

# Topic Maps and the Ontological World

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# Roadmap

- Act I: Introduction
  - Scene I: What are Topic Maps?
  - Scene II: How do TMs work?
  - Scene III: The Family of TM Standards
  - Scene IV: TMs and Related Paradigms



## Roadmap cont'd

- Act II: Allegro
  - Scene V: Ontologies, Schemas, Templates
  - Scene VI: Class hierarchies
  - Scene VII: Inferencing
  - Scene VIII: Consistency constraints
  - Scene IX: Topic Map Query Language (TMQL)
- Epilogue: Conclusions



Act I:  
**Introduction**



Scene I:

# What are Topic Maps?

An overview ...



## The Sound-bites

- “GPS of the information universe”
- “A new paradigm for organizing, maintaining, and navigating information”
- “The bridge between Information Management and Knowledge Management”



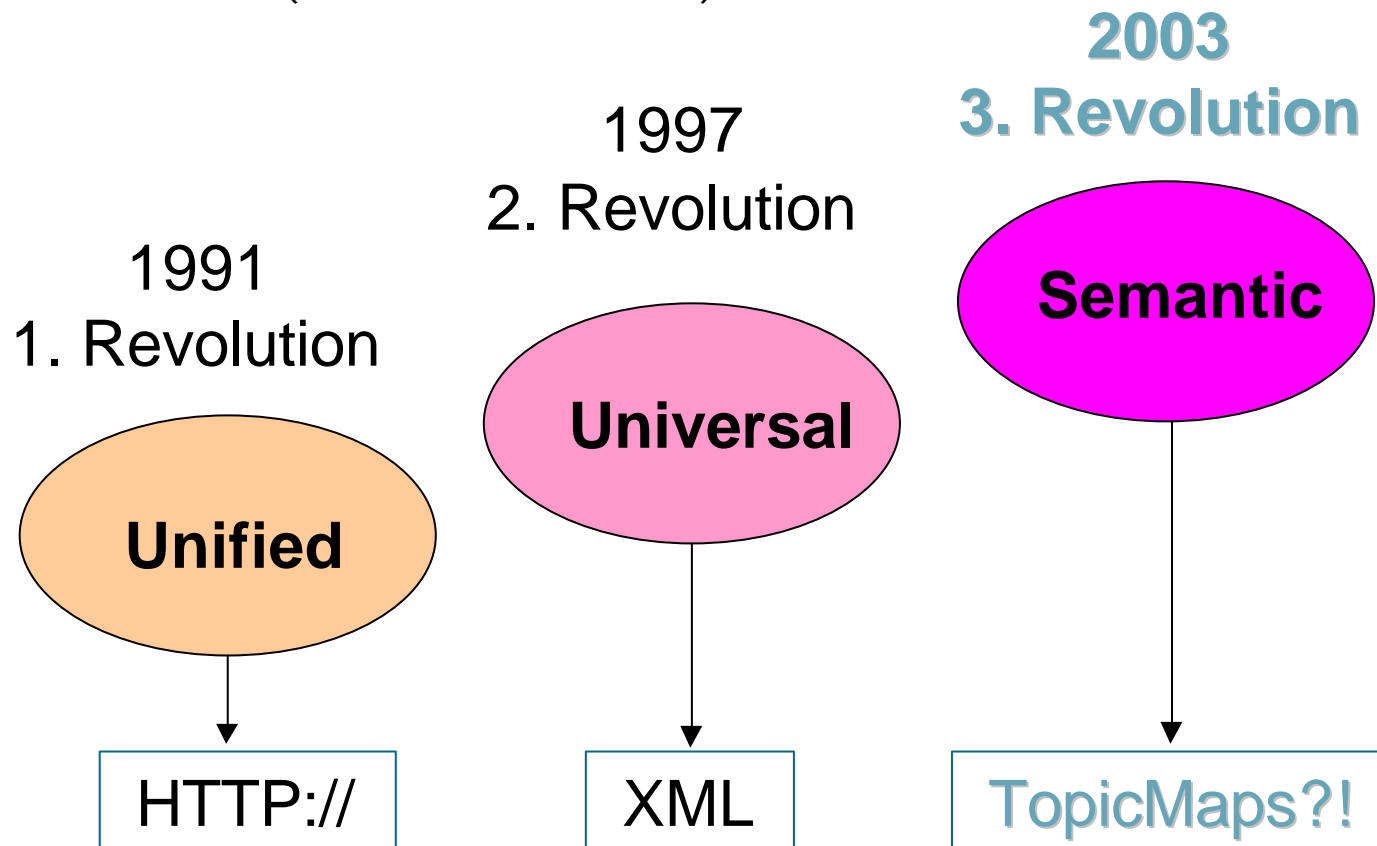
## Topic Maps are ...

- Standardized:
  - An ISO standard describing knowledge structures, electronic indices, classification schemes, ...
- Web enabled:
  - XML Topic Maps (XTM) are ready to use
- Designed to:
  - manage the info glut
  - build valuable information networks above any kind of resources / data objects
  - enable the structuring of unstructured information



# The 3rd Prophecy

By Tim Berners-Lee (father of the Internet)





## Topic Maps – A Promising Technology

- Metadata
  - Topic Map data is not part of the info assets
- Search
  - Search in more precise topics and not in full text
- Linking
  - TMs are well-organized link networks
- Knowledge structures
  - TMs are a base technology for knowledge representation



## Scene II: **How do TMs Work?**

**Brief intro ...**



## Example: Back-of-the-Book Index

<i>Don Giovanni</i> .....	56
Leipzig .....	35, 90
<i>Lohengrin</i> .....	49
Mozart, W.A. ....	11
Mozart festival, see Würzburg	
Wagner, R. ....	22
Vienna .....	11, 42
Würzburg .....	77



