Ontologies in practice

Experiences from the telecom industry

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Background Lars Taxén

- **M.Sc. KTH 1968**
- **Ericsson 1968 - 1990 (tools, methods, processes)**
- **Ellemtel 1990 - 1996 (processes HW and SW)**
- **Ericsson 1996 - 2002 (inc. dev, PDM-systems, Matrix)**
- **Ph.D. Linköping 2003**
  - "A Framework for the Coordination of Complex Systems' Development"
- **Now researcher and consultant**

"There is nothing so practical as a good theory." (Kurt Lewin)

ontologies from literature

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Definition of ontology

"The study of the kind of things that exist"

"Ontologies are content theories about the sorts of objects, properties of objects, and relations between objects that are possible in a specified domain of knowledge. "

Chandrasekaran et al. (1999) "What Are Ontologies, and Why Do We Need Them?"
IEEE Intelligent Systems, Jan/Feb 1999

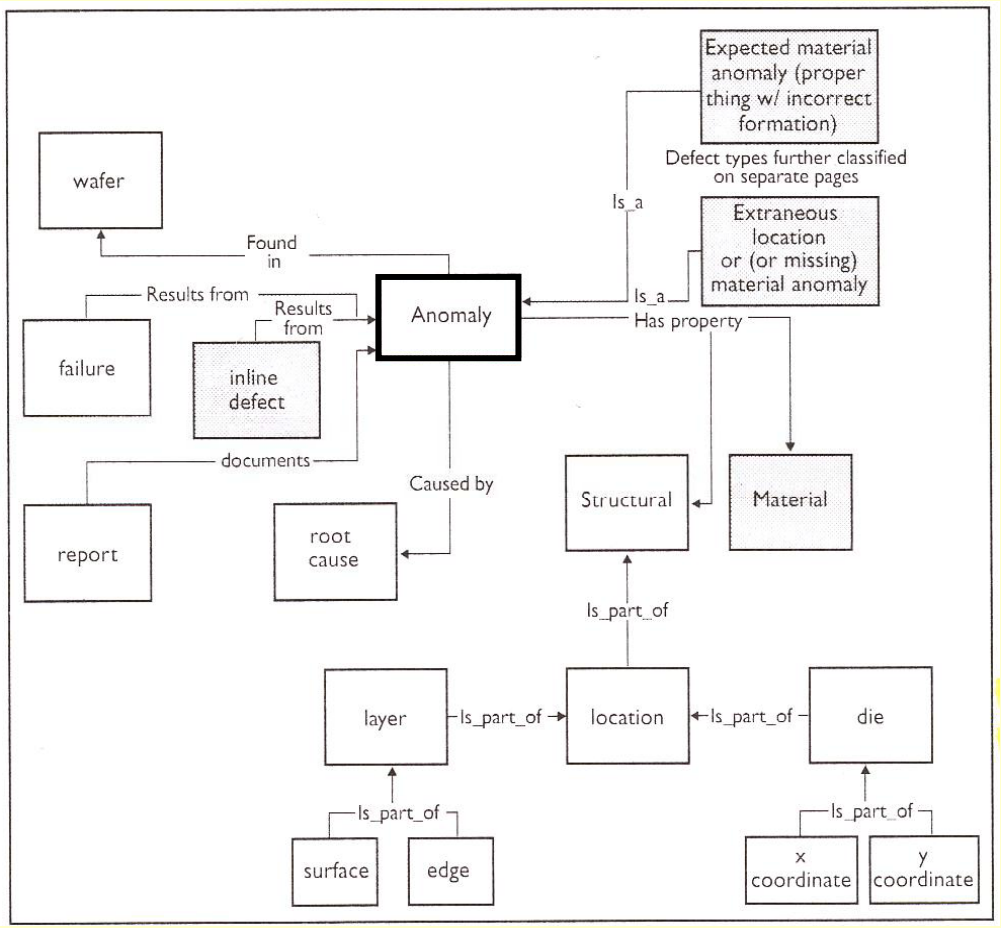
Separation of ontology and knowledge

"An ontology provides a set of concepts and terms for describing some domain, while a knowledge base uses those terms to represent what is true about some real or hypothetical world."

Swartout (1999) "Ontologies", IEEE Intelligent Systems, Jan/Feb 1999

No knowledge related to ontologies?
Reflects the dominant AI background?

Generally agreed about ontologies



- There are objects in the world
- Objects have properties or attributes that can take values
- Objects can exist in various relations with each other
- Objects can have parts
- Properties and relations can change over time
- There are events that occur at different time instants
- There are processes in which objects participate and that occur over time
- The world and its objects can be in different states
- Events can cause other events or states as effects

Adapted after Edgington et al. (2004) "Adopting Ontology to Facilitate Knowledge Sharing",

Chandrasekaran et al. (1999) "What Are Ontologies, and Why Do We Need Them?"

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The problem

"And while formal representation and techniques certainly have a role, we need to find [a] much better way for involving humans in any approach supporting semantics and knowledge management. "

Sheth A, quoted in "Semantic Web and Information Systems: An Agenda Based on Discourse with Community Leaders", *International Journal on Semantic Web and Information Systems*, March 2005

Ontology evo at ///

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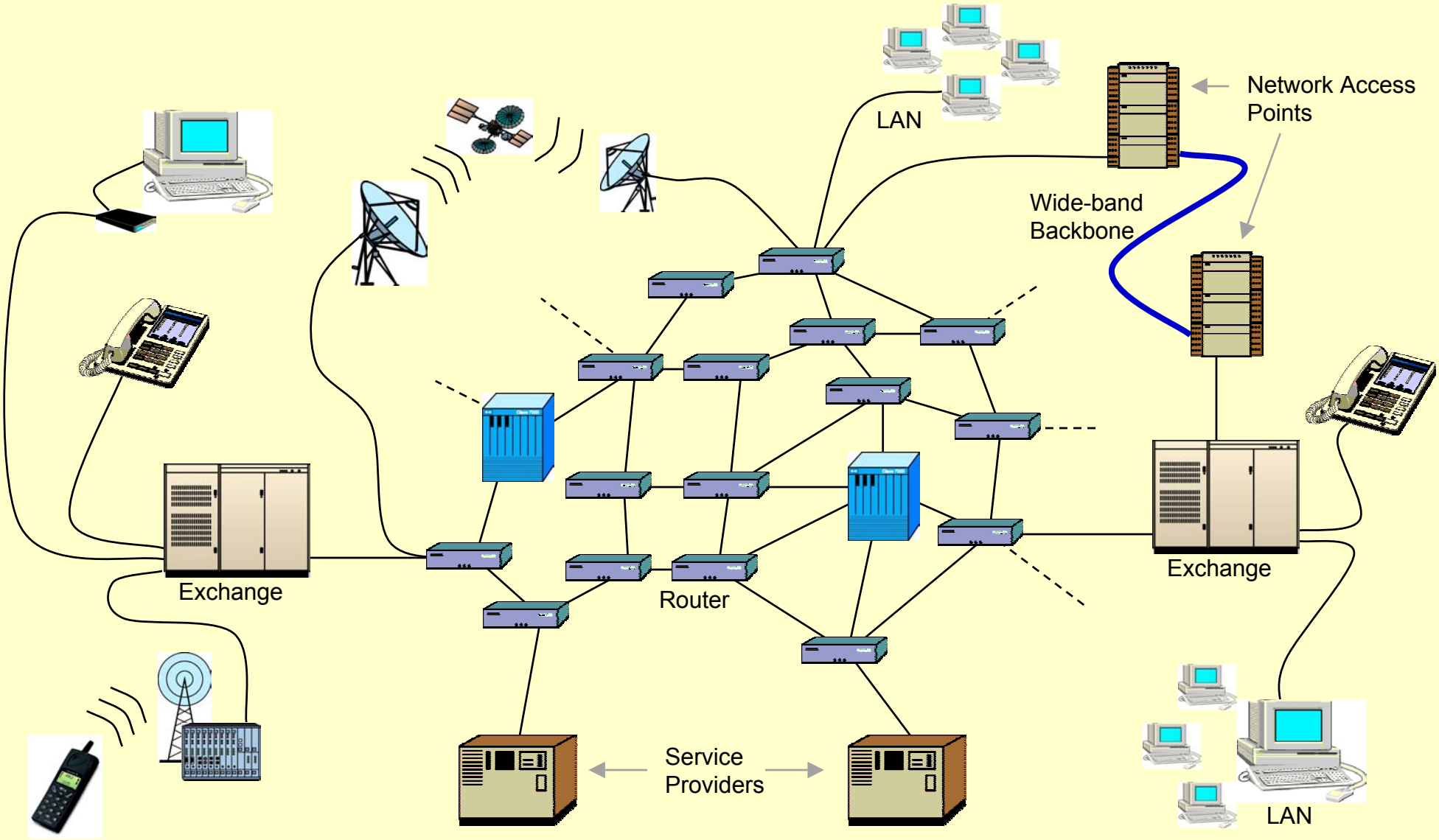
The telecom network



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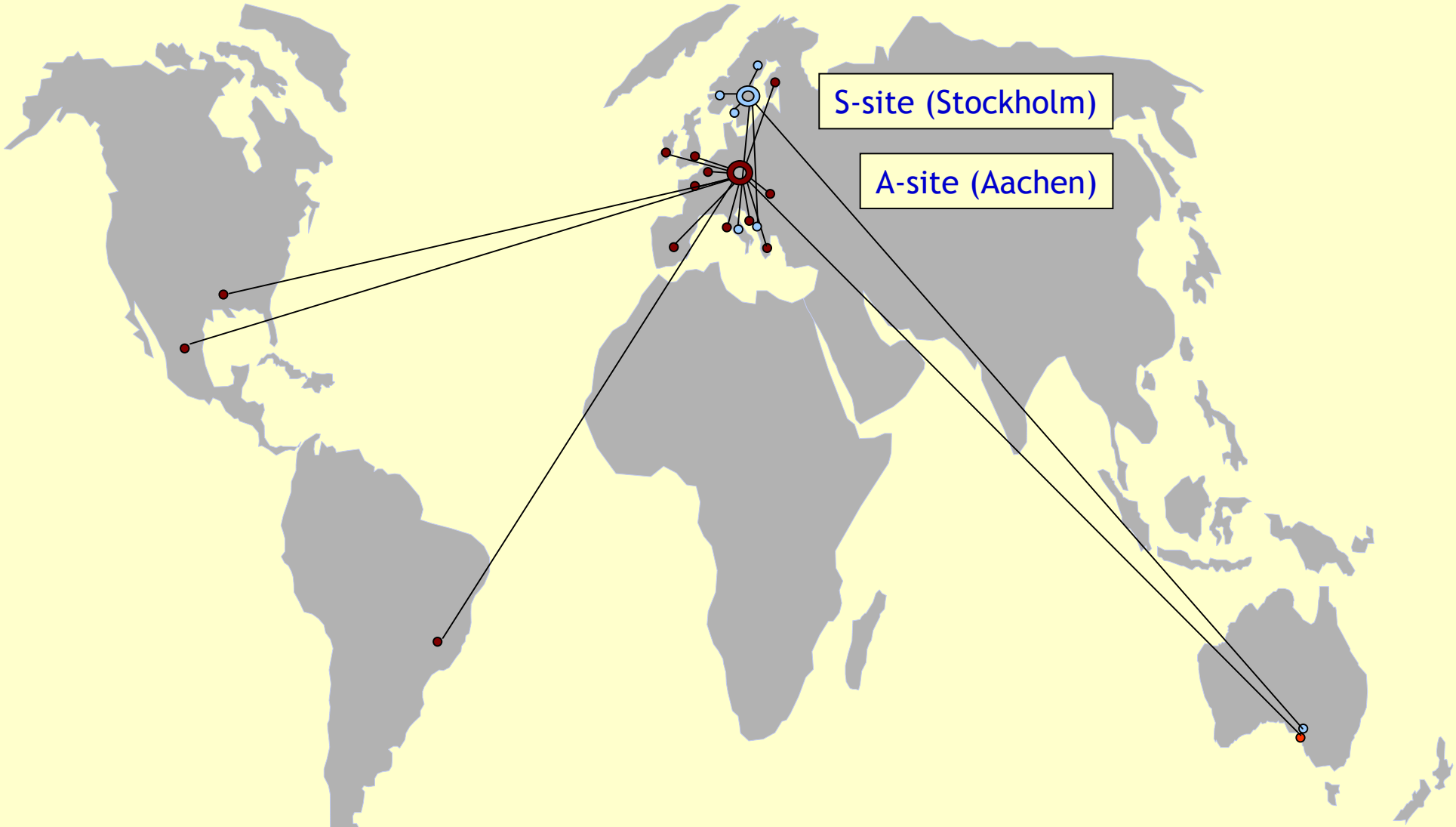
Globally distributed development



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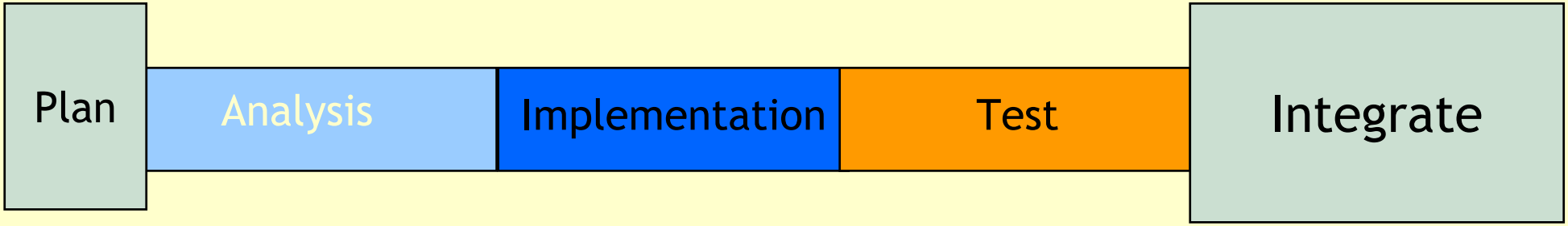
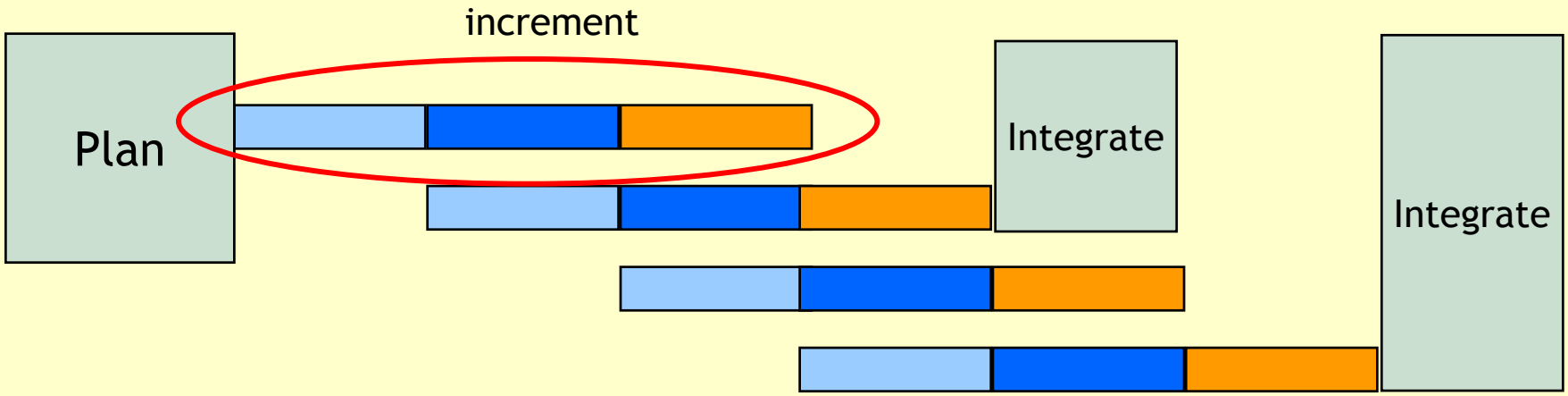
Coordination - a major issue

