INTEGRATING UNCERTAINTY MODELLING WITH USE CASE MODELLING TO DISCOVER UNKNOWNS
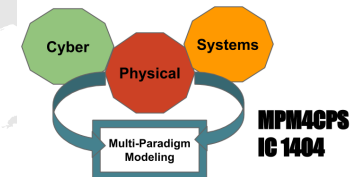
Tao Yue, Shaukat Ali and Man Zhang
(tao, shaukat, manzhang}@simula.no
http://www.zen-tools.com
http://www.u-test.eu/
Chief Research Scientist, **Simula Research Laboratory**, Oslo, Norway

COST
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

HORIZON 2020

Cyber
Physical
Systems
Multi-Paradigm Modeling

MPM4CPS
IC 1404

Workshop of ICT COST Action1404, Malaga, 2016

U-Test is a EU-funded H2020 project (2015 Jan. – 2017 Dec.)

TESTING CYBER-PHYSICAL SYSTEMS UNDER UNCERTAINTY
Website: http://www.u-test.eu
Overall Funding: 3.71 Million Euros
Duration: 2015 to 2018
Partners: 9

We are going beyond the scope of this project and establishing a long-term, industry-oriented research foundation towards this direction.

Two industrial CPS

Automated Warehouse (AW)
ULMA Handling Systems, Spain

Geo Sports (GS)
Future Position X (FPX), Sweden

http://www.u-test.eu/use-cases/

U-RUCM is an extension to RUCM for **specifying uncertainties** as part of system requirements.

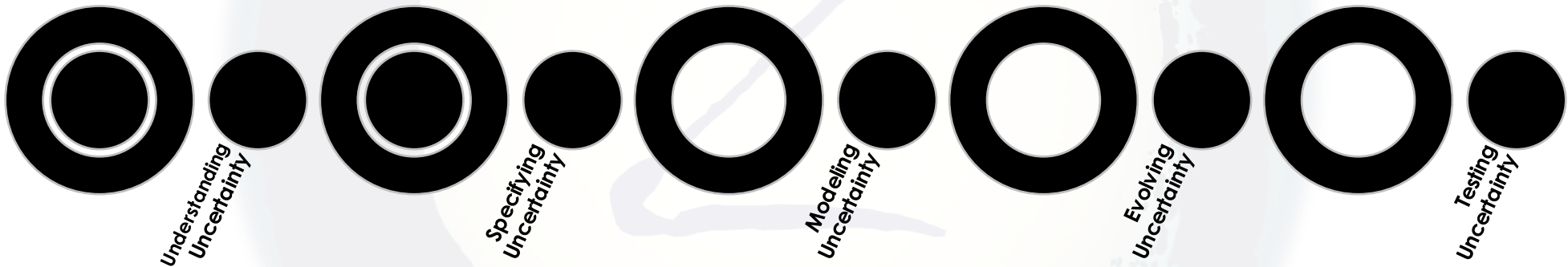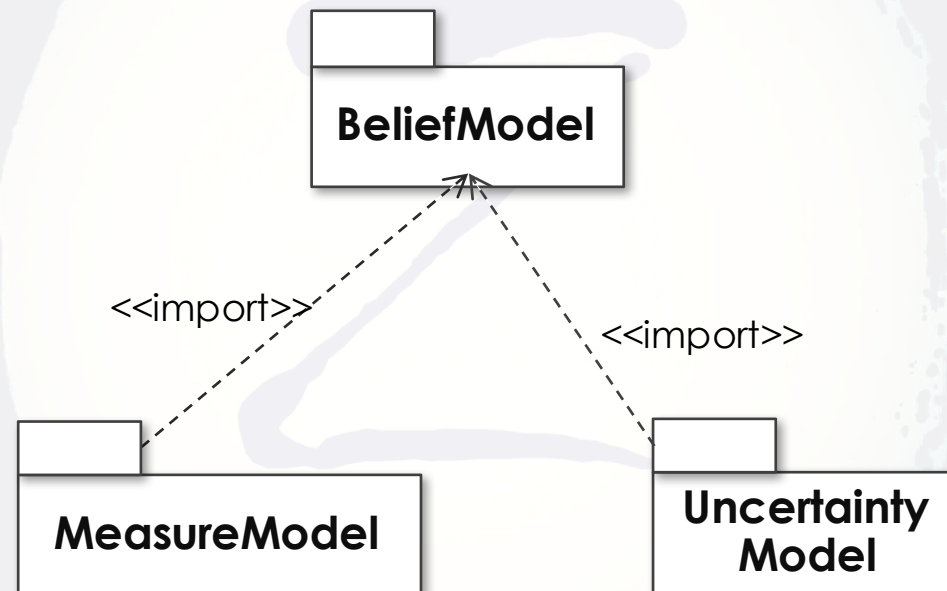| Conceptual model	RUCM (Req. Spe.)	Test Ready Models in UML Class Diagrams and State Machines

