Conceptual Situation Spaces for Situation-driven Processes

- ESWC 2008, Tenerife, June 03, 2008 -

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Knowledge Media Institute, The Open University

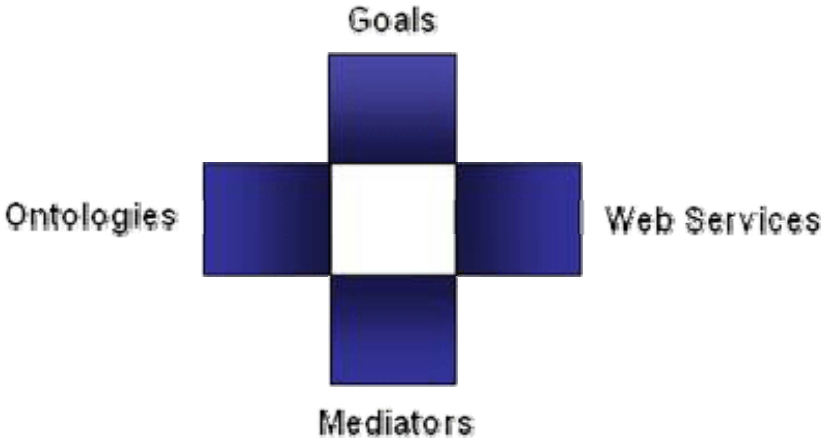
Outline

- Situation-driven Processes for Semantic Web Services
- Conceptual Situation Spaces
- Prototype Application (Demo)
- Conclusions

Semantic Web Services:
WSMO Top Level Notions

Objectives that a client wants to achieve by using Web Services

Formally specified terminology of the information used by other WSMO components

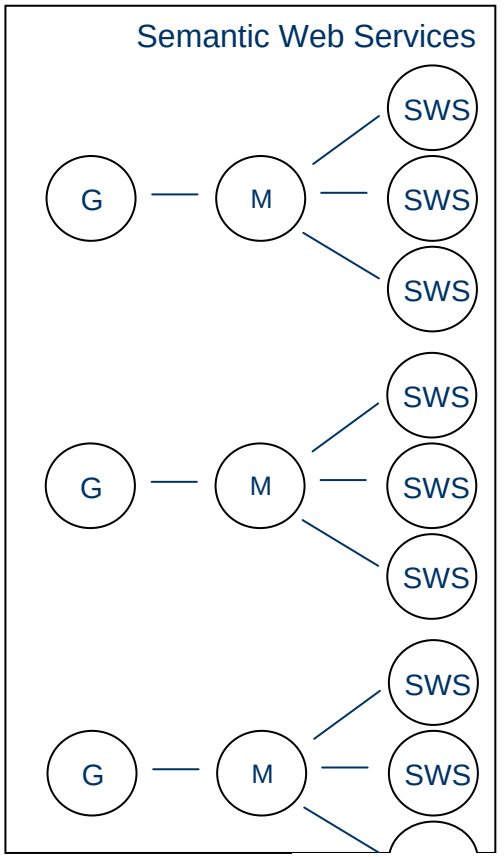


Semantic description of Web Services:
- **Capability** *(functional)*
- **Interfaces** *(usage)*

Connectors between components with mediation facilities for handling heterogeneities

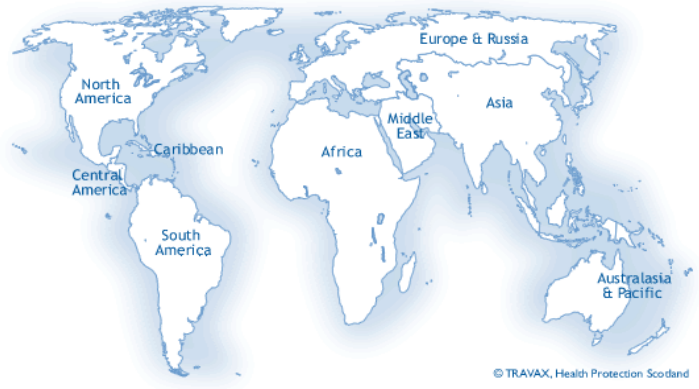
Semantic Web Services: Challenges

Symbolic Representation

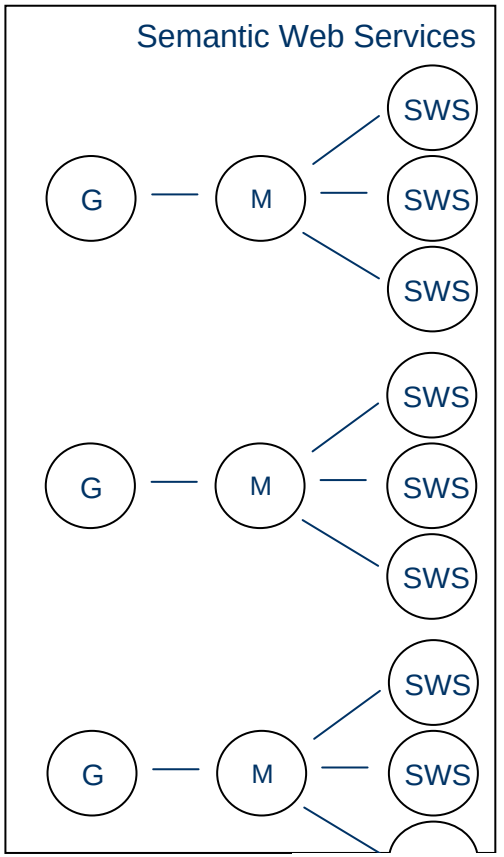


Semantic Web Services: Challenges

The real World



Symbolic Representation



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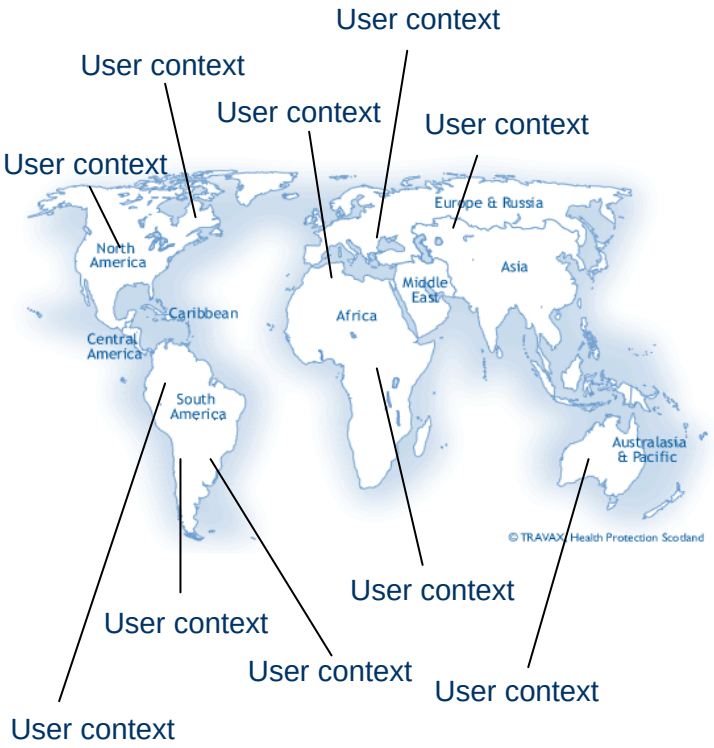
Semantic Web Services: Challenges

…with a variety of **User Contexts…**



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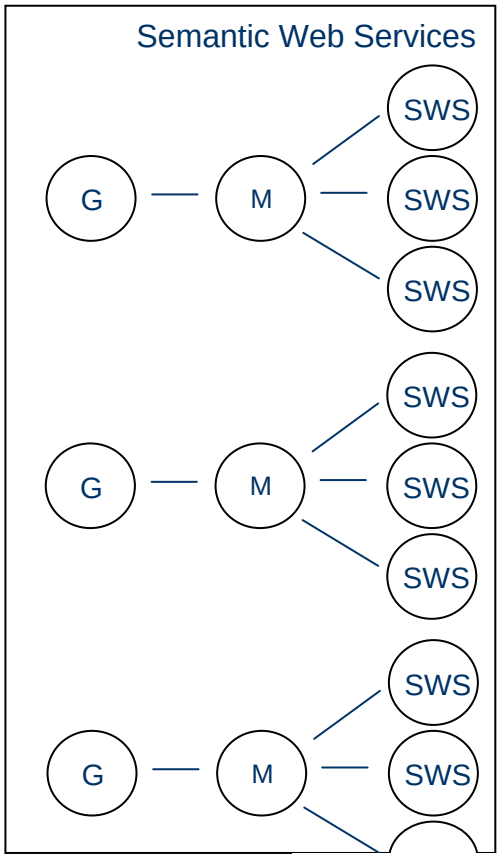
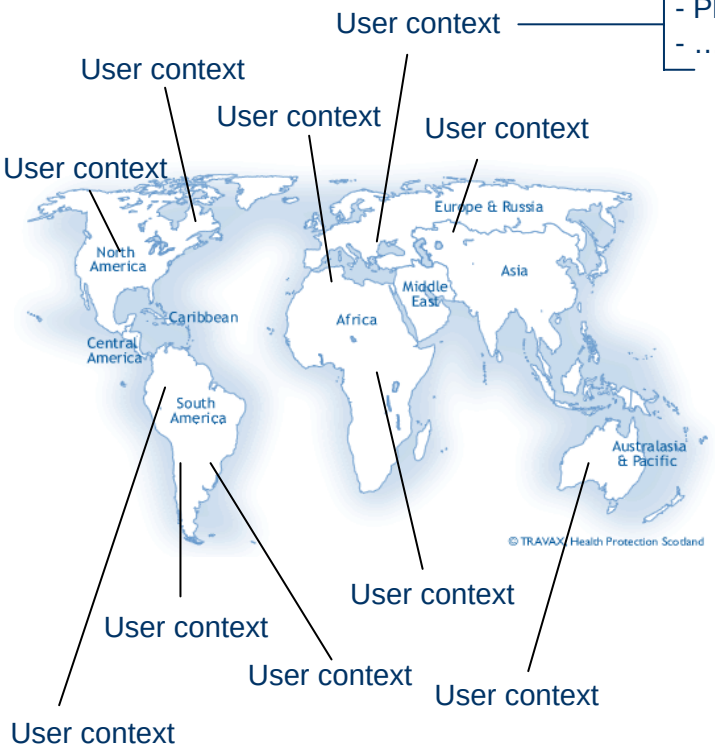


Semantic Web Services: Challenges

…with distinct **Context Parameters…**

- Location X_1
- Device X_2
- Language X_3
- Platform X_4
- …



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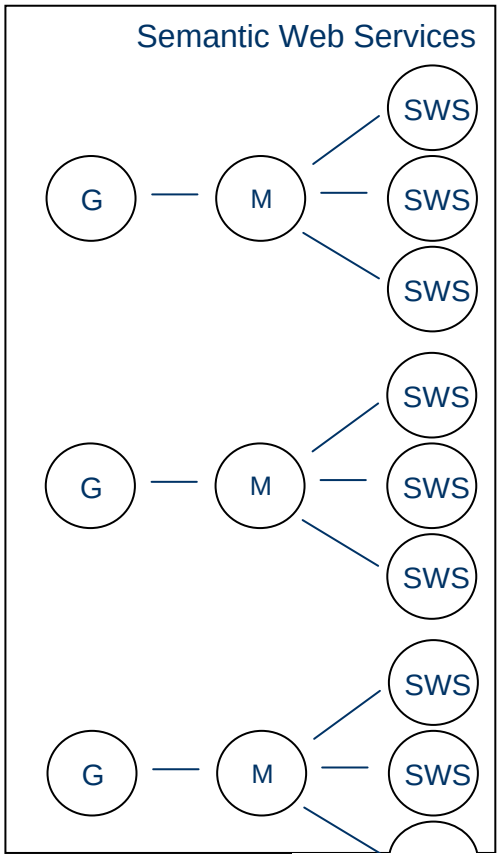

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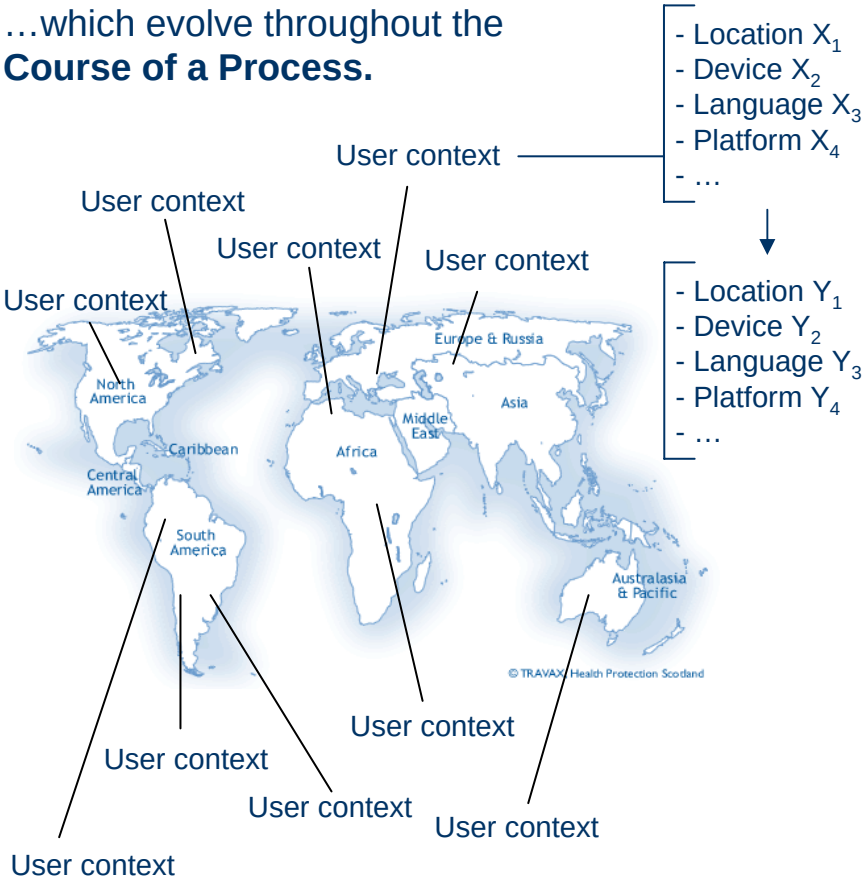
Semantic Web Services: Challenges

…which evolve throughout the **Course of a Process.**



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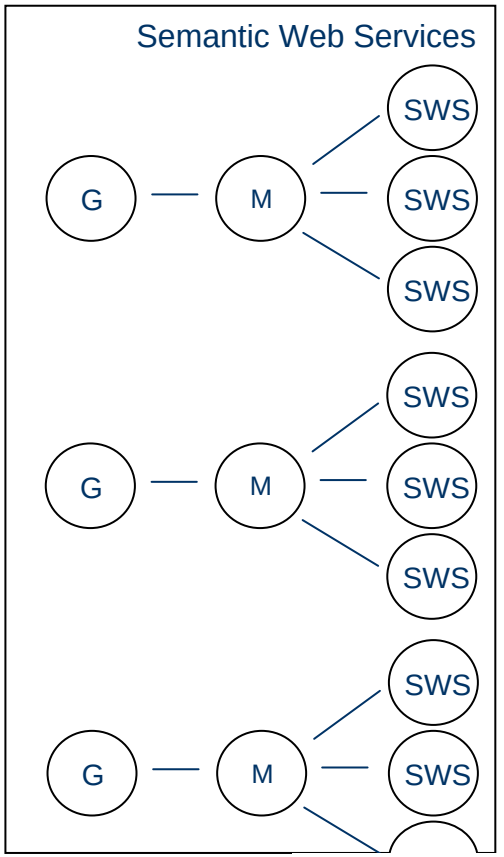

