TDT4252 / DT8802 Enterprise Modelling and Enterprise Architecture

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Overview of lecture today

- Introduction to Enterprise Modelling

Based on the following articles:

A5: Enterprise Project: The Enterprise Ontology, http://www.aiai.ed.ac.uk/project/enterprise/enterprise/ontology.html

A6: Fox, M. S. and Gruninger, M. 1998. Enterprise Modelling. AI Magazine, Fall.109-121.

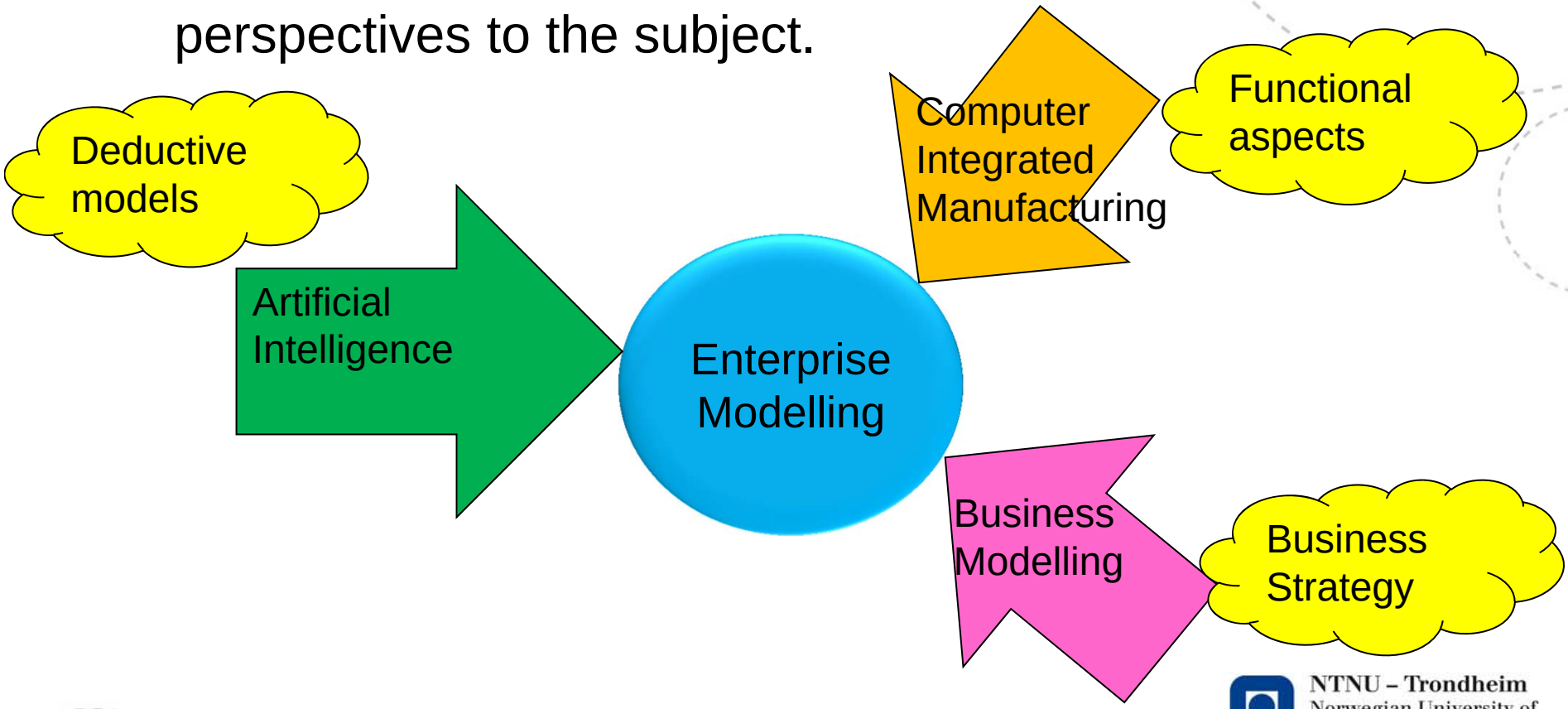
Additional Reading:

Vernadat, F. B. (1996), Chapter 3: Enterprise Modelling. Chapman and Hall, pp. 69-117. ISBN: 0 412 60550 3.

Lillehagen and Krogstie (2008), Chapter 4: State of the Art of Enterprise Modelling. Springer-Verlag, Berlin, Heidelberg. pp. 91-118.

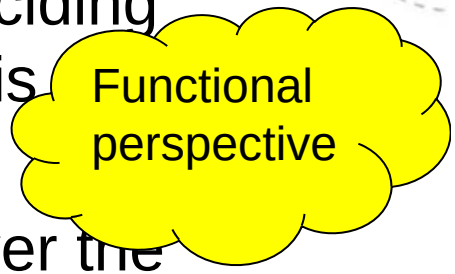
Points of View

- Enterprise Modelling has been of interest to several research areas, and they all bring in different perspectives to the subject.



Enterprise Models: Definition

- An enterprise model is a consistent set of special-purpose and complementary models describing various facets of an enterprise to satisfy some purpose of some business users. (Vernadat)
- In this case, the purpose of business users mostly deals with describing, designing, analysing, deciding or controlling operations and components of this enterprise.
- The contents of the enterprise model is whatever the business user considers important to describe.



