Conceptual framework, models and methods of knowledge acquisition and management for competency management in various areas

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Key points

- **Main problems concerning competency management (CM)**
- **Objectives and requirements for the research**
- **Conceptual framework for CM**
- **LifeLong Learning Space as goals model for knowledge acquisition**
- Tabular form for knowledge representation
- **Tailoring Competency metamodel**
- Further development

Competency management
Projects and tasks

- Designing educational / training courses for professional education
- Developing methodology for curriculum design
- Developing methodology for selecting a relevant candidate for a specific task
- Participating in developing professional standards for qualification requirements
- Consulting on a personal LLL trajectory forming

Competency management Problems

- Abundance of competency definitions
- Arbitrary and vague descriptions of desired competencies even in professional standards
- Experts working with DSS have to modify and adapt them without experience in knowledge engineering
- Necessity to deal with “soft” properties like cognitive and affective skills

Competency management
Objectives and requirements

- Develop a feasible concept of competency
- Develop a conceptual framework for CM
- Determine necessary and sufficient level of formality allowing SD experts to work without knowledge experts
- Enable defining and comparing distinct states of SD objects in the space of LLL
- Introduce procedures for ordering “soft” properties like cognitive and affective skills etc.

Conceptual framework for Competency management based on KAM

General concepts and principles of Competency management & LLL & KM

Conceptual base for

LLL Space:

Objects; States; Targets; Relations; Distances; Gaps; Trajectories; Evaluations

LLL Goals & requirements model for

Meta-level:

Normalized competency meta-model (NCMM); SD meta-knowledge; skills taxonomy (cognitive, affective); performance features and conditions classification etc

Meta knowledge for

Procedures:

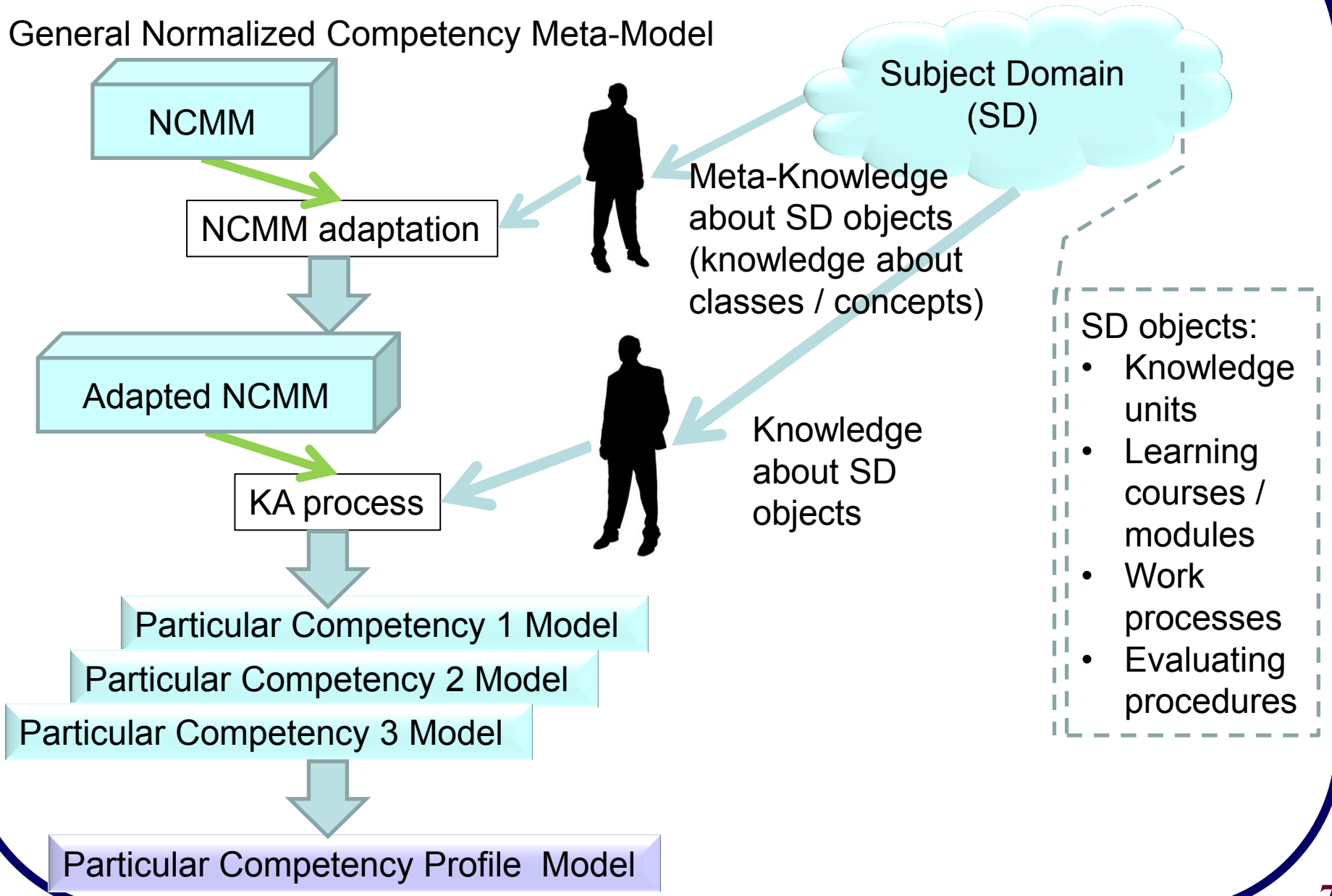
competency knowledge acquisition & storing; competency's property evaluation; concrete competency models forming; composite indicators calculation; competency knowledge transforming

