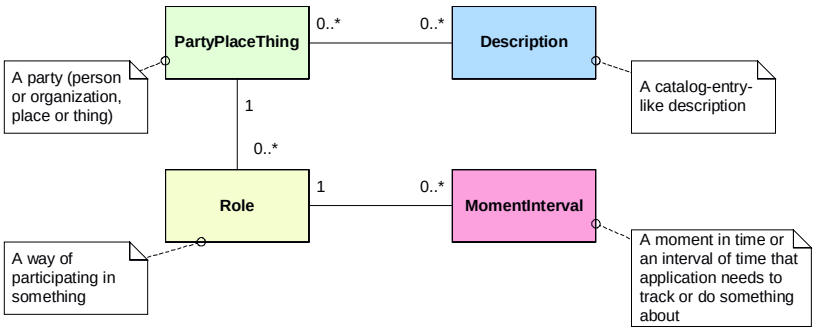
Peter Coad's Four Archetypes



Adapted from Coad et al.: Java Modeling in Color

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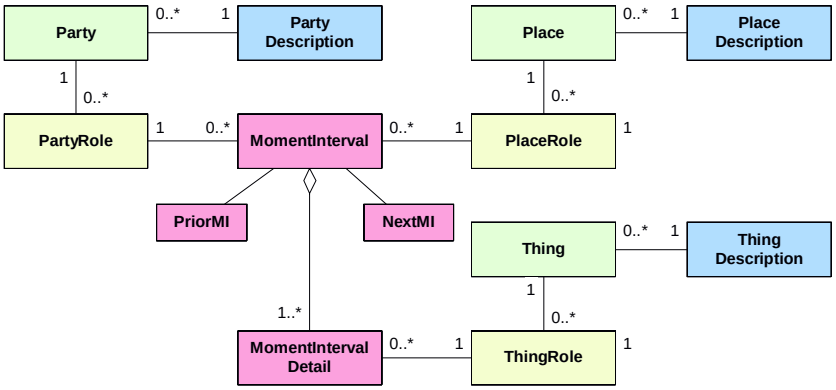
Peter Coad's Domain-Neutral Component



Adapted from Coad et al.: Java Modeling in Color

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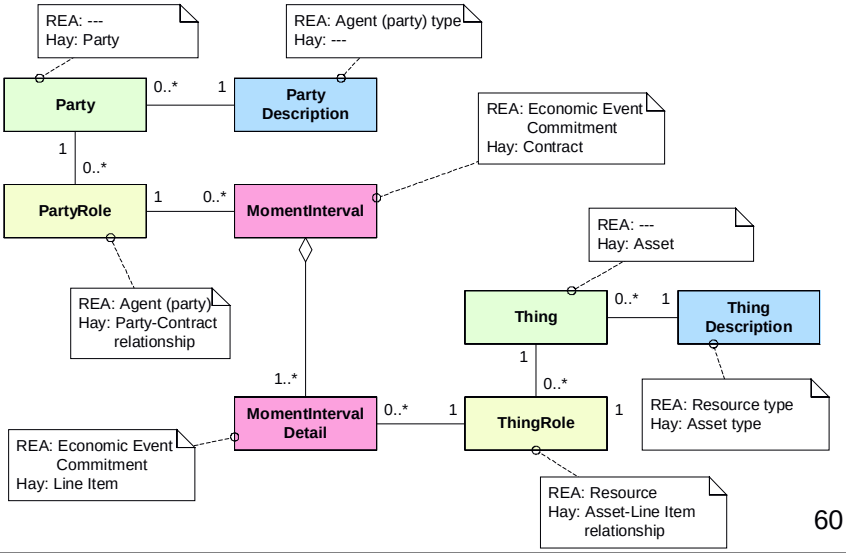
Comparing the Pattern Descriptions



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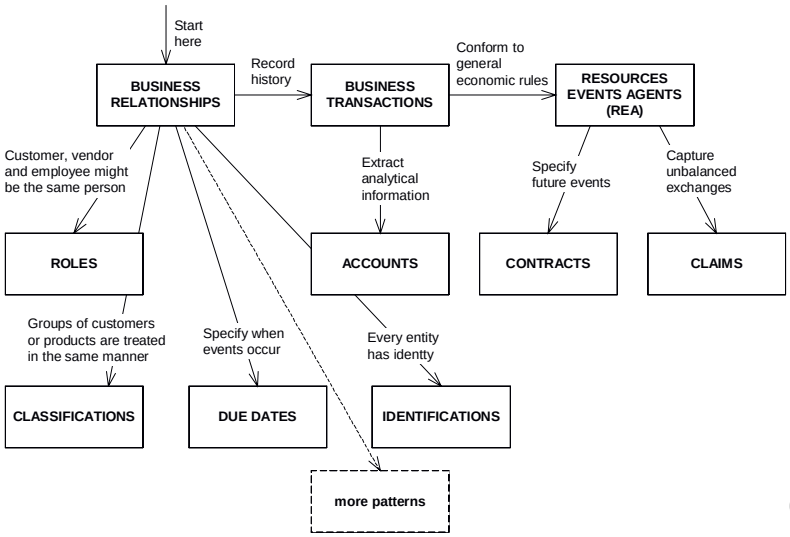
Part 2: Behavioral Patterns

Identification
Account
Due Date
Calendar
Classification

Pattern Language for Business Systems



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Identification: Business Problem

Name
CPR number

Author, Title
ISBN
DOC Number

Number

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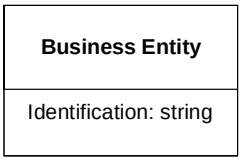
Identification: Context



- There are often specific business rules for creating identifications.