Semantic Web Services: Challenges

The real World

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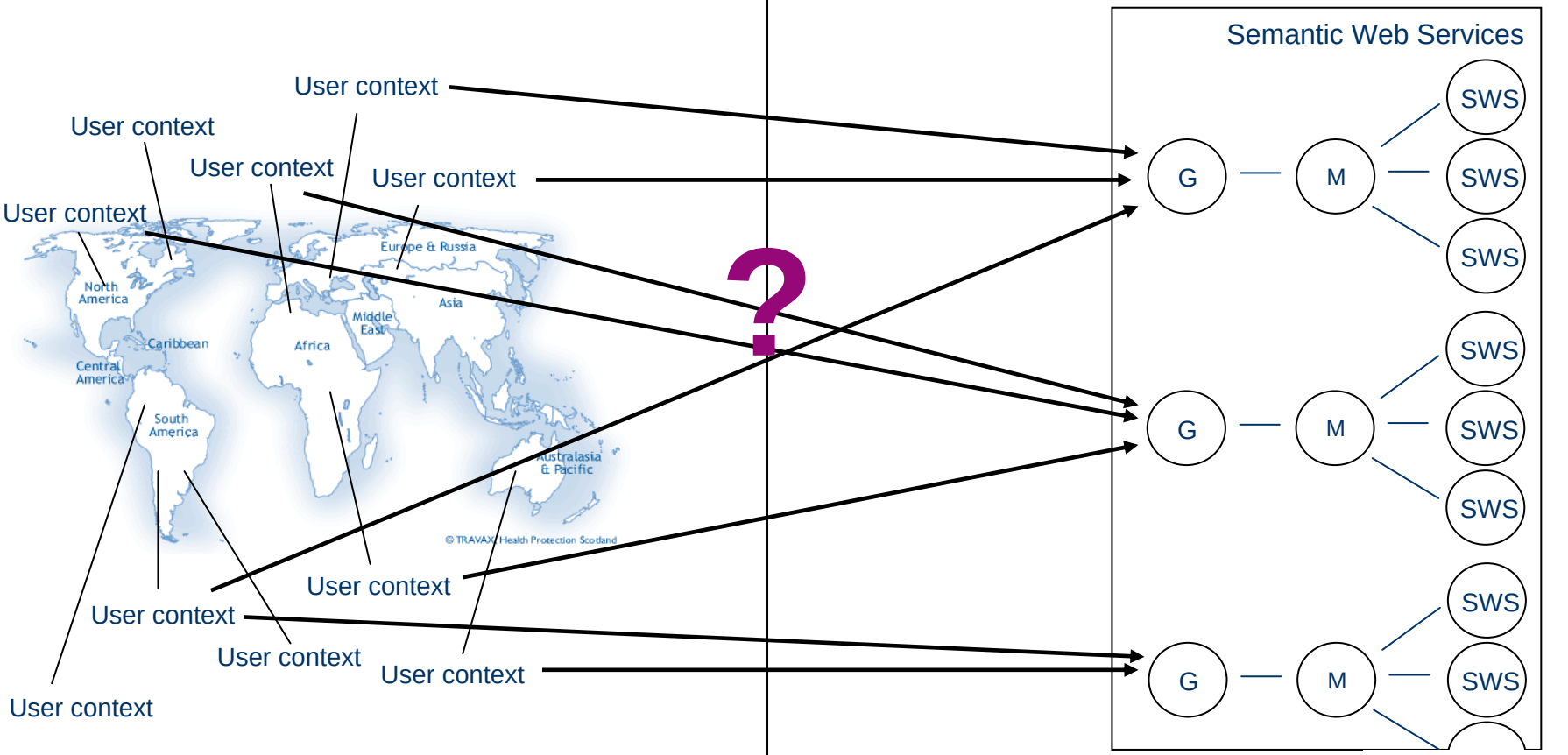

Semantic Web Services: Challenges

Issues:

- WSMO lacks notion of **context** and **process.**

The real World

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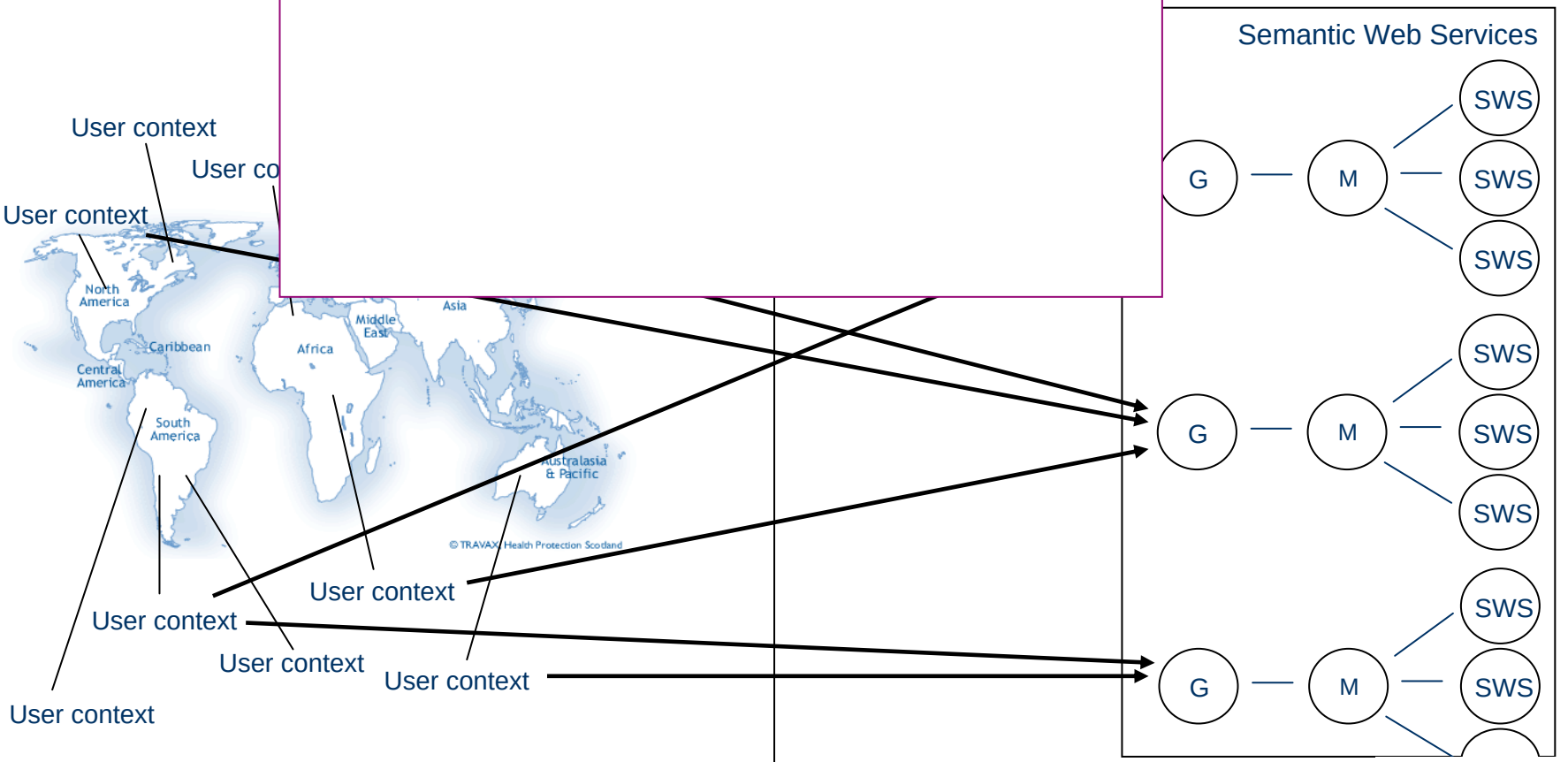


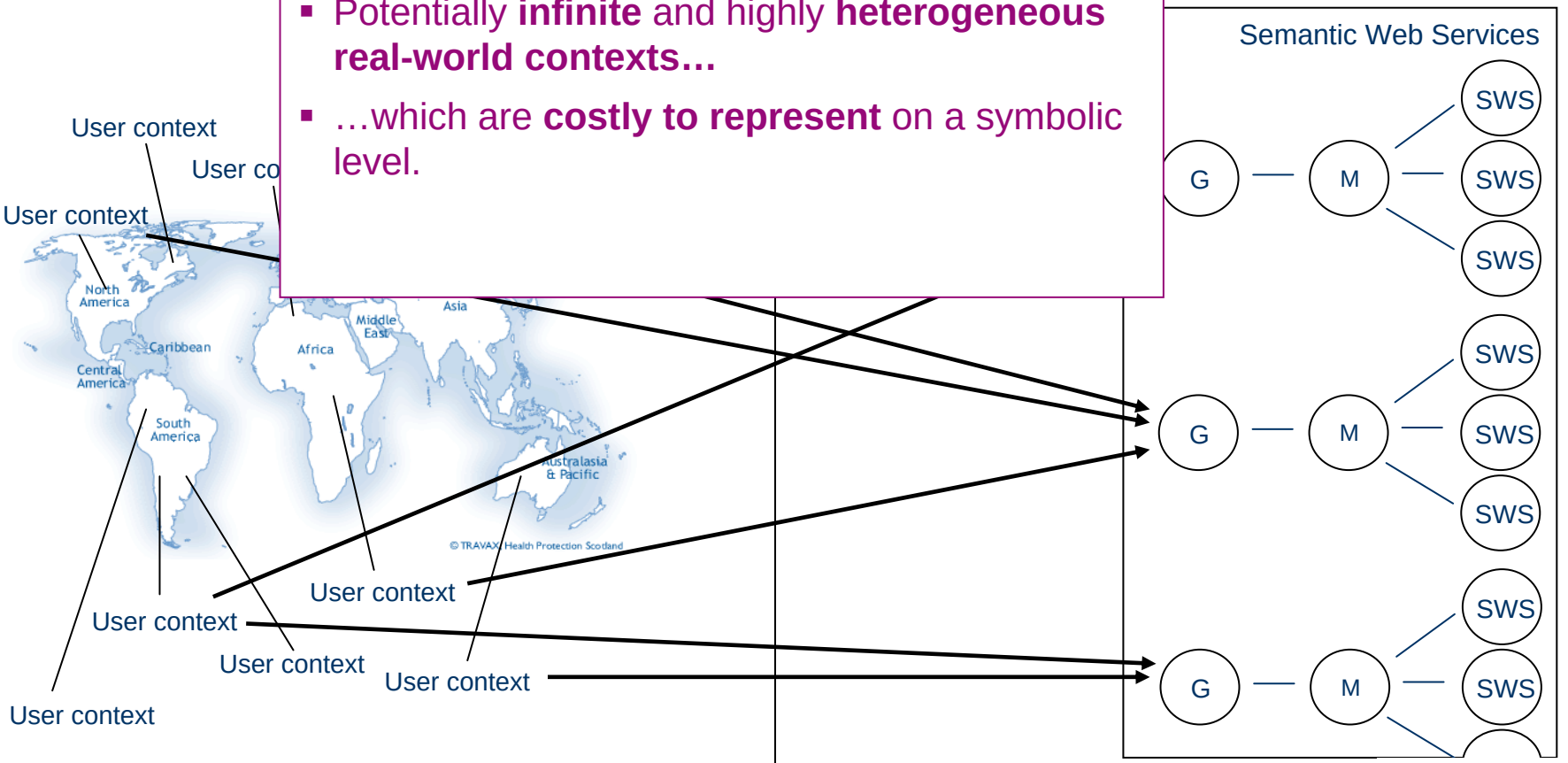
Semantic Web Services: Challenges

Issues:

- WSMO lacks notion of **context** and **process.**
- Potentially **infinite** and highly **heterogeneous real-world contexts…**
- …which are **costly to represent** on a symbolic level.

The real World

Symbolic Representation



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- **Matchmaking** between real-world contexts and **finite set of symbolic representations?**

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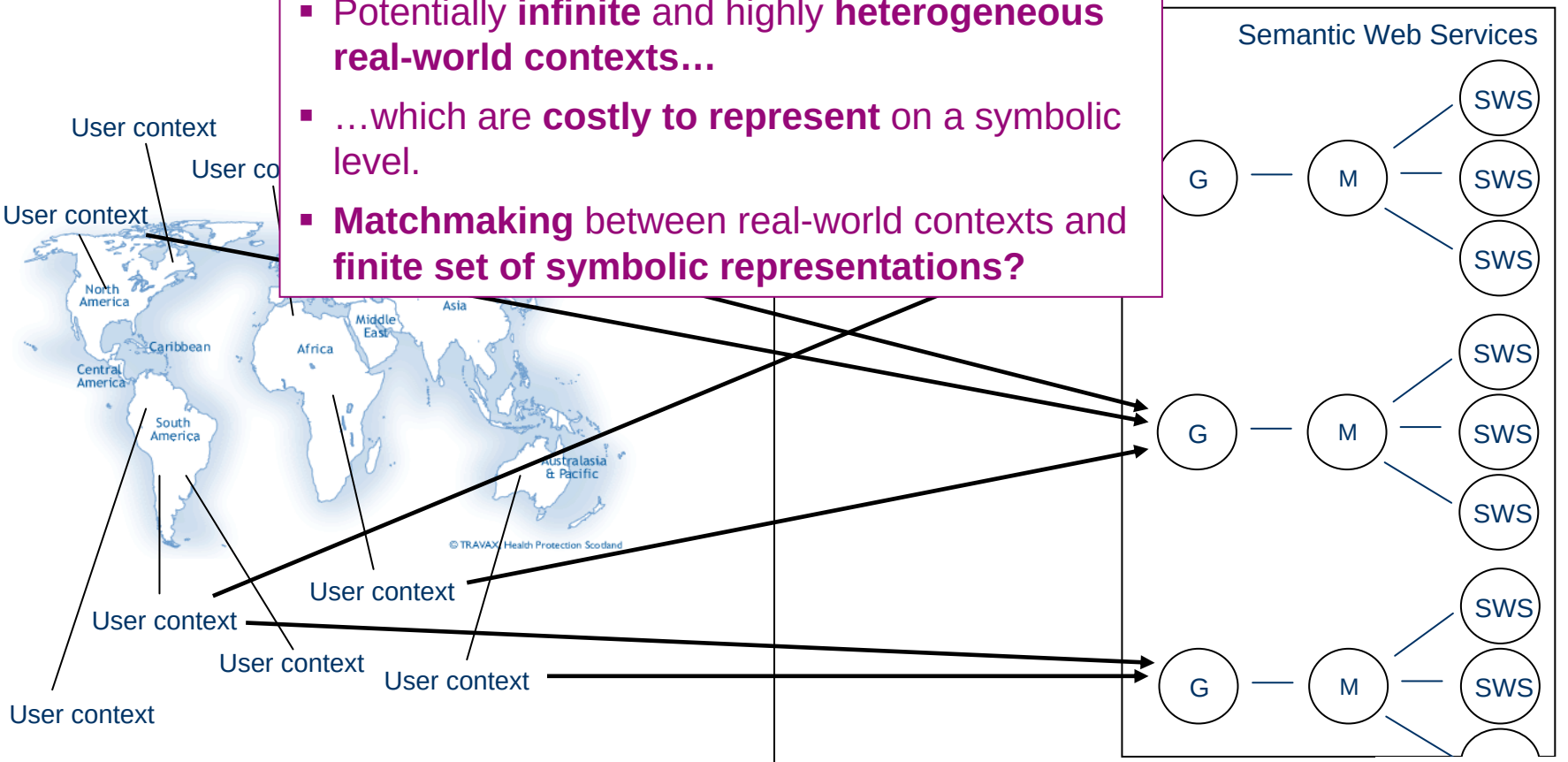

