

# Revisiting Model-driven Engineering for Run-time Verification of Business Processes

**Wei Dou**, Domenico Bianculli, and Lionel Briand  
SnT Centre — University of Luxembourg



**CONTEXT**

# CTIE



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Centre des Technologies de l'Information de l'Etat

Centre des Technologies de l'Information de l'Etat

# Service Compositions for Business Processes

# Run-time Verification of Business processes

Model-driven Engineering

Adopted in Practice

# Model-driven Engineering for Run-time Verification

# OUR VISION



**Design-time**

**Meta**

**Run-time**

**Design-time**

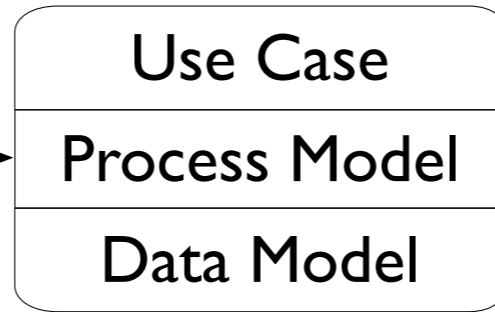
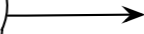
# Design-time

Requirement  
Specifications



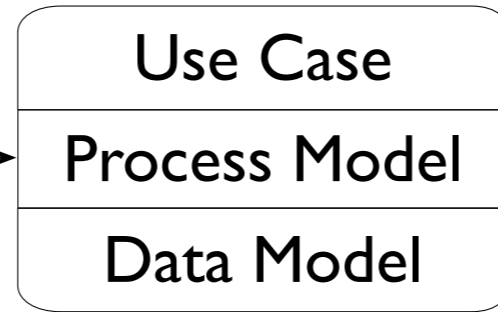
# Design-time

Requirement Specifications

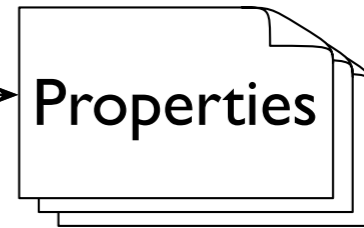


# Design-time

Requirement Specifications

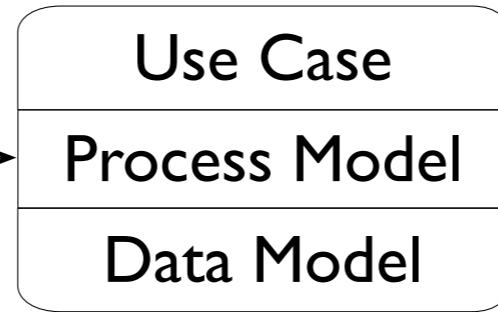
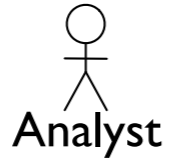


Annotated-with

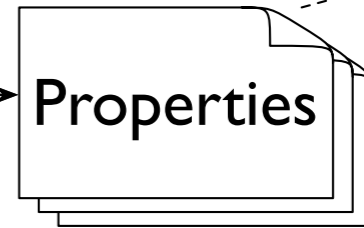


# Design-time

Requirement Specifications

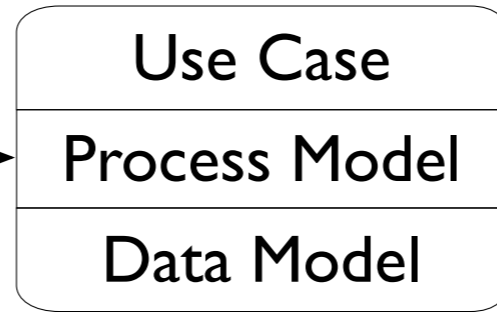
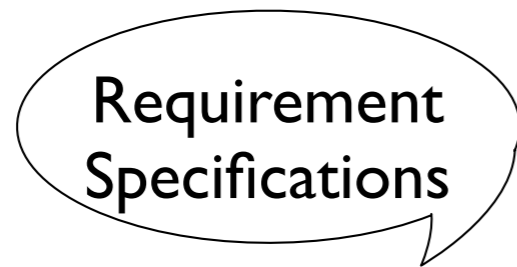