- **"The management of dependencies btw activities"**
  - Malone & Crowston, 1994
- **Coordination items**
  - requirements
  - engineering change orders
  - products
  - documents describing products
  - test cases
  - integrations
  - baselines
  - milestones
  - deliveries
  - ...
- **Information system support for coordination**

From waterfall to incremental development





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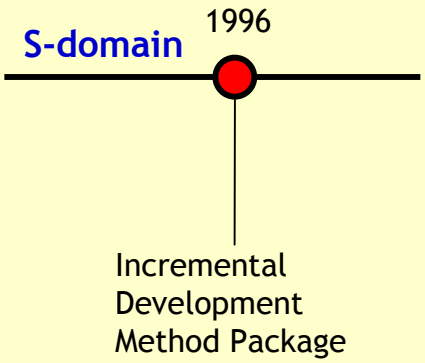
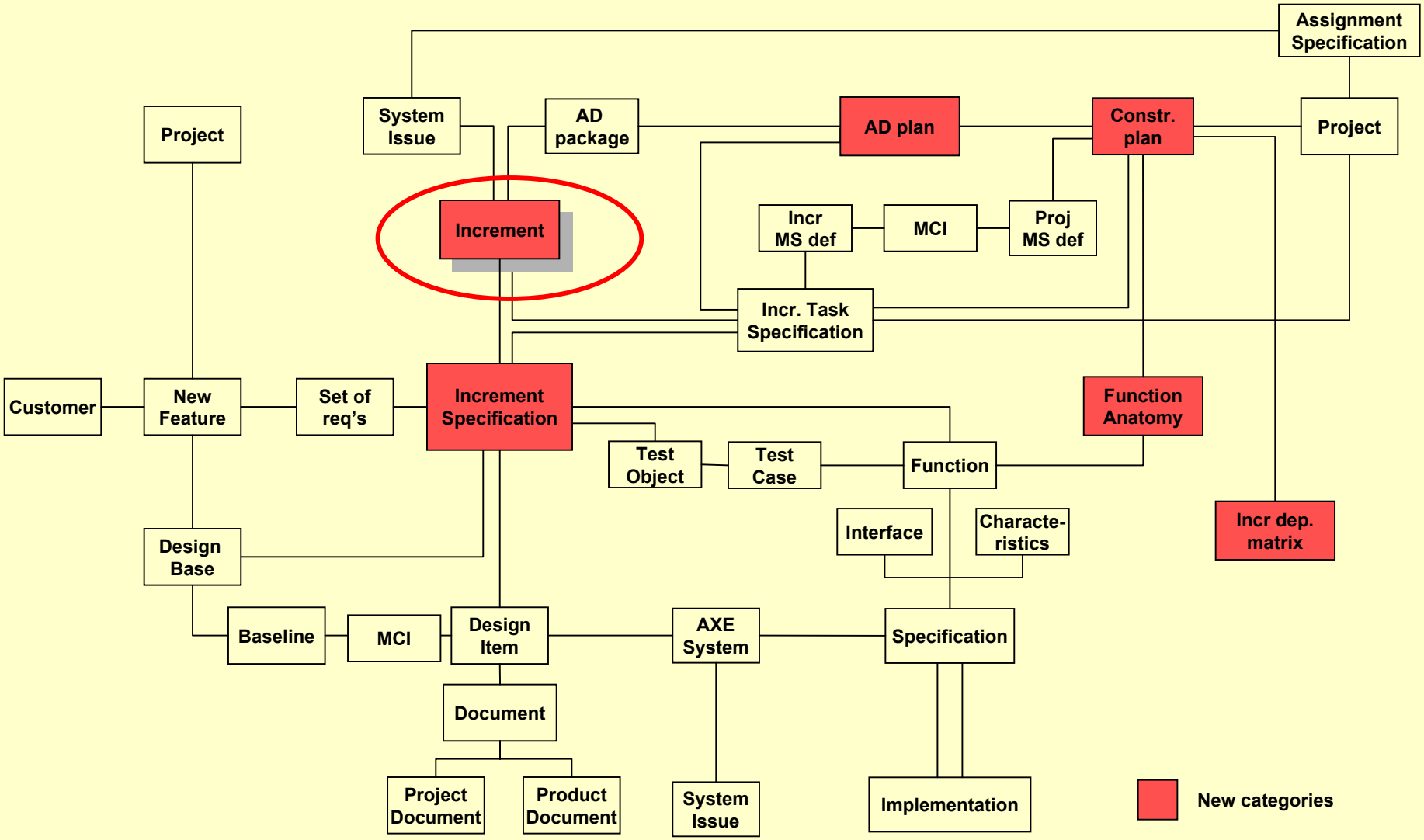
Incremental development



S-domain: Stockholm

Ontology S-domain 1996



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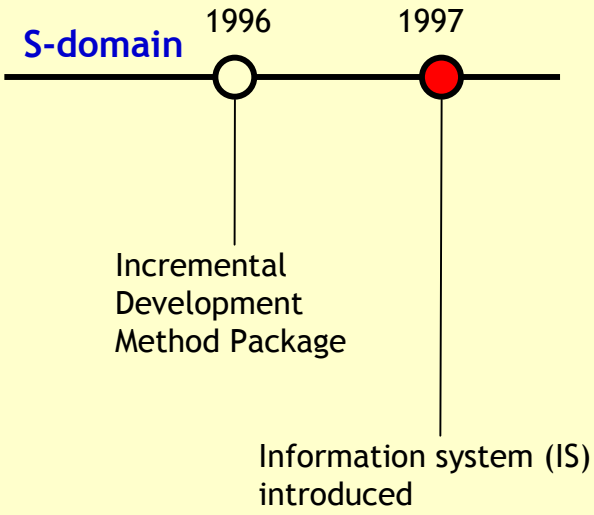
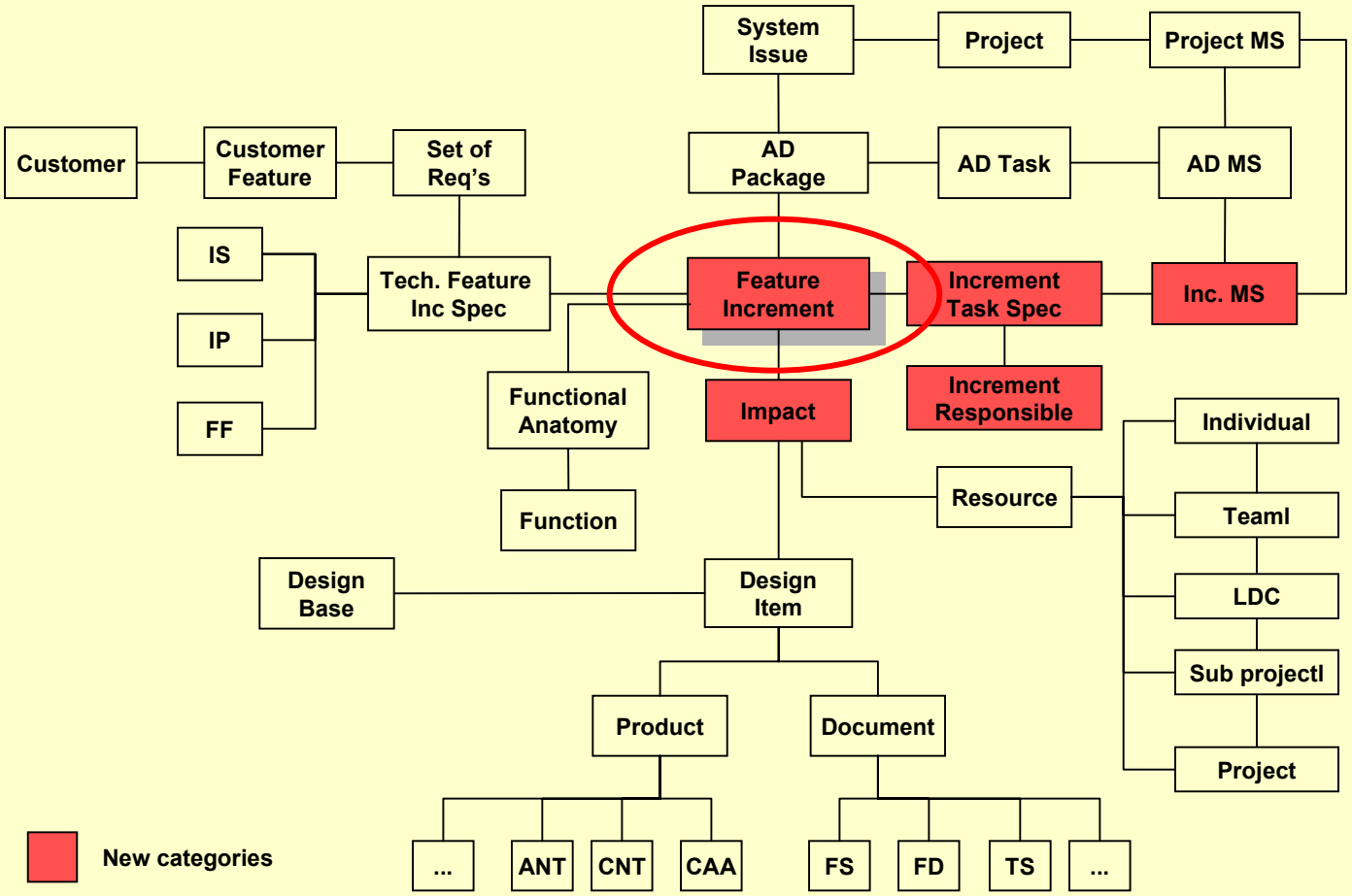
Information system support



S-domain: Stockholm

Ontology S-domain 1997



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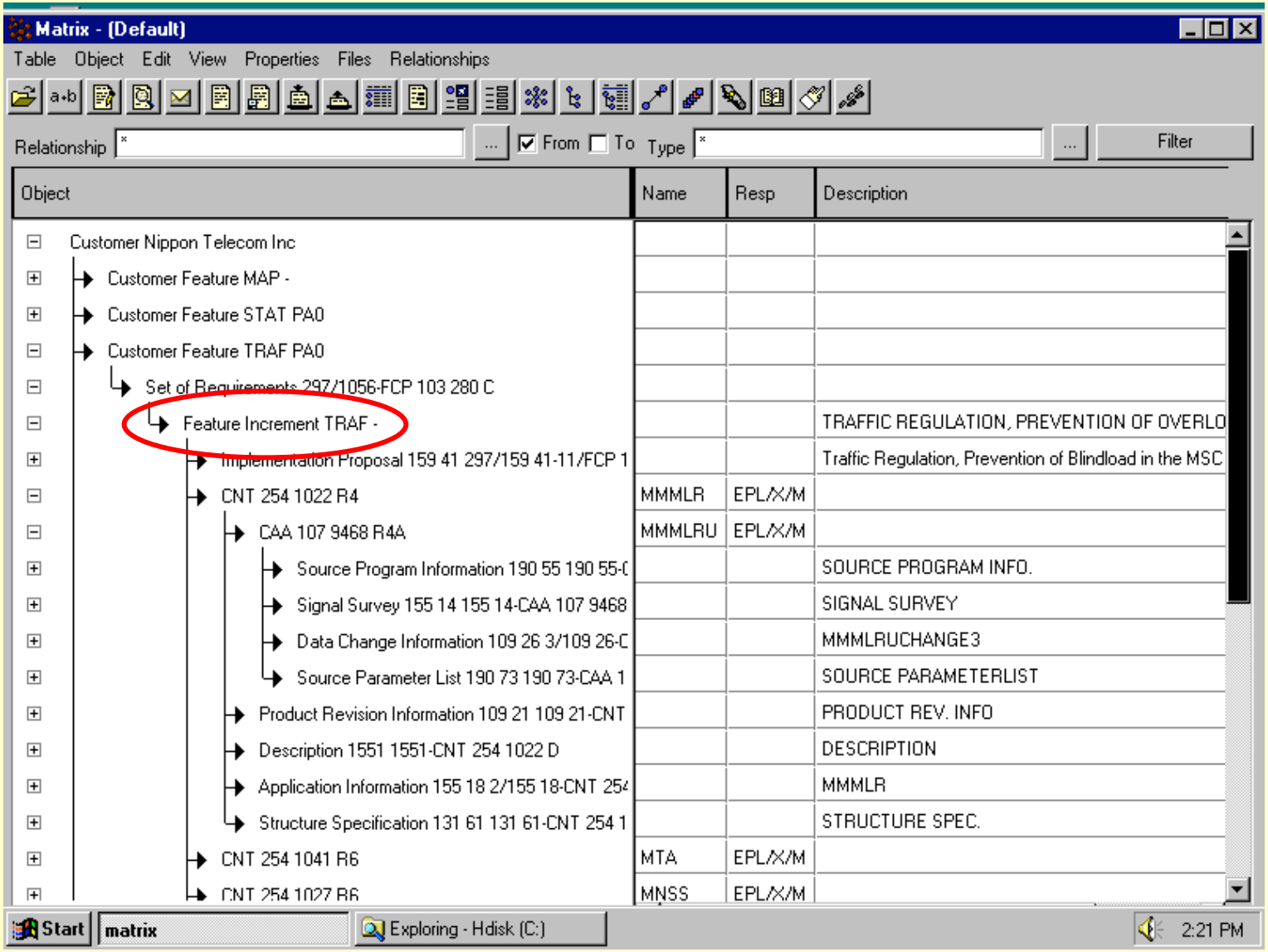
IS support for the ontology S-domain 1997



