

# Comparing Topic Maps Constraint Specification Languages

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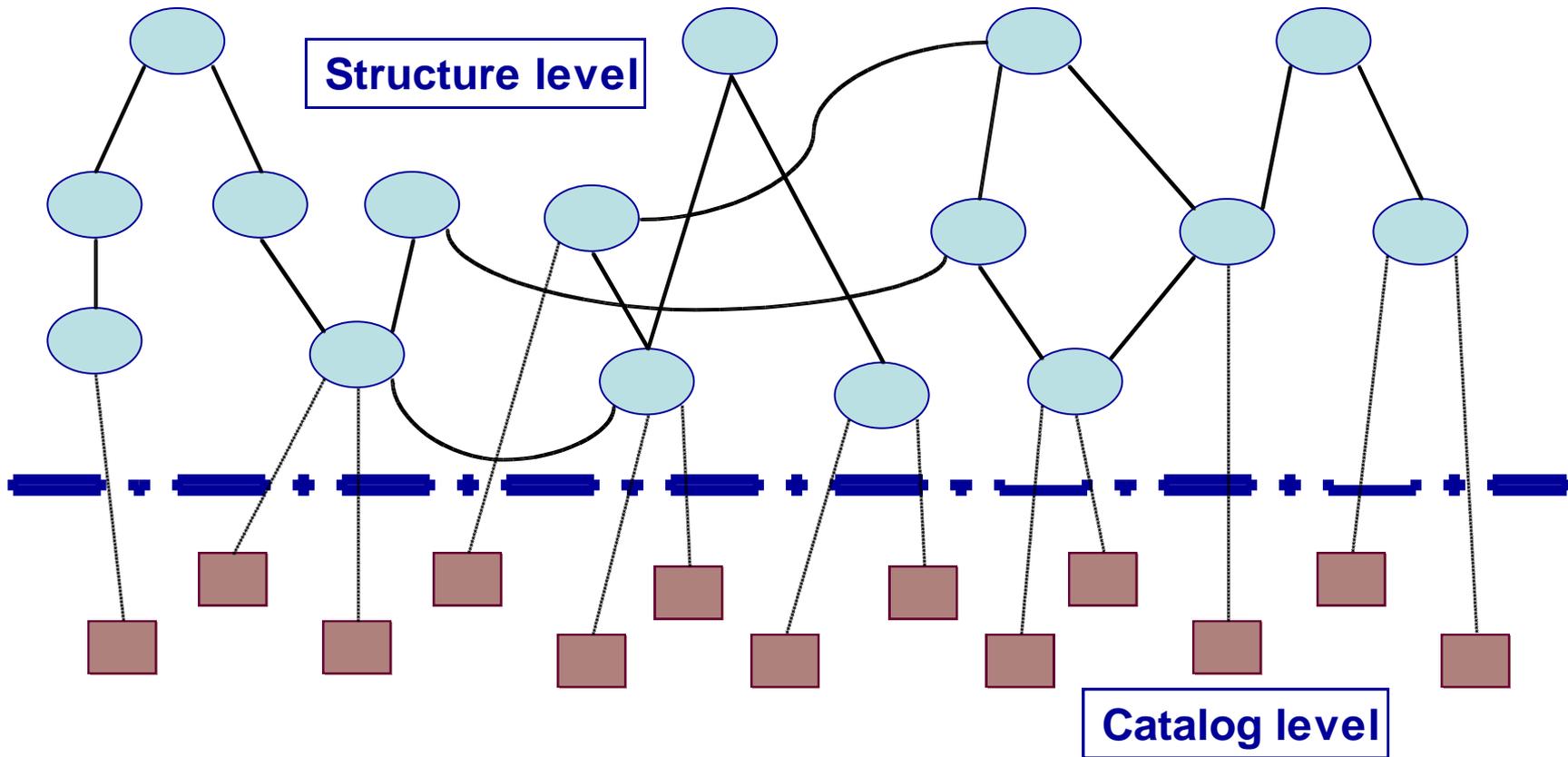
# Agenda

- Motivation
- Our work's background
- What's going on (models)?
- Constraints...
- XTche, OSL, Toma, and AsTMa!
- Case study
- Conclusions

# Motivation

- Why do we need constraints?
  - Topic Maps are too abstract!
    - Many ontologies have a rigid structure
    - Many ontologies have semantic constraints
  - we do not control the process of creation
    - uploads
    - merges
  - manual editing of the Topic Map
- As a side effect we can have a Reporting Service

