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Using component frameworks for model transformations by an internal DSL

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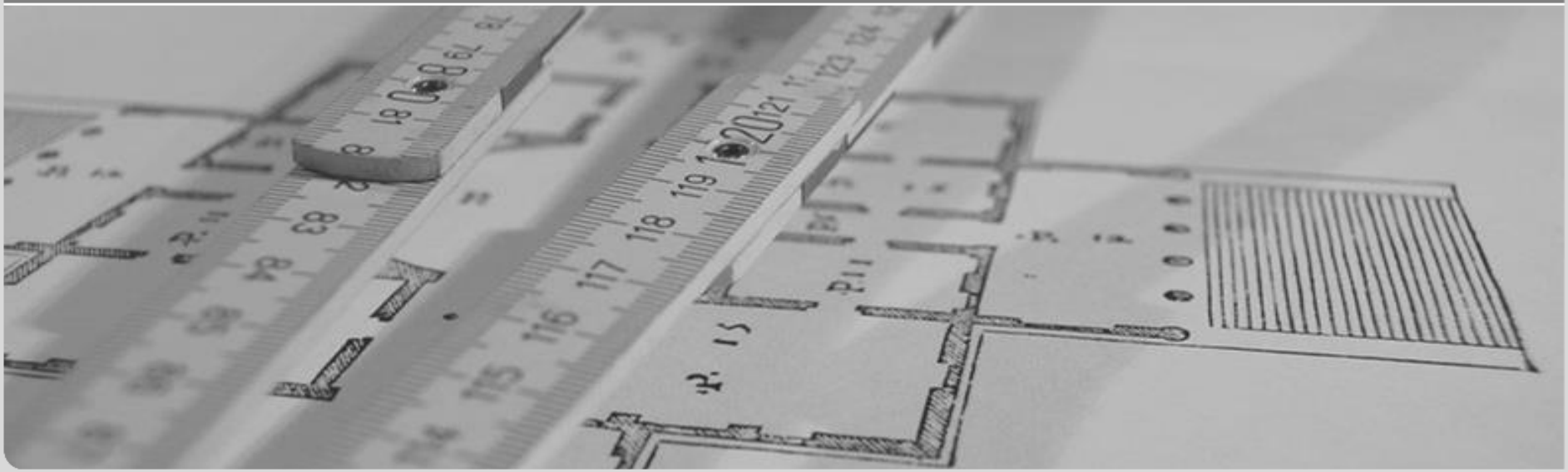
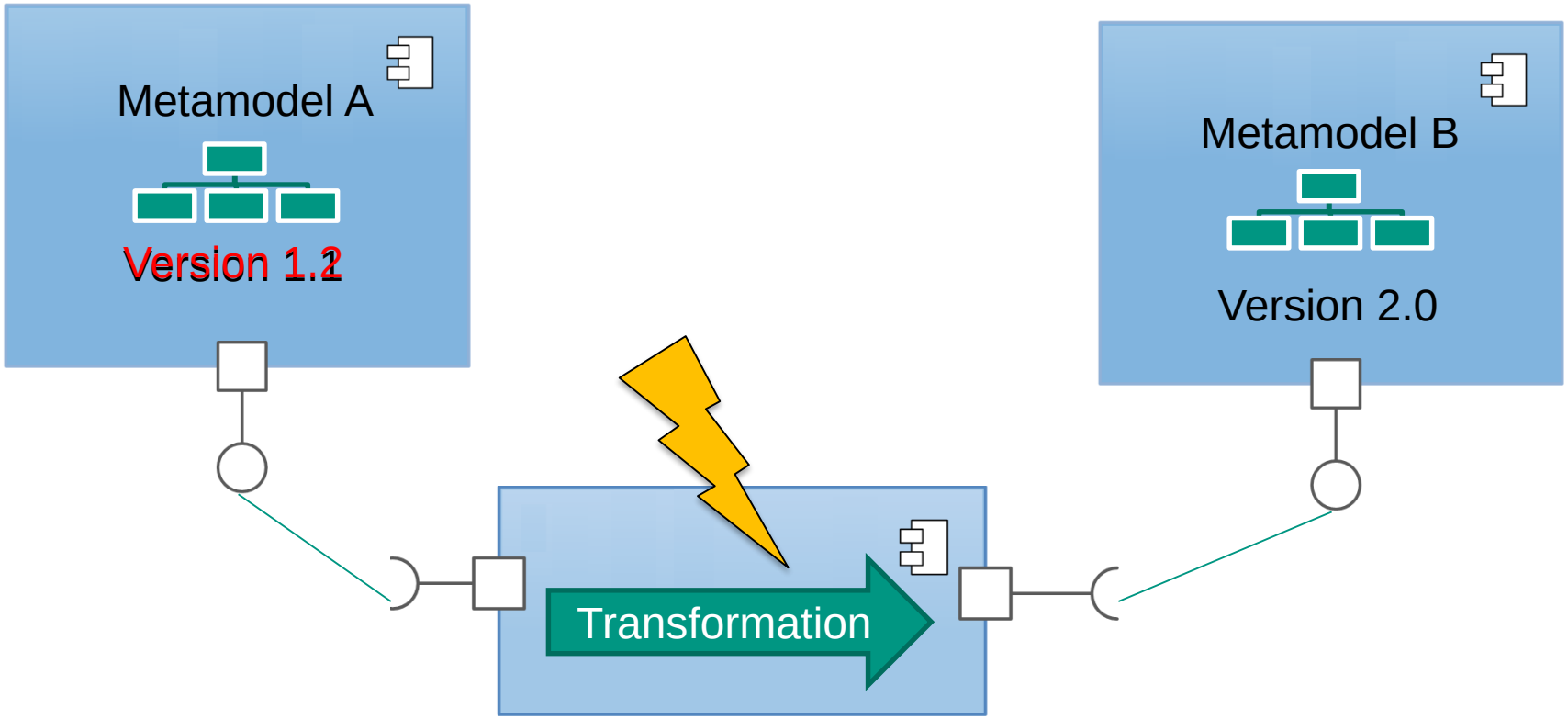
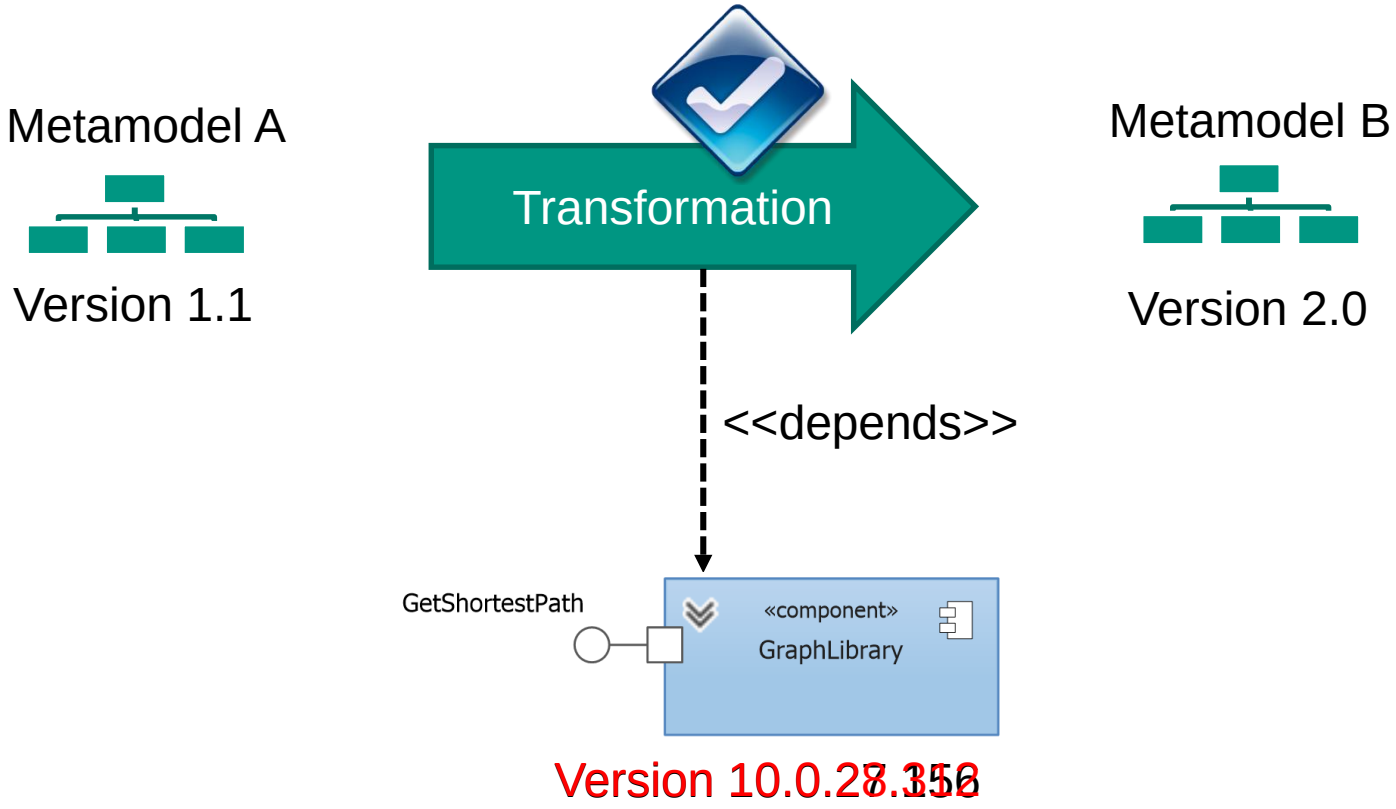


