Automatic Synthesis of Graphical User Interfaces for Health Information Systems

Síntese Automática de Interfaces Gráficas de Usuário para Sistemas de Informação em Saúde

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Introduction

- Model-Driven Development (MDD) for Health Information Systems (HIS) is still a challenge.
  - Transcribing the clinical's knowledge to computer systems is not trivial.
  - One way of mitigating such problem is the use of **clinical data models** (ex.: *open*EHR).
- *open*EHR models help separate the knowledge of the **clinical** domain from the **technological** domain.
  - However, they still demand too much effort to develop HIS implementations.
  - Such models are not sufficient for the construction of HIS (e.g. lack of **architectural information**).

Introduction

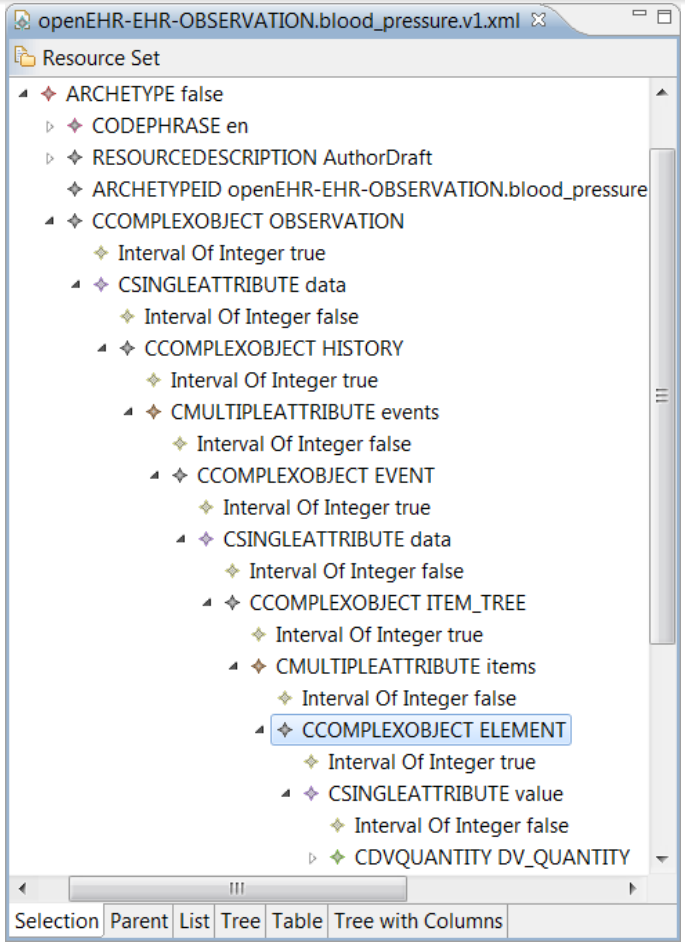
Objective

- Provide an architecture for the automated code generation of GUI for HIS from clinical data models.
  - MDD techniques based on a repository of **reusable rules** for model transformation.
- With this architecture, not only the implementation of HIS but also the specification of transformation rules can be simplified.