# Ontology

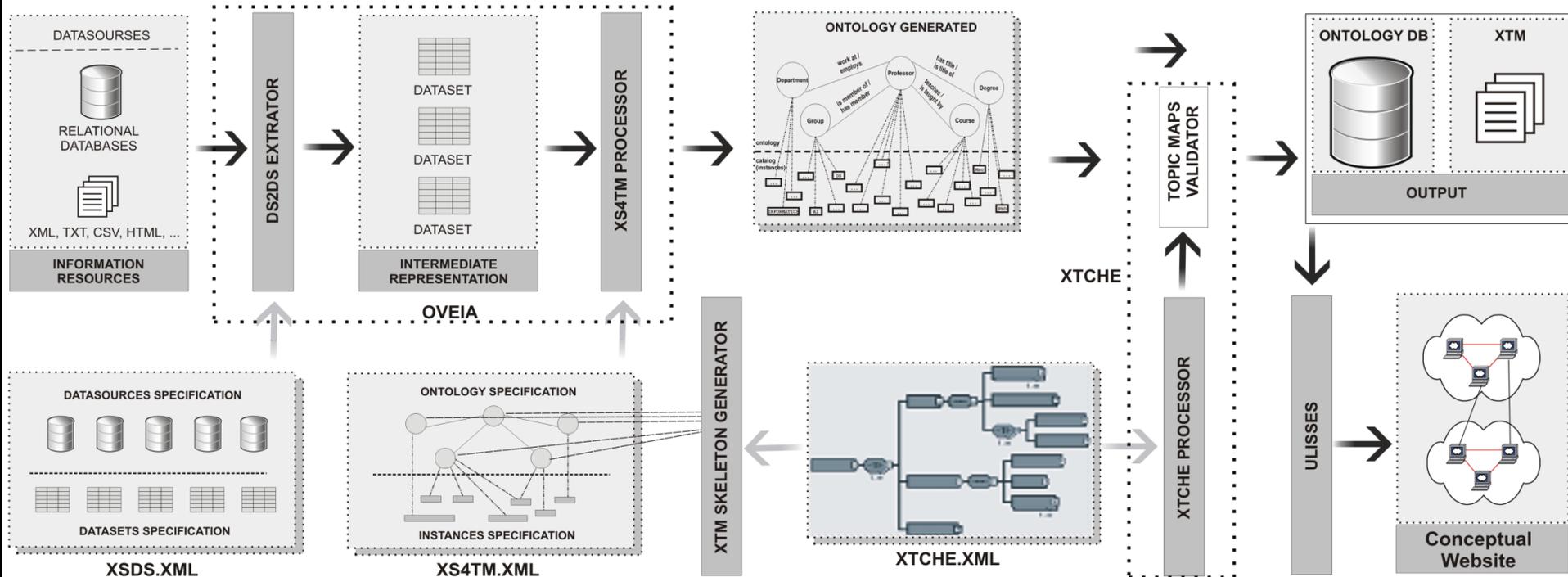


# More questions

- Is a Schema a Constraint Language?
- Creating a new language ... Why?
  - ▶ We are always creating new DSL arguing that we will hide complexity
  - ▶ Aren't we introducing complexity?
- How should we implement this new language?

# Metamorphosis

Back in 2001 we had great expectations towards Topic Maps



LIBRELOTTO, Giovanni R. ; RAMALHO, José Carlos ; HENRIQUES, Pedro Rangel . **Metamorphosis - A Topic Maps Based Environment to Handle Heterogeneous Information Resources**. Lecture Notes in Computer Science, Springer-Verlag GmbH, v. 3873, p. 14-25, 2006.

# Returning to constraints

- What is really a TM?
- According to the XTM DTD
  - A list of ... Topics, associations, occurrences
  - Everything else is constructed by reference
  - **It is easy to get lost in a TM!**
- That DTD is completely abstract
  - There is room for “Specific Semantic Networks Schemas”

# TMCL: Implementation wishes

- Do it simple
- Do it with existing technology
- Do it user friendly
  - If possible do not force the user to learn a new language

# TMCL: Requirements from ISO JTC1 SC34

## Schema constraints:

- Topic of type T must have a specified number of explicit names/occurrences/subject-indicators (cardinality);
- Topic of type T must have as name/occurrence/subject-indicators a value matching a particular pattern;
- Topic of type T must (not) have a name/occurrence with scope S;
- Topic of type T must have a name/occurrence, that is instance of topic type T, in scope S;

...

