Characterizing a data model for software measurement

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Contents

Introduction(1/3)

- Many software measurement schemes fail due to poor definition
  - Measurement mismatch [PSM '02]
    - Picking wrong, ambiguous, or inconsistent measures result in inconclusive data analysis
  - Measurements should be objective, empirical and repeatable
- Measurement data model
  - Identify and define all the elements involved in measurement as well as the relationships existing among them
    - Kitchenham's software measurement model
    - Bøegh's data model for software quality measure
  - "Everyone understands what the measured values present"
    - Not "the definition of measure is theoretically correct"

Introduction(2/3)

- In the previous works,
  - GQM, Ami
    - Provide methods for identifying the measures
    - Not define how such measures should be collected and stored
  - Kitchenham's work
    - Provide entity-attribute-unit structure('95)
    - Provide a method for specifying models of software data sets('01)
      - In order to capture the definitions and possible relationships among software measures
    - Counting rule and measurement context have not been explicitly considered
  - In ISO/IEC 15939, the relations defined between elements involved in the measure definition are not normative

Introduction(3/3)

- Background of MOdel for Software Measurement (MOSME)
  - SQUAD(Software QUality Across Different regions)
    - Enrich the existing project data base with information on the quality measurements of artifacts produced during the early stages
    - SQUID(Software QUality In the Development process)
  - CLeAr and Reliable information For integration(CLARiFi)
    - Create a broker infrastructure to support the application of CBSE in the marketplace
    - Clear software measure concepts was absent with respect to the quality attribute definitions
      - Involving the counting rule to compute the attribute's values
      - When the finding suitable software components for the planned system was failed

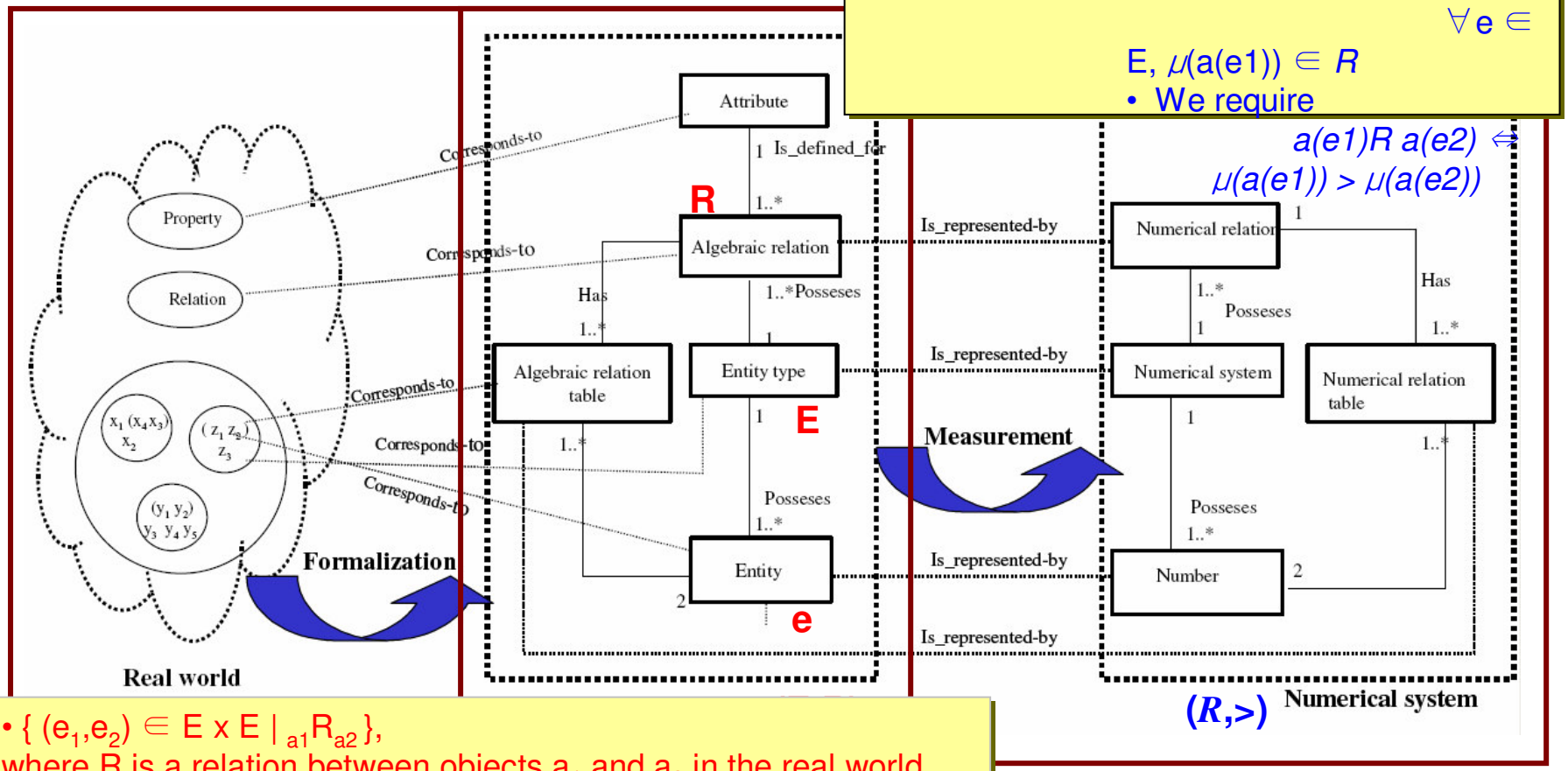
Software measurement elements(1/2)

