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# Understanding Topic Maps

## Towards a Subject-Centric Revolution

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Topic Maps 2008, 2008-04-02



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# Which Steve Pepper?


Microsoft-seieren får pepper

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# Today's agenda

- **Subject-centric computing**
- **The problem of how to find stuff**
- **The TAO of Topic Maps**
- Demo
- **Four cool things to do with a topic map**
- **Applications of Topic Maps**



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# Digital information

- **Our biggest problem with digital information**
  - Making the content findable for users
- **This is the issue that Topic Maps addresses**
- **Topic Maps is**
  - An ISO standard for representing knowledge structures and relating them to information resources
  - ISO 13250 (Parts 1-7)
  - ISO 18048
  - ISO 19756
- **What it's really about is subject-centric computing**

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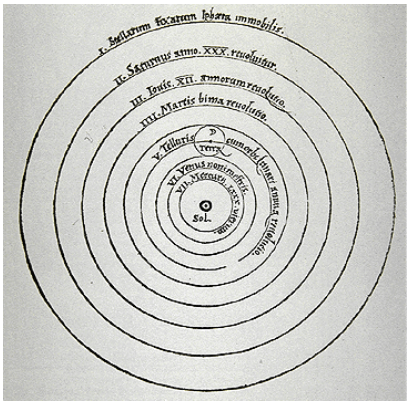
# The copernican revolution

- **For 1,000s of years people thought that the sun revolved around the earth**
  - Actually some Greek, Indian and Muslim scholars knew better, but the view of Aristotle, Ptolemy and the Christian Church was dominant
- **The publication of *On the revolutions of the celestial spheres* (1543) by Nicolaus Copernicus changed all that**
- **The heliocentric theory turned our understanding of the universe upside-down – or inside out.**



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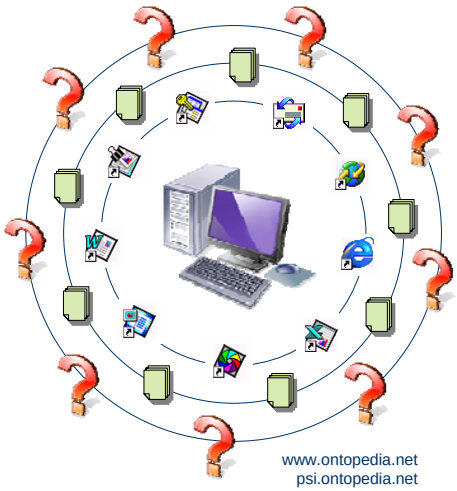
# The Topic Maps revolution

- **Today we face a similar situation in computing and information management**
  - Our computing universe has applications (and documents) at the centre
- **This is wrong, because it does not reflect how humans think**
  - Humans think in terms of subjects (or concepts)
- **We must put subjects at the centre, because that's what we're really interested in**
- **This is the subject-centric approach**



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# A subject-centric revolution

- **Today we face a similar situation in computing and information management**
  - Our computing universe has applications (and documents) at the centre
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# The Topic Maps value proposition

**Topic Maps provides the ability to**

- control infoglut and
- share knowledge

**by connecting**

- any kind of information
- from any kind of source

**based on its meaning.**

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# The problem of how to find stuff
## *Traditional approaches*

What is an index?

What are glossaries, thesauri, and semantic networks?





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# The problem of how to find stuff

- **Is the problem really "new"?**
  - How do you locate information in a book?
- **Isn't that what (back-of-book) indexes are for?**
  - An index is an information retrieval device
  - Publishers have traditionally set great store by indexes:
    - "There is no book … so good that it is not made better by an index, and no book so bad that it may not by this adjunct escape the worst condemnation" *(Sir Edward Cook)*
- **Indexes and maps**
  - The task of the indexer is to chart the topics of the document and to present a concise and accurate map for the readers
    - "A book without an index is like a country without a map"

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# What is an index, really?

Madama Butterfly, 70-71, 234-236, 326
Puccini, Giacomo, 69-71
soprano, 41-42, 337
Tosca, 26, 70, 274-276, 326

topics (in fact, *names of Topics*)

page numbers (locators for *Occurrences*)



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# Constituents of a (simple) index

- **Topics**
  - shown as a list of *topic names*
- **Occurrences**
  - shown as a list of *locators*
- **The kinds (or types) of topics may vary (and so might the addressing mechanism)…**

  **...but the principle is always the same**

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# A more complex index

*Cavalleria Rusticana*, 71, **203-204**
Mascagni, Pietro (composer)
*Cavalleria Rusticana*, 71, **203-204**
*Rustic Chivalry*, see *Cavalleria Rusticana*
singers, 39-52
See also individual names
baritone, 46
bass, 46-47
soprano, 41-42, 337n
tenor, 44-45

+ multiple indexes
+ other conventions

- *Index of names*
- *Index of places*
- *Index of subjects*

Additional concepts:

topic types
occurrence types
topics with multiple names
associations between topics



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# The key features of an index

Topics
- "subjects of discourse"
  - may have multiple names
  - may be typed

Associations
- relationships between subjects

Occurrences
- information relevant to a subject
  - pointed to via locators
  - may be typed

*These are also key concepts in the Topic Maps model*

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# OK, so what is a glossary?

**bass:** The lowest of the male voice types. Basses usually play priests or fathers in operas, but they occasionally get star turns as the Devil.

**diva:** Literally, "goddess" – a female opera star. Sometimes refers to a fussy, demanding opera star. See also prima donna.