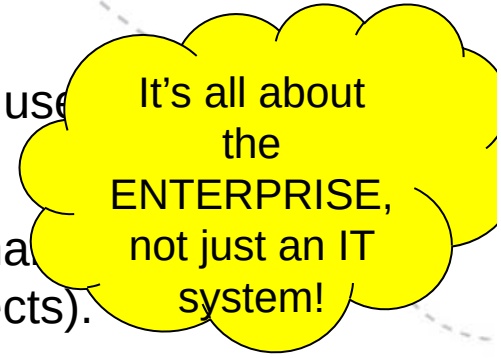
Enterprise Modelling: Definitions

- A computational representation of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business, government, or other enterprise. (Fox & Gruninger)
- Enterprise modelling is the set of activities or processes used to develop the various parts of an enterprise model to address some desired modelling finality. (Vernadat)
- A collective name for the use of models in Enterprise Engineering and Enterprise Integration. (Bernus)

Enterprise Modelling: Purpose

Remember we said that modelling is not always for IT systems design……

- To represent and understand how the enterprise works.
- To capitalise acquired knowledge and know-how for later use.
- To rationalise and secure information.
- To (re)design and specify a part of an enterprise (functional, behavioural, information, organisational or structural aspects).
- To analyse some aspects of the enterprise (economic analysis, oranisational, qualitative, etc.)
- To simulate the behaviour of some parts of the enterprise.
- To make better decisions about enterprise operations and organisation
- To control, coordinate or monitor some parts of the enterprise.



Ref: Vernadat

Enterprise Modelling

Based on the article:

A6: : Fox, M. S. and Gruninger, M. 1998. Enterprise Modelling. AI Magazine, Fall.109-121.

This provides the operational perspectives of an Enterprise and takes an AI approach.

Background

- Enterprises must become agile and integrated across their functions to remain competitive.
- Being agile implies that enterprises must be able to change or adapt easily.
- If there are changes, we need to be able to determine the impact of changes on all parts of the enterprise.

Motivation

- Agility – the key to remain competitive!

A greater degree of communication, coordination and cooperation within and among enterprises –
Enterprise Integration.

Enterprise Integration (1)

- It is concerned with providing seamless communication, cooperation and coordination between enterprises as well as among different functionalities within a single enterprise.
- It is aimed towards improved interoperability.
- It is concerned with facilitating information, control and material flows across organisational boundaries by connecting all the necessary functions and heterogeneous functional entities in order to improve communication, cooperation and coordination within the enterprise, such that the enterprise behaves as a whole.

Enterprise Integration (2)

Structural Integration

Behavioural Integration

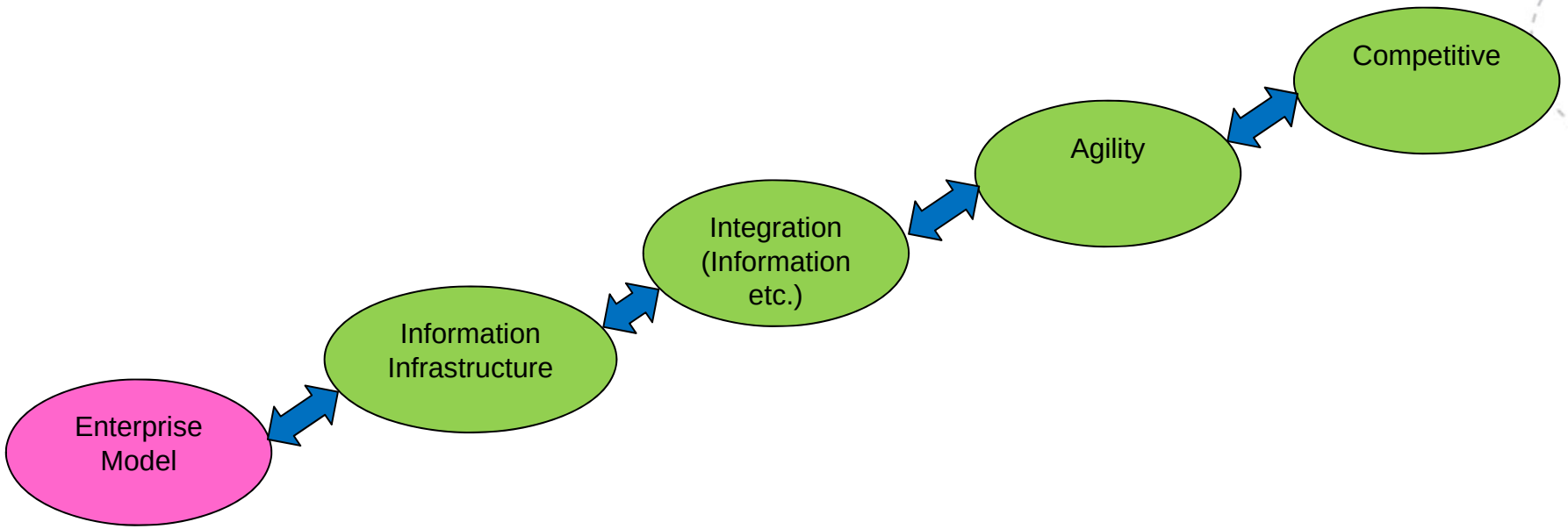
Information Integration

5 Principles of Behavioural and Information Integration:

1. When people understand the vision, they will do the right thing.
2. Empowered people.
3. Comprehensive and effective communications network.
4. Democratisation and dissemination of information throughout the network.
5. Information freely shared with empowered people, distributing the decision process throughout the organisation.