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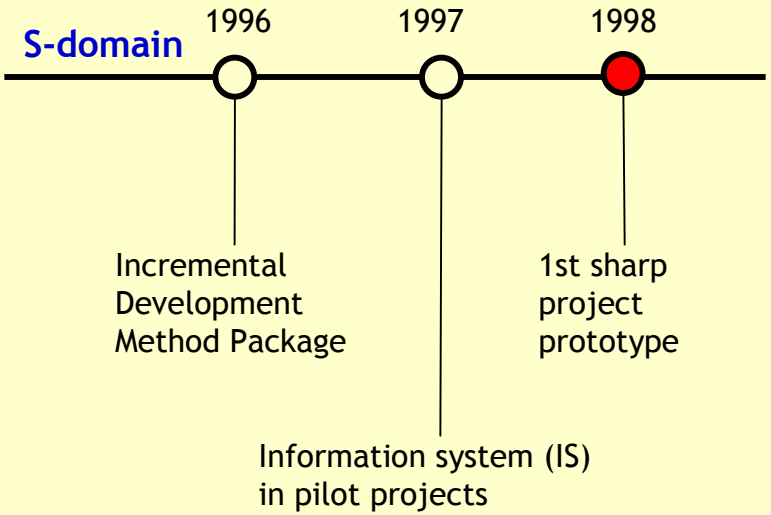
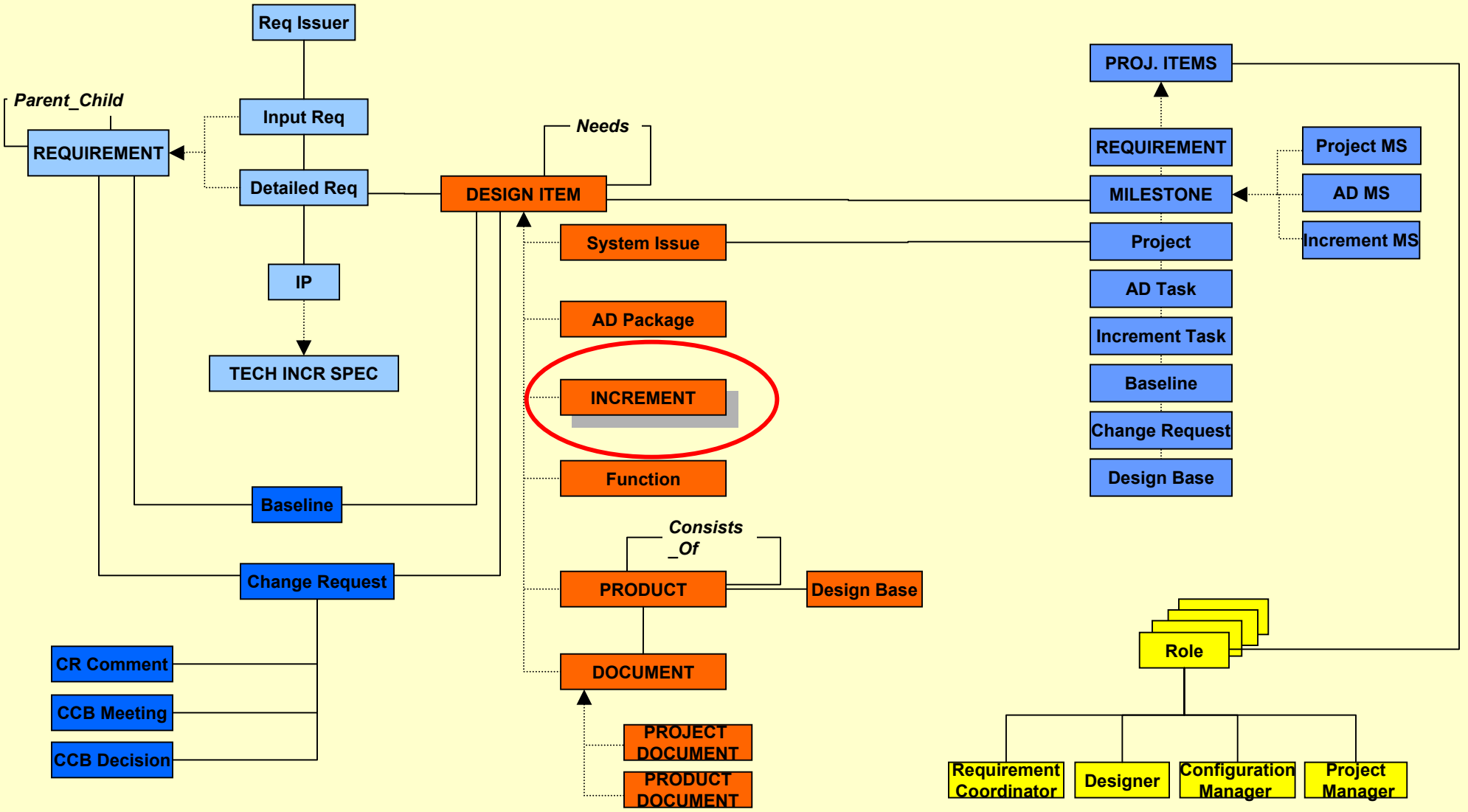
Prototyping “real” usage



S-domain: Stockholm

Ontology S-domain 1998



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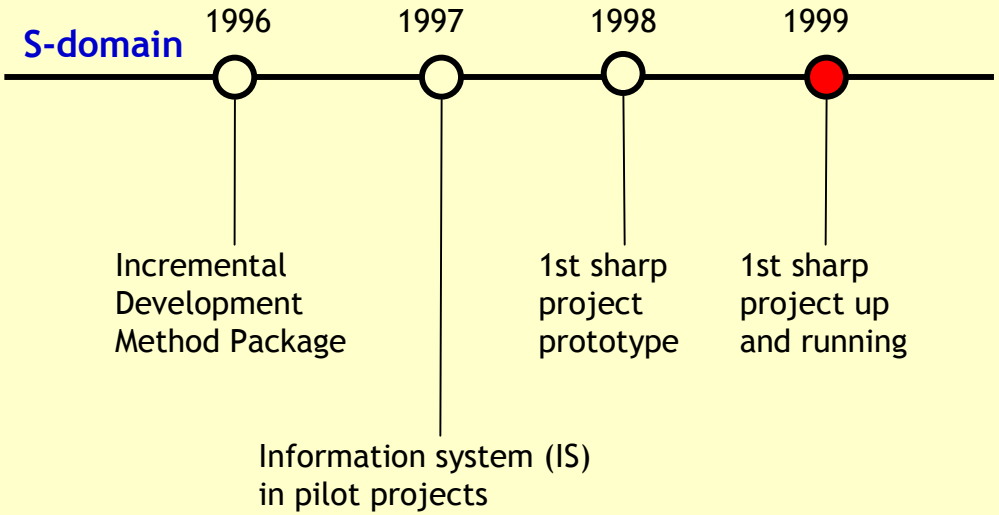
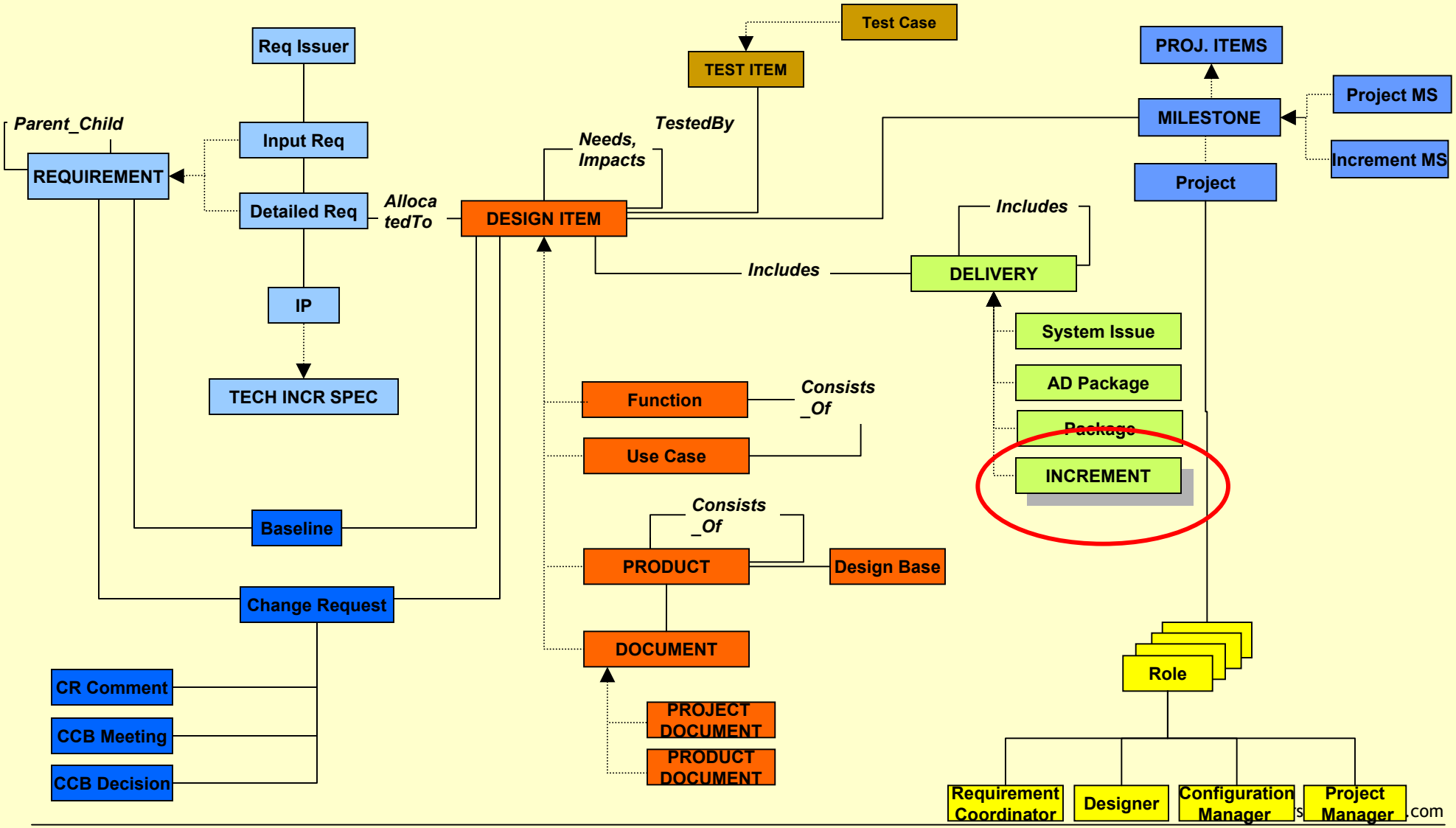
Real usage