Methodology base for

Models and tools:

links to SD knowledge, skills values, integrated competency models, competency and competency profile composite indicators

KA for CM process – high level description



Current working definition of competency

A competency *(professional)* – An aggregate of interrelated knowledge of a subject domain, skills for utilizing this or arbitrary knowledge at a certain level of mastery and possibly of certain performance indicators and other conditions of utilizing this skill for successful performing of a working process or a certain type of a professional or educational activity.

Uses traditions of KSAO structure "Knowledge, Skills, Abilities and Other characteristics**"**

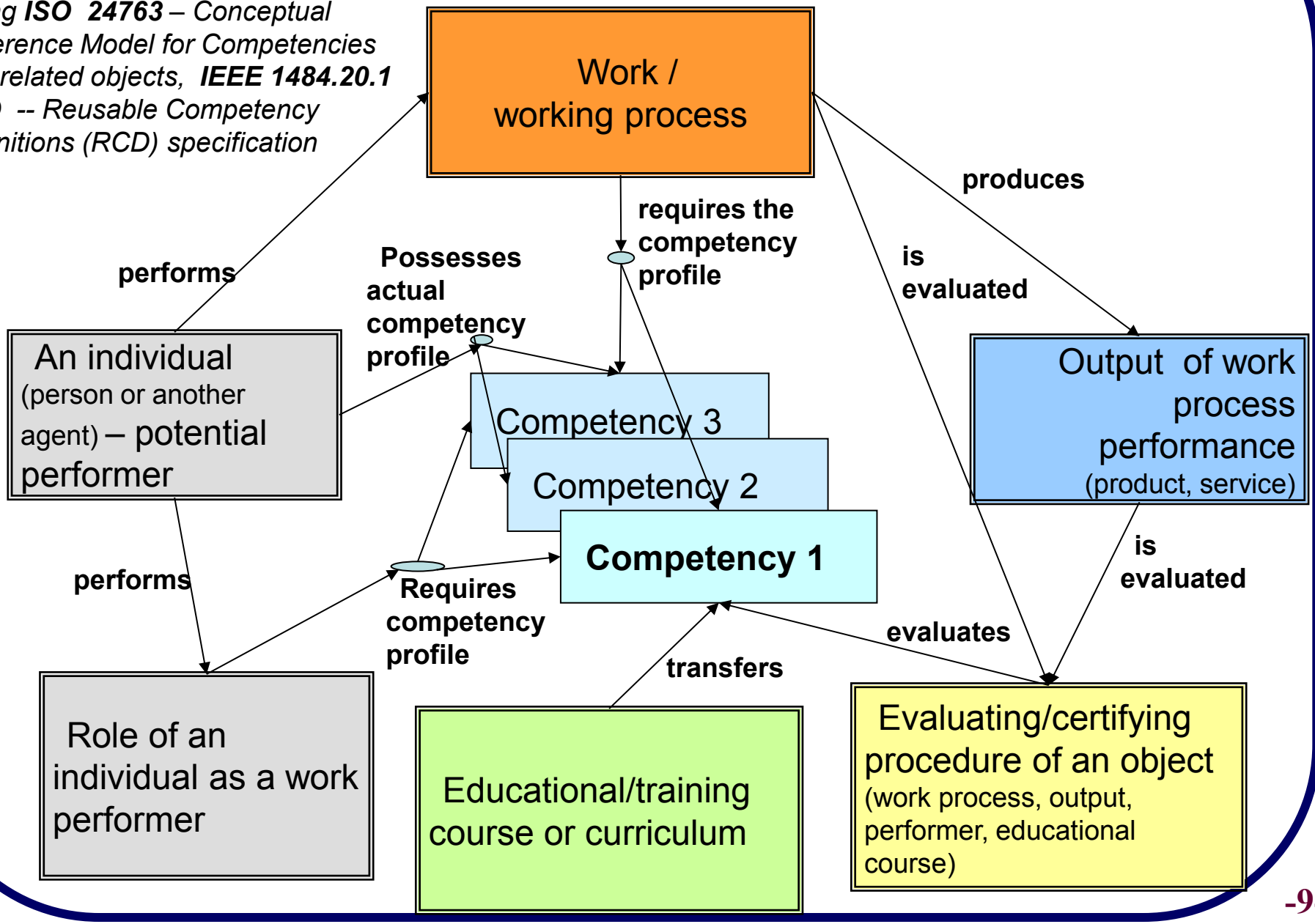
IEEE Std 1484.20.1TM-2007. Standard for Learning Technology—Data Model for Reusable Competency Definitions :