Enterprise Integration (3)

- Achieving integration requires an Information Infrastructure that supports the communication of information and knowledge, the making of decisions and the coordination of actions.
- At the heart of this infrastructure lies a model of the enterprise.



Role of an Enterprise Model

- Towards supporting model-driven enterprise design, analysis and operation.

Perspectives	Examples
Design	An Enterprise Model should provide the language used to define an enterprise. It should support the possibility to explore alternative designs or models. Need to reason about alternative designs, e.g. can a process be performed in different ways? Can a goal be achieved in a different way?
Analysis	Need to be able to detect the impact of changes. E.g. how will the purchase of a machine affect the activities? How will changing the processes affect the resource consumption?
Operation	The Enterprise Model must be able to represent what is planned, what might happen and what has happened. It must supply the information necessary to support the operations of an enterprise.

Enterprise Modelling: Challenges

- All enterprise functions do not share the same Enterprise Models – correspondence problem.
  - Each enterprise model may have the same concepts (e.g. activity), but they may use different names for them (operation vs. task).
  - Some translation of concepts is required for communication.
  - The concepts and representation lack adequate specifications of what the concepts (terminology) mean (semantics).
- Legacy systems – enterprises have their data in independent systems.
- Cost of designing, building and maintaining an enterprise model is huge.

GEM: Generic Enterprise Model

- An object library that defines the classes of objects that are generic across a type of enterprise, such as manufacturing or banking, and can be used (that is instantiated) in defining a specific enterprise.
- A GEM is composed of:
  - A set of object classes structured as a taxonomy, with subclass and super-class relationships.
  - For each object class, a set of relations linking it to other object classes, plus a definition of the intended meaning of the relation.
  - For each object class, a set of attributes plus a definition of the intended meaning of each attribute.

Benefits of GEM

- Predefined object library – allows the modeller to quickly move on to model instantiation.
- Path for growth – Benefit from the experience of others.
- Shared conceptualisation – by adopting a GEM the other parts of the organisation stand a greater chance of understanding what is represented in the Enterprise Model.

Commonsense Enterprise Models (1)

- The usefulness of an instantiated GEM is determined by the functions it can support, e.g. scheduling, forecasting, etc.
- We should be able to query the model and obtain answers to support the organisation.
- Where does the GEM end and inference begin?
- Three types of queries:
  - Factual (direct retrieval of information, surface-level processing, e.g. relational database).
  - Expert (requires that the information system has extensive knowledge, deep-level processing, supports some reasoning).
  - Common Sense – requires that the information system be able to deduce answers to questions that one would normally assume can be answered if one has common sense understanding of the enterprise.

Commonsense Enterprise Models (2)

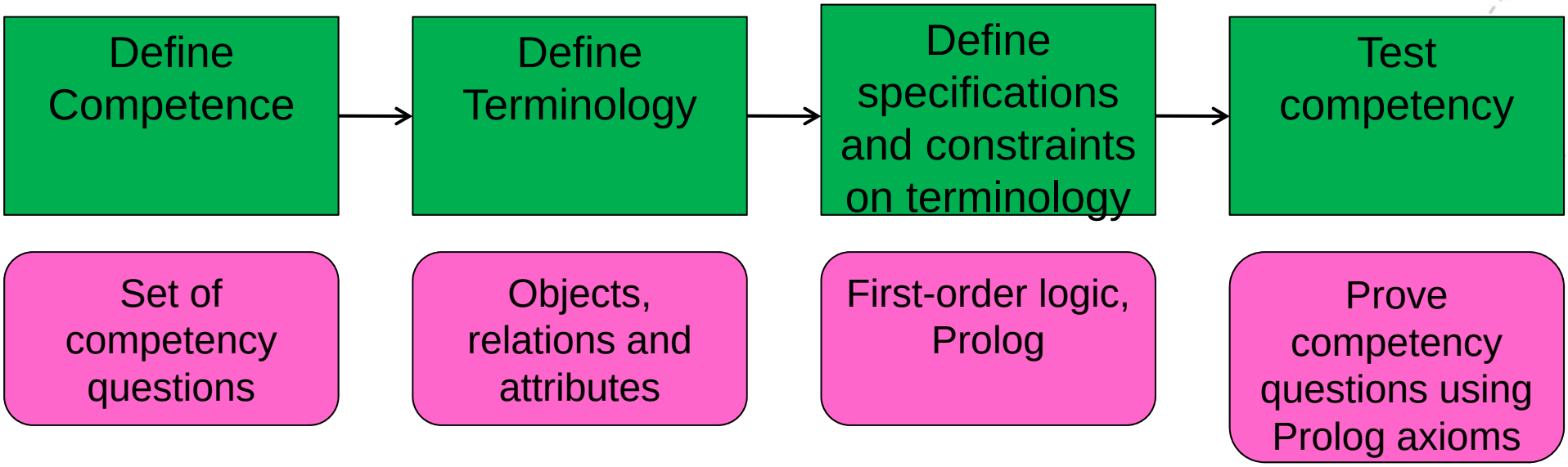
- Commonsense queries:
  - Ability to answer queries as though the model has a common sense understanding of the enterprise.
  - Such an understanding often represents knowledge about the enterprise acquired over a relative short time and does not require expert knowledge.
  - Examples of such knowledge: organisational structure, roles, goals and resources would enable the deduction of what resources a person might allocate based on his/her role in the organisation.
  - We refer to it as shallow-level processing: retrieval that requires a small number of deductions to answer the query.
    - Requires a set of rules of deduction, axioms.