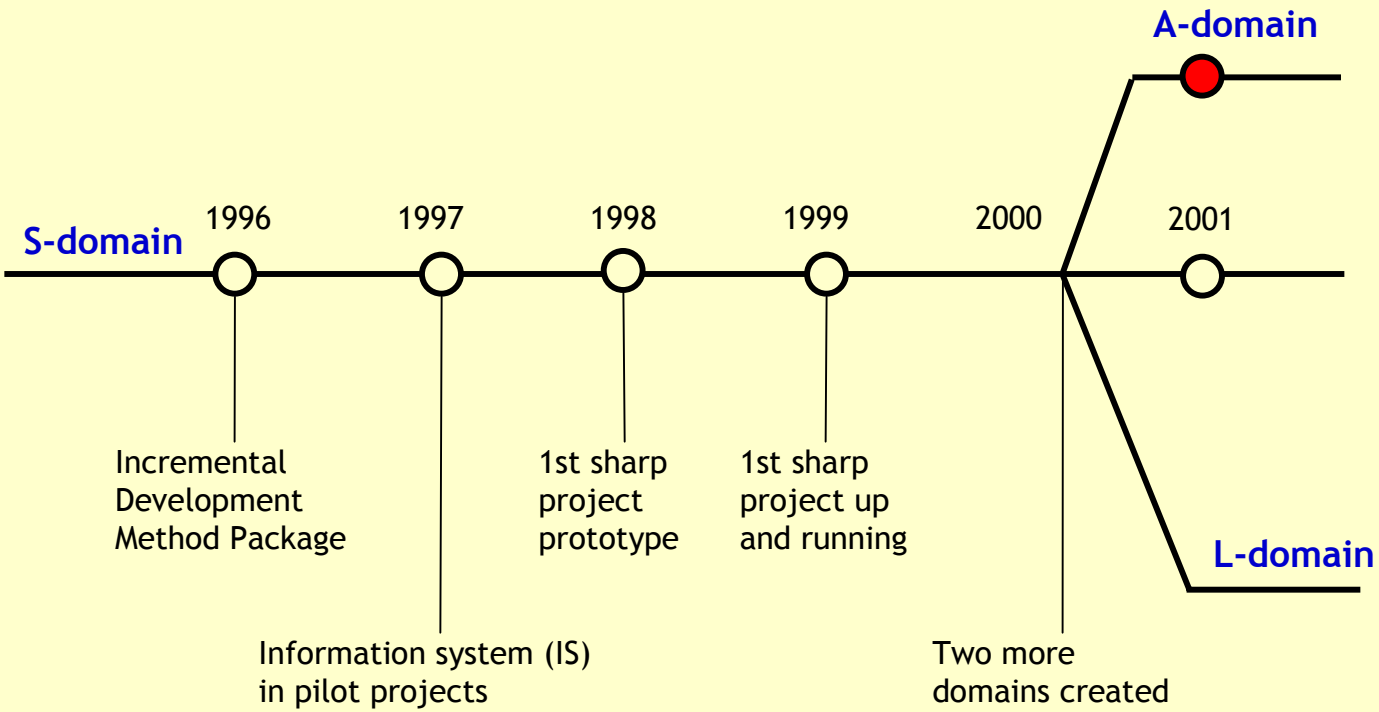


S-domain: Stockholm

Ontology S-domain 1999

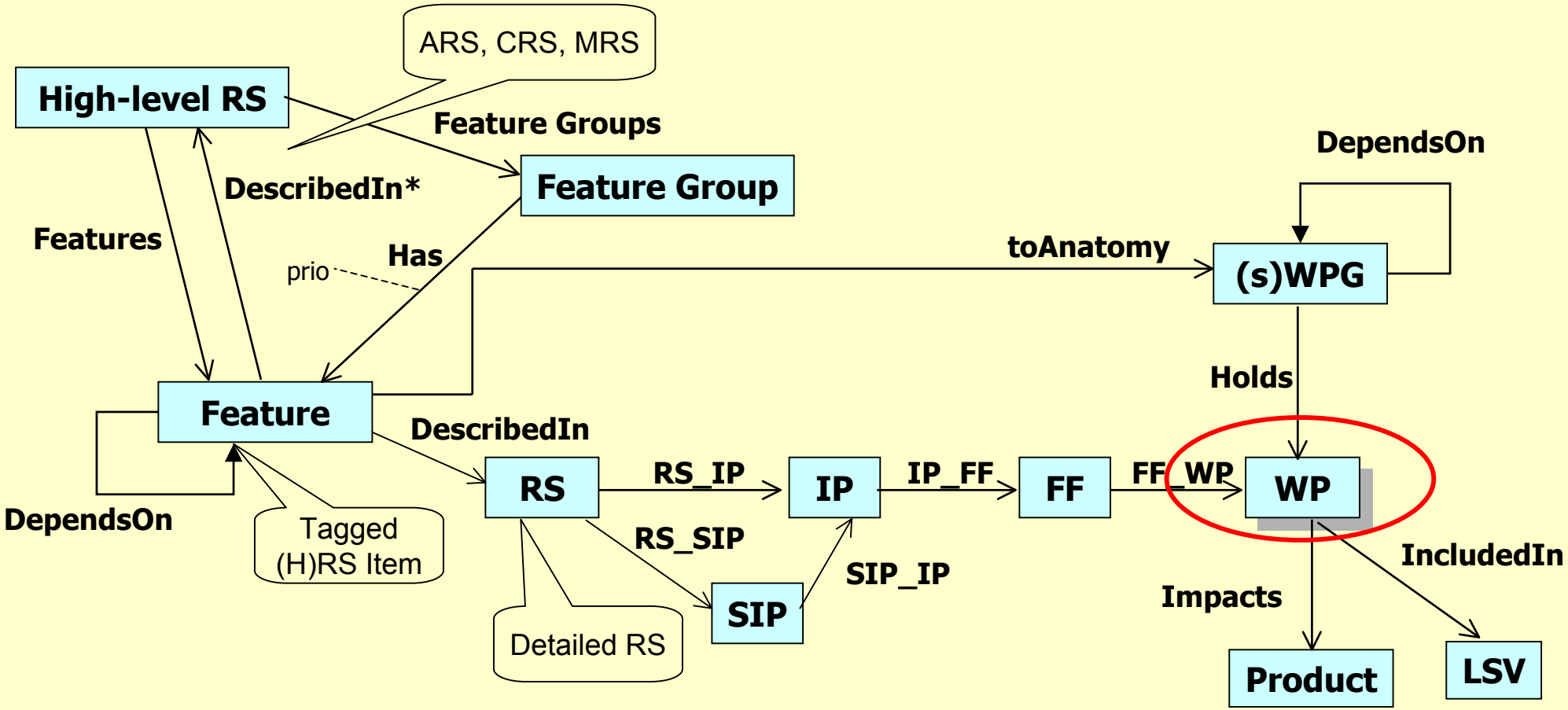


Expansion



S-domain: Stockholm
A-domain: Aachen
L-domain: Linköping

Ontology of the A-domain 2001



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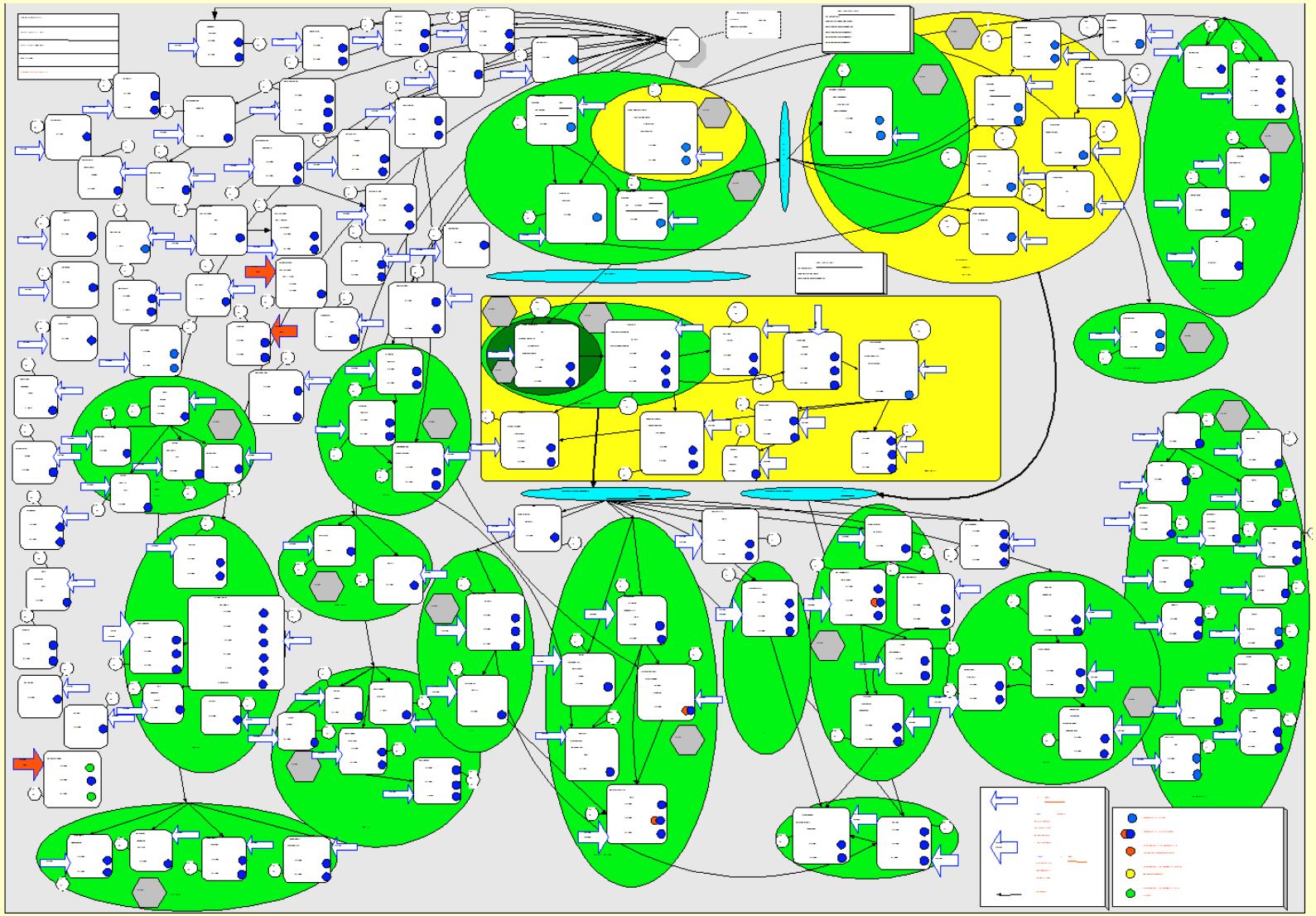
An integration plan for a 3G node



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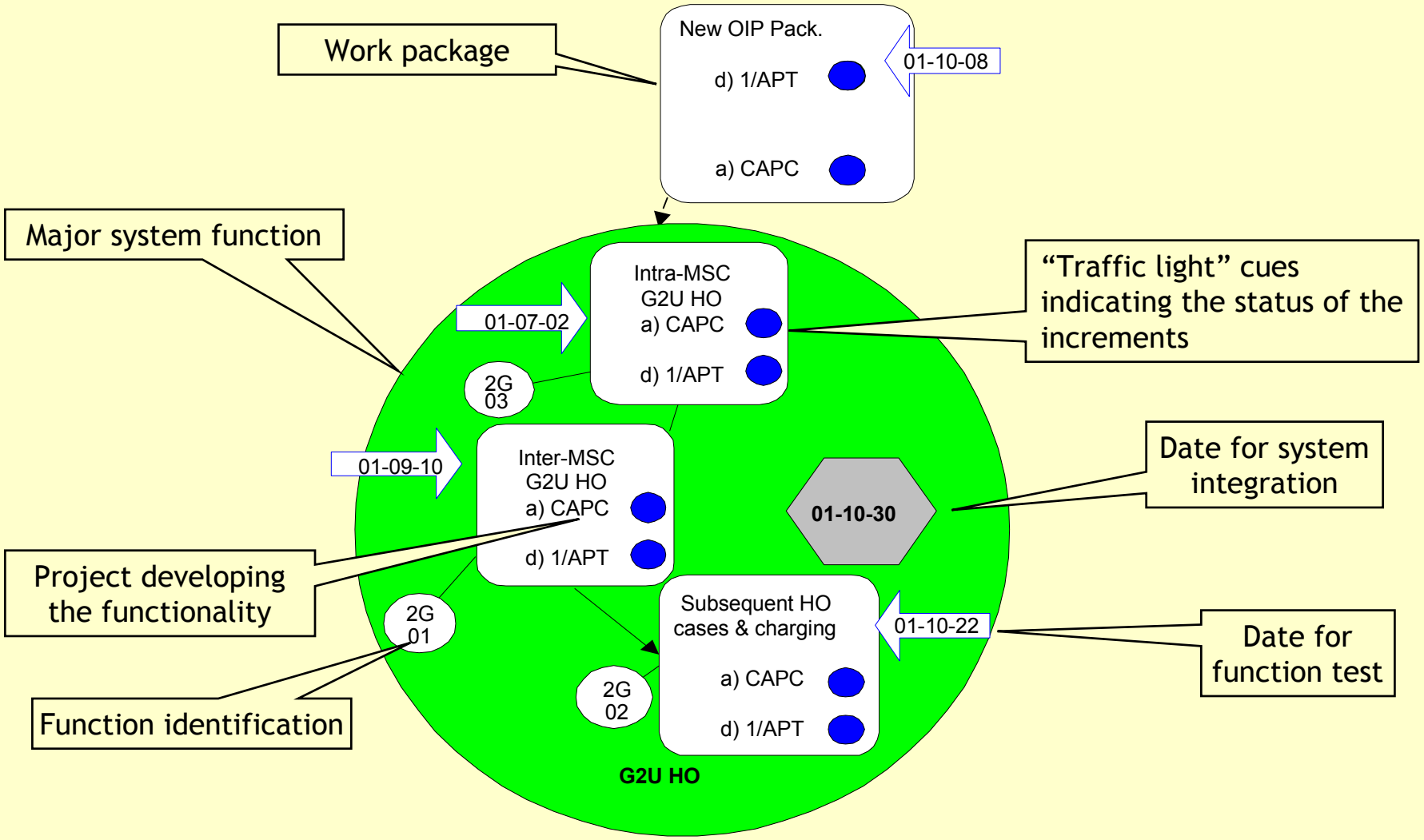
Details



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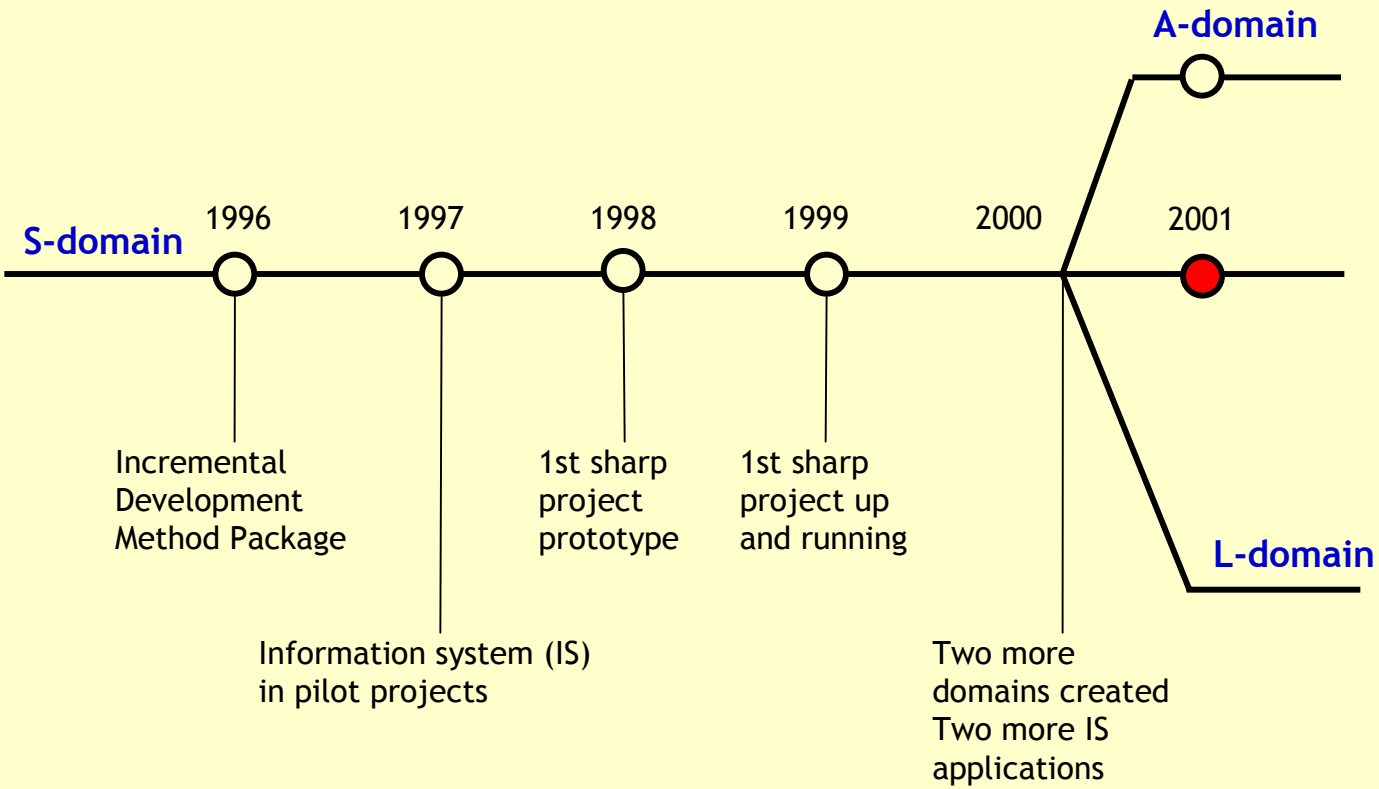
Expansion



