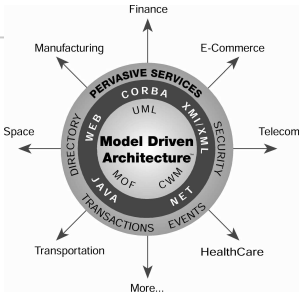
MDA Model driven architecture



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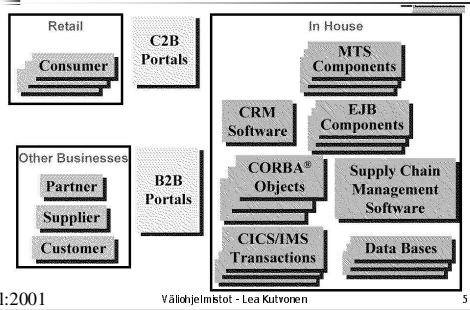
What is MDA?

- using modeling languages as declarative progamming languages
  - rising of abstraction level for programmers
  - improved productivity, quality, longevity outlook
- has been used to generate real-time and embedded systems although term MDA coined later
  - strategic direction of OMG as announced in 2002)
  - Java community process, ebxml, rosettanet using similar concepts

Challenges for MDA

- B2B and B2C integration needs of enterprises
- Reguirement: Preserve investment
  - As enterprise borders shift requiring platform shift
  - As platforms themselves change
    - EJB 1.1 --> EJB 2.0
    - XML --> XML Schema
    - MTS --> COM+
    - CORBA 2.0 --> CORBA 3.0
- Solution: Isolate information and processing logic from technology specifics
  - Build platform independent models
    - UML is independent of CORBA, COM, EJB, XML, etc thus is well-suited as a language for descrbingn
    - Map these models to specific platforms
    - Maintain the separation at the implementation level

Enterprise and its boundaries



Frankel:2001

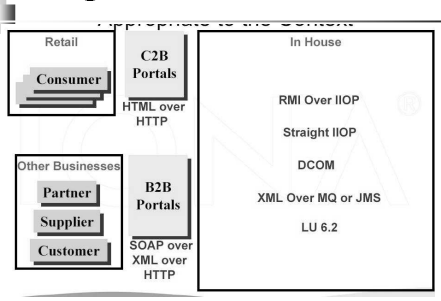
No Universal Component Middleware

Distributed Software Components

Major Challenge!

CORBA	EJB	.NET	. . .

Integration communication



Frankel:2001

Enterprise system integration trend

- "middleware" addresses integration within the enterprise with a distributed computer
- today aim for similar integration between enterprises
  - Avoid typing in from computer-printouts
- ebXML, .NET, RosettaNet and other Web Services initiatives aim to be "the" middleware to link enterprises
  - How to cope with them all?

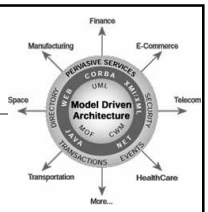
Rising the level of abstraction

- Part of general trend
- Already well-established front and back ends
  - WYSIWYG GUI modeling and data modelign
  - Hand coding no longer predominatees
- Early web-applications wired web front end directly to back end
  - Some companies avoided building intermediate tiers
  - Web services and B2B require intermediate tiers to expose coarse grained business services
  - Abstraction to allow reuse of the coarse grain business services via various technologics.

Program generation from models

- MDA is about using modeling languages as programming languages rather than merely as design languages
- can improve productivity, quality, and longetivity outlook
- new term, old invention
  - CASE-tools in 1980's, integrated object-oriented development environments in 1990's, UML tools, etc.

Model Driven Architecture



- New orientation for OMG activities
  - New step beyond the Object Management Architecture (OMA)
- Models are centric!
  - Target middleware is not important!
- Focus on Platform Independent Models (PIM)
  - Without middleware details
- Abstract Platform Specific Models (PSM)
  - Including all middleware details
- Define PIM to PSM transformations
- Preserving PIM when new middleware appears!