From GEM to DEM

- GEMs can be of two types:
  - GEMs without axioms where deductions are specified by a query.
  - GEMs with axioms that support deduction: DEM
- DEMs would be able to answer queries such as
  - “who does Joe work for?”
- A DEM possesses common sense if the axioms define the meaning of the relations and attributes in the object library.

TOVE DEM

Toronto Virtual Enterprise Deductive Enterprise Model



TOVE Ontology

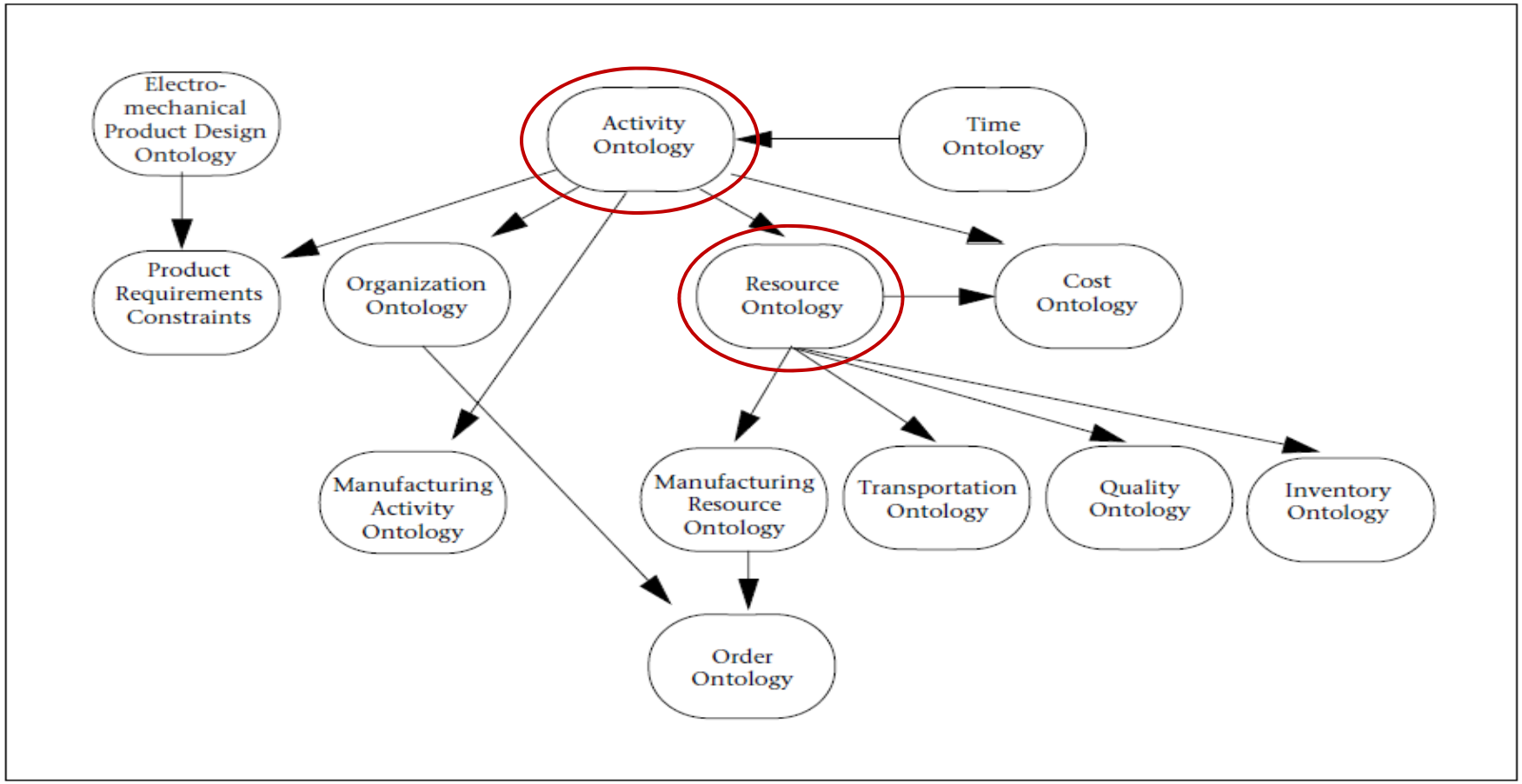
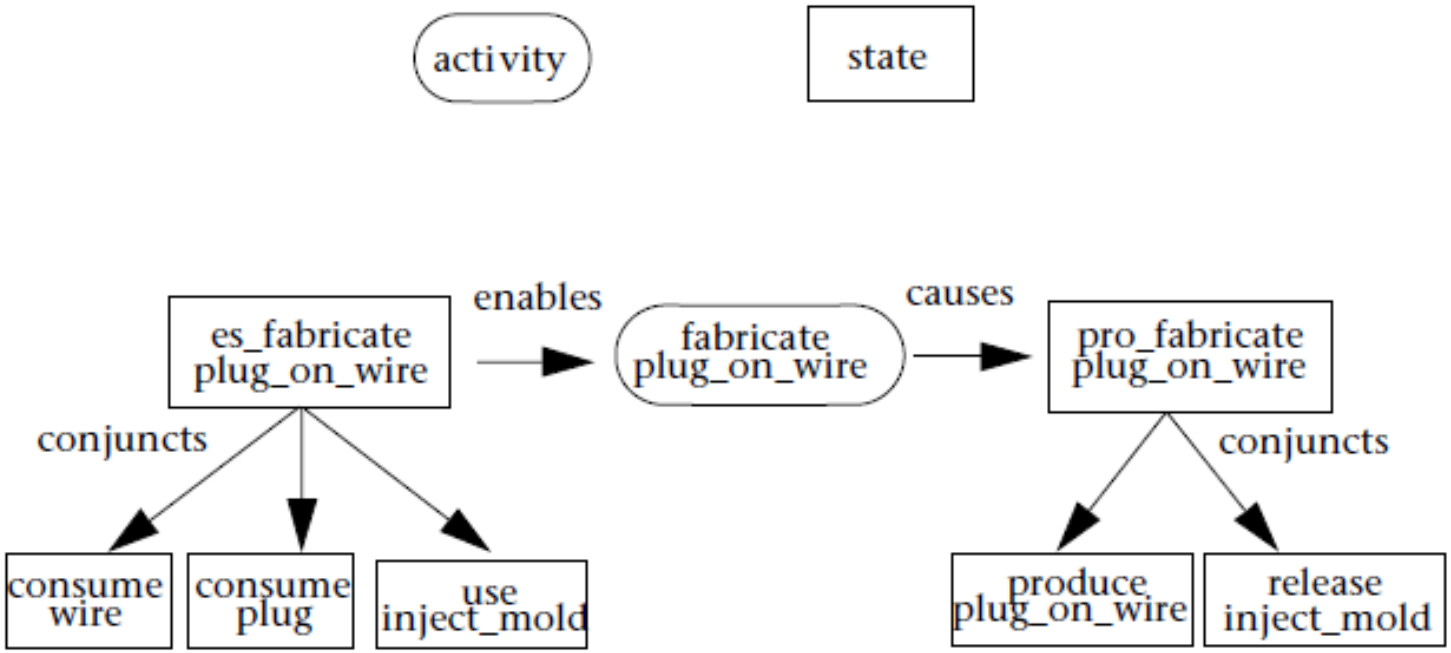