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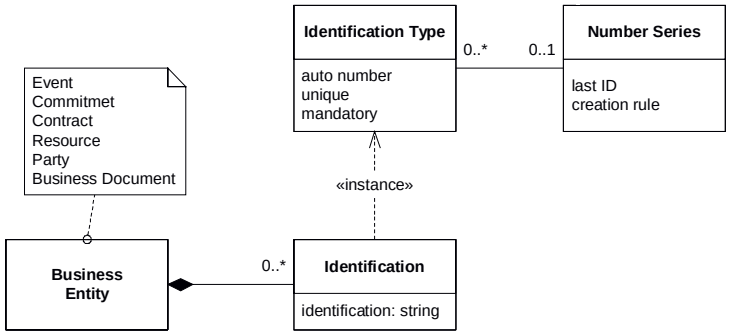
Identification: Structure



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Identification: Resulting Context

- Business Entities can also be identified by their Descriptions (another pattern). However, the purpose of description is different.
- Some users prefer to think about two patterns
  - Number Series (unique identifications)
  - Names (might be both unique or non unique).

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Account: Business Problem (1)

Athena chair
(product)

Purchase 20 pcs
6 January

Sale 2 pcs
10 January

Sale 5 pcs
12 January

...

Purchase 10 pcs
20 January

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Account: Business Problem (2)

Joe Smith
(customer)

Sales 150 USD
6 January

Cash receipt 100 USD
10 January

Cash receipt 50 USD
15 January

...

Sales 50 USD
20 January

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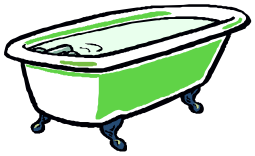
Account: Context

- In some cases, keeping track of the individual entities is not possible or desirable.
- For instance, once a glass of water has been poured into a tub, it is no longer possible to distinguish between the water that was in the tub before the water was poured into it and the water that comes from the glass.
- The only thing that it is possible to keep track of is the total amount of water in the tub.



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Account: Forces

- The business transaction pattern describes how to register and keep track of individual business transactions and their values. However, users of enterprise planning systems would like to get information about aggregated values from the sets of business transactions, economic events and commitments.
- You would like to know a rule that would automatically derive types of aggregations from the business transactions, events, and commitments available in the system.

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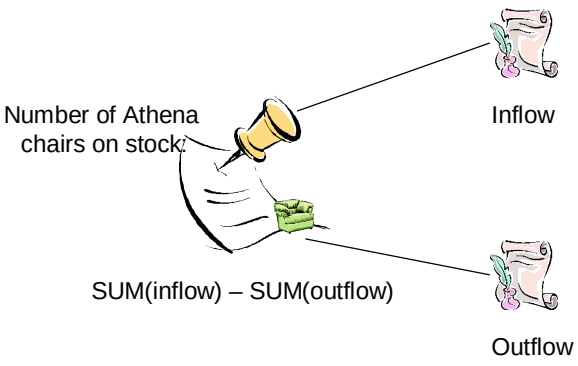
Account: Example in the REA Framework



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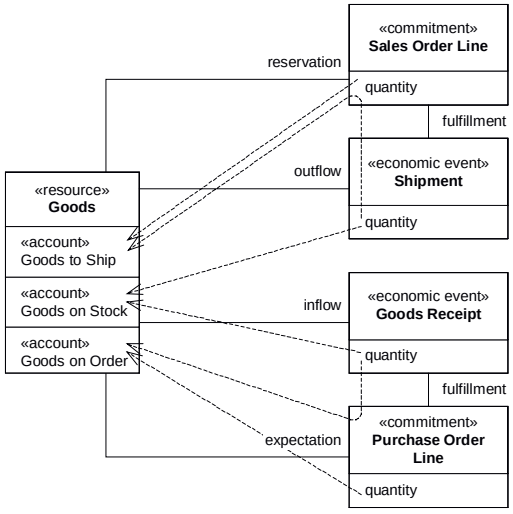
Account: Example in the REA Framework



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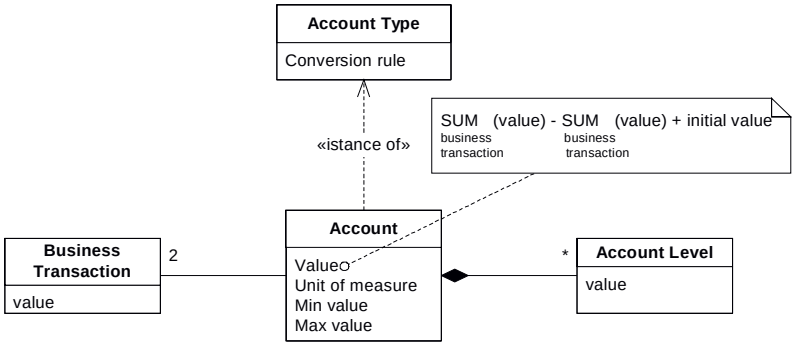
Account: Solution in the REA Framework