S-domain: Stockholm
A-domain: Aachen
L-domain: Linköping

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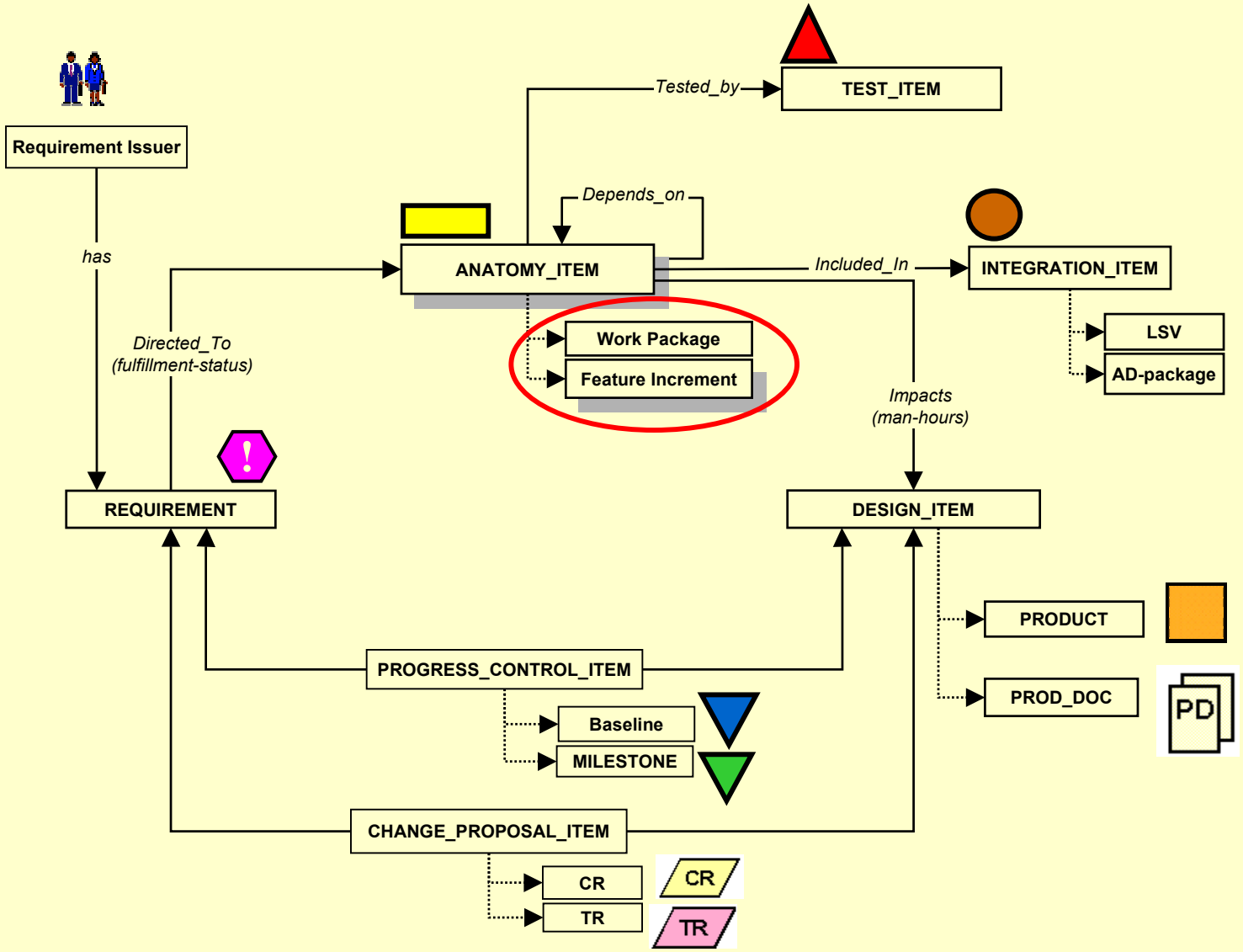
Ontology of the S-domain 2001



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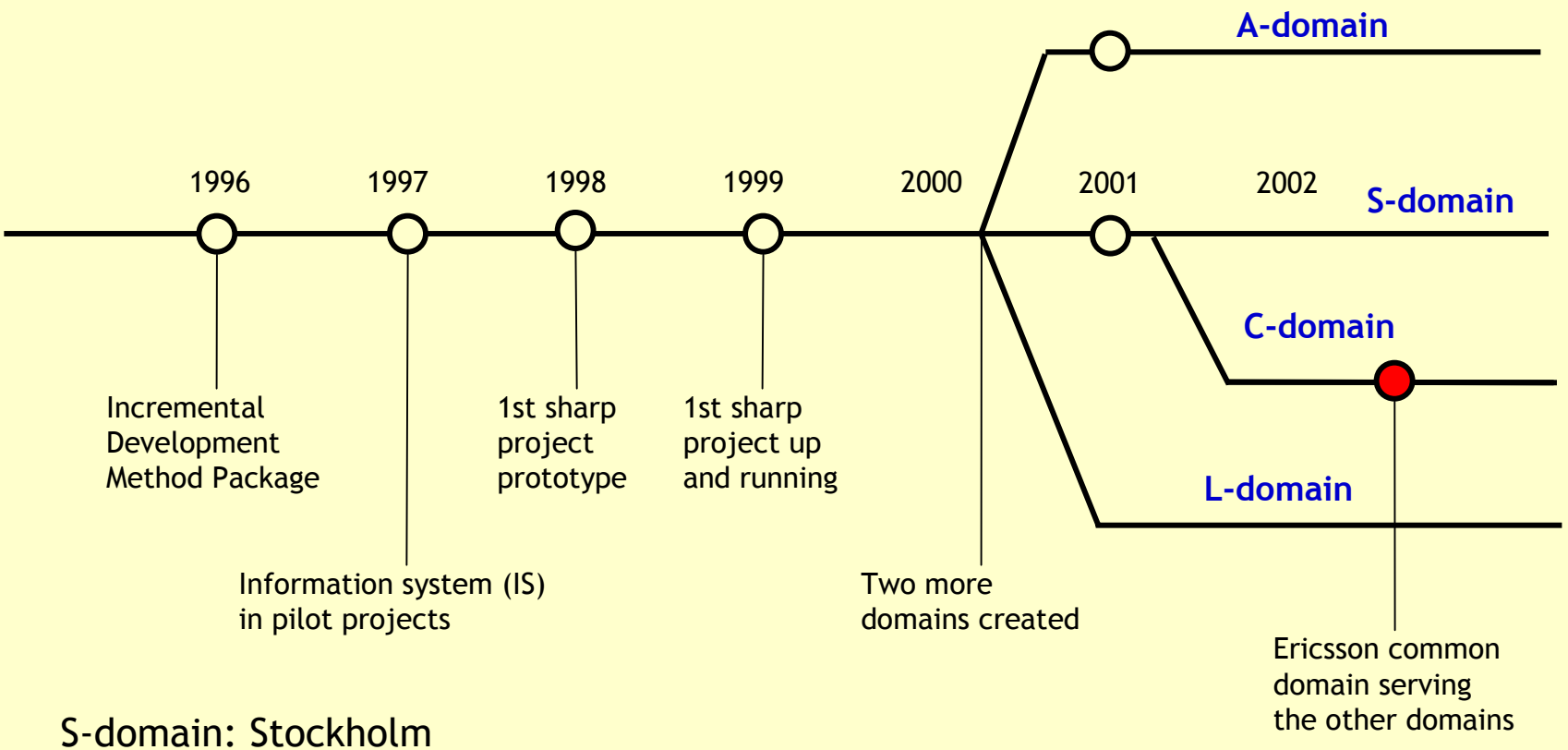
Common domain - platform



S-domain: Stockholm
A-domain: Aachen
L-domain: Linköping
C-domain: Stockholm, common for Ericsson

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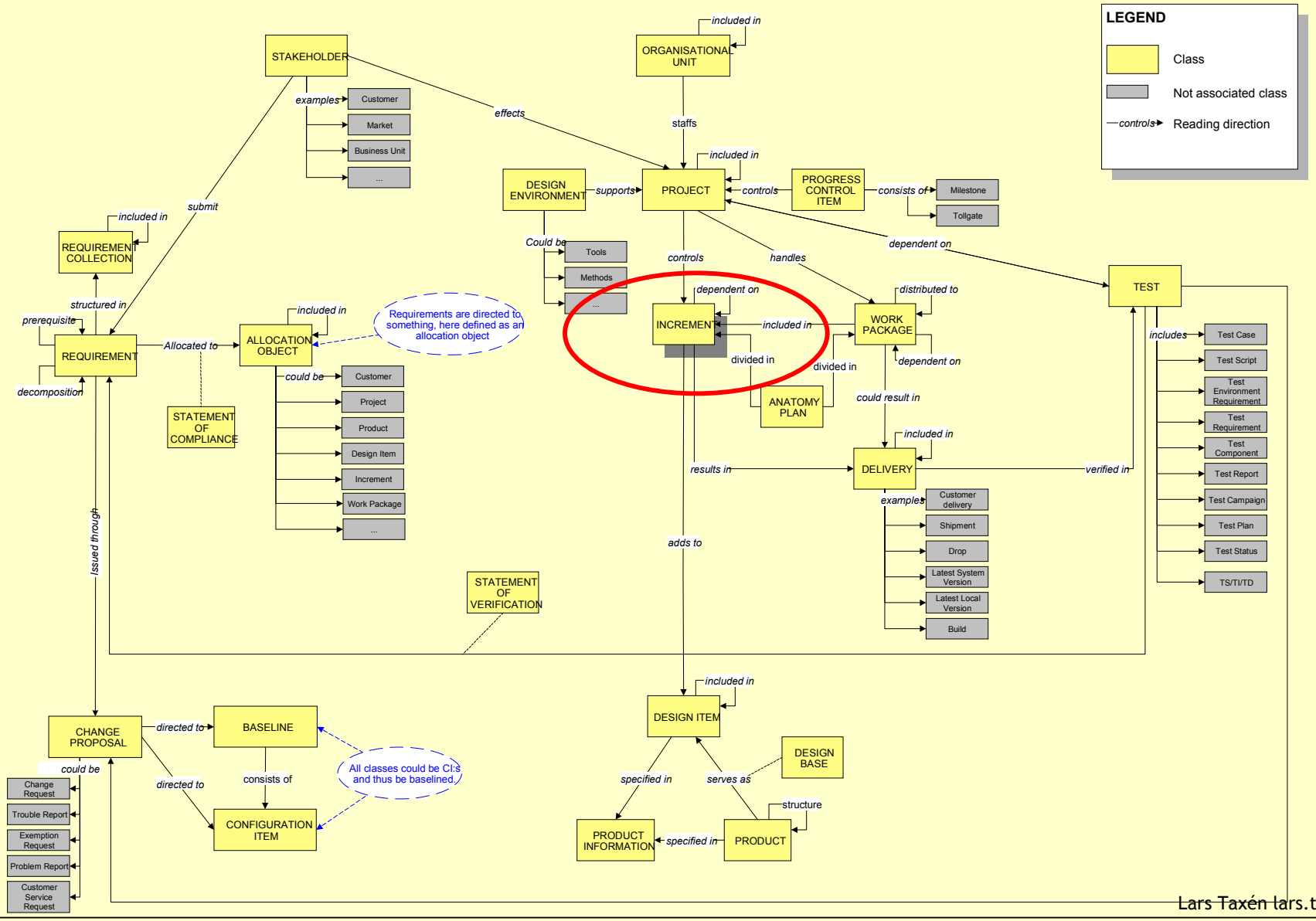
Ontology - C domain 2002



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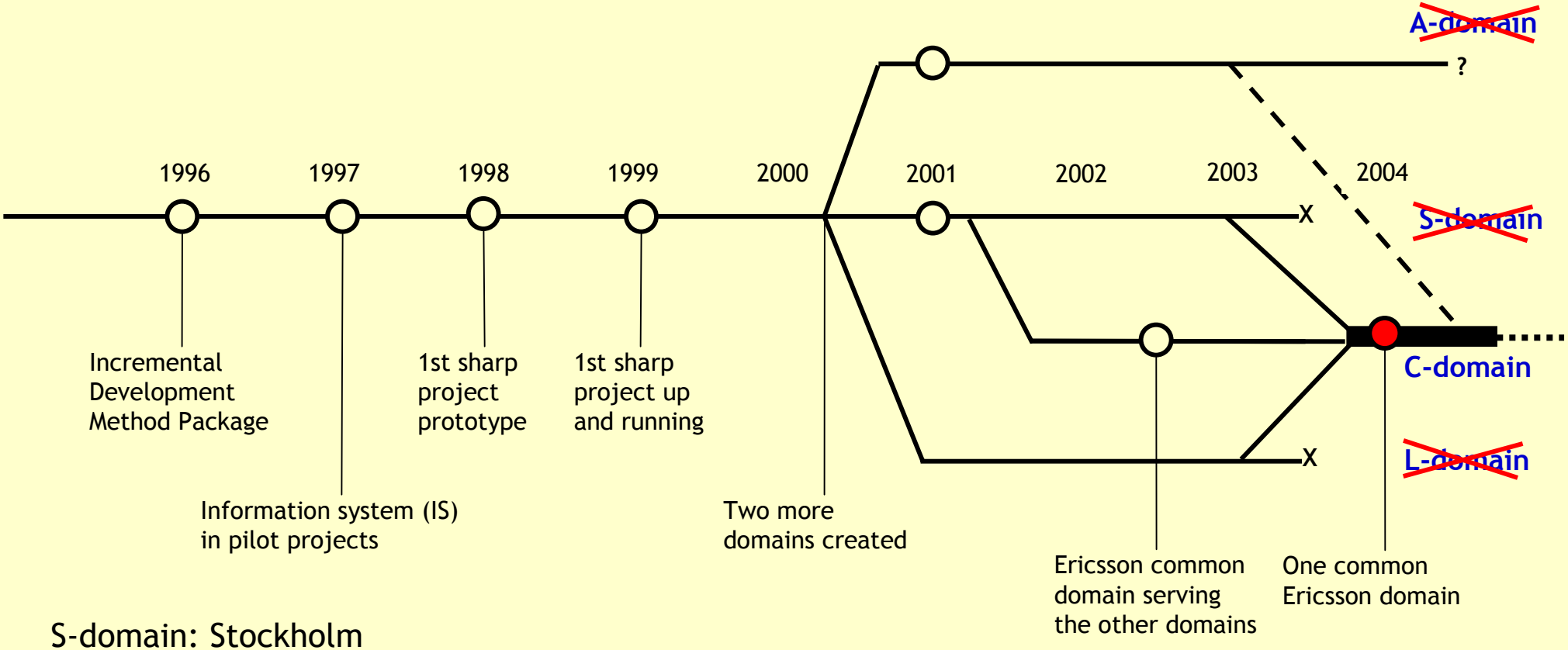
Centralization



S-domain: Stockholm
A-domain: Aachen
L-domain: Linköping
C-domain: Stockholm, common for Ericsson