**first lady:** See prima donna.

**Leitmotif** (German, "LIGHT-mo-teef"): A musical theme assigned to a main character or idea of an opera; invented by Richard Wagner.

**prima donna** ("PREE-mah DOAN-na"): Italian for "first lady". The singer who plays the heroine, the main female character in an opera; or anyone who believes the world revolves around her.

**soprano:** The female voice category with the highest notes and the highest paycheck.

- Glossaries have a different purpose than indexes:
- The purpose is not to provide pointers to every occurrence of a topic...
- ...but rather to provide one specific type of occurrence – the definition
- Therefore, instead of using locators (page numbers) to point to the definition...
- ...the definition is simply placed in-line.
- It looks different on paper, but the underlying model *is exactly the same*

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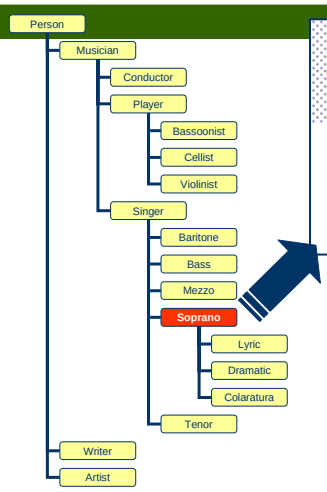
# And what is a thesaurus?




**Soprano**

| | |
|---|---|
| definition: | The highest category of female (or artificial male) voice |
| broader terms: | singer |
| narrower terms: | lyric soprano, dramatic soprano, coloratura soprano |
| related terms: | mezzo-soprano |

*But note one important new "feature": The associations are also typed…*

Basic concepts:

topics
associations
occurrences

Additional concepts:

topic types
occurrence types
**association types**

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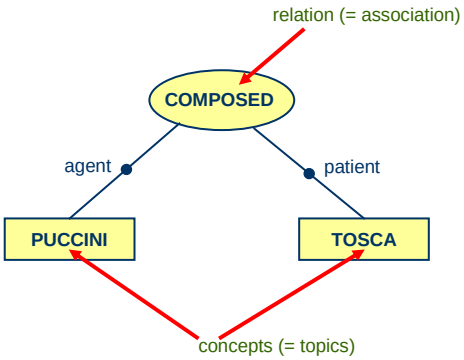
# And what are semantic networks?

- **From the realm of AI (artificial intelligence)**
- **A formalism for representing knowledge**
- **For example:**
  - "Puccini composed Tosca"
  - "Steve is convenor of WG3"
  - "Model B uses part X"
- **The principle building blocks are:**
  - concepts, and
  - relations



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# The TAO of Topic Maps

Topics
Associations
Occurrences

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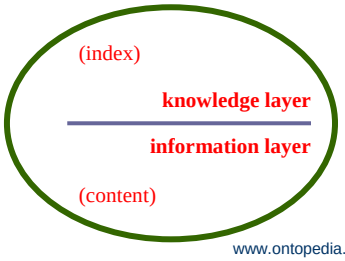
# The basic model

- **Core concepts based on the back-of-book index**
- **Extended and generalized for use with digital information**
- **Consider a two-layer model consisting of**
  - a set of information resources (below)
  - a "knowledge map" (above)
- **This is like the division of a book into content and index**





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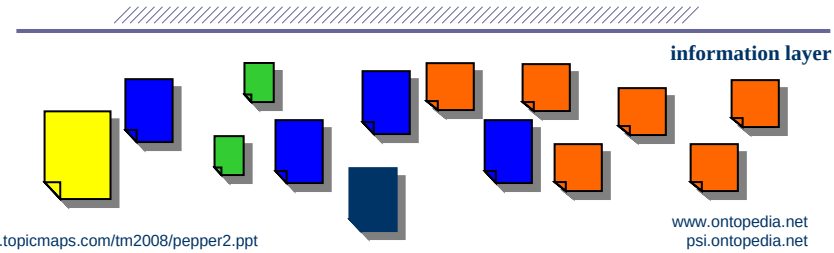
# (1) The information layer

- **The lower layer contains the content**
  - usually digital, but need not be
  - can be in any format or notation or location
  - can be text, graphics, video, audio, etc.
- **This is like the content of the book to which the back-of-book index belongs**



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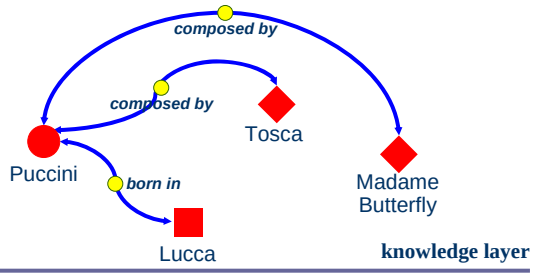
# (2) The knowledge layer

- **The upper layer consists of topics and associations**
  - **Topics** represent the subjects that the information is about
    - Like the list of topics that forms a back-of-book index
  - **Associations** represent relationships between those subjects
    - Like "see also" relationships in a back-of-book index