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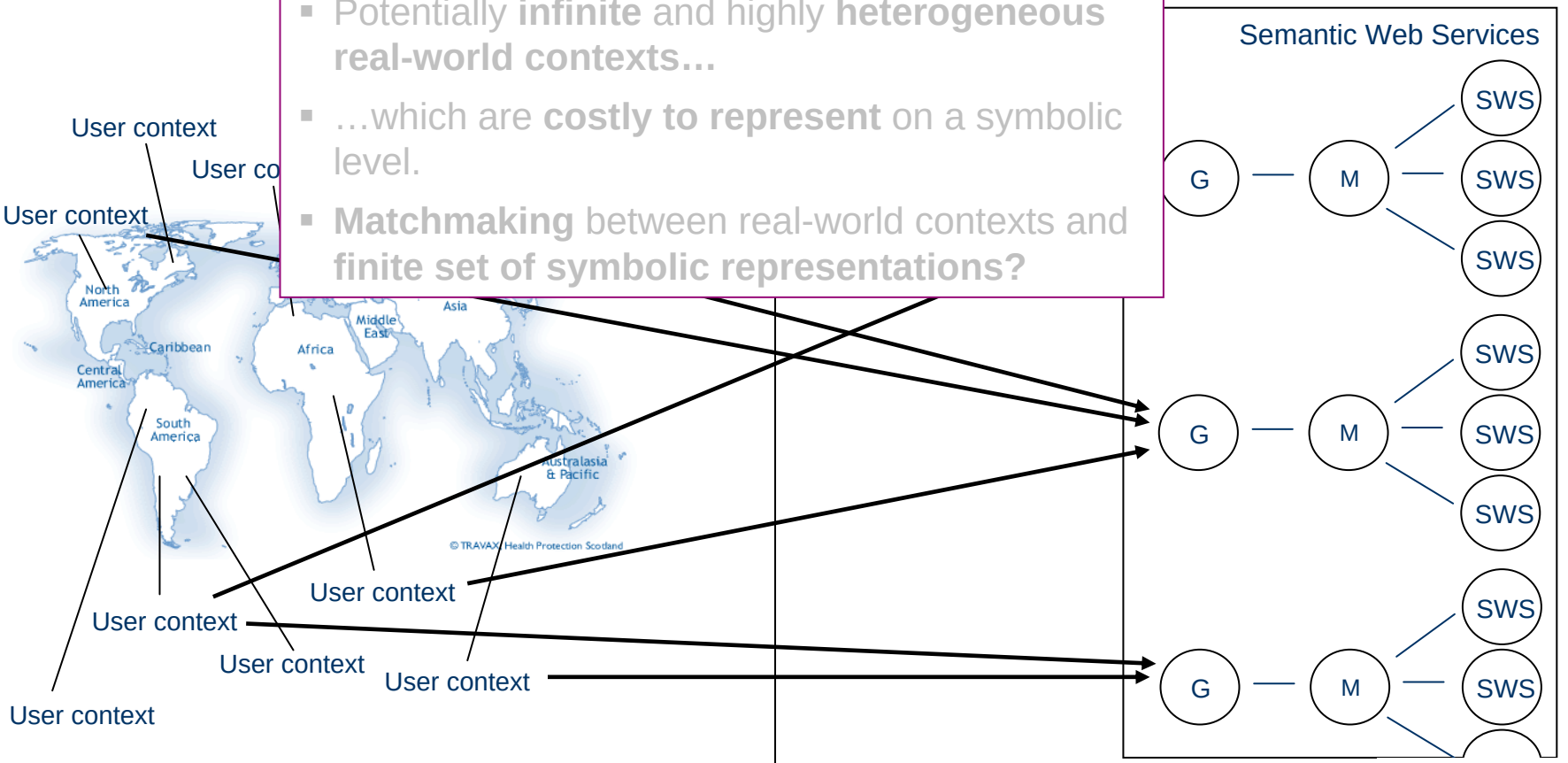
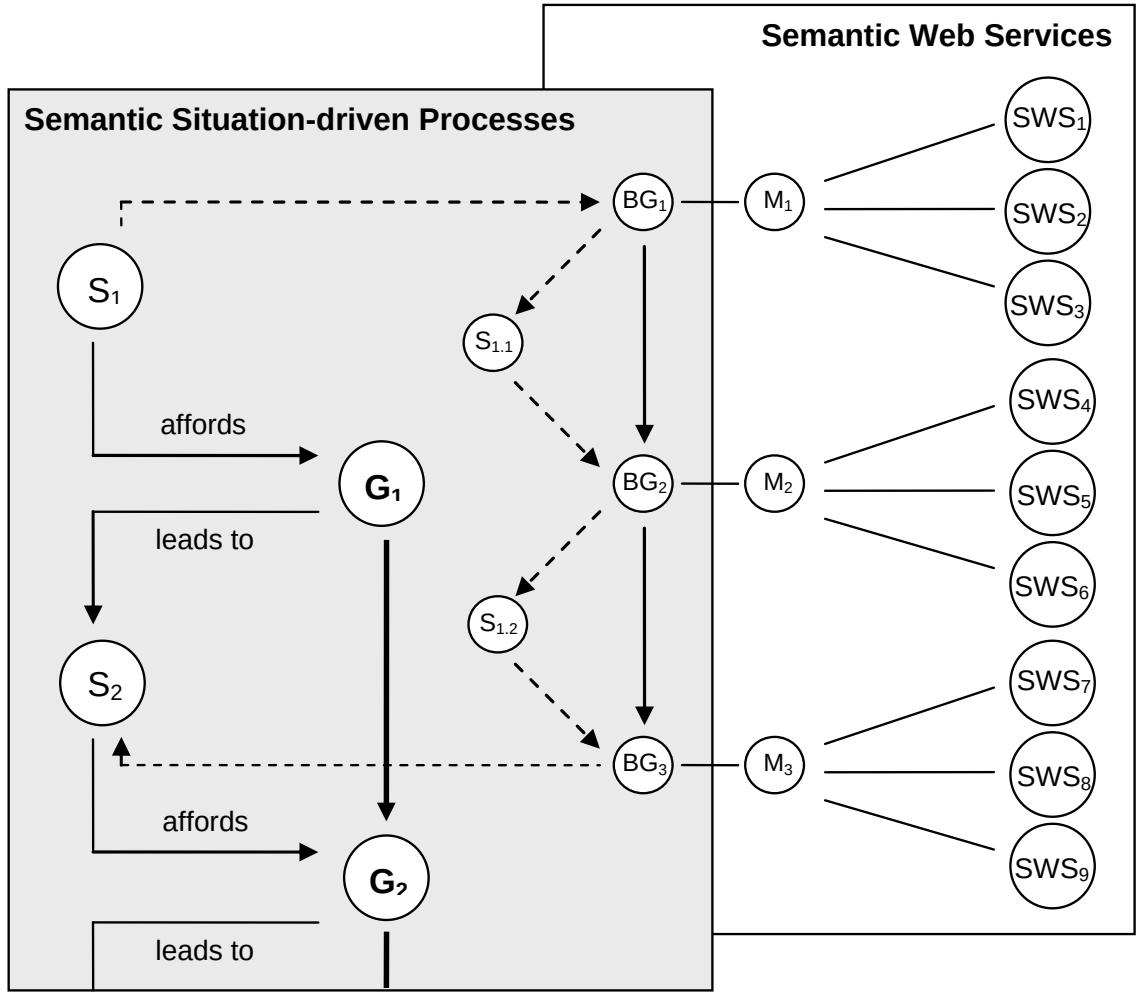


Situation-driven Processes (SDP) for Semantic Web Services



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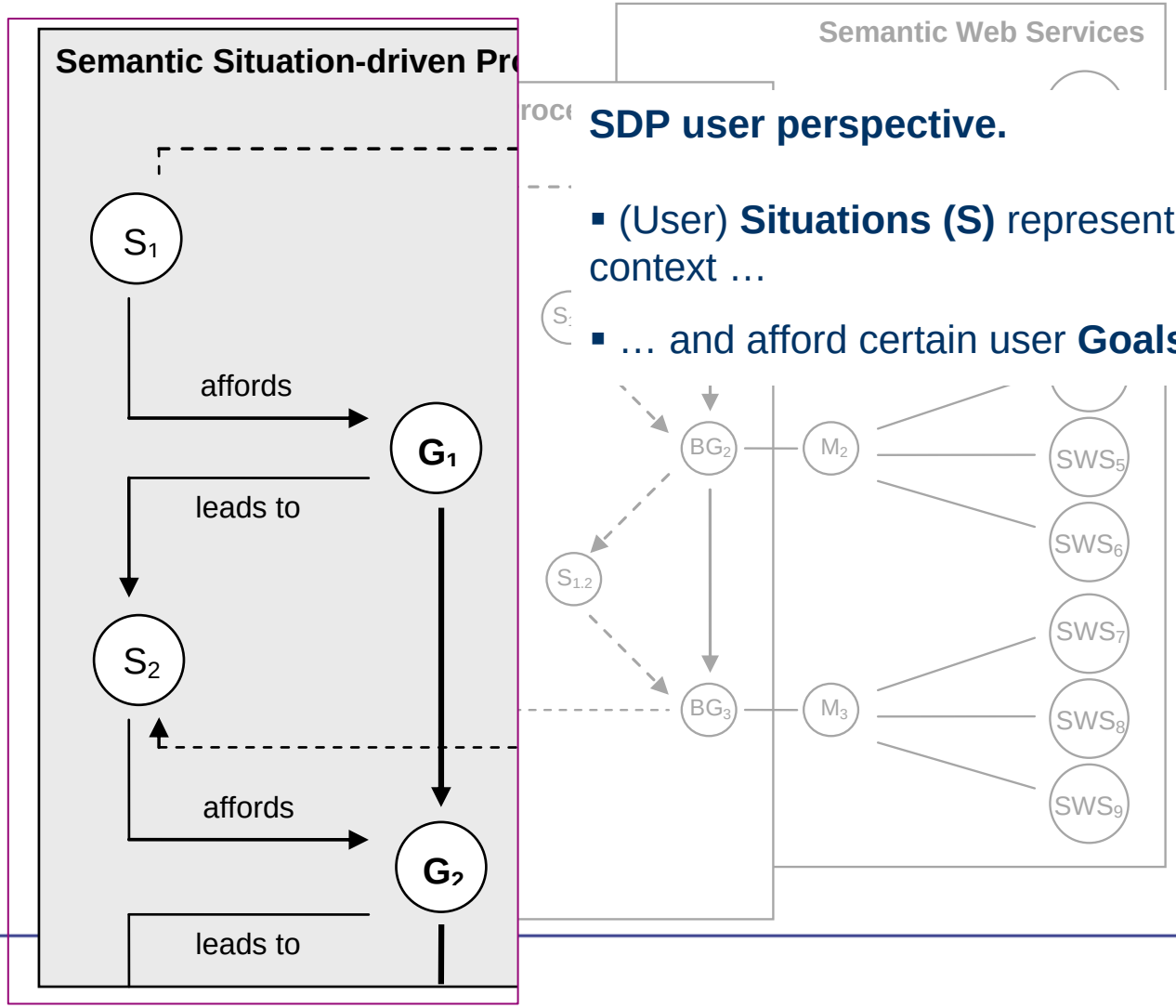


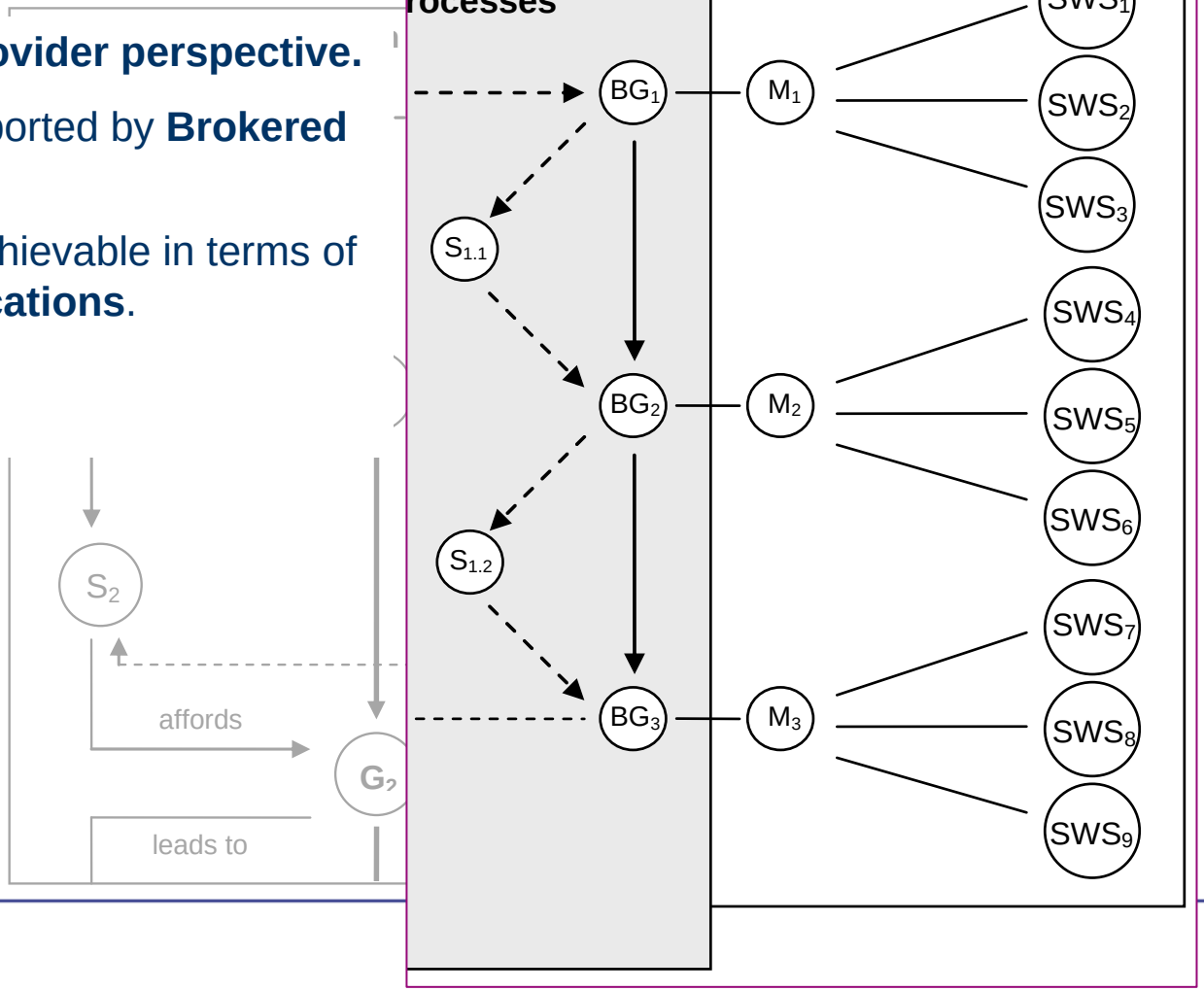
SDP user perspective.

- (User) **Situations (S)** represent a state of context …
- … and afford certain user **Goals (G).**

Situation-driven Processes (SDP) for Semantic Web Services

SDP service provider perspective.

- Goals (G) supported by **Brokered Goals (BG)**…
- …which are achievable in terms of **SWS goal invocations**.