Some Key Terms

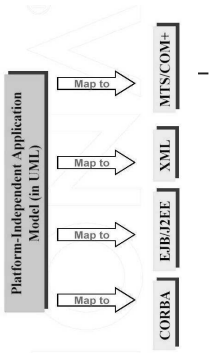
- **Model**
  - **A formal specification of the function, structure and/or behavior of a system. (Model .ne. UML)**
- **Platform**
  - **Technological and engineering details that are irrelevant to the fundamental functionality of a software component.**
- **Platform Independent Model (PIM)**
  - **A formal specification of the structure and function of a system that abstracts away technical details (e.g., funds transfer)**
- **Platform Specific Model (PSM)**
  - **The technical details (CORBA, SOAP, EJB)**

Basic modeling technology

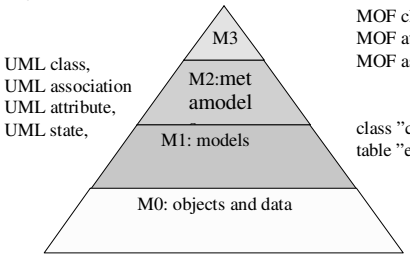
- UML – unified modeling language
- MOF – meta object facility
- XMI – XML metadata interchange

UML

- IDL as abstraction very limited
  - generates same level constructs, stubs and skeletons
- modeling languages – declarative?
  - separation of abstract syntax from concrete syntax
  - invariants, pre- and postconditions
  - precise action semantics and standard mappings on various platforms
  - mappings represent a standard engineering solution for a collaboration concept
- UML has defined profiles for introducing separate sets of transformation rules
  - to model particular domain, eg. business information, business services, collaborations, realtime systems, telecom
  - to parametrize mapping to sepcific technologies
- class vs. behavioural models



MOF

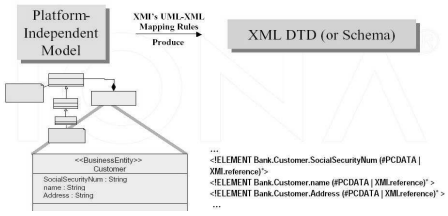


UML class,
UML association
UML attribute,
UML state,

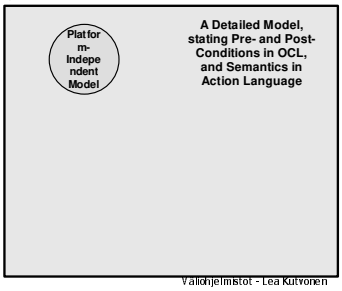
MOF class,
MOF attribute,
MOF association

class ”customer”, …
table ”employee”, …

XMI - XML metadata interchange

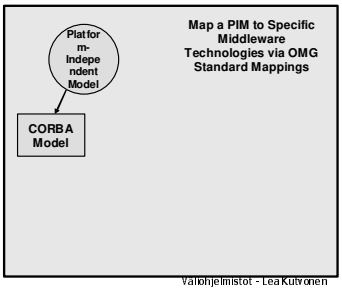


Building an MDA Application



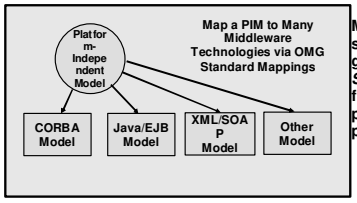
Start with a *Platform-Independent Model* (PIM) representing business functionality and behavior, undistorted by technology details.

Generating Platform-Specific Model



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

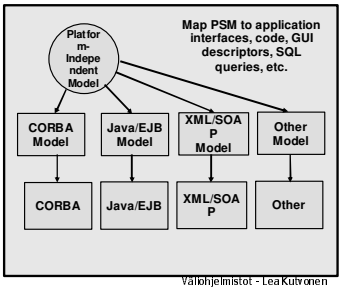
Mapping to Multiple Deployment Technologies



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

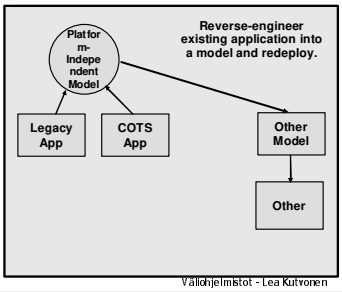
PSM can be viewed as
- presentation model (Web): data schemas, web comps, etc
- Business logic model (EJB): data schemas, key classes, etc
- Data models (DBMS): tables, columns, keys, etc