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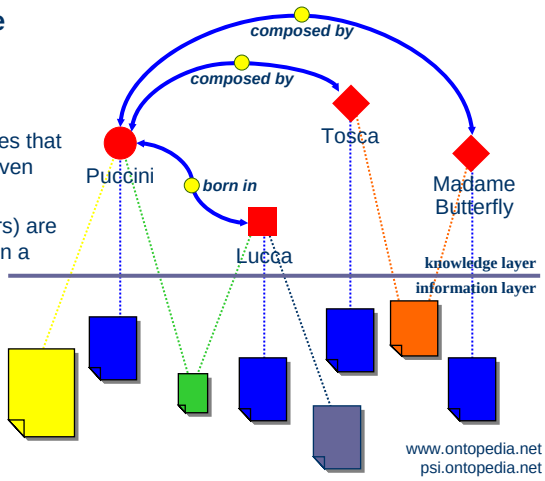
# Occurrences link the layers

- **The two layers are linked together**
  - **Occurrences** are relationships with information resources that are pertinent to a given subject
  - The links (or locators) are like page numbers in a back-of-book index



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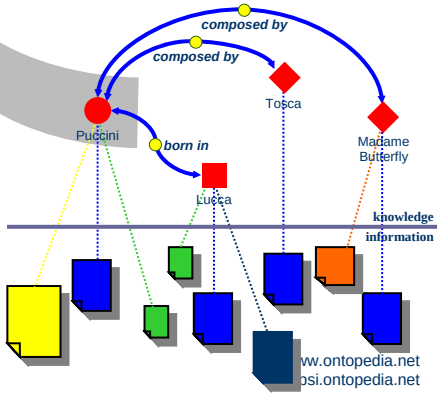
# Summary of core conc


**A pool of information or data, and a knowledge layer consisting of**

- **Topics**
  - a set of topics representing the key subjects of the domain in question
- **Associations**
  - representing relationships between subjects
- **Occurrences**
  - links to information that is somehow relevant to a given subject

= **The TAO of Topic Maps**

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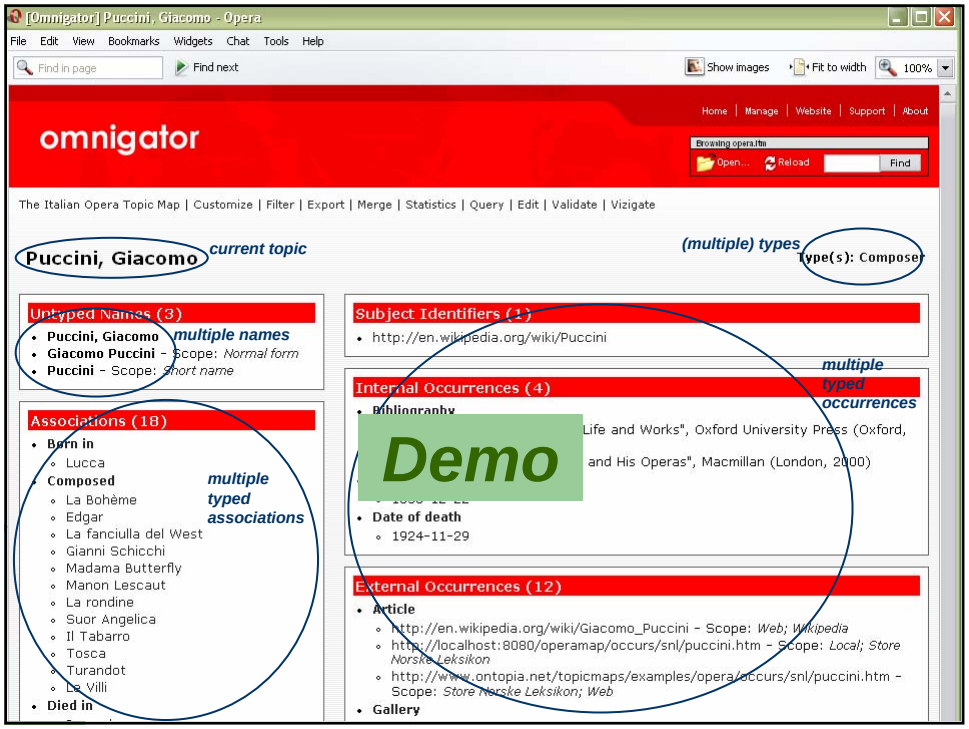

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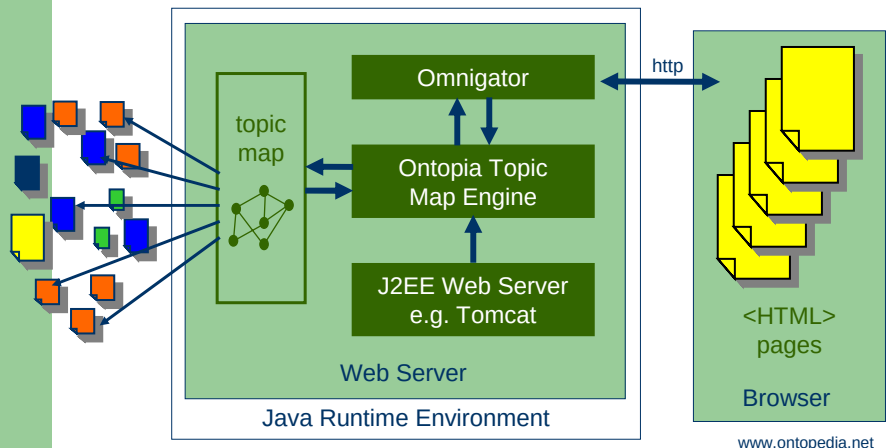
# How the Omnigator works