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Account: Resulting Context

- The accounts are separated from from the transactions. Account number does not need to be specified at the commit (post, register) time.
- However, traditional double-entry bookkeeping systems specify accounts when transaction is committed (posted).
  - legal issues

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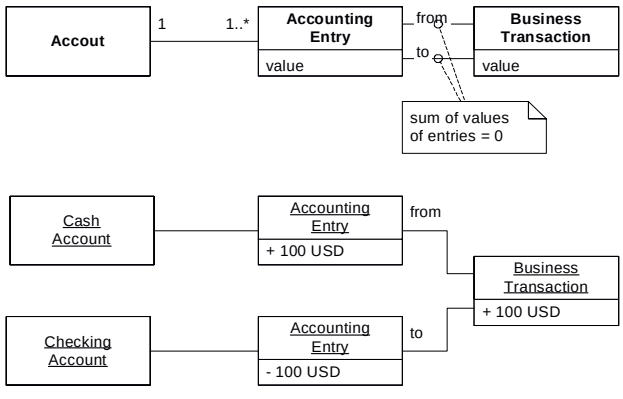
Account: Solution in Double-Entry System



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Account: More Information

- Martin Fowler: Accounting patterns
  - Double-entry bookkeeping patterns
  - http://www.martinfowler.com/apsupp/accounting.pdf
- Paul Keefer wrote a MS thesis on Accounts
  - http://st-www.cs.uiuc.edu/users/johnson/Accounts.html

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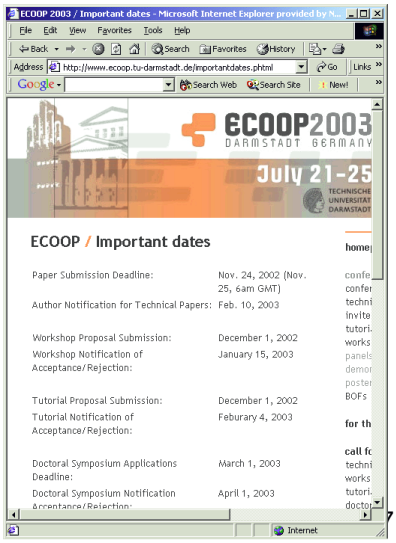
Due Date: Business Problem

Also known as

Deadline and Milestone



Due Date: Context

- Certain actions have to be taken and things have to be done on or before certain date.
- Due dates are often coupled together, to specify two points in time, or time interval.
  - For instance, starting date and end date are due dates, where end date occurs, for example, five days after the starting date.

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Due Date: Forces

1. Dates and time intervals are attributes of business relationship, business transaction, economic event, commitment and claim. You could add the date-time attribute to all of them, but you want to have a uniform behavior for all these entities in your model.

2. Some future events can be recurrent. Examples of recurrent events are periodic shipments, or meetings that occur every week. There might be complicated rules specifying the recurrence.

3. You want to specify what happens when due date expires.

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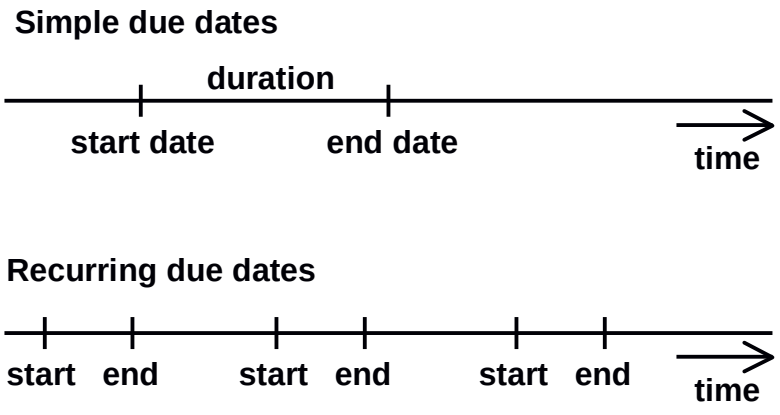
Due Date: Example



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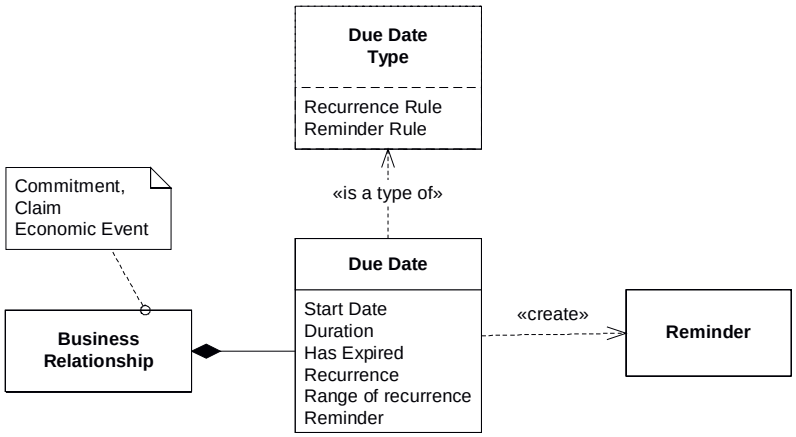
Due Date: Solution



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Due Date: Resulting Context

Calendar provides an aggregated view on due dates.