U-Model

U-RUCM

Uncertainty Modeling Framework

U-Evolve

U-Testing

Understanding Uncertainty

Specifying Uncertainty

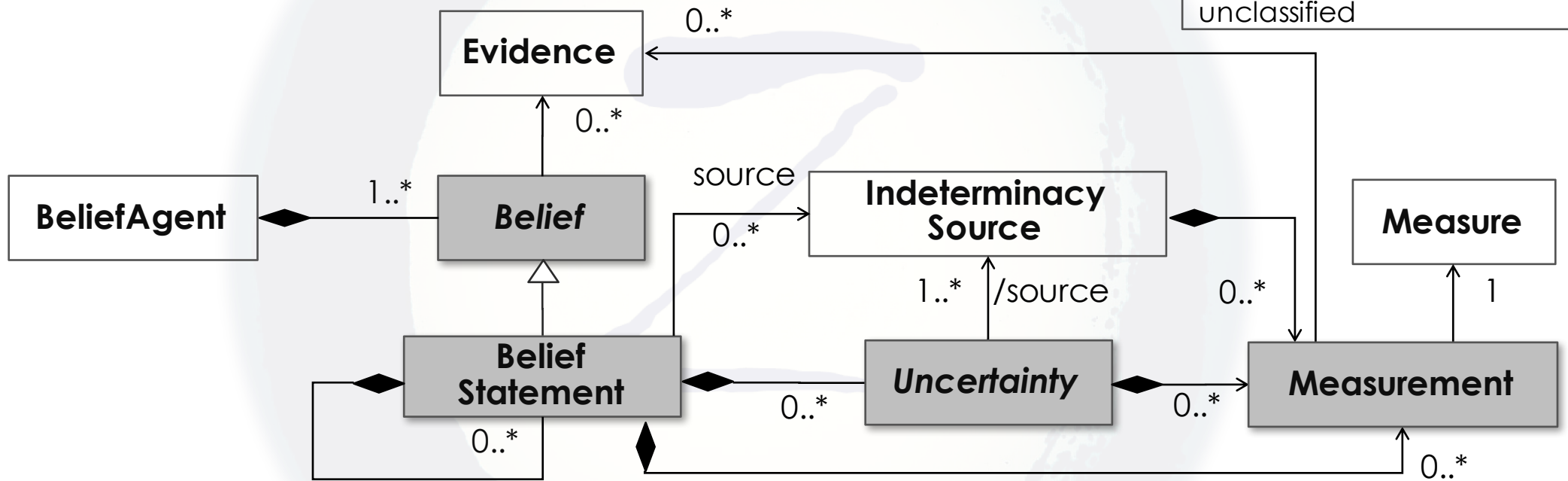Modeling Uncertainty

Evolving Uncertainty

Testing Uncertainty

The U-Model takes a *subjective* approach to represent uncertainty.