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# Typing topics

- **Basic building blocks are**
  - Topics: e.g. “Puccini”, “Lucca”, “Tosca”
  - Associations: e.g. “Puccini was born in Lucca”
  - Occurrences: e.g. “*http://www.opera.net/puccini/bio.html* is a biography of Puccini”
- **Each of these constructs can be typed**
  - Topic types: “composer”, “city”, “opera”
  - Association types: “born in”, “composed by”
  - Occurrence types: “biography”, “street map”, “synopsis”
- **All such types are also topics**

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# What Topic Maps can do

- **Represent subjects explicitly**
  - Topics represent the “things” your users are interested in – or know about
- **Capture relationships between subjects**
  - Associations provide user-friendly navigation paths to information
  - They also promote serendipitous knowledge discovery through browsing
- **Make information findable**
  - Topics provide a “one-stop-shop” for everything that is known about a subject
  - Occurrences allow information about a common subject to be linked across multiple systems or databases



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# What Topic Maps can do (cont.)

- **Represent taxonomies and thesauri**
  - Associations may represent hierarchical relationships
  - Topic Maps permits multiple, interlinked hierarchies and faceted classification
- **Transcend simple hierarchies**
  - Rich associative structures capture the complexity of knowledge and reflect the way people think
- **Manage knowledge**
  - The topic map is the embodiment of “corporate memory”

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# Four cool things to do with a topic map

Querying
Filtering
Visualizing
Merging

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# Querying topic maps

- **Topic Maps is based on a formal data model**
  - This means that topic maps can be queried, like databases
- **Topic Maps Query Language (TMQL)**
  - Allows more powerful use of taxonomies to retrieve information
  - Permits queries that would make Google boggle (see below)
- **Based on Ontopia's query language tolog**
  - (Demo of querying in the Omnigator)
- **Query example:**
  - *"Give me all composers that composed operas that were based on plays that were written by Shakespeare"*

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# Semantic full-text search

- **Traditional full-text indexing has its limitations**
  - Google is great, but
    - it doesn't always give you what you want
    - it always gives you more than you want
- **The problem is one of precision vs. recall**
  - Full-text indexes are based only on *names*
- **Homonyms og polysemes** (lead to low "**precision**")
  - The same name can mean many things
    - Paris (France, Texas, Trojan hero, botany, Reality TV, …)
- **Synonyms** (lead to low "**recall**")
  - One subject can have many names – even in the same language
    - genetically modified food, GM food, genetically modified foodstuffs
- **Topic Maps can add semantic precision**



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# Capturing context

- **A topic map is a knowledge base consisting of a set of assertions about the world**
  - Names, occurrences, associations are collectively known as statements
  - Each statement can be "scoped"
- **Contextual knowledge**
  - Some knowledge is only valid in a certain context, and not valid otherwise
  - Scope enables the expression of contextual validity
- **Multiple world views**
  - Reality is ambiguous and knowledge has a subjective dimension
  - Scope allows the expression of multiple perspectives in a single Topic Map

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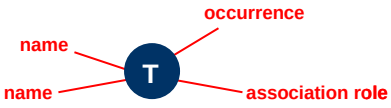
# How scope works

- **We make "statements" about topics**
  - Names, occurrences, associations
- **Every statement is valid within some context**
- **This can be captured using scope**
  - the name "Allemagne" for the topic Germany in the scope "French"
  - a certain information occurrence in the scope "technician"
  - a given association is true in the scope (according to) "Authority X"
- (Demo of scope-based filtering in the Omnigator)




Filtering by scope



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# Applications of scope

- **Multiple perspectives in a single topic map**
  - Capture the complexity of the real world
- **Representing contextual validity**
  - Ditto
- **Traceable knowledge aggregation**
  - Merge topic maps and retain information about provenance
- **Personalized knowledge**
  - Deliver filtered subsets of the topic map based on user needs

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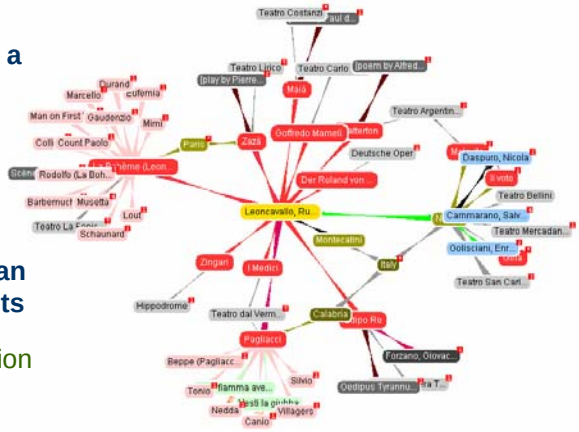
# Visualizing topic maps

- **The network or graph structure of a topic map can be visualized for humans**
- **This provides another "view" on information that can lead to new insights**
- (Demo of visualization using Vizigator)

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# Merging topic maps

- **Topic Maps can be merged automatically**
  - Arbitrary topic maps can be merged into a single topic map
  - This cannot be done with databases or XML documents
- **Merging enables many advanced applications**
  - Information integration across repositories
  - Sharing and reusing taxonomies
  - Automated content aggregation
  - Distributed knowledge management
- **Merging possible due to subject identity**
  - Robust mechanism for using URIs as identifiers...