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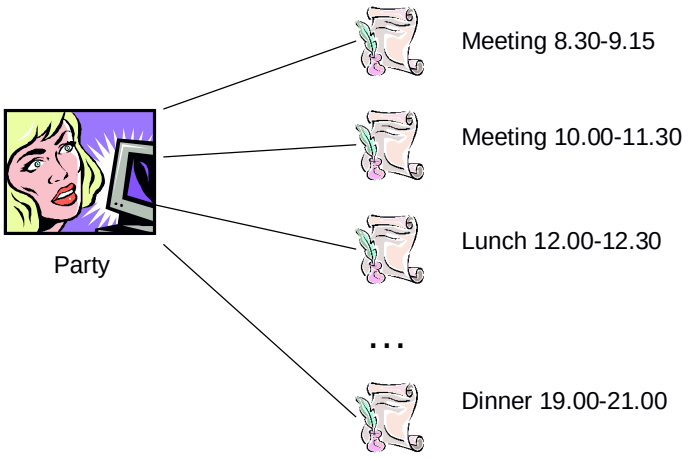
Calendar: Business Problem



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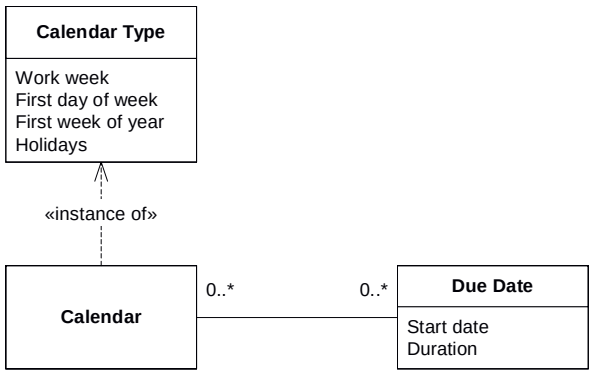
Calendar: Solution



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Classification: Problem

- Also known as
  - Categorization
  - Grouping
- Customers
  - high-volume customers
  - small-yield customers
- Furniture
  - Office
  - Home
- Employee
  - Outstanding performance
  - Average performance
  - Under average performance

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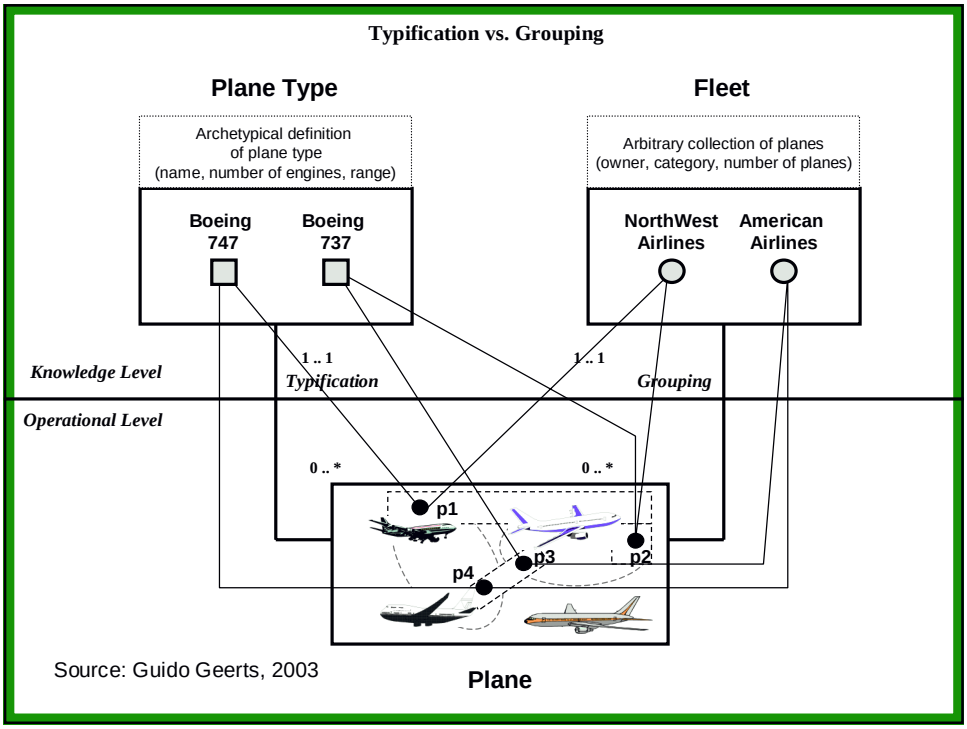
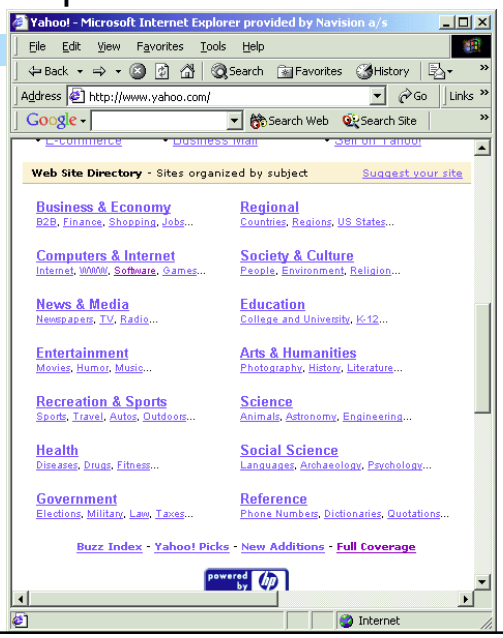


