A Case for Multilevel Modeling

Designing Models and Systems to Support IT Management

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Overview

- Multilevel Modeling – The Need for Applications
- IT Management – The Need for Models
- Vision: Integrated Modeling, Monitoring and Decision Support for IT Management
- DSML Design and Use
  - General Challenges
  - IT Management: Particular Problems
- Outline of a Solution
  - Multilevel DSML for IT Management
  - Multilevel Management and Monitoring System
- Conclusions

The Need for IT Management

- ever increasing penetration of information systems into organizations
  - pivotal relevance for performing business processes
  - … for enabling future business models
  - … for staying competitive
- increasing complexity of
  - IT infrastructures
  - IT products
- demand for flexibility
  - adaptation of products and services
  - … requires adaptation of IT

IT Management: Challenges

- in the old days: focus on IT administration
- today extended responsibilities
  - accounting for future business needs in time
  - communication with various stakeholders about potential and limitations of IT
- growing pressure on IT management
  - total cost of IT perceived as too high by many executives
  - often, no differentiated knowledge about cost & business value of IT
- still insufficient alignment of business & IT
- cultural chasm between IT professionals and business executives not yet overcome

Core Responsibilities

- managing the IT infrastructure
  - point of view
  - from a business perspective evaluation
- decision making
  - assessment and planning of IT infrastructure
  - aligning IT with busine
  - rtefact
  - delines
  - organisation of IT departme ment
  - processes for IT (service) ma
  - objectives & measures

How many printers to we have per employee?

How could the support of business processes be improved?

What is the level of data integration?

What was the average availability of our ERP system in 2013?

How could IT make our business more competitive?

Complexity demands for models and tools.

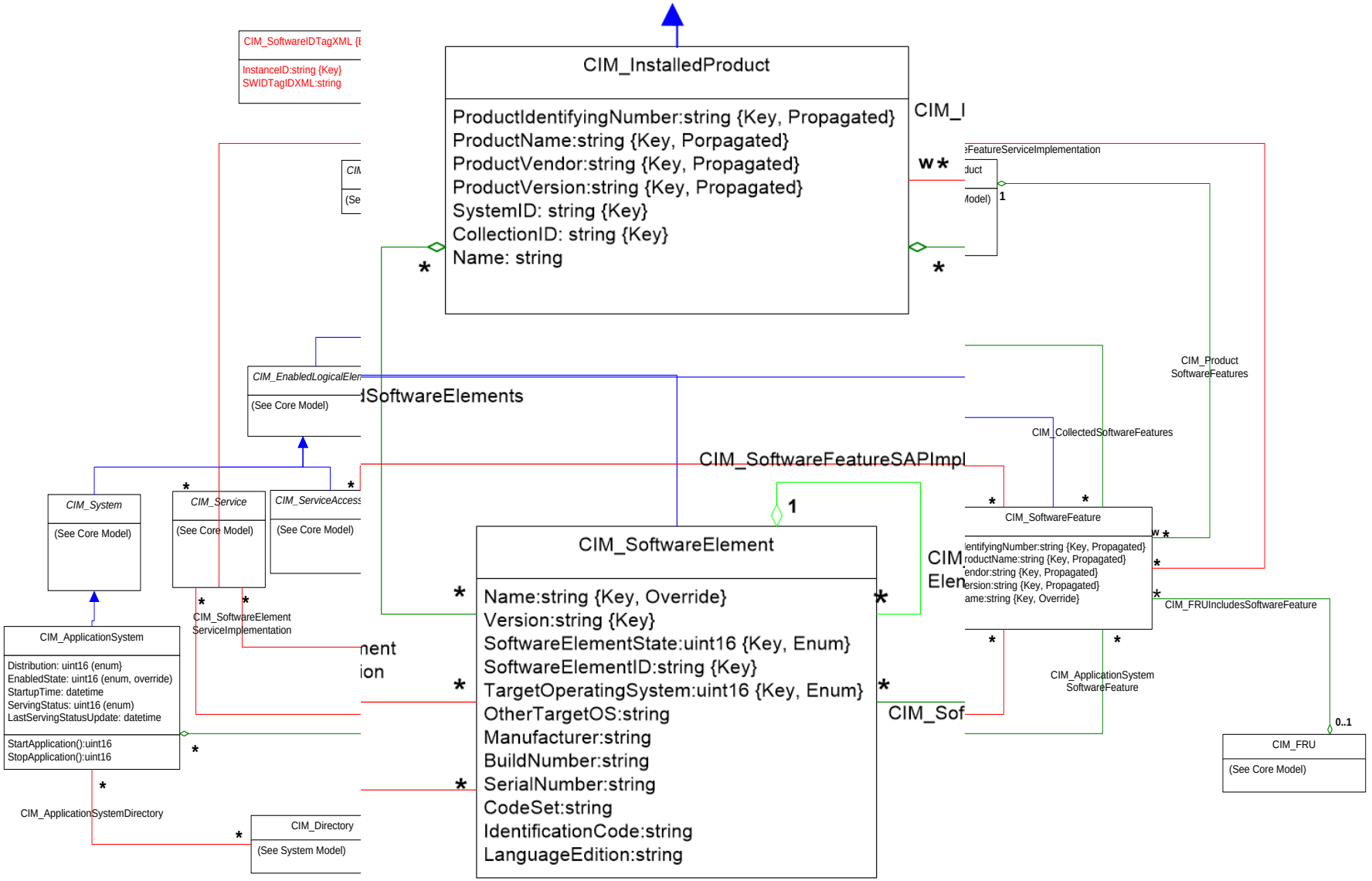
Approaches to Support IT Management

- Distributed Management Task Force (DMTF): Common Information Model (CIM)
- Control Objectives for Information and related Technology (COBIT)
- IT Infrastructure Library (ITIL)
- Enterprise Architecture Management

CIM

- various database schemata for managing IT resources
  - Applications
  - Networks
  - Databases
  - Metrics
  - ....
- no DSMLs (UML like language)
- models only as supplement to illustrate relational schemata

Example: Application Management



IT Infrastructure Library (ITIL)

- aimed at promoting professional IT management through concepts and guidelines
- emphasis on support of business functions
- for this purpose: emphasis on services & documentation
  - reduction of complexity through abstraction from realisation; separation of concerns and contracts – „service level agreements“ (SLA)
  - no precise notion of service: product, process, provision of IT resource …
  - templates for defining SLA
- definition of reference services
  - „service support“
  - „service delivery“

ITIL: Evaluation

- contribution to professional IT management
- wide support by industry
- however: lack of elaborate concepts
  - to describe IT artefacts
  - to evaluate IT artefacts from a technological perspective
  - to analysis for IT business alignment
- only superficial description of processes required to produce services
- ...

no explicit modeling language, no elaborate models

COBIT

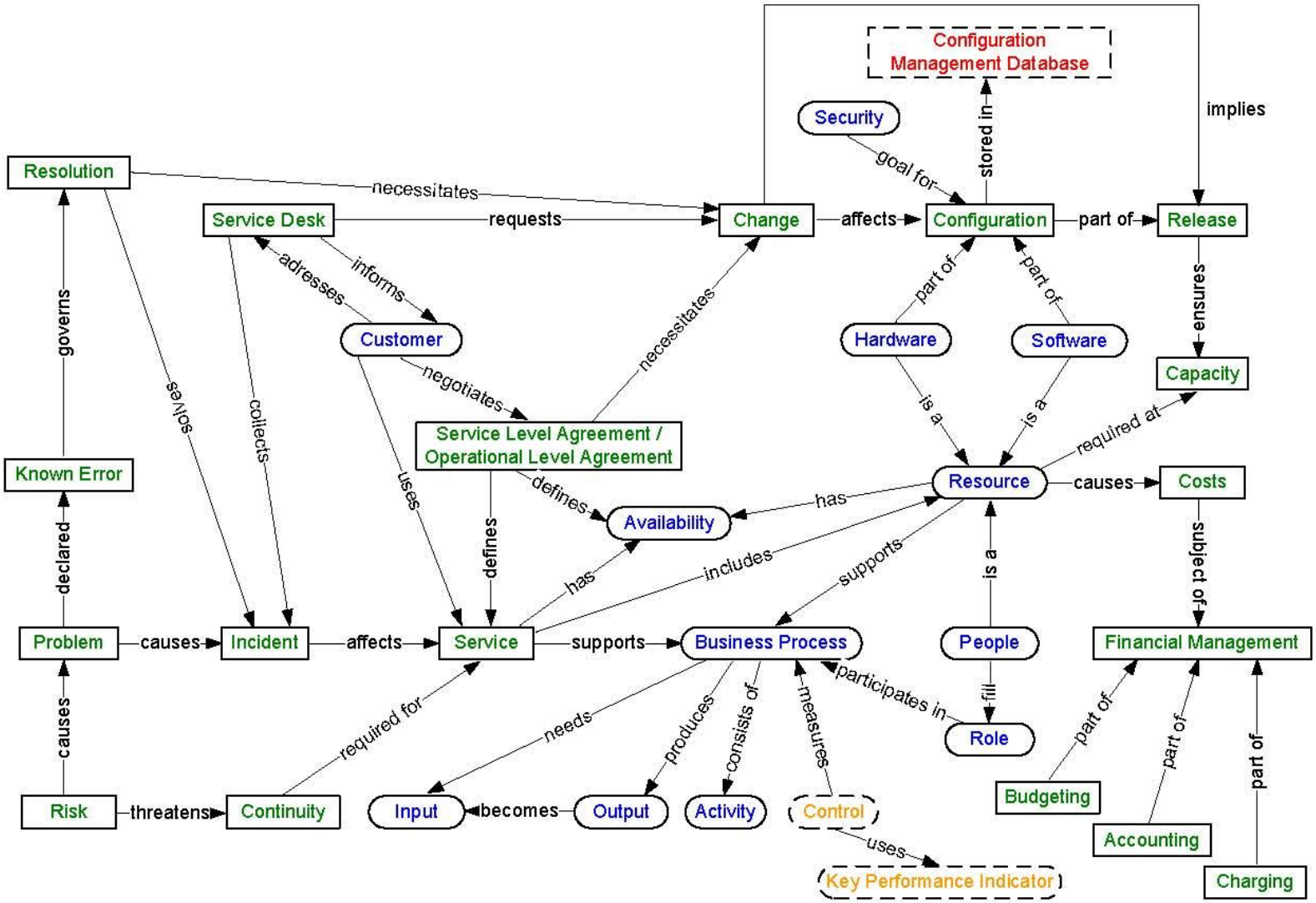
- emphasis on management & control of IT processes that are aligned to business objectives
- for this purpose: definition of core concepts
- definition of core IT processes with emphasis on control objectives, measures and KPIs
- aimed at increasing transparency of IT processes for management and at contributing to evaluating/measuring them
- high level objectives
  - alignment of IT and business (goals)
  - maximizing business benefit from IT
  - adequate management of IT risks