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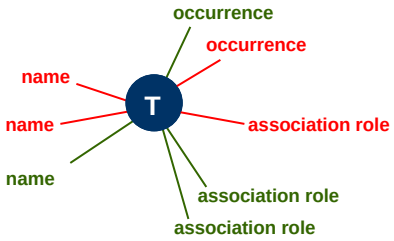
# Principles of merging

- **By definition: Every topic represents exactly one subject**
- **Our goal: Every subject represented by just one topic**
  1. When two topic maps are merged, topics that represent the same subject should be merged to a single topic
  2. When two topics are merged, the resulting topic has the union of the characteristics of the two original topics




...and the resulting topic has the union of the original characteristics

**(Demo of merging in the Omnigator…)**



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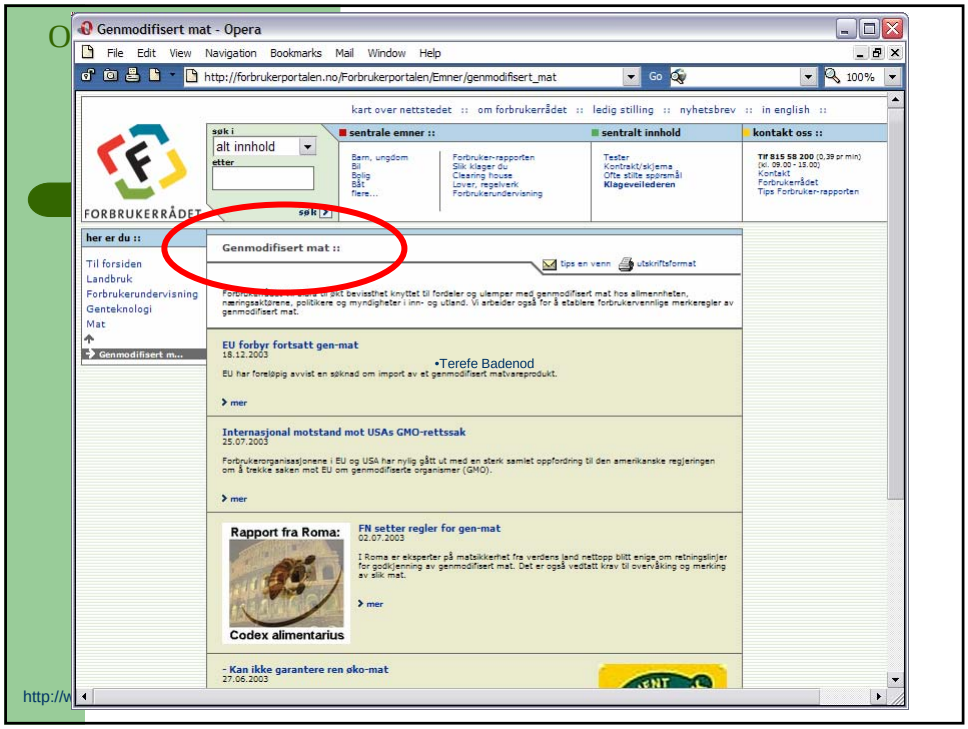
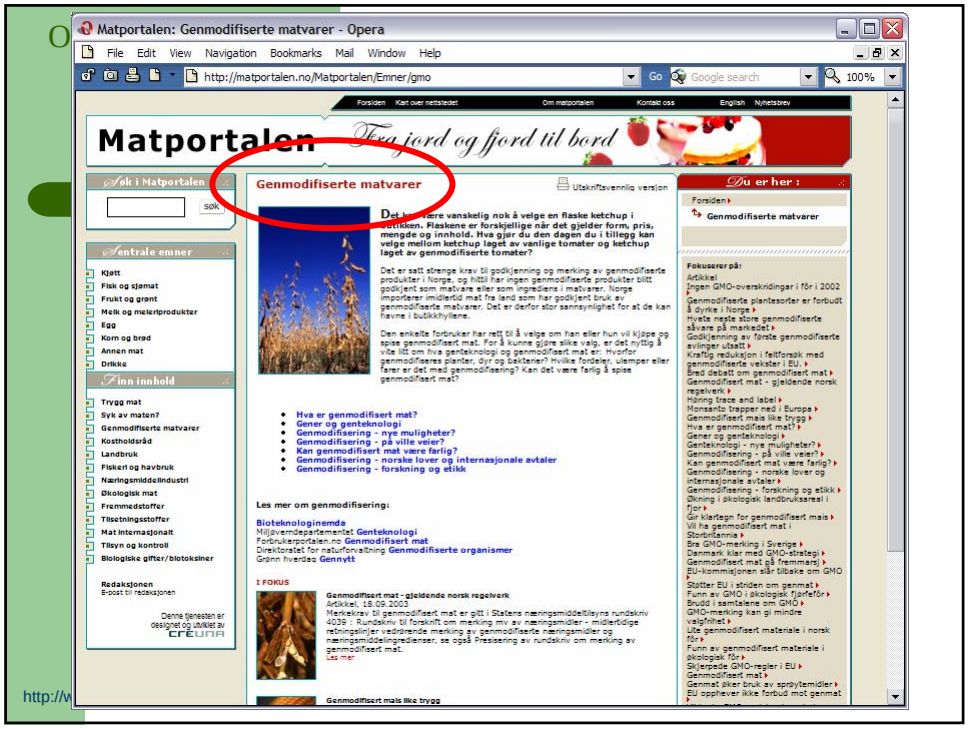
# A vision: seamless knowledge

