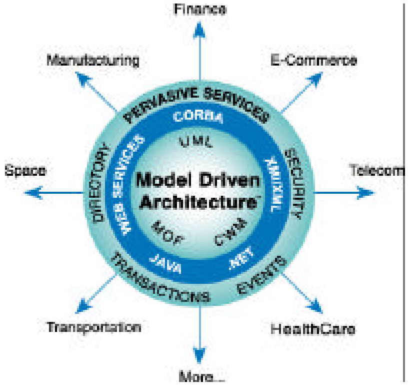
Introduction to Model Driven Architecture



Mike Rosen

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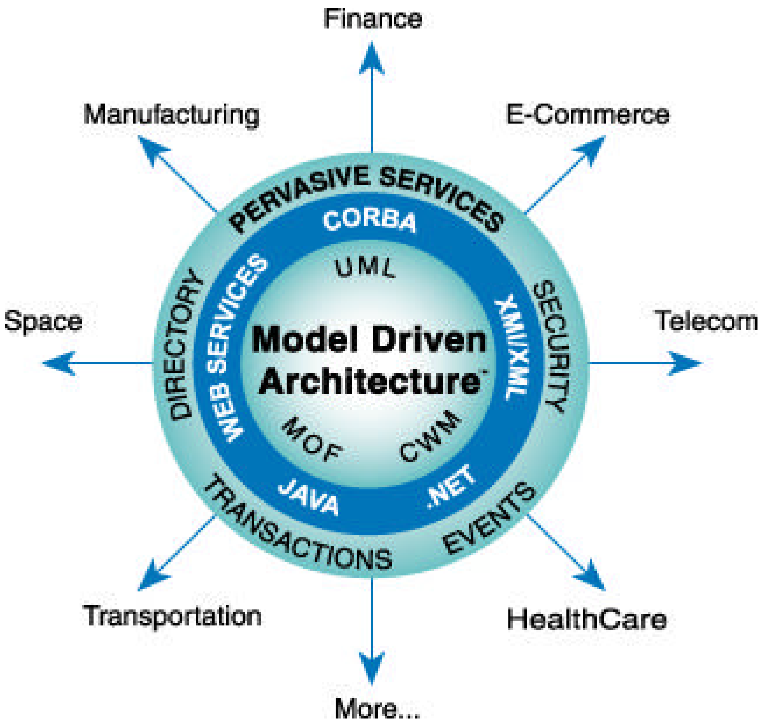
Model Driven Architecture

M²VP



- A set of standards defining the scope, content, creation and usage of models
- An architecture-based process for integrating models into the development process
- Formally separates business and technology concerns

Agenda

- Why MDA?
- A few words about architecture
- MDA concepts
- MDA and standards
- Models and transformations
- MDA development process
- MDA tools
- Conclusion

Today’s IT Challenges

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- Alignment of business requirements with IT systems intended to meet those requirements
- The technology that supports those systems is constantly evolving
- IT must support rapid revenue growth and acquisition strategies
- And move beyond the limitations of stovepipe and point-to-point systems
- While leveraging existing applications
- Within time-to-market and budget constraints

Technology Independence

- Requirement: Preserve application investment
  - As platforms proliferate
  - As platforms themselves change
    - MTS → COM+ → .NET
    - EJB 1.1 → EJB 2.0 → EJB 2.1
    - XML DTD → XML Schema
    - CORBA 2.X → CORBA 3.0
- Solution: Isolate information and processing logic from technology specifics
  - Build platform-independent models
  - Map these models to specific platforms
  - Maintain the separation at the implementation level

Raising the Level of Abstraction

- A logical extension of proven techniques
  - Programming Languages
    - Bits, assembler, 3GL, OO, 4GL
  - Operating Systems, Middleware…
- Already well-established for front and back ends
  - WYSIWYG GUI modeling
  - Data modeling
  - Hand coding no longer predominates
- Working at higher levels of abstraction increases our value
  - Higher productivity
  - More time focused on solving business problems, rather than technology details

MDA Complements Existing Approaches

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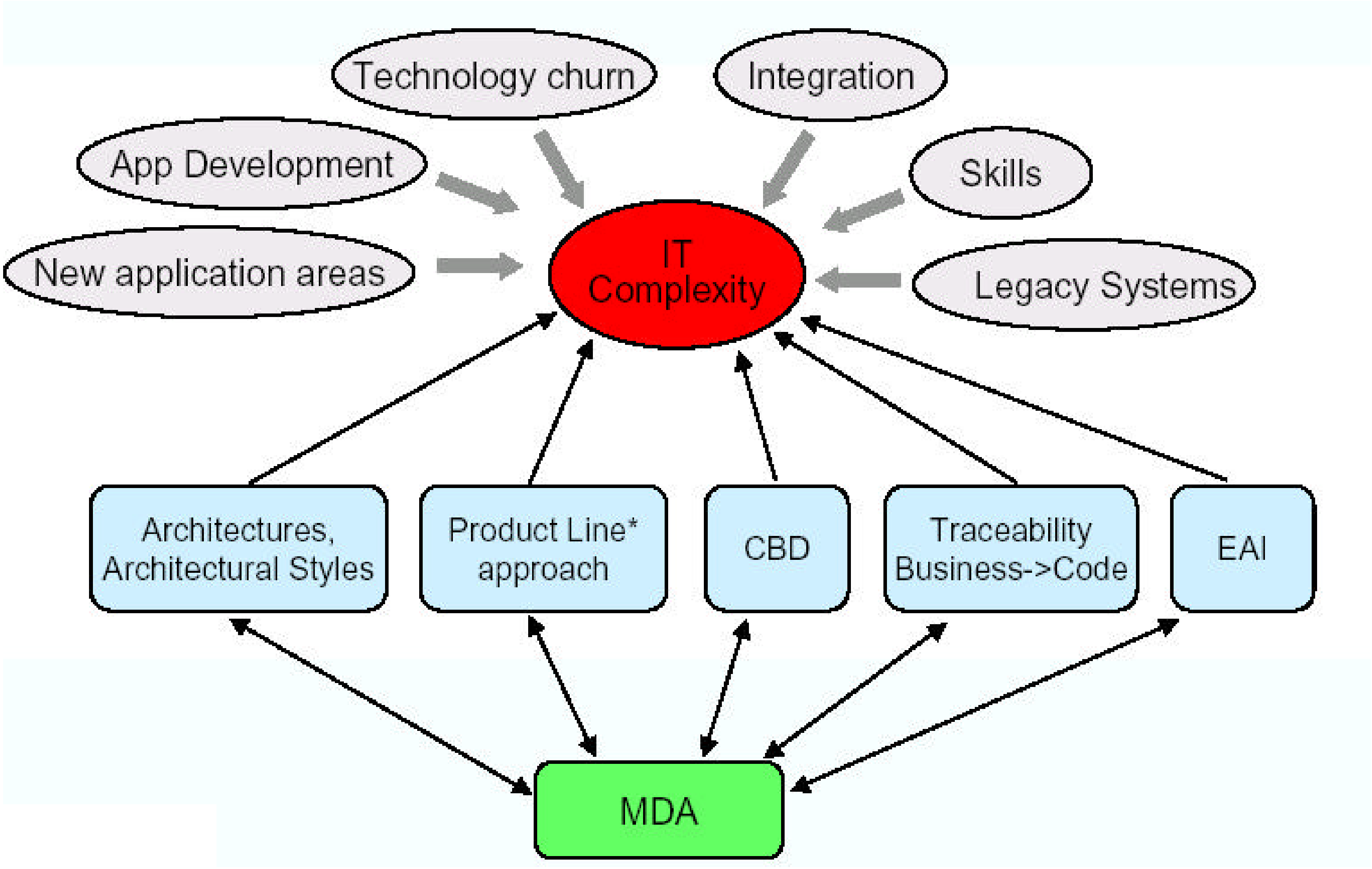

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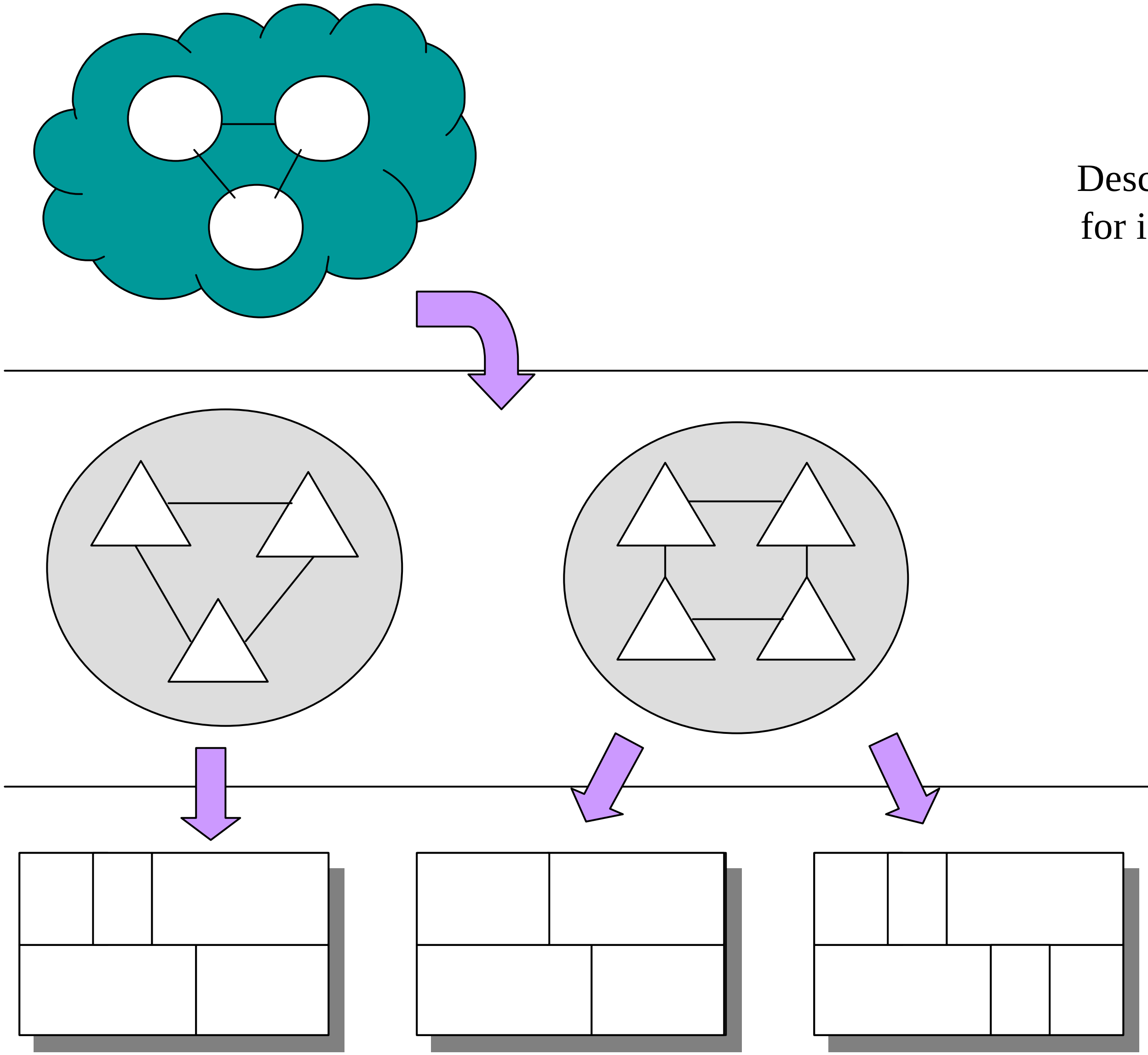
Architecture Principles

- Separation of Concerns (viewpoints) - The architecture should separate the requirements and concerns of different constituents.
  - Business
  - Technical
  - Physical
  - Implementation
  - There must also be relationships and traceability between different viewpoints
- Enable consistent and effective applications development

Architecture Principles

- Accommodate the future
  - Future versions
  - Planned enhancement
  - New technologies
- Rigorous
- Well Documented - Expressed in industry standard UML notation
- Phased Implementation

Architecture Scope

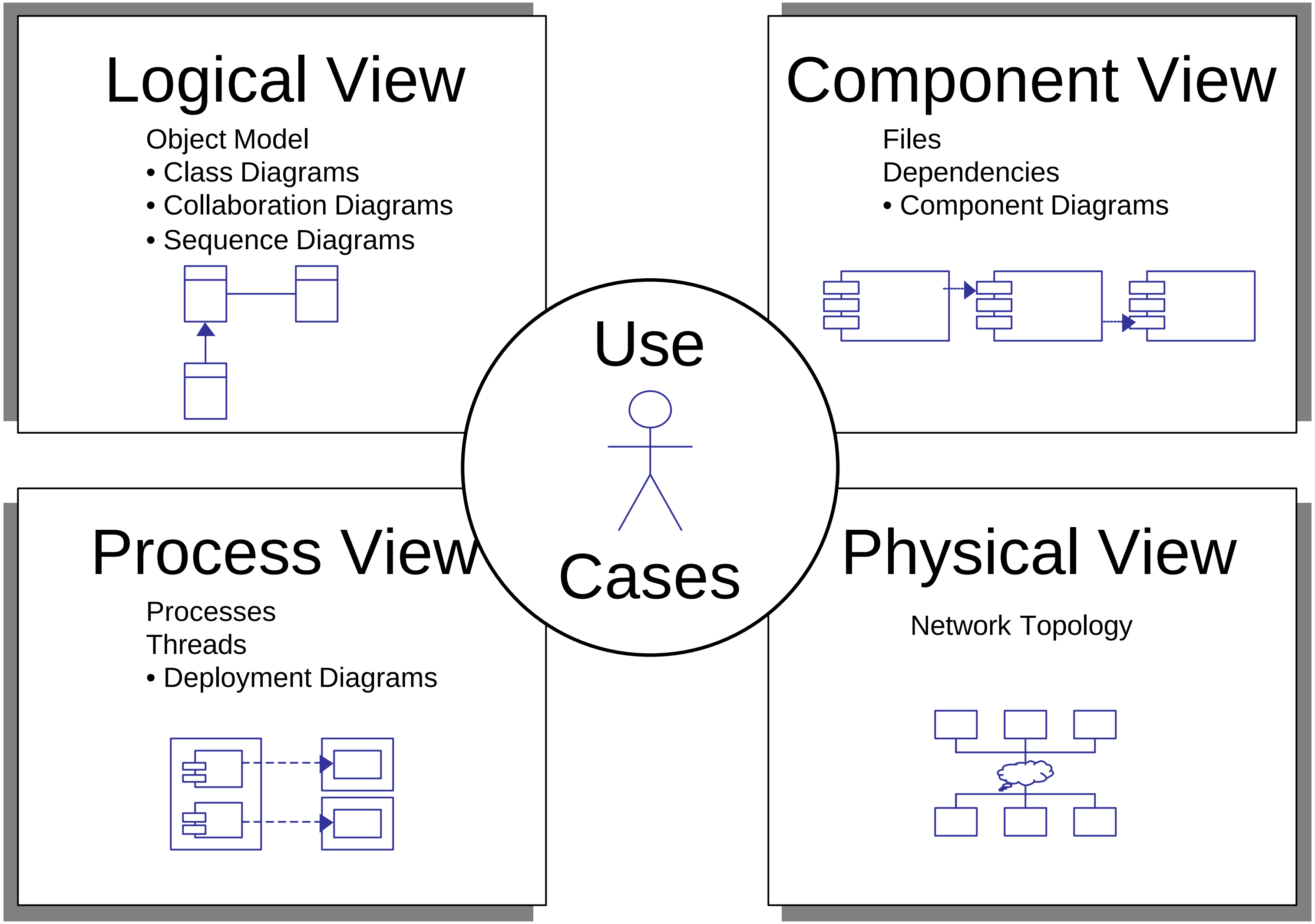


Enterprise Architecture:
Describes concerns and guidelines
for integration of process and data
across the entire enterprise

Application Architecture:
Describes techniques,
frameworks, guidelines
within an application domain

Application:
Implementation of a
specific application

Example: 4+1 Architectural Views



Logical View

Object Model
- Class Diagrams
- Collaboration Diagrams
- Sequence Diagrams

Component View

Files
Dependencies
- Component Diagrams

Use Cases

Process View

Processes
Threads
- Deployment Diagrams

Physical View

Network Topology

Example 2: Architecture Driven Design

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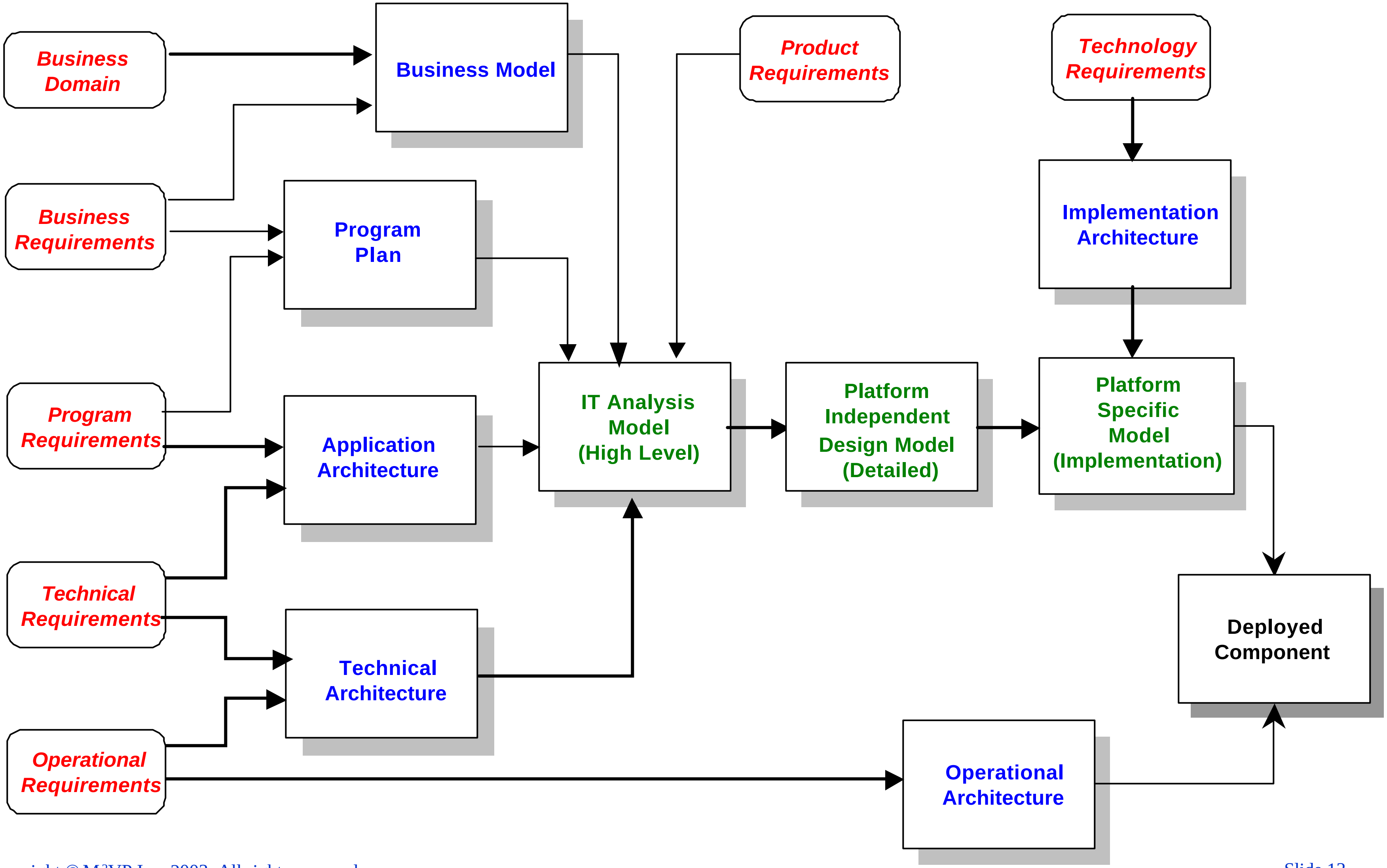

Example 3: RM-ODP

- Reference Model for Open Distributed Processing – ISO Standard
- Transparencies
  - Access, Failure, Location, Migration, Persistence, Relocation, Replication, Transaction
- Viewpoints
  - RM-ODP prescribes five viewpoints as necessary and sufficient to describe the model of a system
  - Enterprise Viewpoint
  - Information Viewpoint
  - Computational Viewpoint
  - Engineering Viewpoint
  - Technical Viewpoint

Architecture Example Summary

- 4+1 Views
  - Separation of concerns
  - Central, unifying viewpoint with traceability
- Architecture Driven Design
  - Architecture process spans application development
  - Separation of concerns addressed by specialized models
  - Business/Domain models drive implementation models
  - Platform concerns addressed independently from business solution
- RM-ODP
  - Formal definition of system viewpoints

Model Driven Architecture

- A standardization of best practices within enterprise architecture and development
- A process for the creation and usage of models as first class development artifacts
- Defines process for model development and refinement within context of enterprise architecture
- A roadmap for consistently applying modeling to enterprise solutions
- Formalizes separation of concerns into specific models
  - Expresses business concepts in formal business model
  - Expresses business services in platform independent IT model

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MDA Distilled

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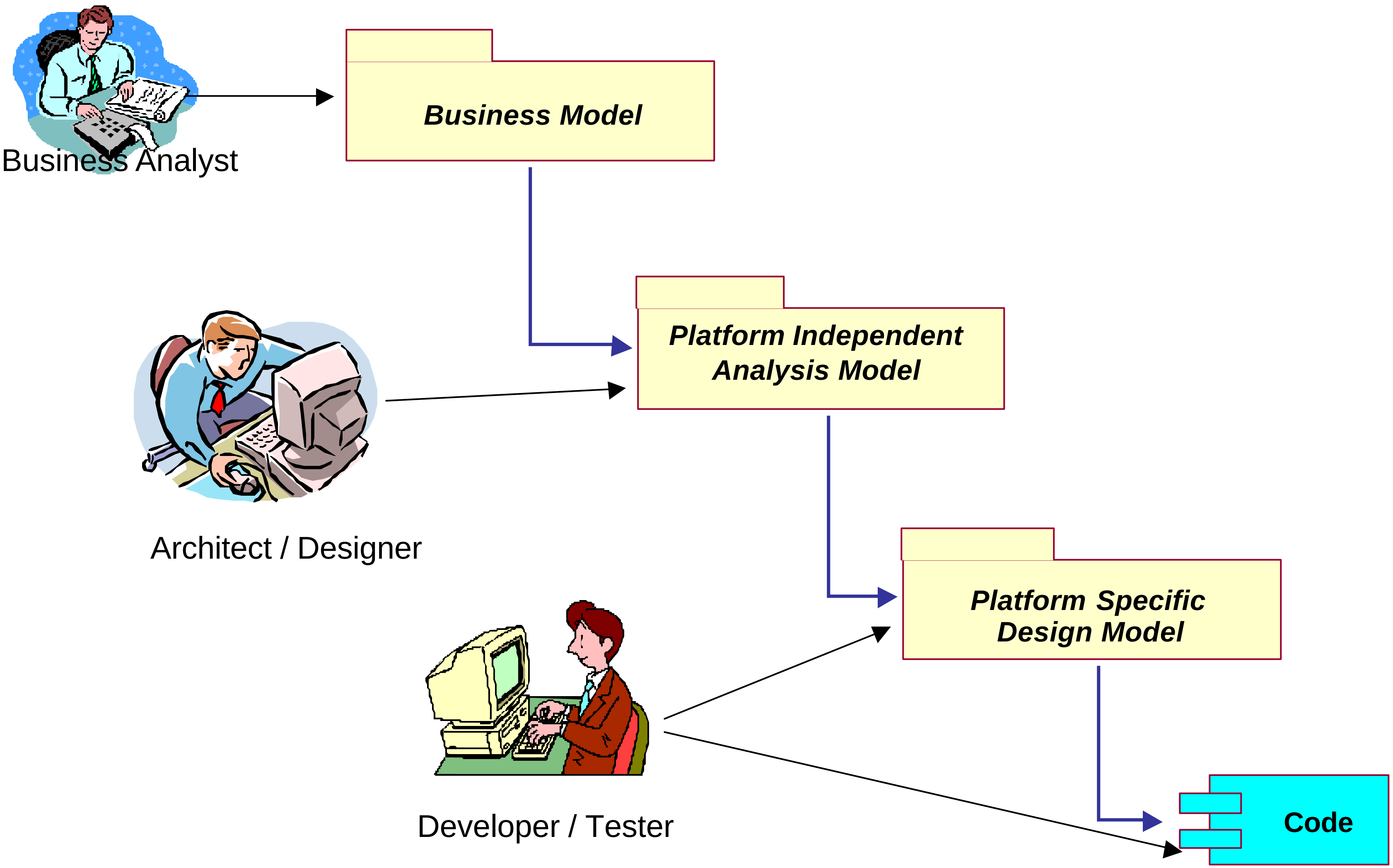


Business Analyst

Business Model

Architect / Designer

Platform Independent Analysis Model

Developer / Tester

Platform Specific Design Model

Code

Basic Concepts

- **Model** - a representation of the system
  - A model describes part of the function, structure and/or behavior of a system.
- **Formal Model** – a representation of the system conforming to rigorous rules
  - A model is said to be formal when it is based on a language that has a well defined form (“syntax”), meaning (“semantics”), and possibly rules of analysis, inference, or proof for its constructs. The syntax may be graphical or textual. An MDA model must be paired unambiguously with a definition of the modeling language syntax and semantics, as provide by the MOF.