COBIT: Evaluation

- supplements IT service management with control/accounting aspects
- provides numerous KPIs
- concepts remain on a superficial level
- process descriptions on a high level of abstraction only
- lack of integration with ITIL
  - potential for mutual supplementation
  - however, concepts partially overlapping; different semantics

no explicit modeling language, no elaborate models

ITIL: Reconstruction of Core Concepts



[Kirc08], p. 135

Concept not available in CobIT

Concept corresponding in CobIT

Concept more elaborate than in CobIT

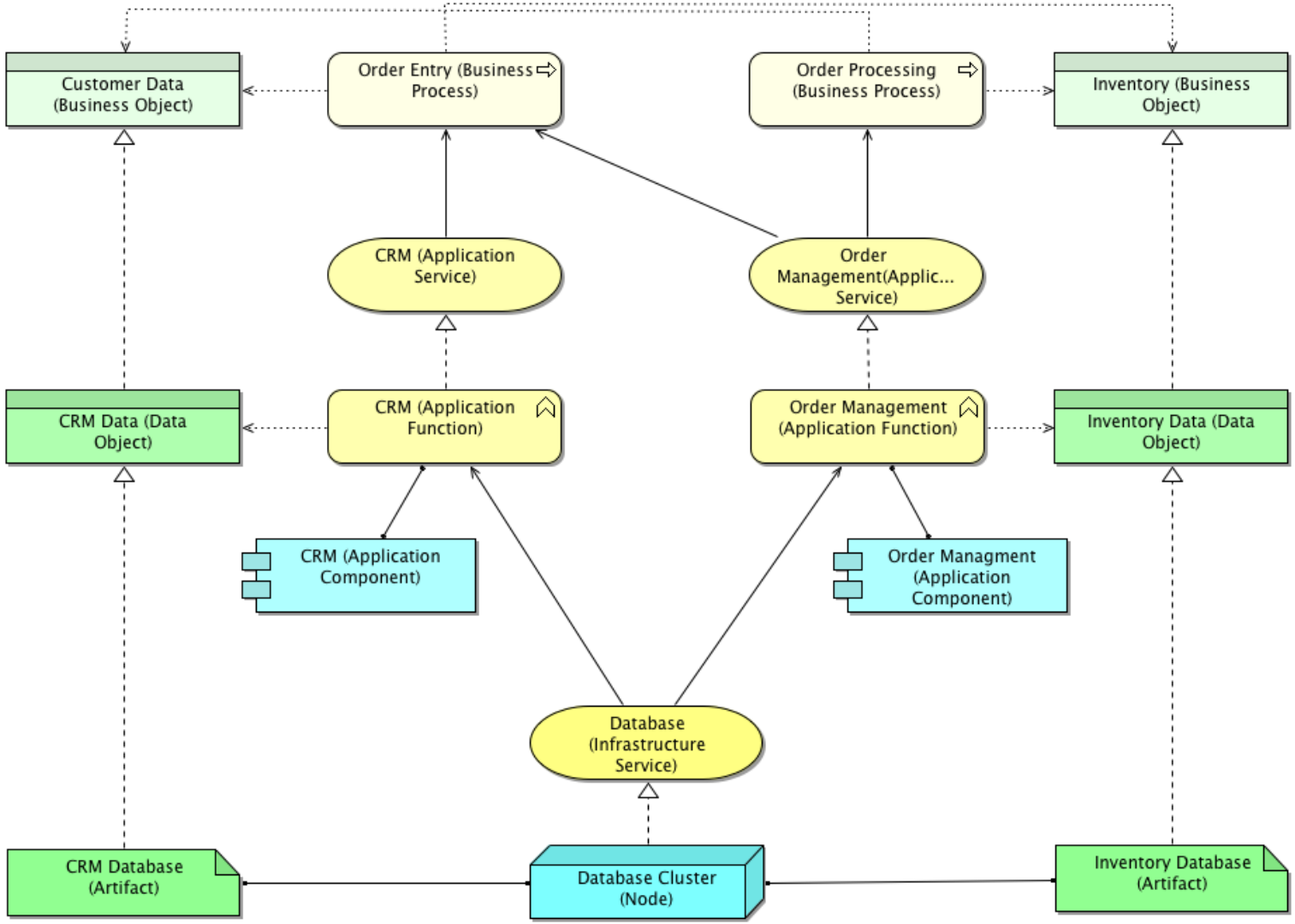
Concept more abstract in CobIT

Enterprise Architecture Management

"EAM is a management practice that establishes, maintains and uses a coherent set of guidelines, architecture principles and governance regimes that provide direction for and practical help with the design and the development of an enterprise's architecture in order to achieve its vision and strategy."—Ahlemann et al. (2012, p. 20)

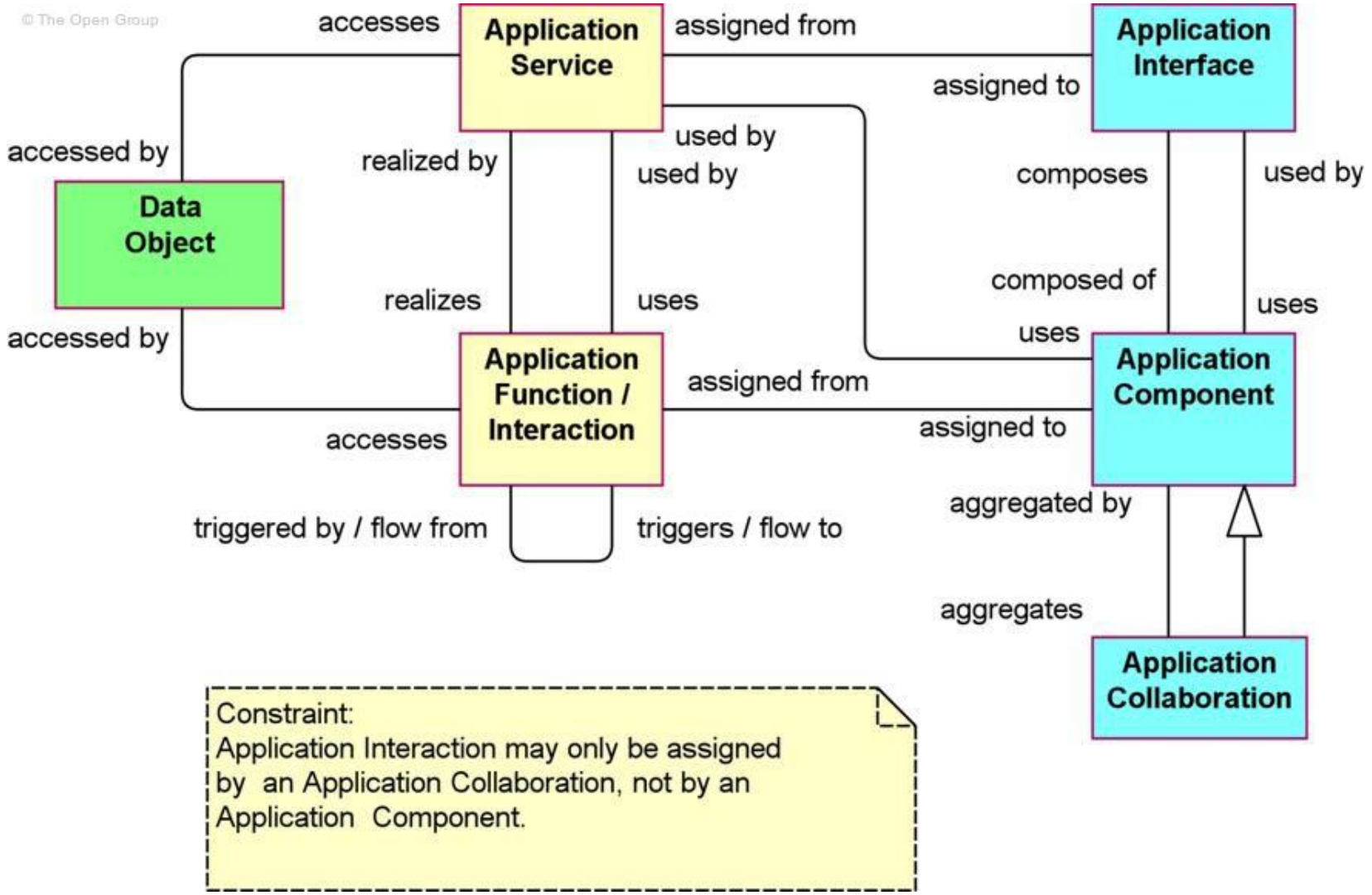
- "Enterprise Architecture" as integrated high-level representation of IT infrastructure an business
- often graphical representation without modeling language
- **Archimate**: language for modeling enterprise architectures

Archimate: Model of Enterprise Architecture



https://archimatemusings.files.wordpress.com/2013/11/archi-colour-example.png

Archimate: „Application Layer Metamodel“



http://pubs.opengroup.org/architecture/archimate2-doc/chap04.html#_Toc371945178

Archimate: Evaluation

- pragmatic approach
- no elaborate DSMLs
- rather generic concepts which can be refined by users
  - allows for various extensions
  - however, no integrity constraints

IT Management Dashboard

- aimed at decision support and awareness
- should provide data relevant for managing IT infrastructures
- focus on aggregate data (KPI), such as
  - availability of resource in time period
  - number of attack attempts
  - number of successful attacks
  - cost per incident
  - IT energy consumption
  - ....
- clearly arranged presentation

usually proprietary solutions

Vision (1): Integration with Enterprise Modeling

- DSML
  - support for creating elaborate models of the IT infrastructure
  - support for analysis – both from technological and economic perspective
- Integration with DSMLs for Enterprise Modeling
  - enables to model and analyse the effect of IT on the business
  - fosters cross-disciplinary communication and collaboration
  - promotes conjoint analysis of IT and business