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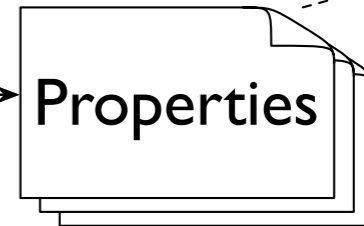


RNL

# Design-time



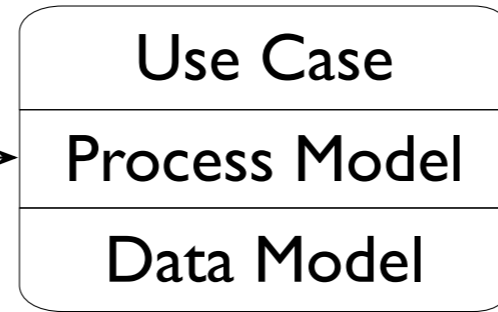
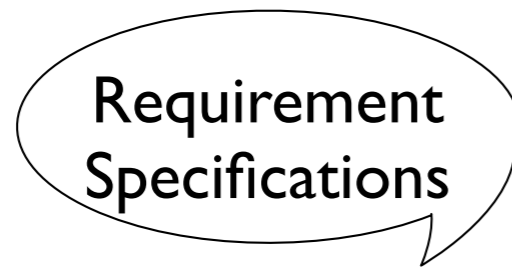
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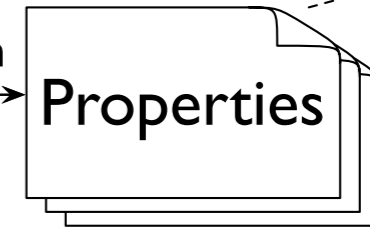
RNL

# Run-time

# Design-time



Annotated-with



RNL

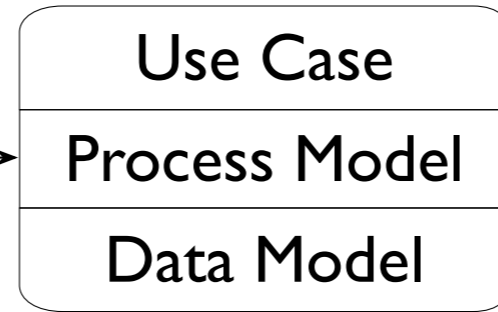
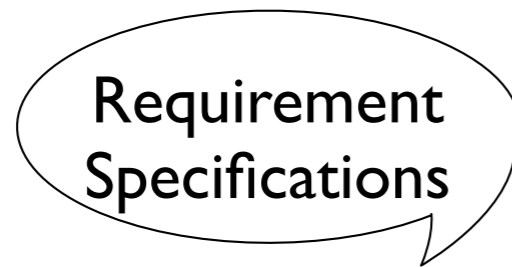
# Run-time

:Process model

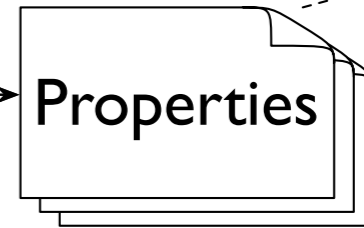




## Design-time



Annotated-with



RNL

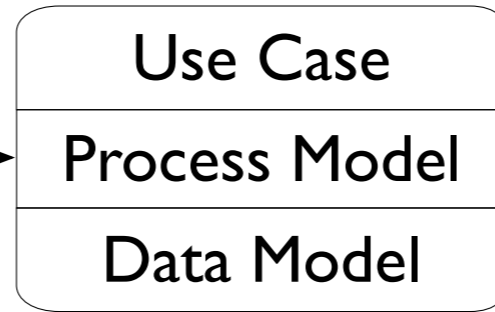
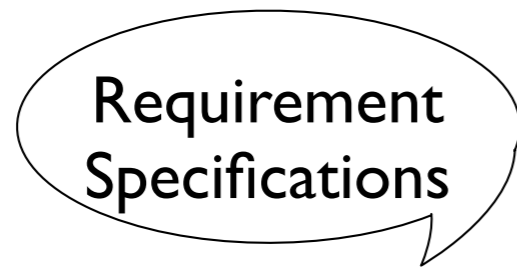
## Run-time