## Contextual constraints:

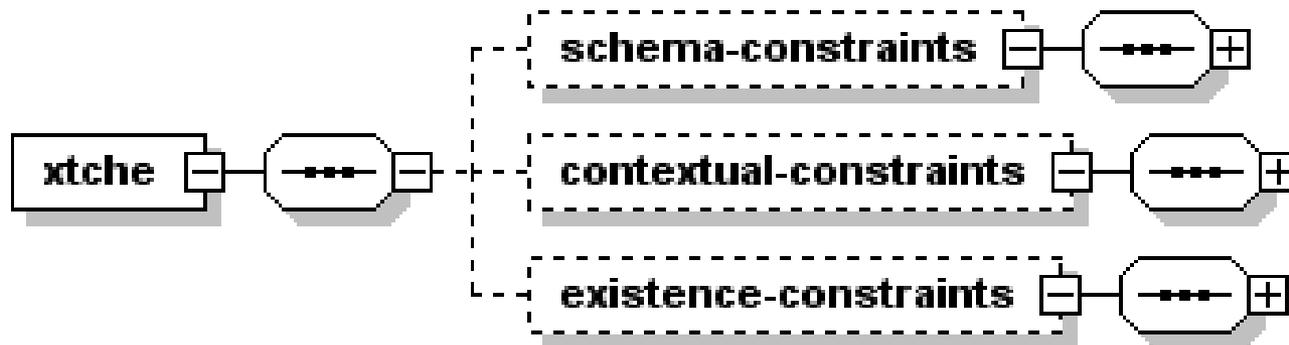
- Topic T can (only/not) be used for typing other topics;
- Topic T can (only/not) be used for typing subject indicator;
- Topic T can (only/not) be used for typing basenames;
- Topic T can (only/not) be used for typing occurrences;

...

# XTche Specification Language

- XML Schema based
  - Constraint lang. = Schema lang.
  - We have some experience with XML Schemas
  - The tools we use have an interesting graphical support that we wanted to use
  - If we choose an existing language to host ours part of the work is already done
- **XTche Spec. = XML Schema + semantic stamps**

# XTche skeleton



- Namespace: `xmlns:xtche=http://www.di.uminho.pt/~gepl/xtche`
- Imports: <http://www.di.uminho.pt/~gepl/xtche/xtche-schema.xsd>

# xtche-schema.xsd

- A set of flags / semantic stamps
- Each flag represents a semantic validation
- The user will associate flags to concrete topics and these will map to semantic constraints that will be verified
- Remaining: **Did we cover the wole TMCL?**

# Flags / Semantic Stamps

- Schema constraints
  - **<xs:attribute name="topicType"/>**
  - “this element represents a Topic type”
- Contextual constraints
  - **<xs:attribute name="associationTypeExclusive"/>**
  - “this topic can only be used to qualify associations”
- Existence constraints
  - To guarantee the existence of at least a specific topic or association

# Astma language set

- Non-XML syntax
- Language for: structuring, adding, querying, constraining...
- An object algebra...
- It has its own model. The Topic Map must be Uploaded to this model.