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Topics



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Occurrences



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Different  
topic classes



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Multiple Topic Names





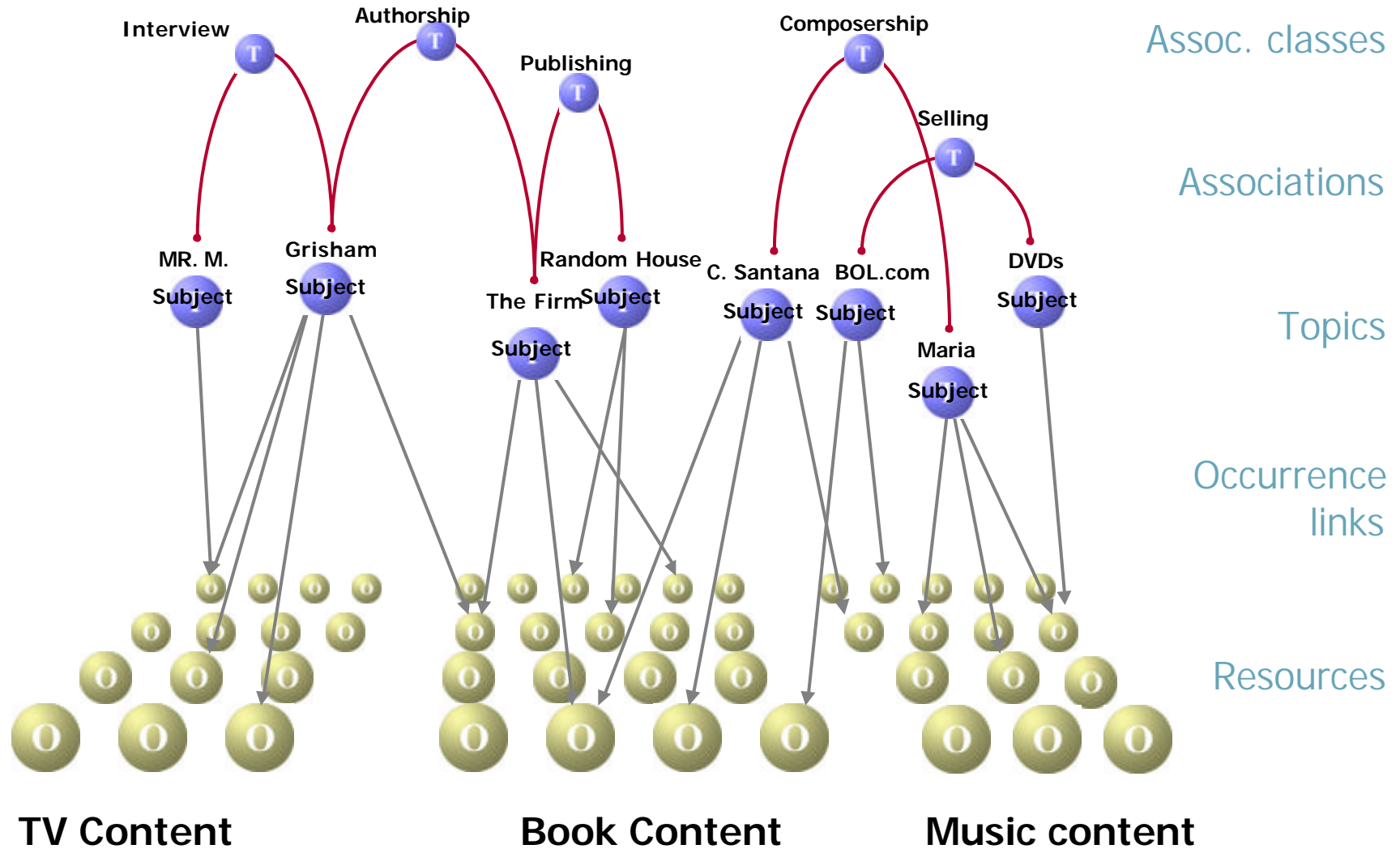
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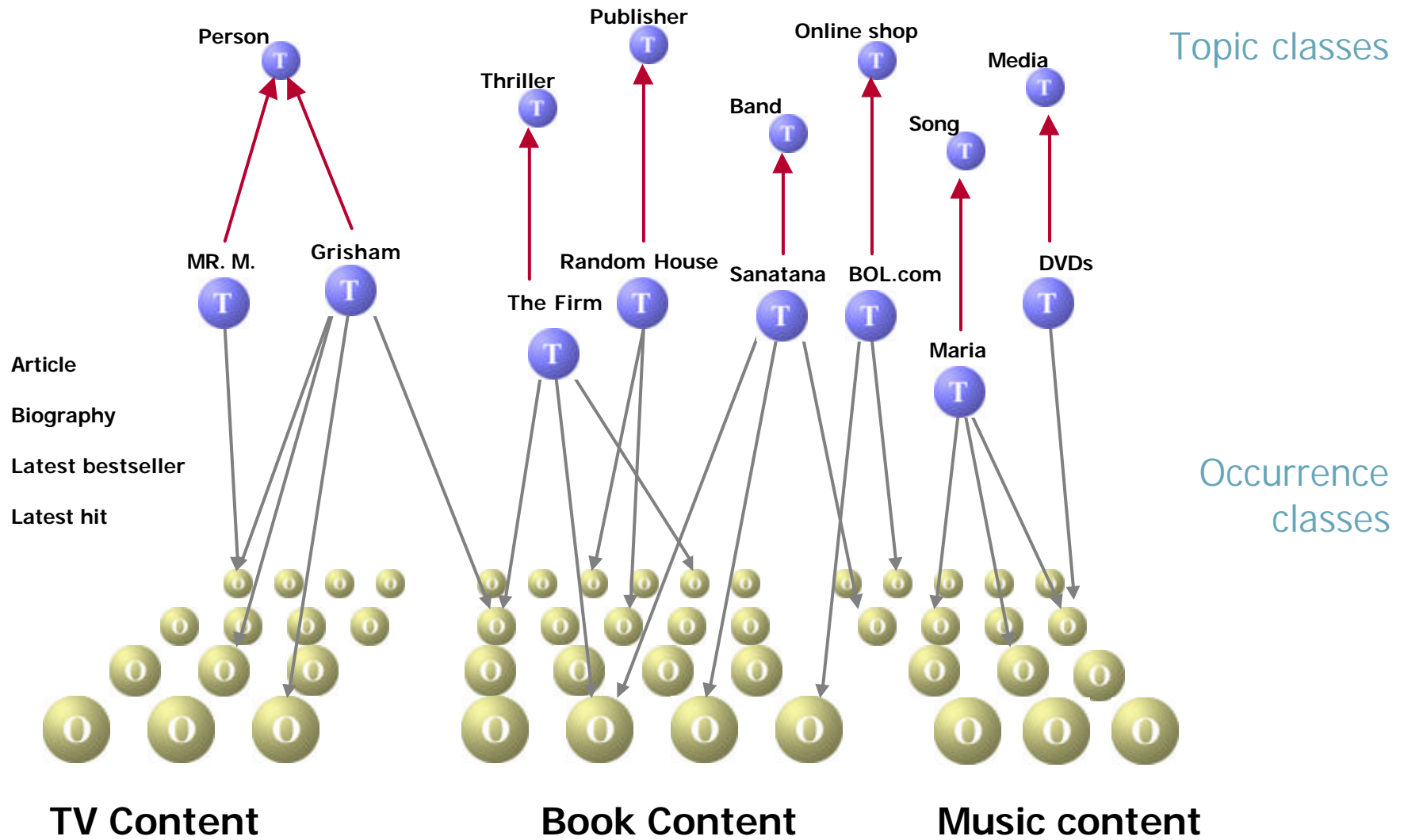
Association