Basic principles

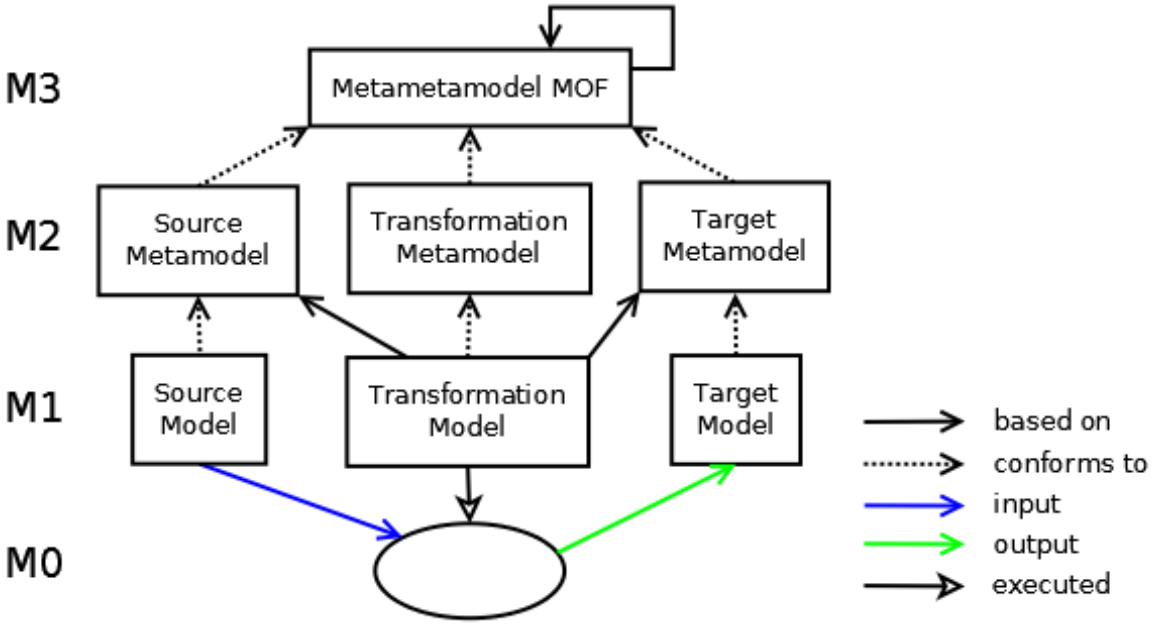
Clinical data models – *open*EHR

- *open*EHR is an open and collaborative specification for interoperable clinical data models.
- Metamodels: overall characteristics of the components of the health record.
- Models (archetypes): formal definitions of prescribed combinations of metamodel elements that describe clinical domain concepts.
  - Reuse of domain concepts in healthcare.
  - Reduced dependence among physicians and technologists in the development process.



Example of an archetype in the Eclipse platform.

Basic principles
Model Transformation



Model Transformation

Related work

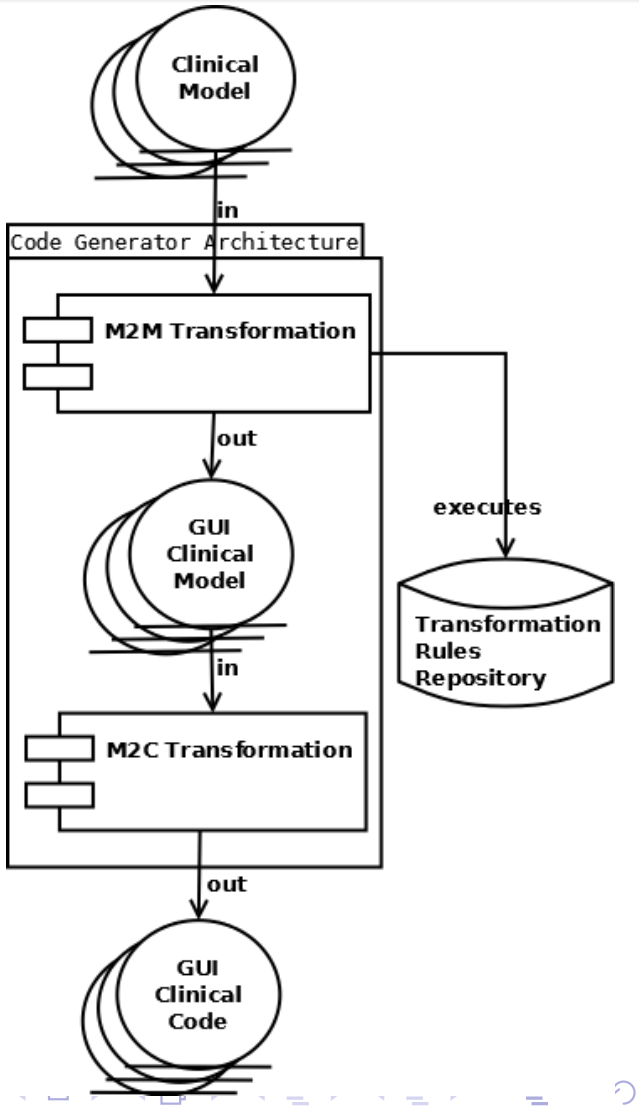
- GUI code generation for HIS from clinical data models [Schuler et al, 2006, Nardon et al, 2007, Van Der Linden, 2009, Atalag e Yang, 2010].
  - Do not employ metamodeling and transformation rules.
  - Compromises design reuse in MDD.
- GUI code generation with metamodeling and model transformations [Costa, 2011].
  - Not restricted to HIS and does not use a common metametamodel.
  - Compromises the reuse of clinical concepts and, therefore, the HIS interoperability.
- The work [Menárguez-Tortosa et al, 2011] explores the aforementioned concepts, however, does not consider architectural information.