"Competency: Any aspect of competence, such as knowledge, skill, attitude, ability, or learning objective. The term "competency" is also used to include all classes of things that someone, or potentially something, can be competent in"

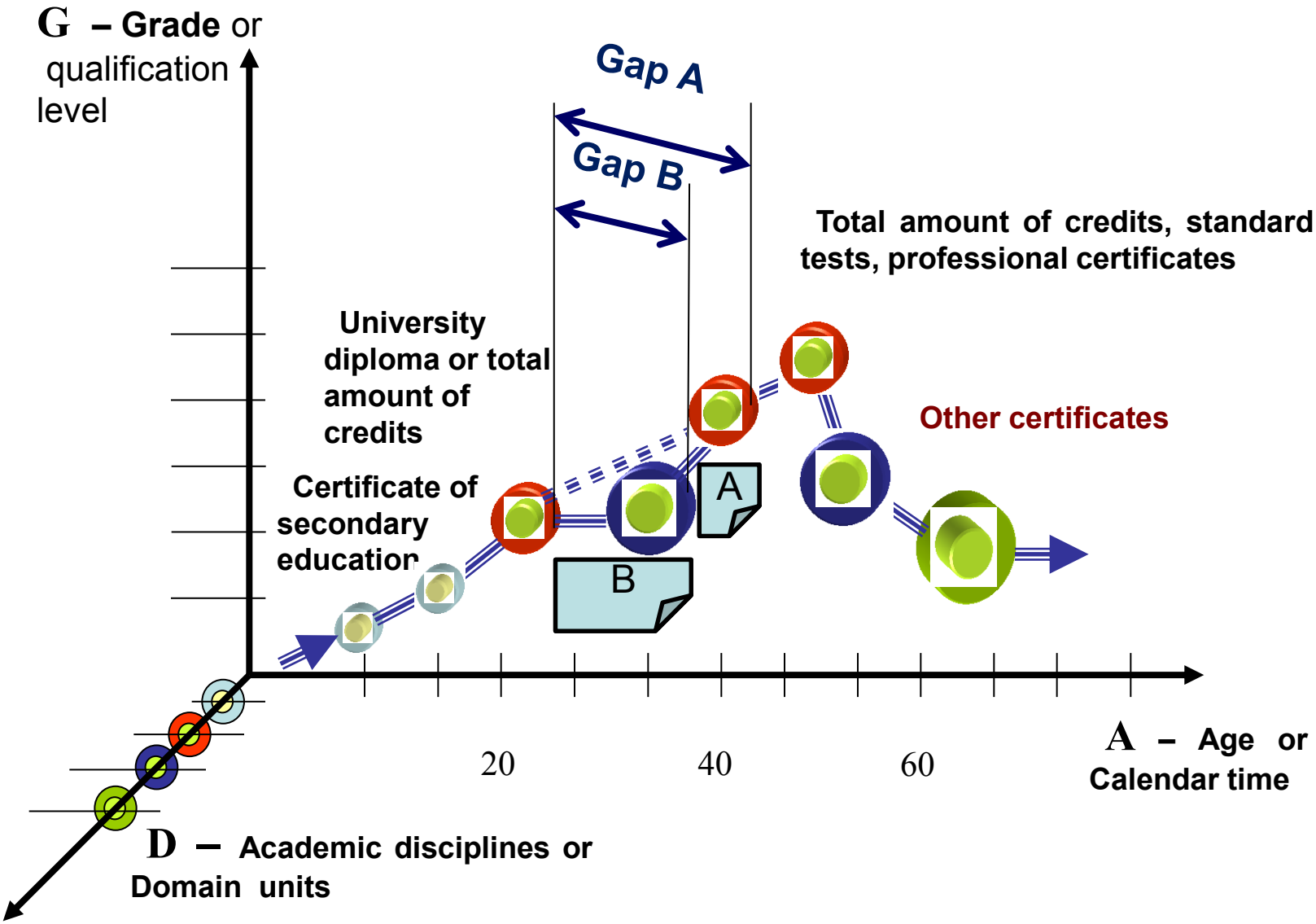
Uses elements of G. Paquette competency definition, ideas of *ISO 24763 – Conceptual Reference Model for Competencies and related objects* and some others sources.

