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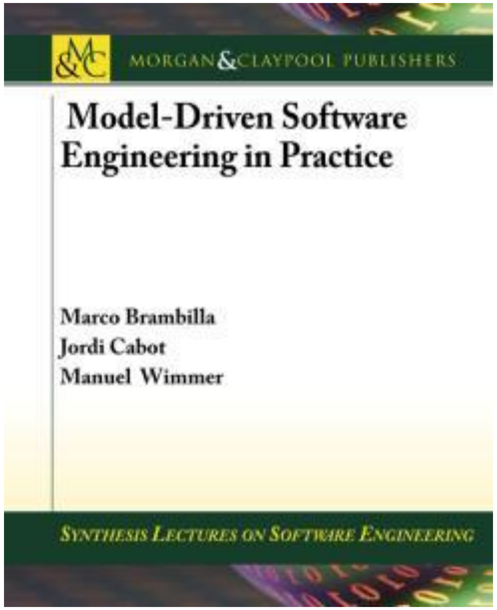
Chapter #3

MDSE USE CASES

Teaching material for the book
Model-Driven Software Engineering in Practice
by Marco Brambilla, Jordi Cabot, Manuel Wimmer.
Morgan & Claypool, USA, 2012.



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Model-Driven Software Engineering in Practice

Marco Brambilla
Jordi Cabot
Manuel Wimmer

SYNTHESIS LECTURES ON SOFTWARE ENGINEERING

MDSE GOES FAR BEYOND CODE-GENERATION

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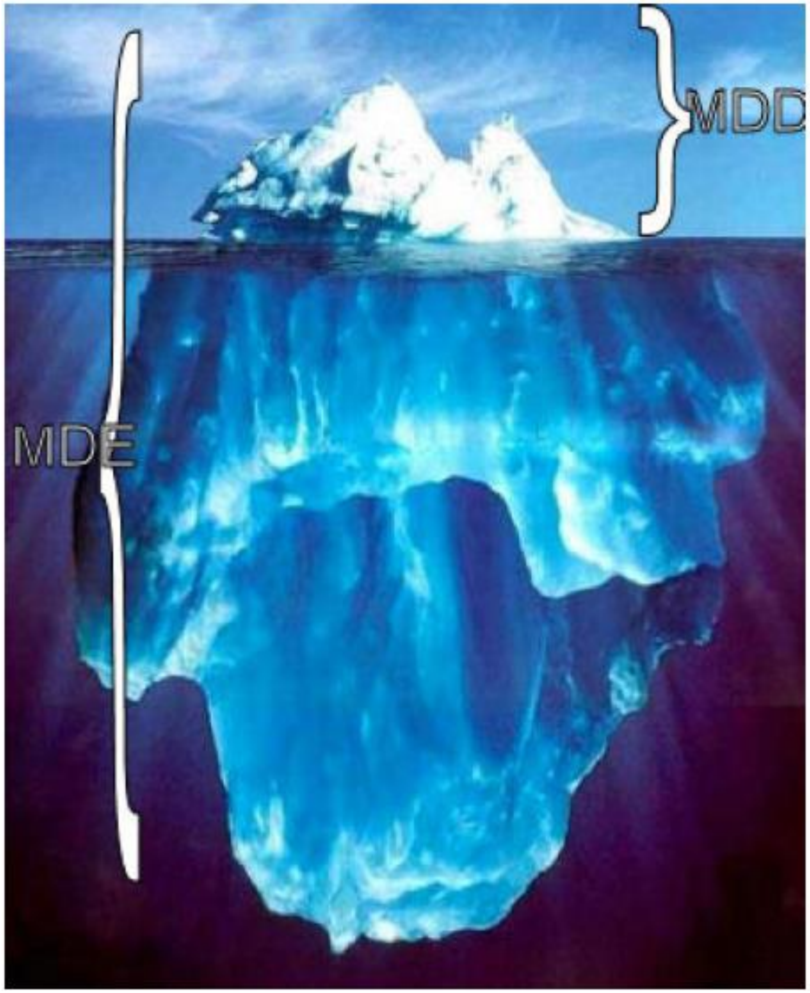
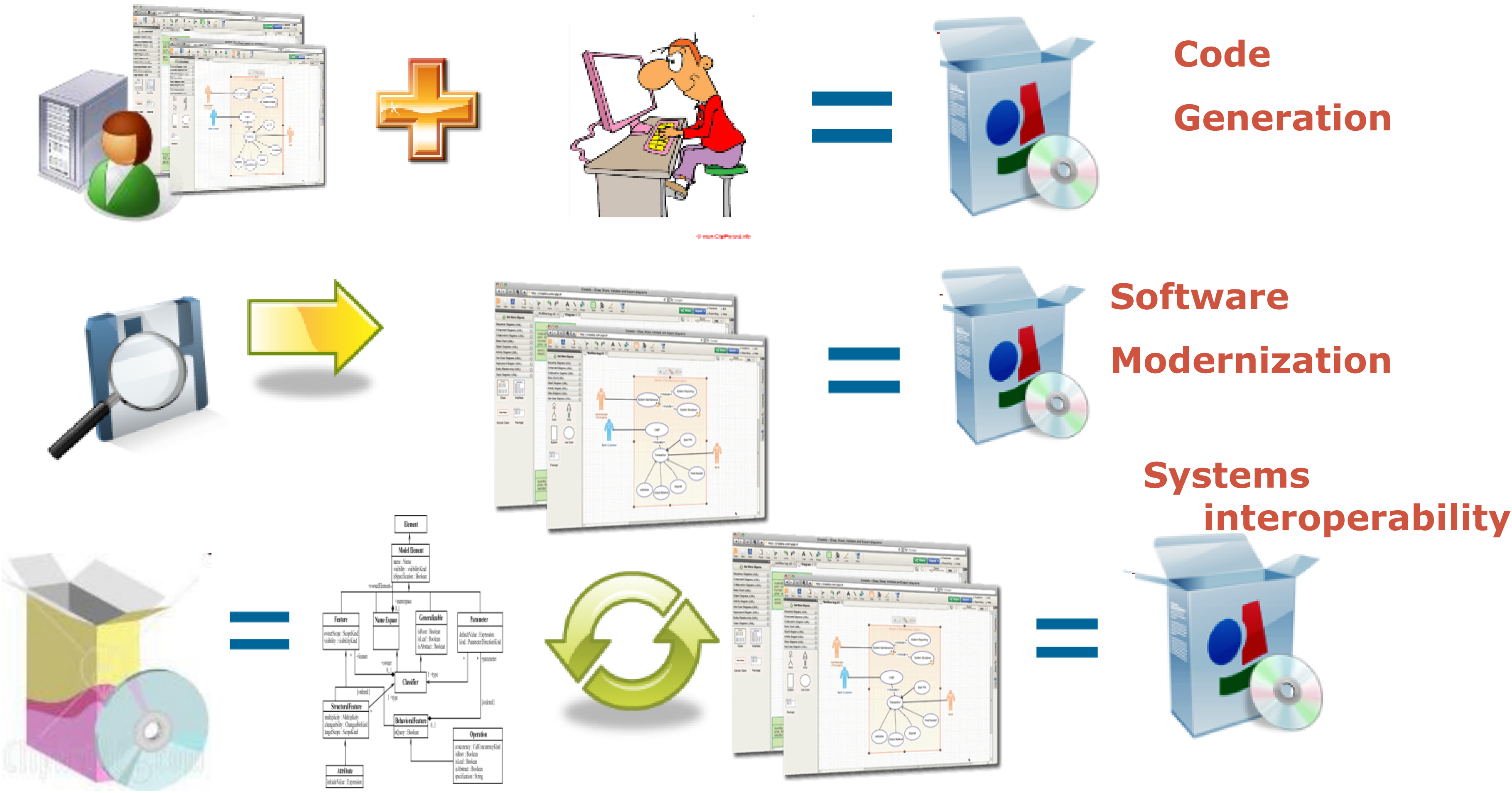
Synthesis Lectures on Software Engineering