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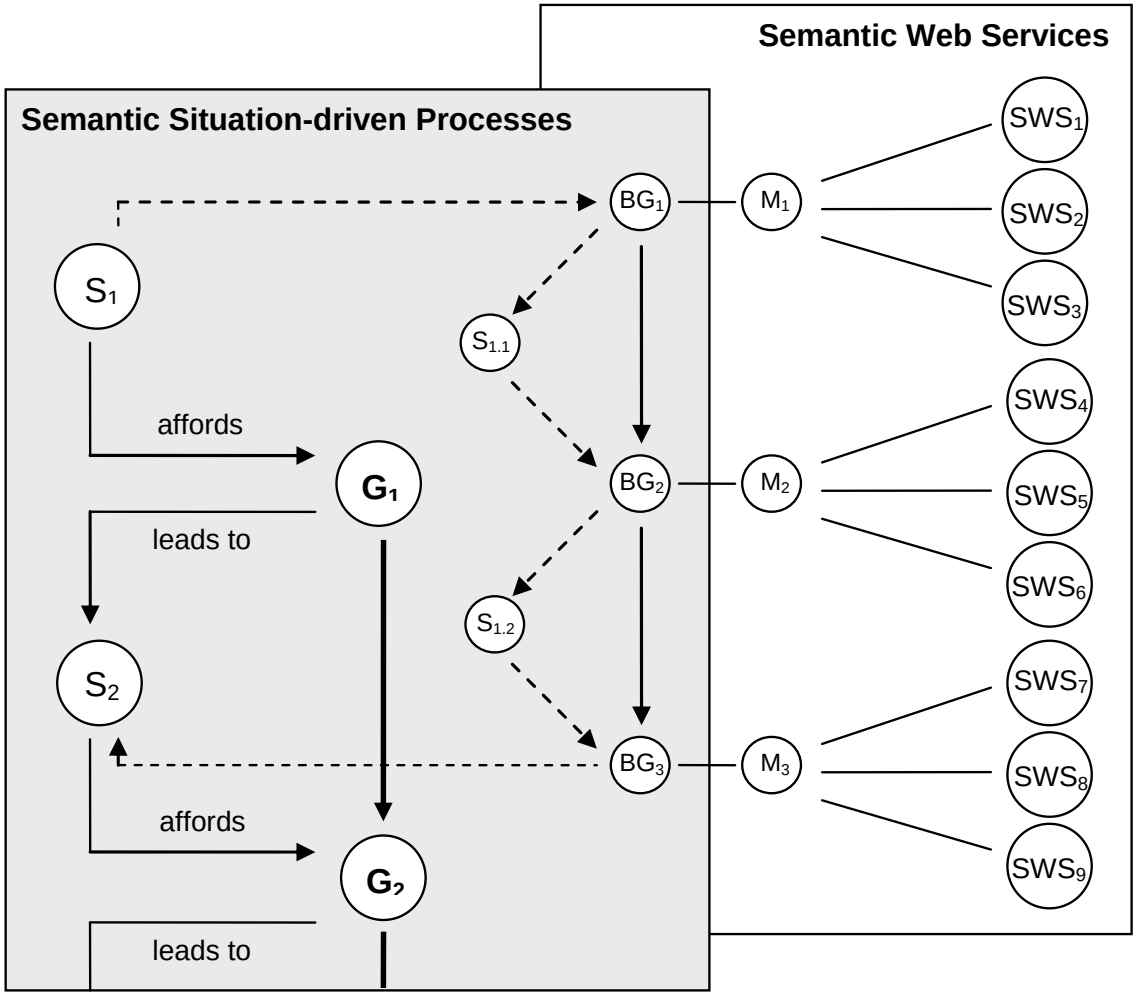
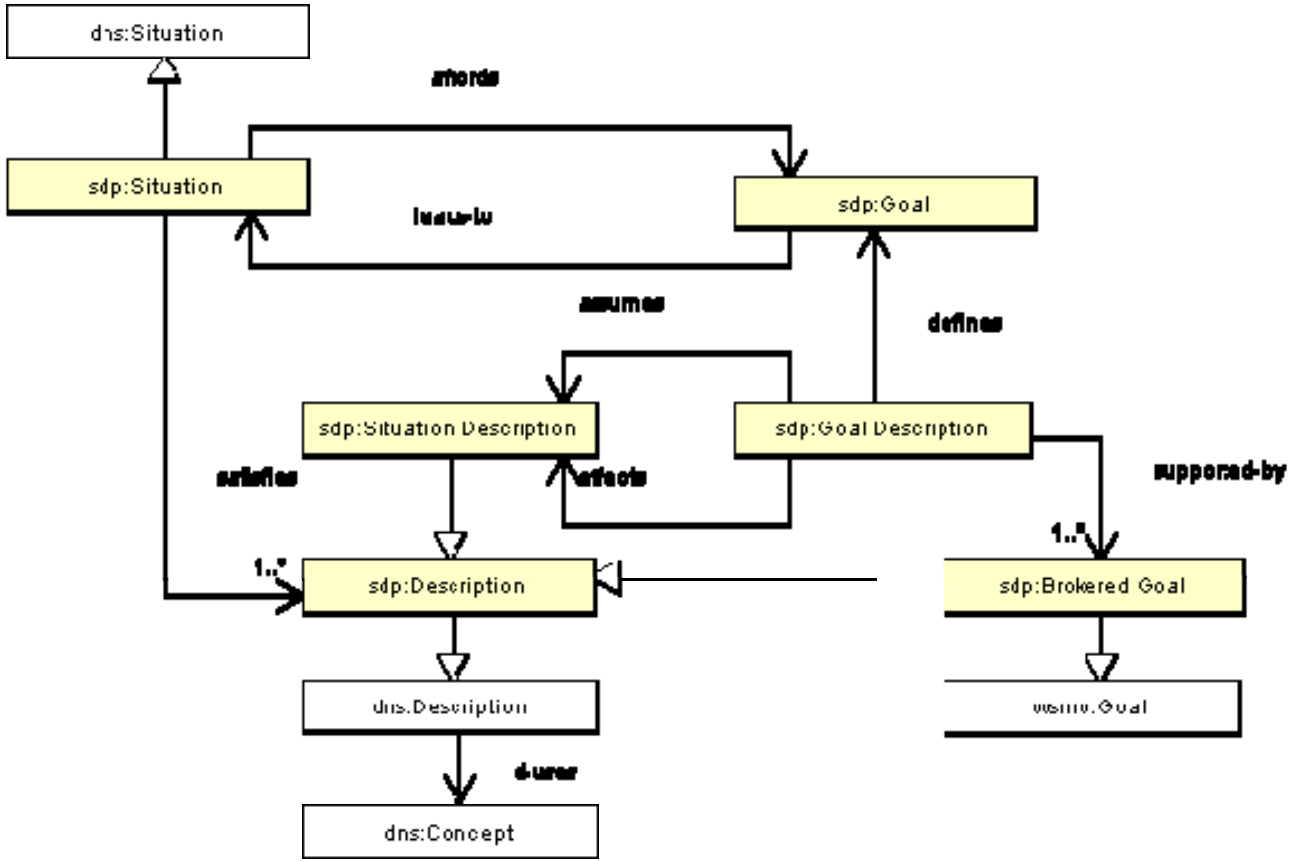


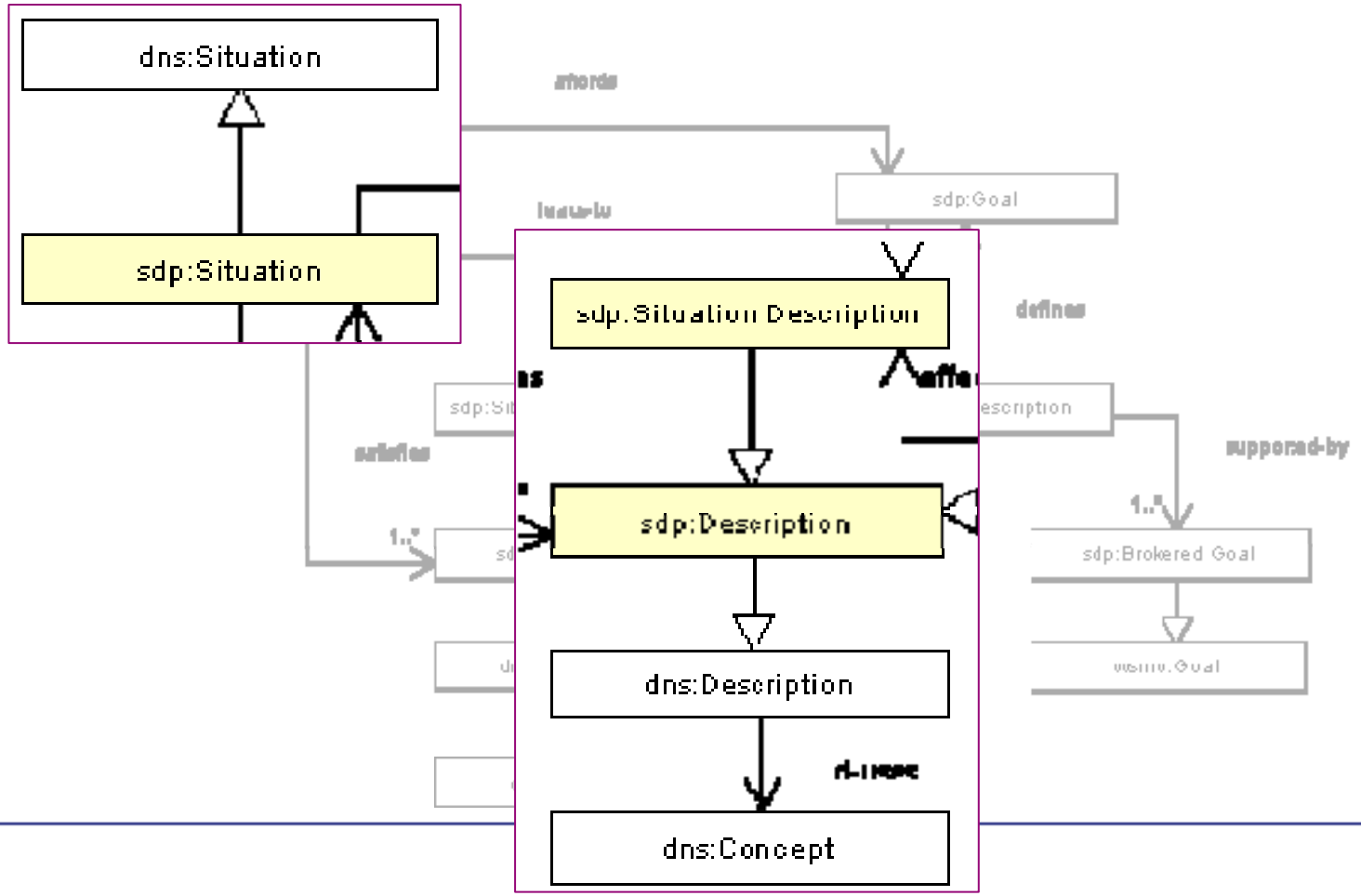
Situation-driven Processes (SDP): Ontology Overview

SDP formalised through (domain-independent) **SDP Ontology** …
(upper level concepts shown below)



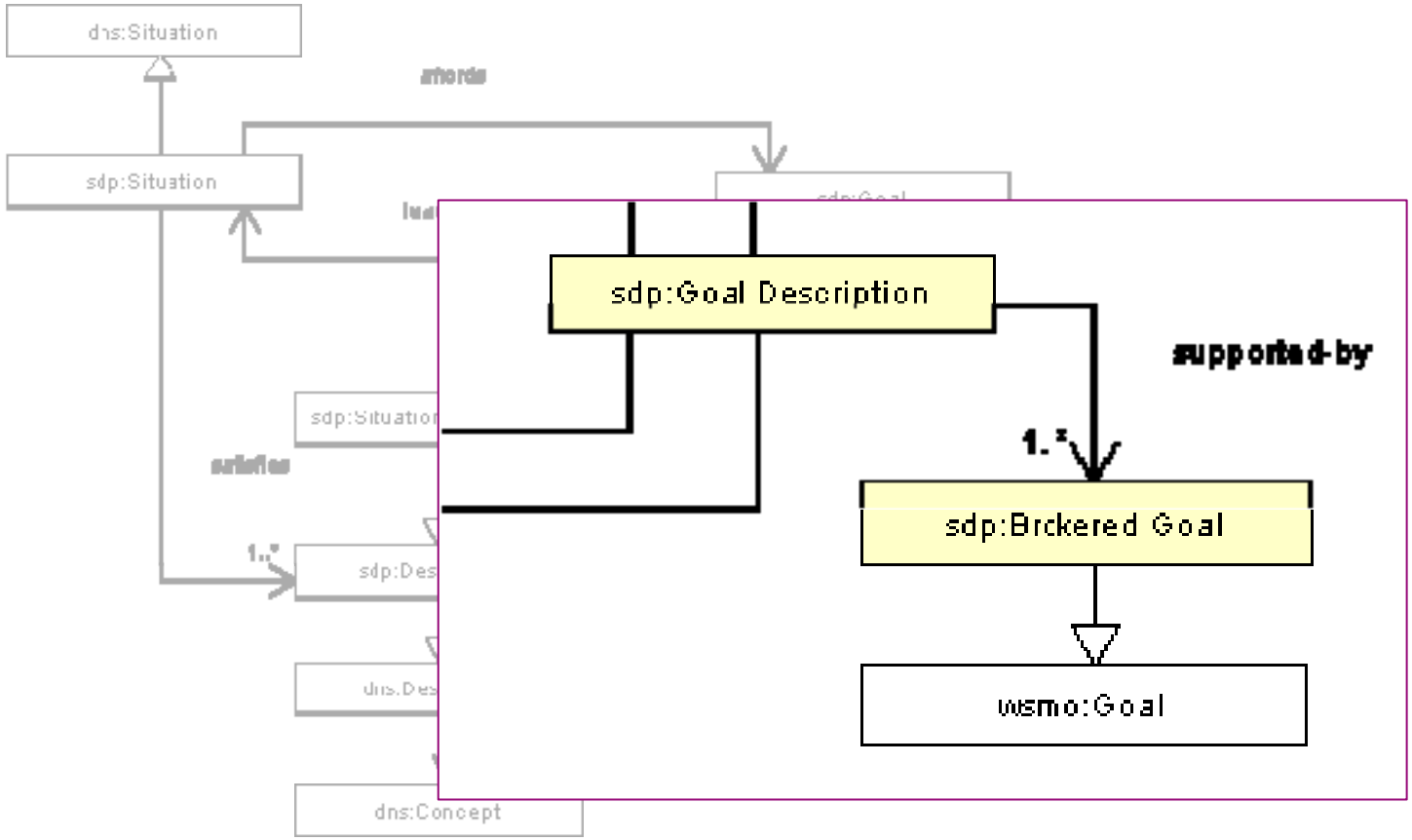
Situation-driven Processes (SDP): Ontology Overview

…introducing **Situations** represented by **Situation Descriptions**…
(derived from **DOLCE** Descriptions & Situations)



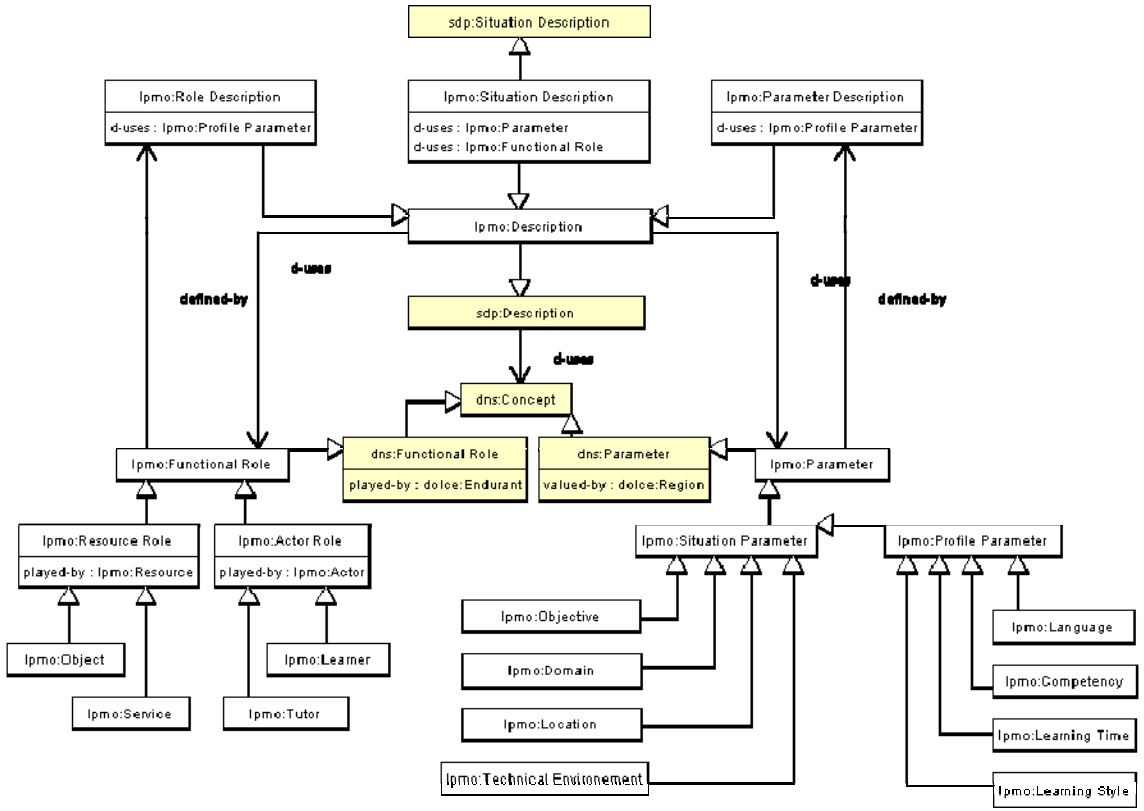
Situation-driven Processes (SDP): Ontology Overview