Competencies in relations with related SD objects

*Using **ISO 24763** – Conceptual Reference Model for Competencies and related objects, **IEEE 1484.20.1 STD** -- Reusable Competency Definitions (RCD) specification*

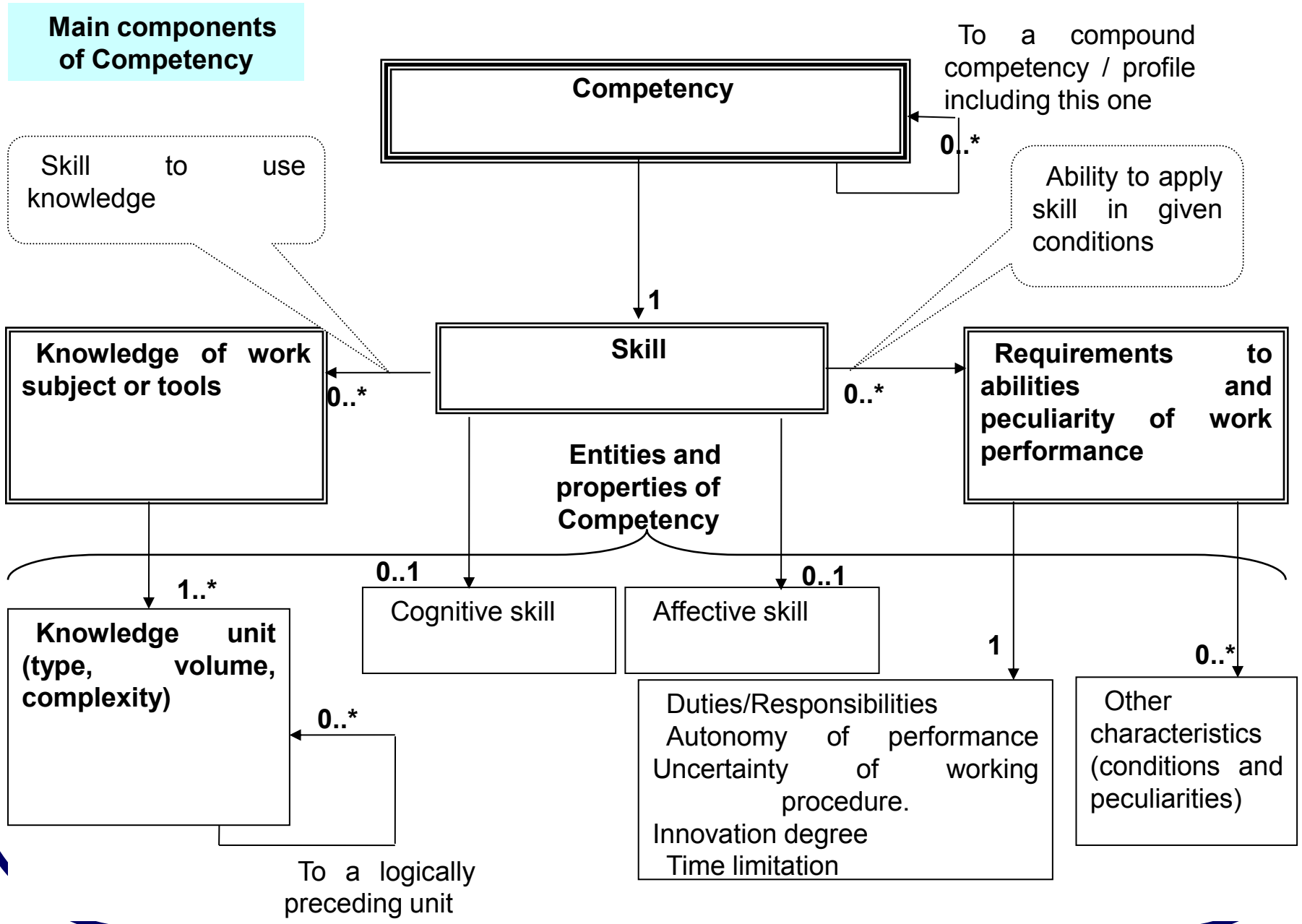


LifeLong Learning Space (LLLS)



The size of a circle p*i,j,k* (a*i*, d*j*, g*k*) *reflects the volume of acquired knowledge at a specific section from* a*i-1 to* a*i.*

General Normalized Competency Meta-Model



Knowledge types (Bloom - Anderson):

Factual	separate fragments of knowledge such as definitions and knowledge of specific details
Procedural	algorithms, empirical methods, techniques and knowledge when to use these procedures
Conceptual	knowledge of information theories and systems such as classification and categorization
Metacognitive	knowledge about cognitive processes and about managing these processes effectively

Generic Levels of Knowledge Volume/ Complexity

1. Factual knowledge (K) about concrete professional elements, equipment components, separate functions, procedural K of simple procedures

2 . + factual K about an object as an aggregate with the set of main elements but without considering all connections and their interaction; procedural K about variants of problem solving, variant selection criteria

3. + factual K of connections and features of aggregated object elements interaction, some knowledge from other domains; procedural K of methods for analysis and predicting; conceptual K of general laws; professional K about interaction with environmental subjects

4. + factual K about complex objects in own domain (complex IS, …) and in other domains; procedural K about complicated procedures for interacting with other enterprises, conceptual K of theories and models, about methods of conceptions development, about methods of shared using information from different domains