Source: Guido Geerts, 2003

Classification: Example

- Categories of web pages in Yahoo



Classification: Forces

- You want to make a uniform model for, for example, event categories, agent categories, resource categories.
- It should be possible to categorize different entity types using the same classification hierarchy
  - For example, different resources share the same VAT (sales tax) categories.
- When an object changes its category, does not change its type.
  - For example, when customer changes from small-volume to high-yield, it still has attributes name, address, phone number…
- The entity typically does not change its category when its attributes change.

  For example, let's suppose that the payment entity belongs to a certain priority category. If due date of the payment is over, the payment entity still belongs to the same priority category.

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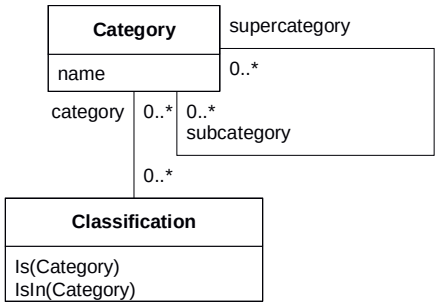
Classification: Solution



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Classification: Resulting Context

- The Types can also be used to categorize objects.
  - Use types if objects in different categories have different attributes and methods.
  - Use classification if objects in different categories have the same attributes and methods.
- The Lifecycle (State Machine) can also be used to categorize objects.
  - The states can be viewed as categories.
  - Use lifecycle if you need to specify rules for transitions from one category (state) to another.
  - Use lifecycle if an event can change the object's category (state).

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Classification: Exercise

- ”Categories” of sales order: quotation, accepted order, shipped order, paid order.
  - Would you use classification (grouping), type, or lifecycle (state machine) patterns?
- The library has different types of books: computer books, history books, crimi books, etc.
  - Would you use classification (grouping), or type patterns?

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Part 3: Implementation

Model Driven Architecture (MDA)
Business Patterns and MDA
Implementation Approaches

Model-Driven Architecture™

- An approach to using models in software development [1)].
- OMG (Object Management Group) adopted MDA™ in 2001.
  - specify the kinds of models to be used
  - relationships of the models
- MDA Goals
  - specify a system independently of the platform
  - portability ,interoperability, reusability

– 1) OMG MDA Guide V1.0, May 2003, http://www.omg.org/mda

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MDA Concepts (OMG approach)

CIM – Computation Independent Model	(informal)
PIM – Platform Independent Model	a ”blueprint” UML model
PSM – Platform Specific Model	implementation model
Platform	CORBA, .NET

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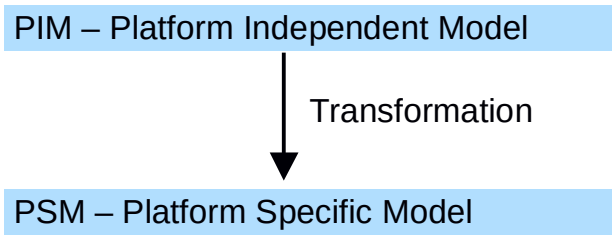
Model Transformation

- A process of converting one model to another model of the same system.



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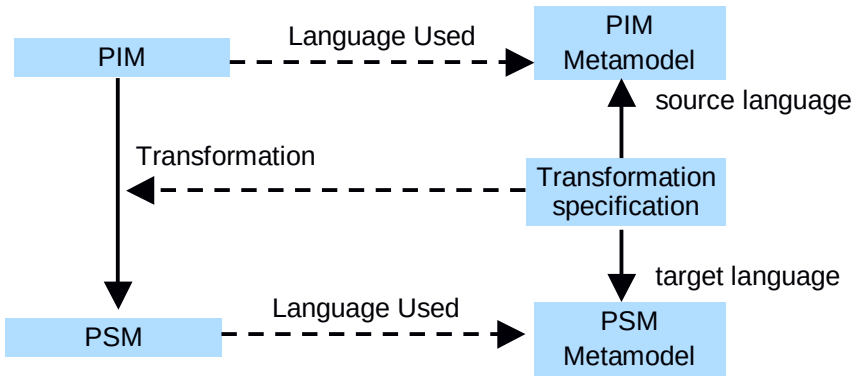
Metamodel Transformation