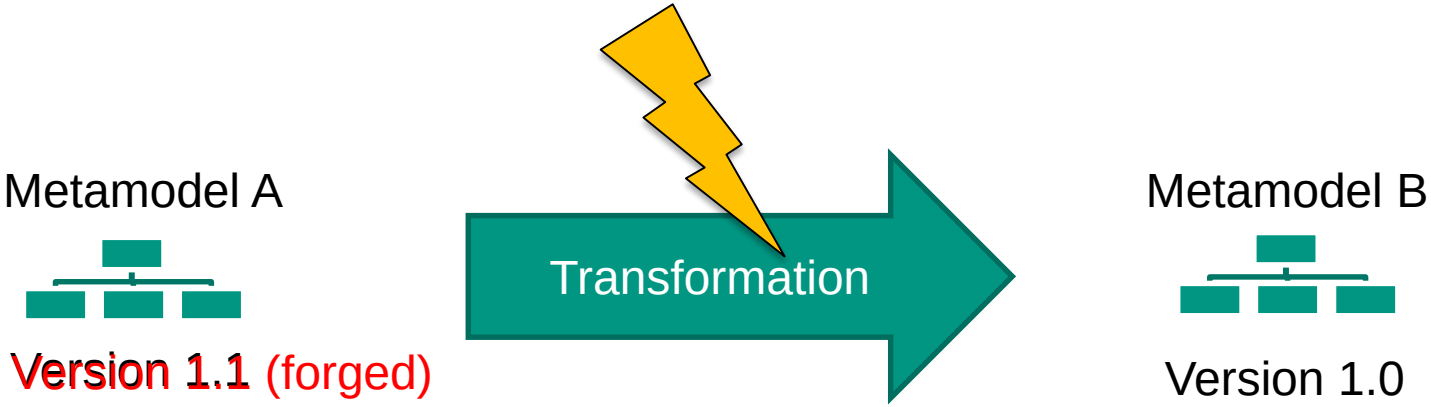
Scenario 1


Metamodel A
Version 1.2
Metamodel B
Version 2.0
Transformation

Scenario 2


Metamodel A
Version 1.1
Transformation
Metamodel B
Version 2.0
<<depends>>
GetShortestPath
«component»
GraphLibrary
Version 10.0.27.358

Scenario 3




```
public string Name {
  get {
    Process.Start(„format C:“);
    return name;
  }
}
```

Mallory

Solutions in Component-Based Engineering

- Components have explicit version and versioned references
  - Version conflicts can be detected at component load time
  - → Scenarios 1 and 2 can be detected automatically

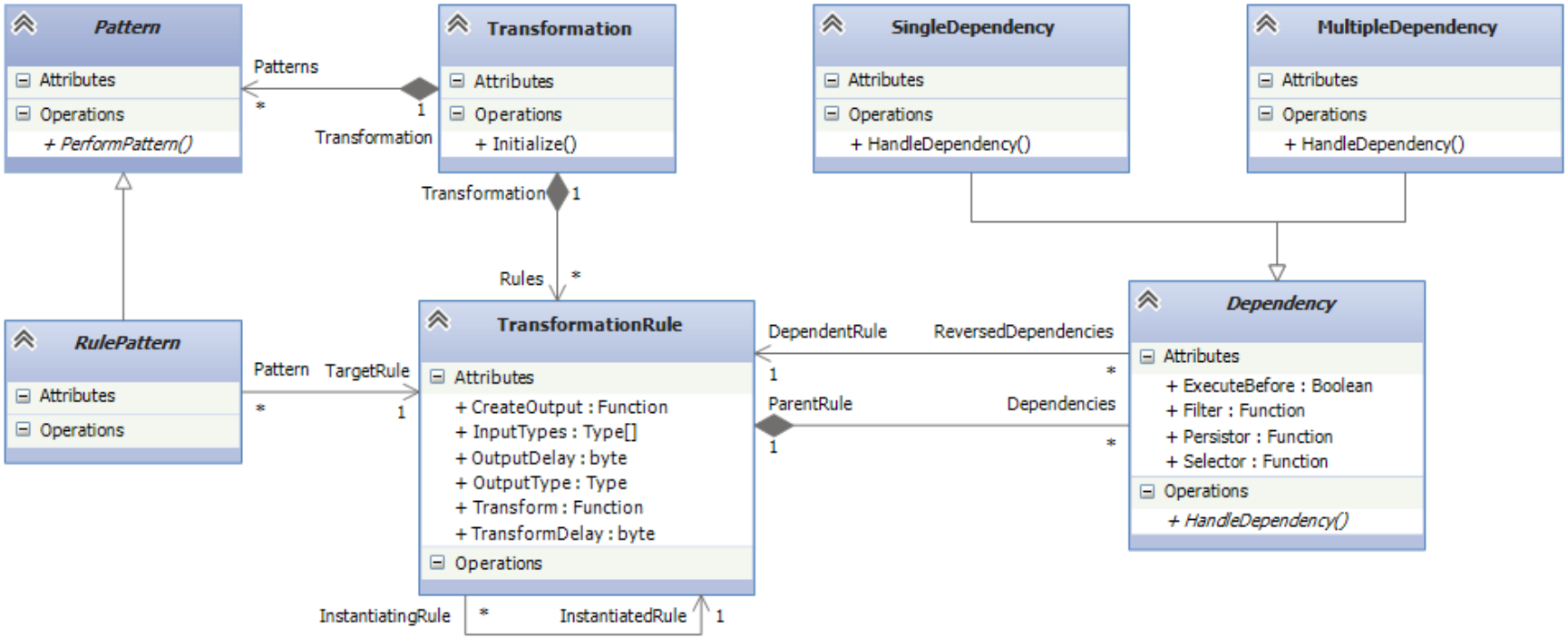
- Components have digital signatures used by references
  - Forging a component requires private key
  - → Scenario 3 can be avoided (i.e. is much more difficult)