- Measurement terminology
  - Measure(metric)
    - Rule for assigning a quantitative or categorical value from a defined scale to one or more attributes
    - Refer collectively to base measures, derived measures and indicators
  - Indicator
  - Measurement
    - Use of a measure or mapping to assign a value from the scale to an attribute of an entity
    - Mapping from the empirical world to the formal, relational world

Software measurement elements(2/2)

- Formalization of measuremen

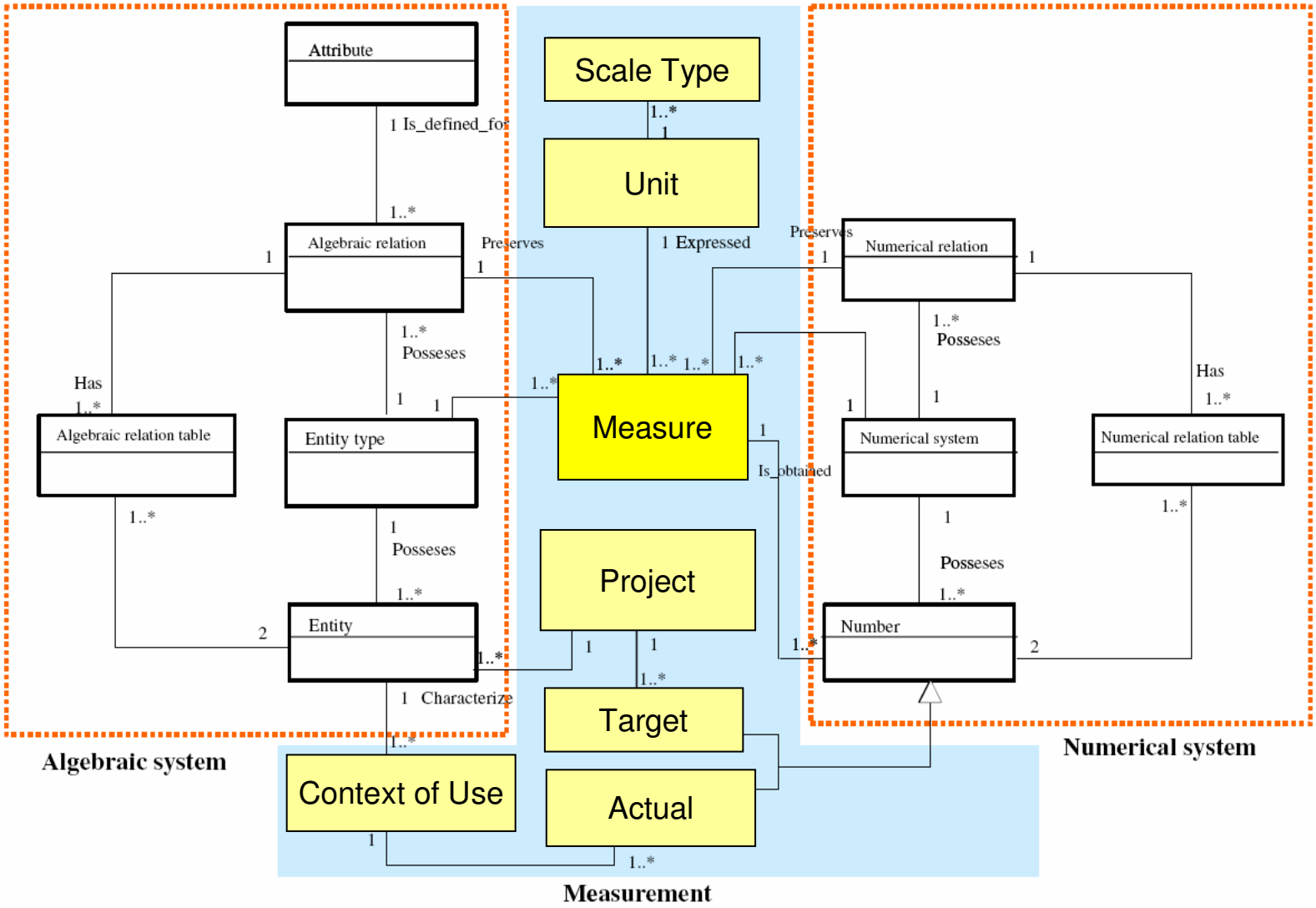
• Homomorphism
$\mu : (E, R) \rightarrow \mu(R, >)$, where for $\forall e \in E$, $\mu(a(e1)) \in R$
• We require
$a(e1) R\ a(e2) \Leftrightarrow \mu(a(e1)) > \mu(a(e2))$



• $\{ (e_1,e_2) \in E \times E \mid {}_{a1}R_{a2} \}$,
where R is a relation between objects a_1 and a_2 in the real world represented by e_1 and e_2 which are entities in the algebraic system

Data model for software measurement(1/2)