Generating Implementations



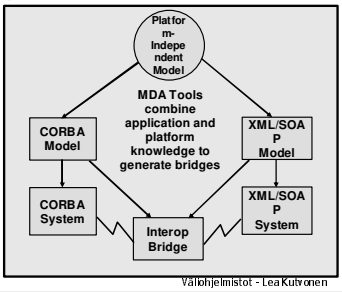
MDA Tool generates all or most of the implementation code for deployment technology selected by the developer.

Integrating Legacy & COTS



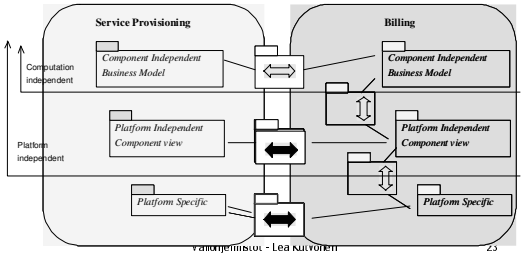
MDA Tools for reverse engineering automate discovery of models for re-integration on new platforms.

Automating Bridges

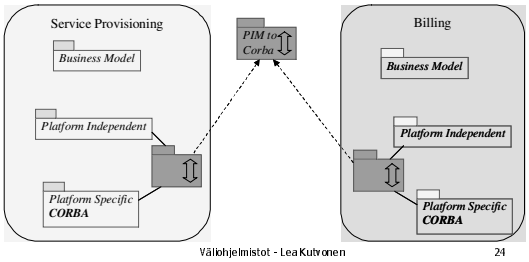


Bridge generation is simplified by common application models, simplifying creation of integrated applications both within and across enterprises.

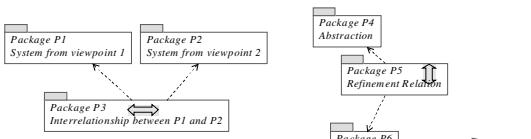
Concepts: Refinement



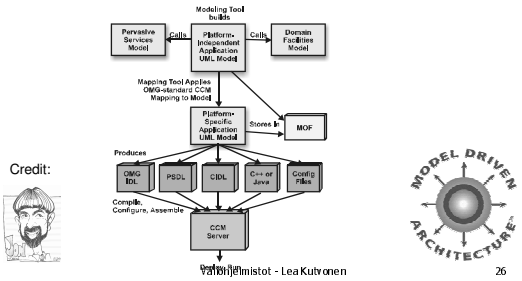
Concepts: Patterns



Concepts: Packages

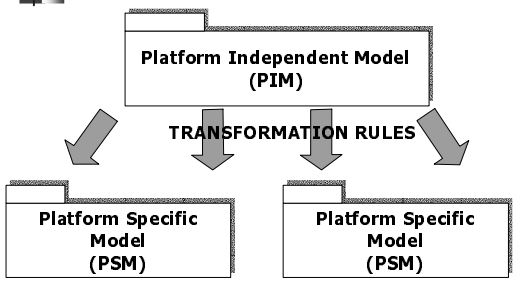


MDA Example

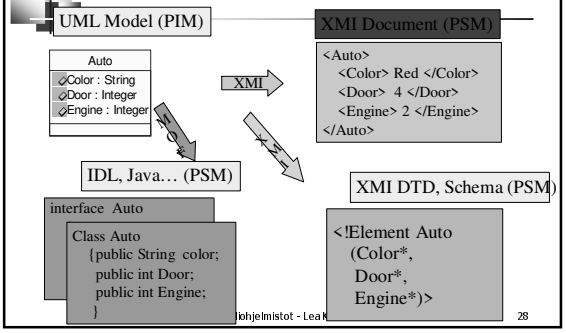


Credit:

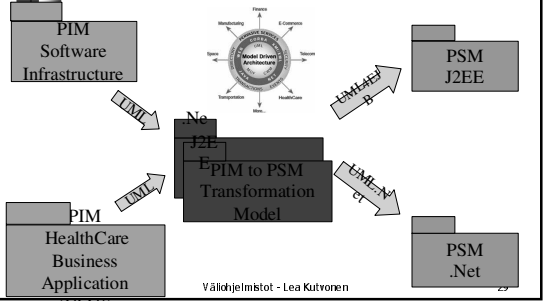
PIM, PSM, and Transformations in MDA



PIM to PSM Transformation Examples with MOF/XMI



Transformation Models in MDA



Why New Component Models?

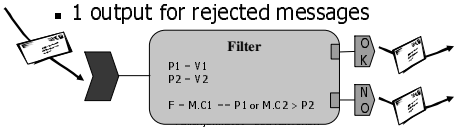
- Often application designers want to use concepts not present in PSM
  - e.g. CCM has no active JavaBeans properties

1) Creating a new PSM but also requires to develop the associated middleware
   - Very expensive and time consuming!!!

2) Creating a new PIM and defining PIM to PSM transformation rules

The Message Filtering Example

- A filter has
  - 1 input for receiving messages to filter
  - Configurable filtering properties
  - 1 filtering function
  - 1 output for accepted messages
  - 1 output for rejected messages



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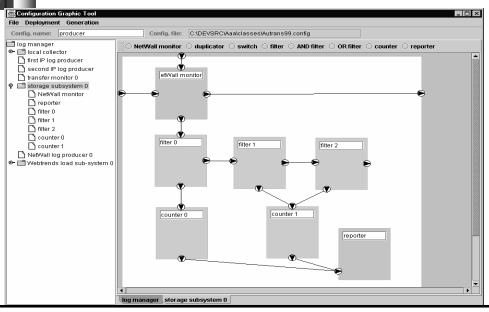
Application = Assembling Filters



Problems

- All must be done manually!
  - Defining OMG IDL for message eventtypes, filter component and home types
  - Implementing CCM eventtypes, components and homes
  - Writing CCM XML descriptors
- Extremely verbose, time consuming and error prone!!!
- How improving productivity and quality?
- How dealing with thousand messages and filters?
- How dealing with other Message Oriented Middleware (MOM)?
  - Like EJB 2.0 message beans

Next Step on the Message Filtering Meta-Model

- Only allow definition of message and filter types
- Only generate OMG IDL types, implementations, and CCM XML packaging descriptors
- Complete the meta model to describe filter instances and connections between them
- Then allow generation of CCM XML assembling descriptors for automatic deployment

Drawback around MDA-oriented Tools

- Few MOF compliant tools to experiment the creation of new component meta models!
- Developing UML profiles are time and money consuming
  - UML Profile Builders are still expensive and proprietary
- No portability of developed UML profiles between UML Tools!!!
- Few formalisms to express MDA transformation
  - OMG RFP under work
- Few PSM meta models for
  - Programming languages like Java, C++, ...
  - Component standard middleware

MDA vs. CASE

- CASE limitations
  - Mappings to implementation technologies were proprietary
    - Risk to CASE customers too great
  - Very limited to extend specification language
- MDA overcomes these limitations
  - Standardized mappings, for each domain
  - UML profiles and MOF

Kirjallisuutta

- Siegel, Jon, Developing in OMG's Model-Driven Architecture. Object Management Group White Paper, Nov 2001.ftp://ftp.omg.org/pub/docs/omg/01-12-01.pdf (pakkollinen)
- OMG Architecture Board, Model Driven Architecture (MDA), Jul 2001, ORMSC/2001-07-01 http://cs.ua.edu/630/Resources/MDA%20White%20Papers/MDA%20-%20Technical%20Perspective%20-%20OMG%20Board%20-%20ormsc-01-07-01.pdf

(täydentävä)

Varhaisia välineitä

- iUML, ICCG www.kc.com
- Adaptive framework www.adaptive.com
- www.kabira.com
- ArchStyler (in Borland's Enterprise studio 2) www.io-software.com