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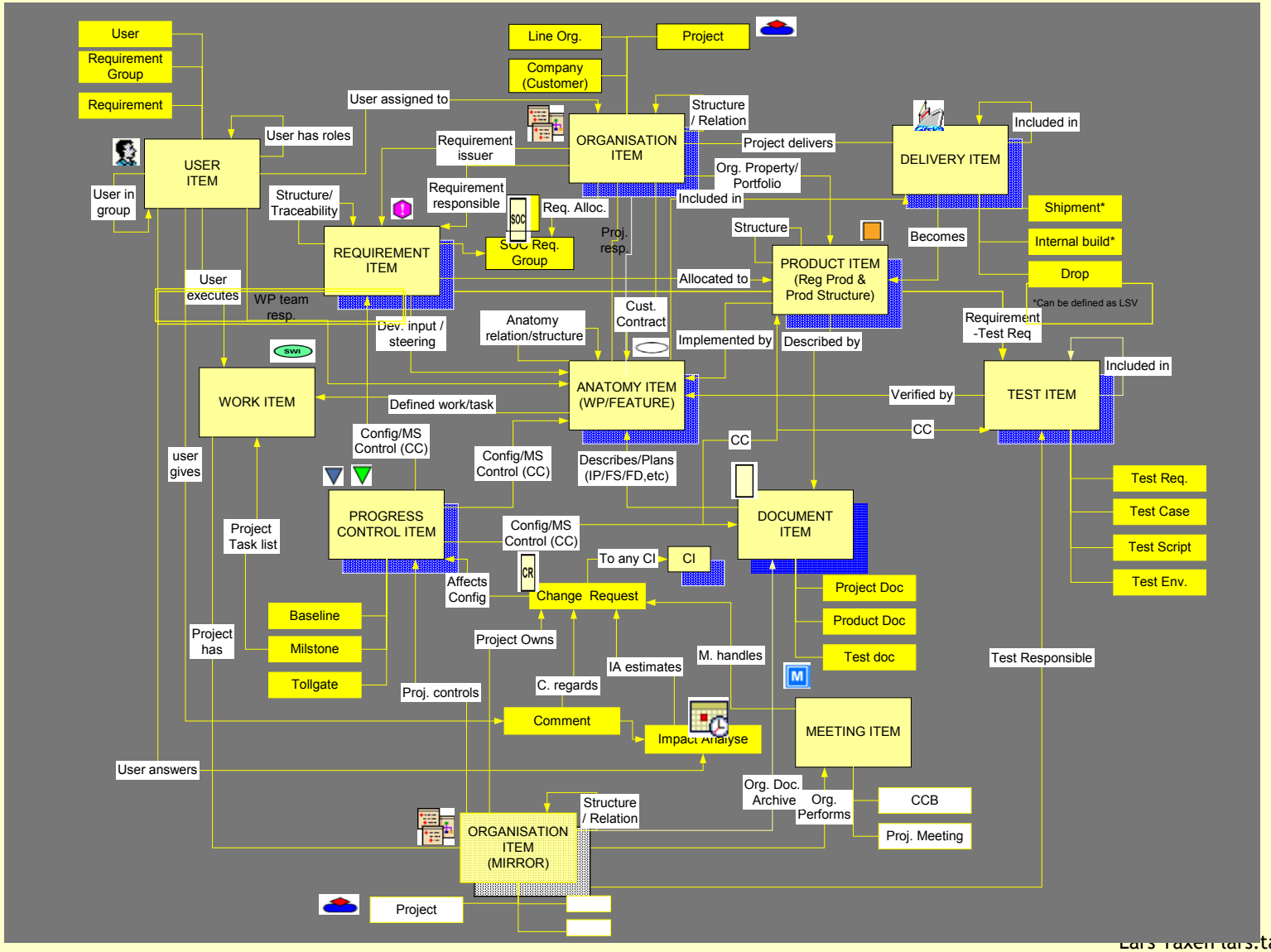
Ontology C-domain 2003



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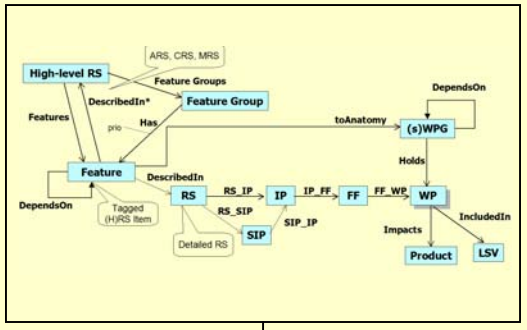
Ontology evolution



A-domain

?

1996 1997 1998 1999 2000 2001 2002 2003 2004

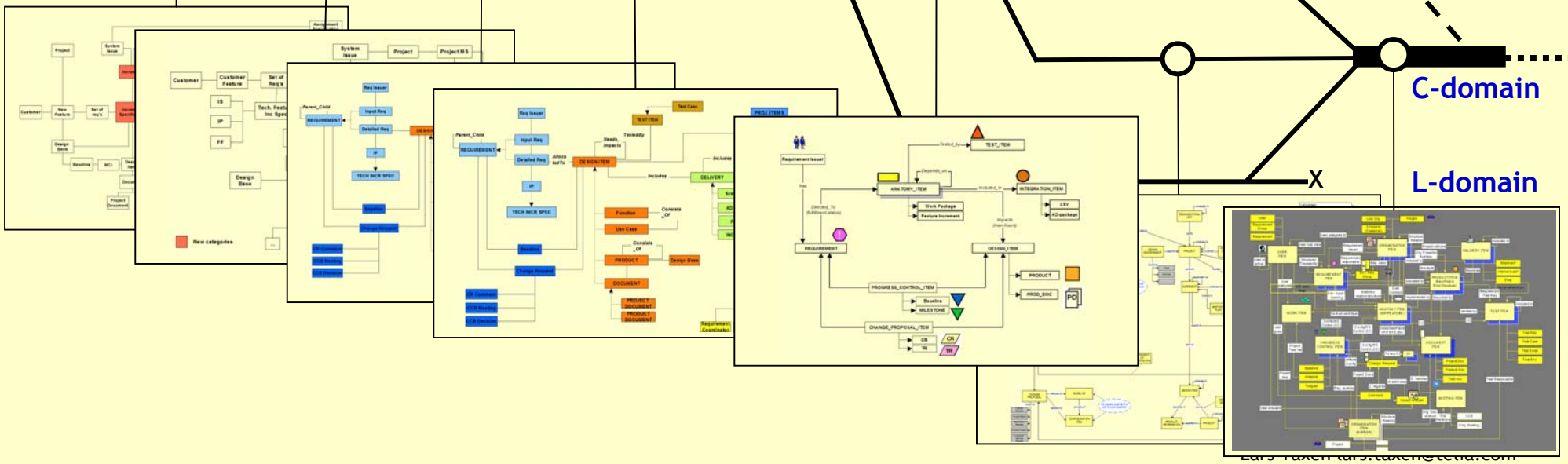
X

S-domain

C-domain

X

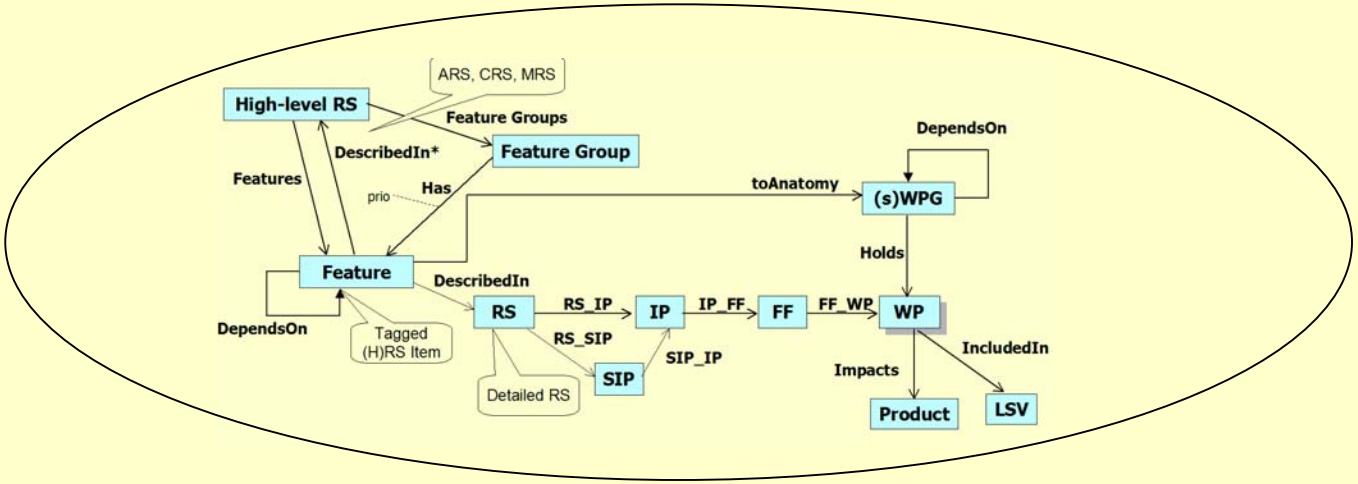
L-domain



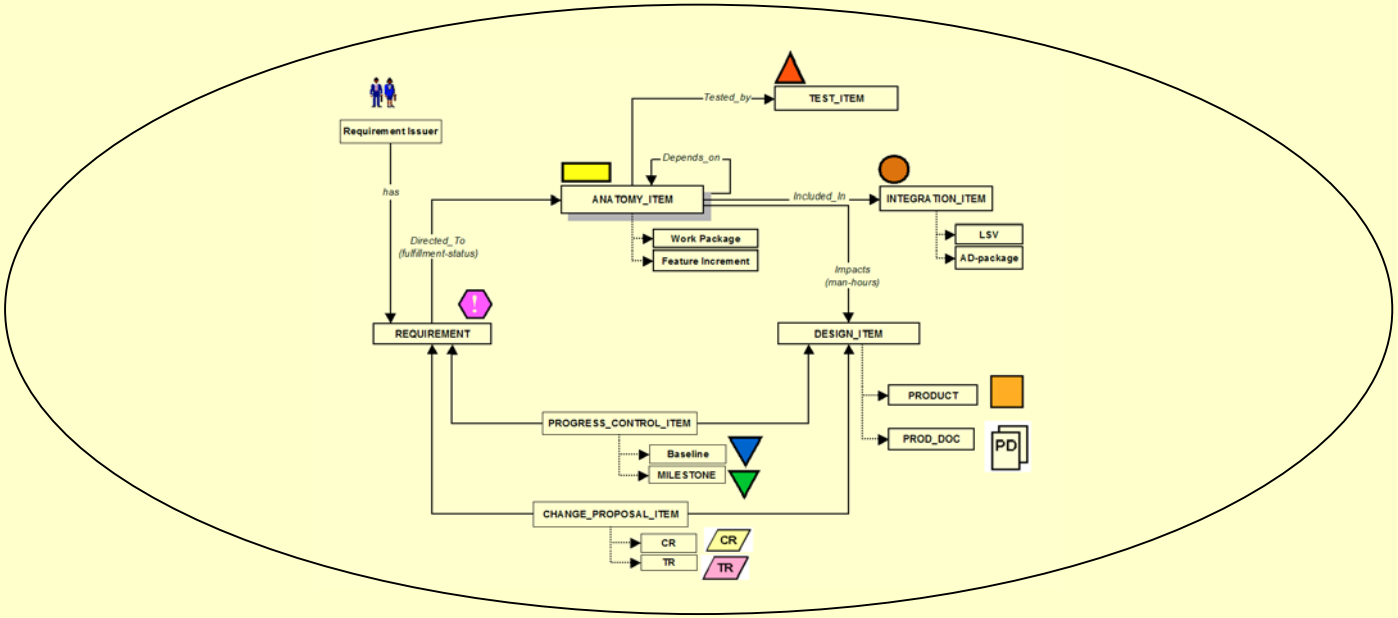
observations

Ontologies differ in spite of the same purpose

A-domain 2001



S-domain 2001



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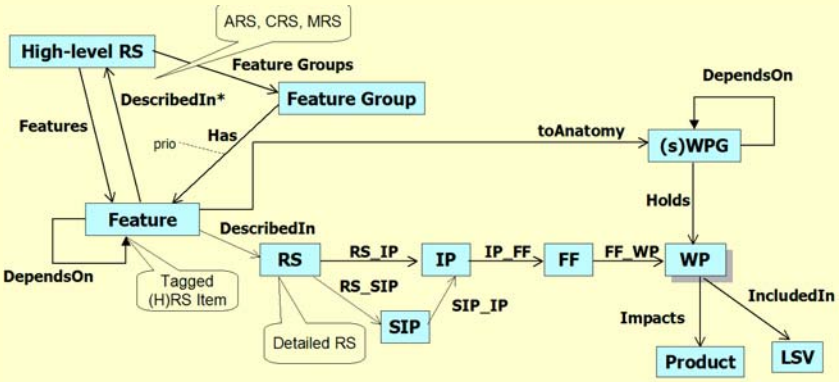
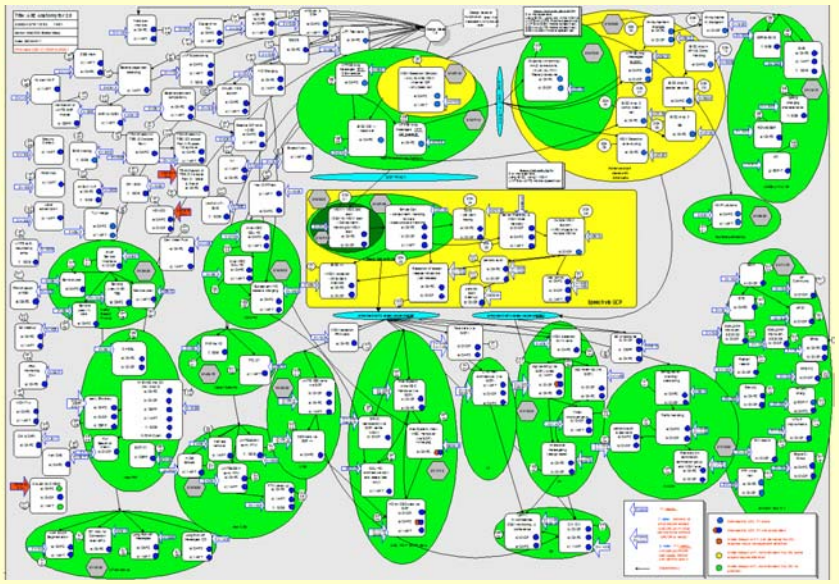
Actions rather than “facts”

“Ontology”



“Knowledge, facts”



“What can we do?”
“What happens if we do this?”
“We reschedule the R3 delivery”
…

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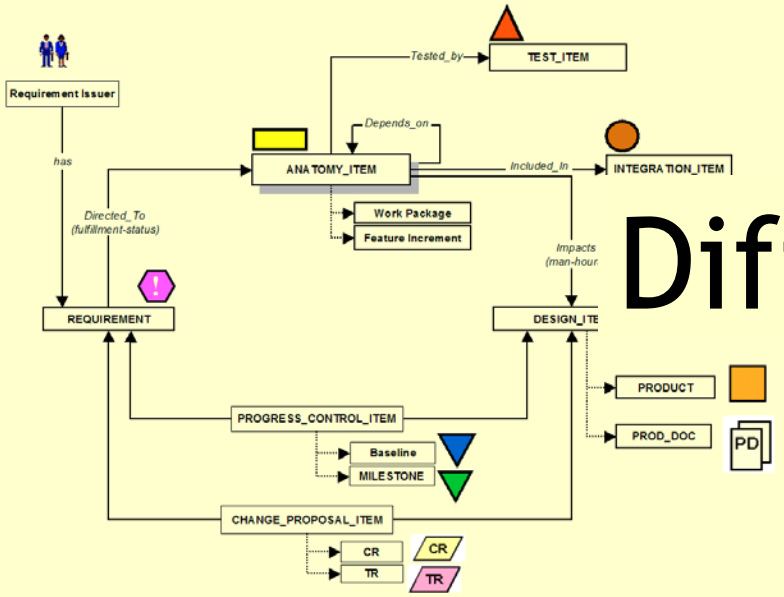
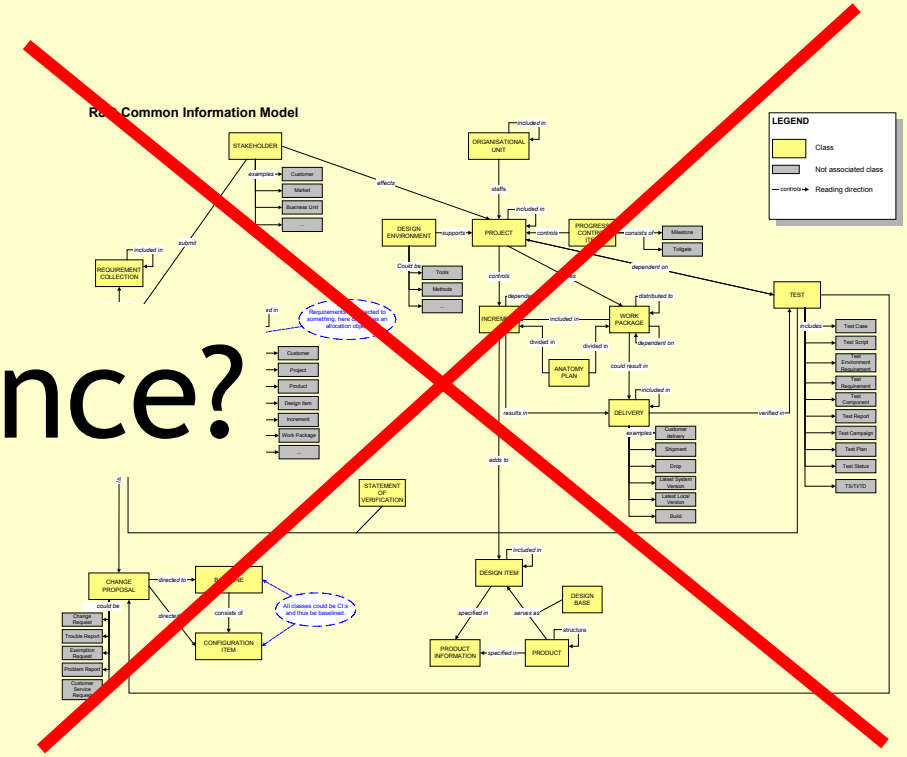
Ontologies must be tried out in practice



Difference?