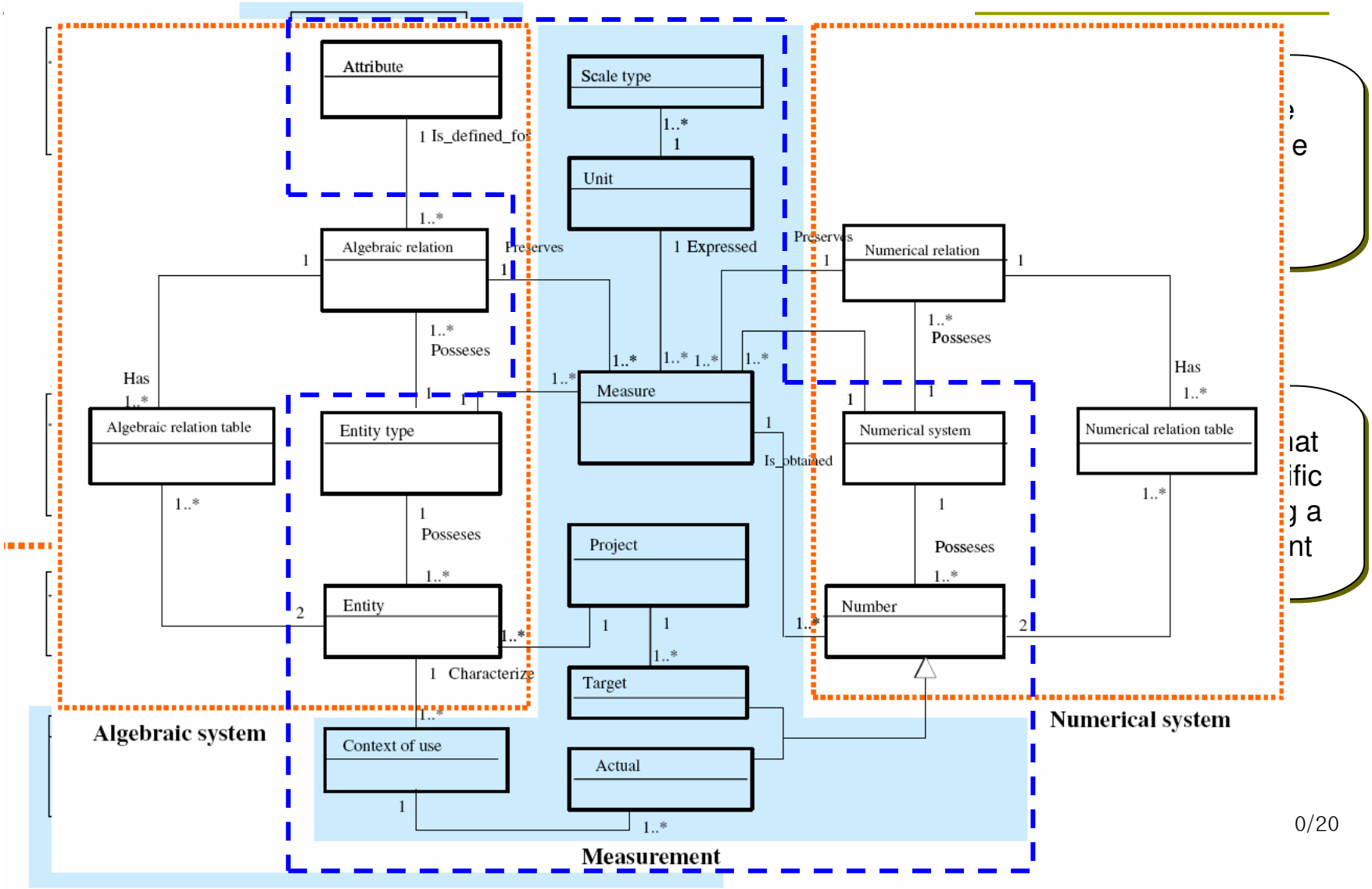
[Data model for software measurement]



Data model for software measurement(2/2)

- Counting rule
  - Procedure
    - Specify the set of actions to be performed to obtain the value of the attribute on the basis the selected unit
    - Expression method :
      - Descriptive text or formula
  - Context(context of use)
    - Circumstances or context under which the measurement is performed
      - Frequency of the measurement
      - Tools to be used to extract and store the data values
      - Responsible for the data extraction
      - Environmental elements
  - Conditions
    - Conditions on the target values for a specific attribute

Considerations for implementing the software measurement data model(1/3)



Considerations for implementing the software measurement data model(2/3)

- Main activities for the measure definition
  - 1. Define the algebraic system
    - 1.1 Identify the entity type that shall be analyzed
    - 1.2 Identify and define the attributes involved in the entity type
    - 1.3 Identify the algebraic relations and their empirical interpretations for the entity type with respect to the attributes
  - 2. Construct the underlying numerical system to which the algebraic system will be mapped
  - 3. Define the mapping between the algebraic system and the numerical system(measure):
    - 3.1 Define the unit and scale type
    - 3.2 Specify the counting rule: procedure, context of use(if applied to all the entities) and condition(if applicable)

Considerations for implementing the software measurement data model(3/3)

- Main activities for defining the project measures
  - 1. Identify the project
  - 2. Identify the entity type to be controlled during the development process
  - 3. Assign target values to the attributes
  - 4. Define the entities to be measured in the project and link them to the corresponding entity type according to the development process adopted
  - 5. Define the context of use where the measure will be applied

Applying MOSME to a case study(1/3)