Proposed approach

- Until the submission of this article, two different strategies for defining model transformation rules that combine clinical data models and architectural information were evaluated:
  1. Transformation without explicit architectural information.
  2. Transformation based on architectural annotation models.
- A third strategy is being investigated right now:
  3. Transformation based on Acme models.

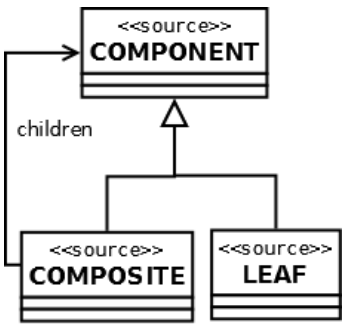
Architecture for code generation of GUI for HIS

- First step
  - M2M transformation (clinical data models to GUI models)
  - This process is executed through a repository of reusable rules.
- Second step
  - M2C transformation (GUI models to GUI code).
  - This process is executed through tools (RichUbi [Cirilo et al, 2010]) that generate code from models.



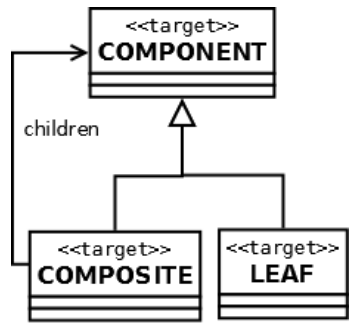
Rules repository

- Rules are structured according to the *open*EHR metadata hierarchy to generate different GUI elements.
  - Allows to capture the structure from archetypes information.
  - Also allows to apply **design patterns** on the transformations rules.



SOURCE

```
1  create target: TARGET from  source : SOURCE;
2
3  rule Component2Component{
4      from source: SOURCE!Component
5      to target: TARGET!Component
6  }
7
8  rule Composite2Composite extends Component2Component{
9      from source: SOURCE!Composite
10     to target: TARGET!Composite(
11         children <- source.children
12     )
13 }
14
15 rule Leaf2Leaf extends Component2Component{
16     from source: SOURCE!Leaf
17     to target: TARGET!Leaf
18 }
```



TARGET

First strategy

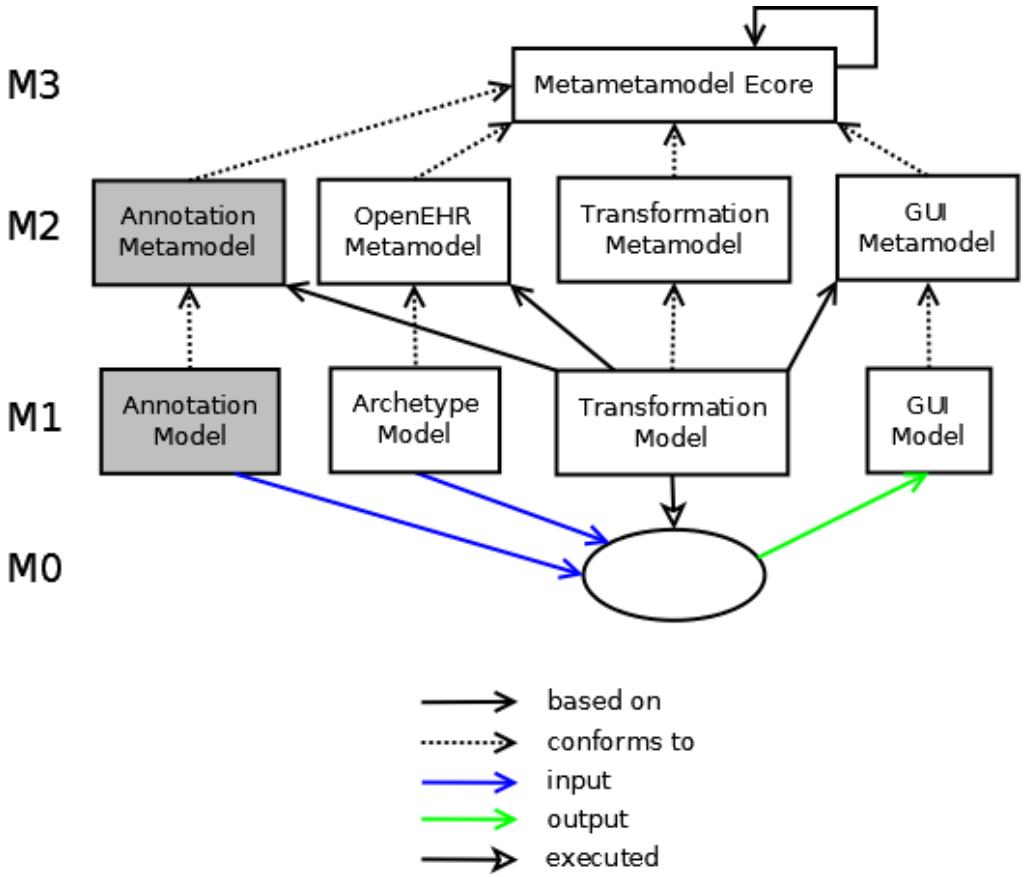
Transformation without explicit architectural information.