# Topic Map Concepts

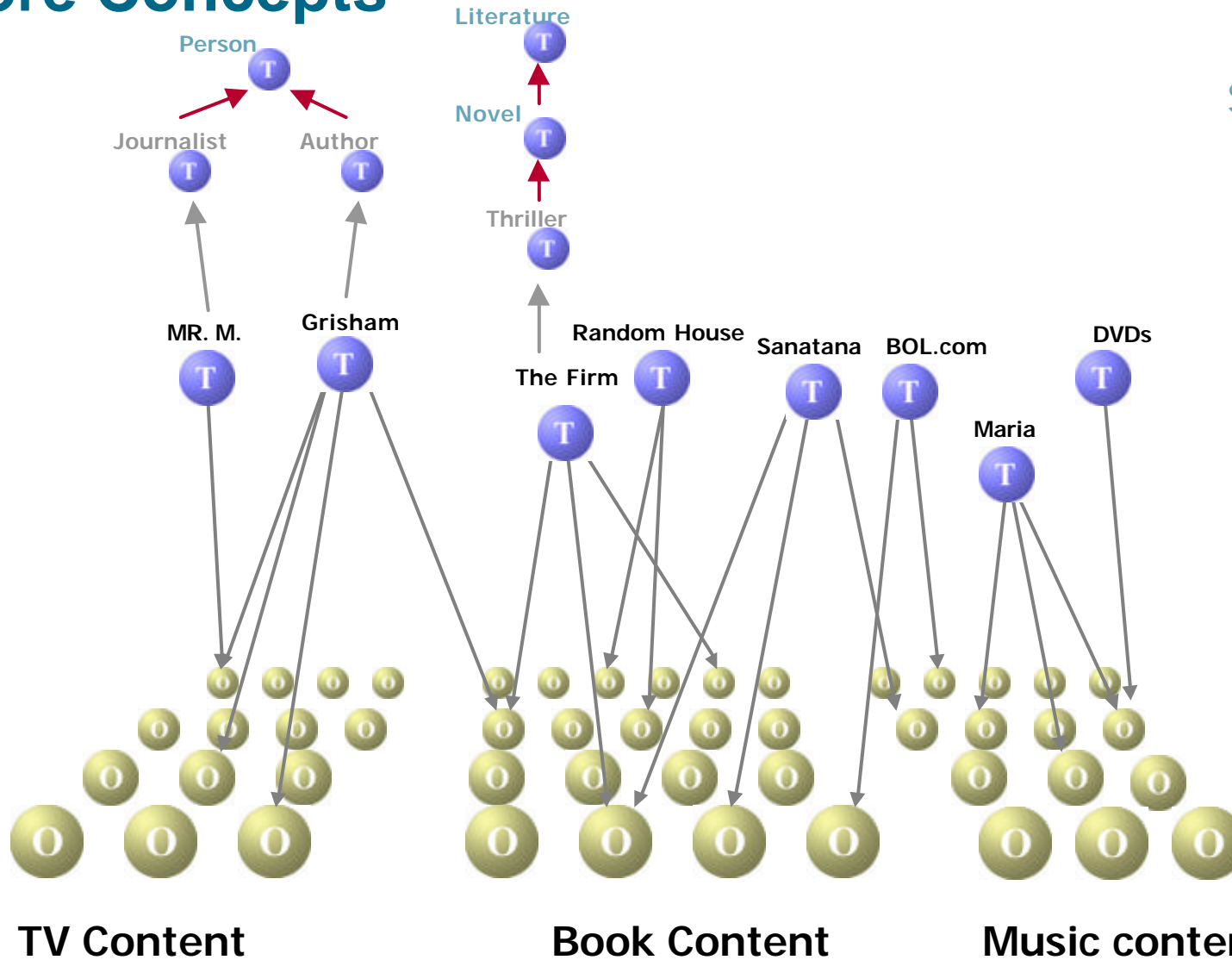


# More Concepts

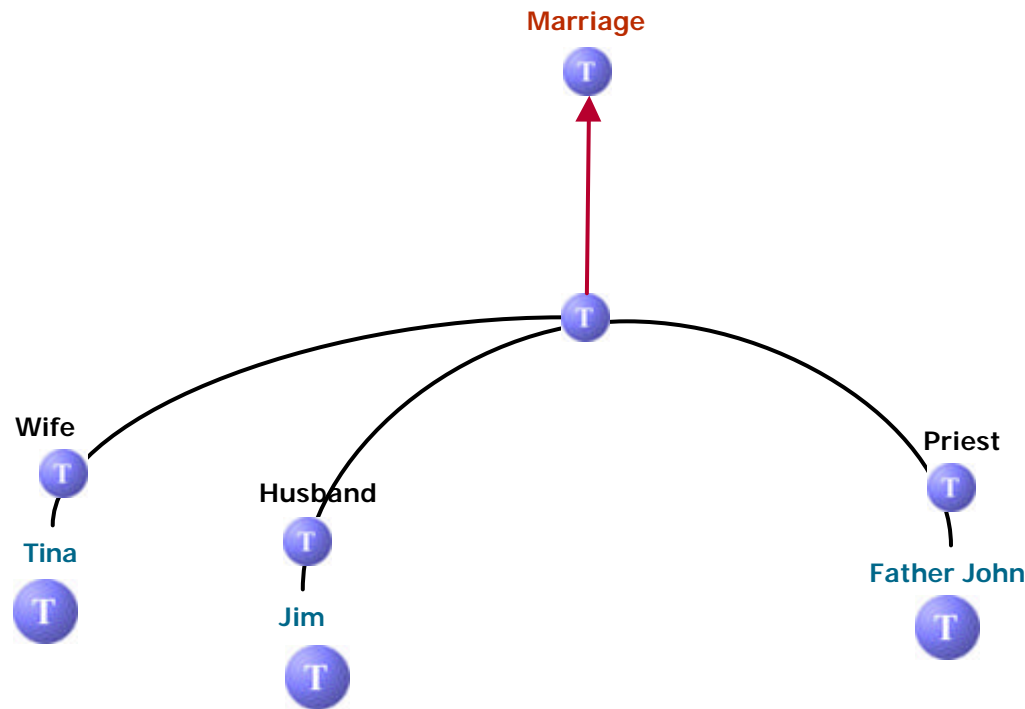


# More Concepts

Super classes



# Association Concepts



Association class

Association instance

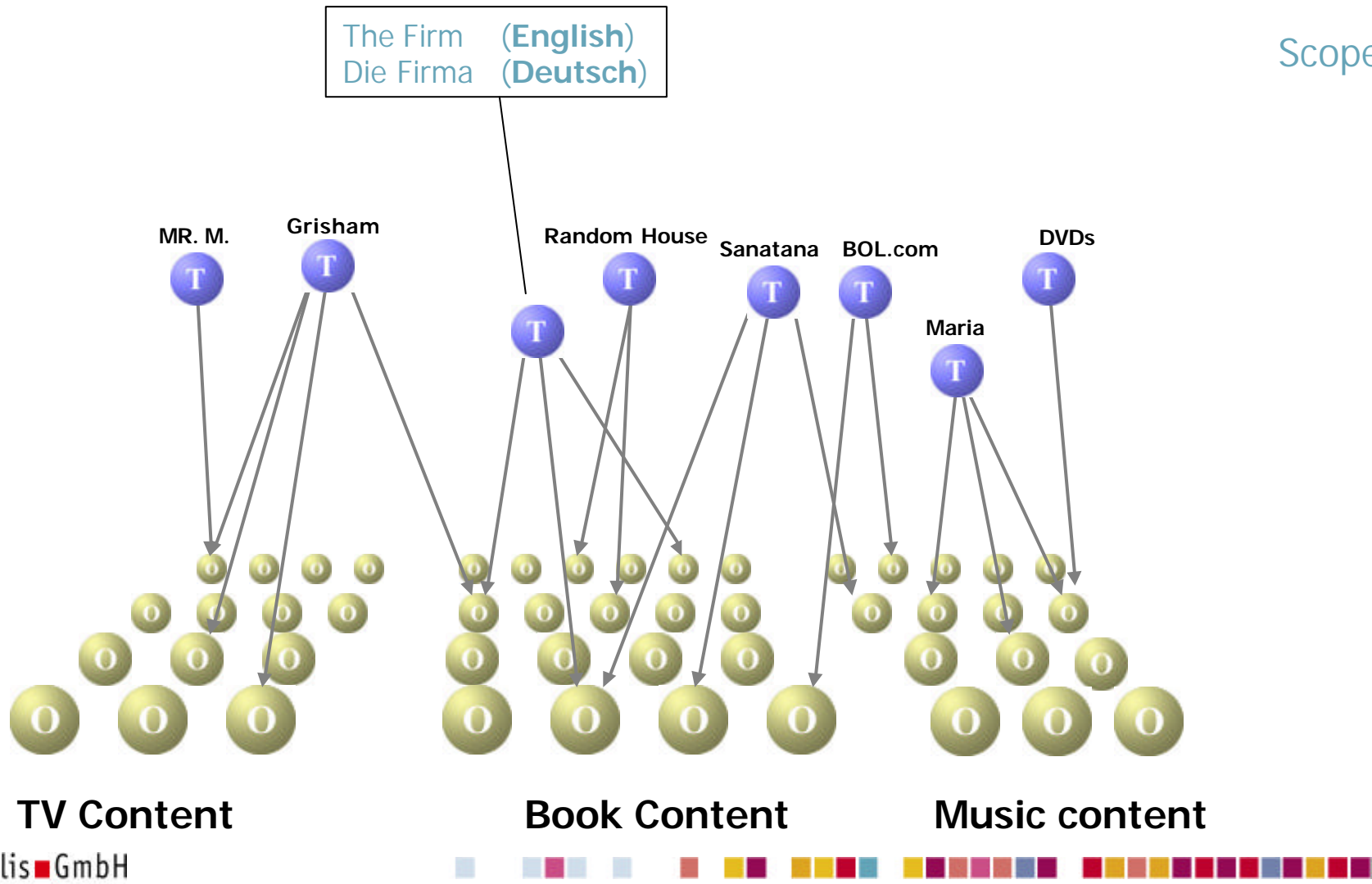
Assoc. roles

Role playing topics



# More Concepts

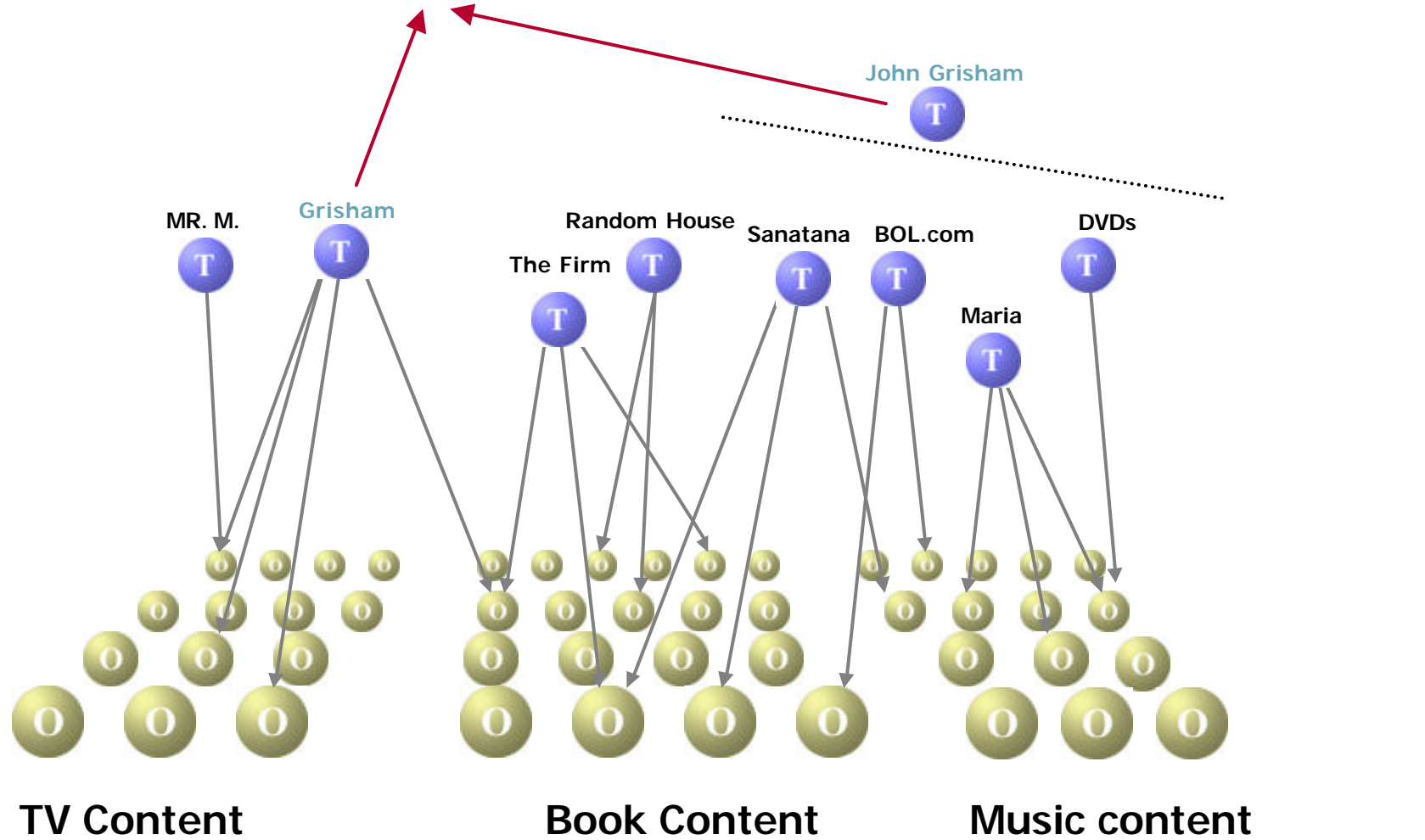
Scopes



# More Concepts

<http://www.topicmaps.org/PSI/authors.html#john-grisham>

Identity



## Summary: Topic Map Concepts

- Topic (reified subject)
- Occurrence
- Association, association role
- Topic class, occurrence class, and association class
- Class-instance
- Super-subclass
- Scope and scoping topic
- Identity and subject indicator





Scene III:

# The Family of Topic Map Standards

ISO/IEC 13250, Data Model,  
Conceptual Model,  
TMQL, TMCL



## Family of TM Standards

- ISO/IEC 13250:2000
  - ISO standard defining general concepts and interchange syntax (SGML/HyTime + XML/Xlink)
- TM Data Model
  - ISO project
  - The foundation of the TM paradigm
  - Independent of any particular (storage/interchange) syntax
- TM Conceptual Model
  - ISO project
  - Defines mapping between particular syntax (SGML and XML) and TM Data Model



## Family of TM Standards cont'd

- TMQL – TM Query Language
  - ISO project
  - ‘SQL’ for TMs
  - Standardized creation/modification of TMs stored in TM Management Systems