Illustration (1): Navigation – IT and Business

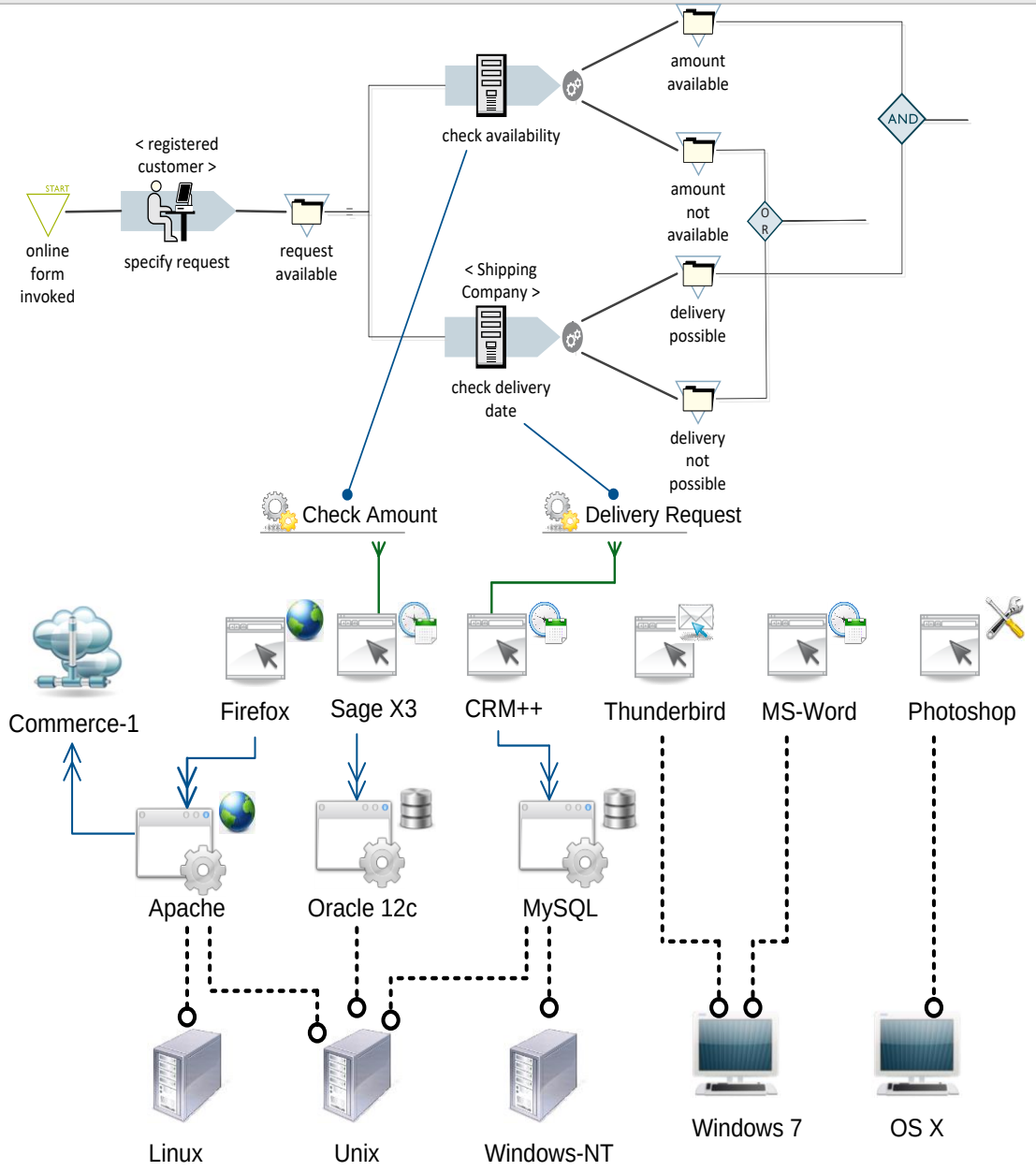
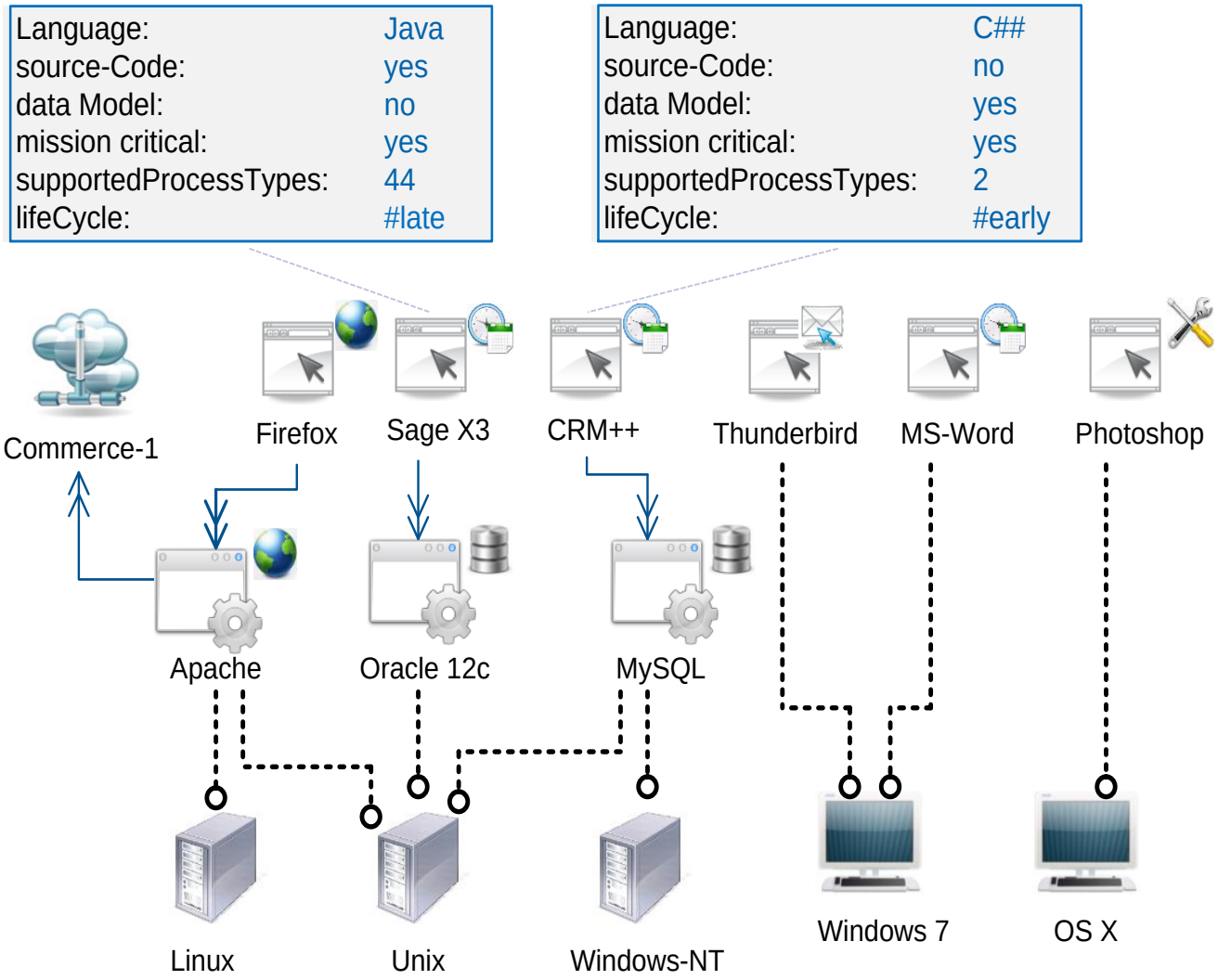


Illustration (2): Adding Detail



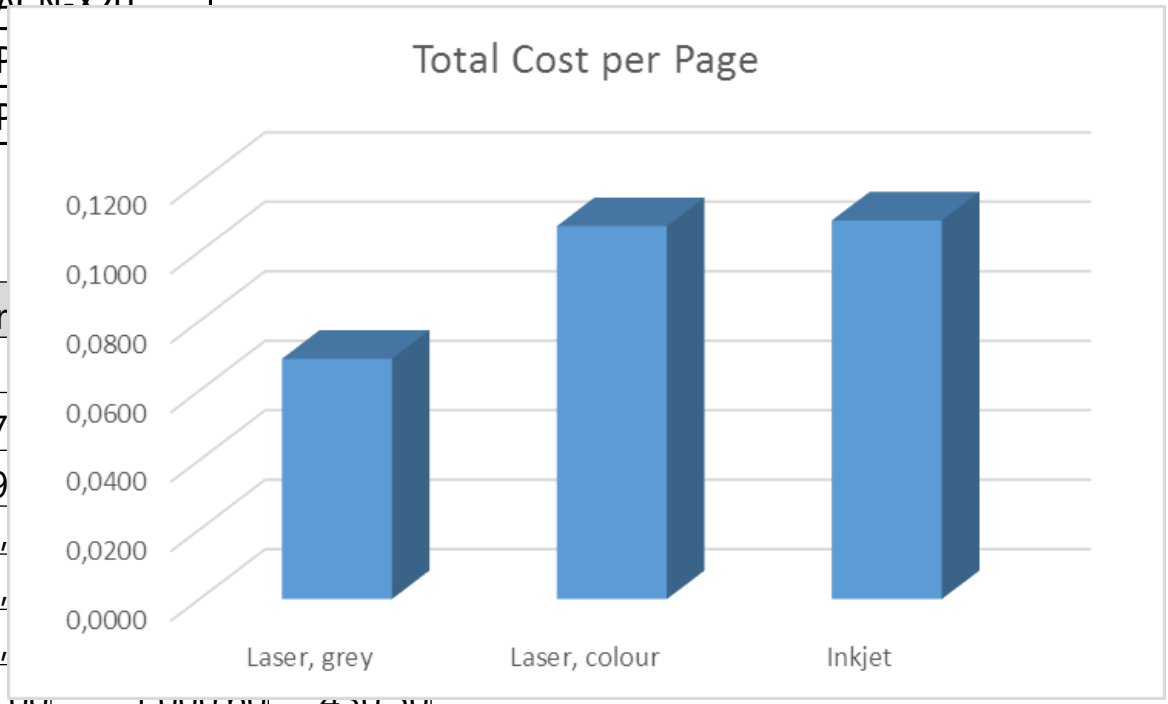
Vision (2): Integration with Monitoring Tool

- account for both, conceptual models and corresponding instances
- integration of modeling environment and monitoring tool
- allows for navigating various interdepent models (IT, business)
- enable advanced users to customize decision support
  - by using DSMLs for adapting models
  - and even allow for modifying DSML

Illustration (3): Reports

vendors
locations
costs
processes

Laser, grey	CP-800
Laser, colour	CP-900
Inkjet	ACN-X20



	Laser, gr		
no. of devices			
average pages per year	67		
deviation	19		
variable cost per page	0,		
depreciation per year	85,		
maintenance	45,		
total cost per device	469,00	1.000,00	450,50
total cost per page	0,0692	0,1074	0,1090

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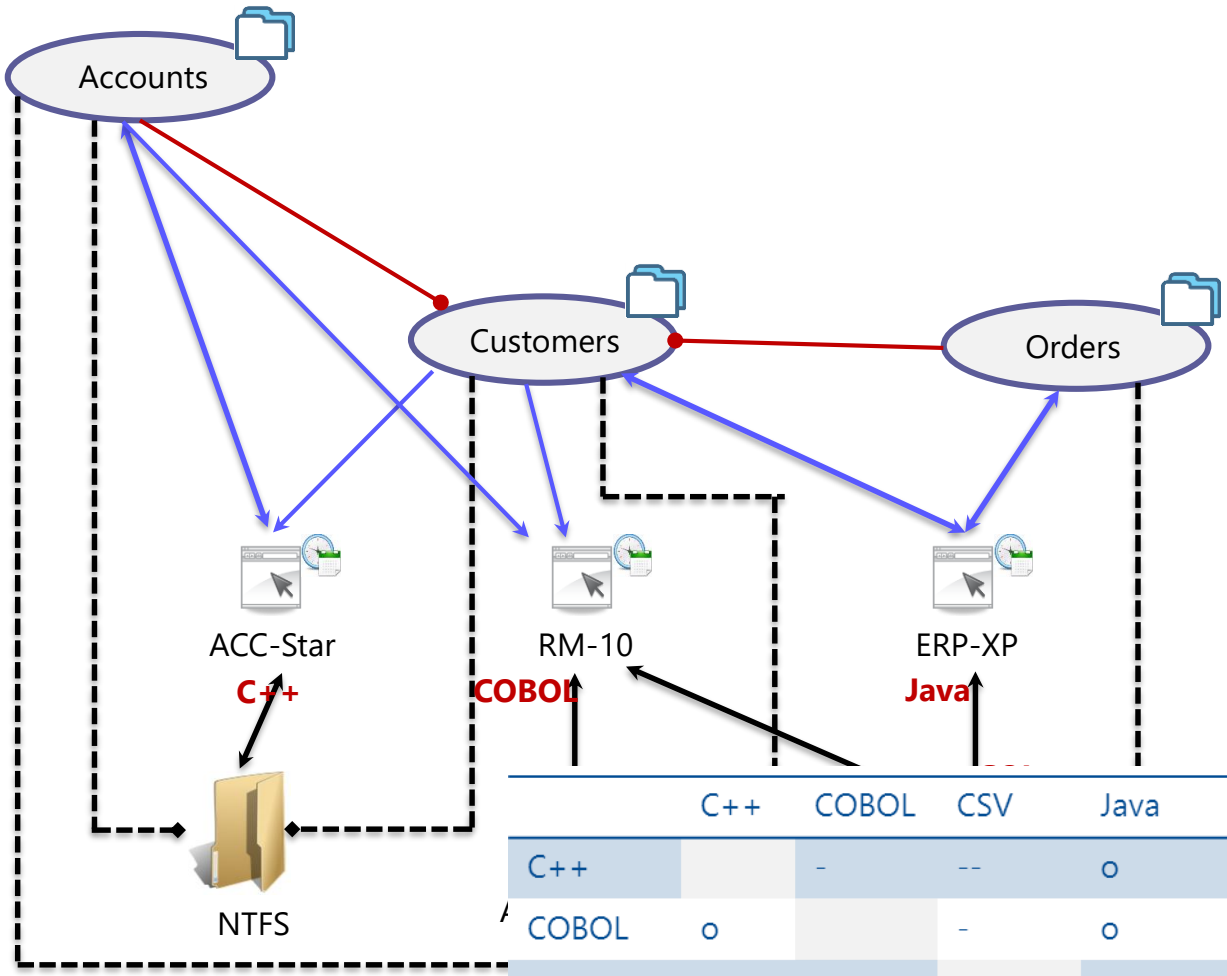
Illustration (4): Advanced Analysis – Data Integration