All MDA models are formal.

Basic Concepts 2

- **Abstraction** - the suppression of irrelevant detail
  - It is useful to characterize models in terms of the abstraction criteria that were used to determine what is included in the model. A model that is based on specific abstraction criteria is often referred to as a *model from the viewpoint defined by those criteria*
- **Refinement** - the addition of specific detail (usually associated with reduction of scope)
  - Some pairs of models are in a *refinement* relationship in which one – the *abstraction* - is more abstract than the other - the *realization*.
- **ViewPoint** – the presentation of a system for a specific audience
  - Each viewpoint, focusing on one aspect of a system, abstracts out details that are not of primary concern to the given viewpoint.

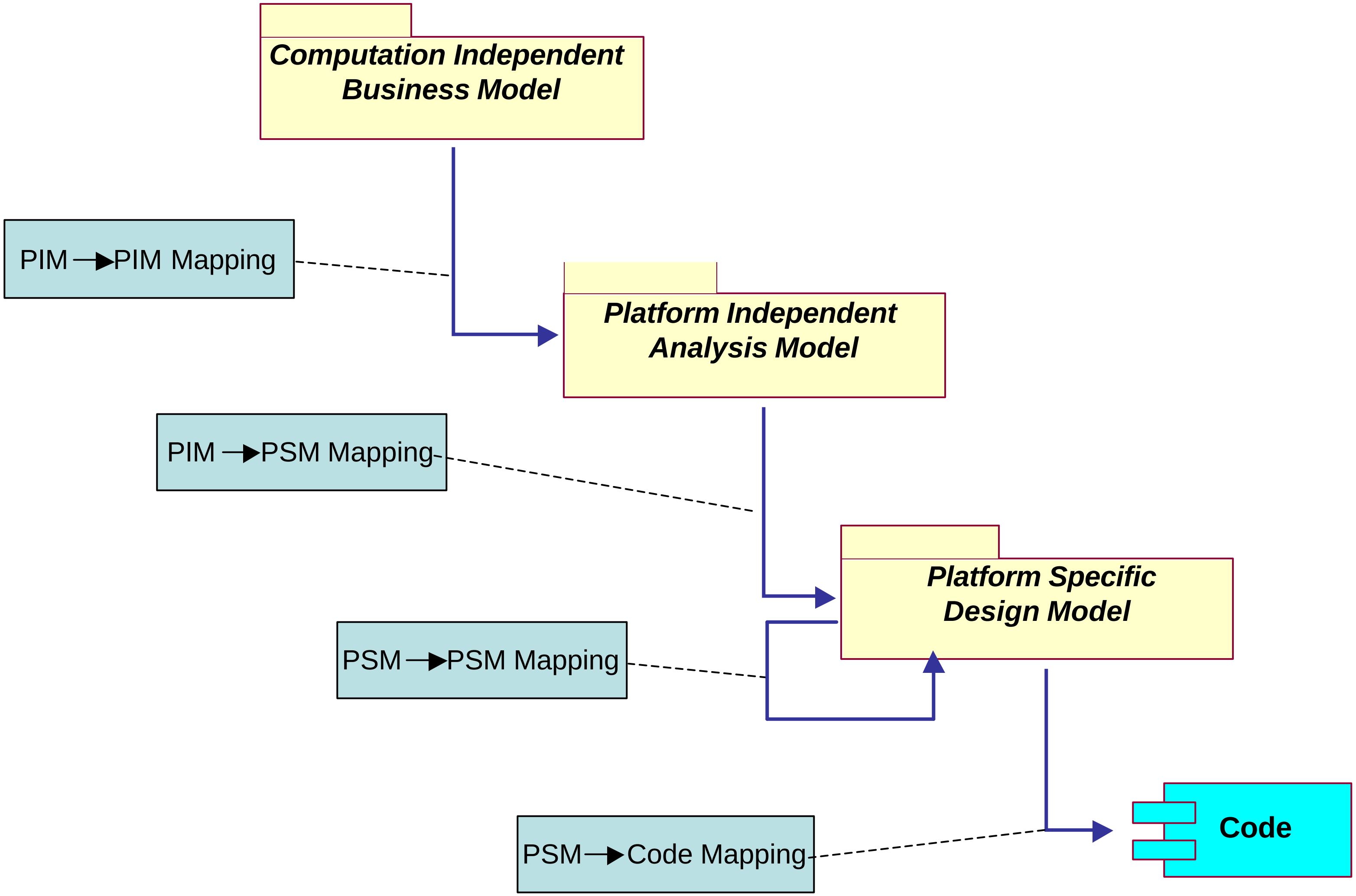
Basic Concepts 3

- **Platform** – the technology implementation of a running system, e.g. J2EE, .NET
  - Refers to technological and engineering details that are irrelevant to the business functionality of a software component.
- **PIM** - *Platform-Independent Model*
  - A formal specification of the structure and function of a system that abstracts away technical detail.
- **PSM** – *Platform-Specific Model*
  - A refinement of a PIM which expresses the system in terms of the *specification model* of the target platform.

Basic Concepts 4

- **CIM** – *Computationally-Independent Model*
  - A higher level abstraction of a PIM which contains only business concerns.
- **Mapping / Transformation** – controls the conversion of models
  - A mapping defines a formal algorithm and method for converting one type of model to another – a transformation is the process of applying the mapping.
- **Traceability** – the ability to relate an element in one model to another model
  - Ties an element in one model to it’s transformation in another across different levels of abstraction.

MDA Mappings



Computation Independent Business Model

PIM ▶PIM Mapping

Platform Independent Analysis Model

PIM ▶PSM Mapping

Platform Specific Design Model

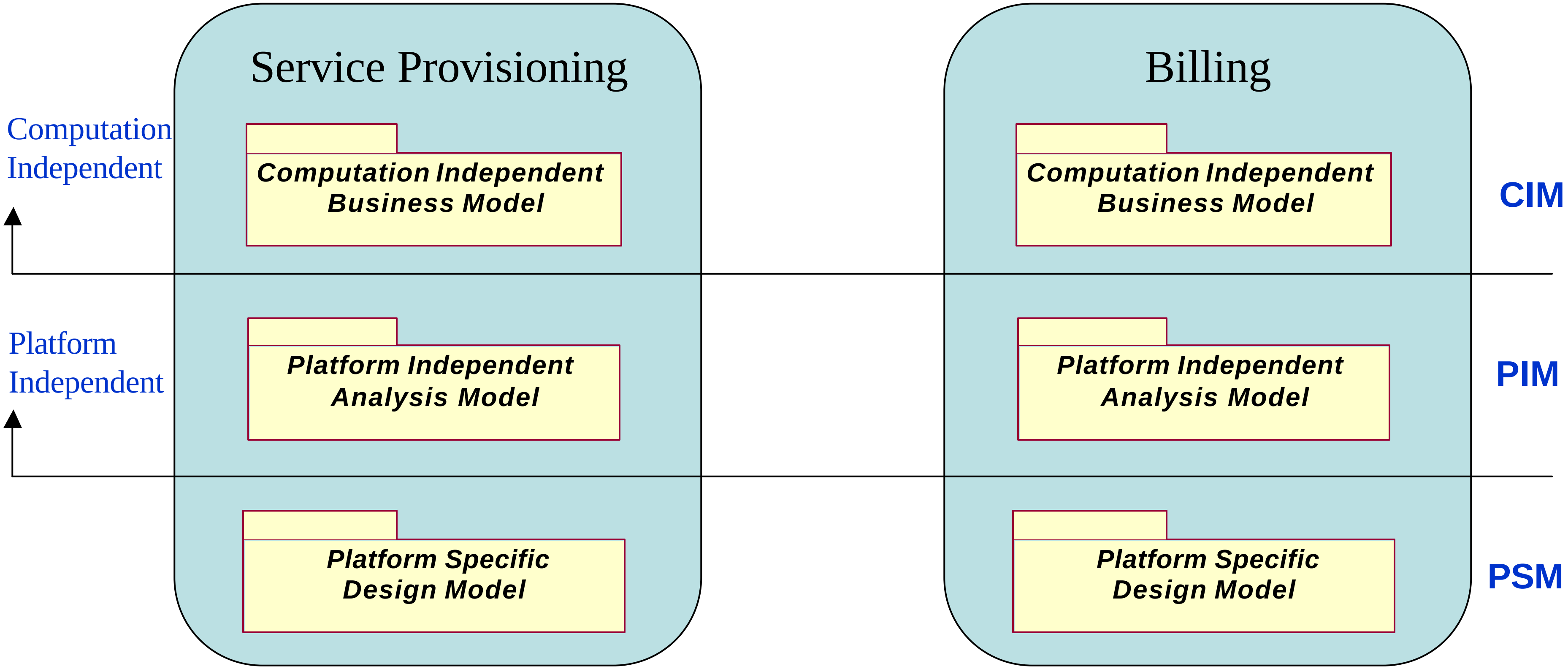
PSM ▶PSM Mapping

PSM ▶Code Mapping

Code

Consistent Model Separation

M^{2}VP



Service Provisioning

Billing

Computation Independent

Platform Independent

Computation Independent Business Model

Computation Independent Business Model

CIM

Platform Independent Analysis Model

Platform Independent Analysis Model

PIM

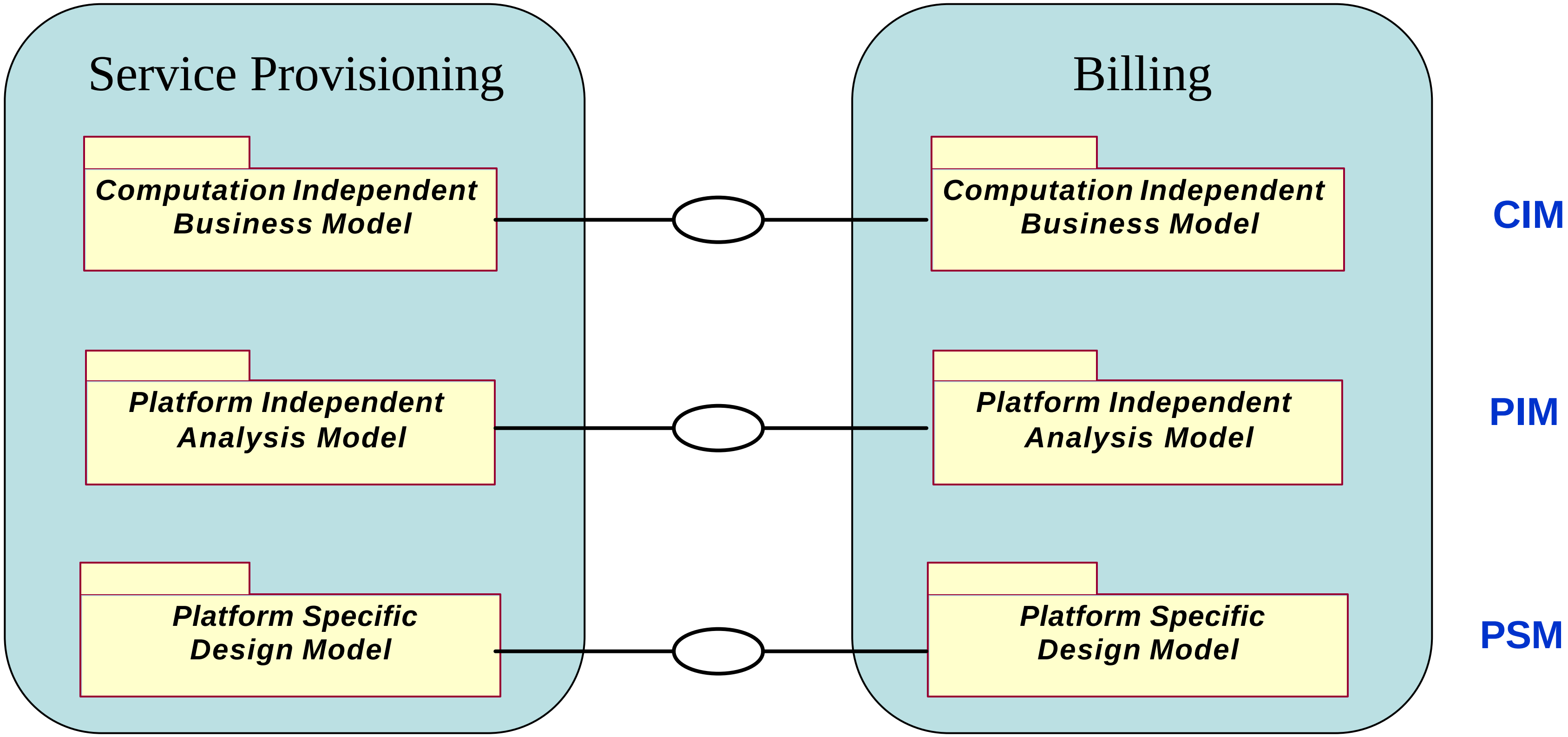
Platform Specific Design Model

Platform Specific Design Model

PSM

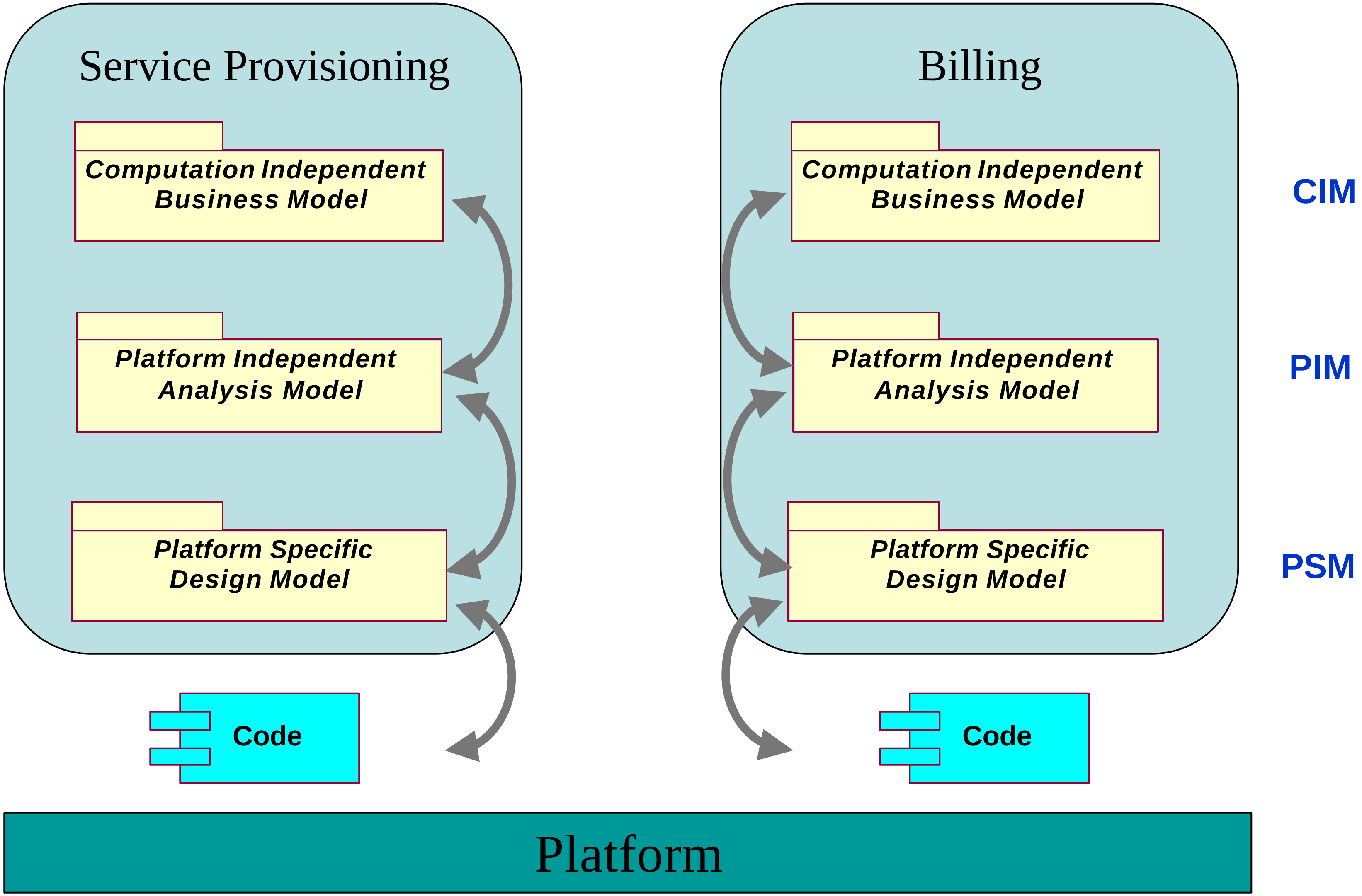
Consistent Relationships

M²VP


Service Provisioning
Computation Independent Business Model
Platform Independent Analysis Model
Platform Specific Design Model
Billing
Computation Independent Business Model
Platform Independent Analysis Model
Platform Specific Design Model
CIM
PIM
PSM

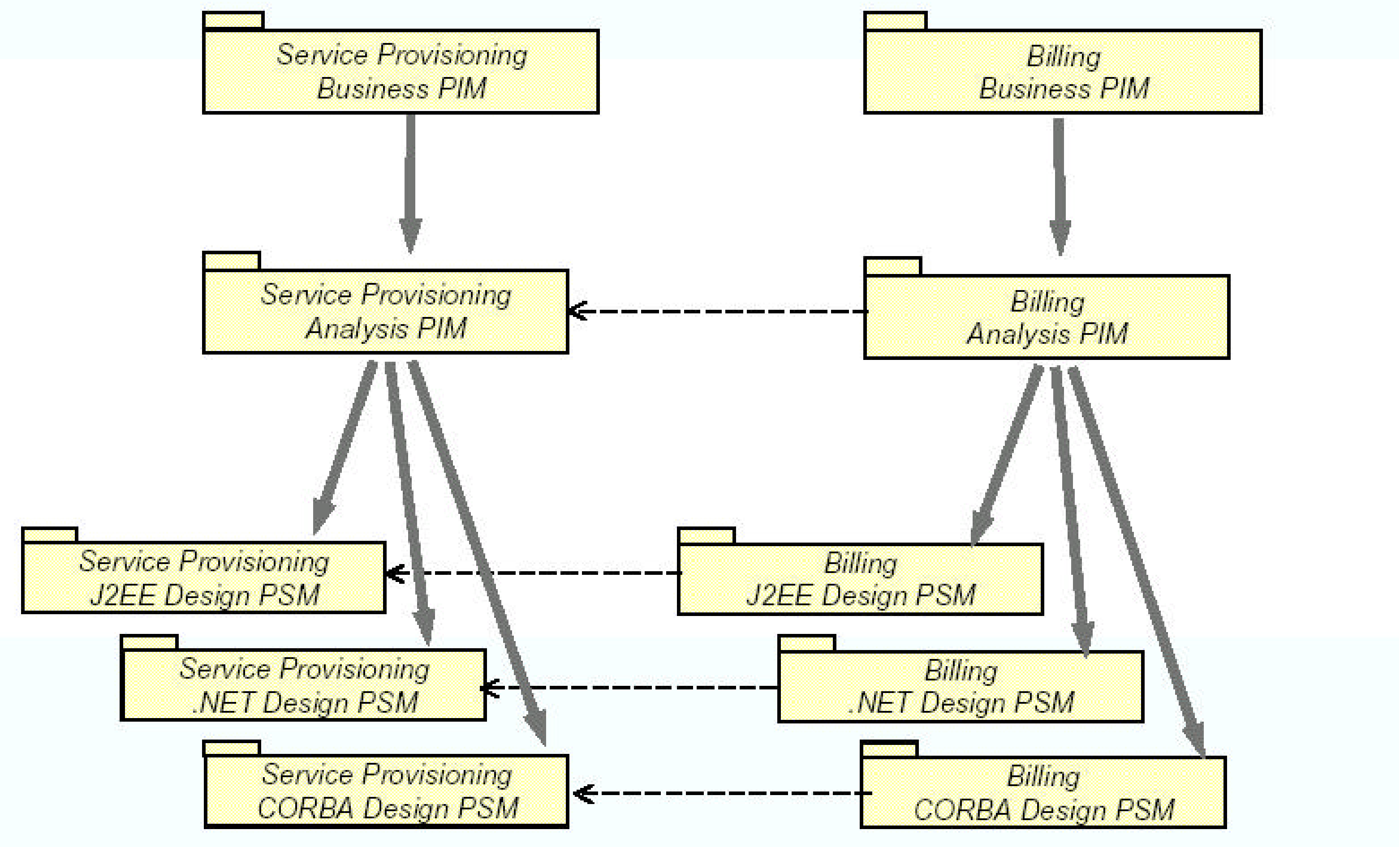
Consistent / Shared Mappings

M²VP



Service Provisioning
Computation Independent Business Model
Platform Independent Analysis Model
Platform Specific Design Model
Code
Billing
Computation Independent Business Model
Platform Independent Analysis Model
Platform Specific Design Model
Code
CIM
PIM
PSM
Platform

Mapping Example


Service Provisioning Business PIM
Billing Business PIM
Service Provisioning Analysis PIM
Billing Analysis PIM
Service Provisioning J2EE Design PSM
Billing J2EE Design PSM
Service Provisioning .NET Design PSM
Billing .NET Design PSM
Service Provisioning CORBA Design PSM
Billing CORBA Design PSM

PIM / PSM Advantages

- Easier to validate correctness of Model
- Easier to produce implementations on multiple platforms
- Integration / interoperability across platforms better defined
- Generic mappings / patterns can be shared by many designs