:Process model

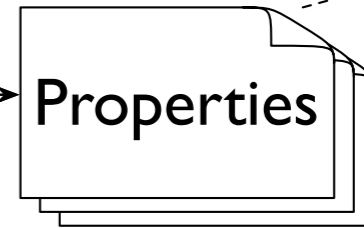


Data Collector

## Design-time



Annotated-with



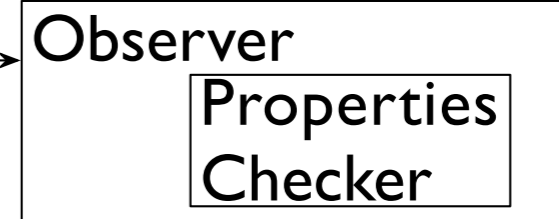
RNL

## Run-time

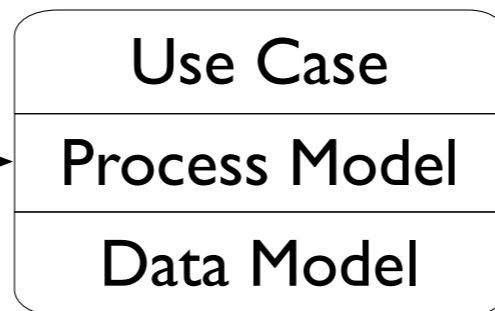


:Process model

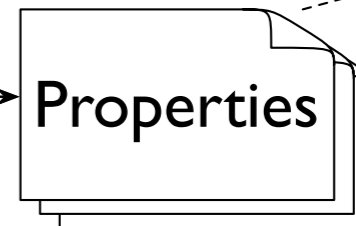
Data Collector



# Design-time



Annotated-with



RNL

# Meta

Translate-into

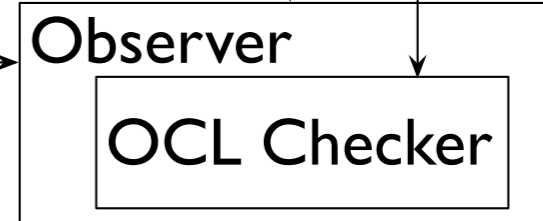
:OCL constraints

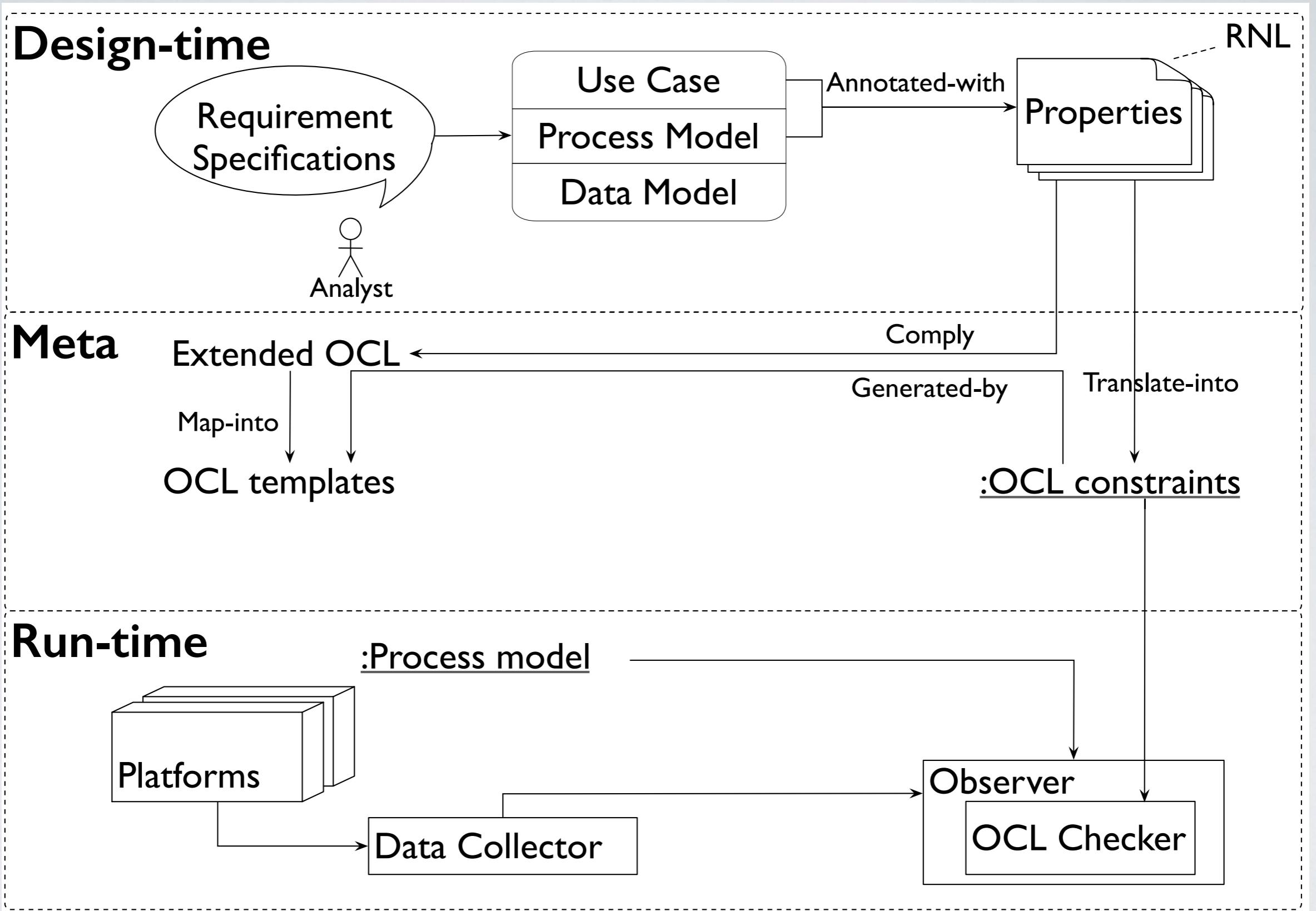