Chiseled out on the combat field between 1997 - 2002

Defined by a committee and maintained by a clerk

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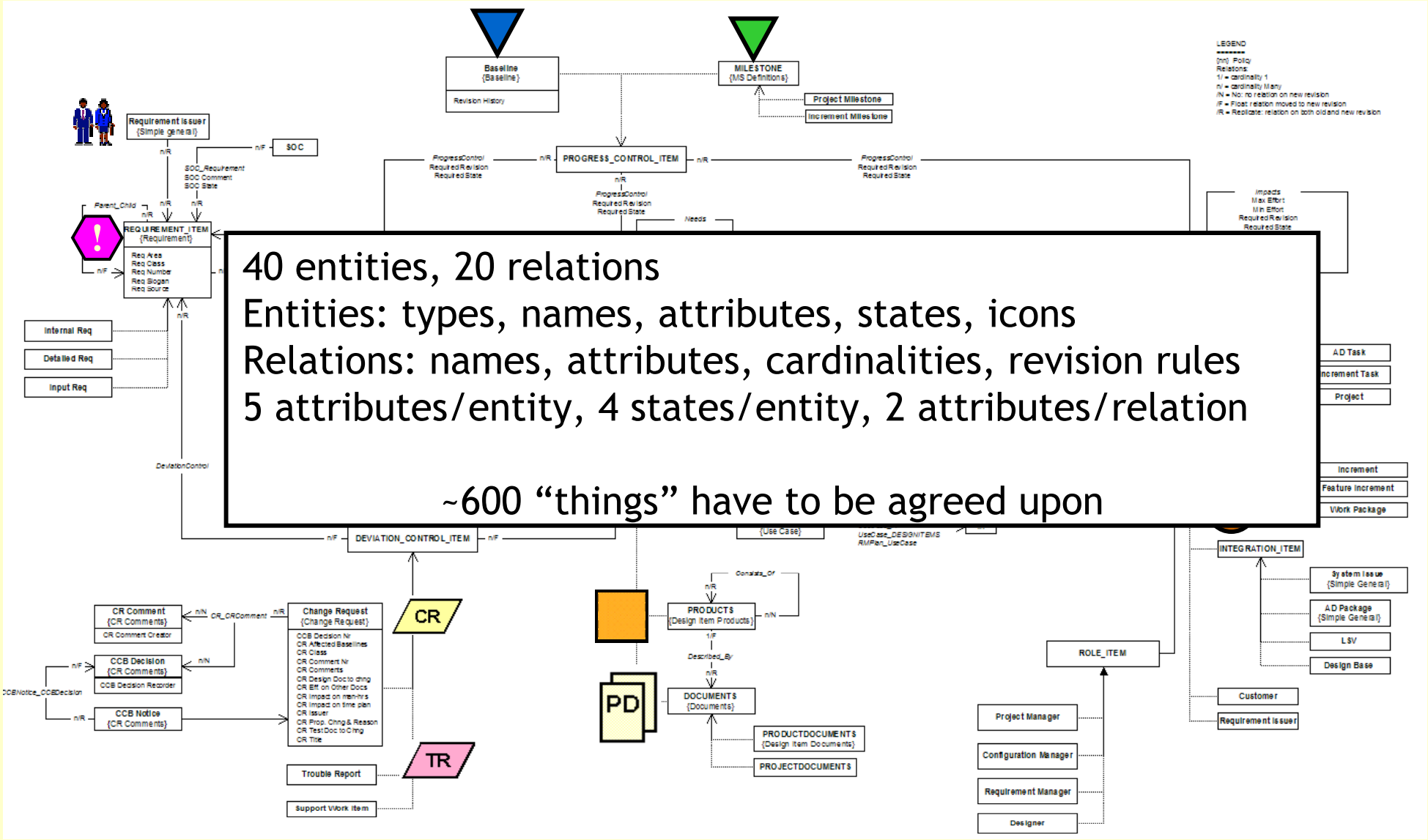
Constructing shared meaning is awesome



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Constructing shared meaning is awesome

We also had major discussion about the attributes for each and every object, what do they really mean and how are they to be used. That was also something that caused quite a lot of time.

(Project Manager 3G)

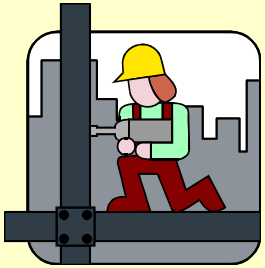
Observations

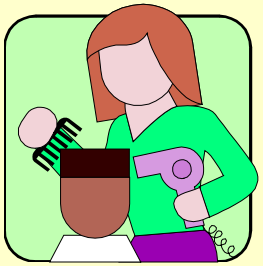
- **Ontologies are in constant development**
- **Ontologies differ depending on context**
  - in spite of fulfilling the same needs
- **Ontologies are instruments for action**
- **Ontologies are validated according to usefulness**
  - not “truth” or representativeness
- **Constructing shared meaning is awesome**
- **Ontologies are impacted by the introduction of IS**
- **The term “ontology” was never used at Ericsson**
  - still isn’t?
  - information model, data model, context model ...

theory

Approach - the workpractice

”A workpractice means that some actors make something in favour of other actors.”



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Why workpractices?

- **Human activity is organized in workpractices**
- **Meaning is constructed in workpractices**
- **Meaning differs with respect to workpractices**
- **Constellations of workpractices**
  - workpractices within workpractices, recursive construct
  - networks of workpractices
- **Not the same as an organization**
  - may coincide
- **Continuous development**
- **Socio-technical approach**

Elements of workpractices - example 1

- **Motive, need**
  - why?
- **Actors**
  - who?
- **Things and relations (ontology)**
  - what is relevant?
- **Order of activities**
  - when?
- **Tools, instruments**
  - with what?
- **Rules, norms, traditions, habits**
  - what is a valid way of working?
- **Change, development**

All elements are interdependent!

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Constitution of workpractices - Activity Domain Theory

- **Motive**
- **Actors**
- **Change and development**
- **Spatial elements** **= Ontology**
  - signifies relevant things and their relationships
- **Temporal elements**
  - signifies dependencies between activities
- **Stabilizing elements**
  - rules, norm, procedures, traditions, habits, beliefs, etc.
- **Instrumental elements**
  - tools, symbols, signs, etc.
- **Transitional elements**
  - signifies how workpractices interact

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Pragmatic view on knowledge

- **Created in action**
  - Learning by doing - Dewey
- **Action oriented**
  - Achieve a goal
- **Situated**
- **Shared**
- **Usefulness rather than “true” of “false”**

“Man thus has no particular need for truth. However, there is a huge and unsatisfiable need for meaning”

ontology construction

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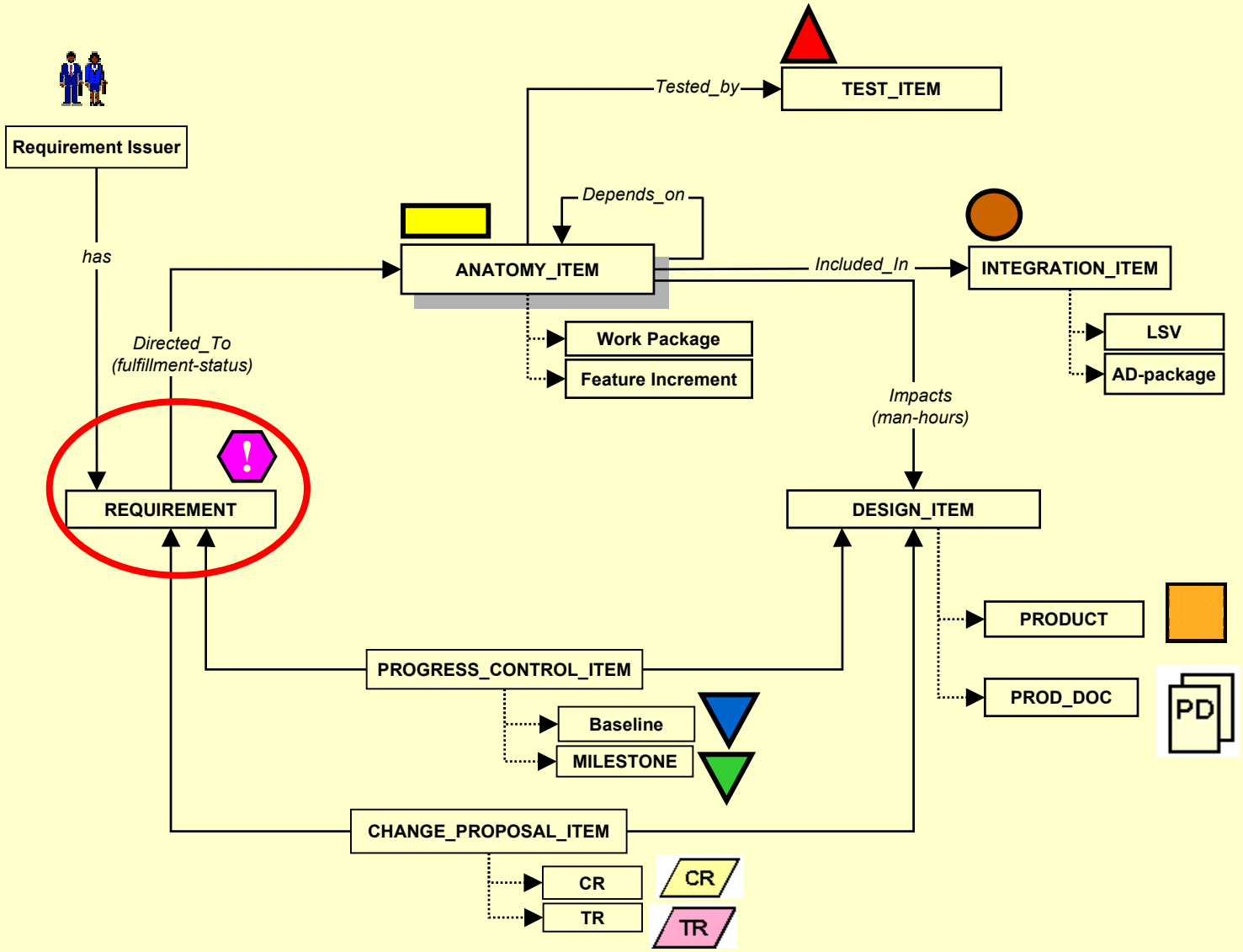
Ontology of the S-domain (Stockholm) 2001



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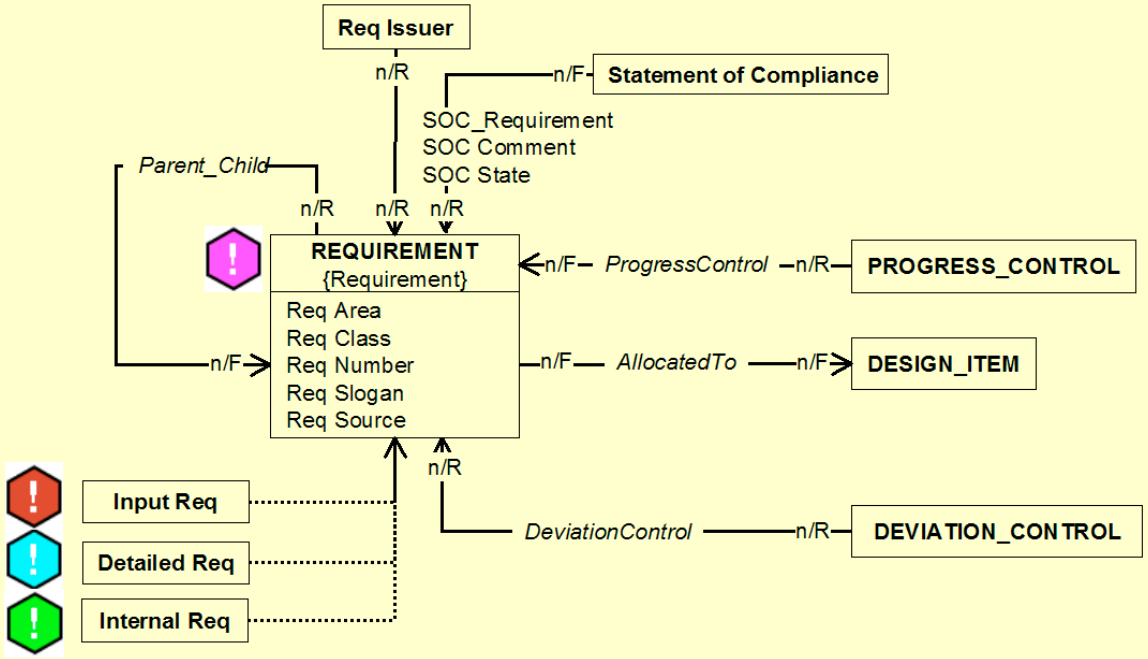
Requirement management as a workpractice

- **Motive**
  - provide requirement management to the project
- **Actors - participants**
  - Requirement manager
  - Project manager
  - IS vendor specialist
  - Workpractice architect, this author
- **Main elements**
  - Requirement management ontology
  - IS implementing of the ontology
  - rules for identifying requirements
  - ...

Requirement ontology



To be defined...