MDA Process

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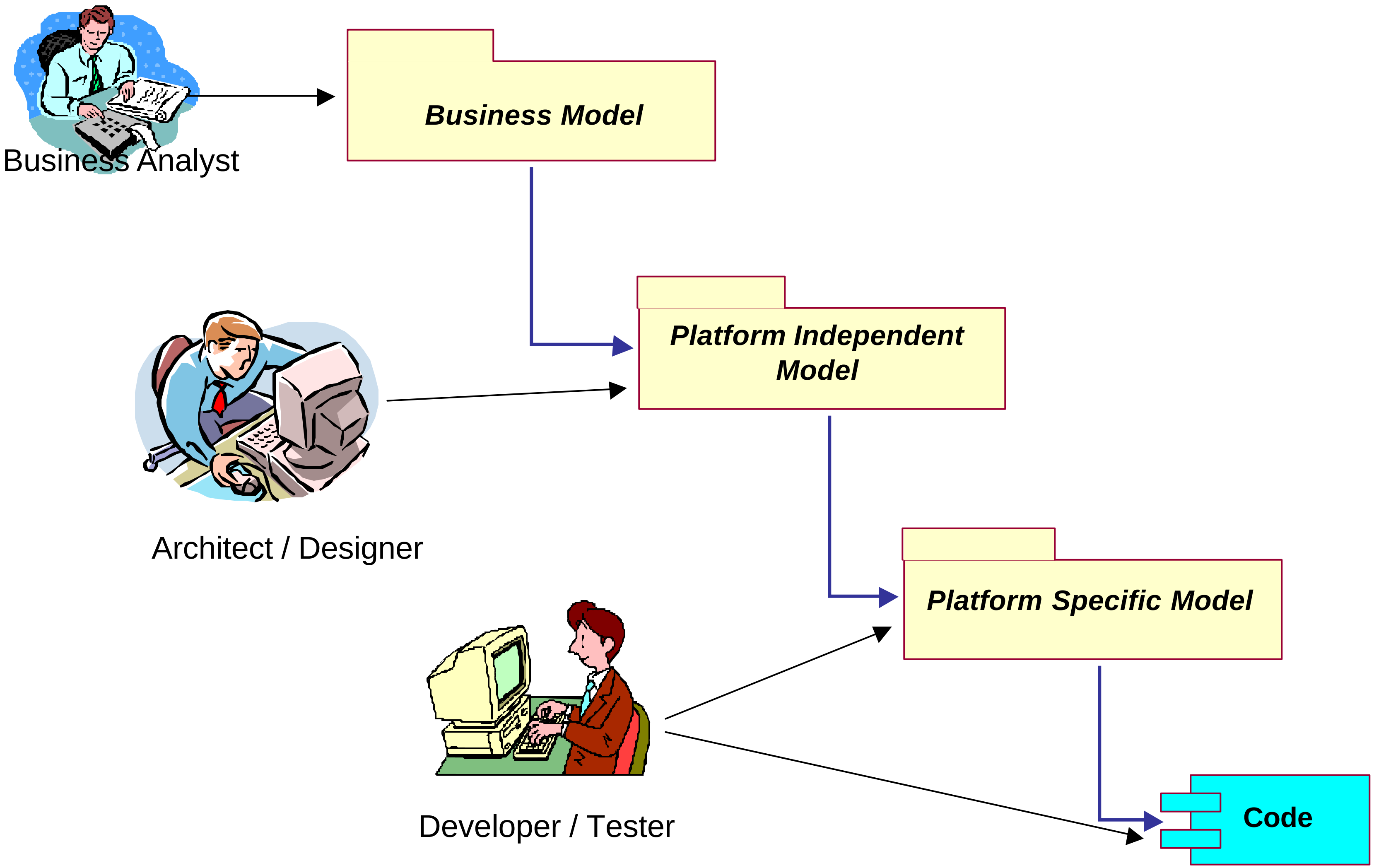
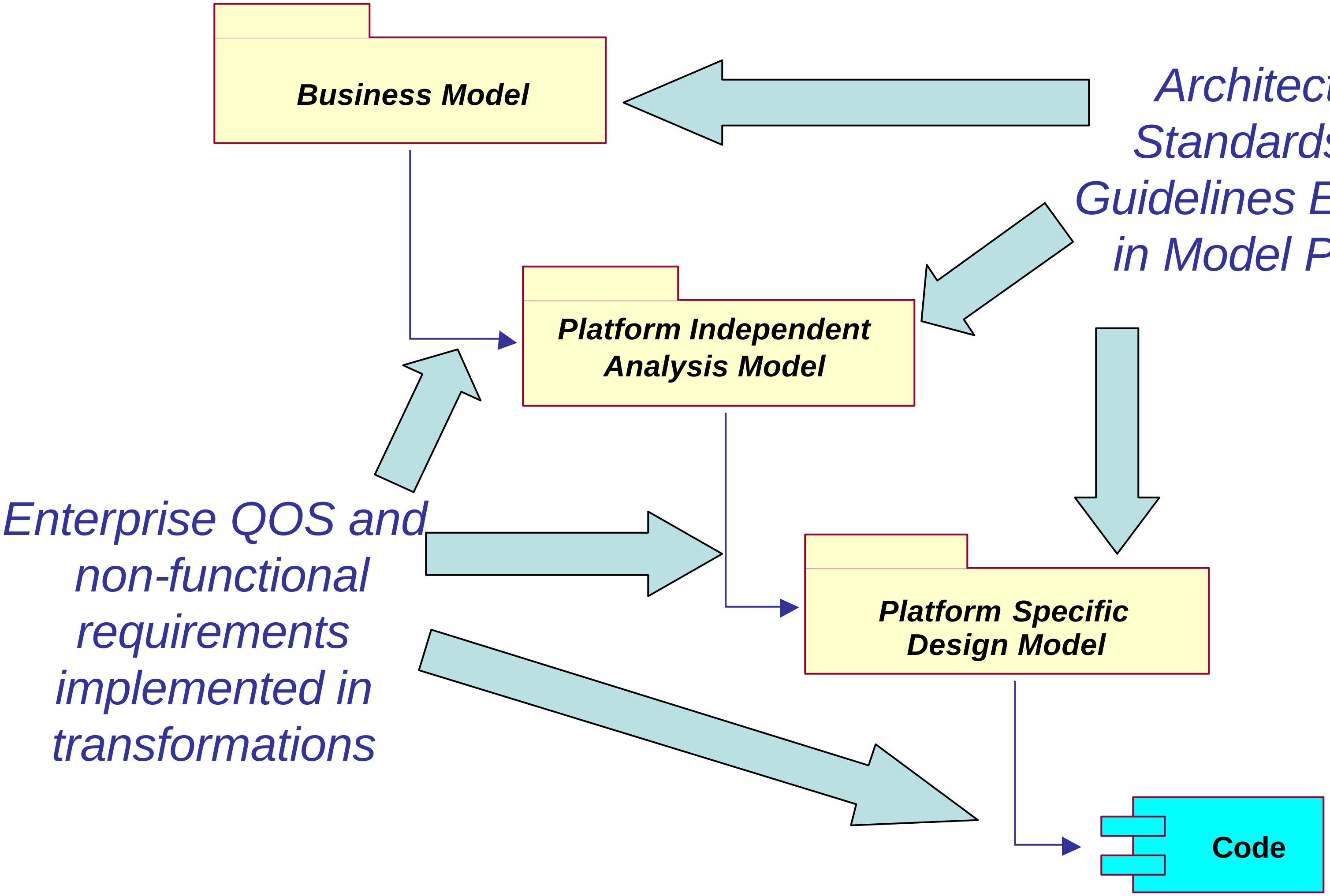


MDA Under the Hood



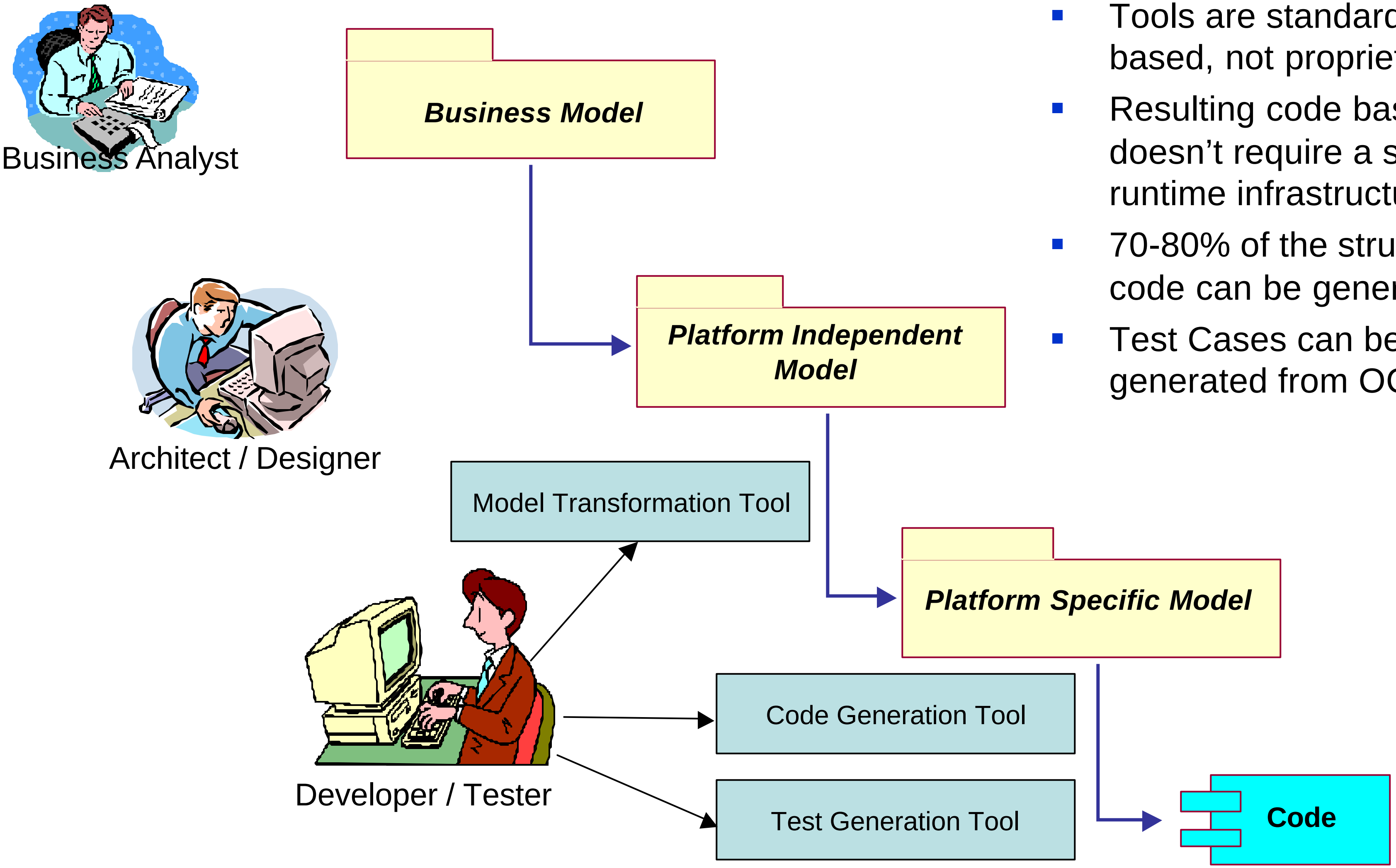
Business Model
Platform Independent Analysis Model
Platform Specific Design Model
Code

Architectural Standards and Guidelines Enforced in Model Profiles

Enterprise QOS and non-functional requirements implemented in transformations

MDA explicitly supports Enterprise Architecture

Generation Capabilities



Business Analyst

Business Model

Architect / Designer

Platform Independent Model

Model Transformation Tool

Platform Specific Model

Developer / Tester

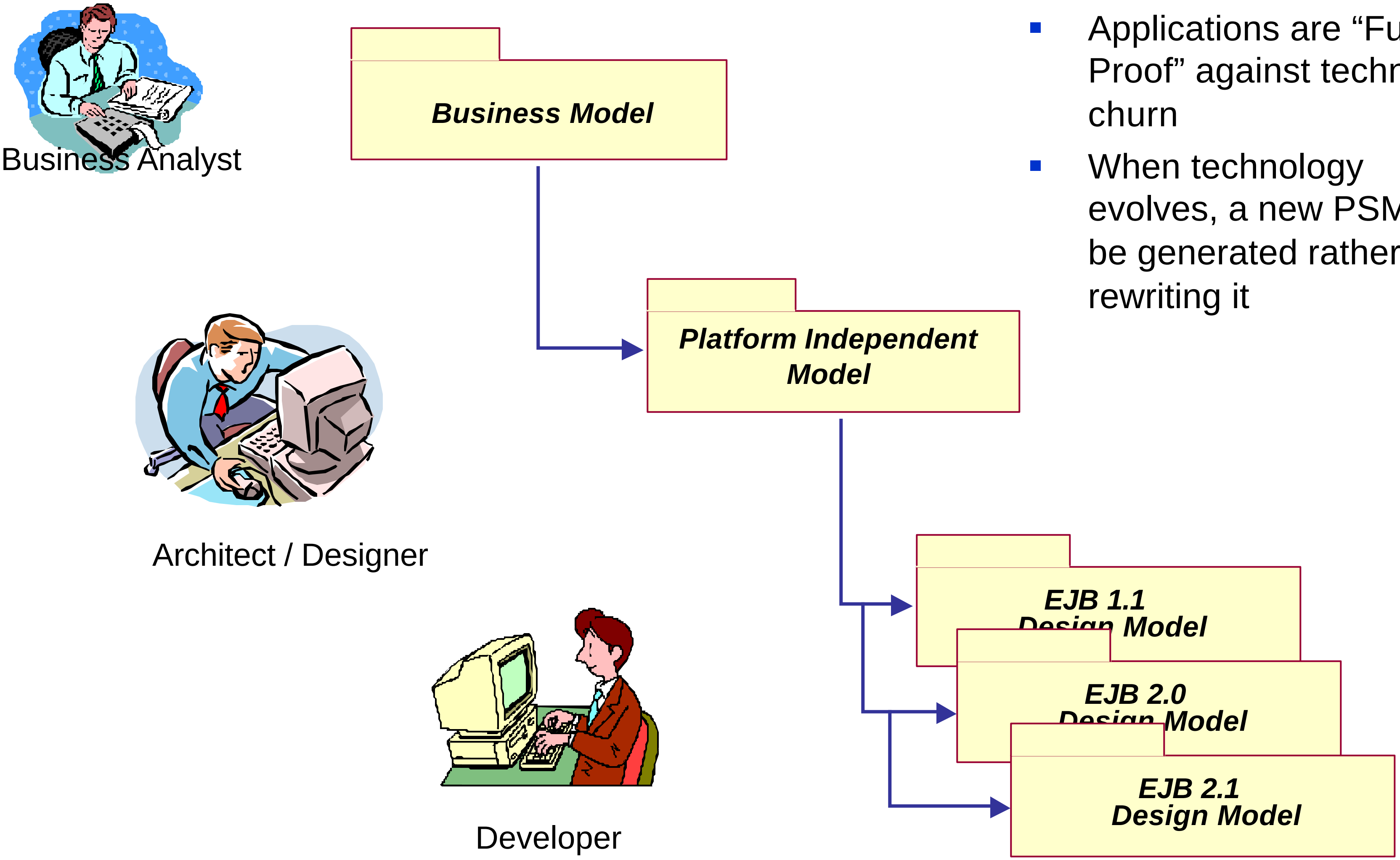
Code Generation Tool

Test Generation Tool

Code

- Tools are standards based, not proprietary
- Resulting code base doesn’t require a specific runtime infrastructure
- 70-80% of the structural code can be generated
- Test Cases can be generated from OCL

Technology Independence



Business Analyst

Business Model

Architect / Designer

Platform Independent Model

Developer

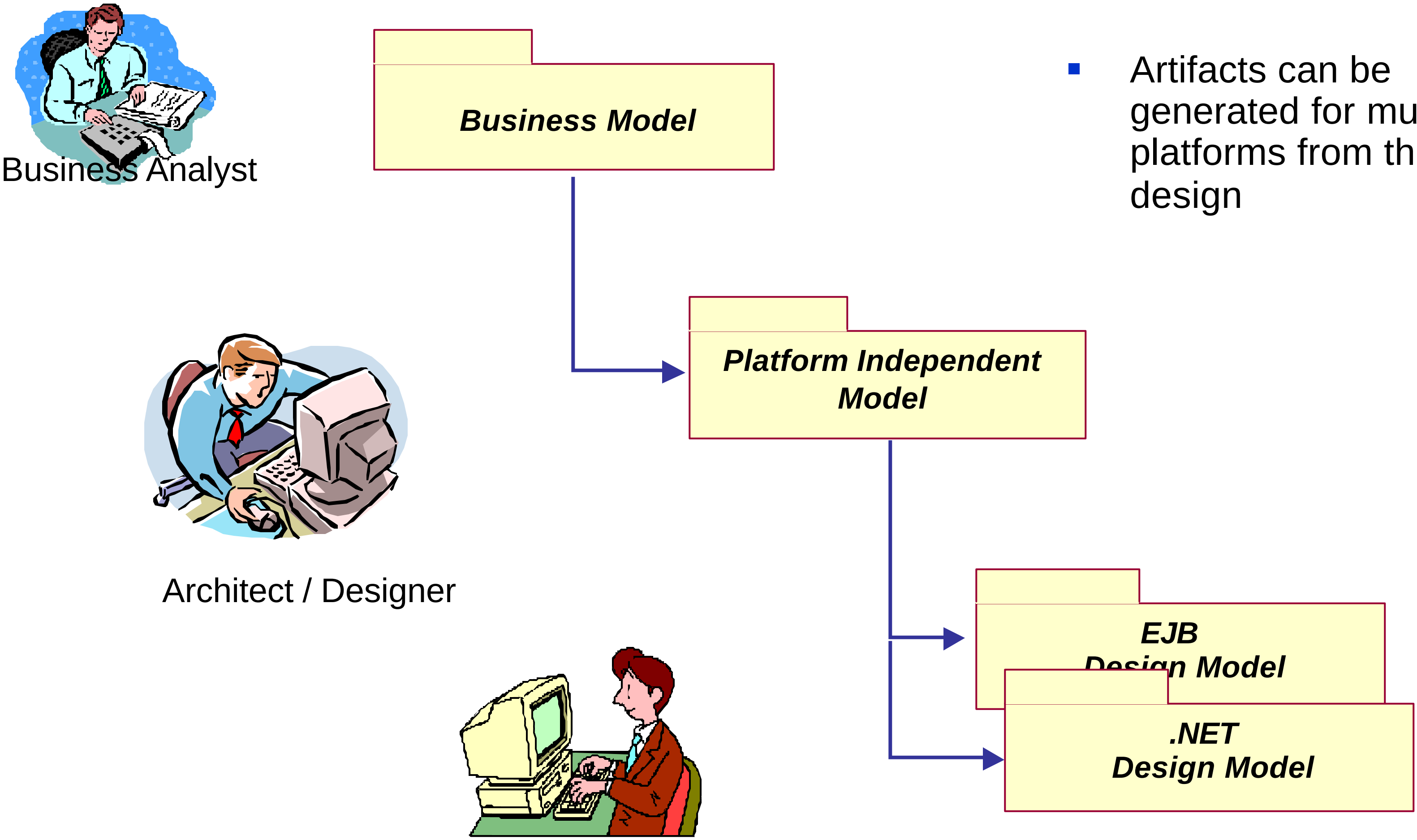
EJB 1.1 Design Model

EJB 2.0 Design Model

EJB 2.1 Design Model

- Applications are “Future-Proof” against technology churn
- When technology evolves, a new PSM can be generated rather than rewriting it

Multi-Platform Artifacts



Business Analyst

Architect / Designer

Developer

Business Model

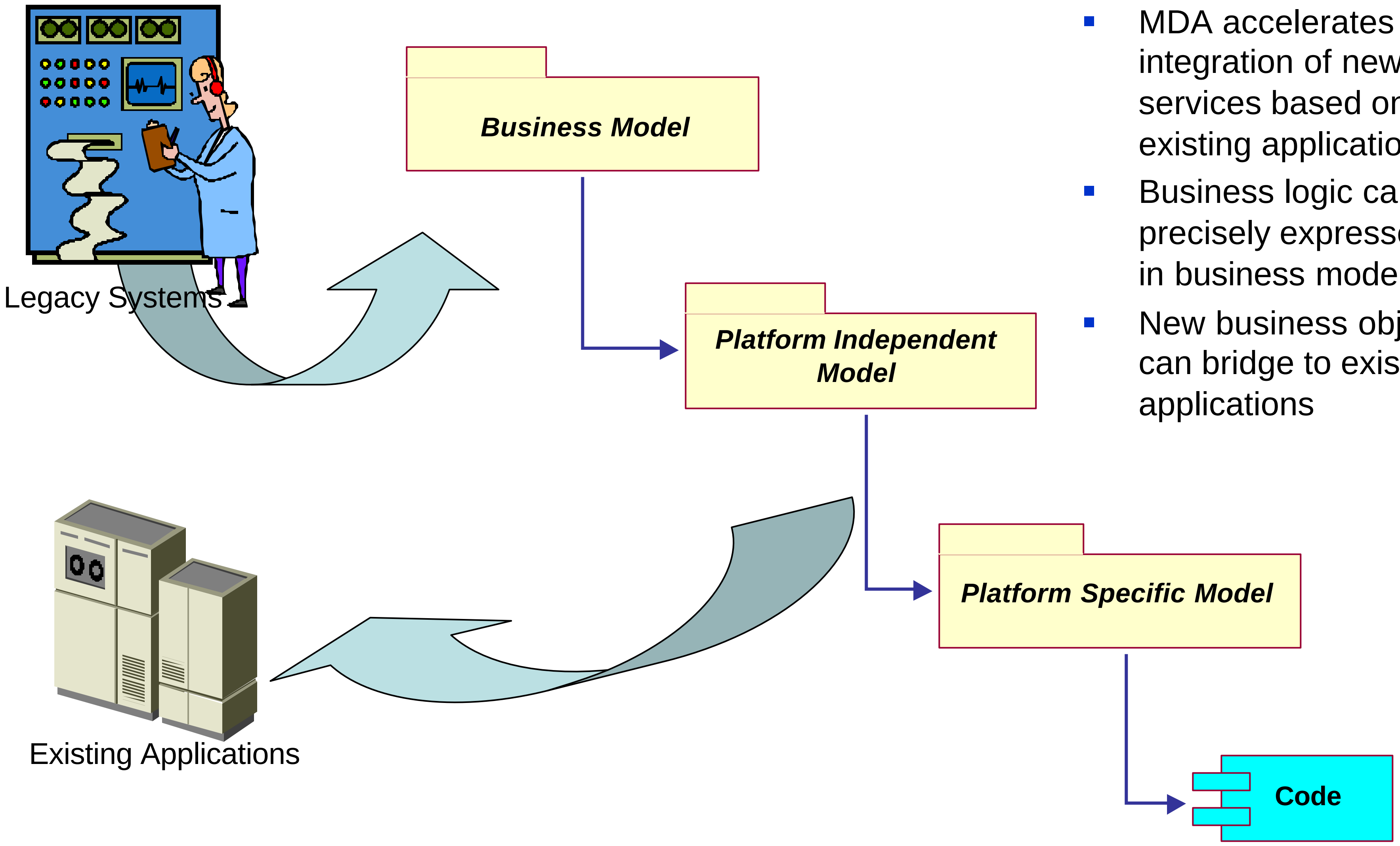
Platform Independent Model

EJB Design Model

.NET Design Model

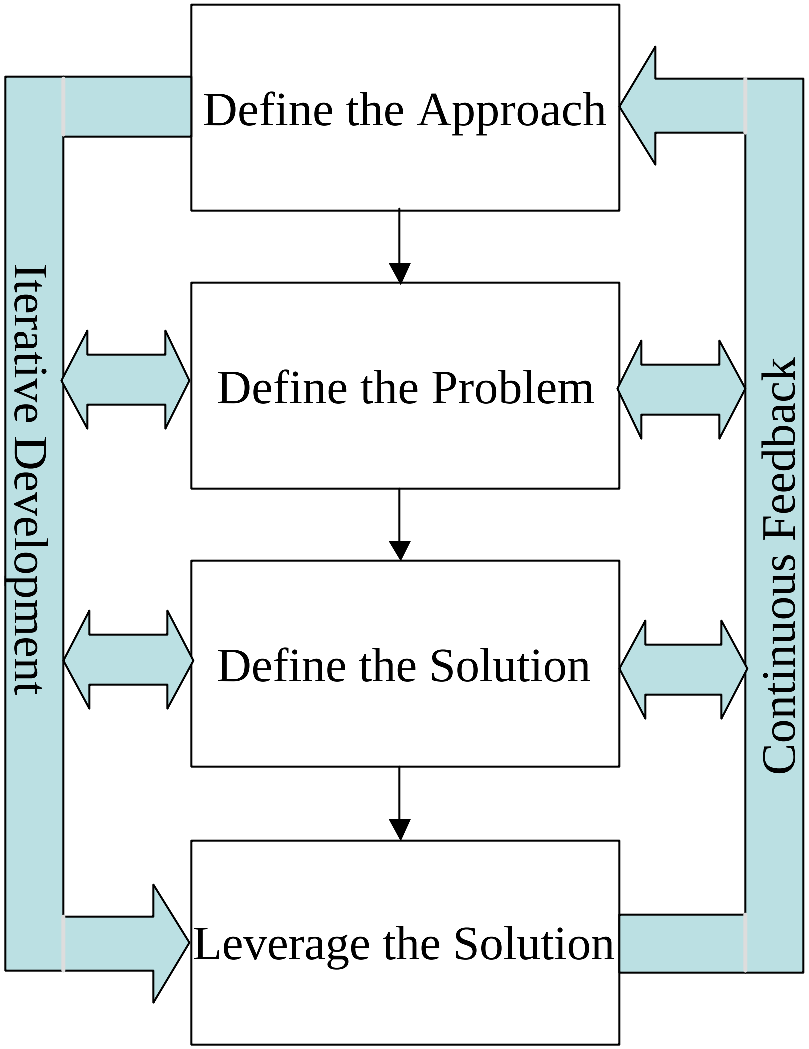
- Artifacts can be generated for multiple platforms from the same design

Integrate Existing Assets



- MDA accelerates the integration of new services based on existing applications
- Business logic can be precisely expressed in business models
- New business objects can bridge to existing applications

APSL Process



1. Define the approach
   - Integrate enterprise architecture into the development process.
   - Create meta-models and profiles
2. Define the problem
   - Create Business Models (Domain, CIM, System)
3. Define the solution
   - Refine into PIMs and PSMs
4. Leverage the solution
   - Integrate assets into a reuse repository
   - Architecture and design accommodates: reuse, customization, enhancements, versioning…

MDA Benefits

- Better alignment of business requirements and IT implementations
- Unambiguous description (and validation) of business services
- Clear process and guidelines for producing and consuming models
- Integration of architectural standards
- “Future proofing” against technology changes
- Reduction of low value tasks

Agenda

- Why MDA?
- A few words about architecture
- MDA concepts
- MDA core technologies
- Models and transformations
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MDA Core Technologies

- UML – Unified Modeling Language
  - – OCL – Object Constraint Language
- MOF – MetaObject Facility
- CWM – Common Warehouse Metamodel
- XMI – XML Metadata Interchange