# Run-time

:Process model

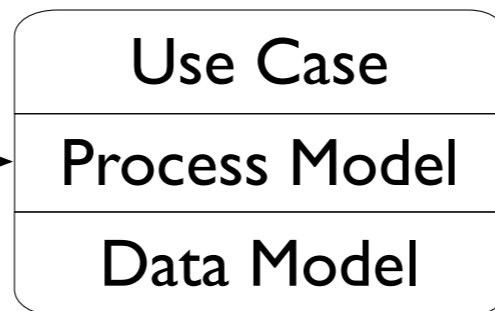


Data Collector

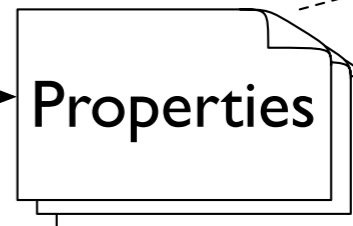




# Design-time



Annotated-with



RNL

# Meta

Extended OCL

Comply

Map-into

OCL templates

+

Conceptual model

-----  
Process Model

Data Model

Type of properties

Generated-by

Translate-into

:OCL constraints

# Run-time

:Process model

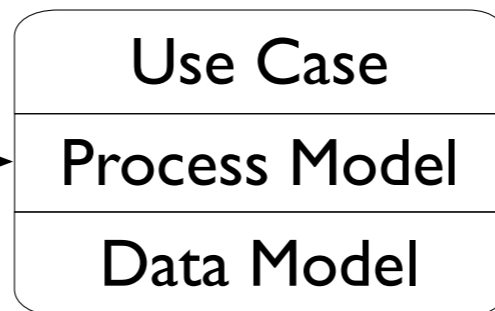
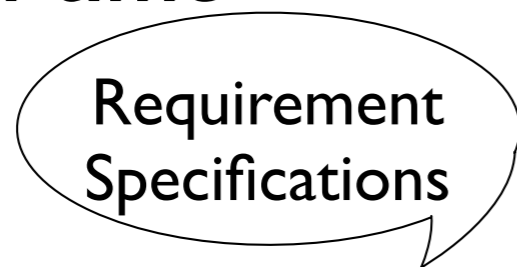