# TOMA

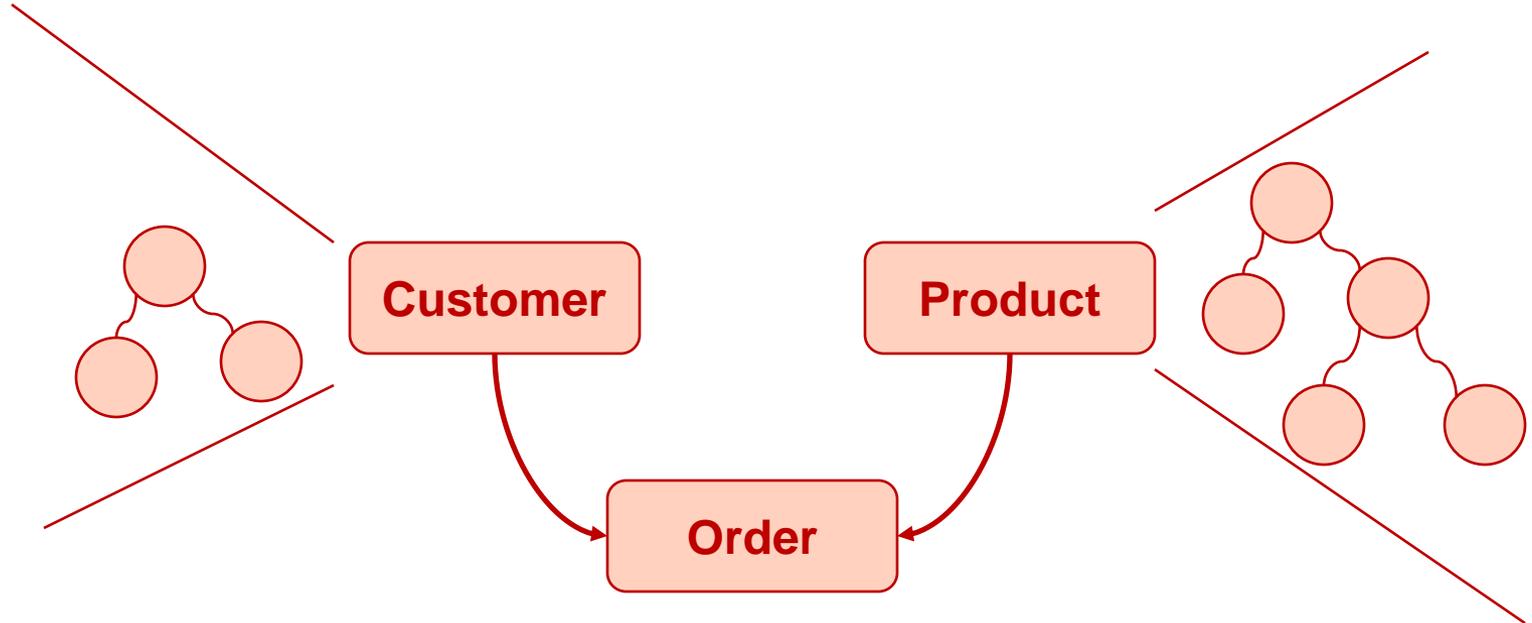
- *Toma* is an "all-in-one" TM\*L:
  - TMQL, TMML, and TMCL
- *Toma* offers statements like:
  - SELECT, INSERT, UPDATE and DELETE
- *Toma* provides functions that allow to modify, convert and aggregate the data coming from the topic map.

# Ontopia Schema Language (OSL)

- XML Schema based
- Allows the user to specify a schema for a specific Topic Map
- Since we are in the schema domain we are not allowed to use instance values