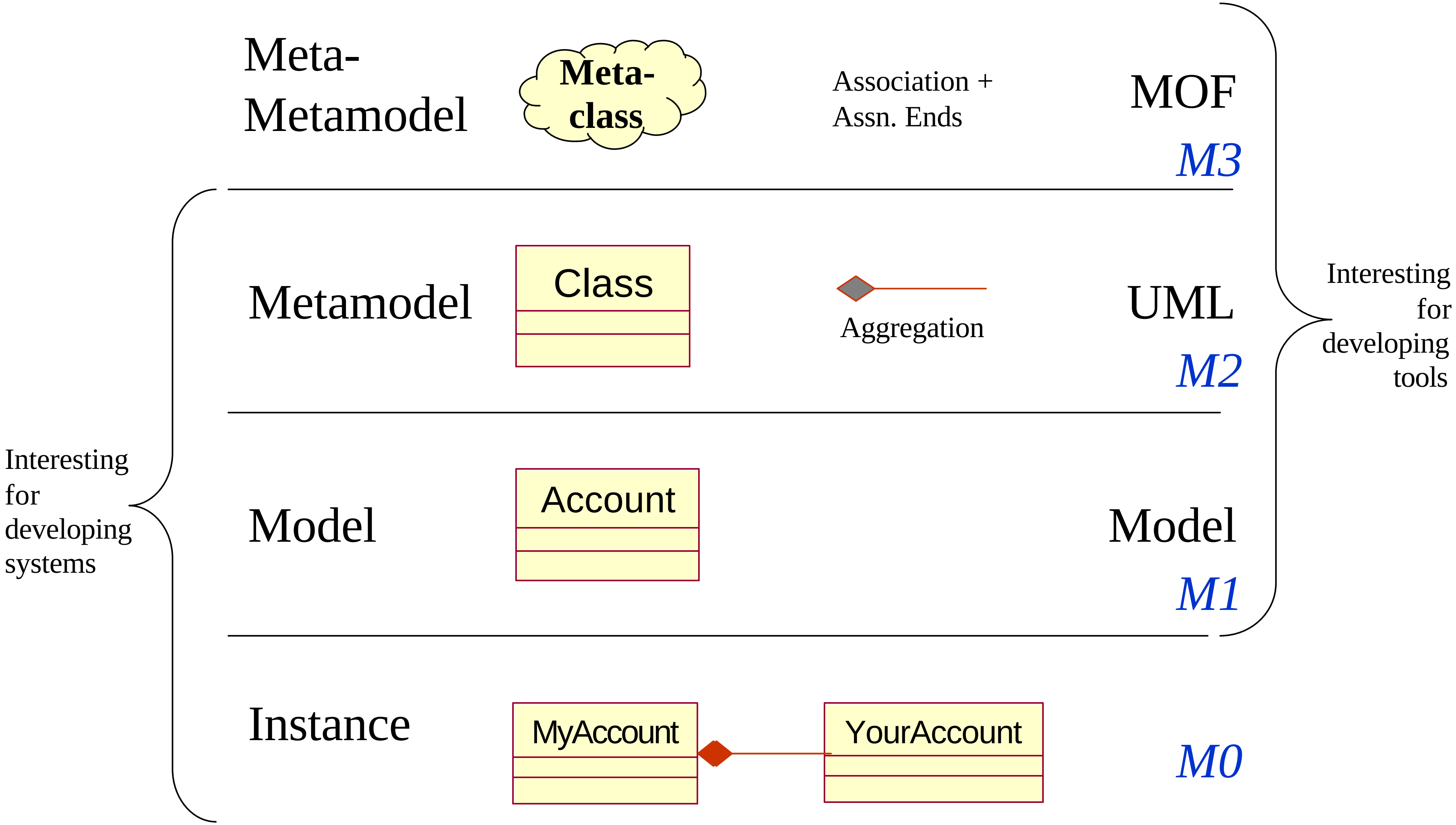
UML

- UML models are declarative, with the following advantages:
  - UML models are semantically rich
    - Invariants
    - Pre and Post conditions
    - Legal values (null?)
    - Operation side effects
    - Whether subtypes are disjoint or partition
    - Patterns of specification, design and refinement
  - UML is defined using core UML / MOF concepts
  - UML can be visual and/or textual
- UML (Unified Modeling Language) is an OMG Standard

OCL

- Object Constraint Language
- Design By Contract
  - Provides precise instruction to the programmer
  - Improves interoperability between different implementations of the same specification
  - Acts as a basis for conformance tests
  - Can provide input to code / test generation

So, What’s a Metamodel



Meta-Metamodel

Meta-class

Association + Assn. Ends

MOF

M3

Metamodel

Class

Aggregation

UML

M2

Model

Account

Model

M1

Instance

MyAccount

YourAccount

M0

Interesting for developing tools

Interesting for developing systems

MOF – Meta Object Facility

- A consistent way to define metamodels
- A consistent way to store models
- A consistent way to access models
- Rules for defining lifecycle, composition and closure of elements
- A hierarchy of reflective interfaces
- Provides interoperability between otherwise dissimilar models and metamodels

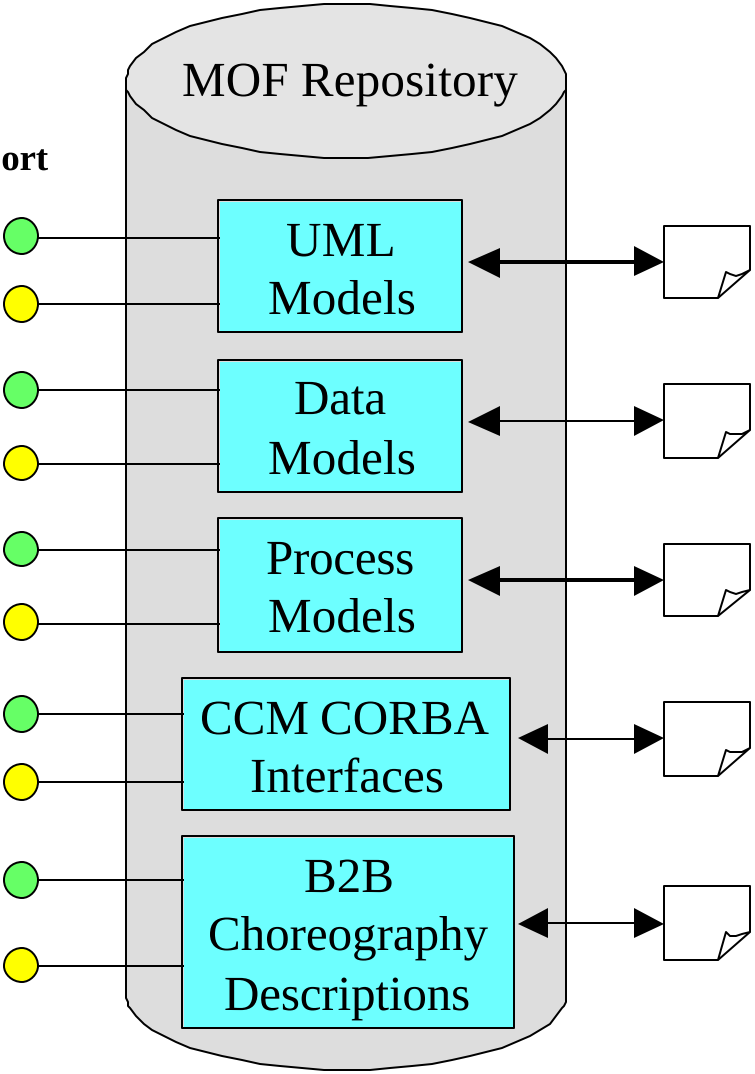
MOF Repository

🟢 = MOF CORBA Interfaces

🟡 = MOF Java Interfaces (JMI)

🗎 = MOF XML (XMI) Import / Export

Work in progress: MOF-WSDL mapping



MOF Repository

UML Models

Data Models

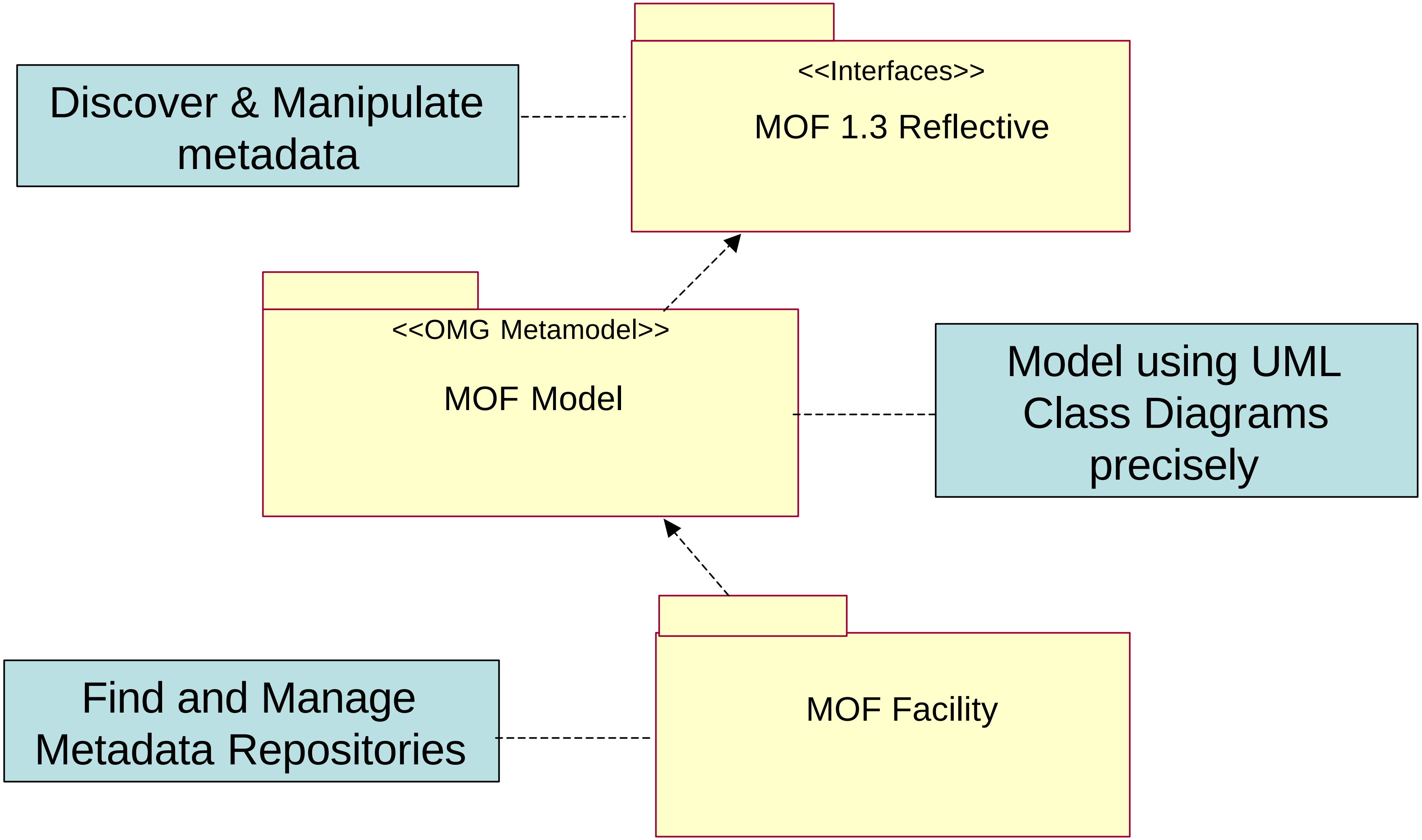
Process Models

CCM CORBA Interfaces

B2B Choreography Descriptions

Copyr Courtesy David Frankel

MOF Components



Discover & Manipulate metadata

<<Interfaces>>

MOF 1.3 Reflective

<<OMG Metamodel>>

MOF Model

Model using UML Class Diagrams precisely

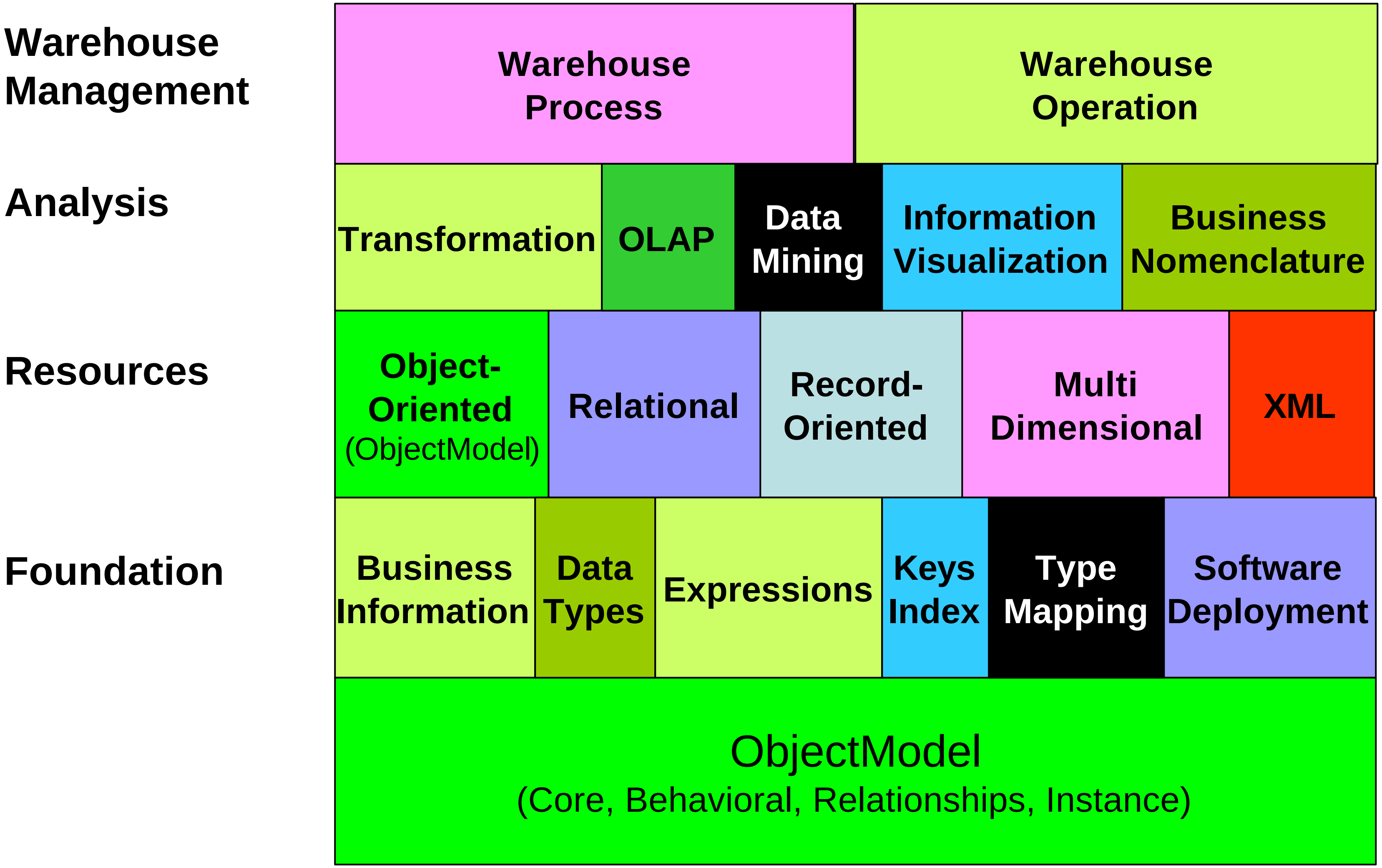
Find and Manage Metadata Repositories

MOF Facility

Common Warehouse Metamodel

- Standard for data warehousing
  - Buisness and technical metadata for business analysis and data warehousing
- Covers full data lifecycle
  - Design
  - Build
  - Manage
- Improves integration between development and deployment
  - Models that span lifecycle segments
  - Profiles that map between segments
- Integration between heterogeneous stores

Common Warehouse Metamodel



Warehouse Management

Warehouse Process

Warehouse Operation

Analysis

Transformation

OLAP

Data Mining

Information Visualization

Business Nomenclature

Resources

Object-Oriented (ObjectModel)

Relational

Record-Oriented

Multi Dimensional

XML

Foundation

Business Information

Data Types

Expressions

Keys Index

Type Mapping

Software Deployment

ObjectModel (Core, Behavioral, Relationships, Instance)

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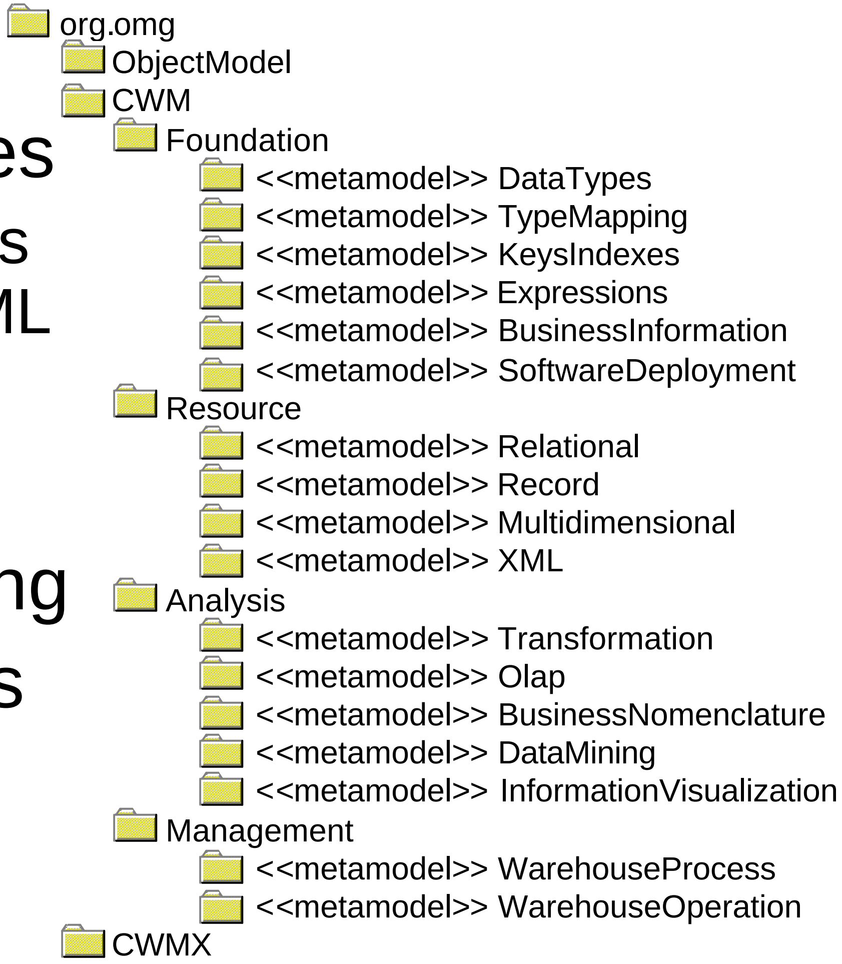
CWM Package Architecture

Modular Design

- Minimum dependencies
  - Cross package services provided by links to UML
- Avoid subpackages
- Reduced complexity, improved understanding
- Use only the packages you need



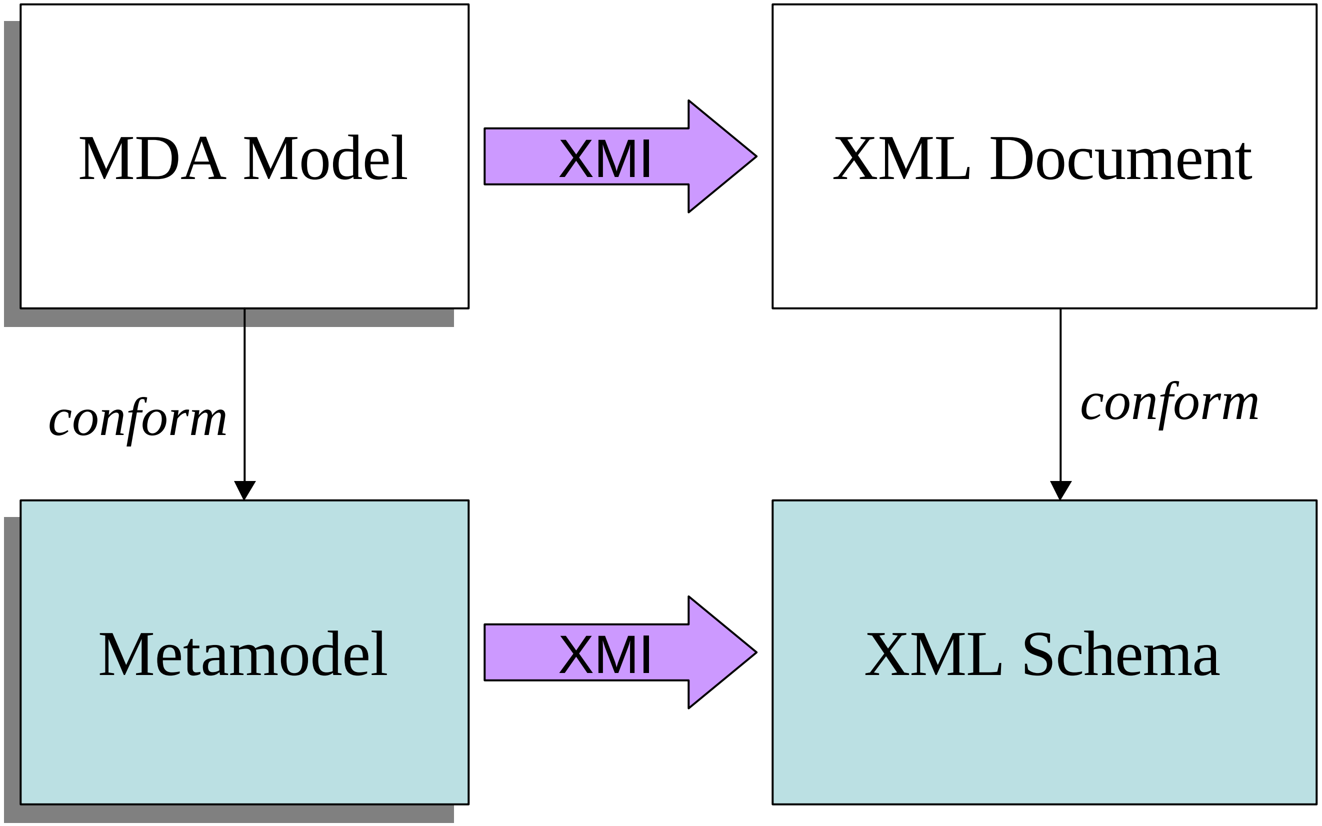
- org.omg
  - ObjectModel
  - CWM
    - Foundation
      - <<metamodel>> DataTypes
      - <<metamodel>> TypeMapping
      - <<metamodel>> KeysIndexes
      - <<metamodel>> Expressions
      - <<metamodel>> BusinessInformation
      - <<metamodel>> SoftwareDeployment
    - Resource
      - <<metamodel>> Relational
      - <<metamodel>> Record
      - <<metamodel>> Multidimensional
      - <<metamodel>> XML
    - Analysis
      - <<metamodel>> Transformation
      - <<metamodel>> Olap
      - <<metamodel>> BusinessNomenclature
      - <<metamodel>> DataMining
      - <<metamodel>> InformationVisualization
    - Management
      - <<metamodel>> WarehouseProcess
      - <<metamodel>> WarehouseOperation
  - CWMX