- Problem description
  - COMERX
    - Building an Enterprise Application Portal(EAP) to articulate its main business activities(B2C, SCM, CRM)
    - Its main goals are to provide efficient answers to customer's requests and to guarantee continuous availability of the COMERX functionality
- MOSME is applied
  - To define the measures for the attributes identified for the ISO/IEC 9126-1 quality model adapted to the EAP domain
  - As part of a quality requirements specification process

Applying MOSME to a case study(2/3)

- Main quality characteristics, sub-characteristics and attributes

External quality characteristics (ISO/IEC 9126-1, 2001)	External quality sub-characteristics	External quality sub-sub-characteristics	Attributes
Efficiency: the capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions	*Time behavior:* The capability of COMERX to provide appropriate response and processing times and throughput when performing its function, under stated conditions		• *Response time:* time taken by COMERX to answer to a user's request after being processed • *Throughput* (communication capacity): amount of information transmitted through the portal over a given period of time
Reliability: the capability of the software product to maintain a specified level of performance when used under specified conditions	*Availability:* The capability of COMERX to be in a state to perform a required function at a given point in time, under stated conditions of use	*Fault tolerance:* the capability of COMERX to maintain a specified level of performance in cases of software faults or of infringement of its specified interface	• *Size 1:* number of interruptions that leave the system out of operation during a specified period of time • *Size 2:* number of functions implemented with the capacity of avoiding incorrect operations

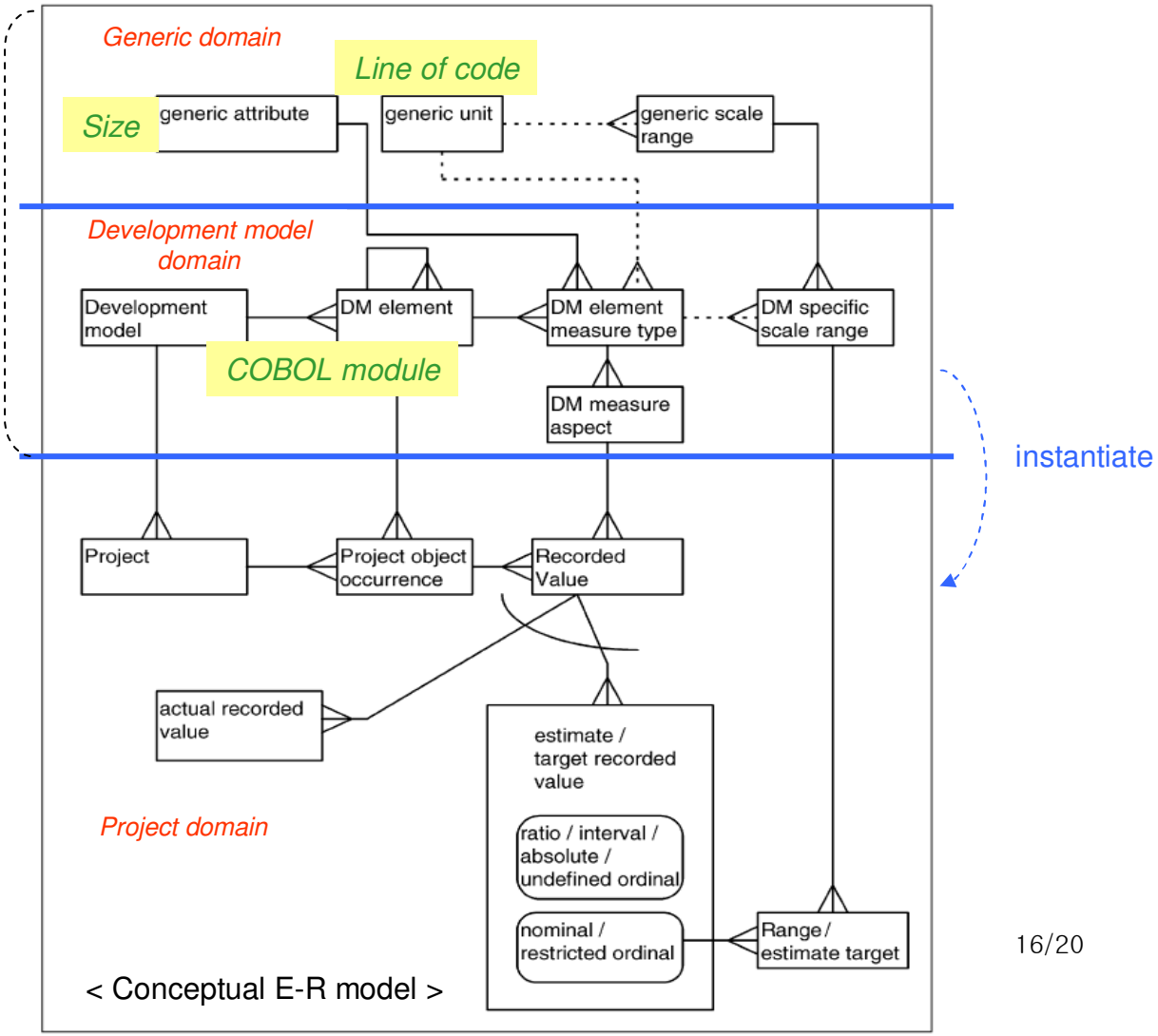
Entity type	Attribute	Algebraic relation	Measure name	Unit name	Scale type	Counting rule	Numerical system	Numerical relation
Name: Service	*Name:* Response time	*Name:* "is more efficient (with respect to response time) than" denoted by "•>"	*M1RT*	*Second*	*Ratio*	*Procedure*	*Real*	>
	Description: time taken by the application to answer to a service request	*Empirical interpretation:* the lower response time taken by a service invoked through the portal gives an idea of a greater efficiency of the different components involved in producing the service. It is an indicator that affects the acceptance of the portal in the user's context				*Descriptive text:* counting the elapsed time from the application acknowledgement of the service request until the response is obtained	*Upper value:* 10 s	Response time > 0
						Context: • *Stage:* testing, after completing the service coding • *Frequency:* at the first compilation and after each fault correction • *Who:* measurement engineer • *Operating system*: UNIX • *Internet data transmission rate:* 25 KBps (corresponds to the platform used by enterprise X) • Channel bandwidth:	*Lower value:* 0.1 s	