- TMCL – TM Constraint Language
  - ISO project
  - Framework for the definition of ontologies / schemas for vertical or domain specific applications
  - Support for semantic validation



Scene IV:

# Topic Maps and Related Paradigms

## Semantic Networks, RDF



# Topic Maps and Semantic Networks

- Pros of Semantic Networks:
  - Inheritance of node properties
  - Inferencing
  - Partitioning
  - Formal notation
- Pros of TMs:
  - Occurrences
  - Rich associations ( $n$ -ary, roles)
  - Subject Identity
  - Merging
  - Standardized notation



## Topic Maps and RDF

- TM / RDF – Similarities
  - Structured, complex metadata
  - Based on graphs
  - Standardized notations
  - Knowledge representation, ontologies
  - Help power the Semantic Web idea
  - TMs on top of RDF ↔ RDF on top of TMs



## Topic Maps and RDF cont'd

### ■ TM / RDF – Differences

TM	RDF
topic-centric	resource-centric
pre-defined semantics	simple data structure
<i>n</i> -ary associations with role players (instead of direction)	directed binary relations
distinguishes between addressable and non-addressable subjects	–
merging	–
real products, projects, use	'toys' (as of today)



# Act II: Allegro

## TMs and knowledge representation





## Quine's Criterion

# What is there?



## Quine's Criterion

# Everything!



Scene V:  
**Ontologies, Schemas,  
Templates**

**The Starting Point ...**



## TM Ontology

- John F. Sowa:

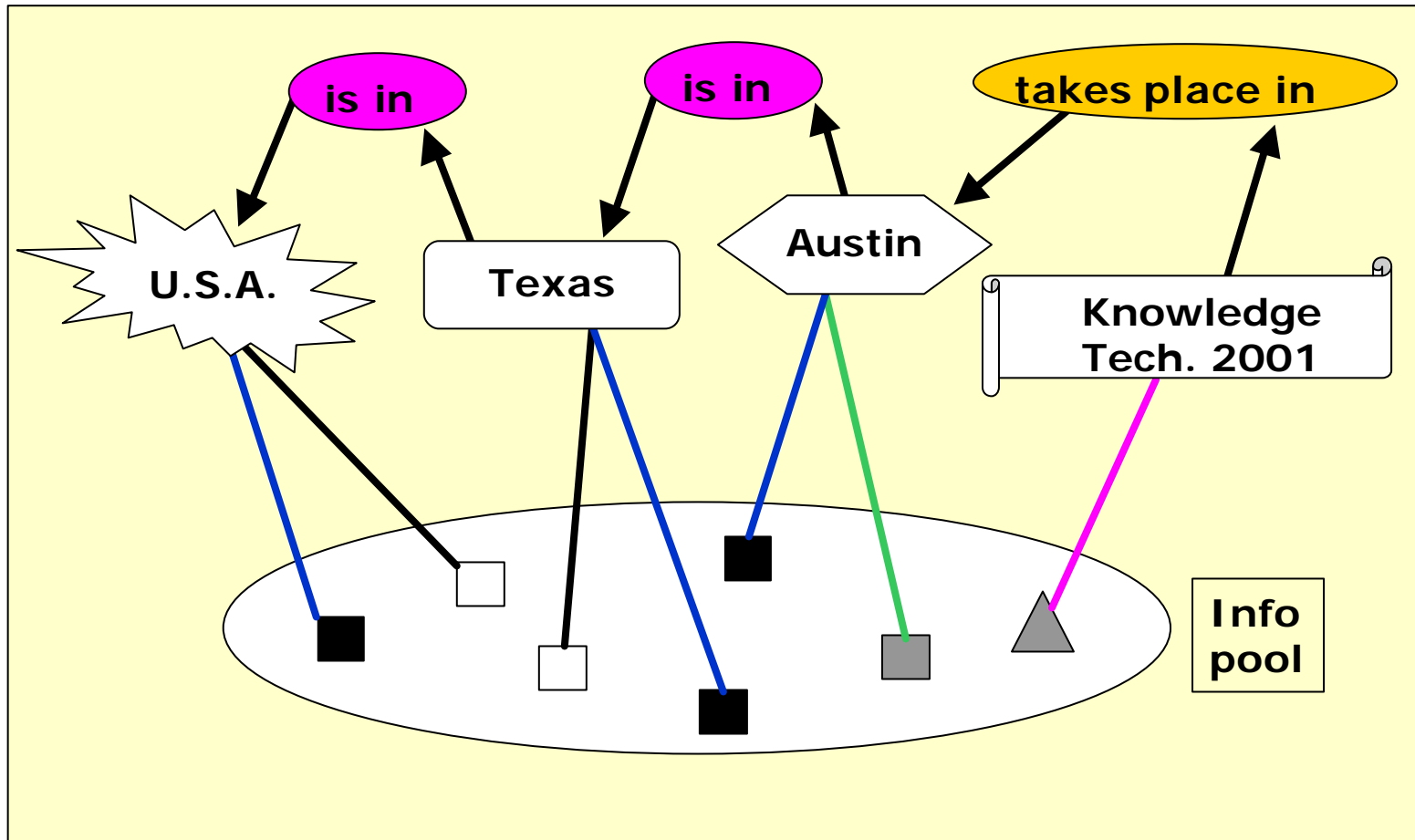
“*Ontology* defines the **kinds of things** that exist in the application domain.”

or

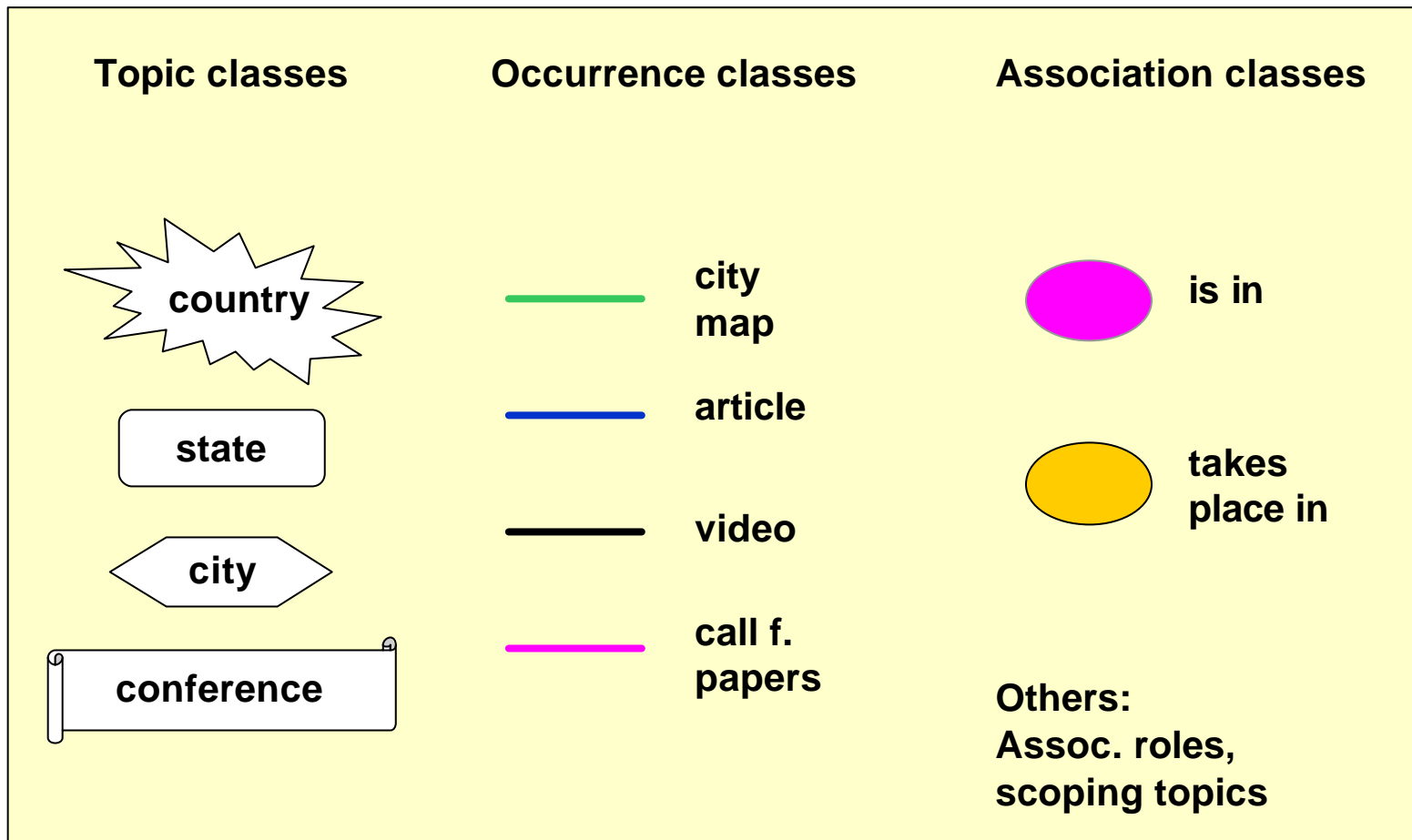
“A **classification** of the **types and subtypes of concepts and relations** necessary to describe everything in the application domain.”