XMI

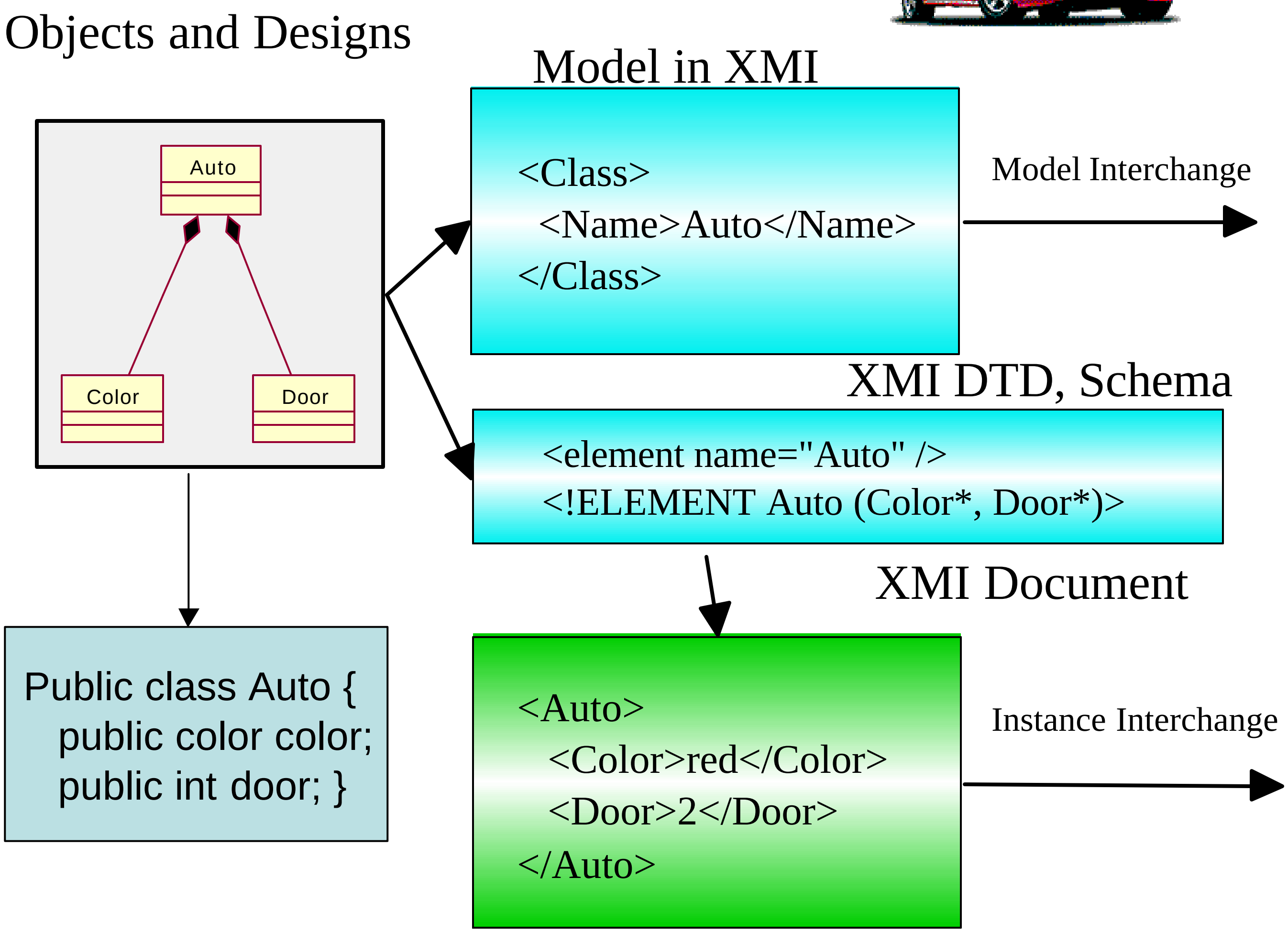
- Standard interchange mechanism
  - Tools
  - Repository
  - Middleware
- Produce XML Schema and DTD’s
- Serialize via XML documents
- Applies to any MOF repository

XMI in MDA

M²VP



XMI Example



Objects and Designs

Model in XMI

```
<Class>
  <Name>Auto</Name>
</Class>
```

Model Interchange

XMI DTD, Schema

```
<element name="Auto" />
<!ELEMENT Auto (Color*, Door*)>
```

XMI Document

```
<Auto>
   <Color>red</Color>
   <Door>2</Door>
</Auto>
```

Instance Interchange

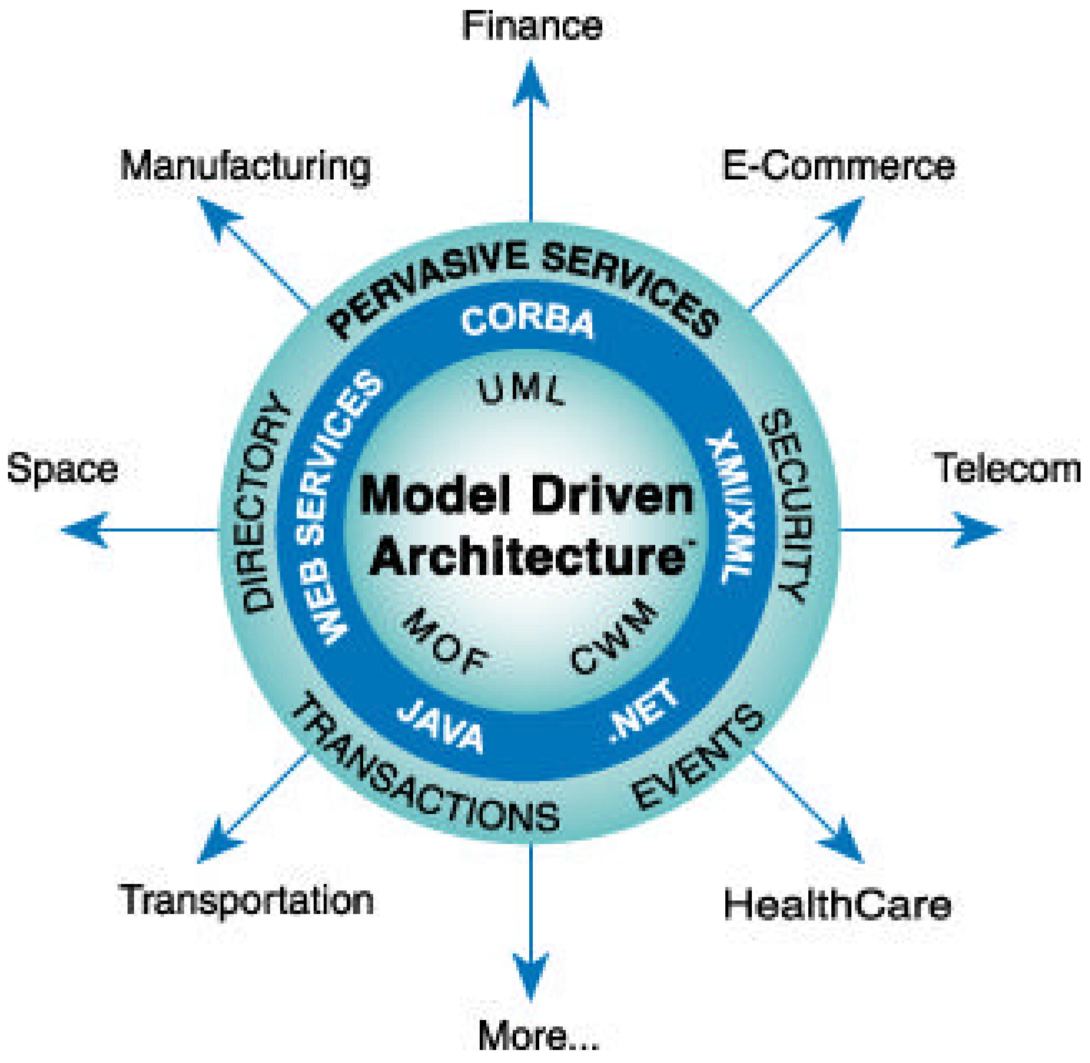
```
Public class Auto {
   public color color;
   public int door; }
```

Java and MDA

- Several J2EE standards are formal mappings of MDA into Java
  - JMI
  - JOLAP
  - JDM
- A trend toward the realization of MDA, MOF, CWM interfaces in Java

OMG’s Model Driven Architecture

M^{2}VP



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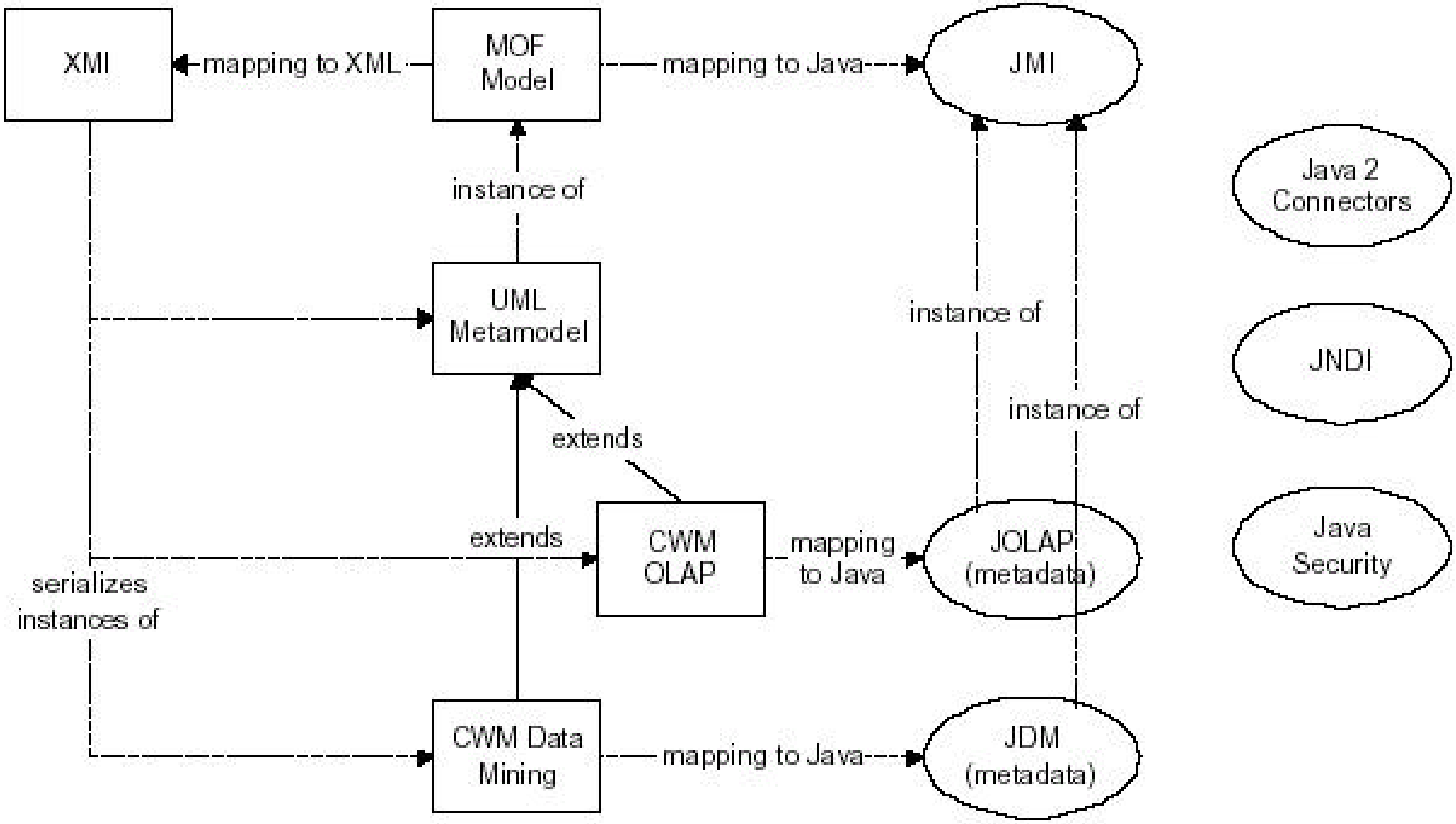
Technology Relationships



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Informal UML Models

- Informal modeling
- Used to sketch out basic concepts
- Advantage over typical box and line diagrams because shapes and line types have specific meanings
- Important way to use UML, but can’t drive code generators and dynamic execution engines
  - Analogously, informal text can’t be compiled and executed like 3GL text

Formal UML Models

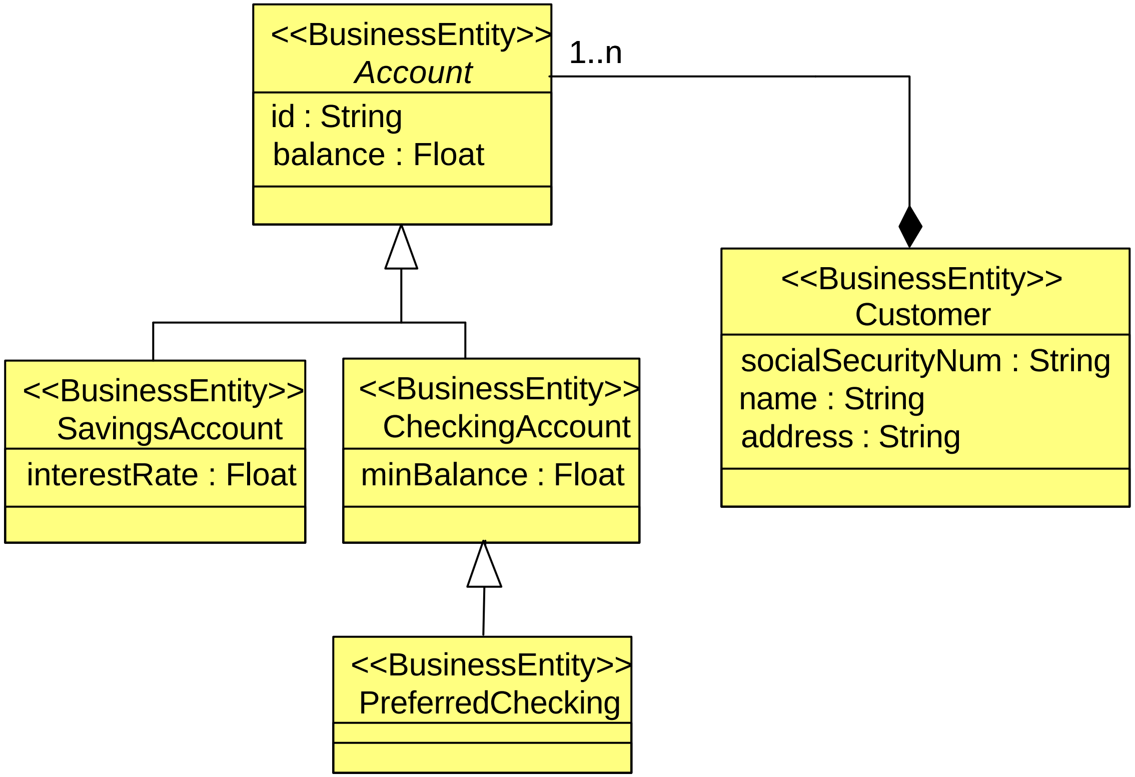
- Precise
  - – Precision and detail are *not* the same!
- Complete
  - – Missing properties and unresolved references not acceptable
  - – 3GL analogy…
    - an incomplete expression such as “a +” does not compile
    - An undeclared identifier does not compile

Computationally Complete Model

- A model that can be executed - via code generation or interpretation - is said to be “computationally complete”
- Requires:
  - Action Language for algorithmic logic
  - Computational structure
- The vision is to build computationally complete PIMs
  - All development at the model level
  - Execute the model to test
  - Generate code where necessary

Business Information Model Imprecise and Incomplete

M²VP



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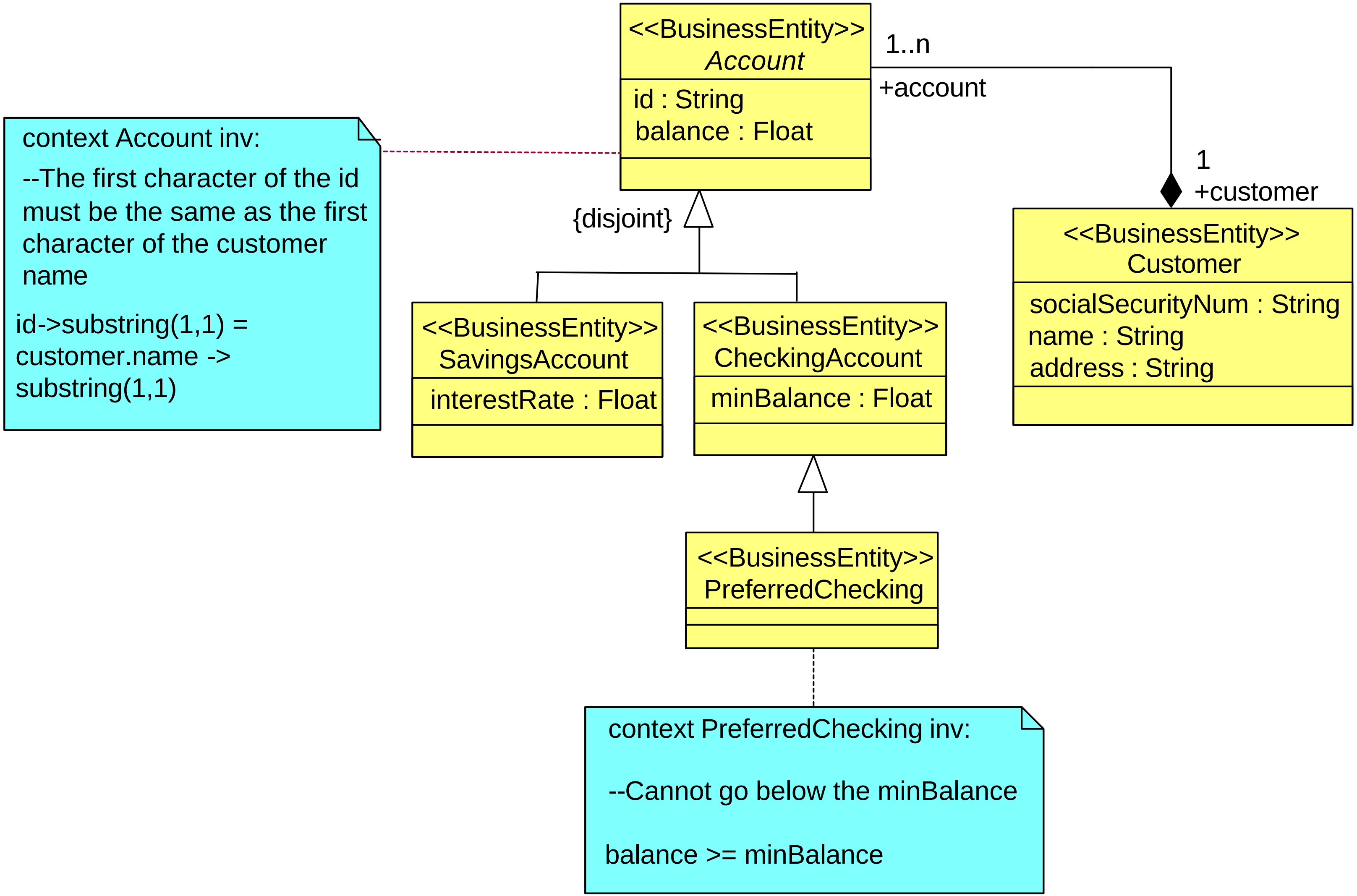
Business Information Model
Precise and Complete



context Account inv:

--The first character of the id must be the same as the first character of the customer name

id->substring(1,1) = customer.name -> substring(1,1)

context PreferredChecking inv:

--Cannot go below the minBalance

balance >= minBalance

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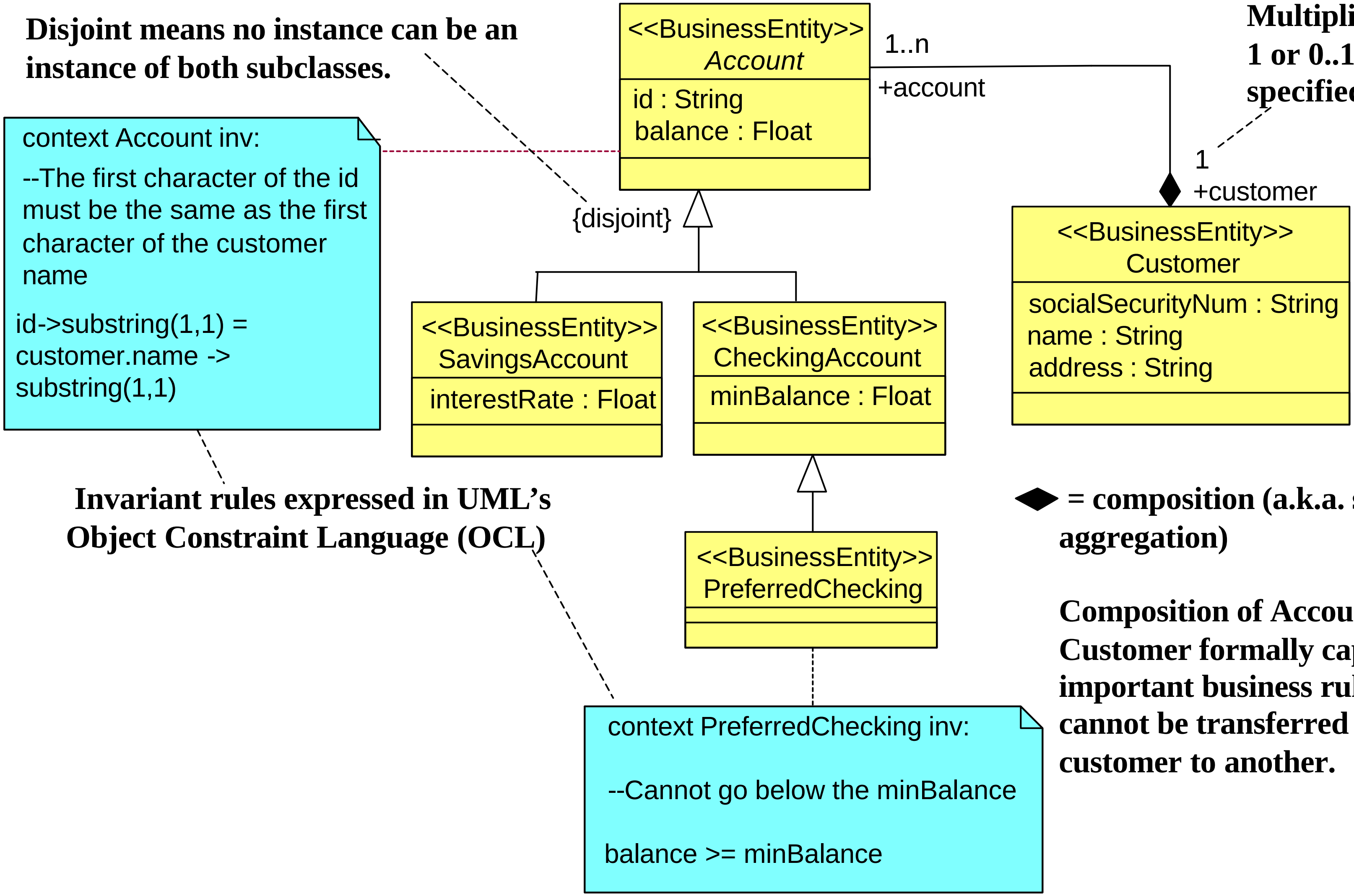
Business Information Model Precise and Complete



Disjoint means no instance can be an instance of both subclasses.