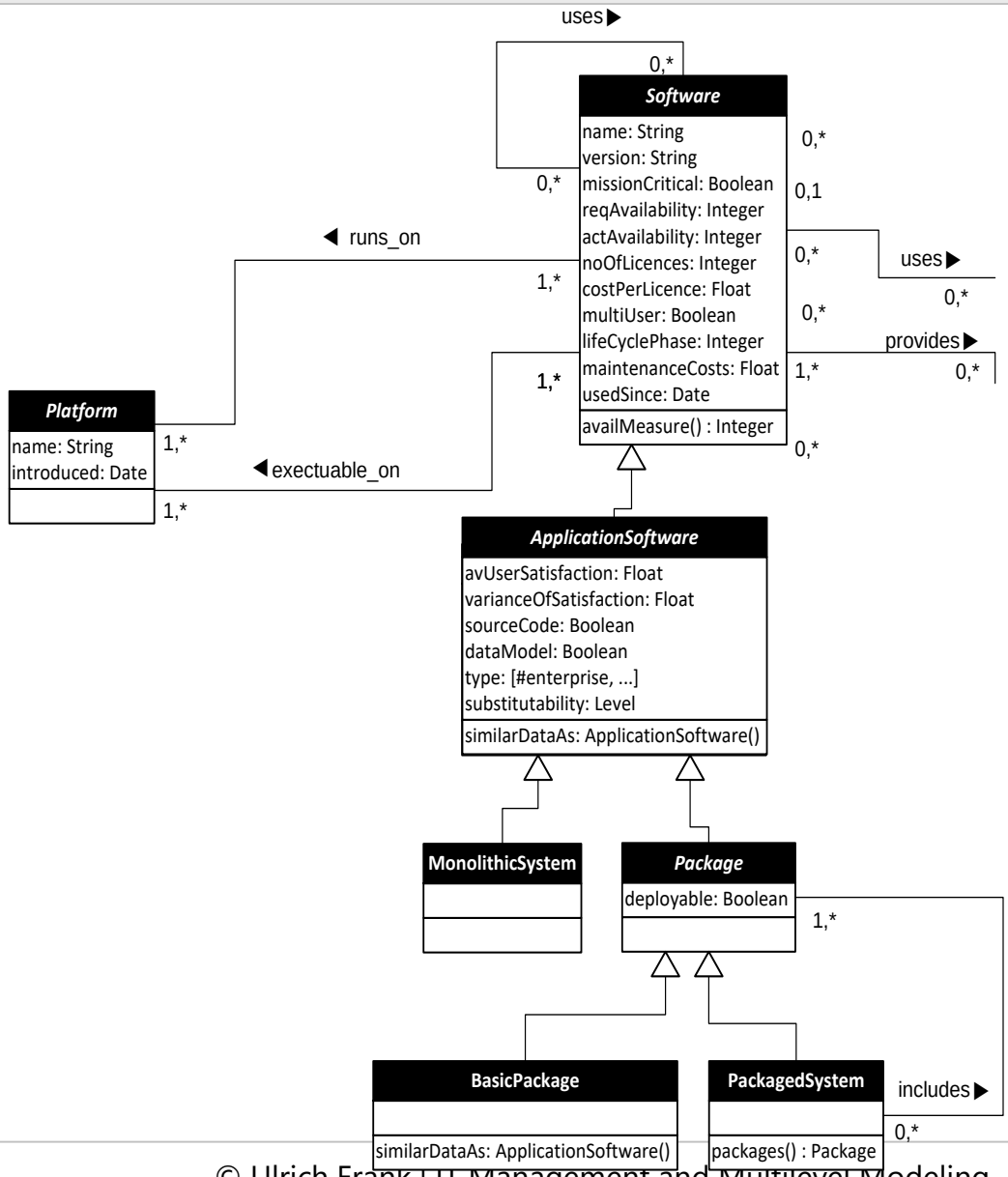


	C++	COBOL	CSV	Java	SQL	ACC
C++		-	--	o	-	-
COBOL	o		-	o	o	-
CSV	o	o		o	o	-
Java	o	-	--		-	-
SQL	(-)	(-)	--	(-)		-
ACC	o	o	(-)	o	o	

Illustration (5): Modification of DSML

Language:	Java
source-Code:	no
data Model:	yes
mission critical:	yes
supportedProcessTypes:	2
lifeCycle:	#early
substitutability:	#high

CRM++



Challenges

- DSML: general design problems
  - distinction between language and language application
  - conflict between range of reuse and productivity
- synchronization of (meta-) models and code
- (meta) modeling languages: lack of expressiveness

Language vs. Language Application

Platform

ERP-System

Software

Goal

Product

Process

DBMS

Operating System

Risk

Computer

Peripheral Device

Spreadsheet Software

Printer

Desktop

MS

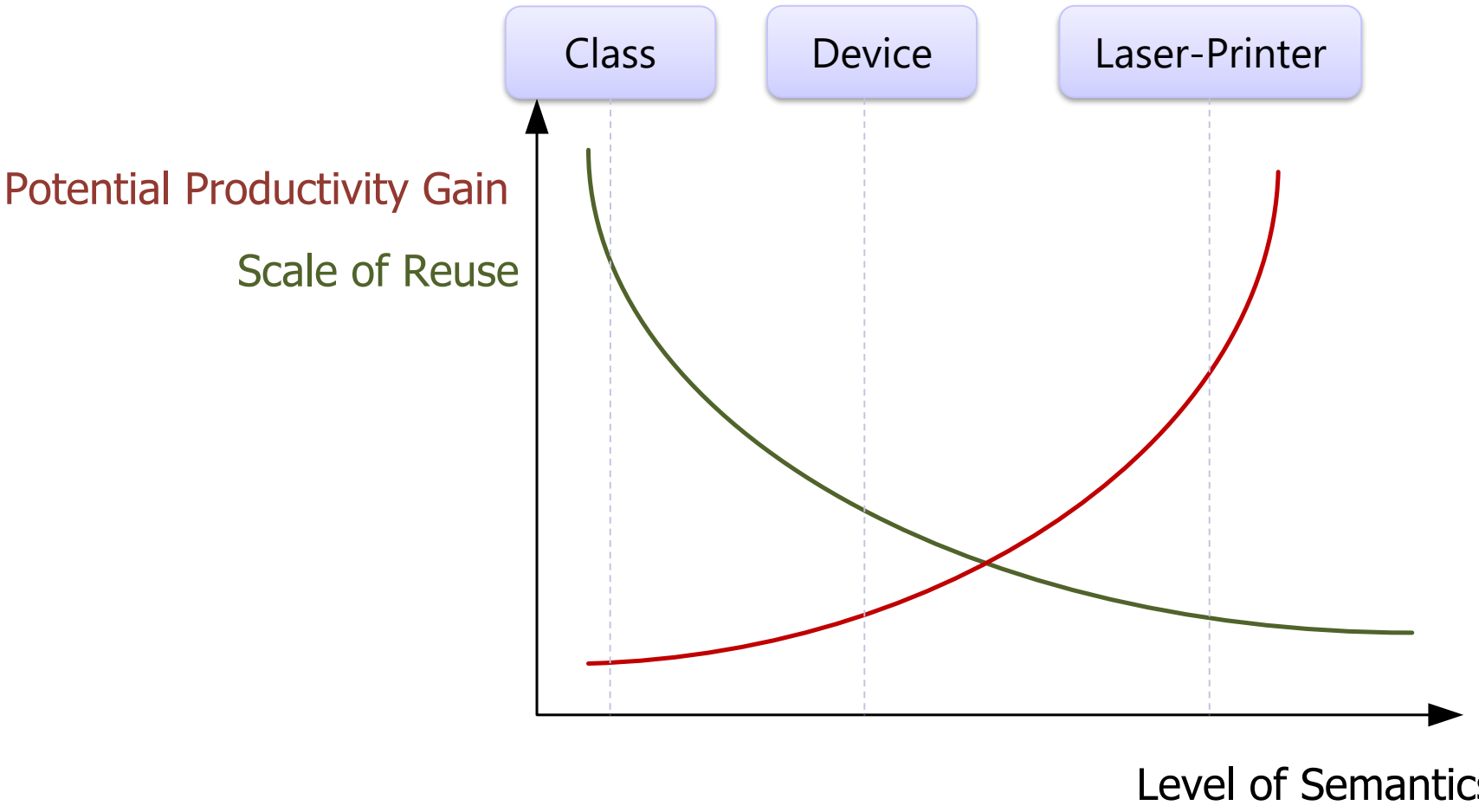
Application

Laser-Printer

Language concept or language application?

Paradigm requires distinction, but how?

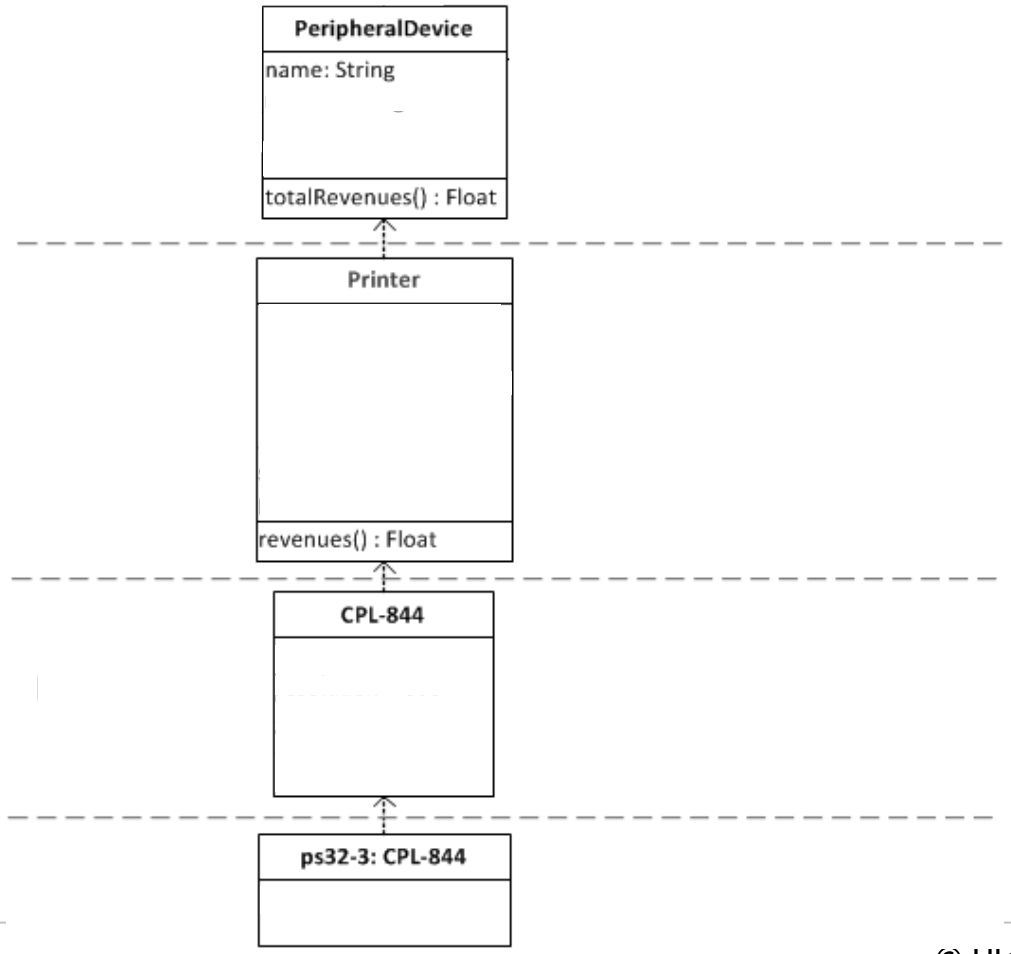
Essential Design Conflict



Lack of Expressiveness

Instantiation and specialisation are mutually exclusive.