- **Starting with ITU in 2001, Norway has seen an explosion in the number of portals that are based on Topic Maps**
  - Today there are dozens, especially in the public section
- **As the number of portals multiplies, the amount of overlap increases…**
  - The potential for integration is … mind-blowing
- **Take these three portals as an example:**
- **forskning.no** (Research Council web site aimed at young adults)
- **forbrukerportalen.no** (Norwegian Consumer Association)
- **matportalen.no** (Biosecurity portal of the Department of Agriculture)


forskning.no: Genmodifisert mat - Opera
http://www.forskning.no/Temaer/genmodifisert_mat
forskning.no
Genmodifisert mat
Sykdomsutbrudd av genmodifisert mais?
Professor Terje Traavik ved Genøk har gått ut med foreløpige funn som antyder at et sykdomsutbrudd i en filippinsk landsby kanskje kan kobles til genmodifisert mais. Saken har skapt furore verden over.
10.03.2004
Britene sier ja til genmodifisert mais
Storbritannia har gitt grønt lys for å dyrke genmodifisert mais på britisk jord. Dette er en historisk avgjørelse, selv om britene stiller en rekke betingelser til dyrkingen.
08.03.2004
Advarer mot genmanipulerte organismer
Et panel av amerikanske forskere mener vi vet for lite om konsekvensene når vi slipper genmanipulerte organismer ut i naturen. Nå oppfordrer de til større forsiktighet.
25.02.2004
Ja eller nei til genmodifisert mat?
"To be or not to be?" er ikke det heteste spørsmålet i Storbritannia for tiden. Det er snarere ja eller nei til genmodifisert mat. Etter lekkasje fra en regjeringskomité har spekulasjonene tatt av i pressen.
kultur
samfunn
helse
miljø
teknologi
hav og fiske
jord og skog
naturvitenskap
i fokus
Forskningsåret 2003
Det er ikke sunt å pynte seg - og annen god lærdom fra biologien
Det meste av det menneskelige er oss fremmed
Frankenfood, nazister og knokler på vidvanke
Noen kommer, noen går
Norge - moralens høyborg
Penger, privatisering og allmenn paranoia
Sorte hull, mørk energi og universets undergang
Været 2003 - mot normalt?


Genmodifisert mat - Opera
http://forbrukerportalen.no/Forbrukerportalen/Emner/genmodifisert_mat
FORBRUKERRÅDET
Genmodifisert mat ::
EU forbyr fortsatt gen-mat
18.12.2003
•Terefe Badenod
Internasjonal motstand mot USAs GMO-rettssak
25.07.2003
Rapport fra Roma:
Codex alimentarius
FN setter regler for gen-mat
02.07.2003
- Kan ikke garantere ren øko-mat
27.06.2003


Matportalen: Genmodifiserte matvarer - Opera
File Edit View Navigation Bookmarks Mail Window Help
http://matportalen.no/Matportalen/Emner/gmo
Matportalen
Fra jord og fjord til bord
Genmodifiserte matvarer
Utskriftsvennlig versjon
Du er her :
Forsiden
Genmodifiserte matvarer
Søk i Matportalen
Sentrale emner
Kjøtt
Fisk og sjømat
Frukt og grønt
Melk og meieriprodukter
Egg
Korn og brød
Annen mat
Drikke
Finn innhold
Trygg mat
Syk av maten?
Genmodifiserte matvarer
Kostholdsråd
Landbruk
Fiskeri og havbruk
Næringsmiddelindustri
Økologisk mat
Fremmedstoffer
Tilsetningsstoffer
Mat internasjonalt
Tilsyn og kontroll
Biologiske gifter/biotoksiner
Redaksjonen
E-post til redaksjonen
Hva er genmodifisert mat?
Gener og genteknologi
Genmodifisering - nye muligheter?
Genmodifisering - på ville veier?
Kan genmodifisert mat være farlig?
Genmodifisering - norske lover og internasjonale avtaler
Genmodifisering - forskning og etikk
Les mer om genmodifisering:
I FOKUS
Genmodifisert mais like trygg

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Three portals – one subject
➔ one “virtual portal”
with seamless navigation in all directions
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# Making information findable

- **Intuitive navigational interfaces for humans**
  - The topic/association layer mirrors the way people think, learn and remember
- **Powerful semantic queries for applications**
  - A formal underlying data structure
- **Customized views based on individual requirements**
  - Personalized information delivery using scope
- **Information aggregation across systems and organizations**
  - Topic Maps can be merged automatically



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Taxonomy Management
Metadata Management
Semantic Portals

# Applications of Topic Maps

Information Integration
eLearning
Business Process Modelling
Product Configuration
Business Rules Management
IT Asset Management
Asset Management (Manufacturing)

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# Taxonomy management

- **For managing unstructured content**
  - Organization by subject – because that's how users search
- **A taxonomy is a simple form of topic map**
  - Topic Maps provides subject-based organization *de-luxe*
- **Using Topic Maps offers many benefits:**
  - Standards-based means vendor independence and data longevity
  - Associative model allows for evolution beyond simple hierarchies
  - The taxonomy can also be used as a thesaurus, a glossary or an index
  - Identity model permits merging and reuse
- **Dutch Tax and Customs Administration (Belastingdienst) uses Topic Maps as the basis of a taxonomy management system**
  - http://www.idealliance.org/papers/dx_xmle04/papers/04-01-03/04-01-03.html
- **Capability can be added to any Content Management System**