MDSE has many applications

- MDD is just the tip of the iceberg
  - And MDA a specific “realization” of MDD when using OMG standards



Three killer MDSE applications



Code Generation

Software Modernization

Systems interoperability

USE CASE1 – MODEL DRIVEN DEVEOPMENT

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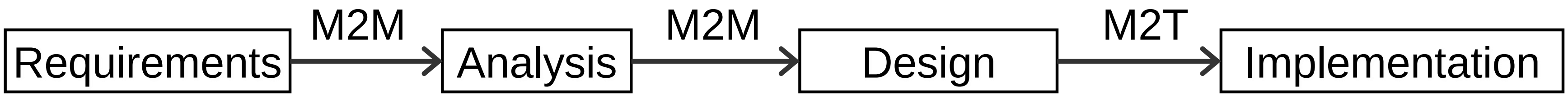
MDD contribution: Communication

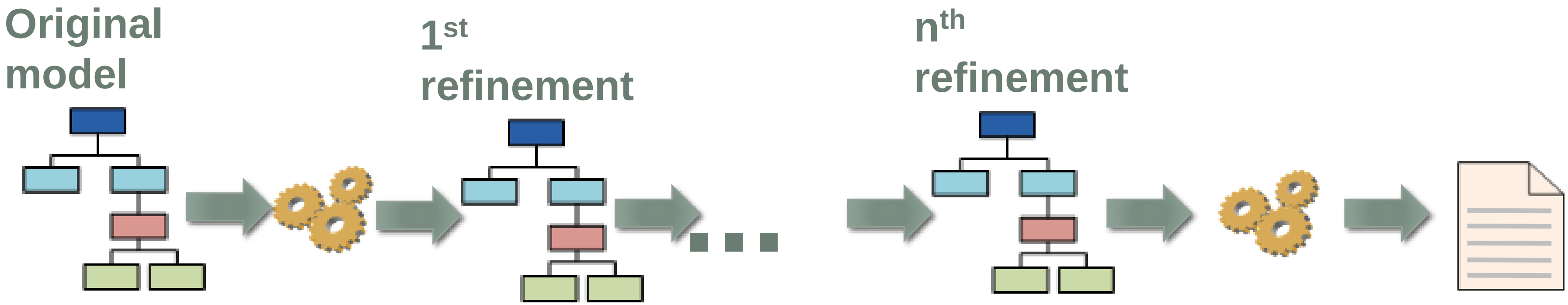
- Models capture and organize the understanding of the system within a group of people
- Models as *lingua franca* between actors from business and IT divisions



Requirements \xrightarrow{M2M} Analysis \xrightarrow{M2M} Design \xrightarrow{M2T} Implementation

MDD contribution: Productivity

- MDD (semi)automates software development
- In MDD, software is derived through a series of model-to-model transformations (possibly) ending with a model-to-text transformations that produces the final code



Original model

1st refinement

...

nth refinement

Model-to-model Transformation

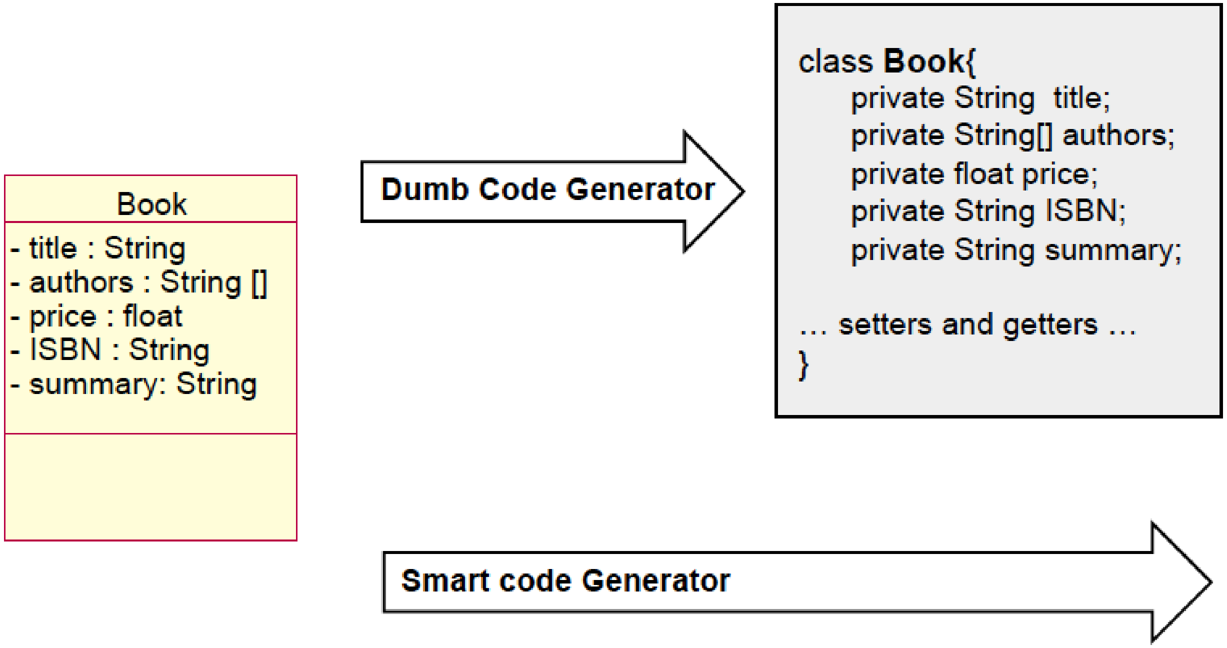
Model-to-text Transformation

Executable models

- An executable model is a model complete enough to be executable
- From a theoretical point of view, a model is executable when **its operational semantics are fully specified**
- In practice, the executability of a model may depend on the adopted execution engine
  - models which are not entirely specified but that can be executed by some advanced tools that are able to fill the gaps
  - Completely formalized models that cannot be executed because an appropriate execution engine is missing.