Data Collector

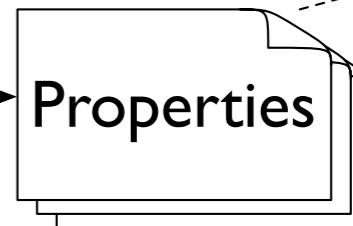
Observer

OCL Checker

# Design-time



Annotated-with



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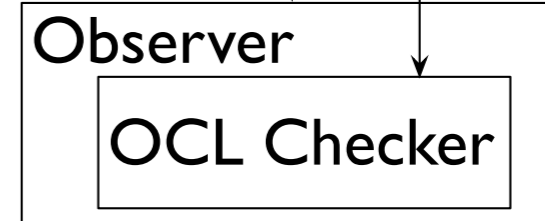
# Run-time

:Process model

:Conceptual model



Data Collector

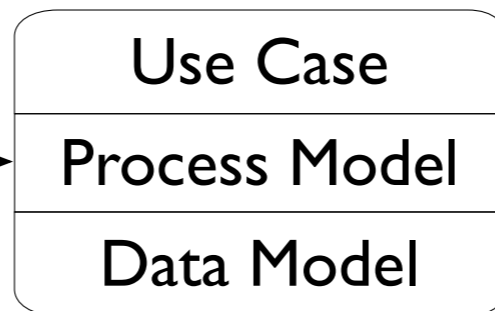


# ROAD MAP

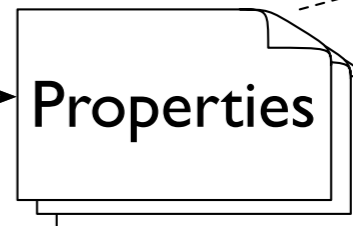
# **REQUIREMENTS SPECIFICATION LANGUAGE**



# Design-time

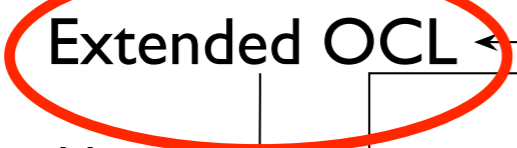


Annotated-with



RNL

# Meta



Map-into

OCL templates

+

Conceptual model

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Process Model  
Data Model  
Type of properties