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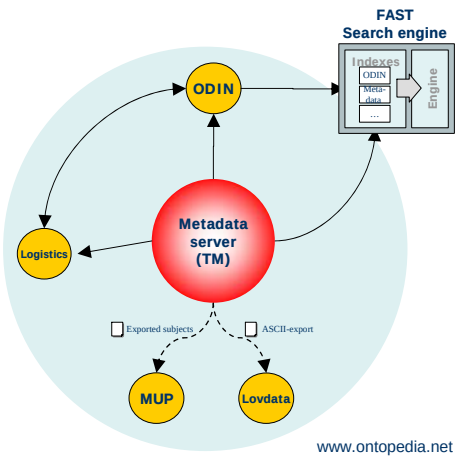
# Metadata management

- **A Metadata Server based on Topic Maps**
  - Management of metadata for government publications
  - Used in the central public information portal (ODIN)
- **Primary goal**
  - Ensure much greater consistency in the use of metadata across different government publications in order to improve findability for users
- **ODIN now re-architected as regjeringen.no**
  - Solution based on Topic Maps



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# Semantic portals

- **Topic Maps as the Information Architecture**
  - for web-based publishing (web sites, portals, intranets, etc.)
- **Site structure is defined as a topic map**
  - Each page represents a topic (subject-centric)
  - User-friendly navigation paths defined by associations
  - Topics used to classify content
- **Potential for subject-based portal connectivity**
- **Smooth evolution into Knowledge Management solutions**



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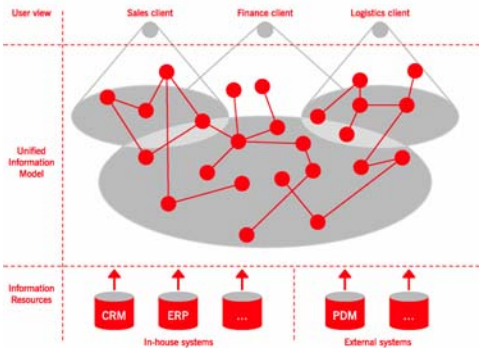
# Enterprise information integration

- **Topic Maps are designed for ease of merging**
  - Generate topic maps from structured data (or create topic map views of that data)
  - Merge topic maps to provide a unified view of the whole
- **Easy to filter**
  - Create personalized views of this unified model
- **Advantages:**
  - Consolidated access to all related information
  - No need to migrate existing content
  - Standards-based

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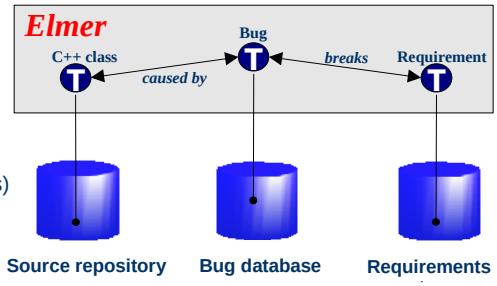
# Enterprise information integration

- **Example: Elmer project at Starbase (Borland)**
  - Integration server for software information
- **Multiple disparate applications hold related data**
  - Unified topic map layer enables search across repositories
  - Data integration without changing the underlying applications
- **Portal interface**
  - Intuitive navigation
  - Full-text and structured queries
- **Smarttags integration**
  - Elmer terms (topic names) highlighted
  - Provide links into the portal

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# E-learning: BrainBank

- **Topic maps are associative knowledge structures**
  - They reflect how people acquire and retain knowledge
- **Students describe what they have learned**
  - Pilot users: 11-13 year olds
- **Key learning concepts are**
  - captured, named, described
  - associated with other concepts
- **Students are able to**
  - capture the essence of a subject
  - describe what they have learned
  - keep track of their knowledge
- **Teachers are able to**
  - monitor students' understanding

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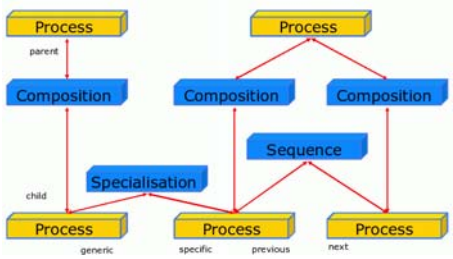
# Business processes

- **Multinational petrochemical company**
  - Uses TMs to manage business process models
  - Flexible model allows arbitrary relationships to be captured easily
- **Processes are modelled in terms of**
  - Steps involved, their preconditions, their successors, etc
- **Processes related through**
  - Composition (one process is part of another),
  - Sequencing (one process is followed by another),
  - Specialization (one process is a special case of a more general process)

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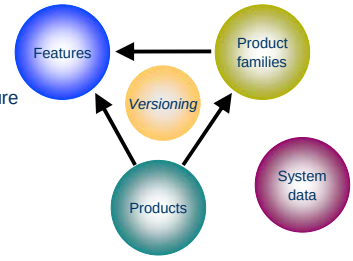
# Product configuration

- **Managing product configuration for mobile phones**
  - Products belong to families
  - Features belong to products or product families and are grouped in feature sets
  - There are dependencies between features and they apply in different regions, etc.
- **Network of dependencies is already quite complex**
  - Now throw versioning into the mix!
  - Managing all this data is not easy…
- **Dependencies modelled in a topic map**
  - Product configuration engineers use this to configure products using a very user-friendly interface
- **System is driven by inference rules**
  - These work on the topic map
  - Easily capture complex logic
  - Also integrates with product documentation