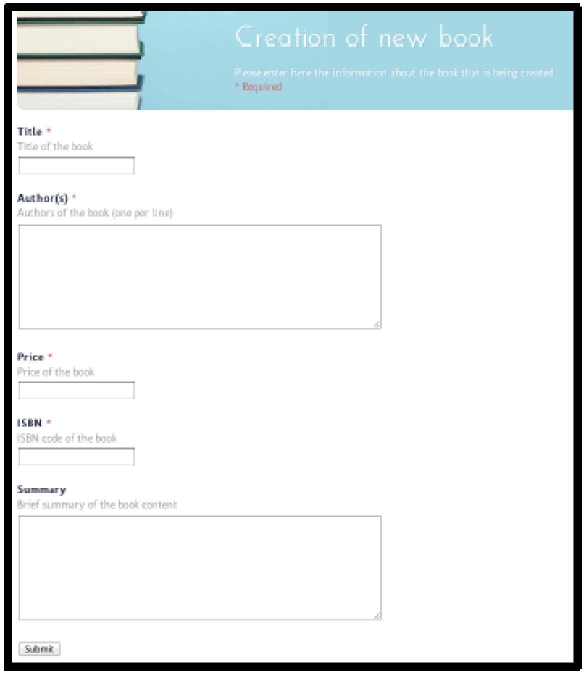
Smart vs dumb execution engines

- CRUD operation typically account for 80% of the overall software functionality
- Huge spared effort through simple generation rules



```
class Book{
     private String  title;
     private String[] authors;
     private float price;
     private String ISBN;
     private String summary;

… setters and getters …
}
```



Creation of new book

Please enter here the information about the book that is being created

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ISBN code of the book

Summary
Brief summary of the book content

Executable models

- Most popular: Executable UML models
- Executable UML development method (xUML) initially proposed by Steve Mellor
- Based on an action language (kind of imperative pseudocode)

- Current standards
  - Foundational Subset for Executable UML Models (fUML)
  - Action language is the Action Language for fUML (Alf)
    - basically a textual notation for UML behaviors that can be attached to a UML model

Executable models: 2 main approaches

- **Code generation**: generating running code from a higher level model in order to create a working application
  - by means of a rule-based template engine
  - common IDE tools can be used to render the source code produced

- **Model interpretation**: interpreting the models and making them run

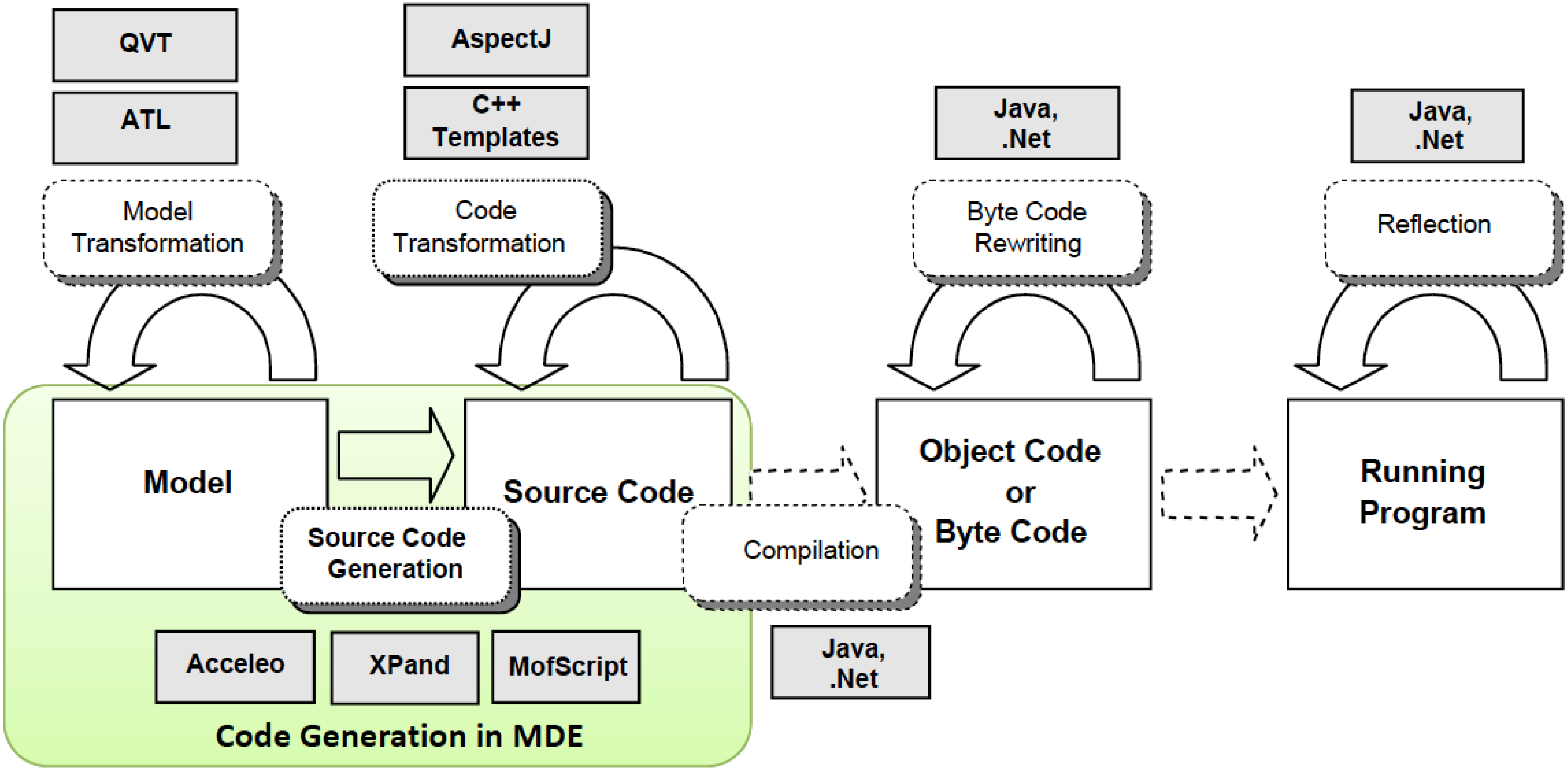
- Non-empty intersection between the two options