Figure 1. Toronto Virtual Enterprise Ontologies.

TOVE: Activity Cluster



Enabling state

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Enterprise Project: The Enterprise Ontology

Based on the article:

A5: Enterprise Project: The Enterprise Ontology, http://www.aiai.ed.ac.uk/project/enterprise/enterprise/ontology.html

This brings in a business and AI perspective.

Enterprise Ontology

- Enterprise Ontology: a collection of terms and definitions relevant to business enterprises.

- Developed by a project called Enterprise Project (UK).
- Partners: AI Applications Institute, University of Edinburgh, IBM, Lloyds Register, Logica, Unilever.
- In this project, the aim of Enterprise Modelling is to obtain an enterprise-wide view of an organisation which can then be used as a basis for taking decisions.
- The project focused on management innovation and the strategic use of IT to help manage change.

Business Perspective

- Businesses have a need to increase their relative and absolute performance. e.g.
  - improve customer satisfaction; improve financial performance; decrease cycle times; and adapt to growth and recession cycles.
- To achieve successful management of change, businesses need to be able to monitor and improve their performance against strategic objectives.
- Businesses need support to analyse and improve various aspects of how a business works and how it is organised.
- The project aimed at providing a method and computer toolset which will help capture aspects of a business and analyse these.

Enterprise Ontology: Concepts (1)

- Activities and Processes
  - Intended to capture anything that involves “doing”, including “action”.
  - Linked with the idea of a “doer”. A person or an organisational-unit or machine.
  - Closely related to “resource”: something used or consumed in an Activity.
- Organisation
  - A legal entity, or an organisational unit.
  - E.g. person, machine, corporation.
  - Terms related to how an organisation is structured.

Enterprise Ontology: Concepts (2)

- Strategy
  - Central concept is “Purpose”: captures the idea of something a “plan” can “help achieve”.
  - Terms related to high-level planning of an enterprise.
  - Vision, mission, objectives, goals, strategy planning, strategic action.
- Marketing
  - Central concept is “sale”: an agreement between two legal entities for the exchange of a “product” for a “sale-price”.
  - Terms related to marketing and selling of goods and services.
  - Vendor, customer, competitor.
  - Analysis of market: features of products, needs of customers, etc.

Role of Enterprise Ontology

- The major role of the Enterprise Ontology is to act as a communication medium between:
  - Different people, including users and developers, across different enterprises.
  - People and implemented computer systems.
  - Different implemented computer systems, including modules of the enterprise toolset, DBMS, etc.
- It is intended to assist:
  - Acquisition, representation and manipulation of enterprise knowledge.
  - Structuring and organising libraries of knowledge.
  - The explanation of the rationale, inputs and outputs of the Enterprise toolset modules.