…which represent the **assumptions/effects** of **Goal Descriptions…**
(**Brokered Goals** derived from **WSMO**)



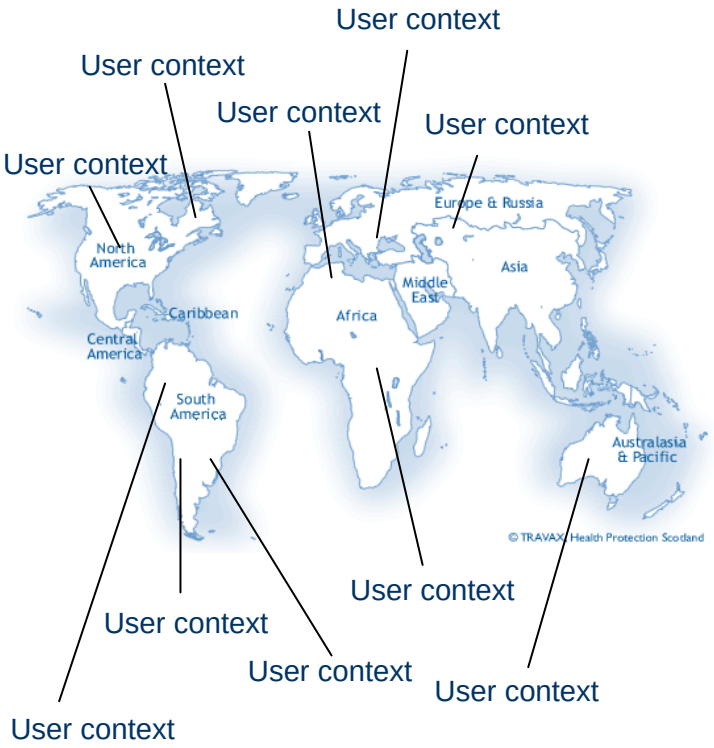
Situation-driven Processes (SDP): Ontology Overview

… and serves as basis for **domain-specific derivations**.
(e.g. LPMO as SDPO specialisation for eLearning; used within EU STREP LUISA)

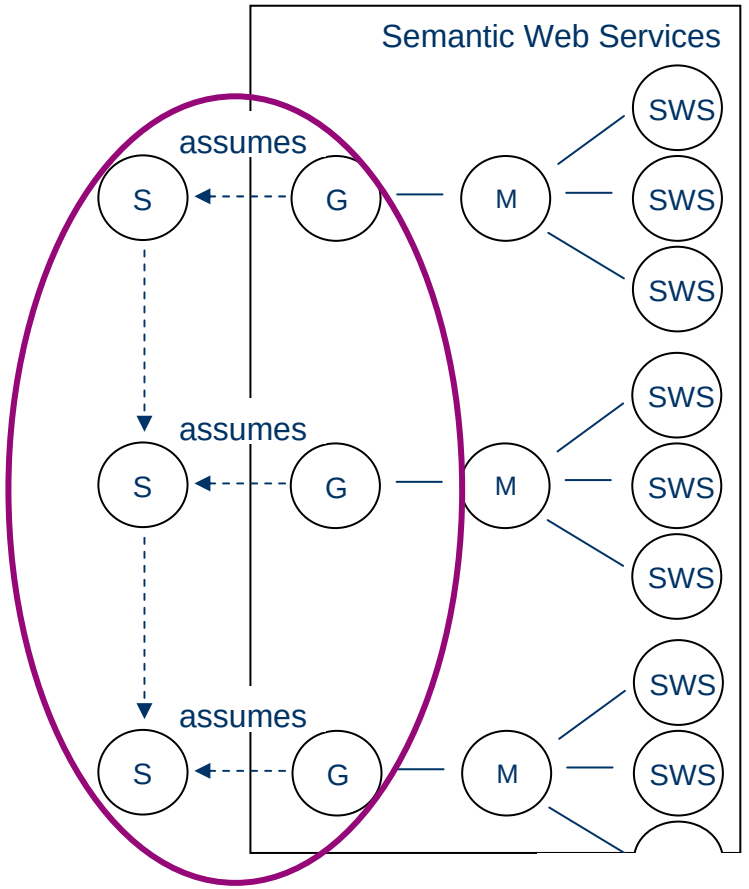


SWS incorporated into SDP

The real World



Symbolic Representation



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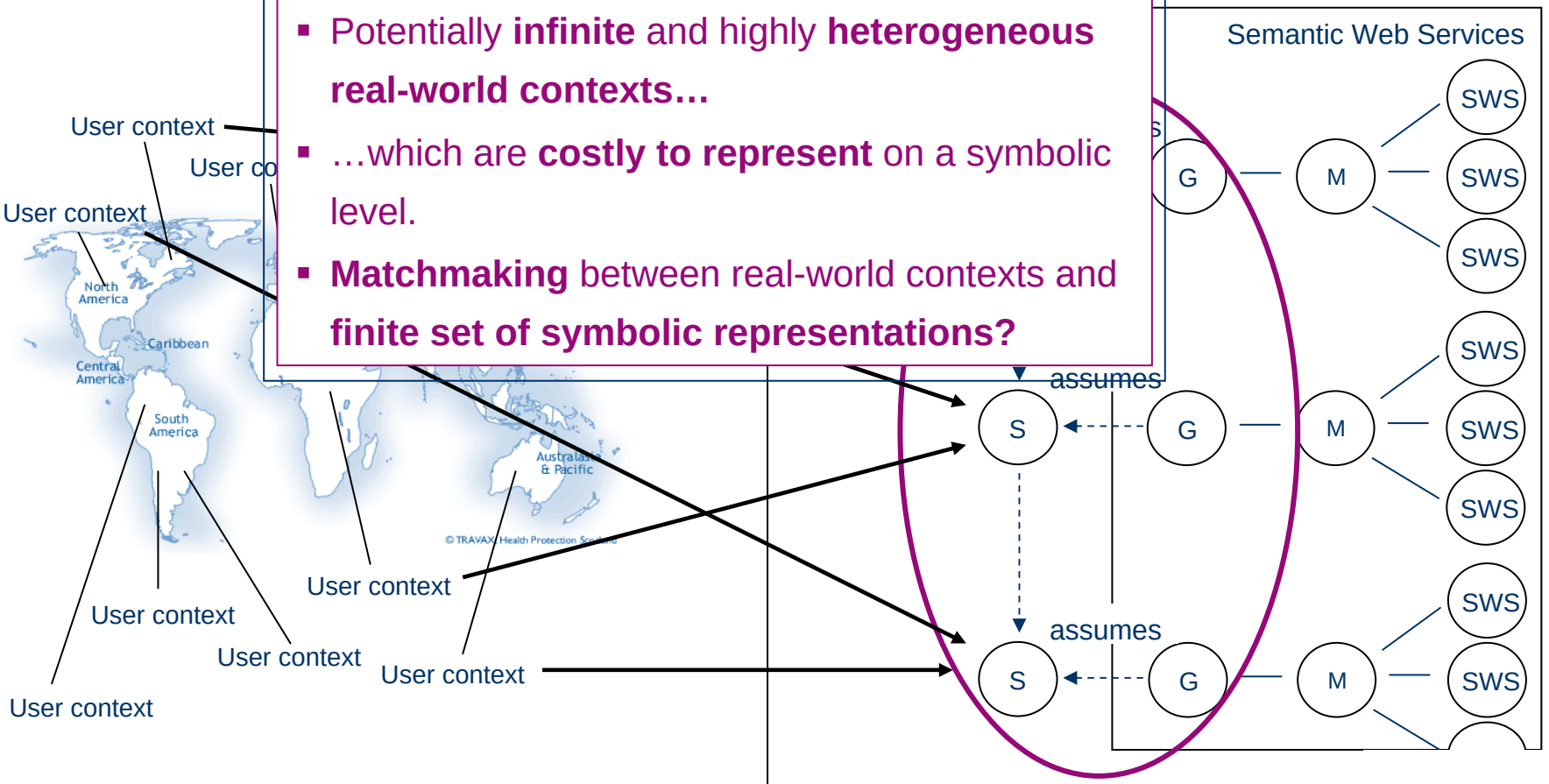
Symbolic Representation

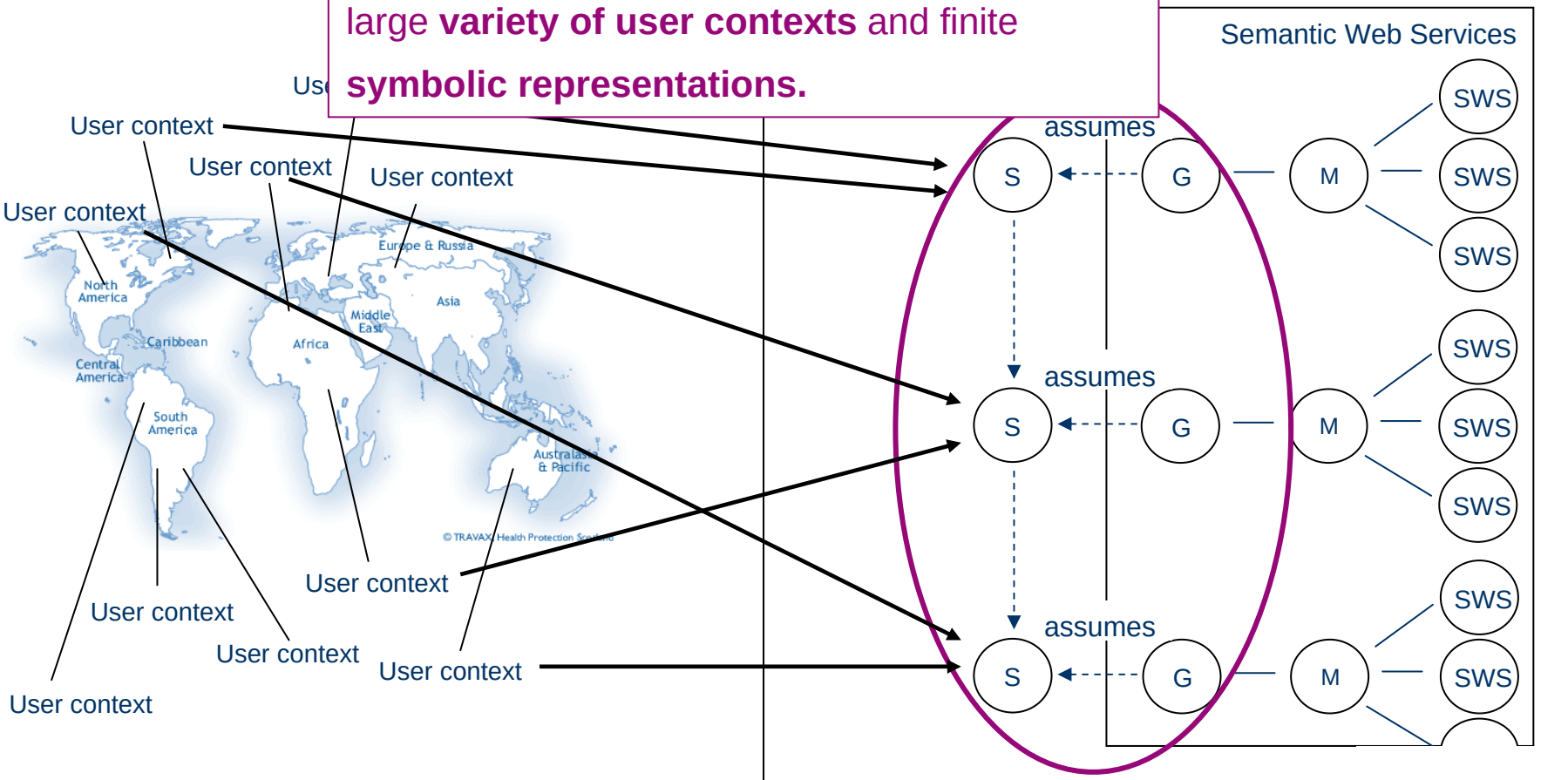


SWS incorporated into SDP

The real World

Need for **rather fuzzy matchmaking** between large **variety of user contexts** and finite **symbolic representations.**

Symbolic Representation

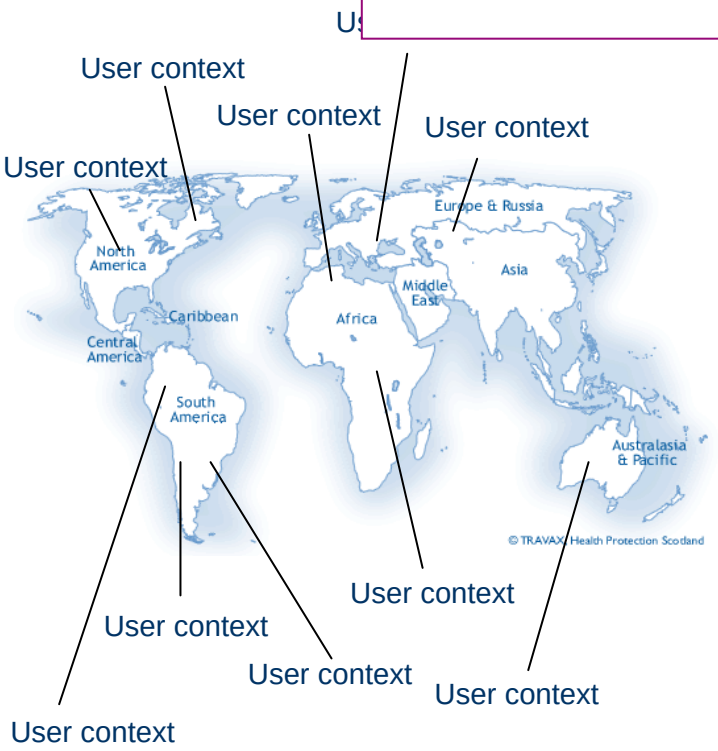


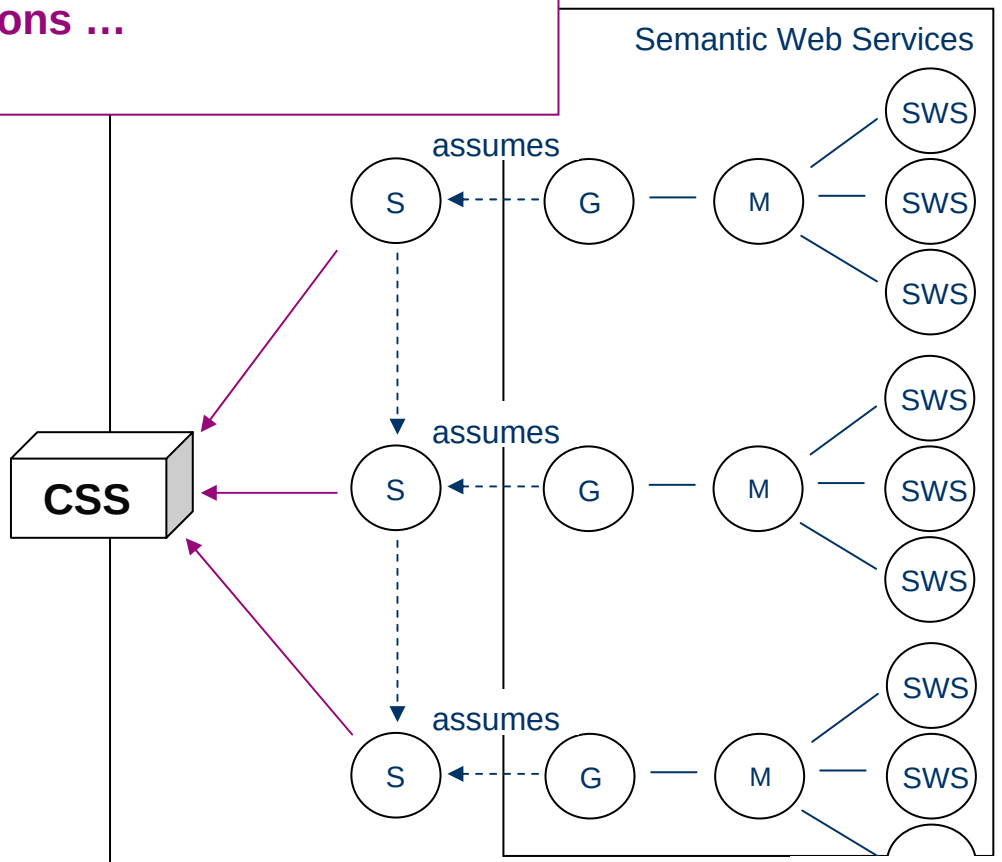
Conceptual Situation Spaces for Situation-driven Processes