There is a clear distinction between model and modelling language.



Sometime no clear distinction between instantiation or specialisation – both make sense.

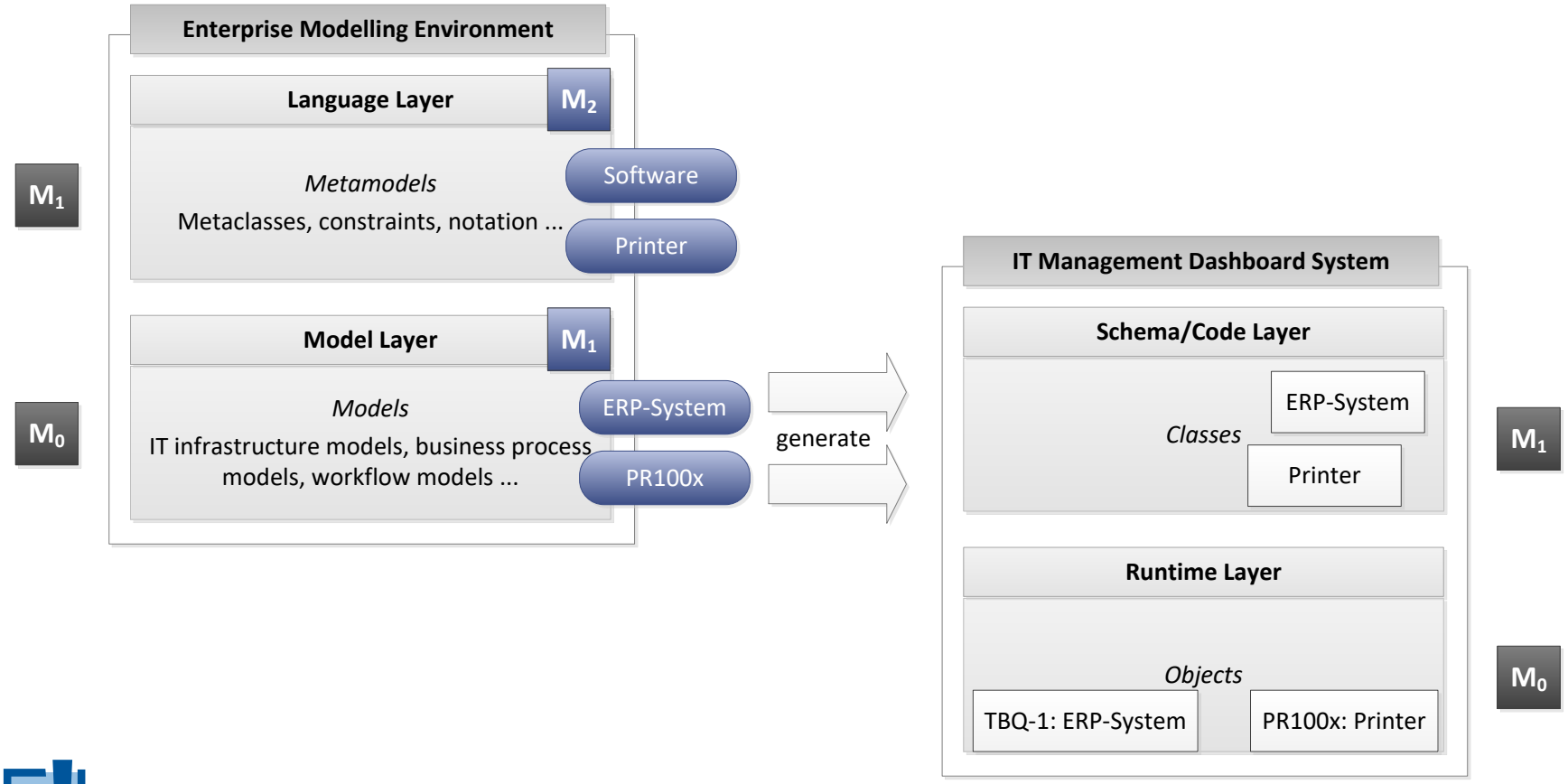
Instantiation sometimes deferred to lower levels.

(Meta) classes may have relevant state.

(Meta) classes may have features that need to be derived or calculated.

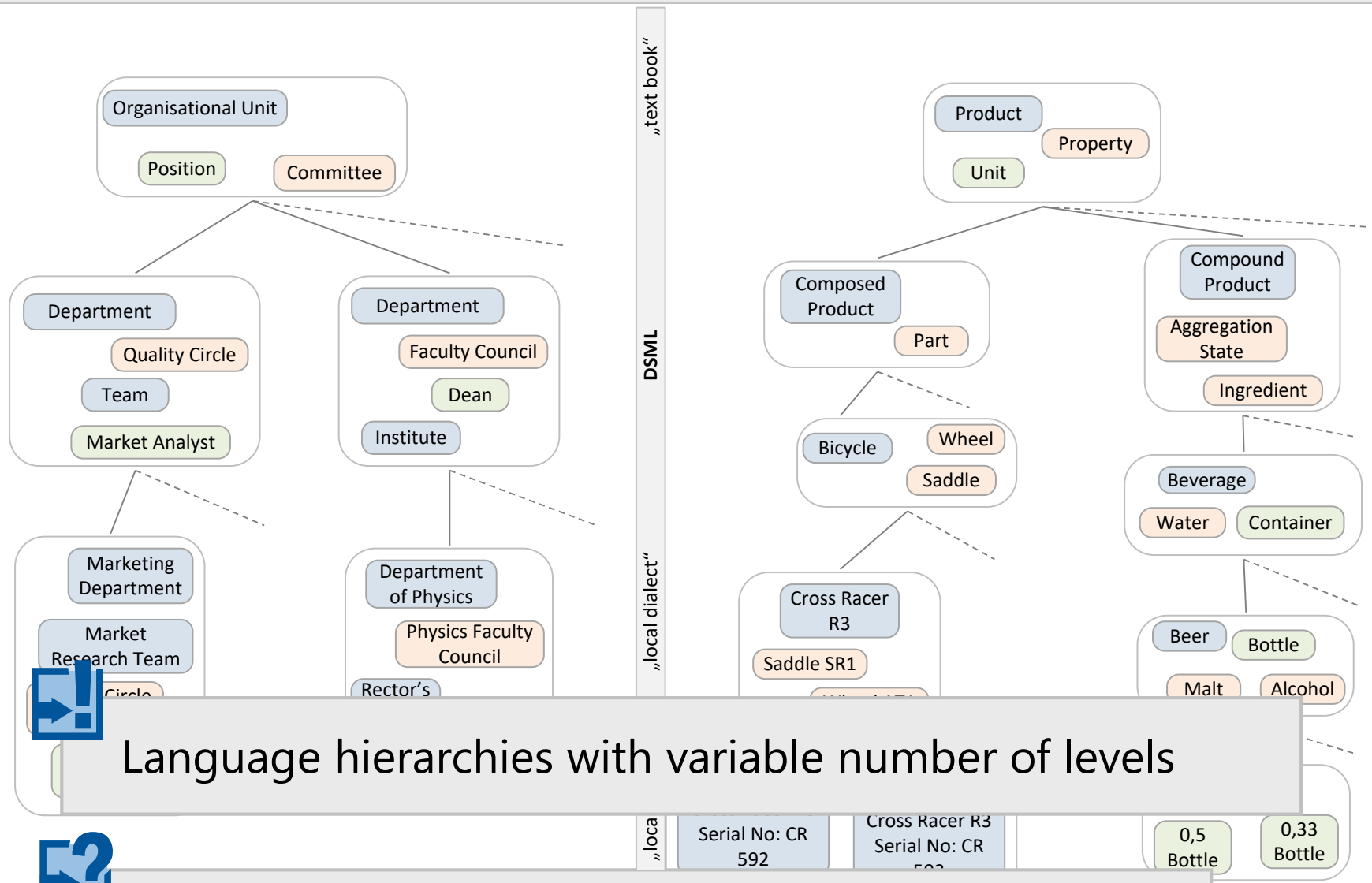
(Meta) classes should be conceptualized as objects.

Separate Representation of Models and Code



Widely prevents interactive use of models during run time.