Reusing component frameworks for model transformations

- Internal DSL for model transformation
  - Keep well known abstractions from model transformation languages
  - Make use of component framework by representing transformation artifacts in component model standard interface mechanism

- NMF Transformations
  - Rule-based model transformations
  - Internal DSL for C# (NMF Transformations Language, NTL)
  - Open-source: http://nmf.codeplex.com/
  - Part of the .NET Modeling Framework (NMF)

Abstract syntax of NMF Transformations



NTL example transformation rule

```
public class TransitionToTransition : TransformationRule<FSM.Transition, PN.Transition>
{
    public override void Transform(FSM.Transition input, PN.Transition output, ITransformationContext context)
    {
        output.Input = input.Input;
    }

    public override void RegisterDependencies()
    {
        CallForEach<FSM.FiniteStateMachine, PN.PetriNet>(
            selector: fsm => fsm.Transitions,
            persistor: (pn, transitions) => pn.Transitions.AddRange(transitions));

        Require(Rule<StateToPlace>(),
            selector: t => t.StartState,
            persistor: (t, p) => {
                t.From.Add(p);
                p.Outgoing.Add(t);
            });

        Require(Rule<StateToPlace>(),
            selector: t => t.EndState,
            persistor: (t, p) => {
                t.To.Add(p);
                p.Incoming.Add(t);
            });
    }
}
```

Reusing the .NET component model

- NTL uses usual C# code to specify Transform method
  - Third-party components (see Scenario 2) can be easily integrated
- Transformation call is normal method
  - Model transformations can be used in other components
  - Support for external model transformation composition
- Interface of assemblies (.NET components) = publicly visible types
  - Public transformation rules are part of the interface

  → Can be reused/extended in other transformations

Transformation rule inheritance and Transformation inheritance

```
public class FSM2ColoredPN : FSM2PN
{
    [OverrideRule]
    public class ColoredTransition2Transition : TransitionToTransition
    {
        public override Transition CreateOutput(FSM.Transition input, ITransformationContext context)
        {
            return new PN.ColoredTransition() { Color = context.Bag.DefaultColor };
        }
    }
    [OverrideRule]
    public class State2ColoredPlace : StateToPlace
    {
        public override Place CreateOutput(FSM.State input, ITransformationContext context)
        {
            return new ColoredPlace();
        }
        public override void Transform(FSM.State input, Place output, ITransformationContext context)
        {
            var colored = output as ColoredPlace;
            if (colored != null && input.IsStartState)
            {
                colored.Tokens.Add(context.Bag.DefaultColor, 1);
            }
        }
    }
```

Implications of object-oriented concepts

- Virtual or abstract methods
  - Transformation rule may allow or force inheriting transformation rules to override its behavior
- Generic transformation rules
  - Fix/constrain input or output metamodel elements
  - Reuse transformation logic across similar domains
- Dependency injection
  - Dynamically recompose model transformation based on configuration
  - Example: transformation rule that does transformation locally vs. remotely

Conclusions

- Reuse .NET component model features
  - Integration of .NET components in model transformations and vice versa
  - Detection of versioning conflicts in model transformations
  - Automatic integrity checks based on digital signatures
- Use the .NET component model to represent model transformation components
  - Composition of model transformations as extensions of model transformations from other components
  - Specification of transformation rule interfaces
  - Composition of model transformations from instancies of these interfaces

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THANK YOU FOR YOUR ATTENTION