The real World

Utilization of **Conceptual Spaces** (Gärdenfoers) to **represent situations ...**

Symbolic Representation



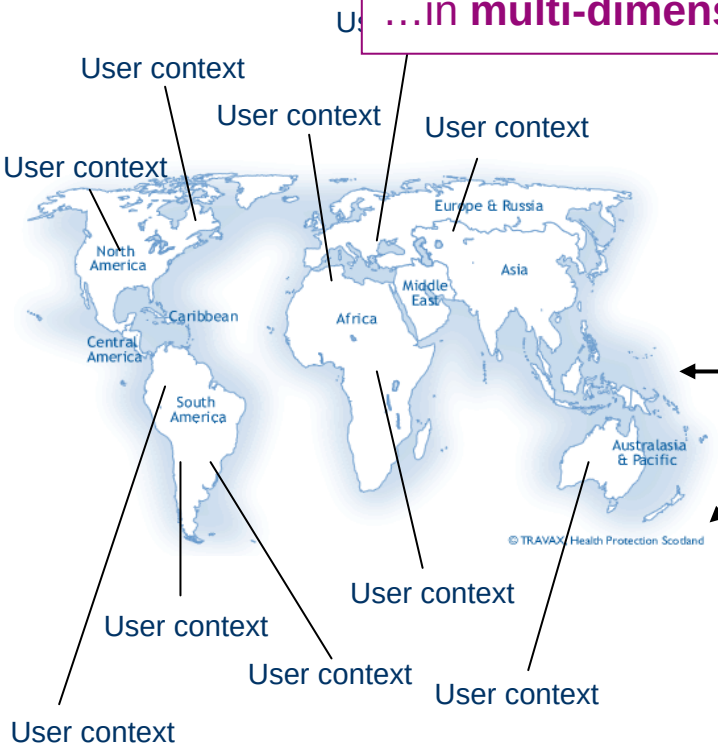


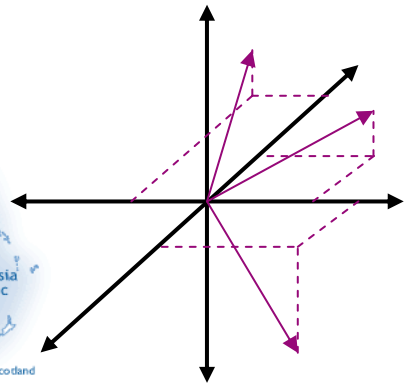
Conceptual Situation Spaces for Situation-driven Processes

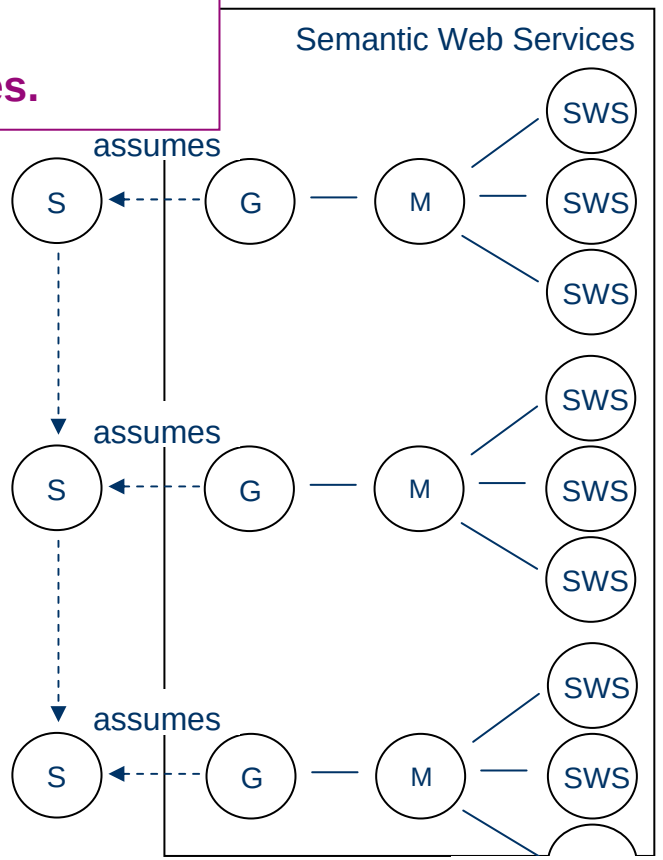
The real World

Utilization of **Conceptual Spaces** (Gärdenfoers) to **represent situations …** …in **multi-dimensional vector spaces.**

Symbolic Representation



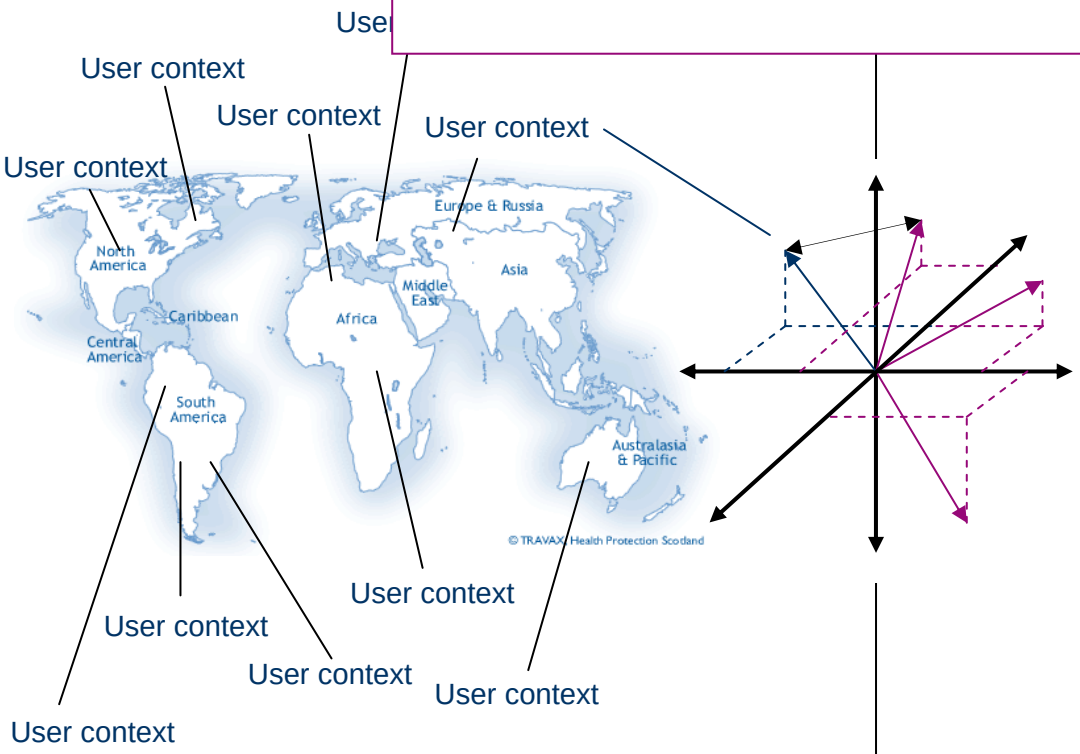




Conceptual Situation Spaces for Situation-driven Processes

Enabling **calculation of distances** between actual context and symbolic representations…

The real World



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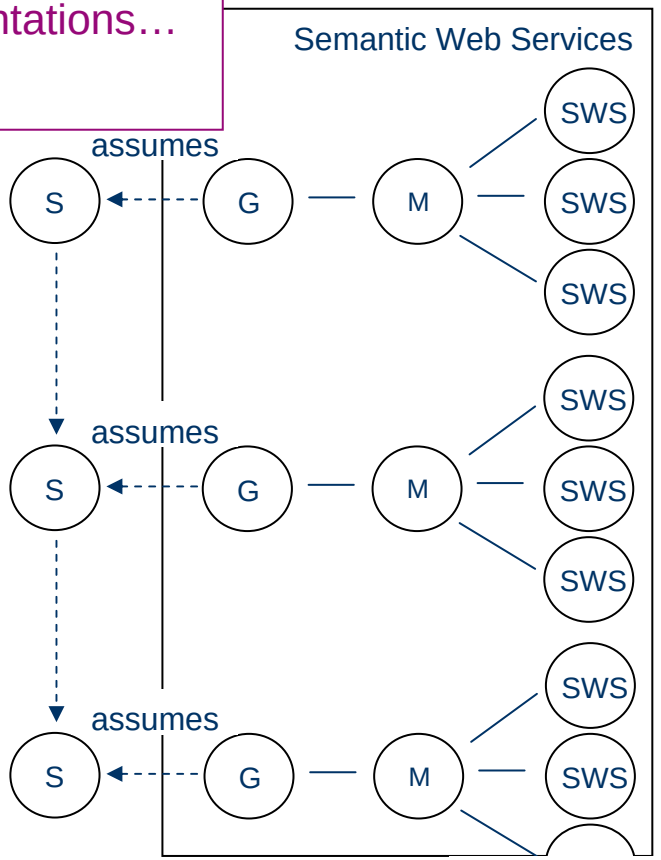
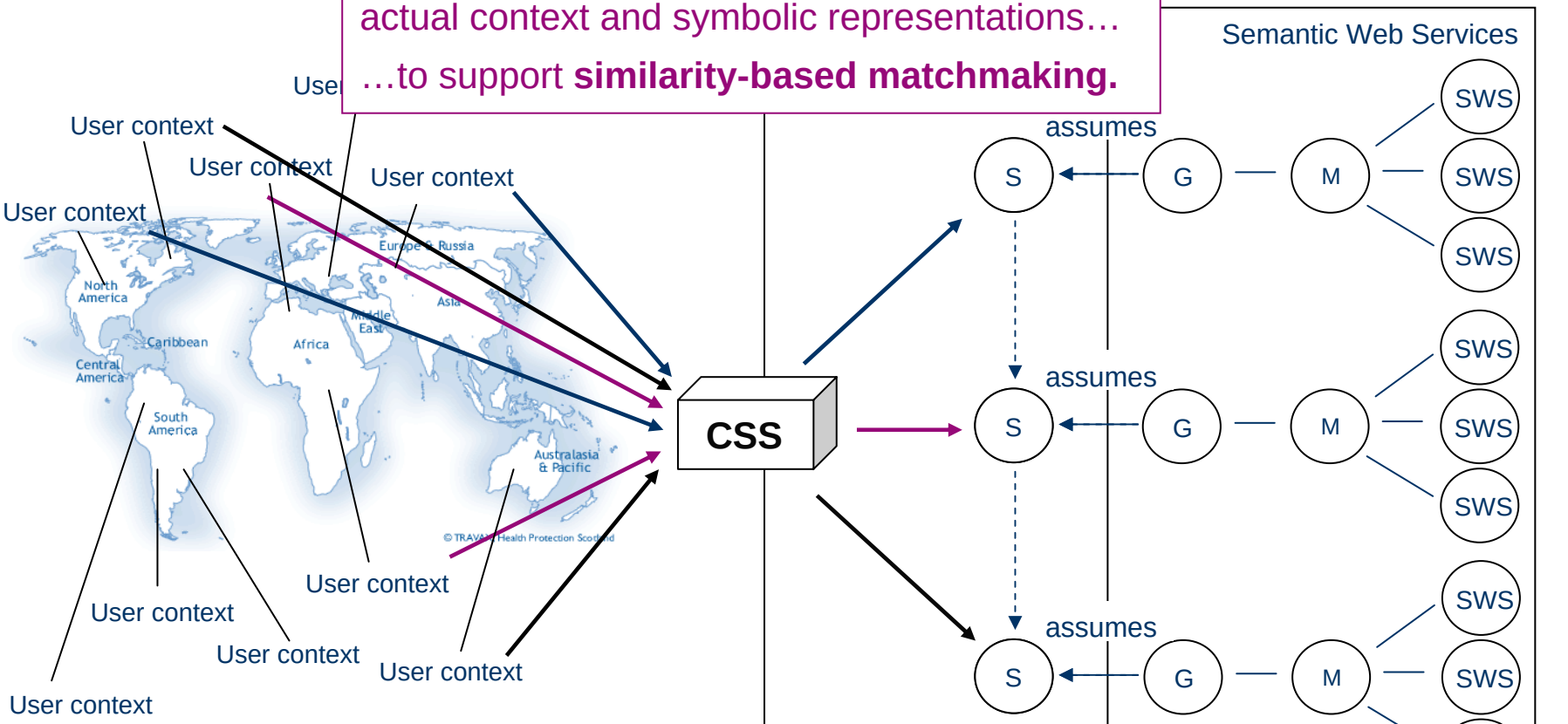


Conceptual Situation Spaces for Situation-driven Processes

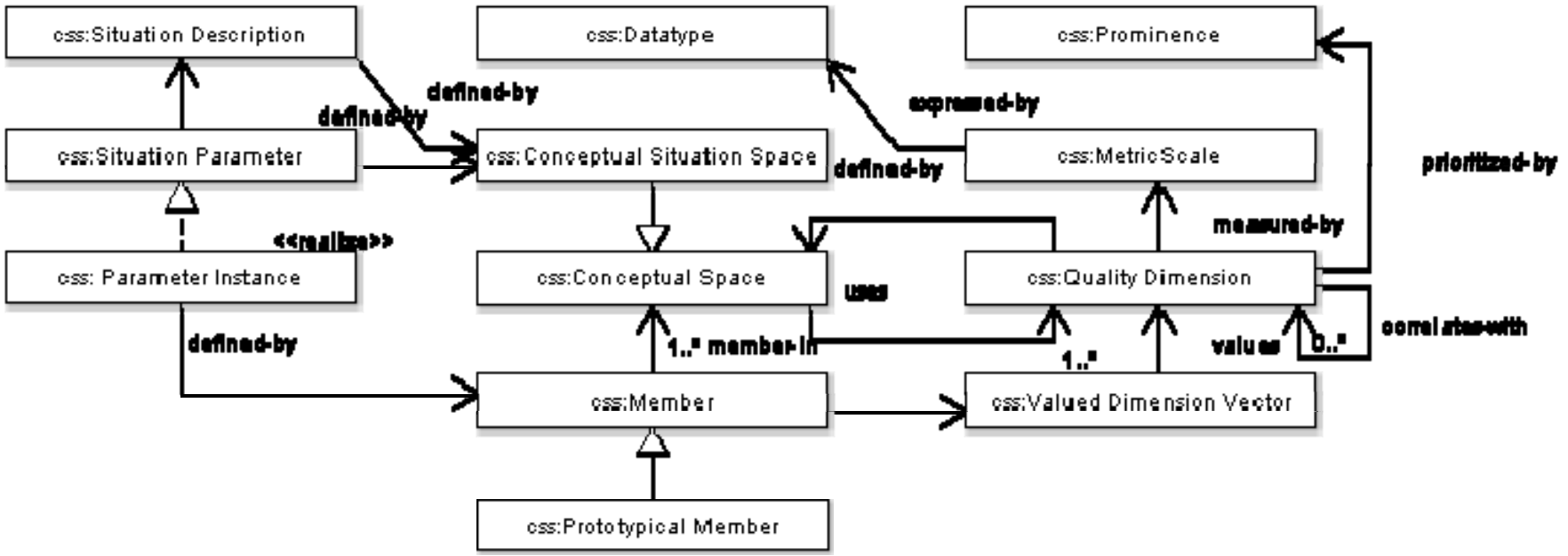
The real World

Enabling **calculation of distances** between actual context and symbolic representations…
…to support **similarity-based matchmaking.**