Man Zhang, Bran Selic, Shaukat Ali, Tao Yue, Oscar Okariz and Roland Norgren, **Understanding Uncertainty in Cyber-Physical Systems: A Conceptual Model**, 12th European Conference on Modelling Foundations and Applications (ECMFA), 2016. https://www.simula.no/file/u-modeltrfinalpdf/download

U-MODEL – BELIEF MODEL

«enumeration»
IndeterminacyNature

nondeterminism
insufficientResolution
missingInfo
composite
unclassified

Evidence

0..*

0..*

BeliefAgent — 1..* — *Belief*

source

0..*

Indeterminacy Source

0..*

1..* /source

0..*

Measure

1

Belief Statement

0..*

Uncertainty
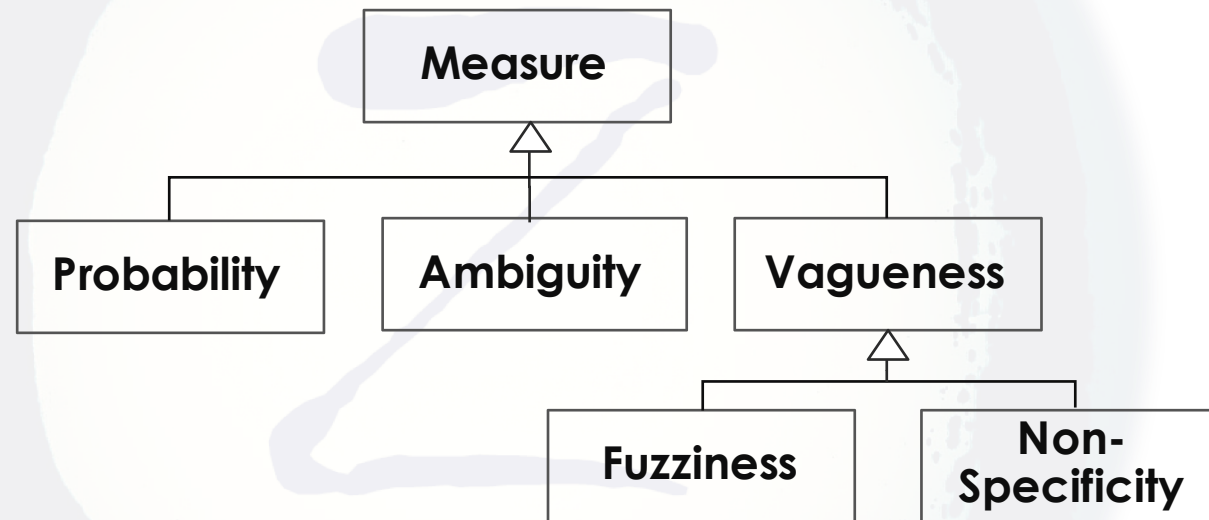
0..*

0..*

Measurement

0..*

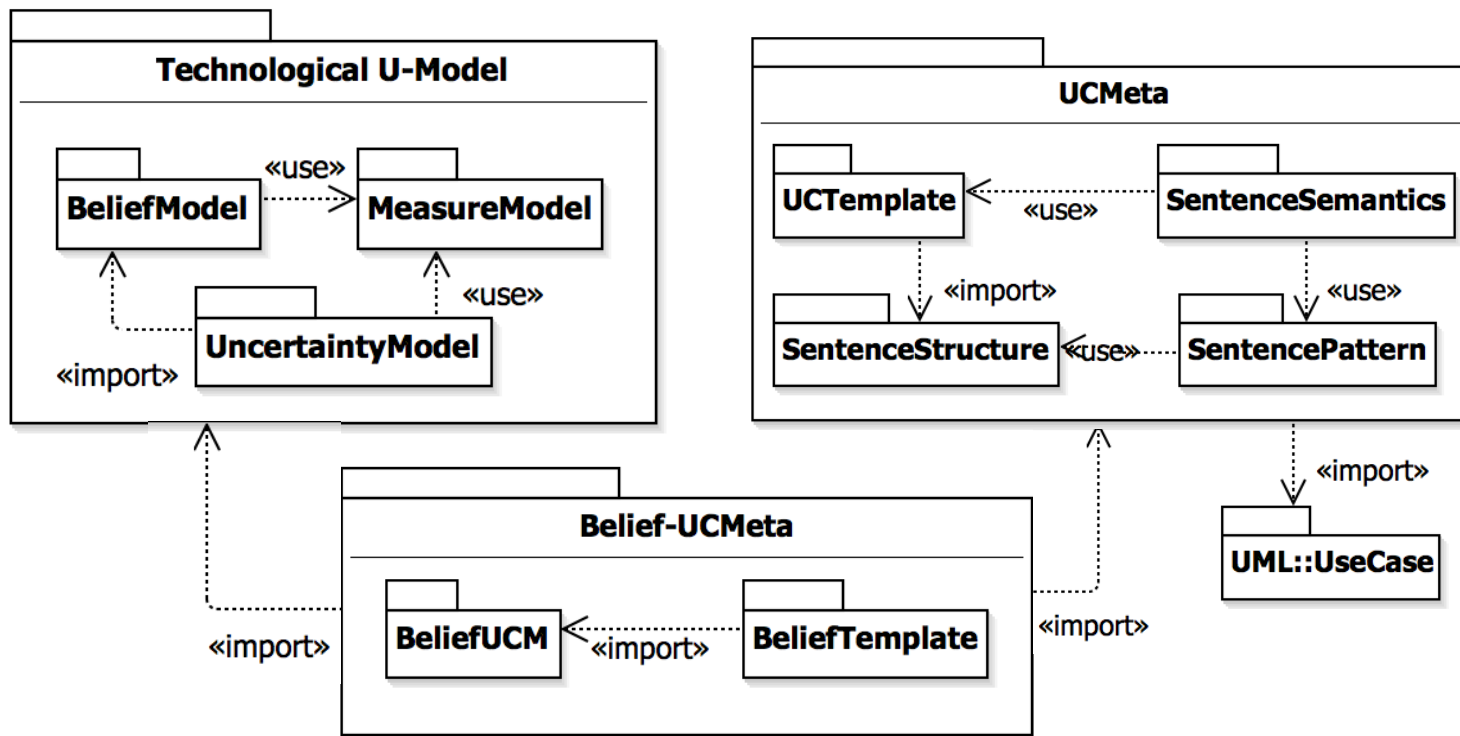substatements

☐ = objective concept
▨ = subjective concept

6

The *Uncertainty Model* Expands On *Uncertainty* From Several Different Viewpoints And Introduces Related Abstractions.
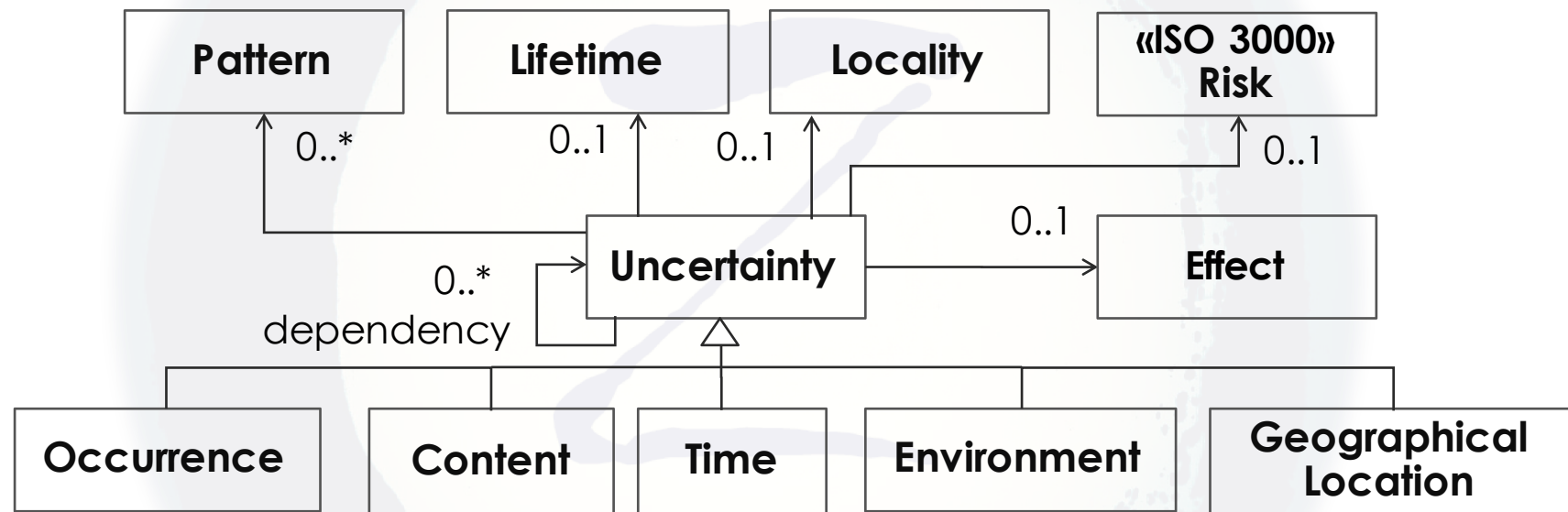
The Purpose Of The **Measure Model** Is To Give A High-level Introduction Of Commonly Known Uncertainty Measures.