5. + factual K about higher aggregation and generalization (enterprise, industry), conceptual K of developing meta models, metacognitive K about methods of new knowledge synthesis

Examples of knowledge levels tailoring for "Applied informatics" subject domain

1 : Knowledge about menus, screen forms and methods for working with them; about using standard programs.

2 : Knowledge about device or program in the whole together with their components and messages; about printer mechanism and way for connecting it to the PC; how to memorize information, what to remember and what to look up in a manual.

3 : Knowledge about basics of DBMS, OS, information security, about methods for predicting professional situation development; about supply and demand; about basics of project management.

4 : Knowledge about IT infrastructure at enterprise; about modern DBMS; about applied IS; how to apply brief summarizing of main document features for understanding its main idea and structure. Knows that logical deduction is used for repairing incomplete or damaged information.

5 : Knowledge about methods of developing and enhancing of integrated systems for enterprise management in modern business conditions; about extended enterprises and their management; about complex projects and programs management.

Generic levels of cognitive skills

1. understand/ explain/ interpret situation (event), give examples, apply standard procedures (includes the previous level – remember/recognize)

2. Analyze, classify, predict basing on simple cause-effect relations, diagnose

3. Repair damaged or missing knowledge (possibly “distorted"), apply deduction method

4. Generalize, draw conclusions using deduction, plan (tasks), model, create innovative (not existing) process / procedure; synthesize, obtain new knowledge from known fragments and analyzing them