Enterprise Ontology: Terms (1)

Activity	Activity Specification, Execute, Executed Activity Specification, T-Begin, T-End, Pre-Conditions, Effect, Doer, Sub-Activity, Authority, Activity Owner, Event, Plan, Sub-Plan, Planning, Process Specification, Capability, Skill, Resource, Resource Allocation, Resource Substitute.
Organisation	Person, Machine, Corporation, Partnership, Partner, Legal Entity, Organisational Unit, Manage, Delegate, Management Link, Legal Ownership, Non-Legal Ownership, Ownership, Owner, Asset, Stakeholder, Employment Contract, Share, Share Holder.
Strategy	Purpose, Hold Purpose, Intended Purpose, Strategic Purpose, Objective, vision, Mission, Goal, Help Achieve, Strategy, Strategic Planning, Strategic Action, Decision, Assumption, Critical Assumption, Non-Critical Assumption, Influence Factor, Critical Influence Factor, Non-Critical Influence Factor, Critical Success Factor, Risk.
Marketing	Sale, Potential Sale, For Sale, Sale Offer, Vendor, Actual Customer, Potential Customer, Customer, Reseller, Product, Asking Price, Sale Price, Market, Segmentation Variable, Market Segment, Market Research, Brand Image, Feature, Need, Market Need, Promotion, Competitor.
Time	Time Line, Time Interval, Time Point.

Enterprise Ontology: Terms (2)

The terms include entities and relationships, and rules to operate on them.

Activity	Activity Specification, Execute, Executed Activity Specification, T-Begin, T-End, Pre-Conditions, Effect, Doer, Sub-Activity, Authority, Activity Owner, Event, Plan, Sub-Plan, Planning, Process Specification, Capability, Skill, Resource, Resource Allocation, Resource Substitute.
Organisation	Person, Machine, Corporation, Partnership, Partner, Legal Entity, Organisational Unit, Manage, Delegate, Management Link, Legal Ownership, Non-Legal Ownership, Ownership, Owner, Asset, Stakeholder, Employment Contract, Share, Share Holder.
Marketing	Sale, Potential Sale, For Sale, Sale Offer, Vendor, Actual Customer, Potential Customer, Customer, Reseller, Product, Asking Price, Sale Price, Market, Segmentation Variable, Market Segment, Market Research, Brand Image, Feature, Need, Market Need, Promotion, Competitor.

Enterprise Ontology: Observations

- Business focus.
- Strong on capturing the business strategy and business activities (e.g. strategy, vision, mission, goal).
- Activity modelling rather than Process Modelling – focus on activity planning and not much on the flow of data or material between the activities.
- Little focus on Product modelling: this appears only in the Marketing aspect as a feature of a product or the sale price or about branding a product.

TOVE and Enterprise Ontology

- Both the Enterprise Models proposed were defined and developed in a formal language: logic.

✓ Good for unambiguous definition of concepts.

✓ This is good for implementing and proving axioms, or rules defined in a formal language.

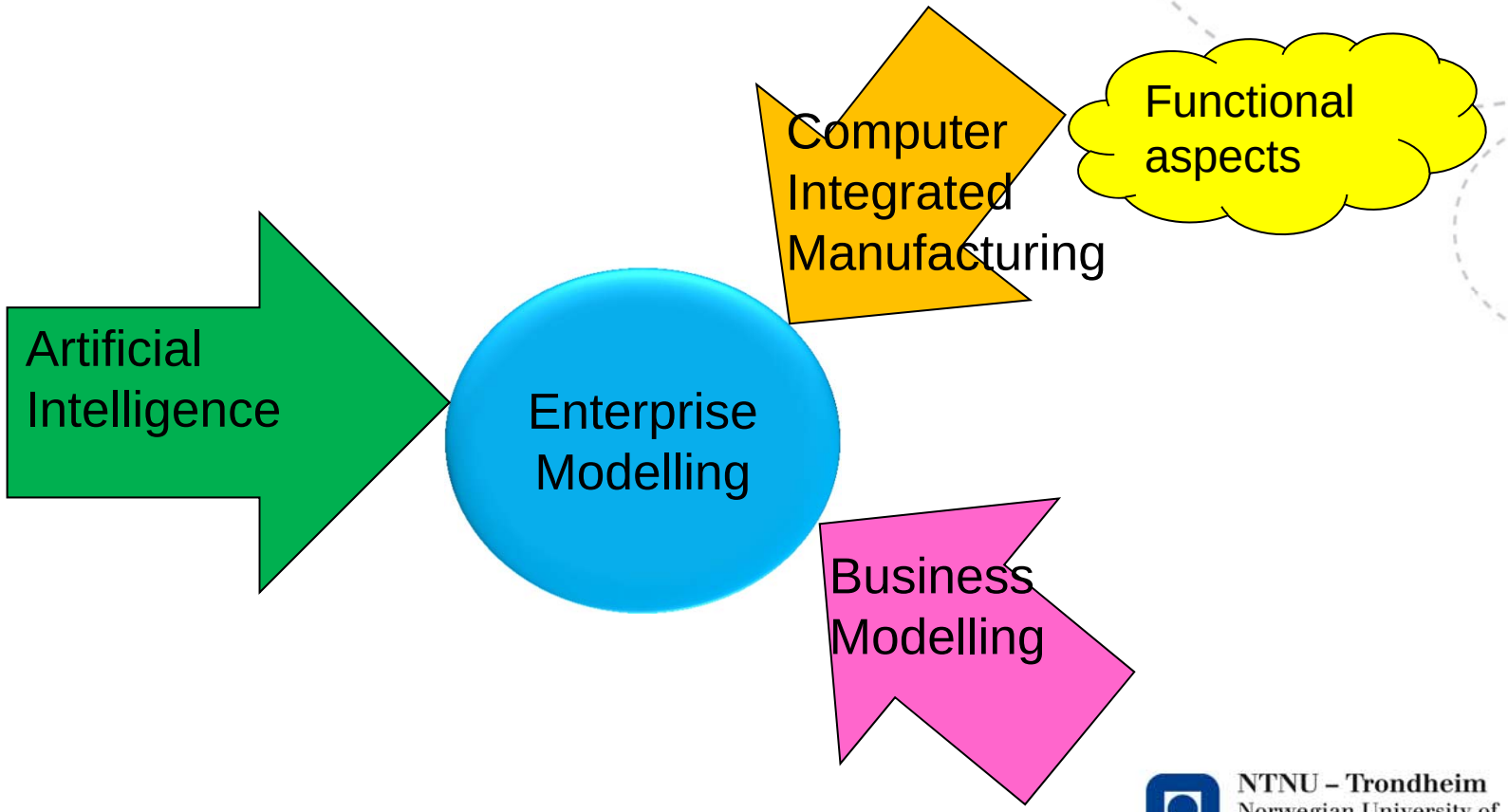
÷ Difficult for business managers to understand.