- Our hypothesis for this strategy is that it leads to a combinatorial explosion of rules (different rules for different combinations among different *families* of HIS).
- Without further architectural information, the developer will have a cognitive overload in defining applicable rules for different families of HIS.

Second strategy

Transformation based on architectural annotation models

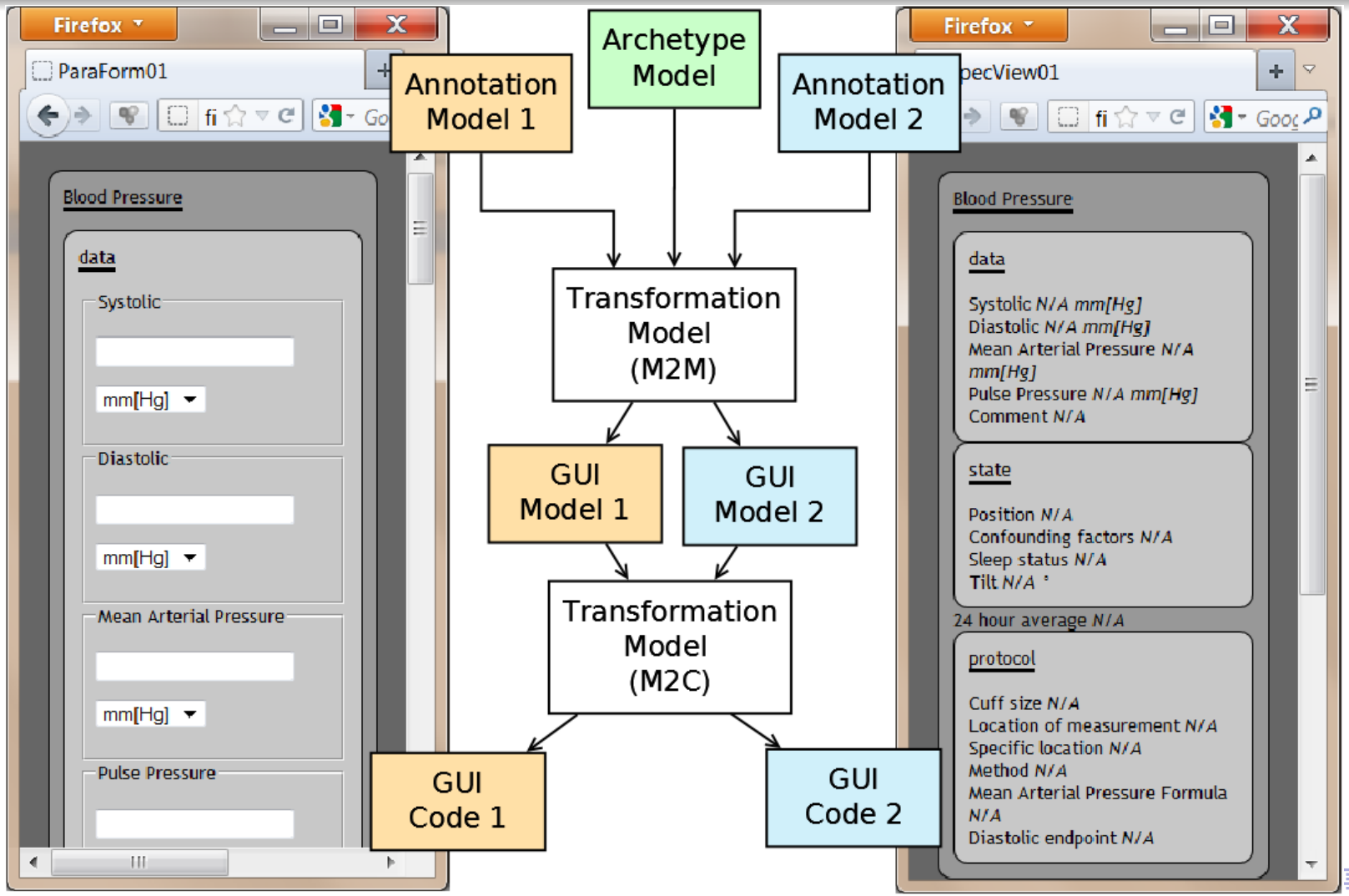
- Inclusion of models for architectural annotations.
- Metamodels for annotations allows to create models using *property-value* pairs.