Multiplicity could be 1 or 0..1, must be specified

<<BusinessEntity>>
Account
id : String
balance : Float

<<BusinessEntity>>
Customer
socialSecurityNum : String
name : String
address : String

context Account inv:

--The first character of the id must be the same as the first character of the customer name

id->substring(1,1) = customer.name -> substring(1,1)

<<BusinessEntity>>
SavingsAccount
interestRate : Float

<<BusinessEntity>>
CheckingAccount
minBalance : Float

<<BusinessEntity>>
PreferredChecking

Invariant rules expressed in UML’s Object Constraint Language (OCL)

◆ = composition (a.k.a. strong aggregation)

Composition of Account by Customer formally captures an important business rule: An account cannot be transferred from one customer to another.

context PreferredChecking inv:

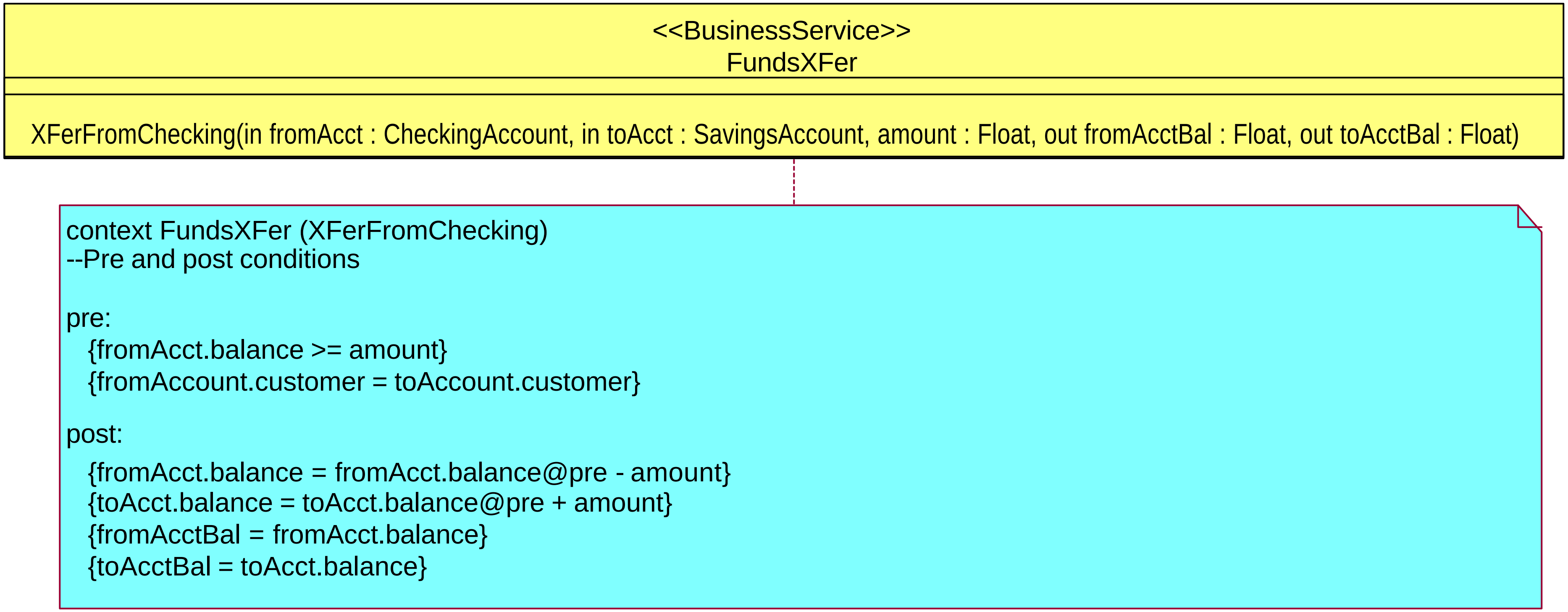
--Cannot go below the minBalance

balance >= minBalance

Courtesy David Frankel, ©2002

Business Service Model Design by Contract™

M²VP



<<BusinessService>>
FundsXFer

XFerFromChecking(in fromAcct : CheckingAccount, in toAcct : SavingsAccount, amount : Float, out fromAcctBal : Float, out toAcctBal : Float)

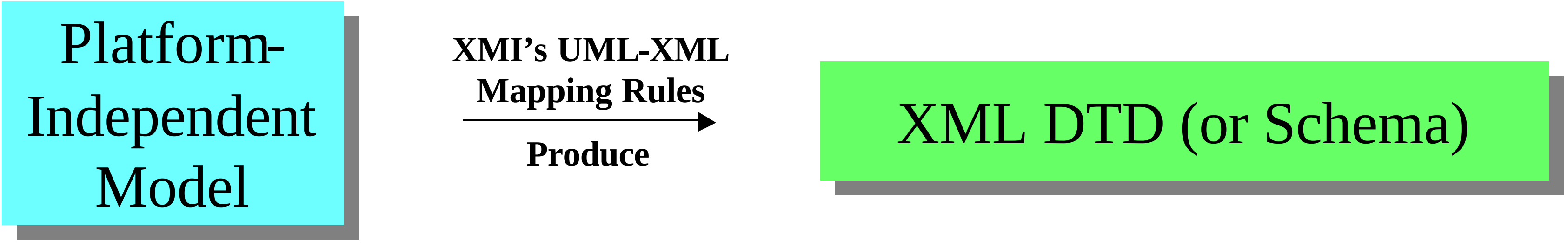
```
context FundsXFer (XFerFromChecking)
--Pre and post conditions

pre:
   {fromAcct.balance >= amount}
   {fromAccount.customer = toAccount.customer}

post:
   {fromAcct.balance = fromAcct.balance@pre - amount}
   {toAcct.balance = toAcct.balance@pre + amount}
   {fromAcctBal = fromAcct.balance}
   {toAcctBal = toAcct.balance}
```

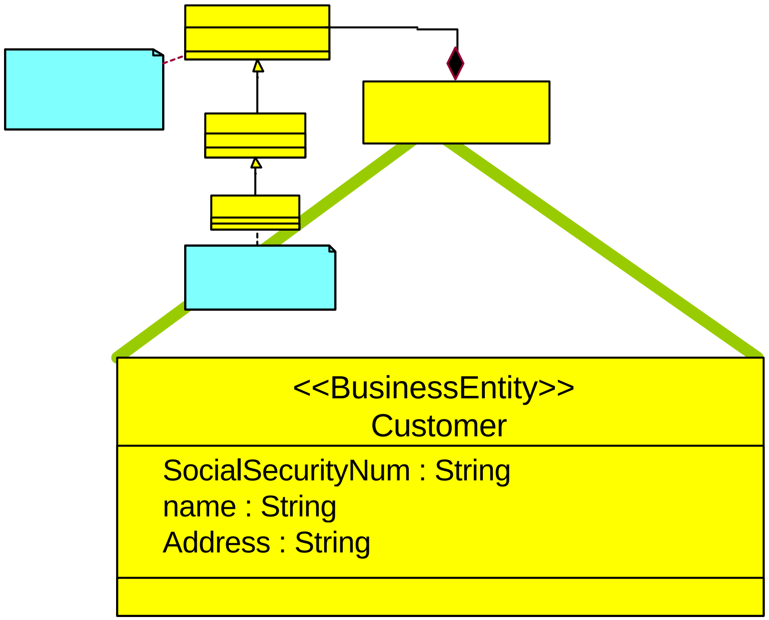
Courtesy David Frankel, ©2002

PSM

- Expressed in UML
  - – UML is platform neutral, so…
- UML Profiles extend UML using stereotypes and tagged values
  - – Create a Platform Specific Template

Mapping the Business Information Model to XML



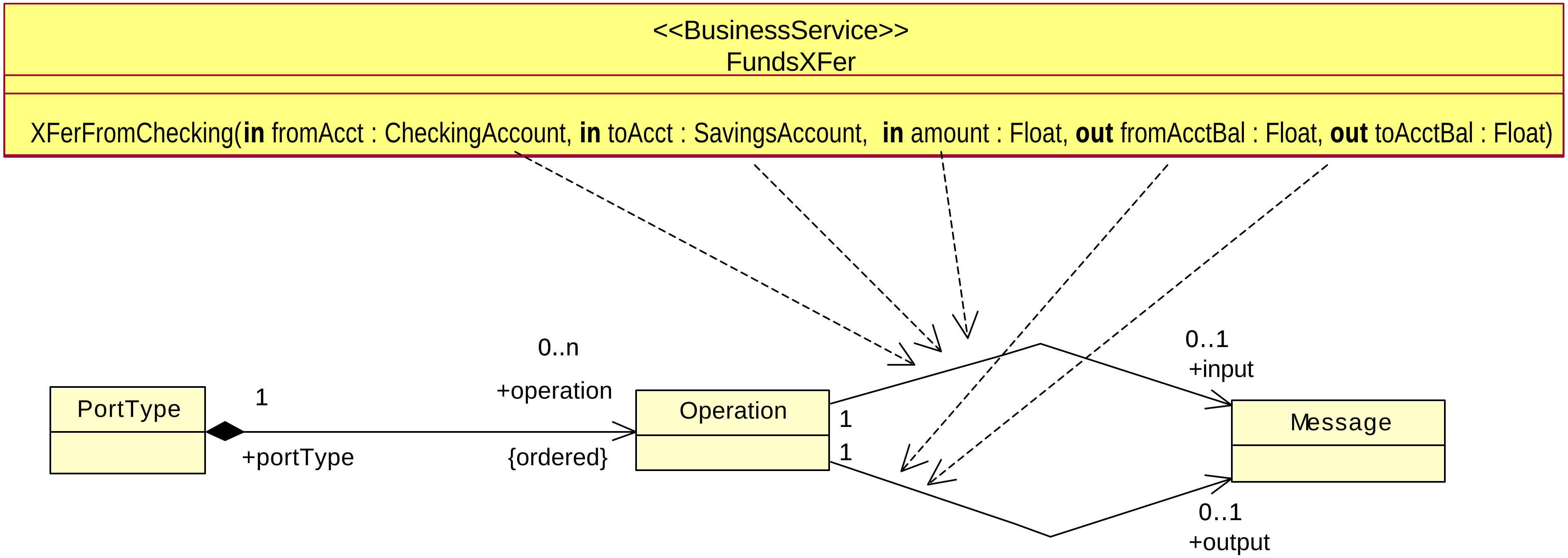


```
…
<!ELEMENT Bank.Customer.SocialSecurityNum (#PCDATA |
XMI.reference)*>
<!ELEMENT Bank.Customer.name (#PCDATA | XMI.reference)* >
<!ELEMENT Bank.Customer.Address (#PCDATA | XMI.reference)* >
 …
```

Courtesy David Frankel, ©2002

Mapping the Business Service Model to WSDL

M^{2}VP



<<BusinessService>>
FundsXFer

XFerFromChecking(**in** fromAcct : CheckingAccount, **in** toAcct : SavingsAccount, **in** amount : Float, **out** fromAcctBal : Float, **out** toAcctBal : Float)

PortType

1

+portType

0..n

+operation

{ordered}

Operation

1

1

0..1

+input

Message

0..1

+output

The message payload format is based on a UML-XML mapping applied to the business information model.

Courtesy David Frankel, ©2002

Modeling System Behavior

- **Functional Behavior**
  - What a component must do to satisfy its functional (business) requirements.
  - This type of behavior is the concern of the business expert, the business analyst, and the functional tester.
- **Non-functional Behavior**
  - What a component must do to satisfy its non-functional requirements.
  - This is the concern of the designer who looks for ways to re-assemble components to generally maximize cohesion, minimize coupling, and to specifically increase throughput, availability, changeability, and other "-ilities" that are required of the system.

Modeling System Behavior (2)

- **Semantic Behavior**
  - – What a “component” must do to interact with other components within its environment.
  - – A specialized form of non-functional behavior that is related to architectural style
  - – This is the concern of the system architect.
- **Idiomatic Behavior**
  - – What a component must do to operate within the environment of its technical platform/programming language.
  - – This is the concern of the programmer.

MDA & Separation of Concerns

- Provides separation of concerns by defining…
  - Platform Independent Models (PIM)
    - Provides formal specifications of the structure and function of the system that abstracts away technical details.
    - Details functional, non-functional, and semantic behavior
  - Platform Specific Models (PSM)
    - Provides idiomatic behavior expressed in terms of the specification model of the target platform.
    - PSMs have to use the platform concepts of exception mechanisms, parameter types (including platform-specific rules about objects references, value types, semantics of call by value, etc.) and component model.

Architecture vs. Architectural Style

- Model Driven *Architecture*
  - We've talked about models.
  - So where's the architecture?
- Architecture
  - The highest level concept of a system in its environment. The architecture of a software system (at a given point in time) is its organization or **structure of significant components** interacting through interfaces, those components being composed of successively smaller components and interfaces.*
  - Architecture, then, is dependent upon the specifics of the system it describes, i.e. **its major components, interfaces, and constraints**.
  - Two companies in the **same** line of business using the same development and deployment platforms will have **different** architectures.

**Rational Unified Process*

Architecture vs. Architectural Style

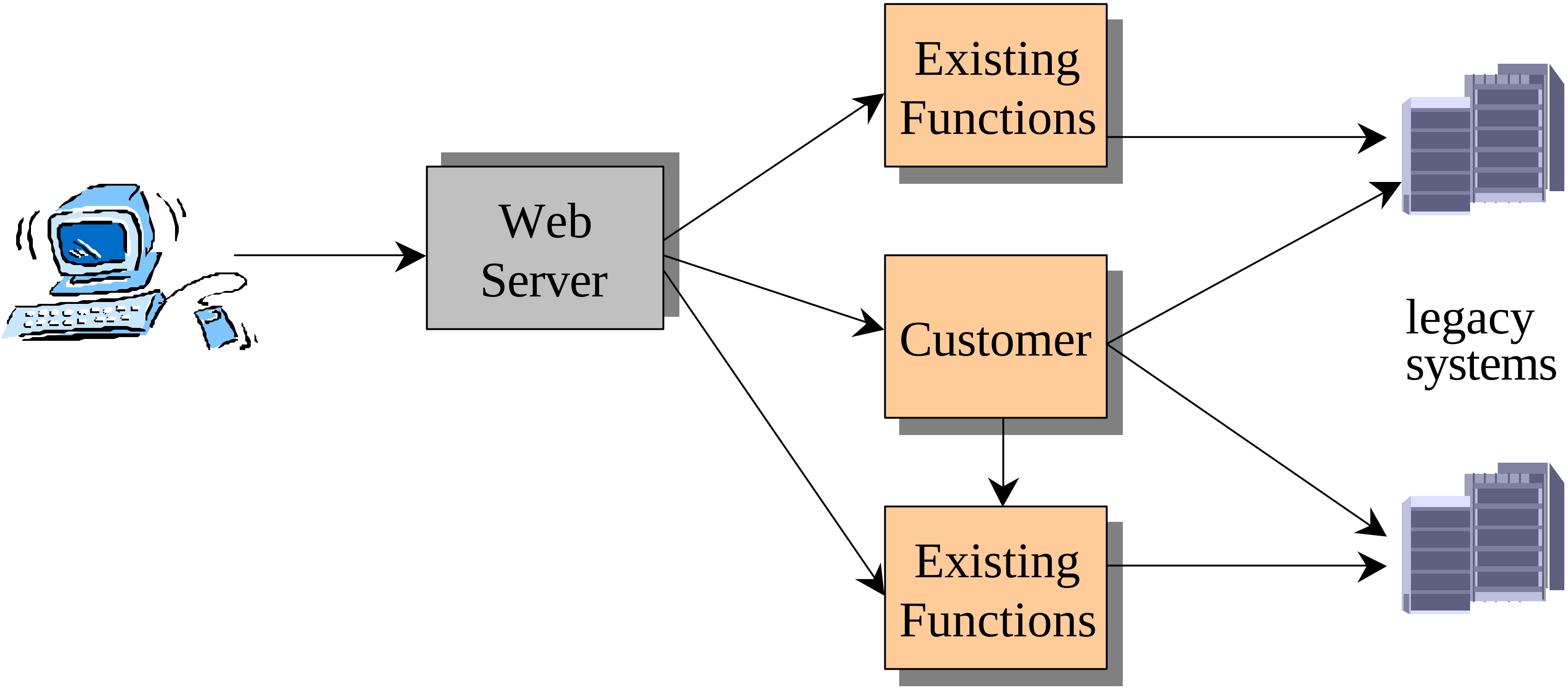
- Architectural Style
  - “A description of **component types** and a **pattern** of their runtime control and/or data transfer. A style can be thought of as a set of constraints on an architecture – **constraints on the component types and their patterns of interaction** – and these constraints define a set or family of architectures that satisfy them.”*
  - Architectural style, then, provides the “**rules of engagement**” when building an architecture. It is a set of patterns that provide guidance on the proper use of the different types of components that exist within your architecture.
  - The best way to convey an **architectural style** is via a formal model of it, referred to as a **metamodel**.

**Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Addision Wesley. (1998)*

Metamodels

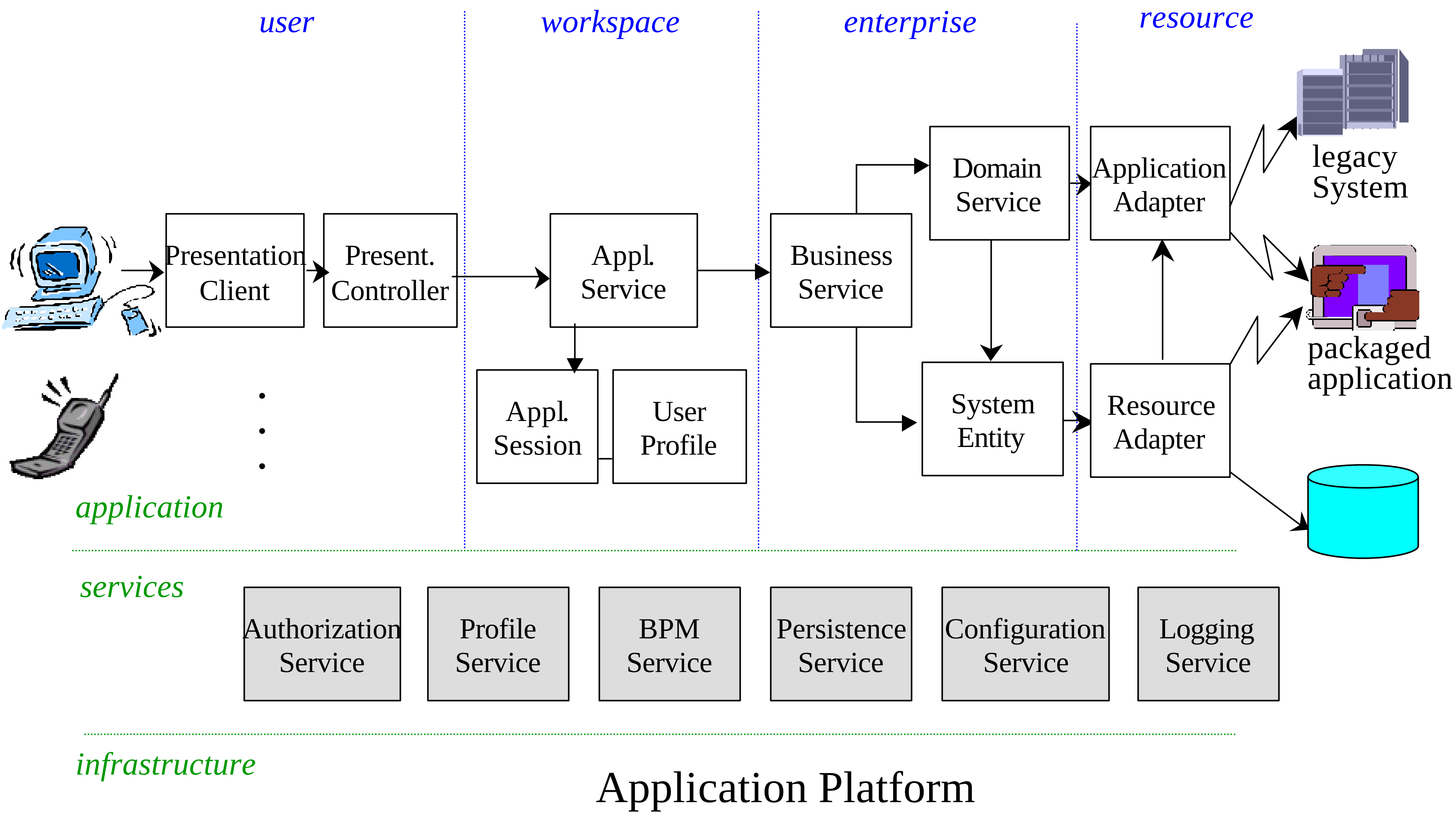
- Provide rules for how to build a correct model for a particular purpose, e.g. “business integration metamodel”
- UML Profile
  - Provides a targeted subset of UML
  - Standard mechanism for extending UML
- Refinement and Constraint
  - Metamodels refine the definition of modeling elements by placing constraints on their behavior through the use of stereotypes
- Stereotypes
  - Standard UML Stereotypes
    - <<boundary>>, <<control>>, <<entity>>
  - Extending the UML Stereotypes
    - Inheritance used to extend and refine the meaning of stereotypes
    - Tagged Values use to apply specific properties

Sample Web Implementation



Sample Web Architecture

M²VP



user

workspace

enterprise

resource

Presentation Client

Present. Controller

Appl. Service

Appl. Session

User Profile

Business Service

Domain Service

System Entity

Application Adapter

Resource Adapter

legacy System

packaged application

application

services

Authorization Service

Profile Service

BPM Service

Persistence Service

Configuration Service

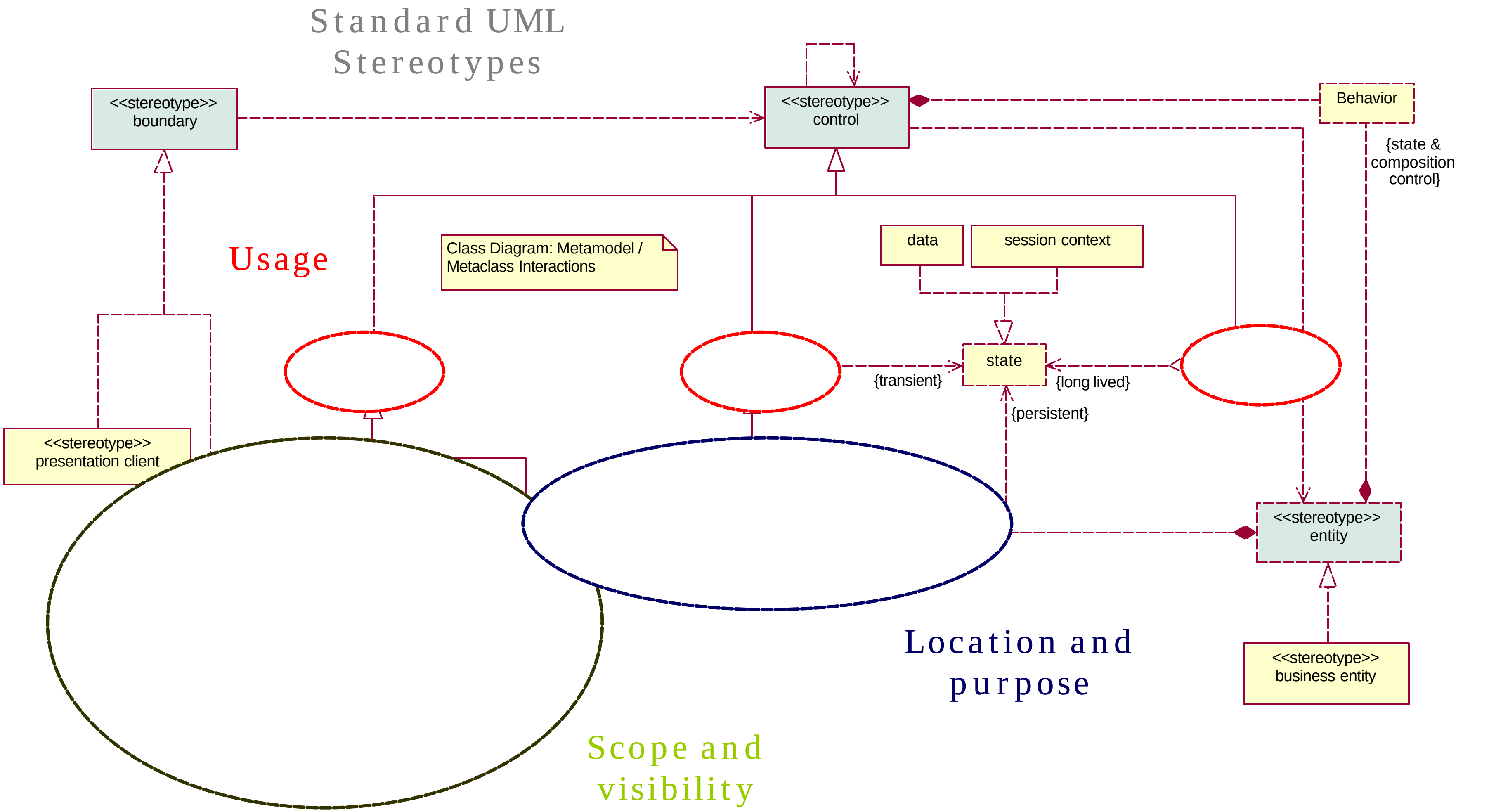
Logging Service

infrastructure

Application Platform

Metamodel Stereotypes

M^{2}VP



Standard UML Stereotypes

<<stereotype>> boundary

<<stereotype>> control

Behavior

{state & composition control}

Usage

Class Diagram: Metamodel / Metaclass Interactions

data

session context

state

{transient}

{long lived}

{persistent}

<<stereotype>> presentation client

<<stereotype>> entity

<<stereotype>> business entity

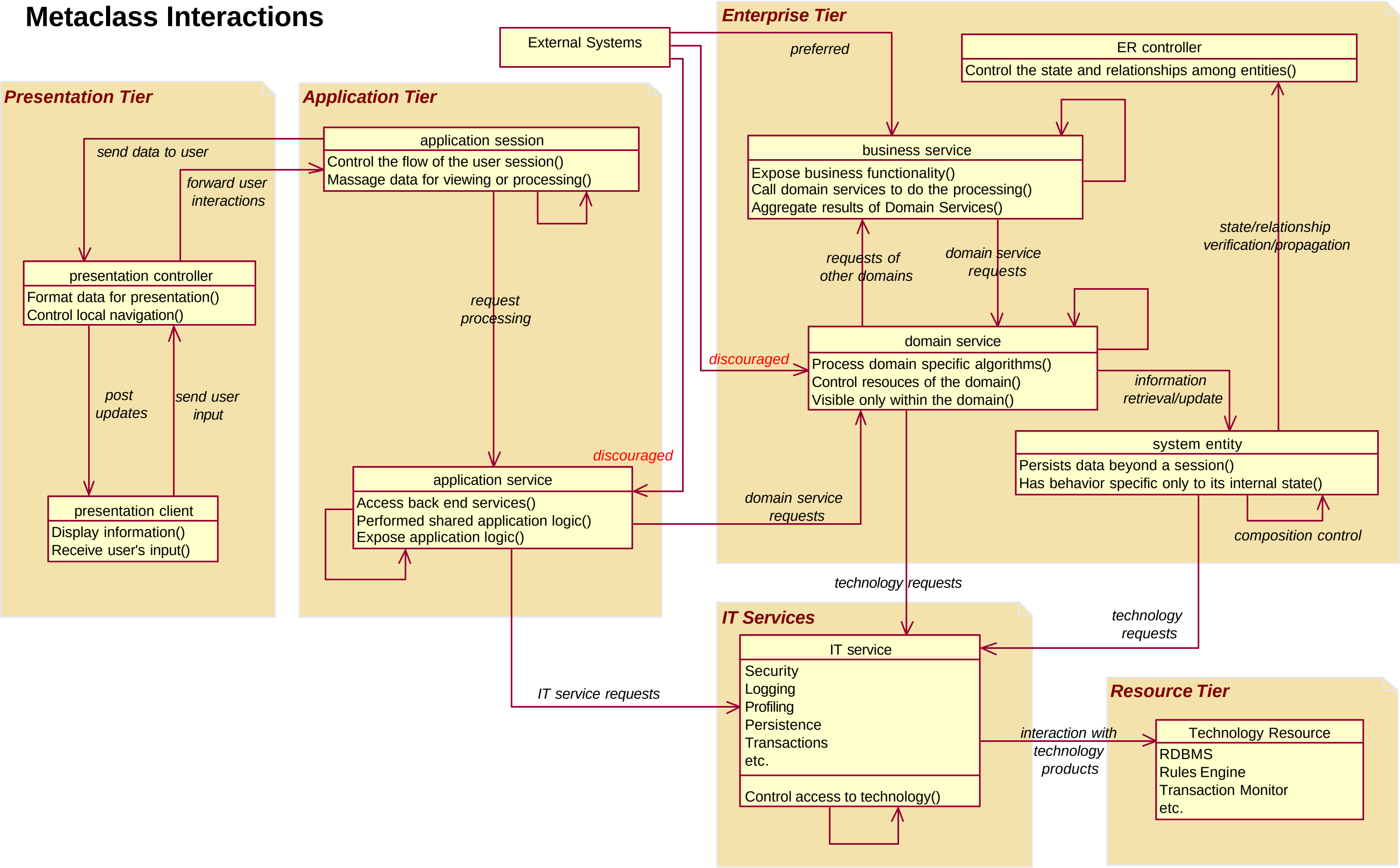
Location and purpose

Scope and visibility

Web Architectural Style Metamodel “Rules of Engagement”