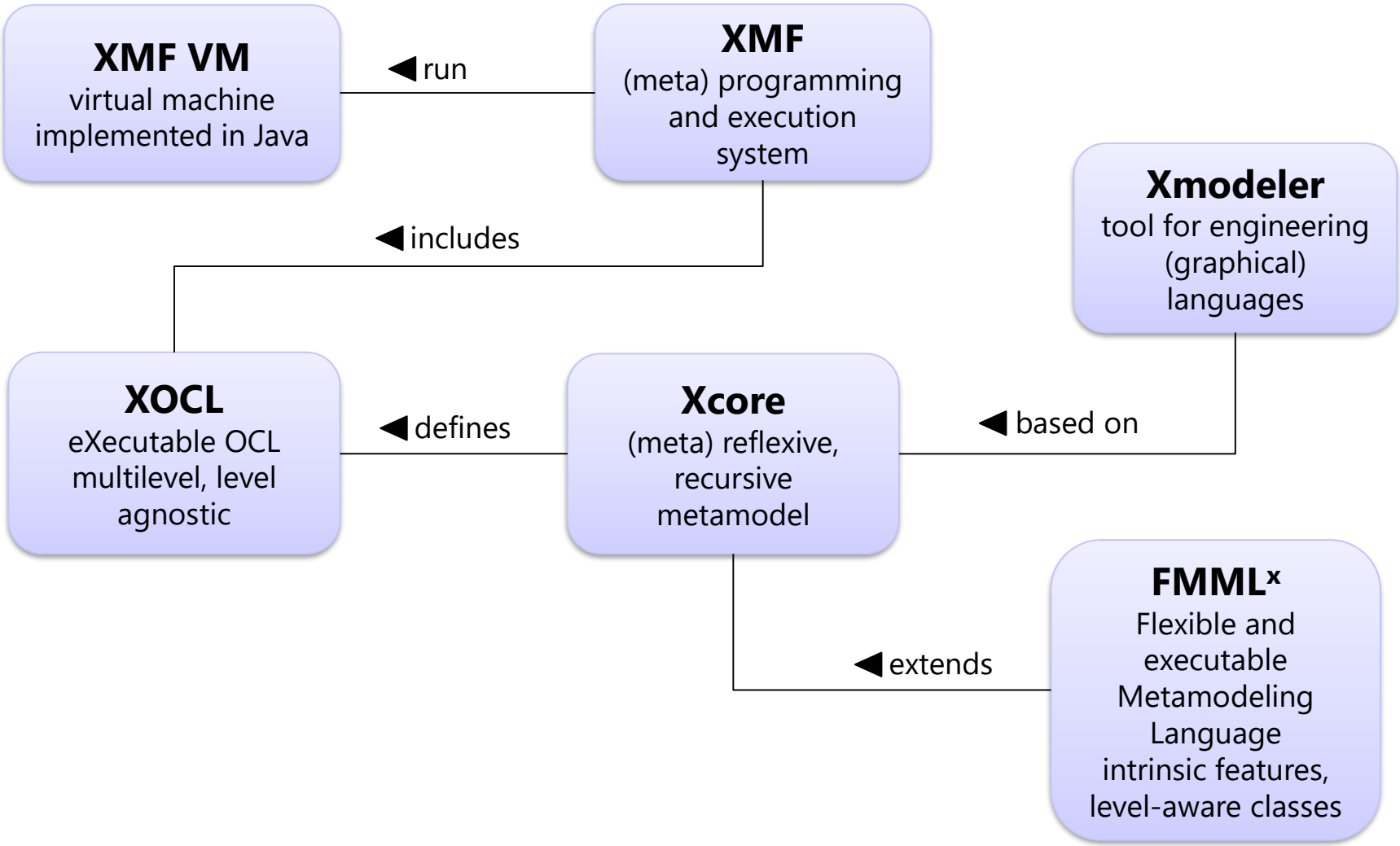
Inspiration: Actual Use of Technical Languages



Language hierarchies with variable number of levels

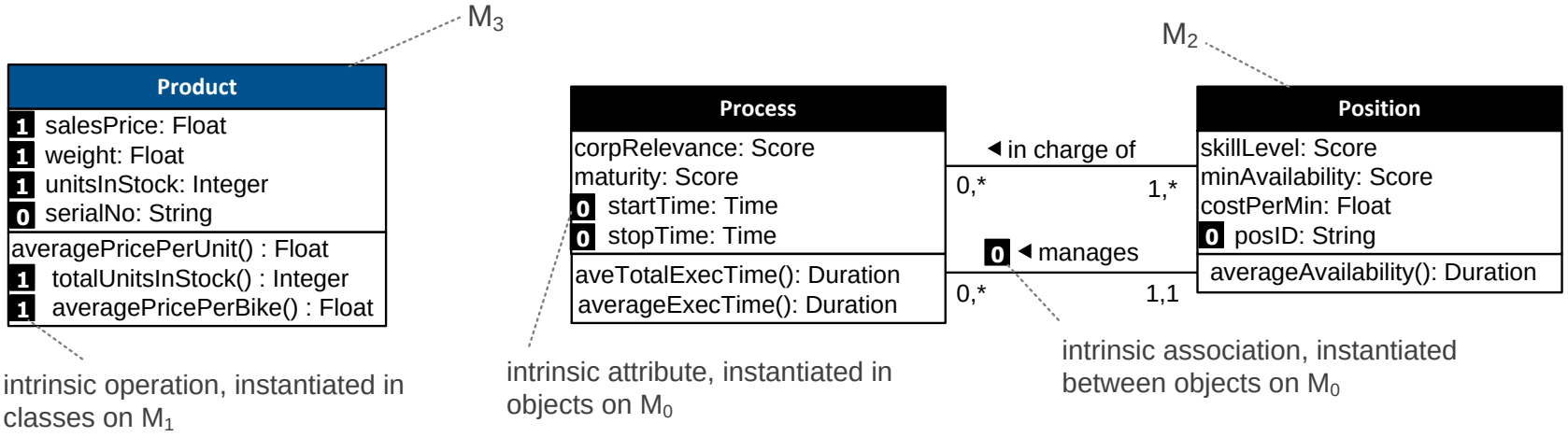
How to represent in modelling tool?

Outline of a Solution

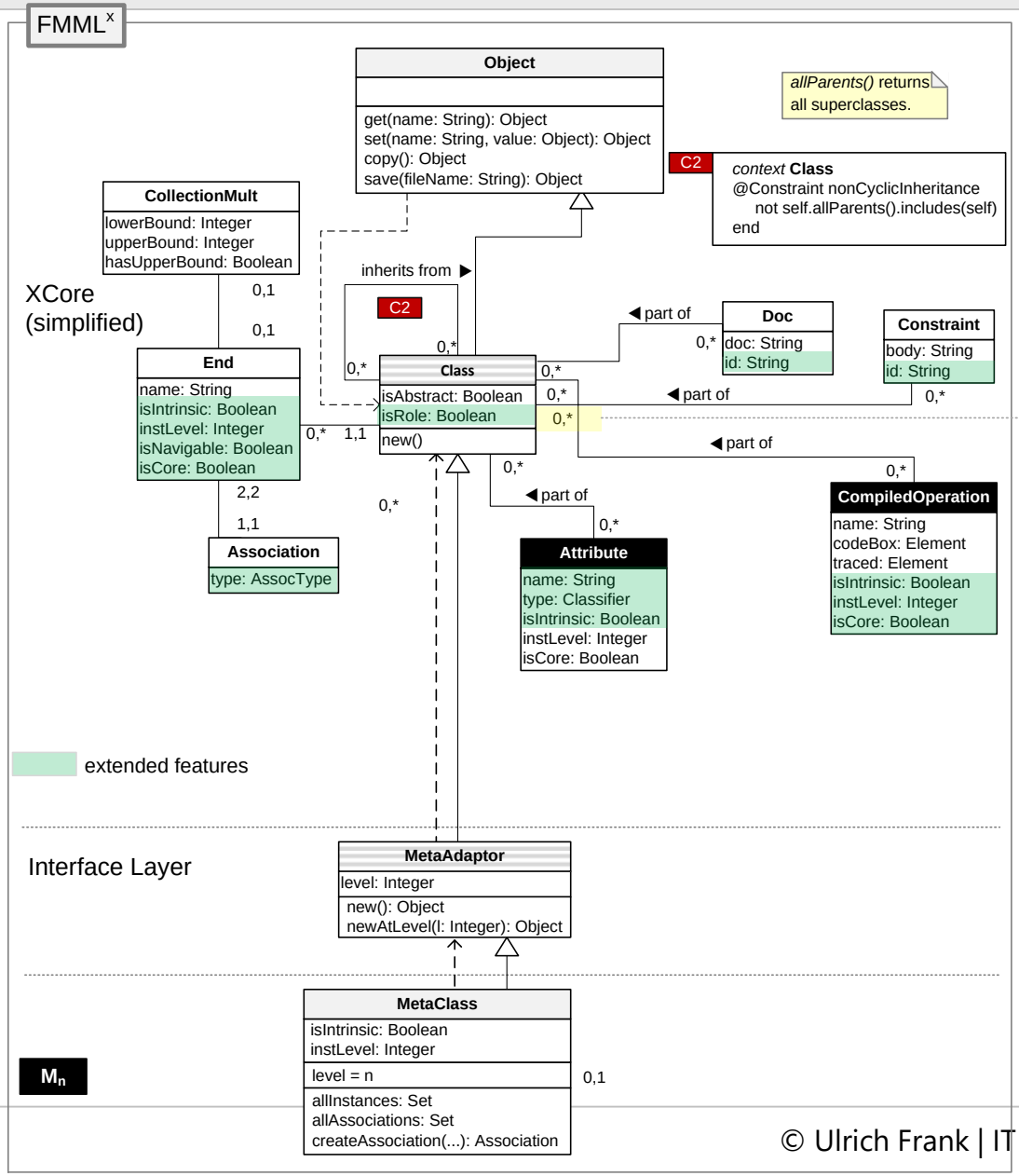


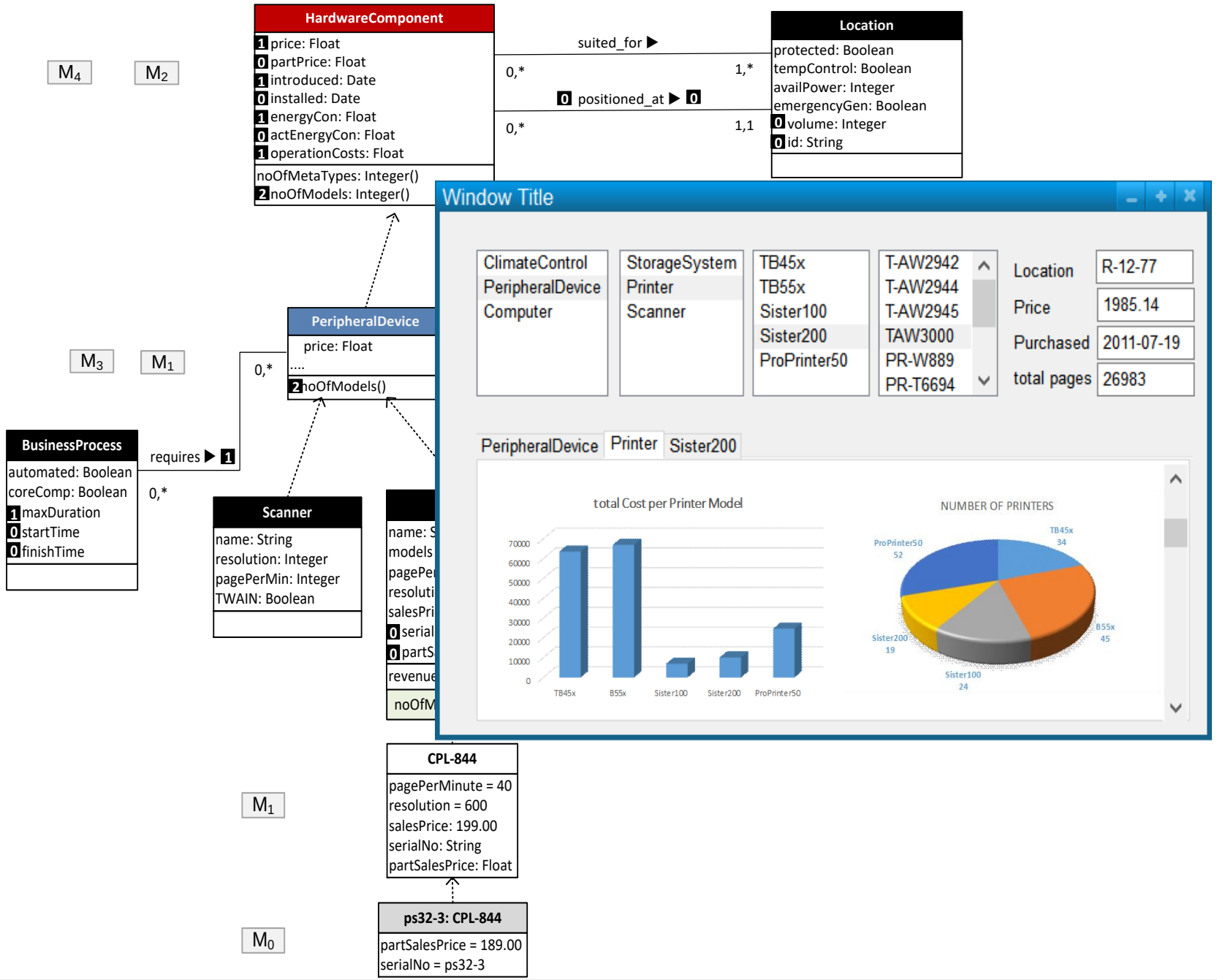
FMML^x: Meta-Language for Multilevel Modeling