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:OCL constraints

Comply

# Run-time

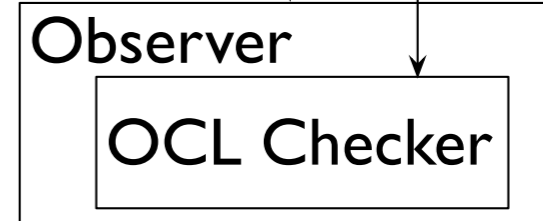


:Process model

Data Collector



:Conceptual model



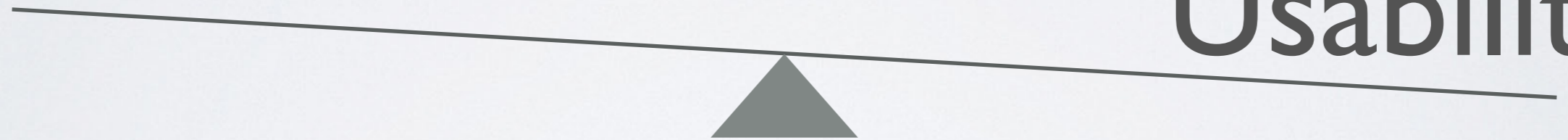
# Requirements Specification Language

## Temporal Properties

# Requirements Specification Language

Expressiveness

Usability



# OCLR

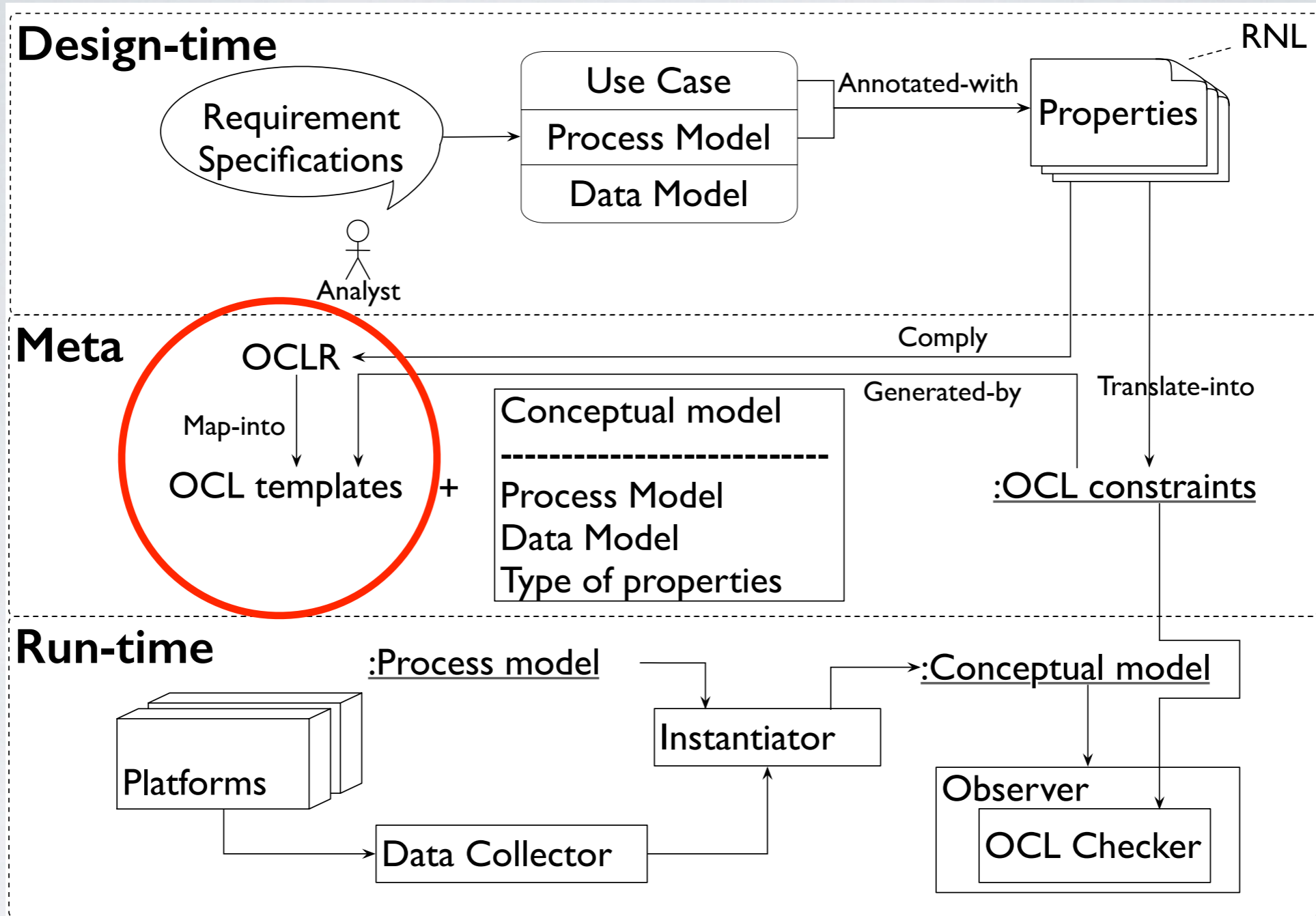
(OCL for Runtime verification)

Dou, W., Bianculli, D., Briand, L.: OCLR: a more expressive, pattern-based temporal extension of OCL. In Proc. of ECMFA 2014. LNCS, vol. 8569. Springer Heidelberg (July 2014)