M²VP

Metaclass Interactions



Presentation Tier

presentation controller
- Format data for presentation()
- Control local navigation()

presentation client
- Display information()
- Receive user's input()

send data to user

forward user interactions

post updates

send user input

Application Tier

application session
- Control the flow of the user session()
- Massage data for viewing or processing()

application service
- Access back end services()
- Performed shared application logic()
- Expose application logic()

request processing

discouraged

IT service requests

External Systems

Enterprise Tier

preferred

ER controller
- Control the state and relationships among entities()

business service
- Expose business functionality()
- Call domain services to do the processing()
- Aggregate results of Domain Services()

requests of other domains

domain service requests

state/relationship verification/propagation

domain service
- Process domain specific algorithms()
- Control resouces of the domain()
- Visible only within the domain()

discouraged

information retrieval/update

system entity
- Persists data beyond a session()
- Has behavior specific only to its internal state()

domain service requests

composition control

technology requests

technology requests

IT Services

IT service
- Security
- Logging
- Profiling
- Persistence
- Transactions
- etc.
- Control access to technology()

interaction with technology products

Resource Tier

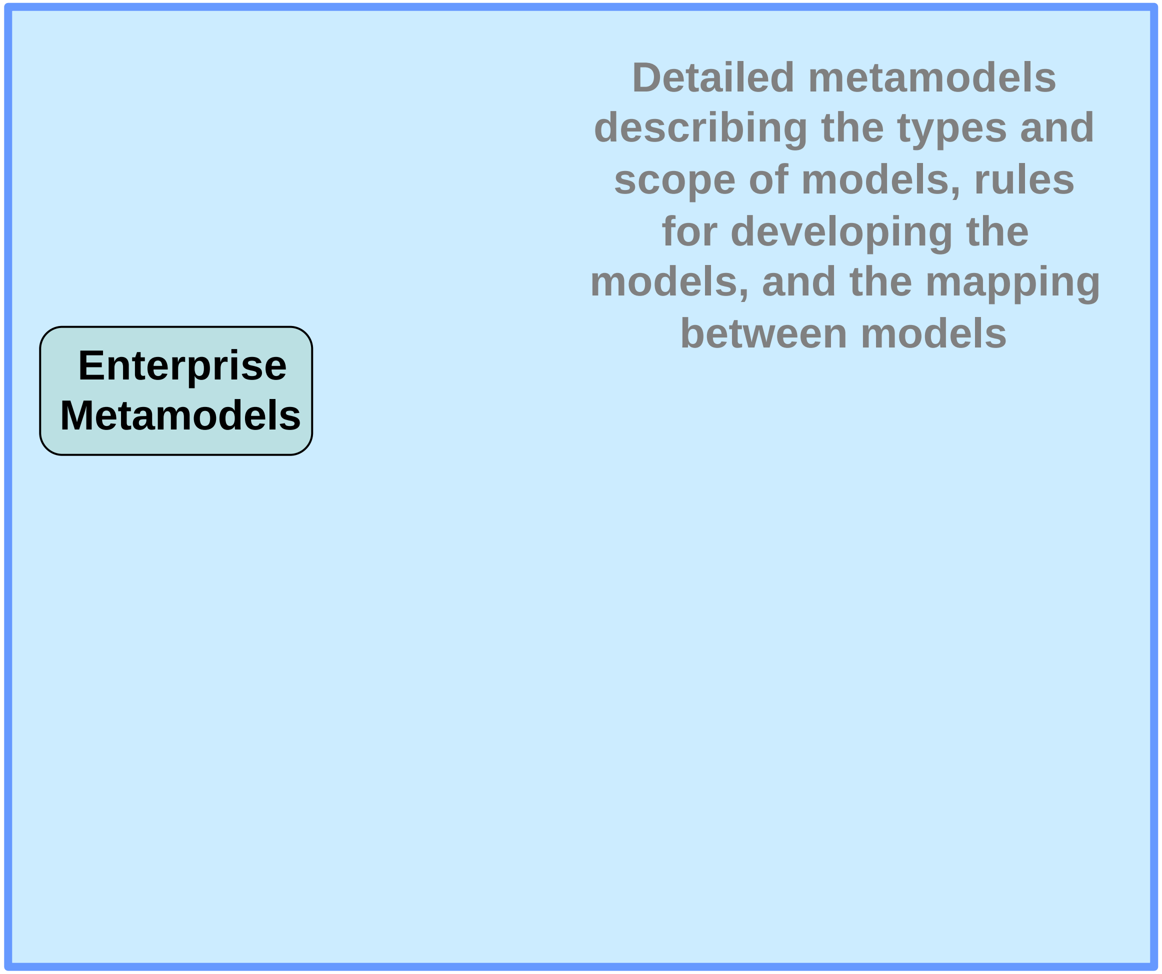
Technology Resource
- RDBMS
- Rules Engine
- Transaction Monitor
- etc.

C Courtesy Terry Merriman, ©2002

Agenda

- Why MDA?
- A few words about architecture
- MDA concepts
- MDA and standards
- Models and transformations
- MDA development process
- MDA tools
- Conclusion

Build the MDA Framework

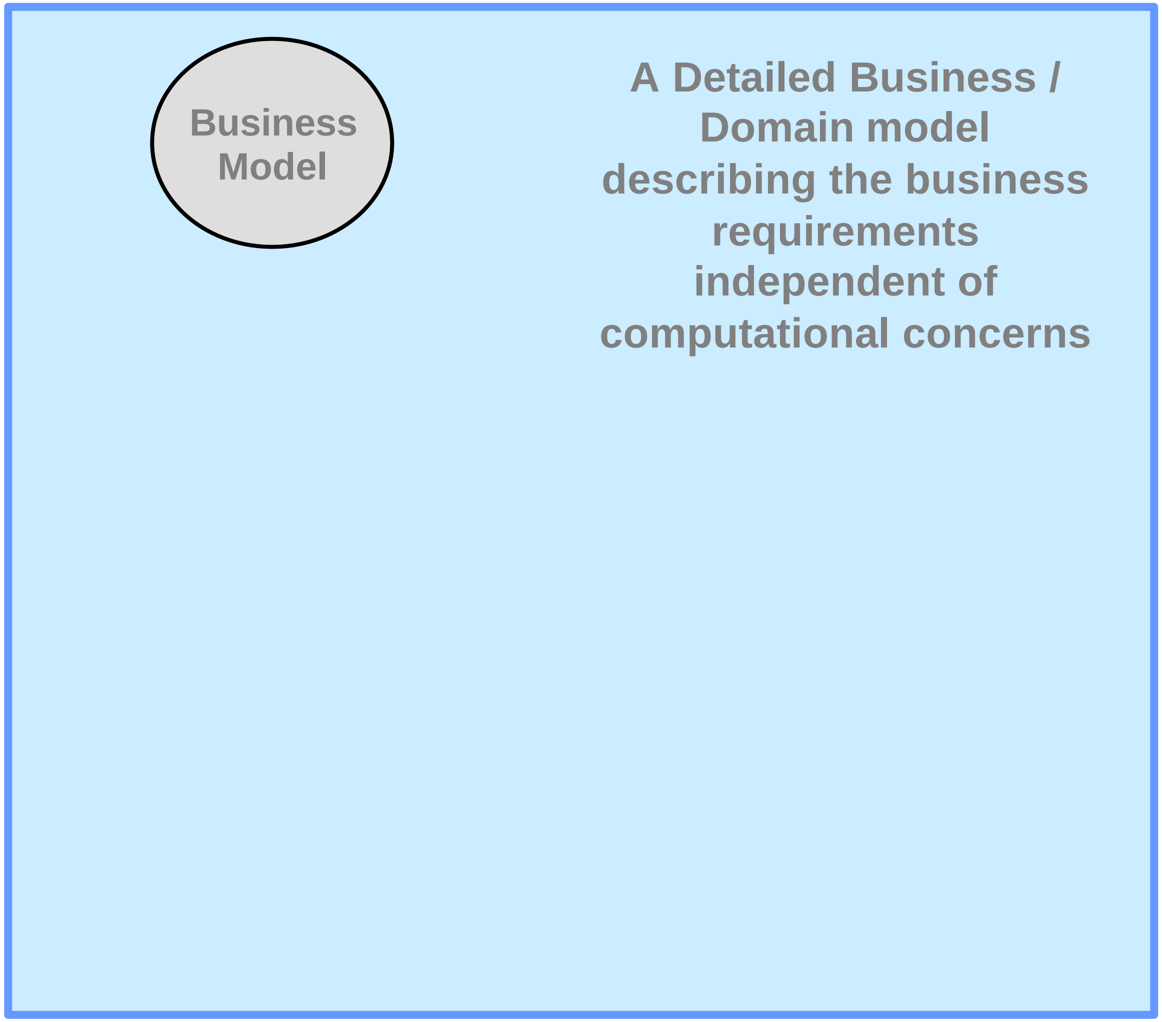


Enterprise Metamodels

Detailed metamodels describing the types and scope of models, rules for developing the models, and the mapping between models

Create the metamodels

Start with a Business Model

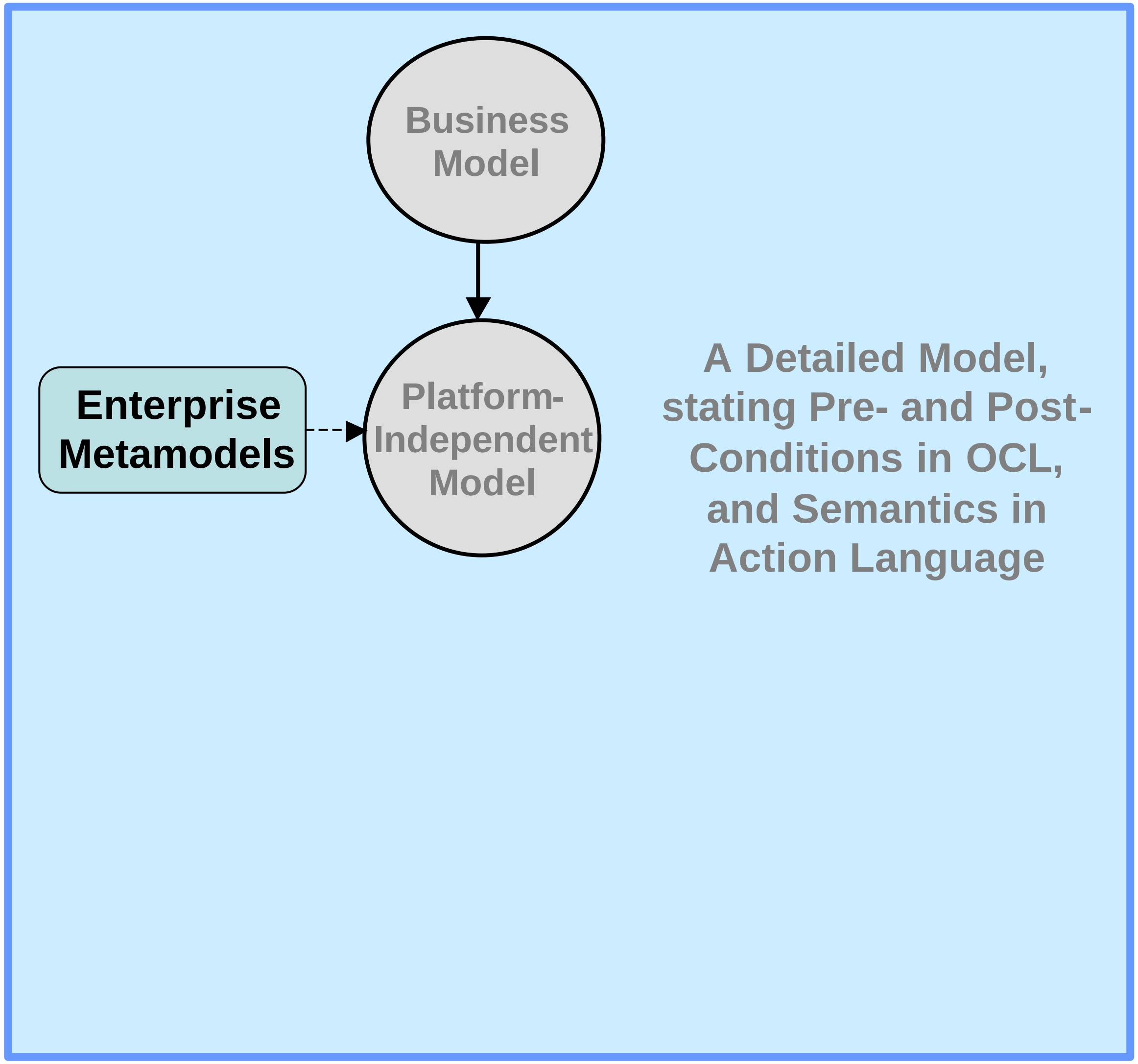


A Detailed Business / Domain model describing the business requirements independent of computational concerns

Start with a *Computational - Independent Business Model* (CIM) representing business requirements and processes independent of if / how they are automated.

Create a PIM

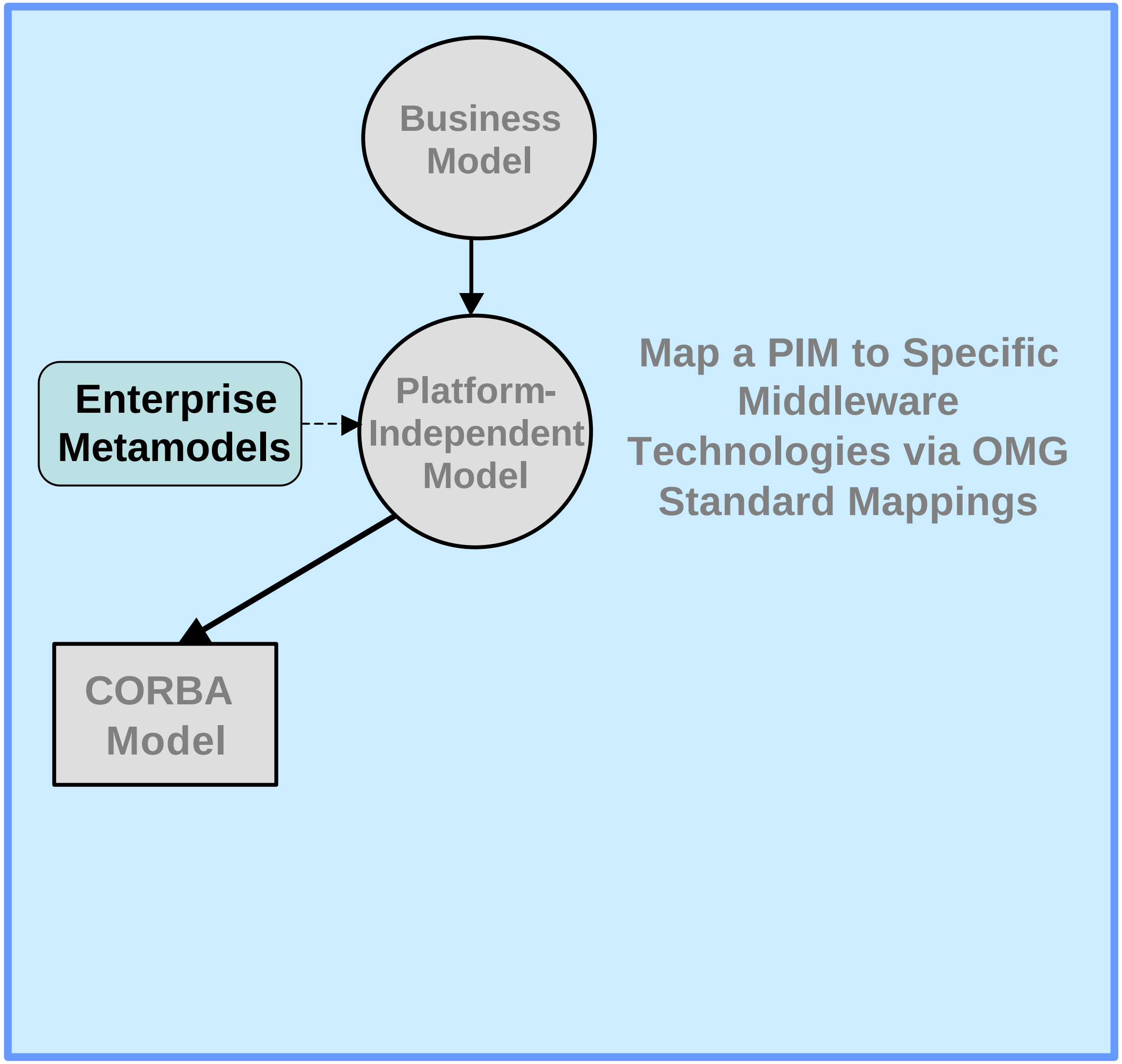
M²VP



A Detailed Model, stating Pre- and Post-Conditions in OCL, and Semantics in Action Language

Create a *Platform-Independent Model* (PIM) by mapping the business model conformant with the enterprise metamodel. The PIM represents business functionality and behavior in terms of computational concepts, but is undistorted by specific technology details.

Generate Platform-Specific Model



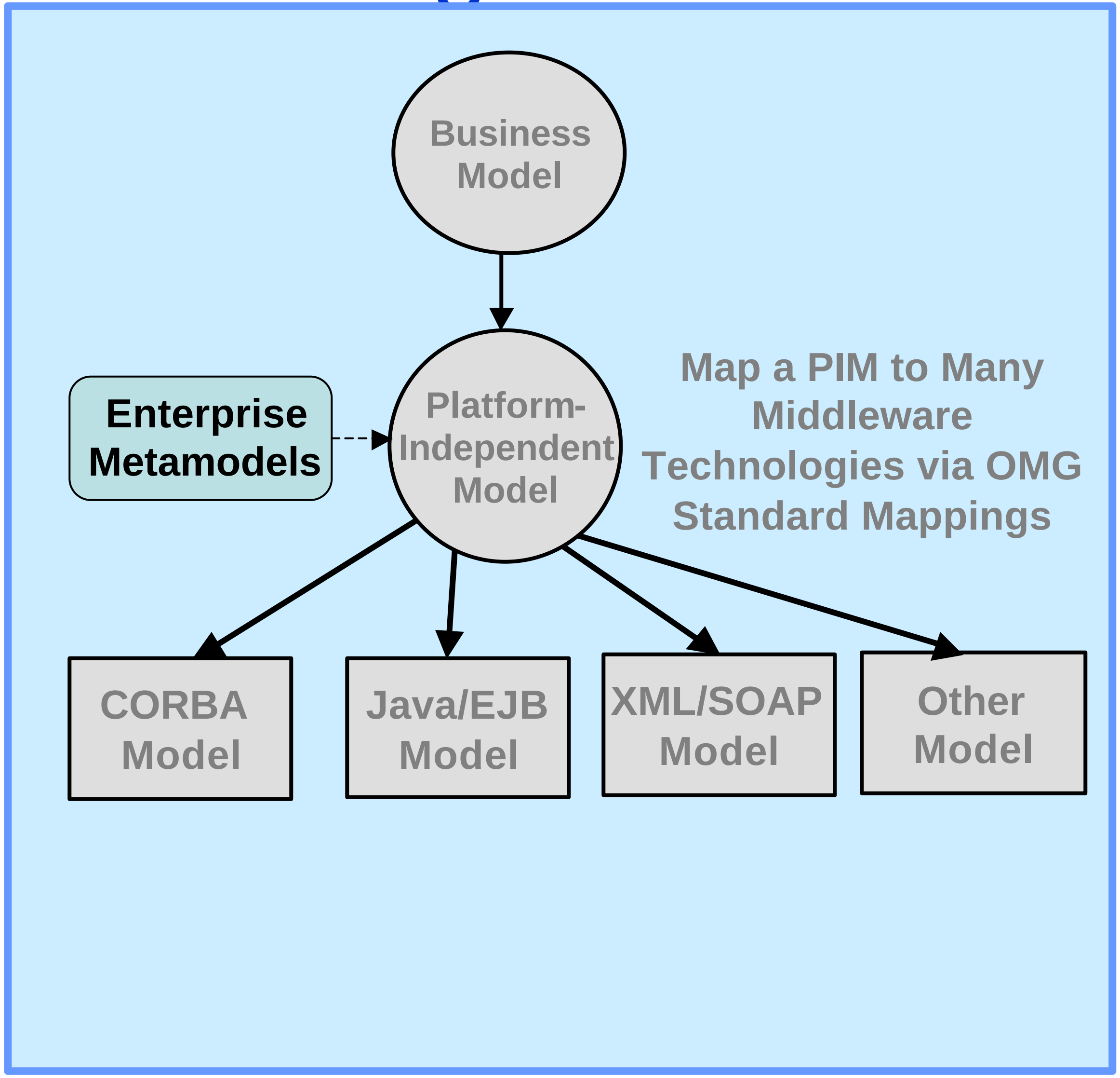
Map a PIM to Specific Middleware Technologies via OMG Standard Mappings

MDA tool applies a standard mapping to generate *Platform-Specific Model* (PSM) from the PIM. Code is partially automatic, partially hand-written.