U-RUCM integrates U-Model and RUCM.

Belief Template Is Newly Introduced To Specify **Belief Use Case Specification**, Which Inherits The RUCM Template.

Key Heading Fields

Different Flow of Events

Use Case Name	The name of the use case. It usually starts with a verb.	
Brief Description	Summarizes the use case in a short paragraph.	
Primary Actor	The actor who initiates the use case.	
Secondary Actor(s)	Other actors the system relies on to accomplish the services of the use case.	
Dependency	Include and extend relationships to other use cases.	
Generalization	Generalization relationships to other use cases.	
Belief Agent(s)	One or more agents who hold belief about this BUCS.	
Time Point and Duration	The time point when the BUCS is specified and the duration in which the belief agent(s)'s belief on the BUCS holds.	
Belief Degree	The degree to which the belief agent(s) believe the BUCS.	
Indeterminacy Source(s)	The set of indeterminacy sources related to this BUCS.	
Evidence	Evidence to support this BUCS, and its contained belief and uncertainty elements.	
Belief Precondition	Belief agent(s)' belief on the precondition, which describes what should be true before the use case is executed.	
Belief Basic Flow *(Belief degree)*	Specifies the main successful path, also called "happy path".	
	Steps (numbered)	A set of ordered belief sentences.
	Belief Postcondition	Belief agent(s)' belief on what should be true after the basic flow executes.
Belief Specific Alternative Flow *(Belief degree)*	Applies to one specific step of the reference flow.	
	URFS	The reference flow step where the belief agent(s) believe there are uncertainties.
	Alternative Step	An alternative to the reference flow step.
	Steps (numbered)	A set of ordered belief sentences.
	Belief Postcondition	Belief agent(s)' belief on what should be true after the specific alternative flow executes.
Belief Bounded Alternative Flow *(Belief degree)*	Applies to more than one step of the reference flow, but not all of them.	
	URFS	A list of reference flow steps where the belief agent(s) believe there are uncertainties.
	Alternative Steps	A set of alternatives to the reference flow steps.
	Steps (numbered)	A set of ordered belief sentences.
	Belief Postcondition	Belief agent(s)' belief on what should be true after the bounded alternative flow executes.
Belief Global Alternative Flow *(Belief degree)*	Applies to all the steps of the reference flow.	
	Belief Branching Condition	Belief agent(s)' belief on the condition, which describes what should be true when branching from any of the steps of the reference flow.
	Steps (numbered)	The set of ordered belief sentences
	Belief Postcondition	Belief agent(s)' belief on what should be true after the global flow executes.

Specify uncertainty with U-RUCM in industry settings

- U-RUCM was able to **significantly improve on characterization,** and **understanding of uncertainty** requirements.

- Key experience
  - ✓ Learn about uncertainty by applying U-RUCM
  - ✓ Systematically **discover unknown known indeterminacy sources and uncertainties** and **transforming them into known unknown uncertainties and known known indeterminacy sources**.

More Information about U-RUCM:

- Video for demonstrating U-RUCM
  - ✓ http://zen-tools.com/rucm/U_RUCM.html

- Technical Report
  - ✓ https://www.simula.no/publications/specifying-uncertainty-use-case-models-industrial-settings

Specifying Uncertainty in Use Case Models in Industrial Settings

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Foster long-term and community-wide benefits through standardization

- Uncertainty Modeling
  - ✓ Initiated the standardization process in June 2016
  - ✓ **Uncertainty RFI** is officially issued in Sep. 2016
  - ✓ Call for responses until Feb. 2017.
  - ✓ http://www.omgwiki.org/uncertainty/doku.php