# OCLR Syntax Excerpt

$\langle \textit{TemporalExp} \rangle$	::= $\langle \textit{Scope} \rangle \langle \textit{Pattern} \rangle$
$\langle \textit{Scope} \rangle$	::= 'globally'   'before' $\langle \textit{Boundary1} \rangle$   'after' $\langle \textit{Boundary1} \rangle$   'between' $\langle \textit{Boundary2} \rangle$ 'and' $\langle \textit{Boundary2} \rangle$   'after' $\langle \textit{Boundary2} \rangle$ 'until' $\langle \textit{Boundary2} \rangle$
$\langle \textit{Pattern} \rangle$	::= 'always' <u><math>\textit{OclExpressionCS}</math></u>   'eventually' $\langle \textit{RepeatableEventExp} \rangle$   'never' $\langle \textit{RepeatableEventExp} \rangle$   $\langle \textit{EventChainExp} \rangle$ 'preceding' [ $\langle \textit{TimeDistanceExp} \rangle$ ]   $\langle \textit{EventChainExp} \rangle$   $\langle \textit{EventChainExp} \rangle$ 'responding' [ $\langle \textit{TimeDistanceExp} \rangle$ ]   $\langle \textit{EventChainExp} \rangle$
$\langle \textit{Boundary1} \rangle$	::= [ $\langle \textit{IntegerLiteratureExpCS} \rangle$ ] $\langle \textit{SimpleEvent} \rangle$ [ $\langle \textit{TimeDistanceExp} \rangle$ ]
$\langle \textit{Boundary2} \rangle$	::= [ $\langle \textit{IntegerLiteratureExpCS} \rangle$ ] $\langle \textit{SimpleEvent} \rangle$ ['at least' <u><math>\textit{IntegerLiteratureExpCS}</math></u> 'tu']
$\langle \textit{EventChainExp} \rangle$	::= $\langle \textit{Event} \rangle$ (',' [ $\textit{\#}$ $\langle \textit{TimeDistanceExp} \rangle$ ] $\langle \textit{Event} \rangle$ )*
$\langle \textit{TimeDistanceExp} \rangle$	::= $\langle \textit{ComparingOp} \rangle$ <u><math>\textit{IntegerLiteratureExpCS}</math></u> 'tu'
$\langle \textit{RepeatableEventExp} \rangle$	::= [ $\langle \textit{ComparingOp} \rangle$ <u><math>\textit{IntegerLiteratureExpCS}</math></u> ] $\langle \textit{Event} \rangle$
$\langle \textit{ComparingOp} \rangle$	::= 'at least'   'at most'   'exactly'