# E-Sell case study (by ISO)

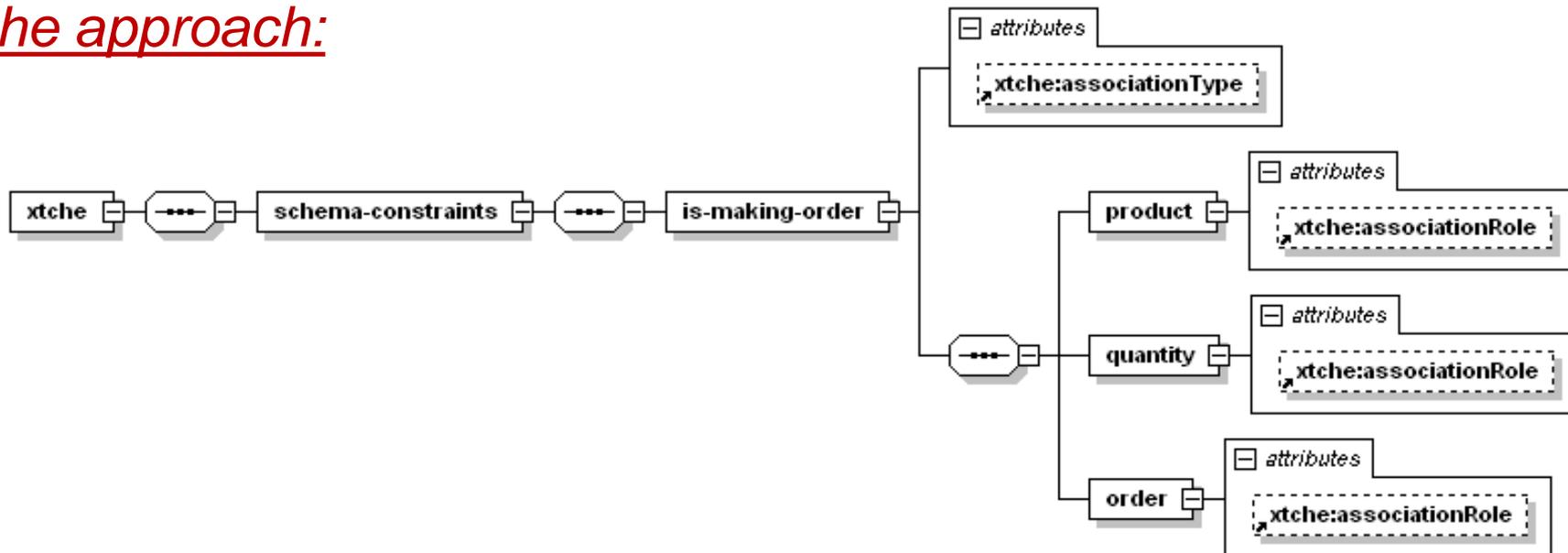
## Customers, products, and orders



# a) Restricting an association structure

$\forall a \in \text{Associations: if}(\text{Type}(a) = \text{"is-making-order"})$   
then  $\text{MemberRoles}(\text{(order, product, quantity)} a)$

XTche approach:



# a) Restricting an association structure

## AsTMA! approach:

```
forall [ * (is-making-order)
  product: *
  quantity: *
  order: * ]
```

## TOMA approach:

```
define constraint is_making_order_constraint
each association $a(is-making-order)
satisfies exists $a(is-making-order)->product = $$
and $a(is-making-order)->quantity = $$
and $a(is-making-order)->order = $$;
```

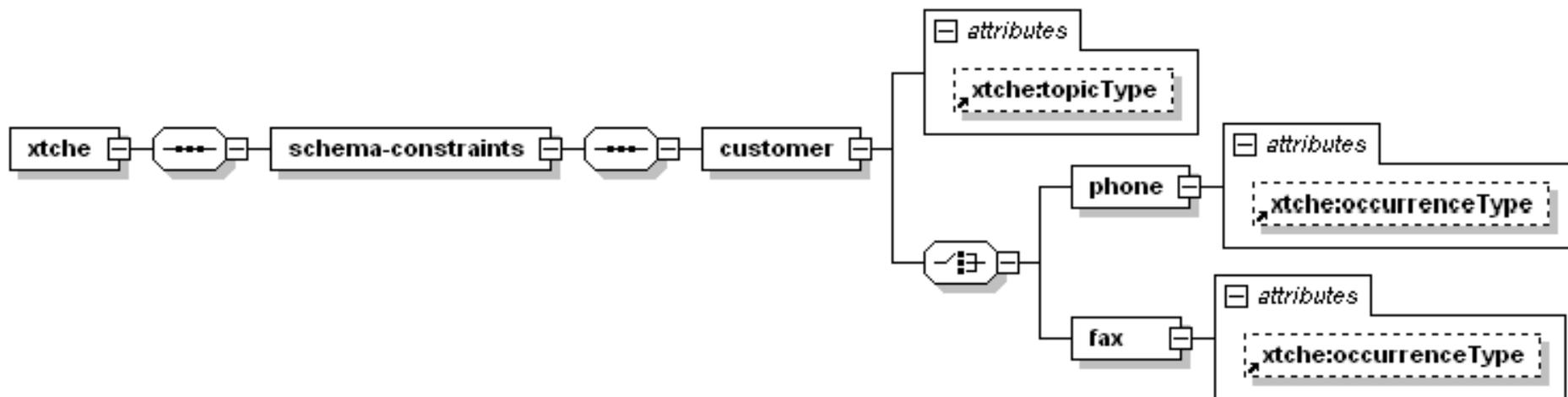
## OSL approach:

```
<association>
  <instanceOf>
    <internalTopicRef href="#is-making-order"/>
  </instanceOf>
  <role min="1" max="1">
    <instanceOf>
      <internalTopicRef href="#product"/>
    </instanceOf>
    <player>
      <internalTopicRef href="#product"/>
    </player>
  </role>
  <role min="1" max="1">
    <instanceOf>
      <internalTopicRef href="#order"/>
    </instanceOf>
    <player>
      <internalTopicRef href="#order"/>
    </player>
  </role>
  <role min="1" max="1">
    <instanceOf>
      <internalTopicRef href="#quantity"/>
    </instanceOf>
    <player> <any/> </player>
  </role>
</association>
```

# b) Each person must have a phone or fax field

$\forall t \in \text{Topics}, \text{TopicType}(t) = \text{"customer"} \Rightarrow \exists r \in \text{Occurrences} : r \subset t$   
 $\wedge (\text{OccType}(r) = \text{"phone"} \vee \text{OccType}(r) = \text{"fax"})$