Code Generation

- Goal: generating running code from higher level models
  - Like compilers producing executable binary files from source code
  - Also known as model compilers

- Once the source code is generated state-of-the-art IDEs can be used to manipulate the code

Code Generation: Scope



Code Generation: Benefits

- Intellectual property
- Separation of modeling and execution
- Multi-platform generation
- Generators simpler than interpreters
- Reuse of existing artefacts
- Adaptation to enterprise policies
- Better performances

Code Generation: Partial Generation

- Input models are not complete & code generator is not smart enough to derive or guess the missing information
- Programmers will need to complete the code manually
- **Caution!** Breaking the generation cycle is dangerous

Solutions:

- Defining protected areas in the code, which are the ones to be manually edited by the developer
- Using round-trip engineering tools (not many available)
- Better to do complete generation of parts of the system instead of partial generation of the full system

Code Generation: Turing test

- A human judge examines the code generated by one programmer and one code-generation tool for the same formal specification. If the judge cannot reliably tell the tool from the human, the tool is said to have passed the test

Model interpretation

- A generic engine parses and executes the model on-the-fly using an interpretation approach

- Benefits
  - Faster changes & Transparent (re)deployment
  - Better portability (if the vendor supports several platforms)
  - The model is the code. Easier model debugging
  - No deployment
  - Updates of the model at runtime
  - Higher level abstraction of the system (implemented by the interpreter)
  - Updates in the interpreter may result in automatic improvements of your software

- Danger of becoming dependent of the application vendor. Limited influence in the –ities of the SW

Generation and interpretation

- Can be used together in the same process
  - Interpretation at early prototyping / debugging time
  - Generation for production and deployment
- Hybrid solutions are possible:
  - Model interpretation based on internal code generation implementation
  - Code generation that relies on predefined, configurable components / framework at runtime. The generated code is e.g., XML descriptor / configurations of the components

USE CASE2 – SYSTEMS INTEROPERABILITY

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Interoperability

- Ability of two or more systems to exchange information (IEEE)

- Needed for collaborative work (e.g. using different tools), tool and language evolution, system integration…