- defined with XMF, extends Xcore
- executable, common representation of models and code
- enables explicit classification levels
- adds intrinsic features
- combines modeling with language engineering



FMML^x Metamodel

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1 introduced: Date
0 installed: Date
1 energyCon: Float
0 actEnergyCon: Float
1 operationCosts: Float
noOfMetaTypes: Integer()
2 noOfModels: Integer()
suited_for ▶
0,*
1,*
0 positioned_at ▶ 0
0,*
1,1
Location
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emergencyGen: Boolean
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M4
M2
M3
M1
PeripheralDevice
price: Float
....
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BusinessProcess
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coreComp: Boolean
1 maxDuration
0 startTime
0 finishTime
requires ▶ 1
0,*
Scanner
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resolution: Integer
pagePerMin: Integer
TWAIN: Boolean
CPL-844
pagePerMinute = 40
resolution = 600
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serialNo: String
partSalesPrice: Float
M1
ps32-3: CPL-844
partSalesPrice = 189.00
serialNo = ps32-3
M0
Window Title
ClimateControl
PeripheralDevice
Computer
StorageSystem
Printer
Scanner
TB45x
TB55x
Sister100
Sister200
ProPrinter50
T-AW2942
T-AW2944
T-AW2945
TAW3000
PR-W889
PR-T6694
Location
R-12-77
Price
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Purchased
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total pages
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Printer
Sister200
total Cost per Printer Model
70000
60000
50000
40000
30000
20000
10000
0
TB45x
B55x
Sister100
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B55x
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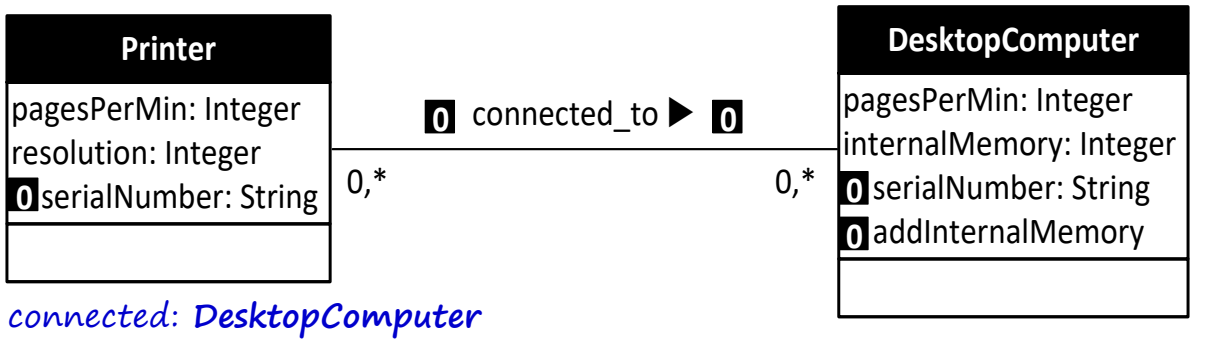
Sister200
19
Sister100
24

Discussion


Printer
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resolution: Integer
0 serialNumber: String
0 connected_to ▶ 0
0,*
0,*
DesktopComputer
pagesPerMin: Integer
internalMemory: Integer
0 serialNumber: String
0 addInternalMemory
connected: DesktopComputer
HP_55
0 serialNumber: String
0 connected_to ▶ 0
0,*
0,*
Dell_M20
0 serialNumber: String
0 addInternalMemory:
Integer
connected: Dell_M20

Conclusions

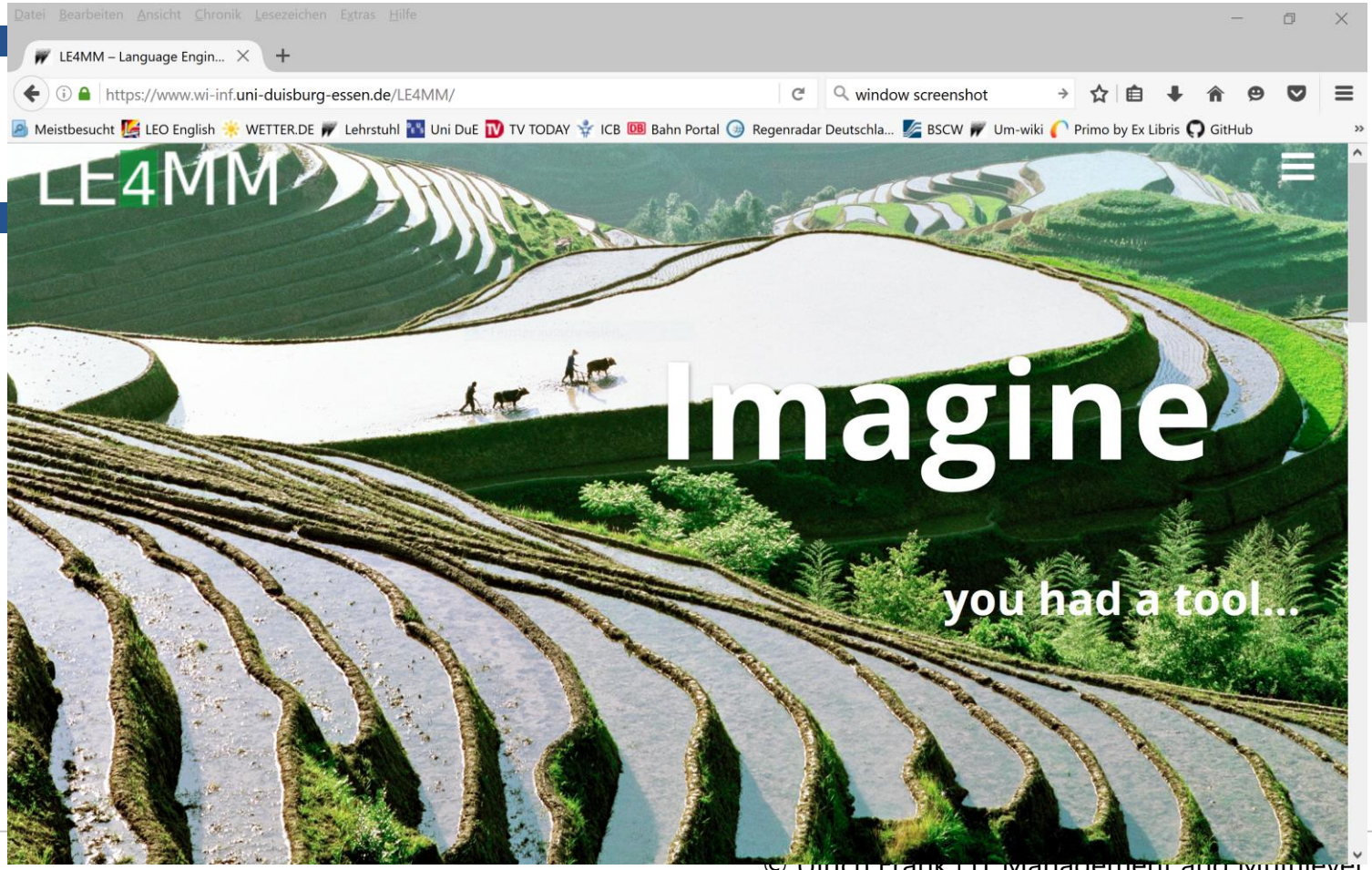
- multilevel DSMLs promising paradigm
  - enables avoiding essential design conflicts
  - allows for reflexive/self-referential tools
  - contributes to user empowerment
- particularly suited for supporting IT management
  - provides conceptual support
  - enables adaptation of concepts and tools by users
  - integrates conceptual perspective with monitoring
- Xmodeler powerful language engineering and execution environment. However,
  - no static typing
  - New paradigm creates serious barriers.

Future Work

- enterprise modeling: multilevel reconstruction of MEMO languages
- support for designing multilevel languages
  - analysis and design method
  - bottom-up approaches
- delegation
  - analysis of use cases (in multilevel environment)
  - guidelines for applying delegation
- process modeling
  - improving reuse through additional abstractions
  - improving consistent adaptation of processes

LE4MM

http://www.wi-inf.uni-duisburg-essen.de/LE4MM/



Meta-Conclusions

- There is need for many languages
- … with different syntax and semantics.
- However, there is increasing need for integration, communication and collaboration.
- Language is evolving over time.
- Standards are good … and evil.
- Hiearchies of languages that capture commonalities and allow for adaptation seem to be a good idea.

How can we tell whether existing languages are good enough …
and how can we make them better?