Measures used in the COMERX Project

Entity	Project	Measure	Target value	Actual value
Order management	COMERX	M1RT	5 s	To be determined by simulation or product execution
Order management	COMERX	M1TT	125 KBps	To be determined by simulation or product execution
Service request management	COMERX	M1RT	5 s	To be determined by simulation or product execution
Service request management	COMERX	M1TT	125 KBps	To be determined by simulation or product execution

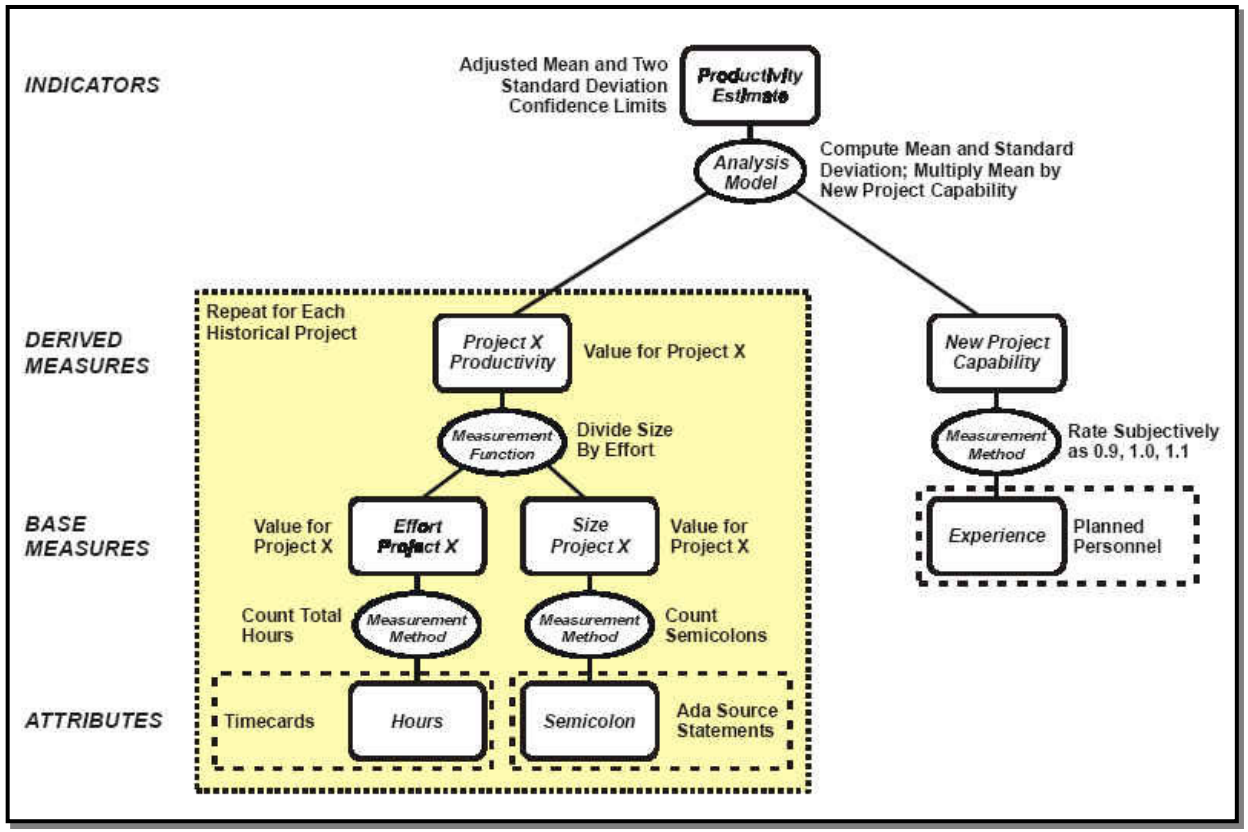
Comparison with other models(1/3)

- Kitchenham's software measurement model



Comparison with other models(2/3)

- Measurement information model of ISO/IEC 15939



Comparison with other models(3/3)

Measurement elements		Measurement data models			
		SQUID (1999)	Kitchenham(2001)	ISO/IEC 15939(2002)	MOSME
Measurement definition					
	Entity type	○	○	X	○
	Entity	Object of evaluation	○	○	○
	Attribute	○	○	○	○
	Unit	○	○	○	○
Structure of counting rule					
	Procedure	Textual description or equation	Textual description	Textual description algorithm or model	Textual description or formula
	Characterization of an entity with respect to the attribute	Not explicitly defined	Not explicitly defined	Not explicitly defined	○
	Context of use	X	X	X	○
	Conditions	○	X	X	○
	Scale	○	○	○	○
	Scale type	○	○	○	○
	Measure type	Direct/indirect	Direct/Indirect	Base/Derived/Indicator	Direct/Indirect
	Correspondence between empirical and formal worlds	Function	Function	Function	Homomorphism between algebraic and numerical systems
	Project	○	○	X	○
	Model of the development process	○	○	X	Entities represent the artifacts

Conclusion

- Proposed data model focuses on
  - Definition and modeling of the elements involved in software measurement
    - Particularly the counting rule and the role played by the context of use

- Weak points
  - Exact and theoretically based definition of these critical elements for software data storage, collection and comparison had not been provided
  - Conditional model is not included in the data model in order to simplify this presentation

Critics

- MOSME does not include
  - Nominal, ordinal scale and the special interpretation of their unit
  - Indirect measurement
    - Authors said indirect measure can be described in the procedure part of counting rule in the form of a formula
    - However, MOSME can't present the relationship between base measures
  - Goal
    - Authors said goal can be described in the context of counting rule
    - However, I think that goal should be the individual element from context
  - Process-oriented measure
    - It only focuses on the product-oriented measure
    - Then, are there any specific elements of process-oriented measure to be added to MOSME?
- Counting rule can be ambiguous