- Interoperability must be done at the syntactic and semantic levels

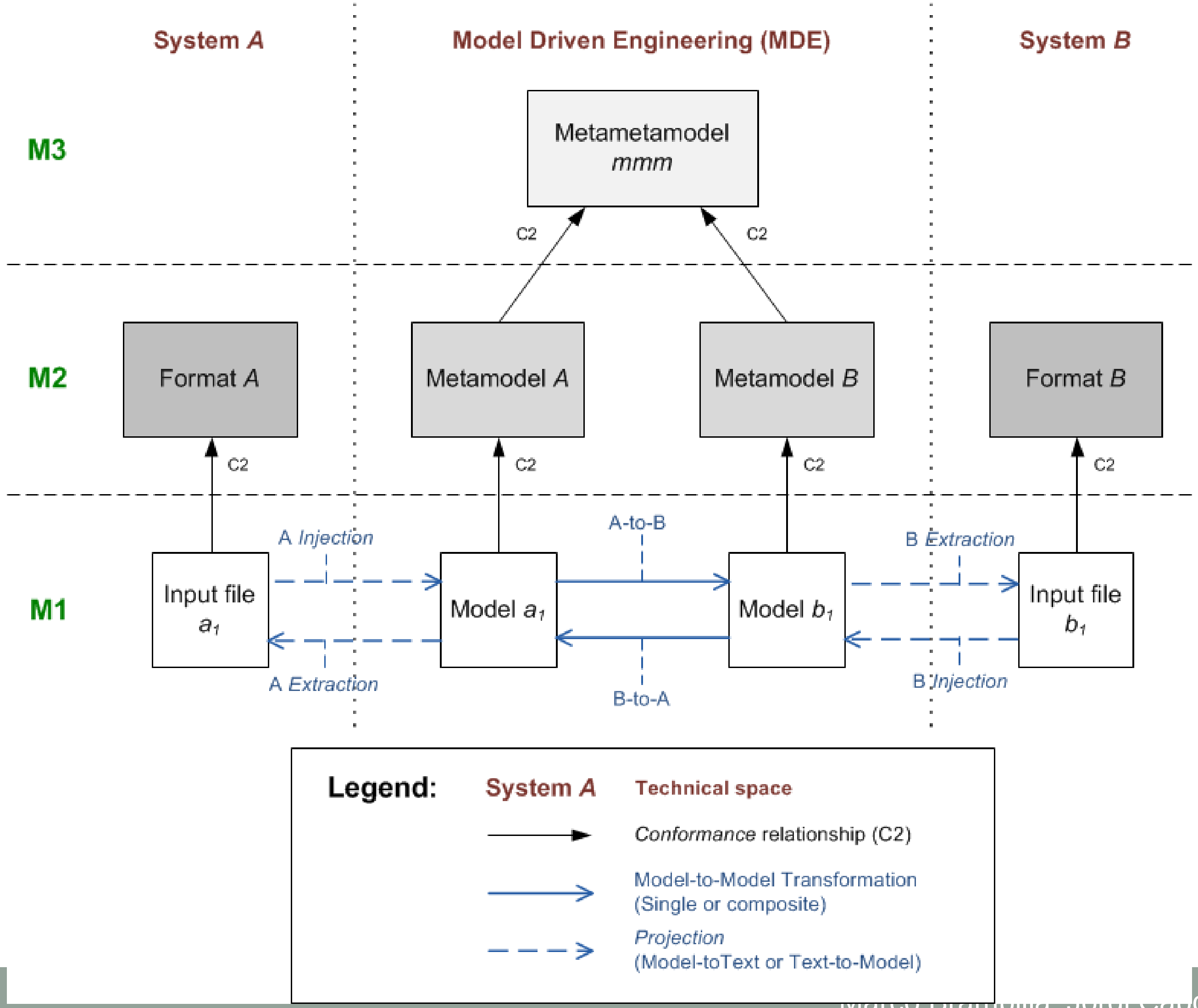
Model-Driven Interoperability

- MDSE techniques to bridge the interoperability gap

- The metamodels (i.e. “schemas”) of the two systems are made explicit and aligned

- Transformations follow the alignment to move information
  - Injectors (text-to-model) represent system A data as a model (syntactic transformation)