Symbolic Representation

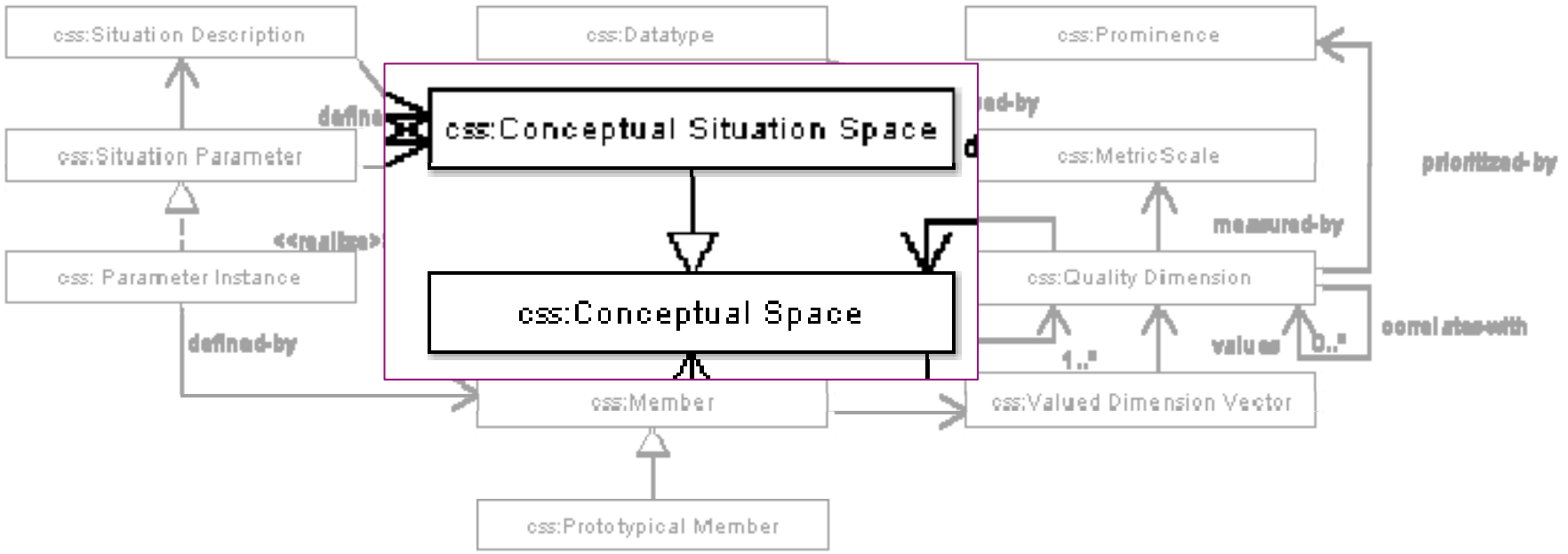


Conceptual Situation Spaces: Formalisation



Conceptual Situation Spaces: Formalisation

CSS *C* as specific derivation of a **Conceptual Space** (geometrical vector space)…



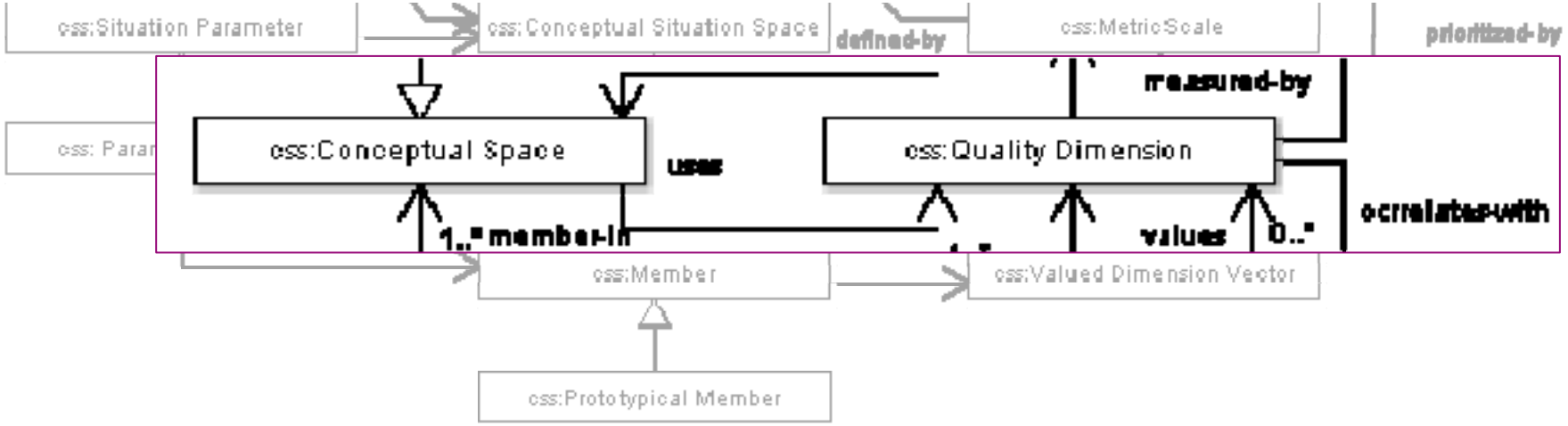
Conceptual Situation Spaces: Formalisation

- **CSS *C*** defined by **quality dimensions c_n:**

$$C^n = \{(c_1, c_2, ..., c_n) | c_i \in C\}$$

- ***C*** refined gradually ("subspaces") by refining its dimensions, for instance:

$$c_j = D^n = \{(d_1, d_2, ..., d_n) | d_k \in D\}$$

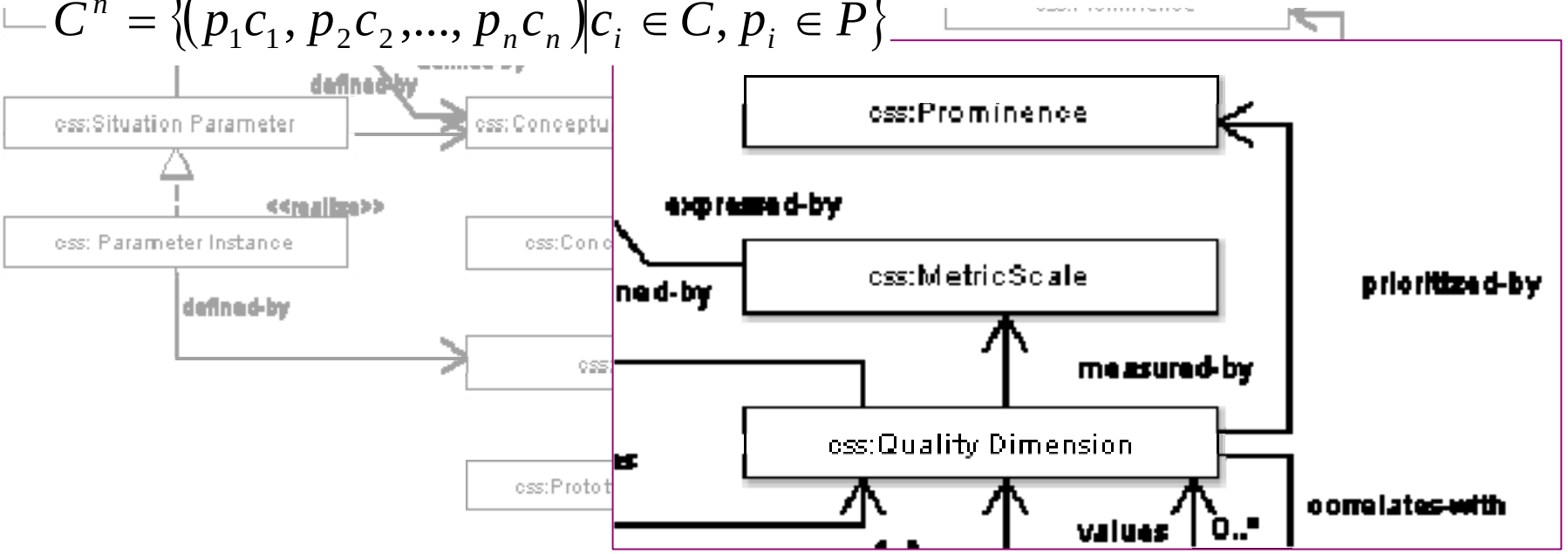


Conceptual Situation Spaces: Formalisation

- Each **quality dimensions c_n** measured on a specific **metric scale.** (ratio, interval, ordinal)

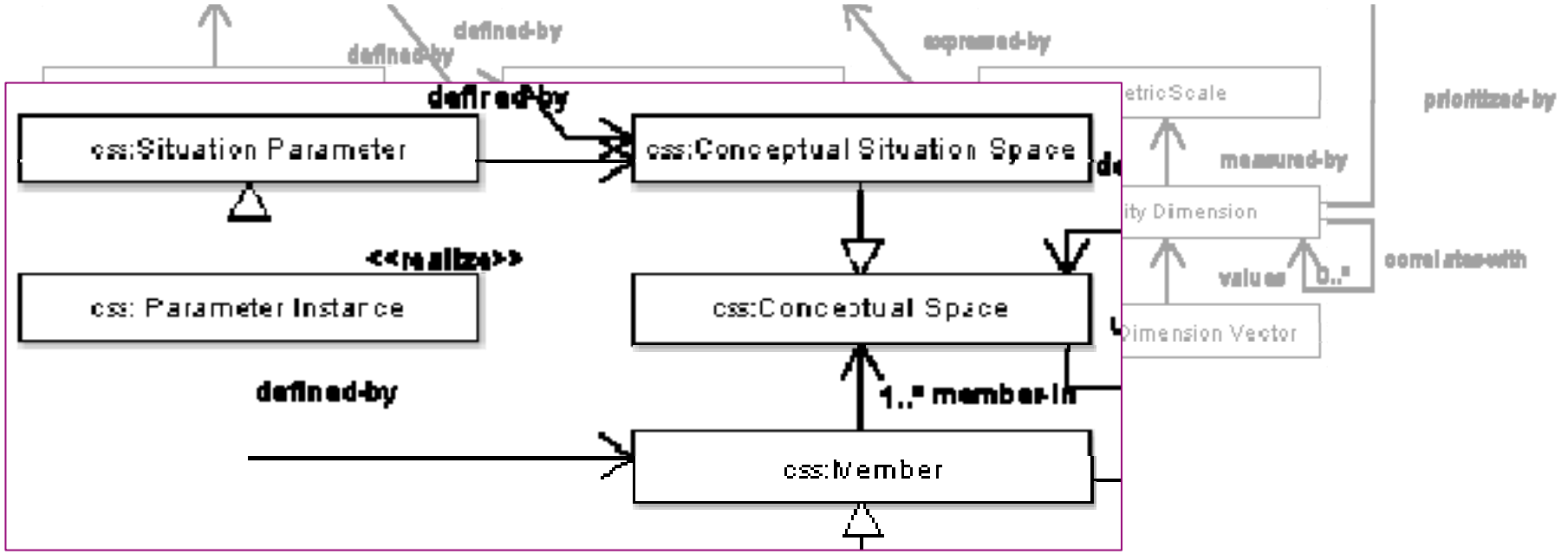
- Impact of dimension **c_n** defined through **prominence value p_n.**

$$C^n = \{(p_1c_1, p_2c_2, ..., p_nc_n) | c_i \in C, p_i \in P\}$$



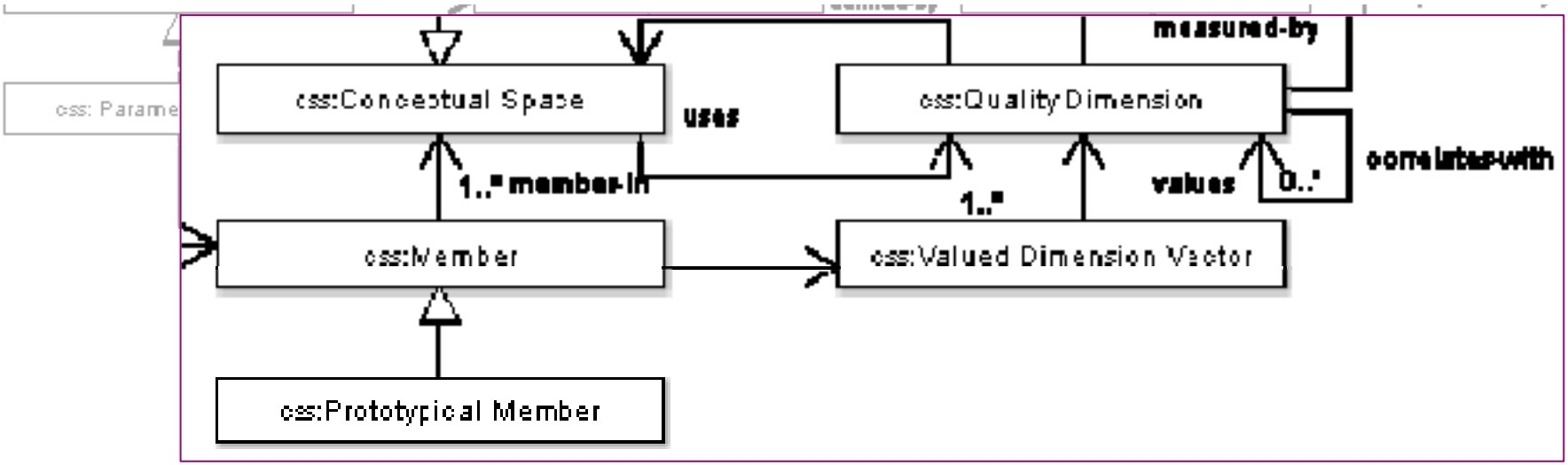
Conceptual Situation Spaces: Formalisation

- **Situation(s) (parameters)** represented as **CSS (or particular subspaces).**
- **Situation (parameter) instances** represented as **members (points) in a CSS.**



Conceptual Situation Spaces: Formalisation

- **Members** (particular contexts) in CSS *C* defined by set of **valued dimension vectors.**

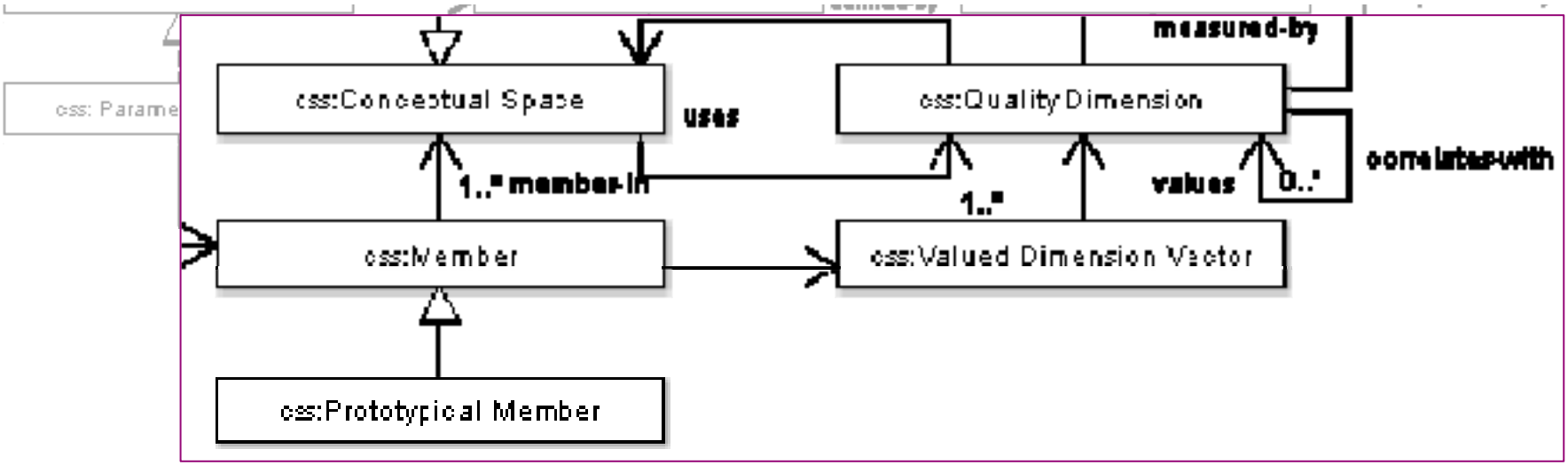


Conceptual Situation Spaces: Formalisation

- **Members** (particular contexts) in CSS *C* defined by set of **valued dimension vectors.**