Relationship between annotation models and the model transformation proposed.

Second strategy

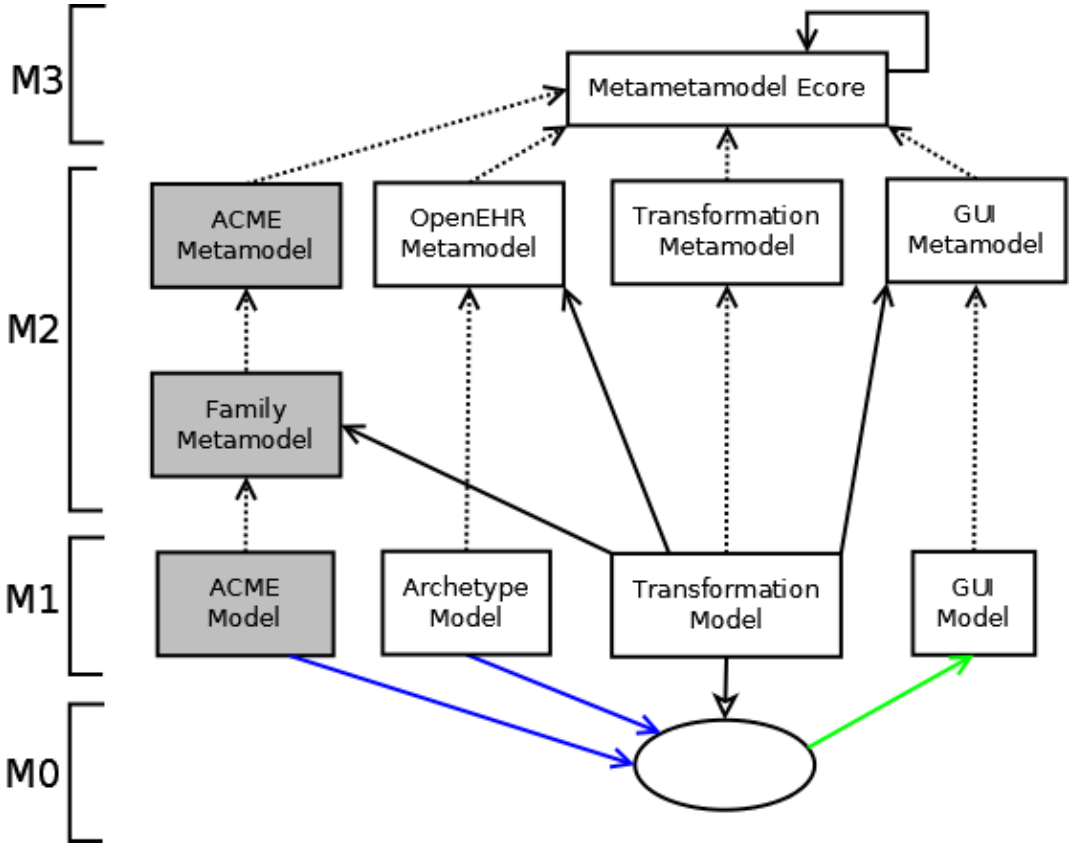
Transformation based on architectural annotation models