Courtesy OMG

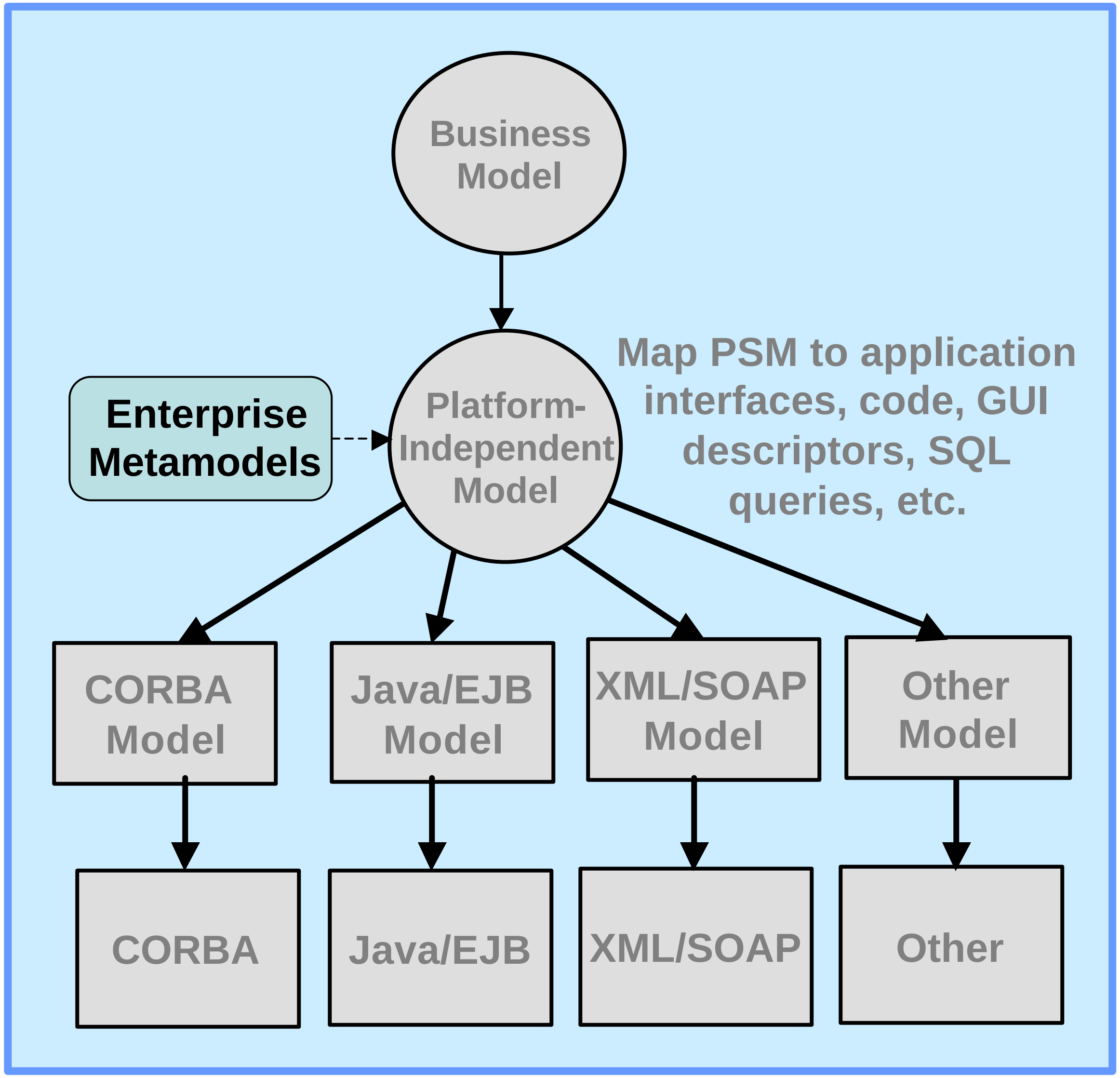
Multiple Deployment Technologies

M²VP


Business Model
Enterprise Metamodels
Platform-Independent Model
Map a PIM to Many Middleware Technologies via OMG Standard Mappings
CORBA Model
Java/EJB Model
XML/SOAP Model
Other Model

MDA tool applies an standard mapping to generate *Platform-Specific Model* (PSM) from the PIM. Code is partially automatic, partially hand-written.

Generate Implementations

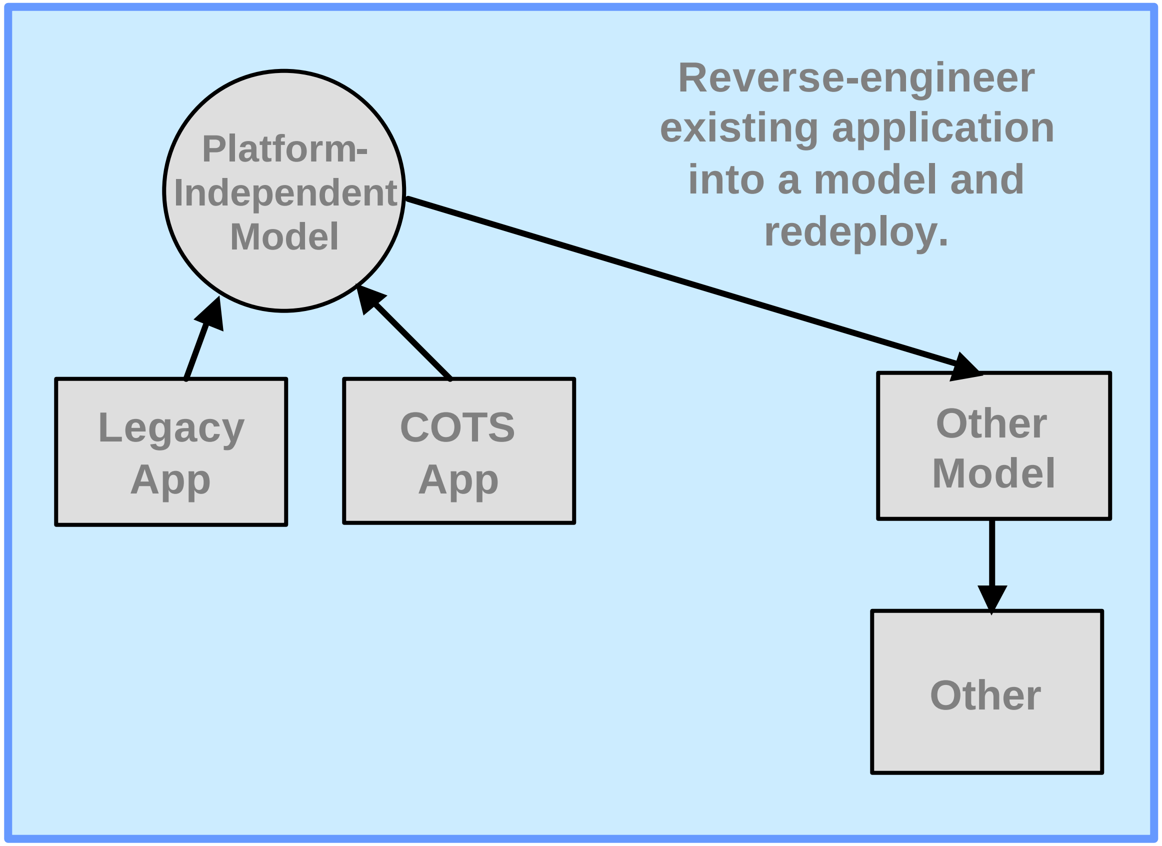


Map PSM to application interfaces, code, GUI descriptors, SQL queries, etc.

MDA Tool generates all or most of the implementation code for deployment technology selected by the developer.

C Courtesy OMG ·rved

Integrating Legacy & COTS



Reverse-engineer existing application into a model and redeploy.

Platform-Independent Model

Legacy App

COTS App

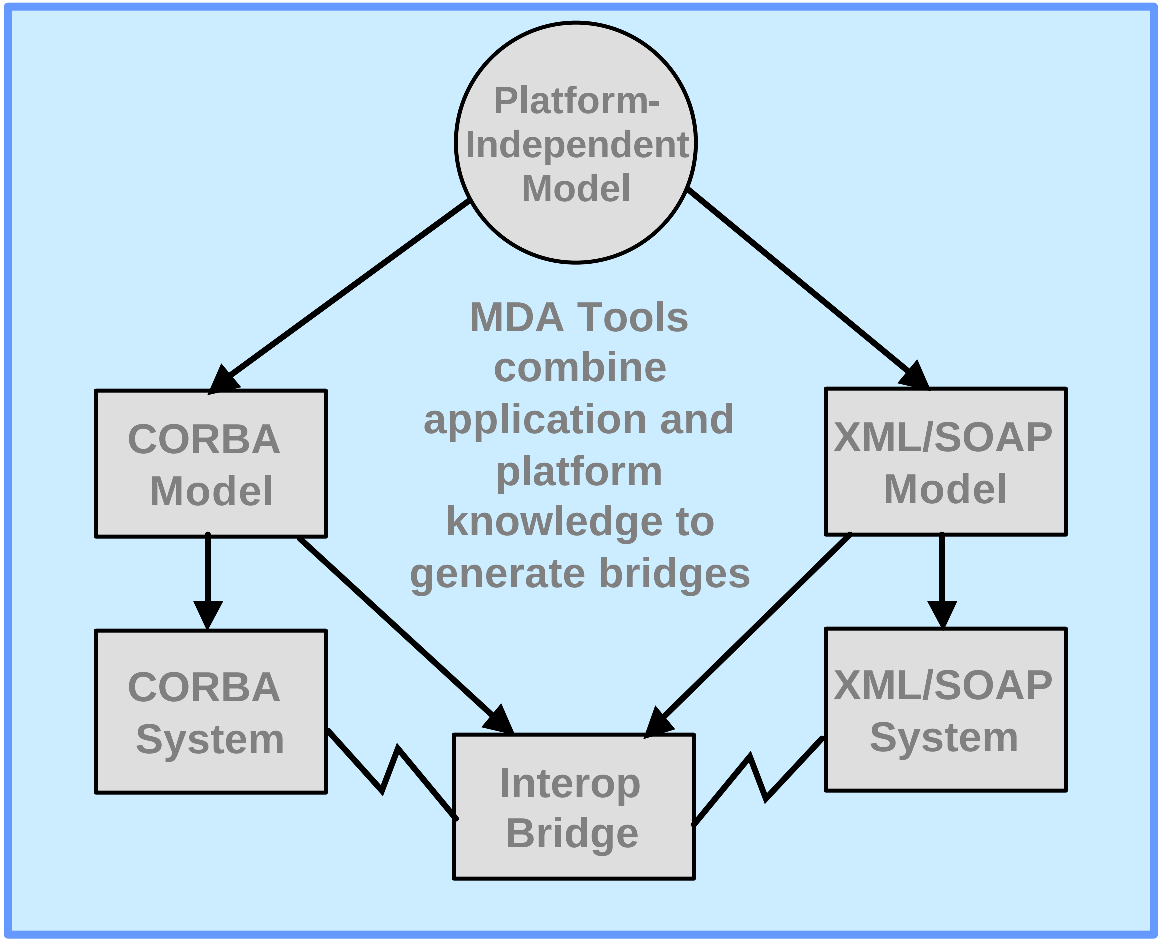
Other Model

Other

MDA Tools for reverse engineering automate discovery of models for re-integration on new platforms.

Automating Bridges

M^{2}VP


Platform-Independent Model
MDA Tools combine application and platform knowledge to generate bridges
CORBA Model
XML/SOAP Model
CORBA System
Interop Bridge
XML/SOAP System

Bridge generation is simplified by common application models, simplifying creation of integrated applications both within and across enterprises.

C Courtesy OMG, ©2002 rved

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M²VP

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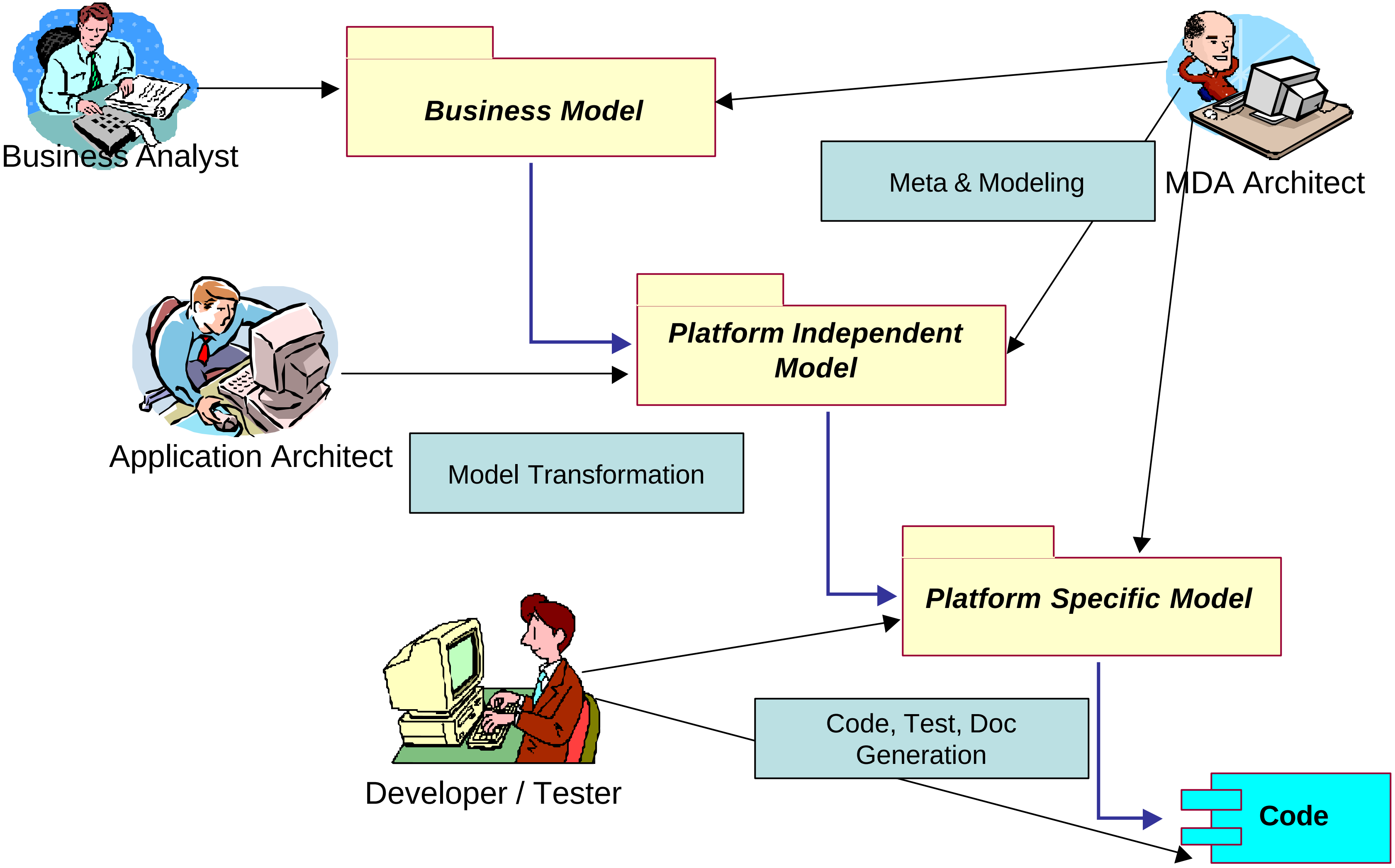
MDA Process Review

M²VP



Business Analyst

Business Model

Meta & Modeling

MDA Architect

Platform Independent Model

Application Architect

Model Transformation

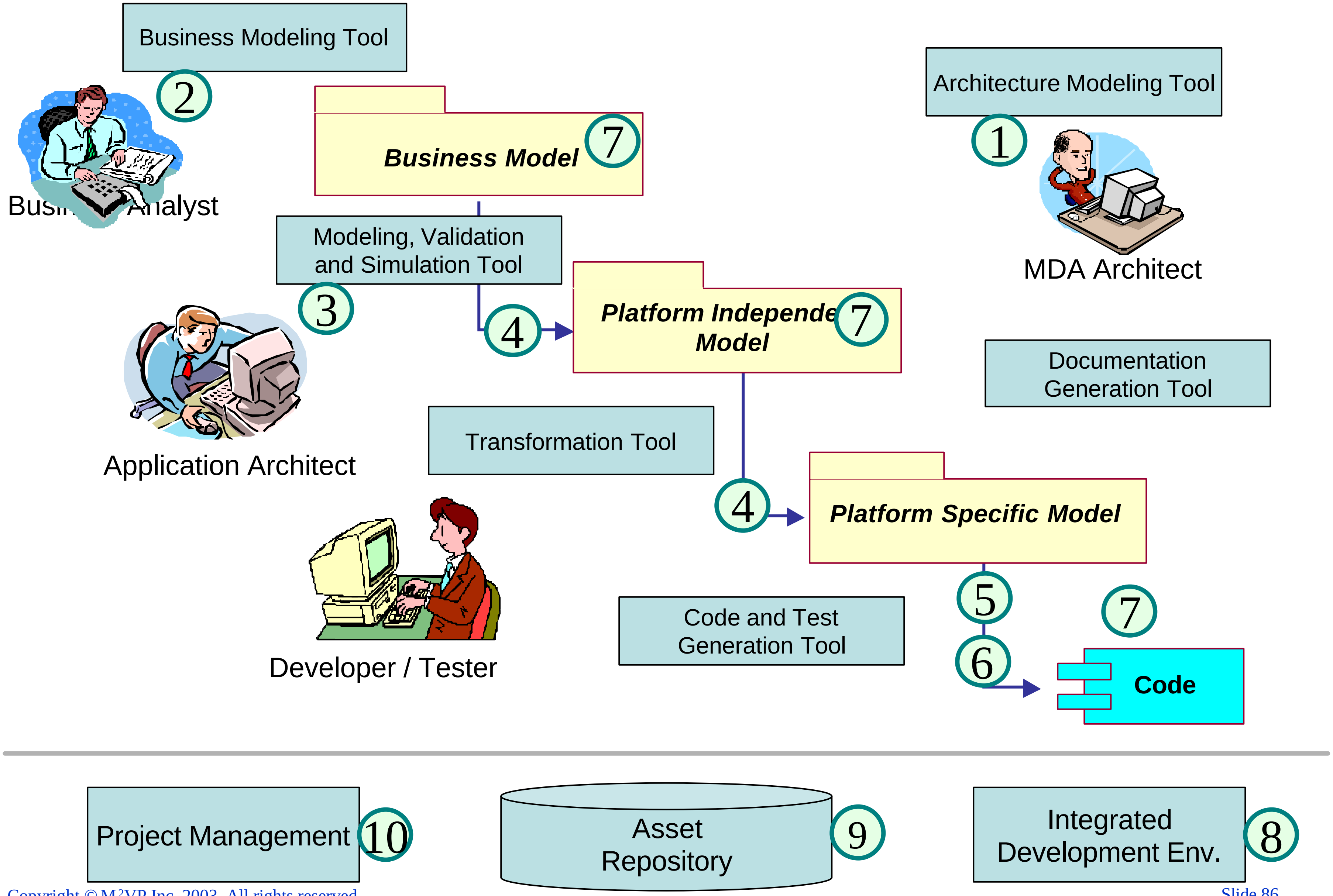
Platform Specific Model

Developer / Tester

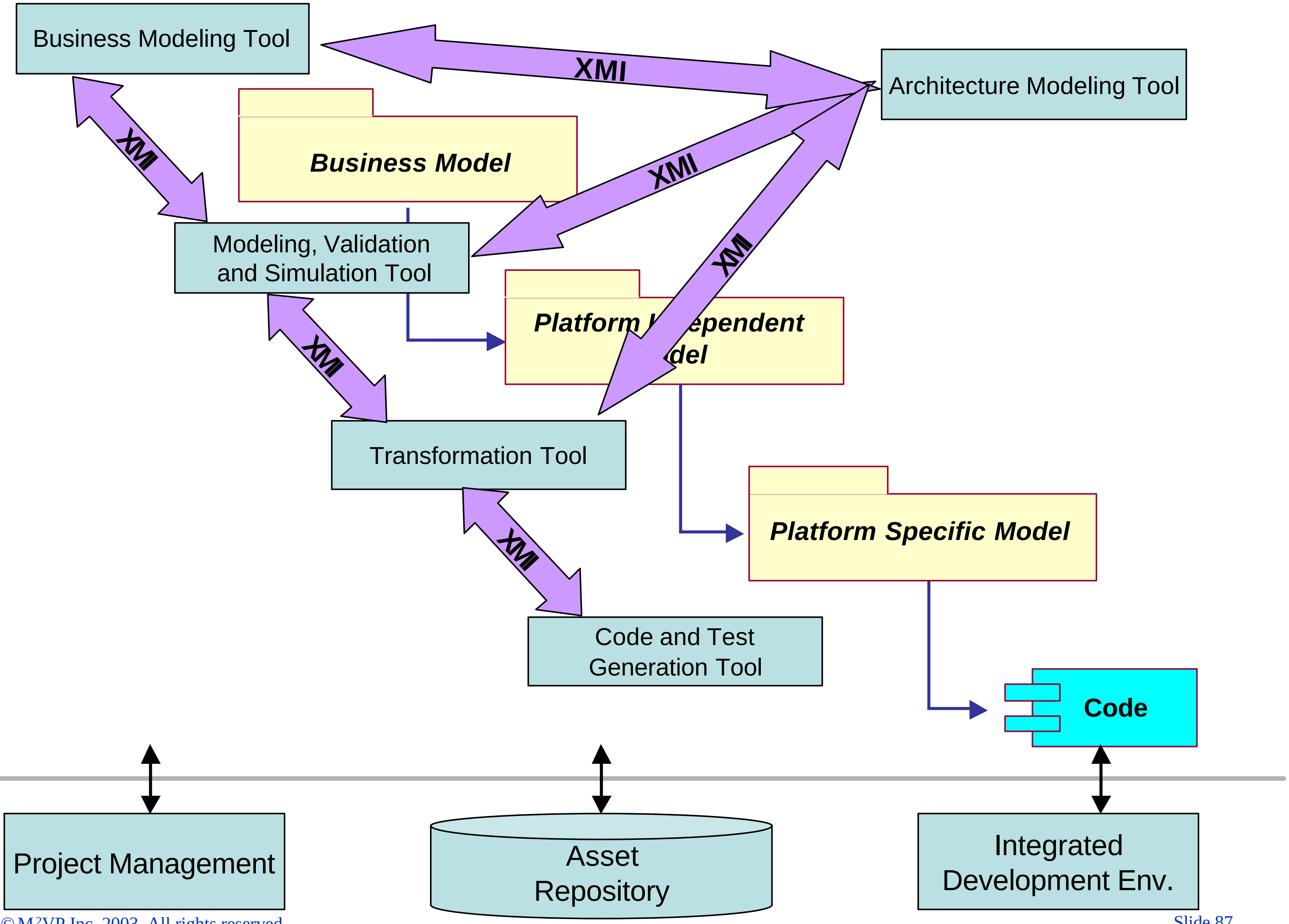
Code, Test, Doc Generation

Code

Tools in the MDA Process



MDA Tool Integration


Business Modeling Tool
XMI
Architecture Modeling Tool
XMI
Business Model
XMI
Modeling, Validation and Simulation Tool
XMI
Platform Independent Model
XMI
Transformation Tool
XMI
Platform Specific Model
Code and Test Generation Tool
Code
Project Management
Asset Repository
Integrated Development Env.

Questions for Your Enterprise

- What current tools and processes does MDA have to integrate with or support for development, test, reuse, documentation, etc.
- What will the MDA development lifecycle be in the organization?
- Who will perform the business modeling?
- What is the enterprise and application architecture?
- Can these be supported by standard profiles or will the organization be creating custom profiles and metamodels
- What technology platforms will need to be supported?

Vendors

- www.omg.org/mda/committed-products
- Adaptive: Adaptive Framework
  www.adaptive.com
- Codagen Tech.: Gen-it Architect
  www.codagen.com
- Ebuilt/Codigo Solutions: CodigoXpress
  www.codigoXpress.com
- Headway Software: Headway ReView
  www.headwaysoftware.com

More Vendors

- Interactive Objects Software GmbH: ArcStyler (Being incorporated in Borland’s Enterprise Studio 2) www.io-software.com
- Kabira Tech: ObjectSwitch, Kabira Business Accelerator www.kabira.com
- Kennedy Carter Ltd: iUML, iCCG www.kc.com

Even More Vendors

- Metamatrix: Modeler, MetaBase, Server
  www.metamatrix.com
- Metanololgy: Meta Development Environment
  www.metanology.com
- ONTOS: ObjectSpeak
  www.ontos.com
- Project Tech.: BridgePoint, DesignPoint
  www.projtech.com
- Secant Technologies: ModelMethods
  www.secant.com

Agenda

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Technical Summary

- Business semantics, technical infrastructure, etc. need to be modeled formally and rigorously
- Technical infrastructure requirements need to be mapped to various middleware, databases, and legacies
- Business semantics should be separated from technology
- Models should be expressed in an industry standard, neutral format designed for models
- Metamodels define the content and scope of models

Benefits

- Even without automation, PIMs:
  - Improve tracing between business and technology models
  - Separates business and technical modeling roles
  - Promotes abstraction leading to better, more comprehensible designs
  - Improve portability to other platforms
  - Ease modifications to either the business or technology

OMG MDA Adoption Status

- Major direction agreed March ’01; overall architecture adopted September ’01.
- UML 1.4 complete; 2.0 in process.
- Mappings (“*profiles*”) underway:
  - EDOC (adopted)
  - CORBA (adopted)
  - EAI (in FTF)
  - EJB (adopted by JCP)
  - SOAP/XML (in process)
  - .Net (RFP issued)

Standardization

- UML standardized modeling notation 5 years ago. Today we have:
  - Lot's of tools
  - Supporting methodologies
  - Interoperability of models
- MDA will standardized architecture like UML standardized modeling:
  - Tools, services, methods.

The Bottom Line

- For MDA to deliver value
  - It must make models *first class development artifacts*
  - Tools must support all aspects
    - IDE for modeling

References and Bibliography

M²VP

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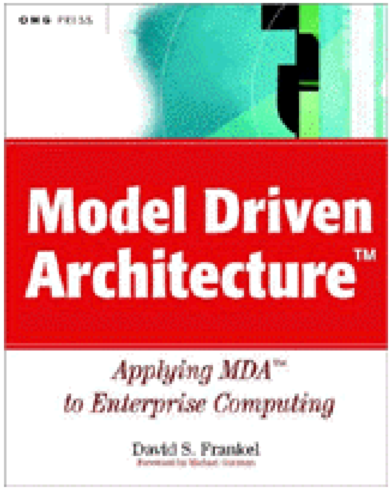
OMG PRESS
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Applying MDA™ to Enterprise Computing
David S. Frankel

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Questions