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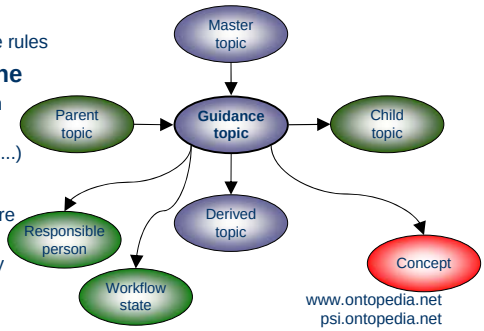
# Business rules

- **US Department of Energy: Rules for security classification**
  - Information about the production of nuclear weapons subject to thousands of rules
  - Rules published in 100s of documents
  - Most documents are derived from more general documents
- **Guidance topics form a complex web of relationships**
  - Captured in a topic map (KB)
  - Concepts connected to if-then-else rules
- **KB used with inference engine**
  - automatically classifies information (documents, emails, ...), and
  - "redacts" information (PDF, email, ...)
- **Benefits:**
  - Model expressive enough to capture complexity of the rules
  - ISO standard = stability & longevity

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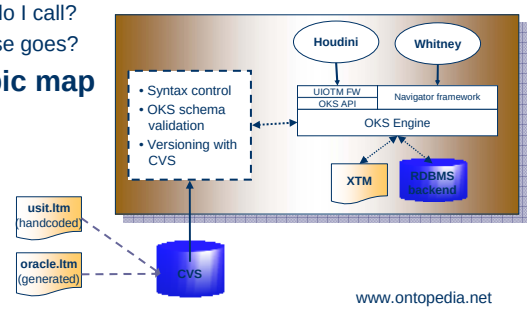
# IT assets

- **University of Oslo: Management of IT assets**
  - Servers, clusters, databases, etc. described in a TM (KB)
- **Used to answer questions like**
  - If operating system Z is upgraded, what apps are affected?
  - Service X is down, who do I call?
  - If I take Y down, what else goes?
- **Uses composite topic map**
  - Partly autogenerated
  - Partly handcoded
- **Two applications**
  - Whitney: online
  - Houston: offline (for use in emergencies)

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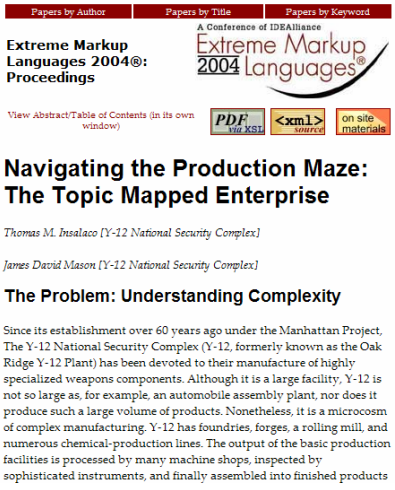
# Manufacturing assets

- **US Department of Energy**
- **Topic map describes Y-12 manufacturing facility**
- **Provides overview of**
  - equipment,
  - processes,
  - materials required,
  - parts already built,
  - etc.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**Navigating the Production Maze: The Topic Mapped Enterprise**

*Thomas M. Insalaco [Y-12 National Security Complex]*

*James David Mason [Y-12 National Security Complex]*

**The Problem: Understanding Complexity**

Since its establishment over 60 years ago under the Manhattan Project, The Y-12 National Security Complex (Y-12, formerly known as the Oak Ridge Y-12 Plant) has been devoted to their manufacture of highly specialized weapons components. Although it is a large facility, Y-12 is not so large as, for example, an automobile assembly plant, nor does it produce such a large volume of products. Nonetheless, it is a microcosm of complex manufacturing. Y-12 has foundries, forges, a rolling mill, and numerous chemical-production lines. The output of the basic production facilities is processed by many machine shops, inspected by sophisticated instruments, and finally assembled into finished products



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# Conclusion

Value Proposition
Key Strengths

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## The Topic Maps value proposition

**Topic Maps provides the ability to**

- control infoglut and
- share knowledge

**by connecting**

- any kind of information
- from any kind of source

**based on its meaning.**



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## Two key strengths

- **It is able to do this because of two key strengths**
  - A flexible and intuitive knowledge model
  - A robust model of identity
- **The combination of these features makes it possible merge arbitrary topic maps – efficiently, reliably and, above all, usefully**
  - Based on an international standard

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# "Flexible"

- **Any knowledge model**
  - can be represented as a topic map
    - includes indexes, glossaries, thesauri, subject classification systems, bibliographic records, faceted classification, etc.
- **Any data structure**
  - can be "viewed" as a topic map
    - e.g. relational (RDB), hierarchical (XML), associative (RDF)
- **A single topic map**
  - can represent a combination of all of these



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# "Intuitive"

- **TAO model is easy for humans to grasp**
  - Reflects the associative way in which the brain stores, accesses, and acquires knowledge
- **"Just enough" semantics for useful application in information management**
  - topics to represent concepts (subjects)
  - names to be able to talk about them
  - n-ary associations to represent relationships
  - occurrences to connect resources to concepts
  - scope to capture the context of assertions

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## "Robust"

- **Based on URIs (actually, IRIs), and**
- **Recognizes the fundamental ontological distinction between information resources and resources in general, i.e.**
  - between subjects in general (which can be anything at all)
  - and the subset of subjects which can be identified by their actual network location



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## Summary

- **Topic Maps is an ISO standard for describing knowledge models and connecting them to information resources**
- **Any knowledge model or data structure can be represented as a topic map**
- **Topic maps can be merged**
- **This technology can solve many of today's information management challenges**
- **Subject-centric computing is the future**


***"Now! …. That should clear up a few things around here!"***