- PIM metamodel is mapped to PSM metamodel



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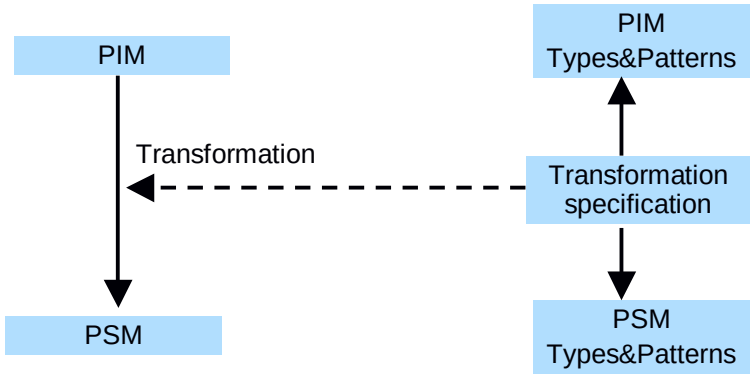
Pattern Application

- PIM patterns are mapped to PSM patterns



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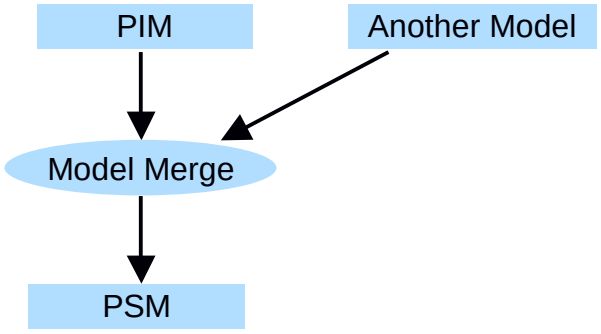
Model Merging



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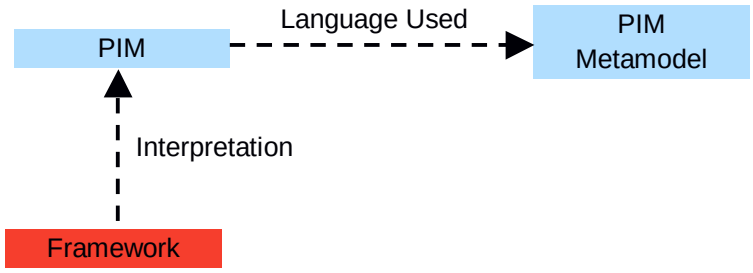
”Virtual Machine” Approach

- PIM is interpreted by a framework at runtime
- No model transformation



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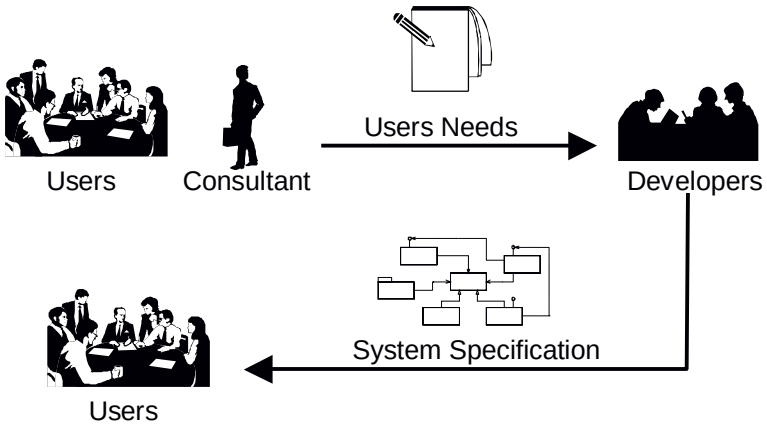
Developer-Centered Model (Traditional)



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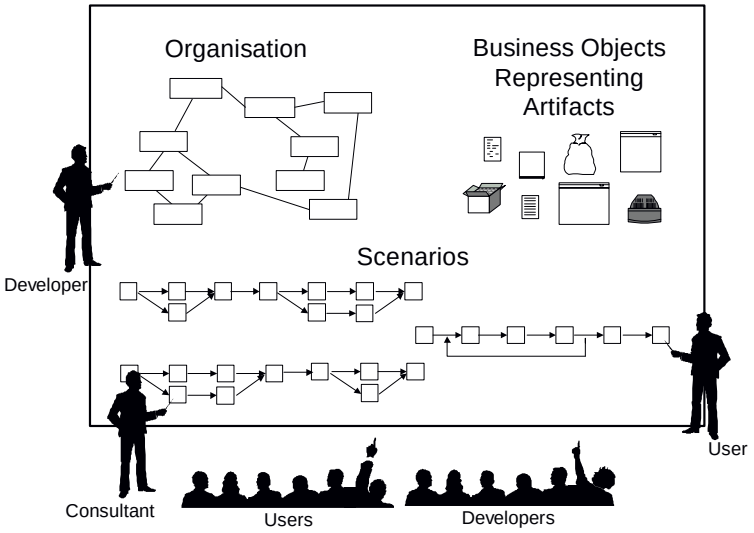
User-Centered Model (Vision and Goal)



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Can it be Achieved?