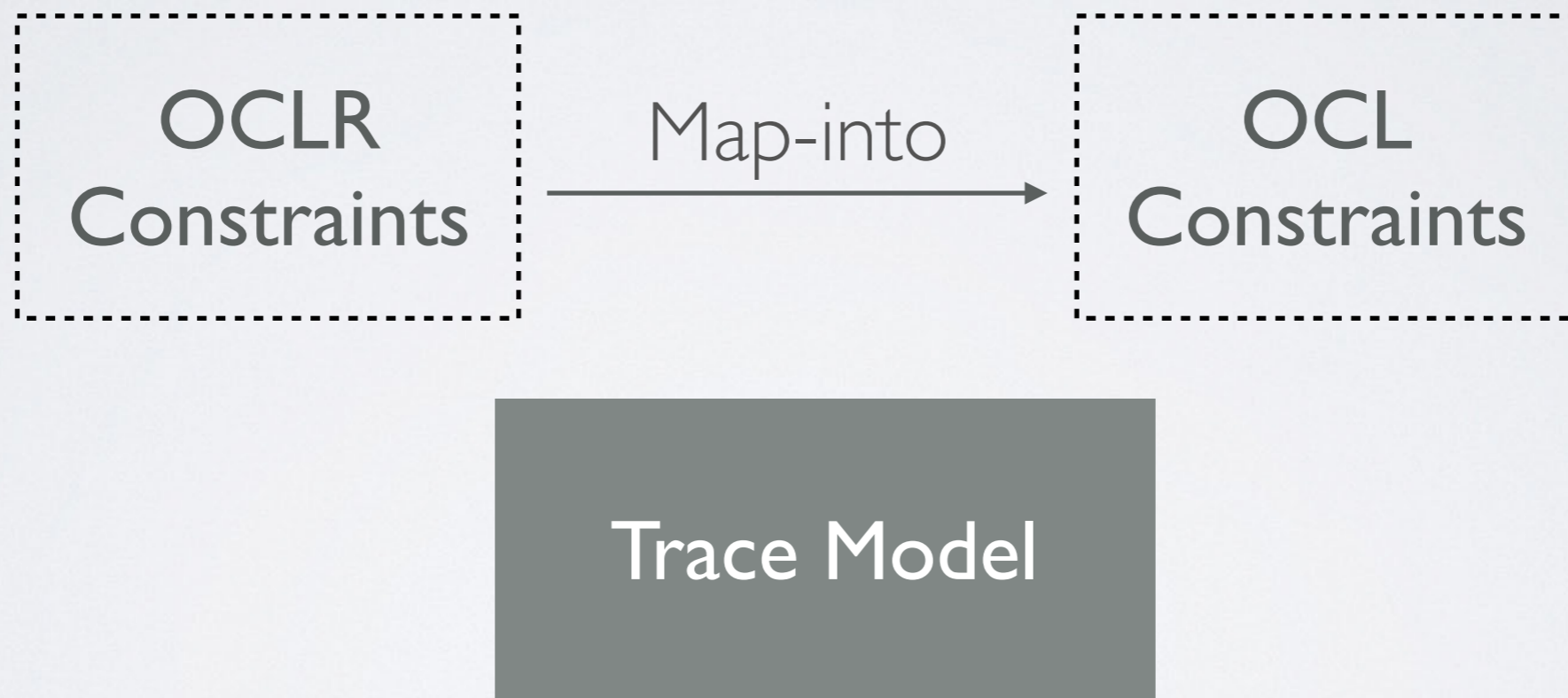
# PROPERTY CHECKING



# Off-line Trace Checking



# Off-line Trace Checking



# Off-line Trace Checking

## OCLR-Check

<http://weidou.github.io/OCLR-Check/>

Dou, W., Bianculli, D., Briand, L.: A model-based approach to trace checking of temporal properties with OCL. Tech. Rep. TR-SnT-2014-5, SnT Centre - University of Luxembourg (September 2014)

# OCLR-Check

# Scalability Evaluation

**NEXT STEPS**

# Run-time trace Checking

# **INTEGRATION WITH RUN-TIME PLATFORMS**

# Integration with Run-time Platforms

JavaEE

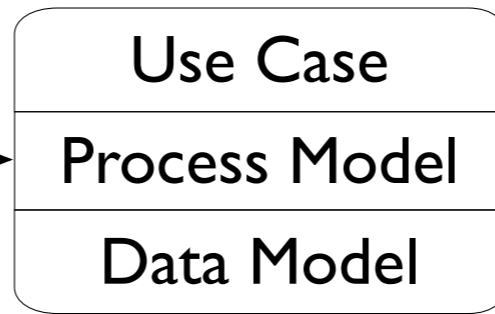
BPMN 2.0 Engine

# Integration with Run-time Platforms

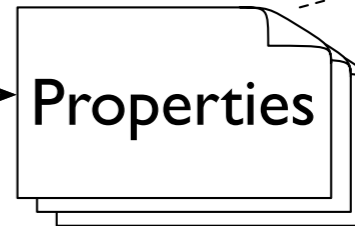
## Platform-specific Data Collector



# Design-time



Annotated-with



RNL

# Meta

Extended OCL

Comply

Map-into

OCL templates

+

Conceptual model

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Process Model  
Data Model  
Type of properties

Generated-by

Translate-into

:OCL constraints

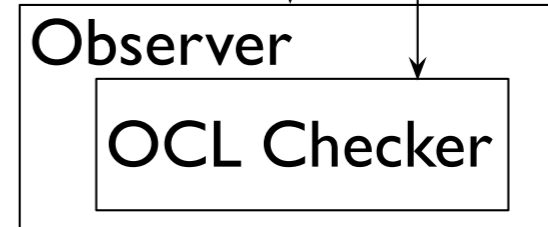
# Run-time

:Process model

:Conceptual model



Data Collector



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