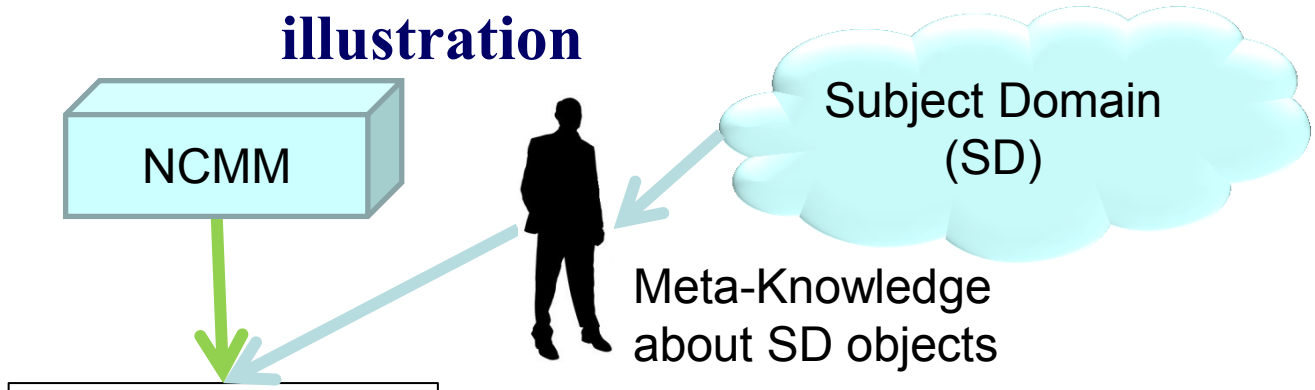
5. Evaluate (result comparing with plans), elaborate assertion about value and significance of a certain idea; choose correcting actions. Ability for self-organization.

Meta-model table representing class: "Knowledge unit"

Entity: Knowledge object	remarks
Knowledge object Identifier	Concatenation 'K'|<integer> Unambiguously identifies knowledge object in a certain information environment (e.g., in professional competencies repository or in a wider library environment).
Knowledge object Name	Conventional name used in qualifications or/and competency standards
Knowledge volume/complexity for knowledge object	Indication of one knowledge type: factual, procedural, conceptual, metacognitive or prevailing type. Some levels include different knowledge types
Knowledge object name synonym (if necessary)	Synonymic name used in knowledge standards de-jure and de-facto.
Knowledge object annotation	Brief substantial knowledge object description.

Normalized Competency Meta-Model adaptation process – illustration

Entity: Knowledge object
(KO ID) Knowledge object identifier
(KO Name) Knowledge object name
(KO KV) Knowledge volume / complexity for knowledge object
(KO SN) Knowledge object name synonym (if necessary)
(KO Annotation) Knowledge object annotation