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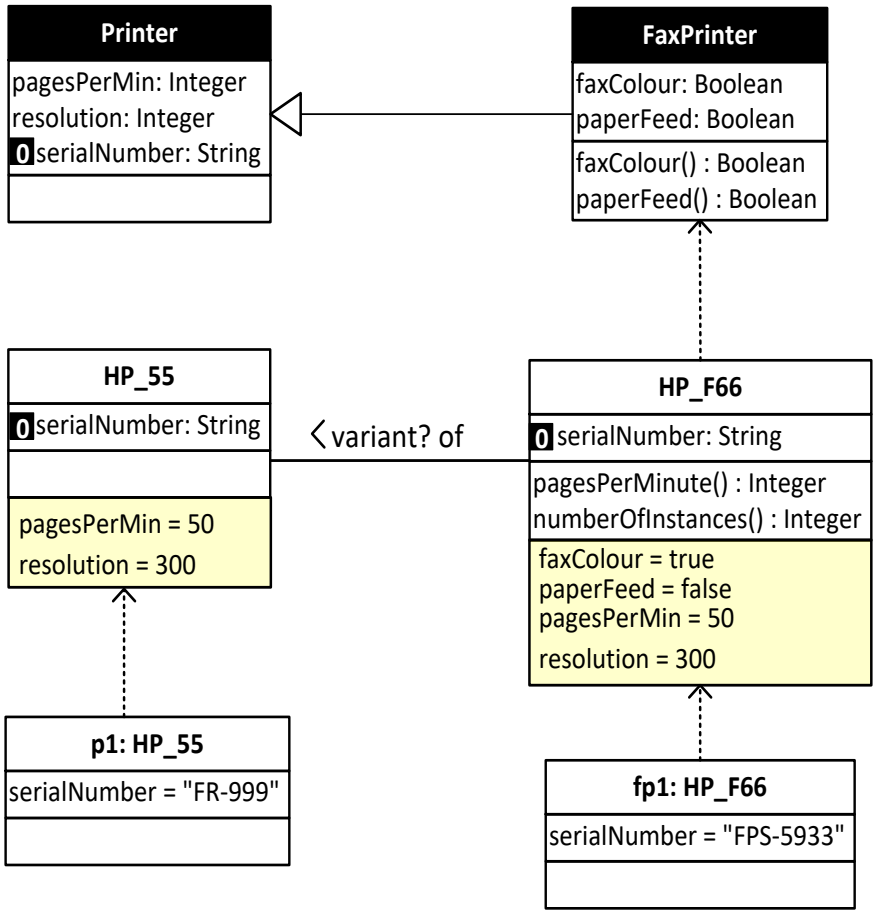
Discussion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resolution: Integer
0 serialNumber: String
FaxPrinter
faxColour: Boolean
paperFeed: Boolean
faxColour() : Boolean
paperFeed() : Boolean
HP_55
0 serialNumber: String
pagesPerMin = 50
resolution = 300
variant? of
HP_F66
0 serialNumber: String
pagesPerMinute() : Integer
numberOfInstances() : Integer
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fp1: HP_F66
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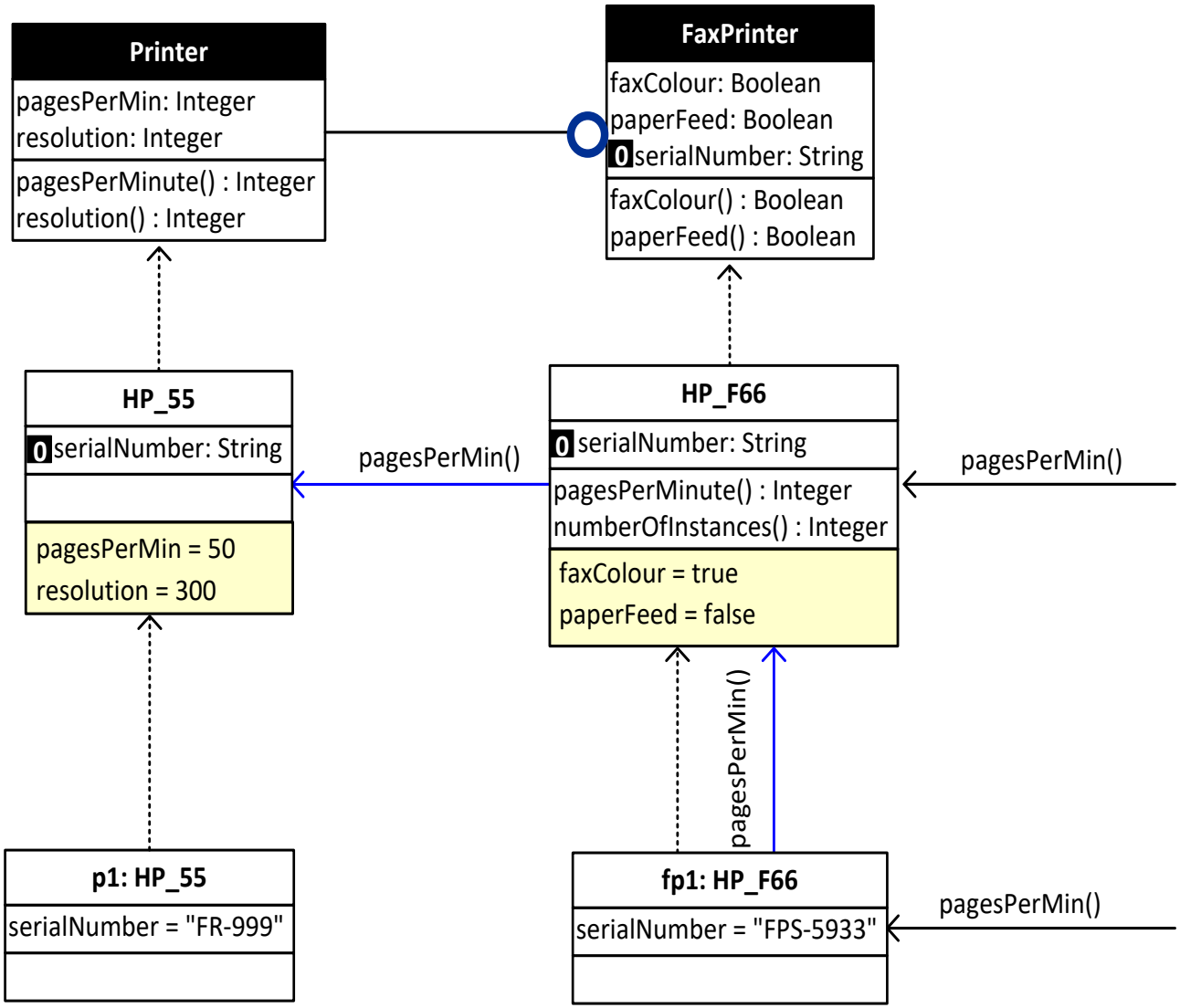
Discussion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pagesPerMin = 50
resolution = 300
pagesPerMin()
HP_F66
0 serialNumber: String
pagesPerMinute() : Integer
numberOfInstances() : Integer
faxColour = true
paperFeed = false
pagesPerMin()
pagesPerMin()
p1: HP_55
serialNumber = "FR-999"
fp1: HP_F66
serialNumber = "FPS-5933"
pagesPerMin()

Example: Basic Presuppositions

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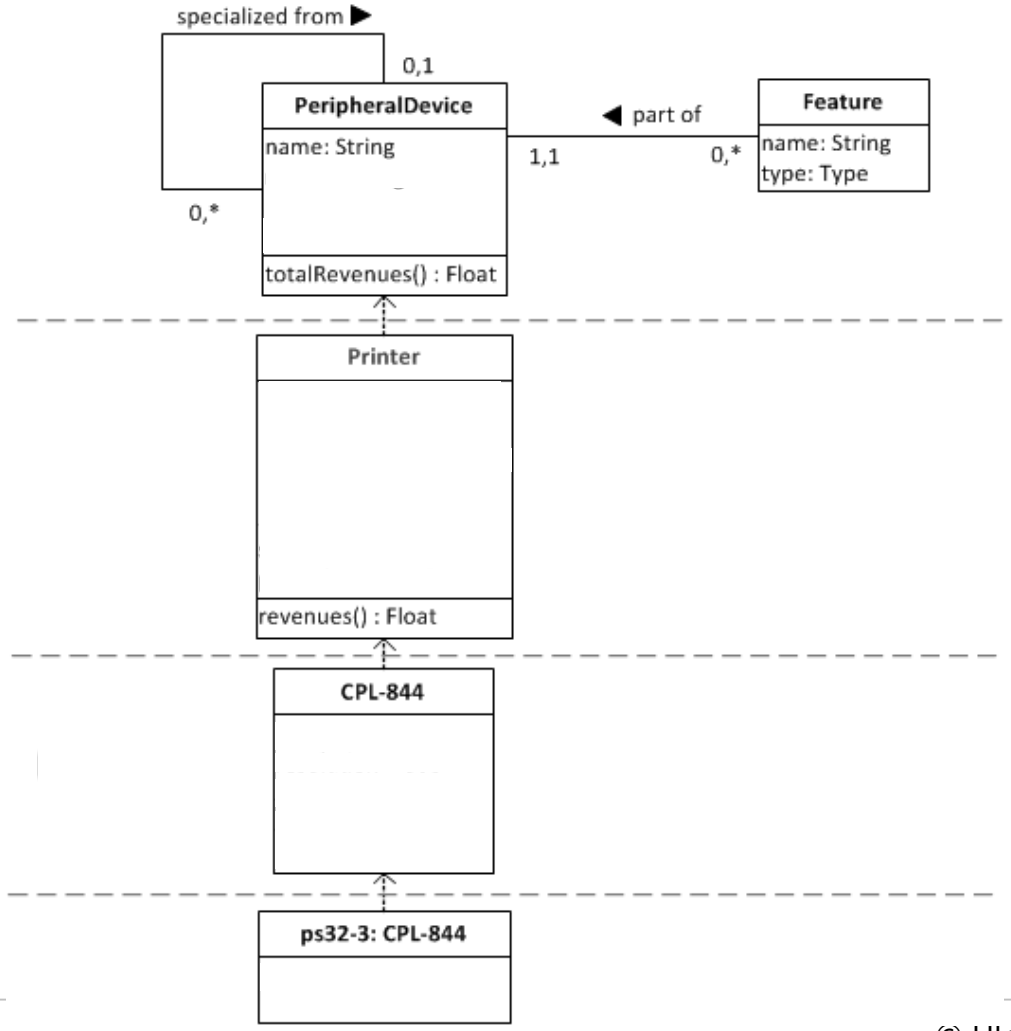
There is a clear distinction between model and modelling language.



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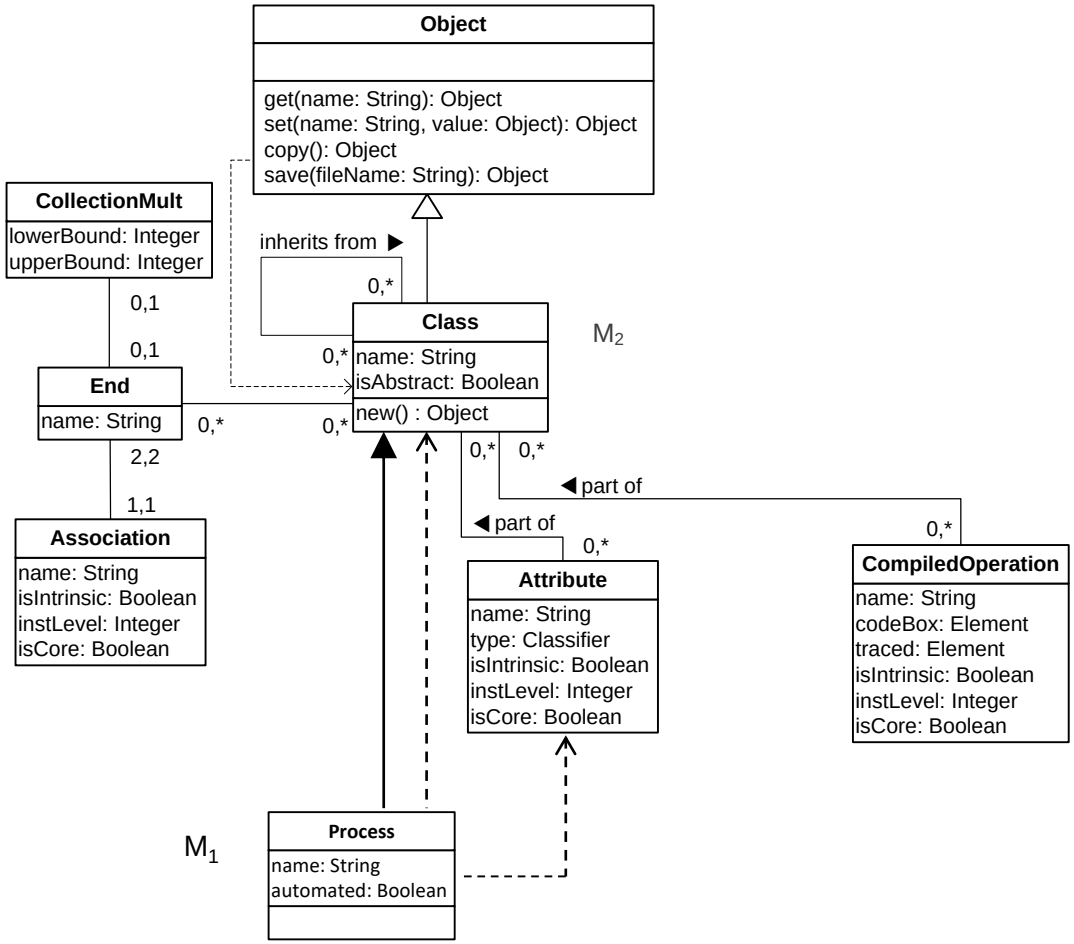
Raising the Level of Classification