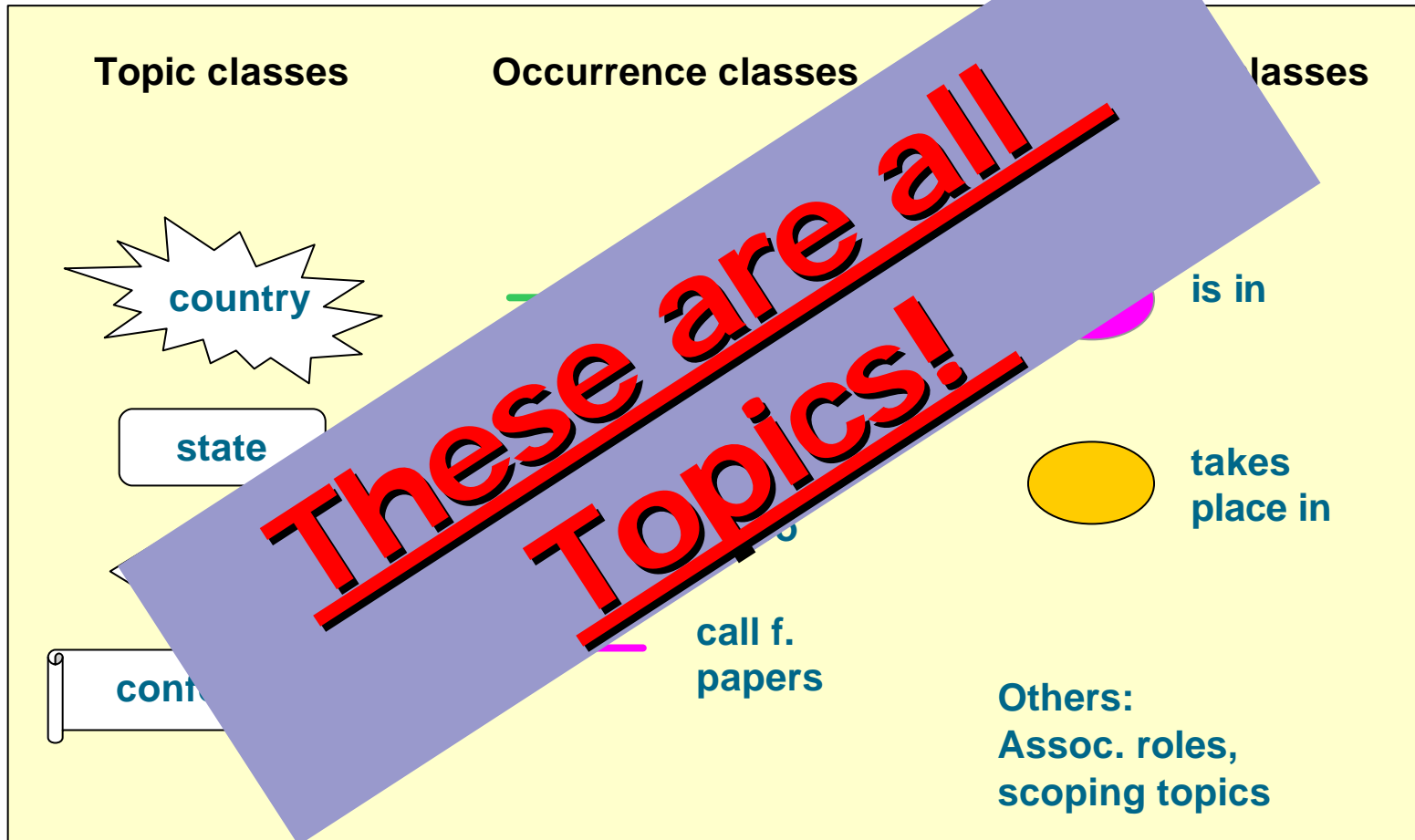
# “Real” TM



# Ontology TM



# Ontology TM



## Solution

- Terms **TM Ontology**, **TM Constraint**, **TM Template**, and **TM Schema** were coined by ISO committee
  - Cover all TM constructs which have a declarative meaning:
    - All classes and scoping topics
    - Classification (see later)
    - Constraints (see later)
- => ISO initiative **TM Constraint Language (TMCL)**





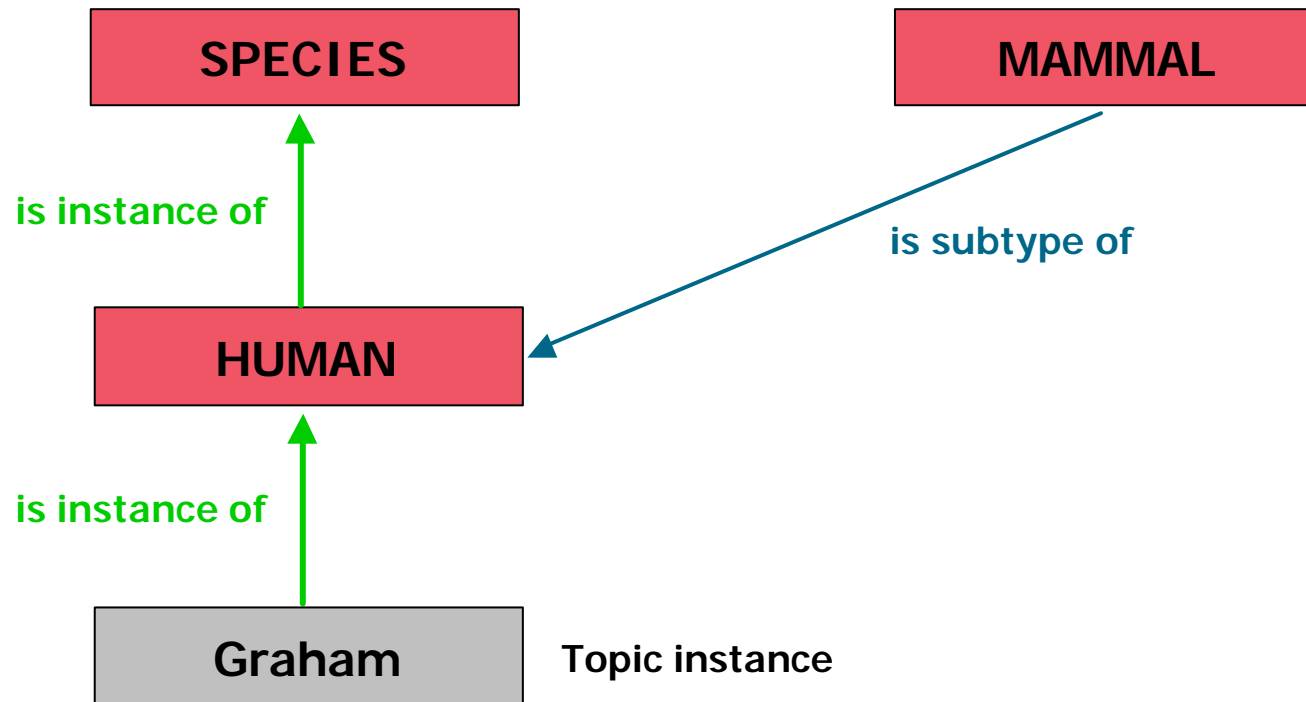
Scene VI:

# Class Hierarchies

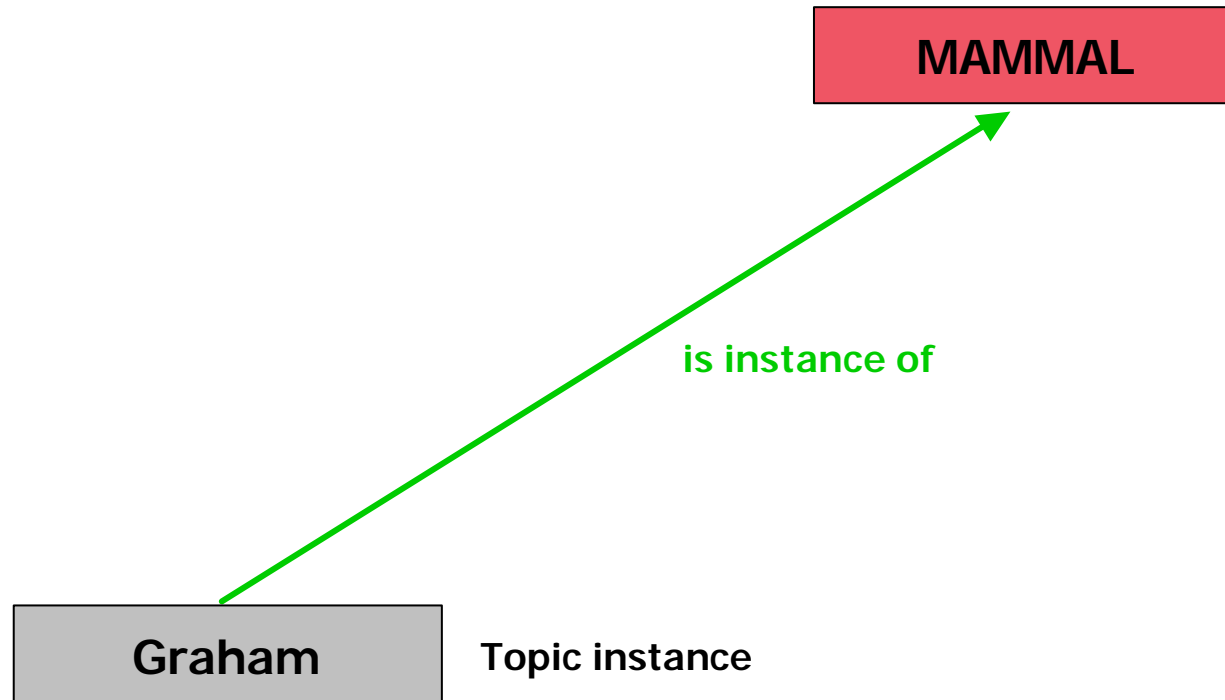
**Building blocks are part of XTM**



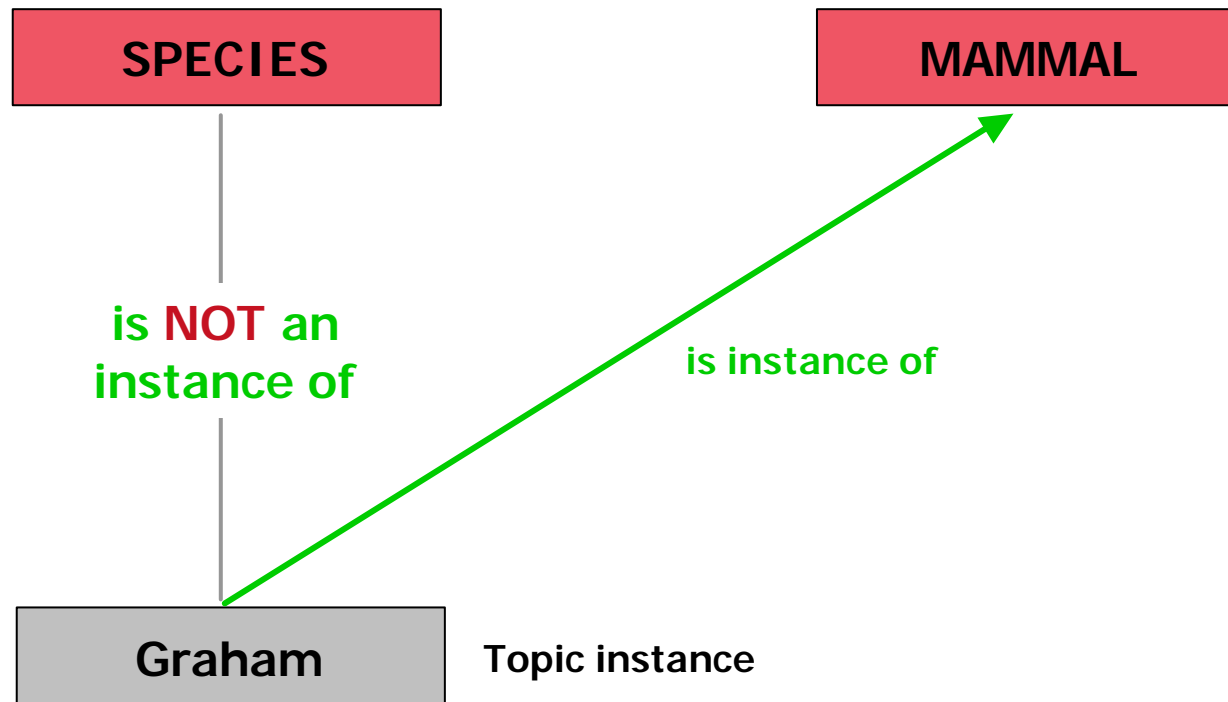
# Requirements



# Requirements cont'd



# Requirements cont'd



## Examples

### ■ Topic classes:

Object ®

piece of art ®

painting, sculpture, novel,  
poem, opera

Person ®

artist ®

painter, sculptor, writer,  
poet, composer



## Examples cont'd

### ■ Association classes:

Object “fostered by” person ®

piece of art “created by” artist ®

opera “composed by” composer



# Scene VII: Inferencing

Deducing knowledge ...



## Association Properties

- Assoc: **geo\_object is in geo\_object**
- Properties: **transitive, anti-reflexive, and anti-symmetric**
- Facts in TM:  
**Bavaria is in Germany**  
**Würzburg is in Bavaria**  
**Munich is in Bavaria**
- Derived knowledge:  
**Würzburg is in Germany**  
**Germany is not in Bavaria**



## Inference Rules

- Class hierarchies and transitivity allow deduction of knowledge not explicitly coded in TM
- But TM might contains more knowledge which could be derived
- Inference rules define – as part of the ontology – how to derive further knowledge



## Example

If \$topic1 is sibling of \$topic2  
and \$topic1 is male

then \$topic1 is a brother

(Eric Freese, XML Europe 2000, Paris)



## Rule components

- “if <condition> then <inference>” defines the inference rule
- “\$topic1” and “\$topic2” are variables which have to be instantiated when the rule is evaluated
- “is a sibling of” and “is a male” are the assoc. types in question
- “is a brother” is the inferred assoc. type



Scene VIII:  
**Consistency  
constraints**

**Dealing with millions of topics ...**



## The Needs

- Manual checking of large TMs is impossible but validation is a requirement
  - TM software should validate during design and creation
    - Permanently or on demand
    - Like structure validation in SGML/XML editors/parsers
  - Constraints control validation process
- => ISO initiative TM Constraint Language (TMCL)

## Example

- Topic type constraints:
  - Names (scope, number)
  - Occurrence role (scope, number)
  - Plays certain role in an association
  
- Example:
  - *Person*
  - *min. 1 englisch basename*
  - *biography (exactly 1), portrait (max. 1)*
  - *participates in born-in association*



## Example cont'd

- Association type constraints:

- Scope
- Association role (number)
- Topic types of associated topics

- Example:

- *is in*

- 1 *Containee*

- city  
county  
state

- 1 *Container*

- country, state, county  
country, state  
country



Scene IX:

# Topic Map Query Language (TMQL)

Query and modify TMs in a  
Standardized Manner



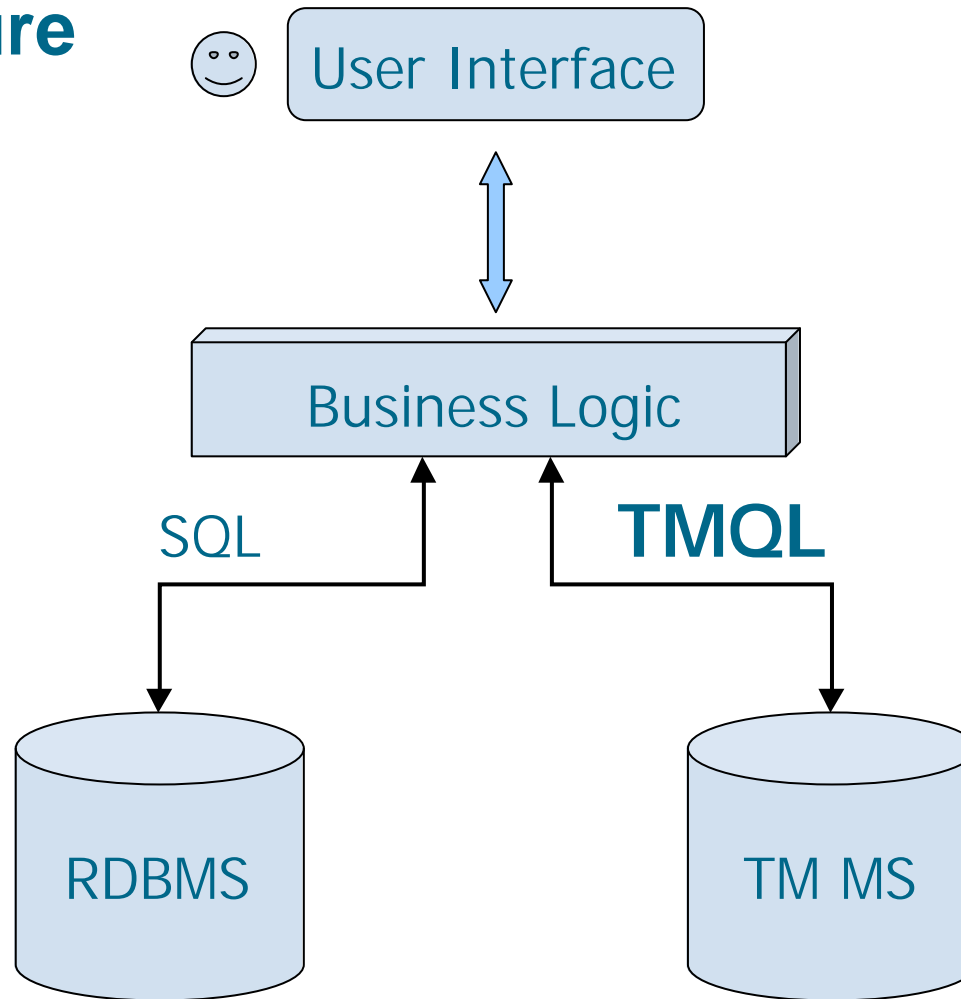


## TMQL Sound Bites ...

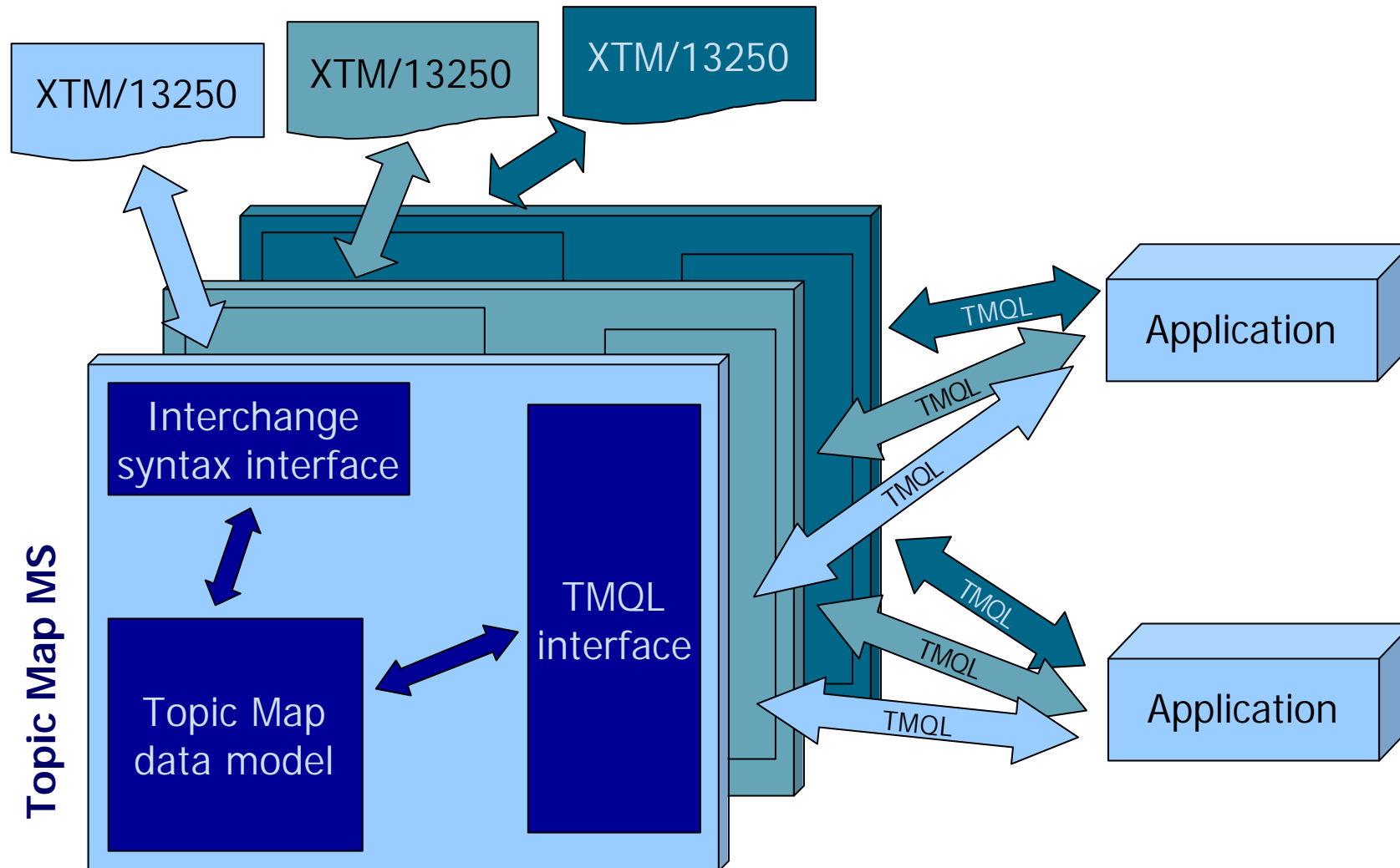
- **“Make Topic Maps Operational”**
- **“SQL for Topic Maps”**
- **“Backbone of Global Knowledge Interchange”**



# TMQL Applied to a 3-Tier Architecture



# TMQL System Context



Epilogue:  
**Conclusions**

## Topic Maps and the Ontological World



## Conclusions

- TMs provide a simple but powerful paradigm
- Real products and real projects and real productive use 18 months after publication of ISO standard
- Accompanying standards (TMCL, TMQL) make TMs ready for the Semantic Web and KM applications
- Harmonization with RDF
- But: TMs don't aim at "Heavy Ontologies" (yet)



# Some Resources

## Addressable and Non-Addressable



## Resources

### ■ Addressable

- <http://www.topicmaps.org>
- [topicmaps-comment@lists.oasis-open.org](mailto:topicmaps-comment@lists.oasis-open.org)
- <http://www.infloom.com/mailman/listinfo/topicmapmail>
- <http://k42.empolis.co.uk>

### ■ Non-addressable

- Standardization:  
ISO JTC1 SC34 WG3
- Vertical applications:  
OASIS Member Section TopicMaps.Org and its various  
Technical Committees



# Announcement: empolis k42<sup>®</sup> EGP

**Free access for  
research projects to k42**





## Announcement

**empolis k42<sup>®</sup> Education Grant Program  
gives non-profit research projects free  
access to its k42 Knowledge Server**

**Find more at**

**<http://k42.empolis.co.uk/egp.html>**



**</End>**

**Thank You!**

**Any Questions?**



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