- Can a single model be
  - intuitive for the users AND
  - precise enough to generate a software application?
- Yes, if the model is at the right level of abstraction.
- Common modeling language between the consultants, developers and users.
  - Modeling language and symbols are identical to the language and symbols of the user's daily work.

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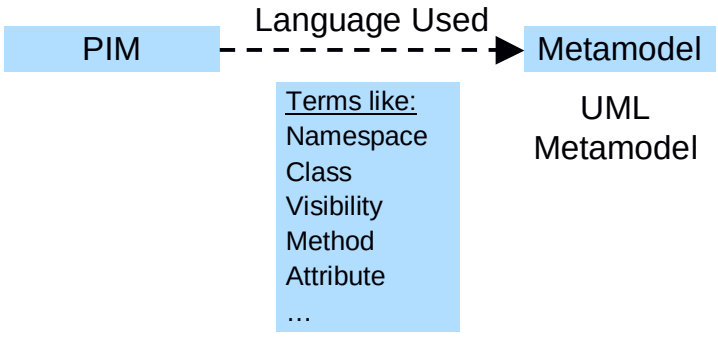
UML Model-Driven Architecture



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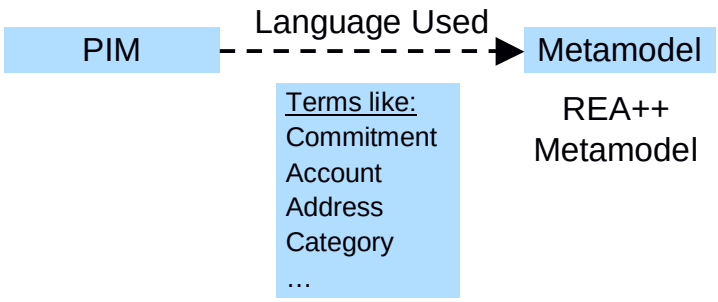
Business Model-Driven Architecture



More info: Kasper Østerbye: http://www.it-c.dk/people/kasper/

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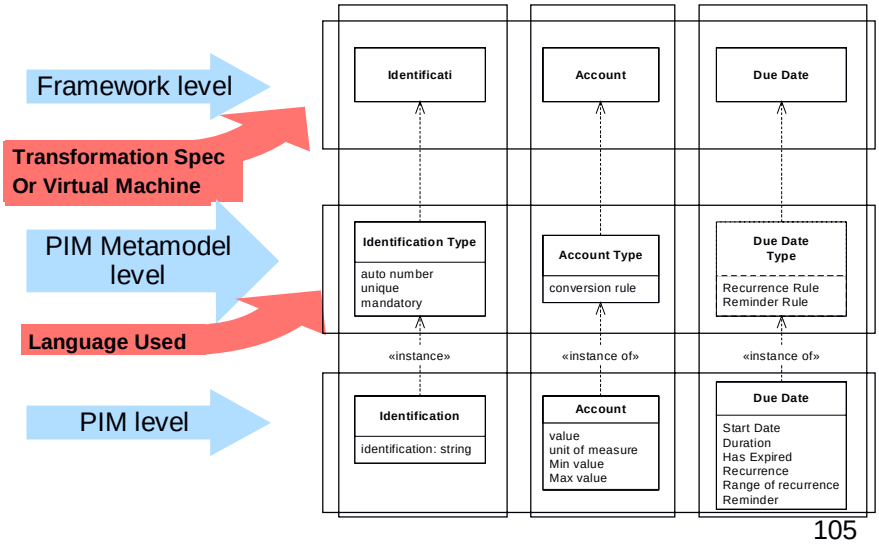
Business Patterns as Components



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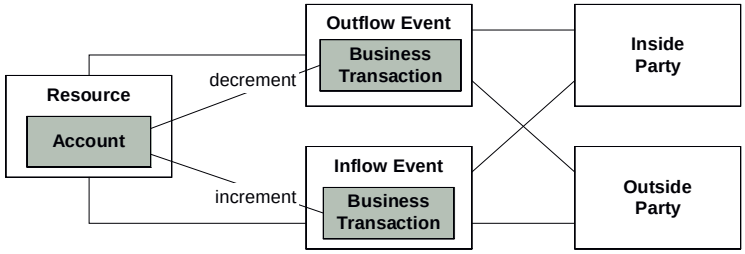
Merging Structural and Behavioral Patterns



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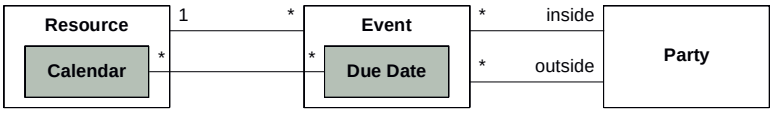
Merging Structural and Behavioral Patterns



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Aspect-Oriented Programming (AOP)