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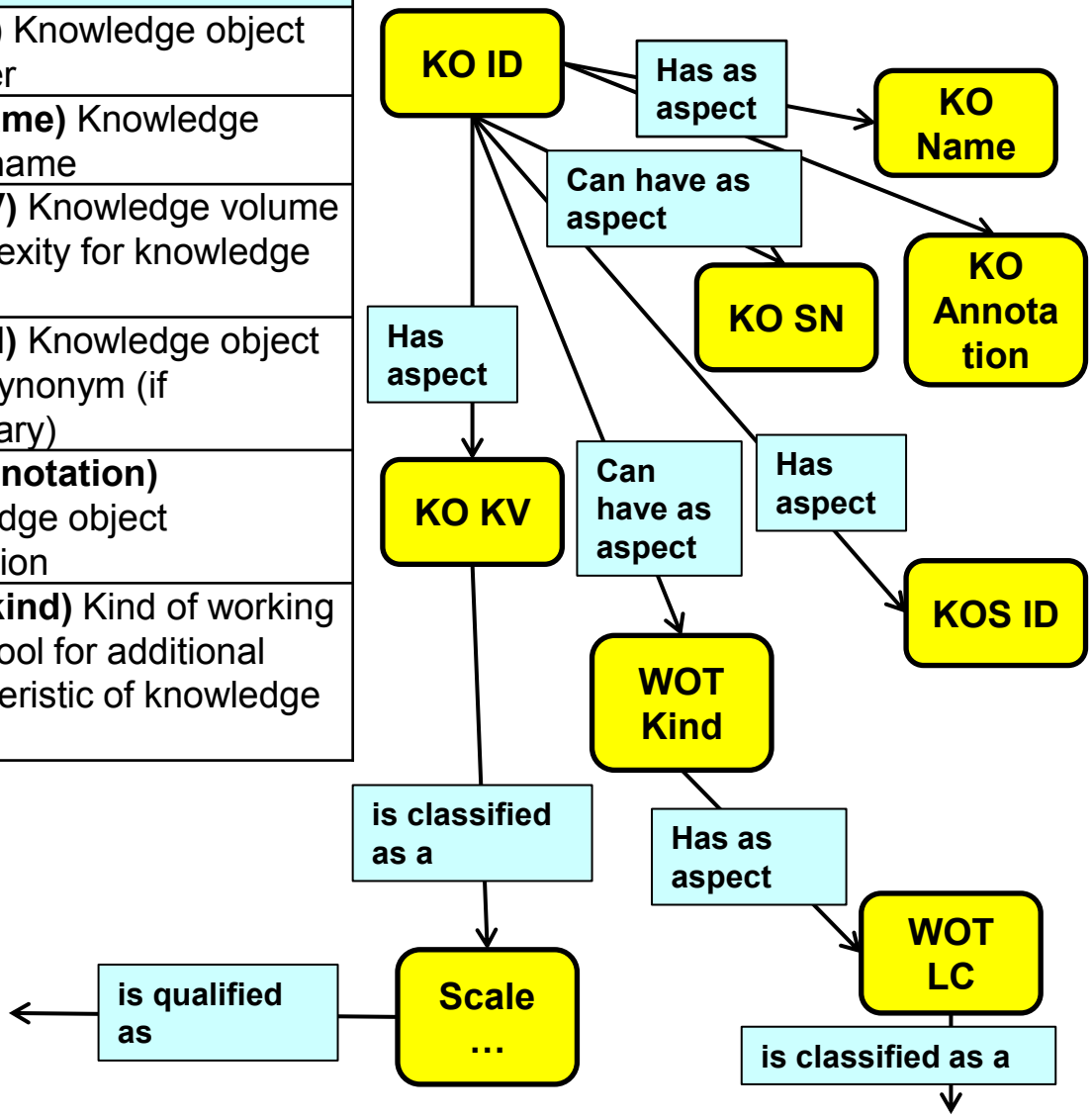
(KO ID) Knowledge object identifier
(KO Name) Knowledge object name
(KO KV) Knowledge volume / complexity for knowledge object
(KO SN) Knowledge object name synonym (if necessary)
(KO Annotation) Knowledge object annotation
(WOT kind) Kind of working object/tool for additional characteristic of knowledge object

Additional knowledge table:

Entity: complexity of knowledge object as complexity level of working object/tool
(WOT Kind) Kind of working object/tool for additional characteristic of knowledge object
(WOT LC) Level of complexity for Kind of working object/tool (from 1 to 5)

Methods for acquiring and storing knowledge retain semantics and use a simple tabular form

Entity: Knowledge object
(KO ID) Knowledge object identifier
(KO Name) Knowledge object name
(KO KV) Knowledge volume / complexity for knowledge object
(KO SN) Knowledge object name synonym (if necessary)
(KO Annotation) Knowledge object annotation
(WOT kind) Kind of working object/tool for additional characteristic of knowledge object