  - M2M transformation adapts the data to system B metamodel (semantic transformation)
  - Extractors (model-to-text) generate the final System B output data (syntactic transformation).

MDI: Global schema



USE CASE3 – MODEL DRIVEN REVERSE ENGINEERING

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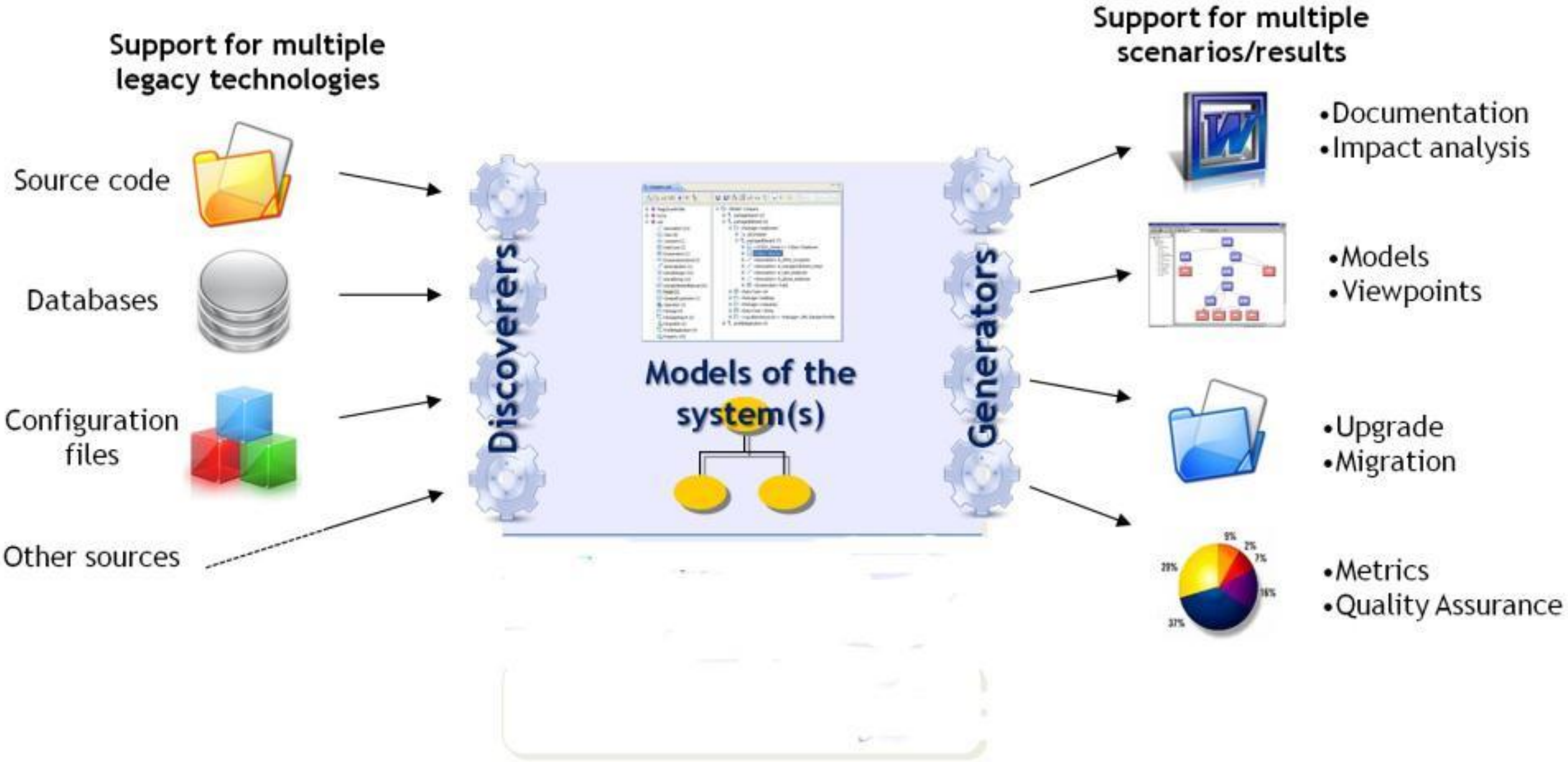
Need for reverse engineering