Current state of work – Third strategy

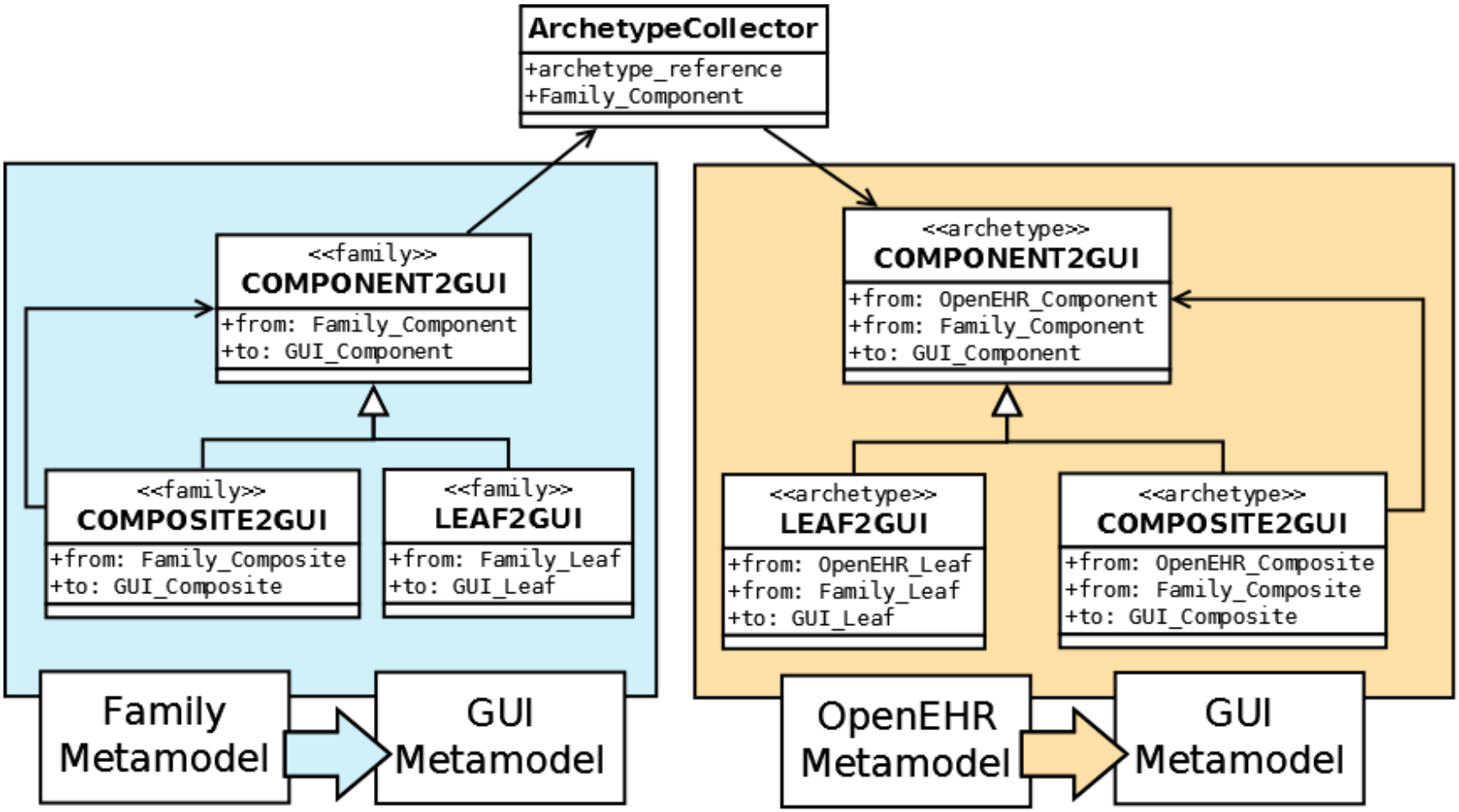
Transformation based on Acme models

- Acme is an Architecture Description Language (ADL)
- Acme has its metamodel specifications mapped onto the Ecore metametamodel.
- The current state of the work consists in exploring families of HIS described using Acme's Ecore metamodel.



Current state of work – Third strategy

Transformation based on Acme models



Conclusions

- Transformation rules are formally specified from the clinical data models.
  - Code generation of GUI for HIS with reuse of domain concepts.
- Employment of Ecore metametamodel allows greater interoperability of software.
- First experiments:
  - Exploration of two families: epidemiological surveillance and prehospital emergency healthcare
    - Conducted under the SPLiCE project (Software-Product Lines in HealthCarE), a software product line for HIS being developed on the National Institute of Science and Technology on Medicine Assisted by Scientific Computing (INCT-MACC).

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