÷ Difficult to visualise.

- A simple graphical representation with a rule engine is preferred.

Points of View

- Enterprise Modelling seen from the manufacturing perspective



Enterprise Modelling in Manufacturing Environments (1)

- To correctly model information in the manufacturing environment, one must first model the functionality and behaviour.
- To model functionality and behaviour, we need to model the resources and temporal events.
- Finally processes and information flow and then allocated to an organisational boundary.

Ref: Vernadat

Enterprise Modelling in Manufacturing Environments (2)

- An enterprise model usually consists of (but not limited to):
  - Product models
  - Resource models
  - Activity models
  - Information models
  - Organisation models
  - Economic models – cost-oriented analysis of the enterprise.
  - Optimisation and decision-making models – from operations research and control theory.

Ref: Vernadat

Benefits of Enterprise Modelling

- To build a common enterprise culture and shared vision to be communicated through the enterprise via the model, used as a common language.
- To capitalise enterprise knowledge and know-how to build an enterprise memory, which becomes a part of the enterprise assets.
- To support decision making concerning enterprise improvement or control.

Ref: Vernadat

Summary

- An introduction to Enterprise Models and Enterprise Modelling
  - Different perspectives to Enterprise Modelling.
  - Roles and purposes of Enterprise Modelling.
  - Two Enterprise Modelling ontologies.