Support for multiple legacy technologies

Source code

Databases

Configuration files

Other sources

Discoverers

Models of the system(s)

Generators

Support for multiple scenarios/results

- Documentation
- Impact analysis

- Models
- Viewpoints

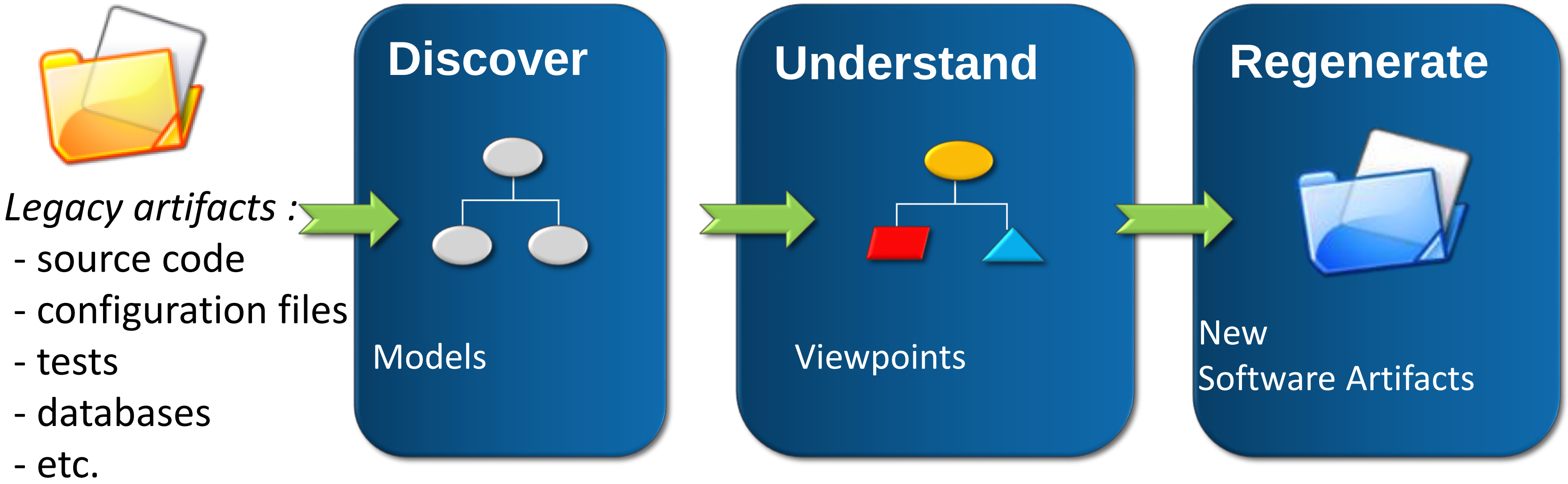
- Upgrade
- Migration

- Metrics
- Quality Assurance

Model-driven reverse engineering

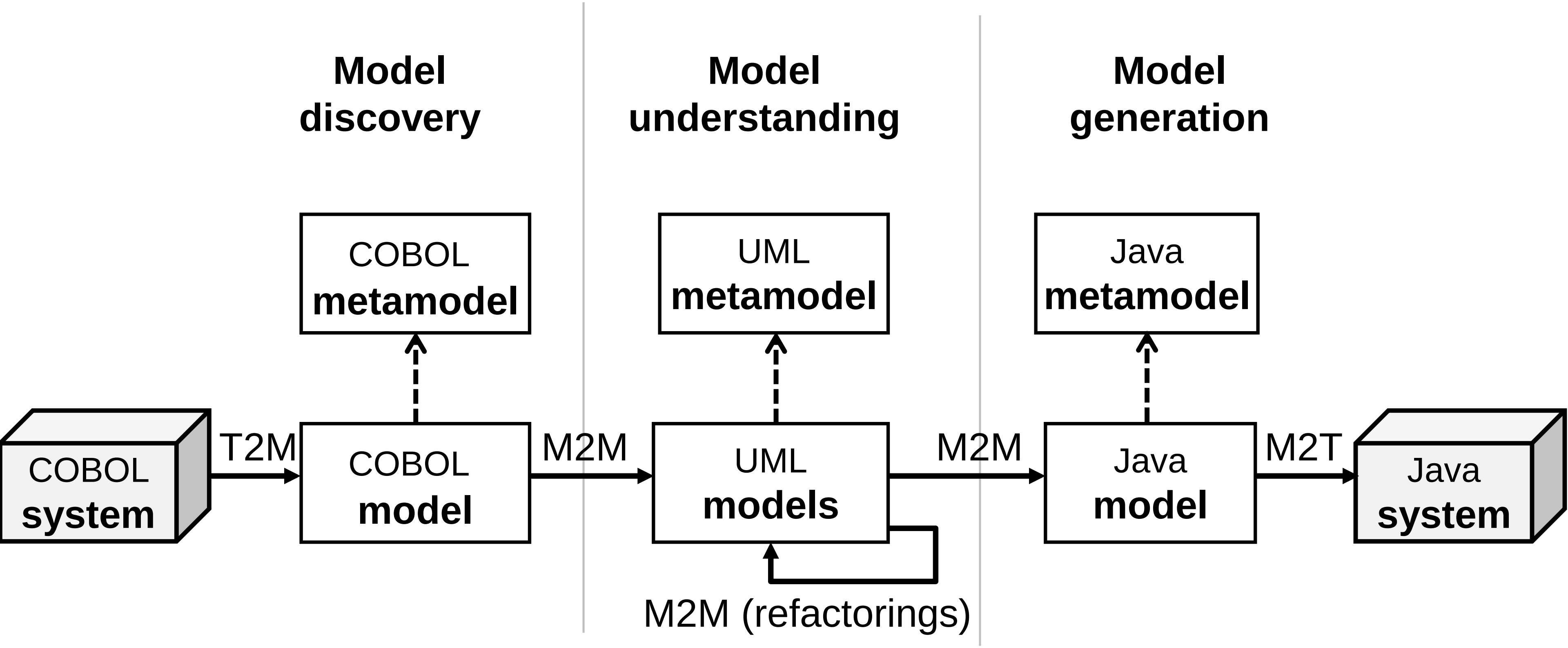
- **Why?** Models provide an homogeneous and interrelated representation of all legacy components.

  No information loss: initial models have a 1:1 correspondance with the code



Legacy artifacts :
- source code
- configuration files
- tests
- databases
- etc.

Model-Driven Interoperability: Example



Model discovery

Model understanding

Model generation

COBOL system

T2M

COBOL metamodel

COBOL model

M2M

UML metamodel

UML models

M2M (refactorings)

M2M

Java metamodel

Java model

M2T

Java system

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MODEL-DRIVEN SOFTWARE ENGINEERING IN PRACTICE

Marco Brambilla,
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Morgan & Claypool, USA, 2012.

www.mdse-book.com
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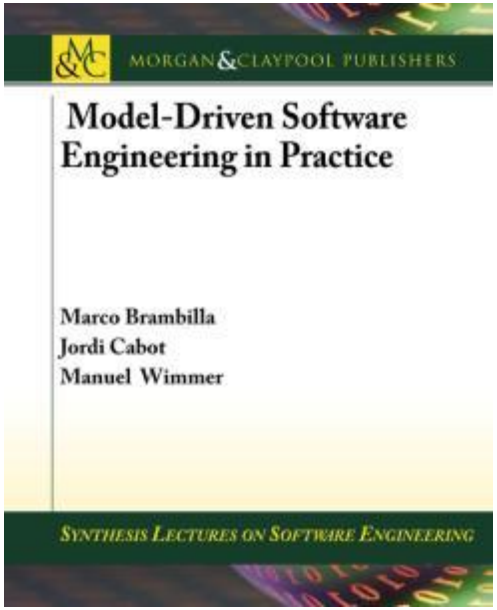
or buy it at: www.amazon.com



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