- AOP captures cross-cutting concerns in a modular way.
  - objects capture primary division of labor
  - aspects capture cross-cutting concerns
- It is useful to think about
  - structural patterns as objects
  - behavioral patterns as aspects

More information about AOP: http://www.aosd.net, and http://www.eclipse.org/aspectj/

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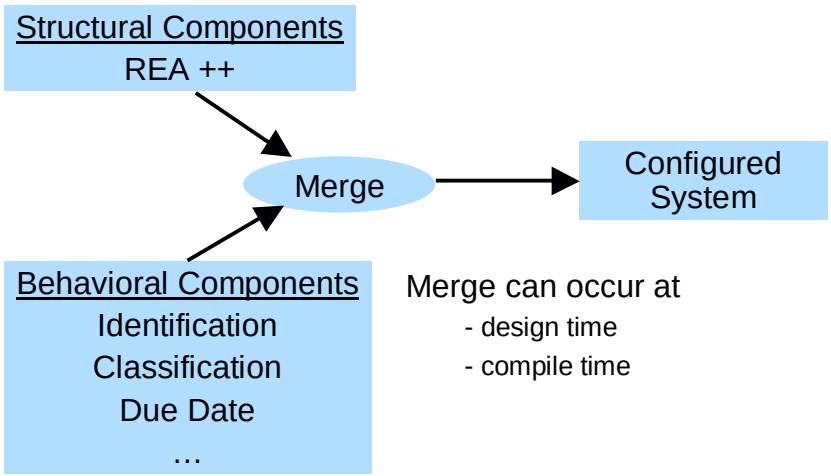
Merging Business Components



Merge can occur at
- design time
- compile time

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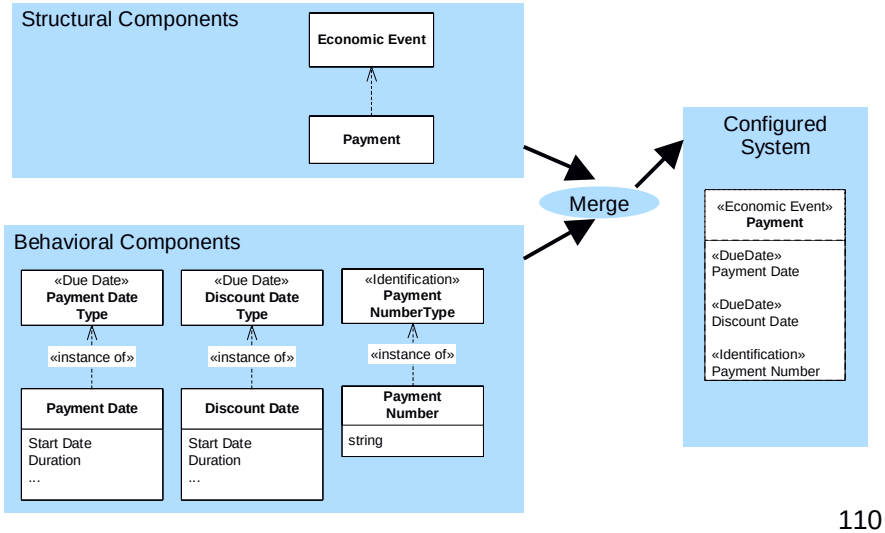
Merging Business Components: Example



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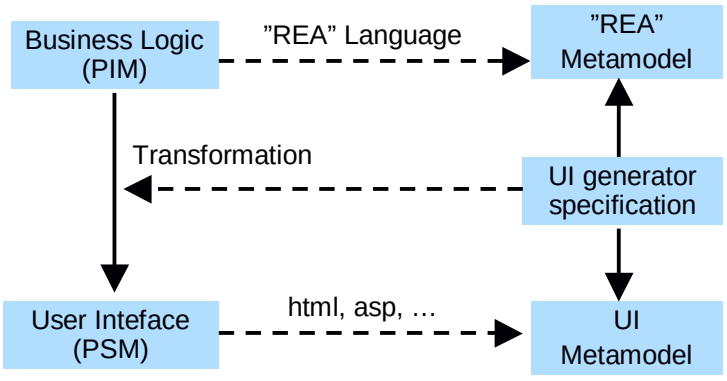
User Interface Model Transformation



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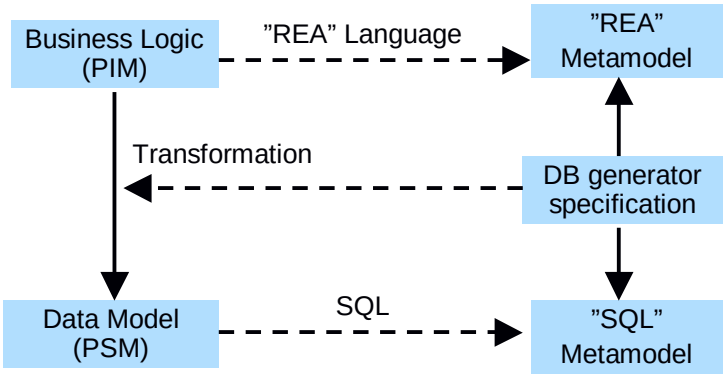
Data Model Transformation



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