## XTche



# b) Each person must have a phone or fax field

## AsTMa!

```
forall $c [ * (customer) ]  
=> exists $c [ in (phone): * ]  
or  
exists $c [ in (fax): * ]
```

## TOMA

```
define constraint customer_must_have_a_contact_number_constraint  
each topic $t  
  where $t.type = 'customer'  
  satisfies exists $t.oc.id = 'phone'  
  or $t.oc.id = 'fax';
```

# b) Each person must have a phone or fax field

## OSL

```
<topic>
  <instanceOf>
    <internalTopicRef href="#customer"/>
  </instanceOf>
  <occurrence min="0" max="1">
    <instanceOf>
      <internalTopicRef href="#phone"/>
    </instanceOf>
  </occurrence>
  <occurrence min="0" max="1">
    <instanceOf>
      <internalTopicRef href="#fax"/>
    </instanceOf>
  </occurrence>
</topic>
```

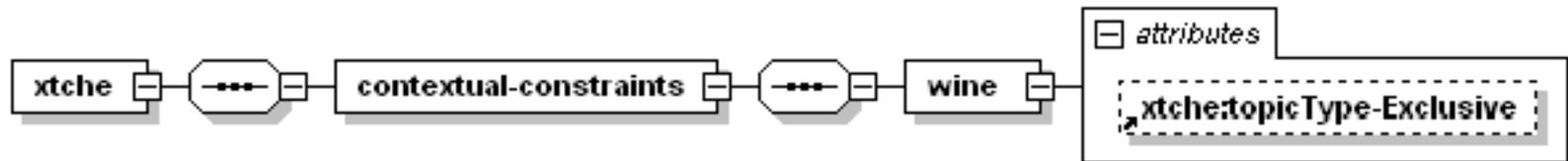
The code above defines a topic instance of customer that has zero or one phone occurrence and zero or one fax occurrence.

But, according this OSL specification, there is no way to impede that a topic instance of customer has both occurrences.

# c) Contextual constraint

Restricting the use of a specific topic: topic “wine” can only be used as a Topic Type

## XTche



## AsTMa!

```
forall [ wine  
      bn: Wine ]  
=> exists [ $w (wine) ]
```

# c) Contextual constraint

Restricting the use of a specific topic: topic “wine” can only be used as a Topic Type

## TOMA

```
define constraint wine_is_type
  each topic $t
    satisfies exists $t.instance
  where $t.id = 'wine'
```

## OSL

There are no constructors for that.

# Comparing the 4 Languages

	XTche	AsTMa!	TOMA	OSL
<b>Background</b>	XML Schema + Stamps	Specific Syntax	SQL, Tolog, OO, AsTMa*	XML Schema
<b>Model</b>	Abstract Doc. Tree (XTM)	Specific (should be open)	TMCL, TMML, and TMQL	Abstract Doc. Tree (XTM)
<b>Range of App.</b>	Til now... it looks promising	Some doubts...	TMCL, TMML, and TMQL	Only structural constraints
<b>Proc. Engine</b>	Schema and XSL proc.	Specific	TopiMaker	Schema proc.
<b>Scalability</b>	Does not scale	???	Does not scale	Does not scale

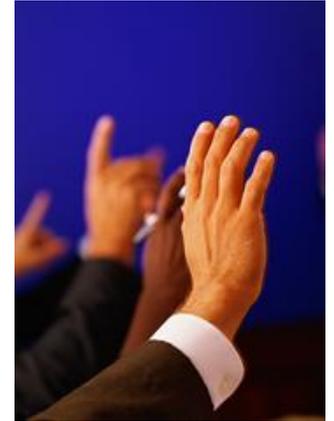
# Comparing the 4 Languages

	XTche	AsTMa!	TOMA	OSL
<b>TM syntax</b>	XTM	AsTMa=	Database ?	XTM, HyTM, LTM, RDF
<b>Existence, boolean, and conditional constraints</b>	Yes	Yes	Yes	No
<b>Data types</b>	Based on XML Schema data types	Strings	Basic data type: string, int, float, ...	No

# Conclusions

- The main conclusion is that *XTche*, *Toma* and *AsTMa!* comply with all requirements stated for *TMCL* whereas *OSL* just includes topic maps structure validation.
- There is work to be done
  - To evaluate the processors performance;

# Questions...?



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