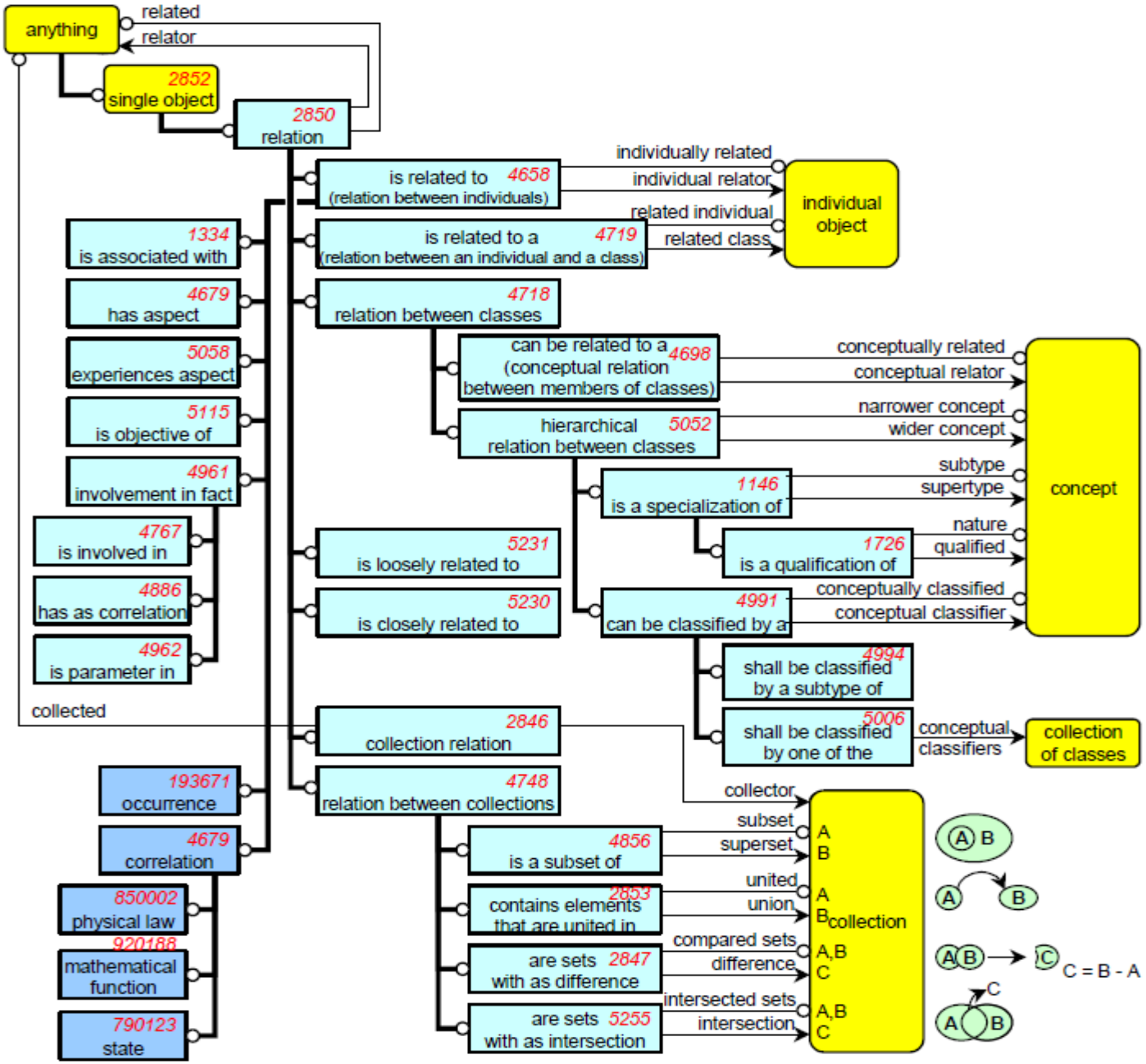
(fragment of Gellish -like ontology)

Entity: Description of knowledge object source
(KOS ID) Identifier of described knowledge object
(KOS ID Alt)Identifier of alternative knowledge object
(KOS RS) Reference to source describing content of knowledge object (not only URI)

Entity: logically preceding knowledge object
(KO ID) Identifier of described knowledge object
(KO ID Pre) Identifier of logically preceding knowledge object

Entity: complexity of knowledge object as complexity level of working object/tool
(WOT Kind) Kind of working object/tool for additional characteristic of knowledge object
(WOT LC) Level of complexity for Kind of working object/tool (from 1 to 5)

Upper ontology of kinds of relations (Gellish)



We build upon a small subset of relations from Gellish upper ontologies for concepts and relations, e.g.:

- **Has aspect**
- **Is parameter in**
- **Collection relation**
- **Is a specialization of**
- **Is classified as a**
- **State**
- **Is qualified as**
- ...

We build upon equivalence of expressive power our Gellish subset and the first-order predicate logic

Conclusion

- Suggested approach was utilized in several projects from different professional spheres;
- possibility of introducing ordering in domains of "soft" characteristics, where initially such relations were not used, was tested;
- possibility for SD experts to work not only with the knowledge base, but also with the knowledge metamodel was demonstrated;
- possibility of retaining semantics in information stored in the tabular form was shown.

ФОСТАС

Further development of this approach will include:

- **applying developed concepts and procedures to other subject domains**
- **extending usage of English Gellish together with restrictions on a Gellish subset for testing & improving SD expert autonomy**
- **further developing the functional part of the framework for designing the set of universal services of LLLS objects evaluations**

Thanks for your attention!

Questions please

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