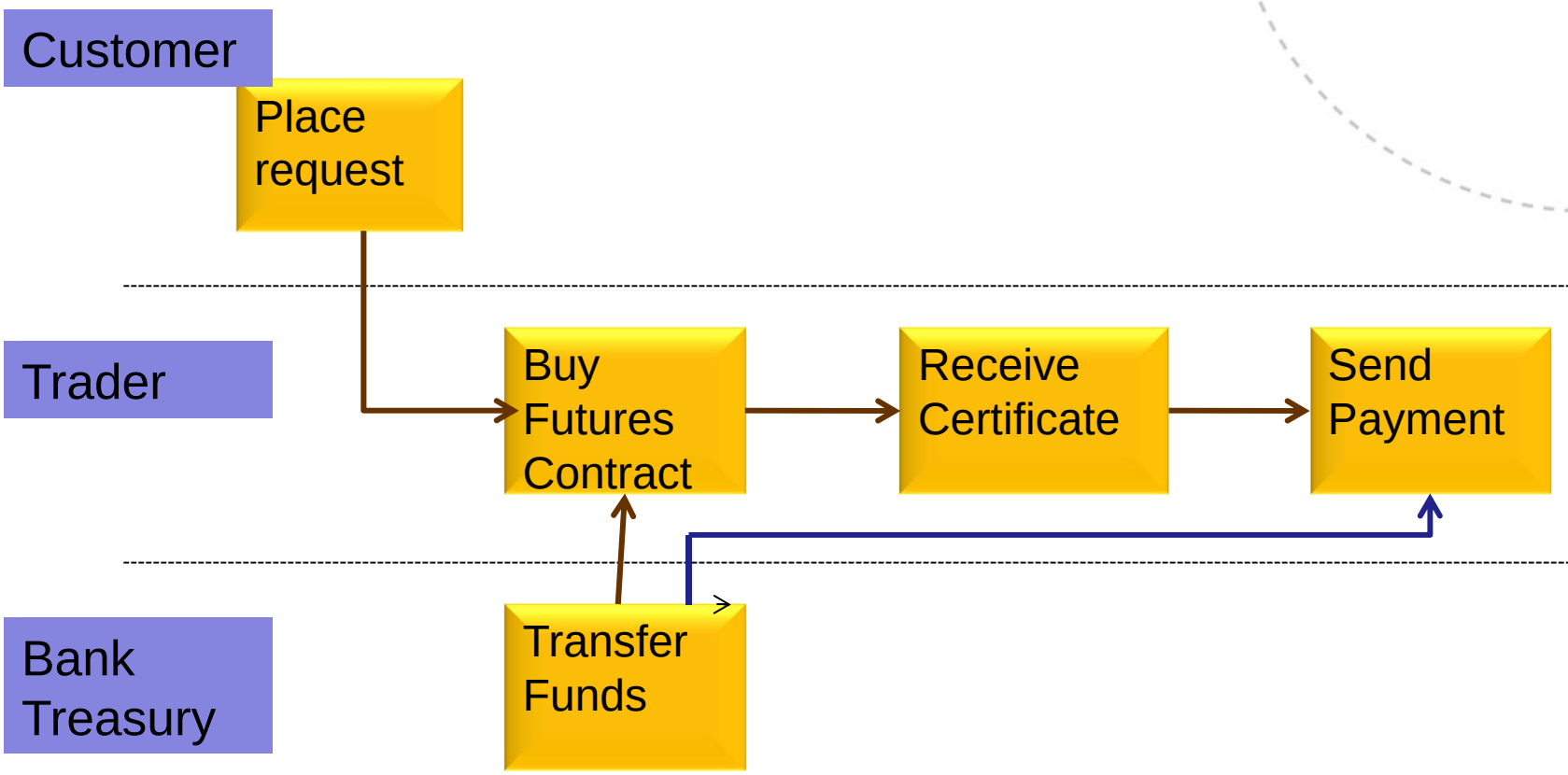
Discussion

Let us review what we have been doing in the previous lectures and the assignment work w.r.t. the contents of today's lecture:

Have we been doing Enterprise Modelling?

Why do you think what we have been doing is Enterprise Modelling?

Revisit the Baring Bank model



Revisit the RESCUE concepts

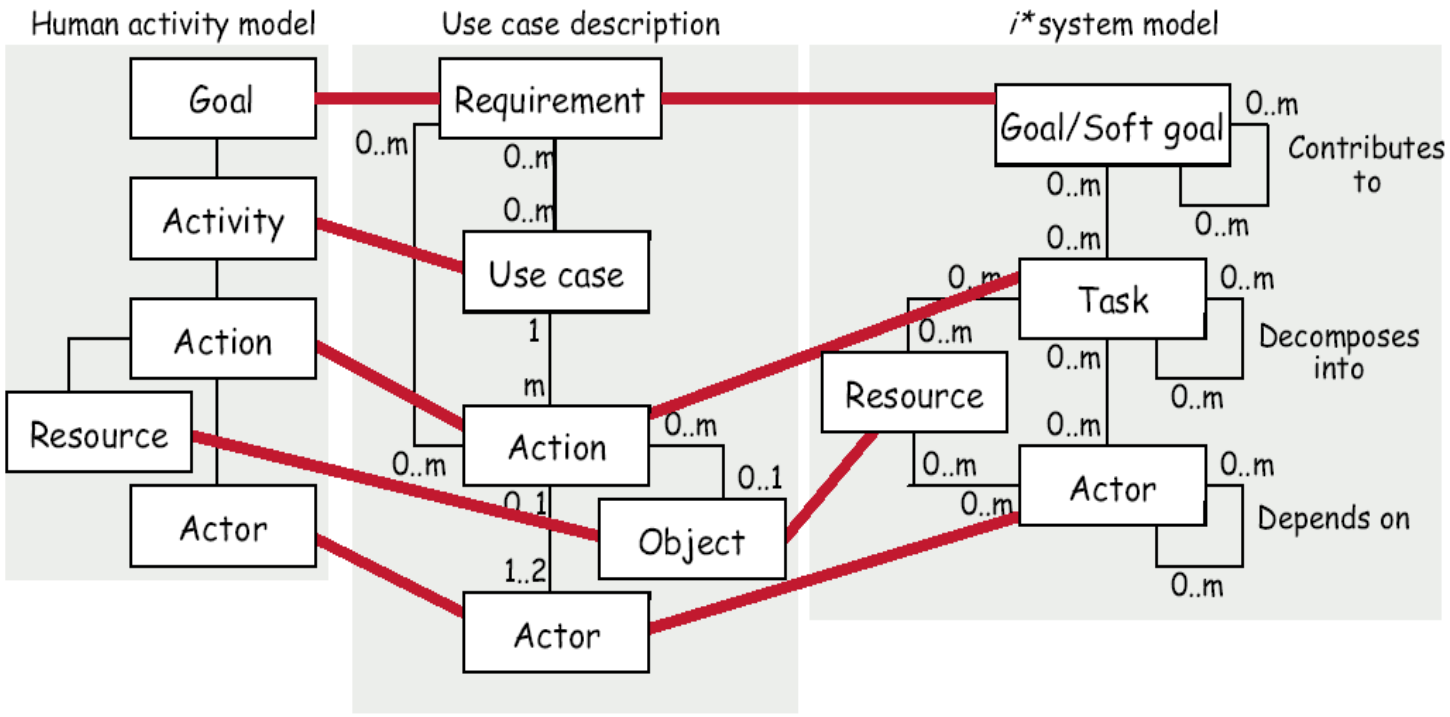


Fig. 5. RESCUE concept meta-model as a UML class diagram showing mappings between constructs in the 3 model types.