- Entities
- Relations
- Names, icons
- Types of requirements
- Life cycle of requirements
- Attributes on requirements
- Attributes on relations
- Cardinalities on relations
- Revision stepping rules
- Actor roles
- Access rights for roles
- ...

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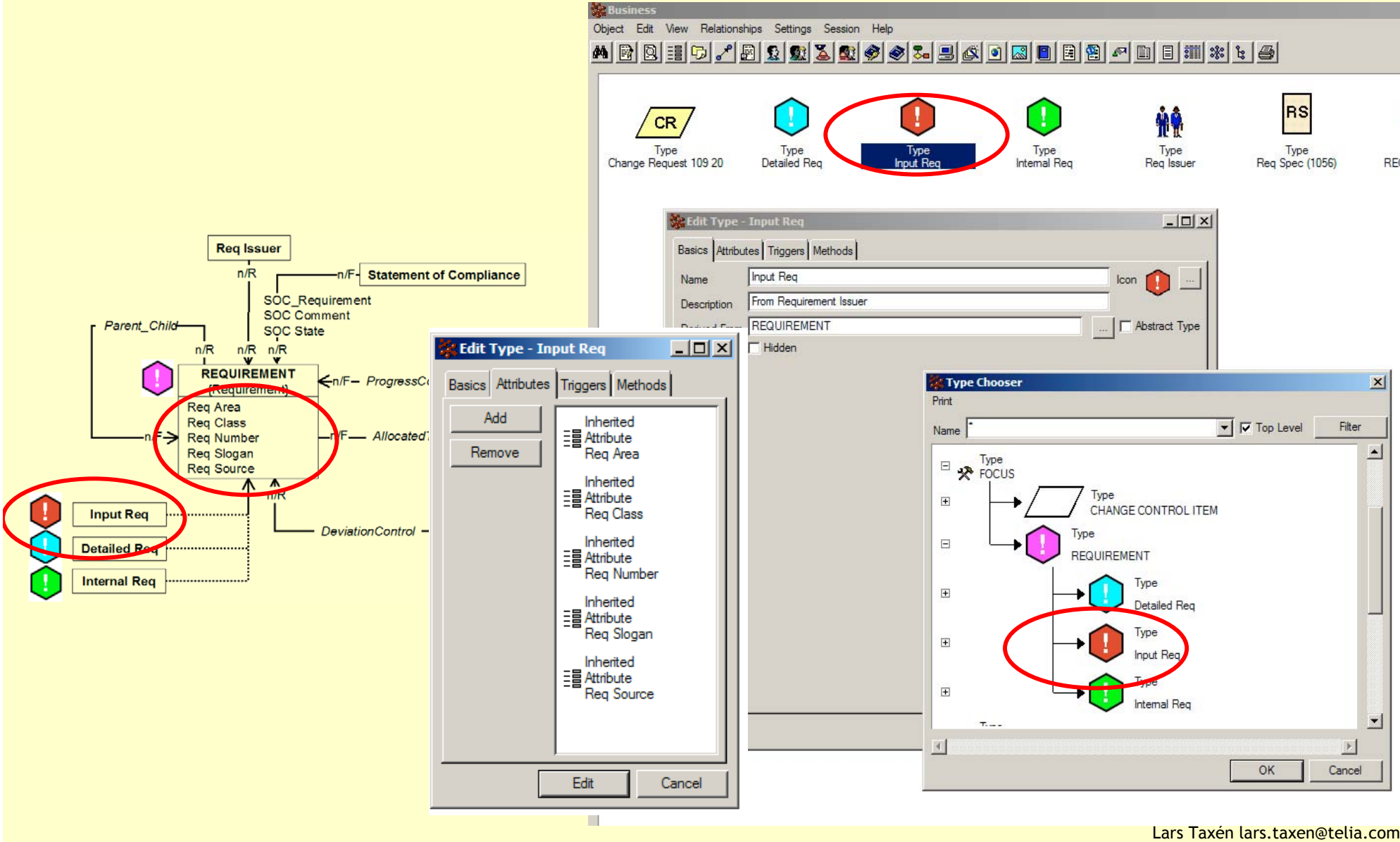
Entity type definition in the IS



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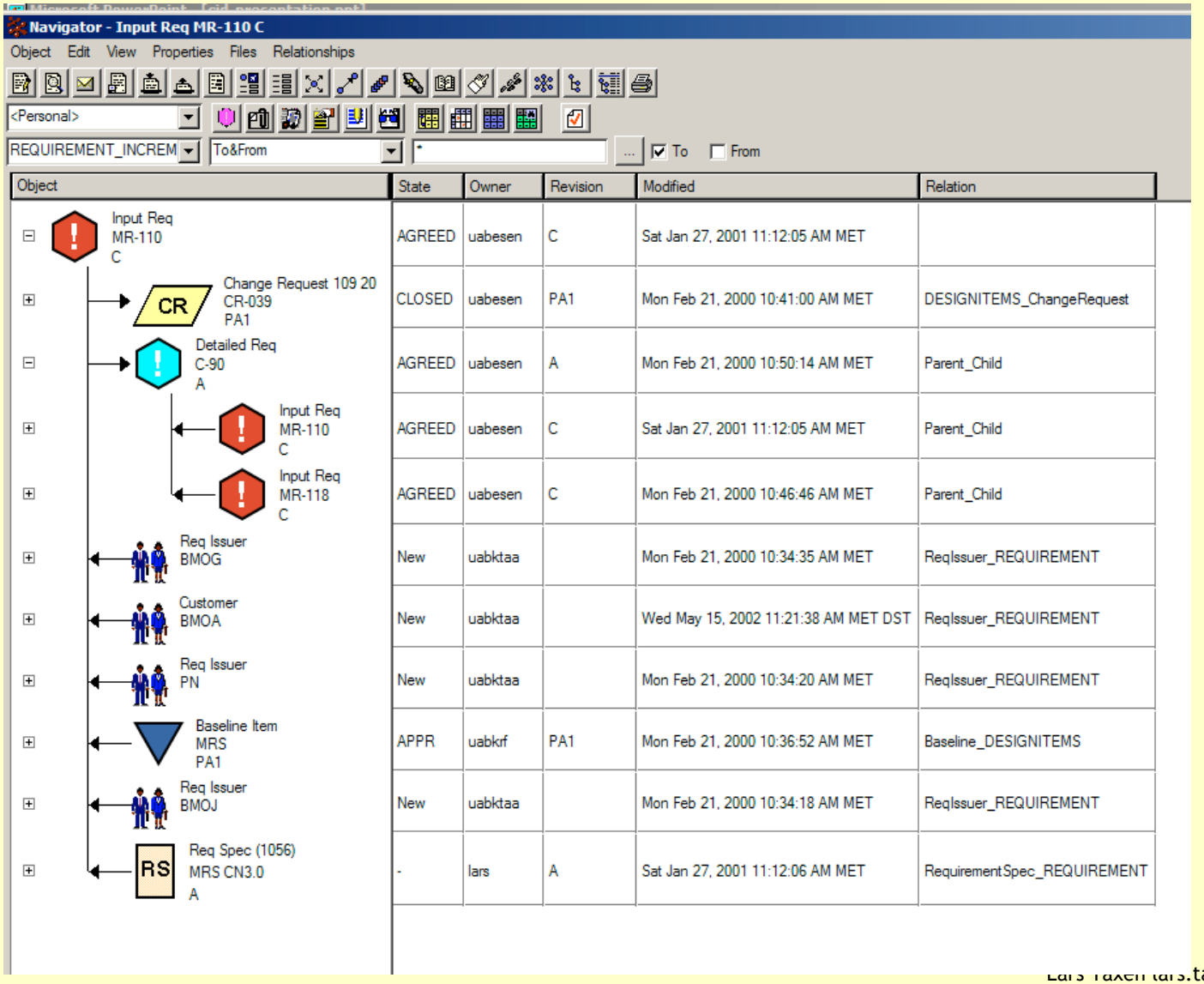
Instances of entities in the IS (“facts”)



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Change Request 109 20 CR-039 PA1	CLOSED	uabesen	PA1	Mon Feb 21, 2000 10:41:00 AM MET	DESIGNITEMS_ChangeRequest
Detailed Req C-90 A	AGREED	uabesen	A	Mon Feb 21, 2000 10:50:14 AM MET	Parent_Child
Input Req MR-110 C	AGREED	uabesen	C	Sat Jan 27, 2001 11:12:05 AM MET	Parent_Child
Input Req MR-118 C	AGREED	uabesen	C	Mon Feb 21, 2000 10:46:46 AM MET	Parent_Child
Req Issuer BMOG	New	uabktaa		Mon Feb 21, 2000 10:34:35 AM MET	ReqIssuer_REQUIREMENT
Customer BMOA	New	uabktaa		Wed May 15, 2002 11:21:38 AM MET DST	ReqIssuer_REQUIREMENT
Req Issuer PN	New	uabktaa		Mon Feb 21, 2000 10:34:20 AM MET	ReqIssuer_REQUIREMENT
Baseline Item MRS PA1	APPR	uabkrf	PA1	Mon Feb 21, 2000 10:36:52 AM MET	Baseline_DESIGNITEMS
Req Issuer BMOJ	New	uabktaa		Mon Feb 21, 2000 10:34:18 AM MET	ReqIssuer_REQUIREMENT
Req Spec (1056) MRS CN3.0 A	-	lars	A	Sat Jan 27, 2001 11:12:06 AM MET	RequirementSpec_REQUIREMENT

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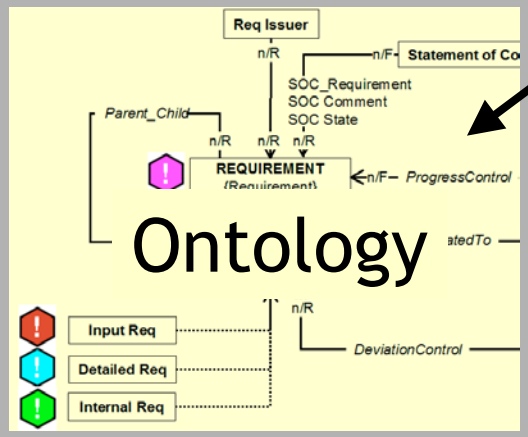
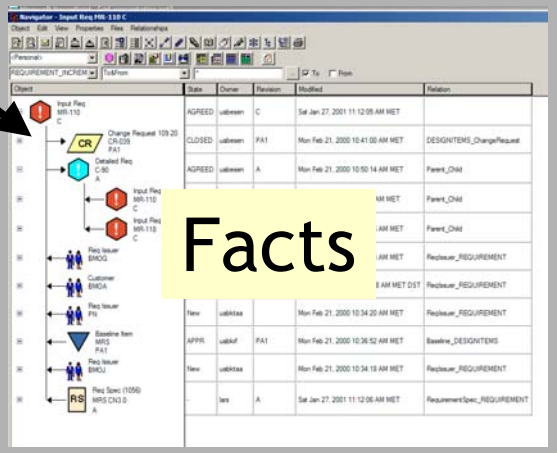
Constructing the workpractice

Req. mgr Proj. mgr IS vendor Architect

Individual meaning

Shared meaning





Meaningful artefacts

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discussion

Discussion

- **Basic assumptions of the “AI” perspective concerning**
  - knowledge
  - the ontology of ontologies
  - unification
  - meaning
  - machine processing of ontologies
  - ontology development
- **The “AI” versus the “workpractice” perspectives**
- **Concerns**
- **Further research**

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Knowledge

"… knowledge is a collection of facts about a domain."

"…encoding knowledge in terms of the concepts and relations."

"Ontological analysis clarifies the structure of knowledge"

- **Knowledge is a thing that can be managed**
- **Knowledge is encoded in things**
- **Knowledge is discovered**

Ontology of ontologies

"An ontology provides a set of concepts and terms for describing some domain, while a knowledge base uses those terms to represent what is true about some real or hypothetical world."

"… ontology is an explicit specification of an abstract, simplified view of a world we desire to represent"

- **The ontology is outside the real world**
- **The ontology represents the world**
- **There is a truth out there**
- **Knowledge and ontology are different**

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Unification

"Communication between distinct groups using different vocabularies creates the need to create common vocabularies, which optimally suit all involved"

- **Different vocabularies should be avoided**
- **The ultimate goal is to unify heterogeneous vocabularies**

Meaning

"...The only languages [to describe the entities involved and the relationships between them] that are likely to fit the bill are mathematical, and the prime contenders are understandable in terms of first-order logic."

"Ontologies will provide the necessary meaning to web content therefore enabling software agents to understand and retrieve information in relevant contexts."

- **Meaning can be expressed by first-order logic**
- **Ontologies contain meaning**

Machine processing

"We have presented an automated approach to unifying heterogeneous information models based on machine-processable metadata specifications."

"The application of Semantic Web technologies to enable Semantic eBusiness provides the organizations the means to design collaborative and integrative, inter- and intra-organizational business processes and systems founded upon the seamless exchange of knowledge."

- **Technology focus**
- **Humans in the background**

Development of ontologies

"Ontology, in the traditional way is supposed to reflect with precision and formality the well established knowledge of a given area. In that sense is it like a theory, it should be stable and throughout used. Of course that its construction demands time."

- **Ontologies are stable**

Basic tenets - the “AI” perspective

- Knowledge is a thing
- Ontologies and knowledge are different things
- Heterogeneous vocabularies can and should be unified
- Ontologies carry meaning
- Ontologies can be machine processable
- Ontologies are stable

“Workpractice” versus “AI” view on ontologies

- **Knowledge is created in action**
  - not a thing, inherently human
- **Ontologies mediate actions**
  - part of the world, not outside
- **Ontologies are workpractice specific**
  - a unified ontology that fits all needs is an illusion
  - transition between ontologies, not unification
- **Meaning is created in workpractices**
  - shared, individual, across workpractices
- **Technology is not the whole story**
  - machine processing where it works
- **Ontologies are always in development**

The “AI” way - concerns raised

- **The philosophical background**
  - is knowledge equal to facts?
  - can knowledge be managed?
  - are ontologies “outside” the world it describes?
- **Meaning**
  - sparsely treated
  - do ontologies encode meaning?
- **Unification**
  - is it possible to define “one size fits all” ontology?
- **Validation**
  - usefulness or truth?
- **Development**
  - stable or dynamic world?

The bottom line

"I find it critical to remember that every ontology is a treaty - a social agreement - among people with some common motive in sharing"

(Tom Gruber, AIS SIGSEMIS Bulletin 1(3) October 2004)

Further research

- **Articulate the "workpractice" approach to ontologies**
  - shared meaning in the Semantic Web
  - machine processing, prerequisites
  - other elements according to the Activity Domain Theory
- **Expand the scope of the Activity Domain Theory**
  - coordination (Ph.D.)
  - product life cycle management - PLM (IJPD)
  - alignment of IT and business strategy (SPIP)
  - Activity Theory (AJIS)
  - project management (PICMET 2005)
  - system development - anatomy concept (ALOIS 2005)
  - HCI (UITQ 2005)
  - distributed SW development (in review)

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