- **Semantic similarity** between two members *V* and *U* in a multi-metric space *C* calculated by means of their **Euclidean distance:**

$$\left|d(u,v)\right|^2 = \sum_{i=1}^{n} p_i (z(u_i) - z(v_i))^2 \text{ with } z(u_i) = \frac{u_i - \bar{u}}{s_u}$$



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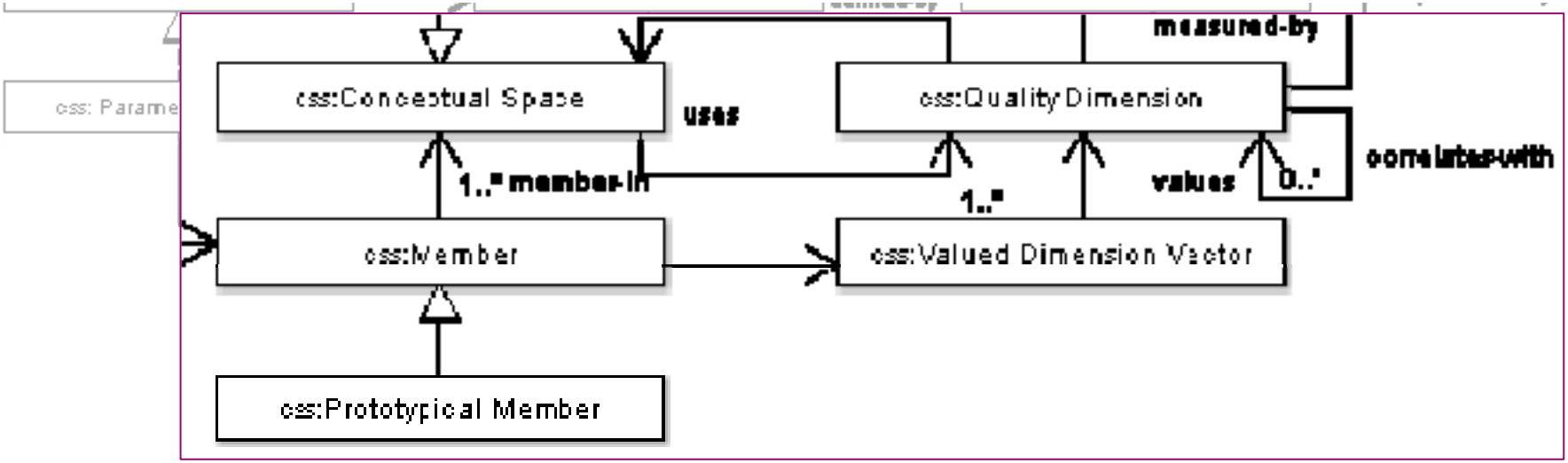
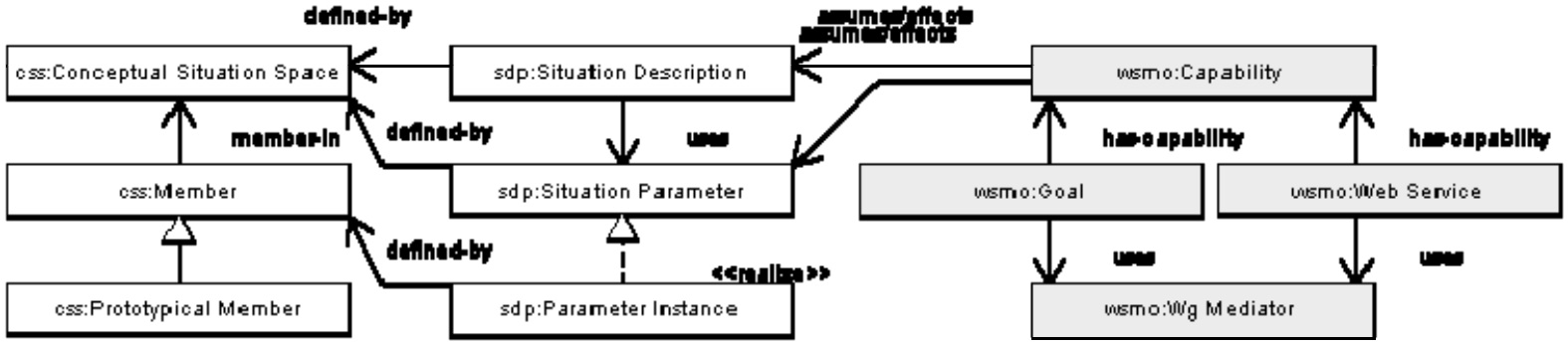
- **Prototypical members** (prototypical contexts) enable classification of arbitrary members.



Plugging everything together: Aligning CSS, SDP & WSMO

- Utilisation of **WSMO, SDP and CSS representations in OCML.**

(reasoning engine IRS-III)



Plugging everything together: Aligning CSS, SDP & WSMO

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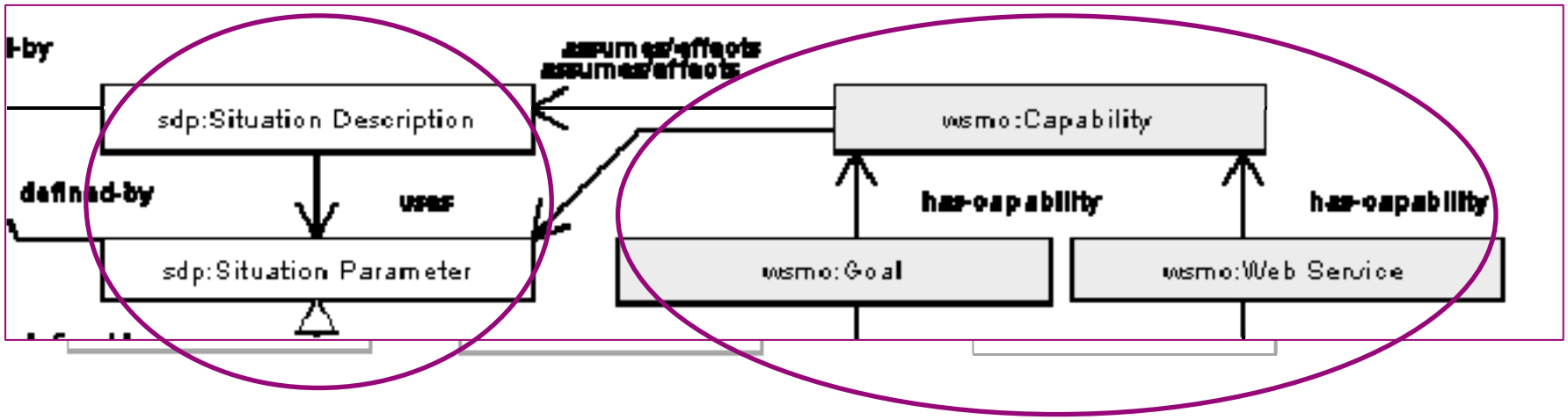
(reasoning engine IRS-III)

- **WSMO capabilities** defined through **(SDP) situation (parameter) instances …**



SDPO **WSMO**

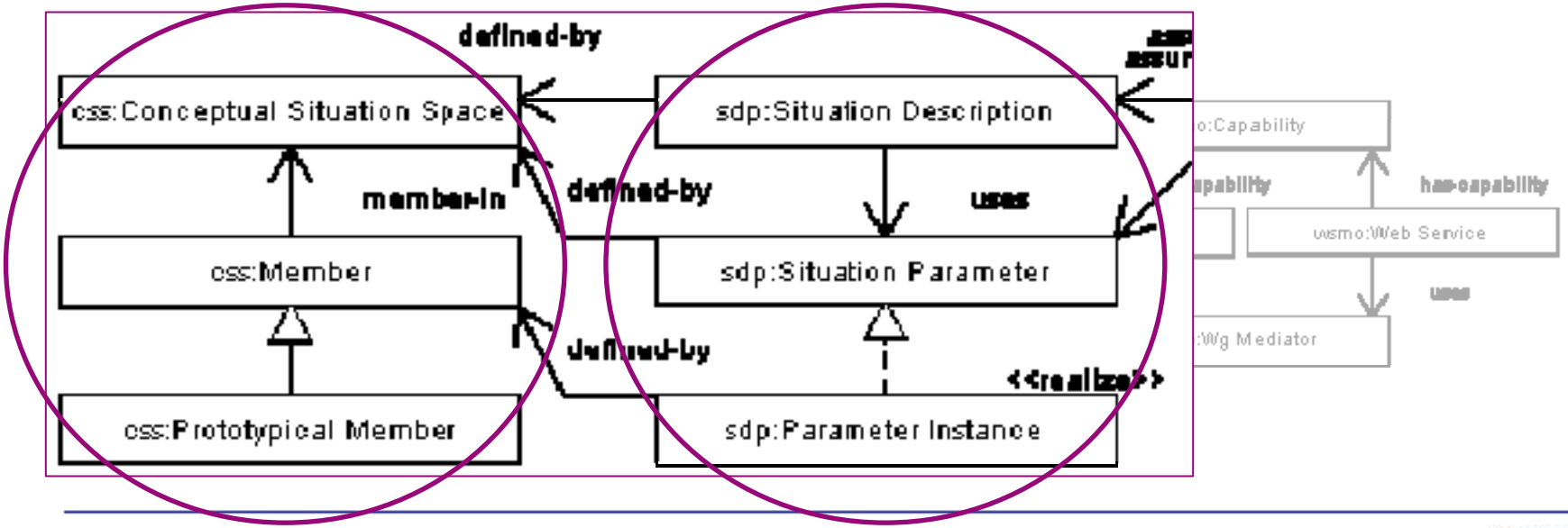
Plugging everything together: Aligning CSS, SDP & WSMO

- Utilisation of **WSMO, SDP and CSS representations in OCML.**
(reasoning engine IRS-III)

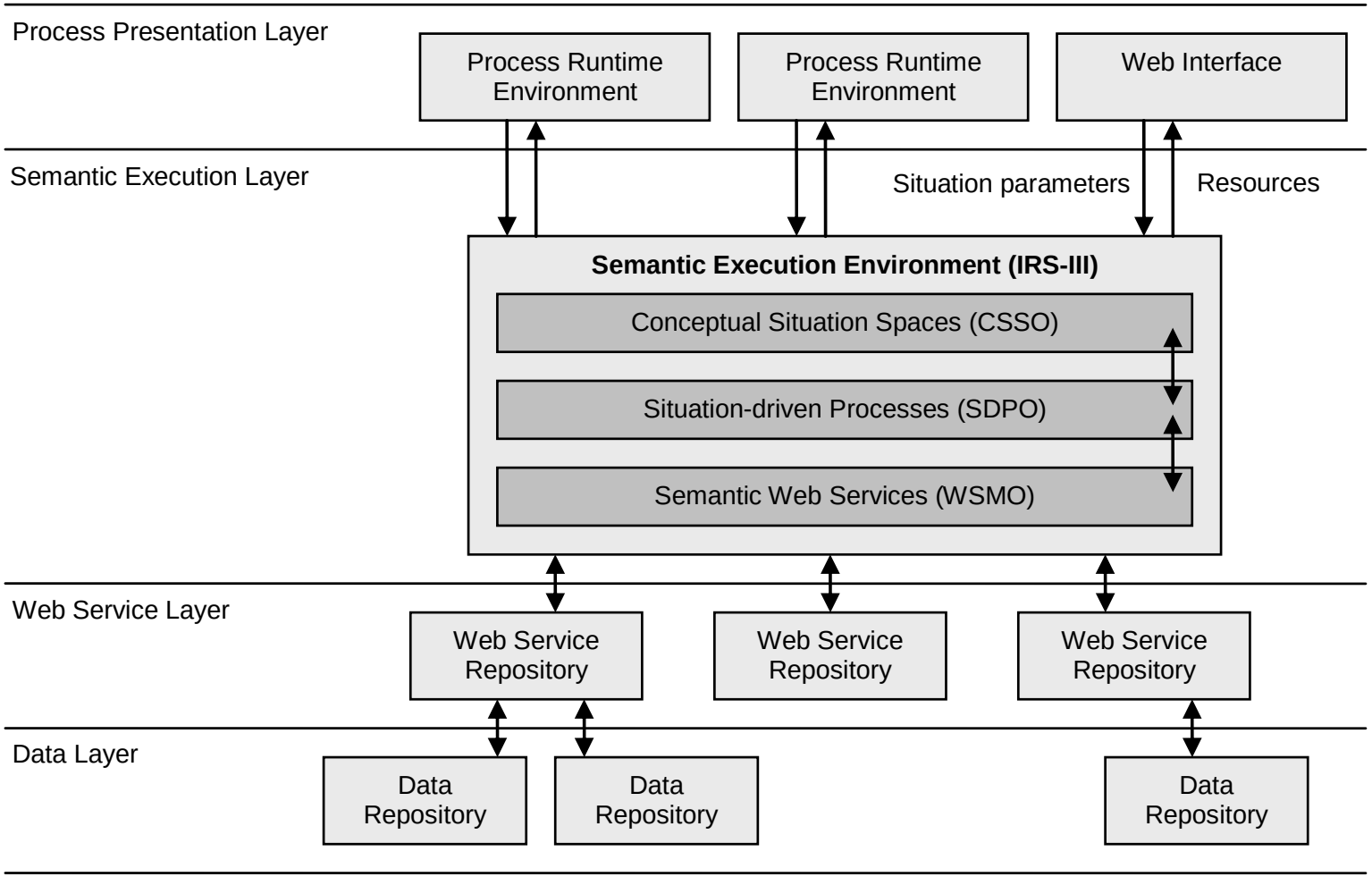
- **WSMO capabilities** defined through **(SDP) situation (parameter) instances …**

- … which are refined as **prototypical members in CSS.**

- **Similarity-based SWS selection through distance calculation** (based on CSS).



Reasoning on SDP/CSS: Approach based on IRS-III



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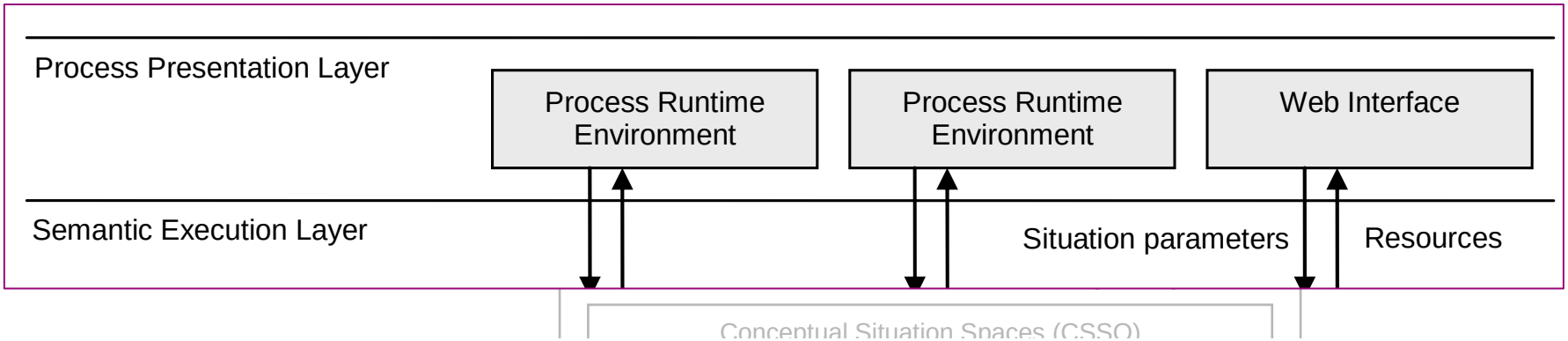
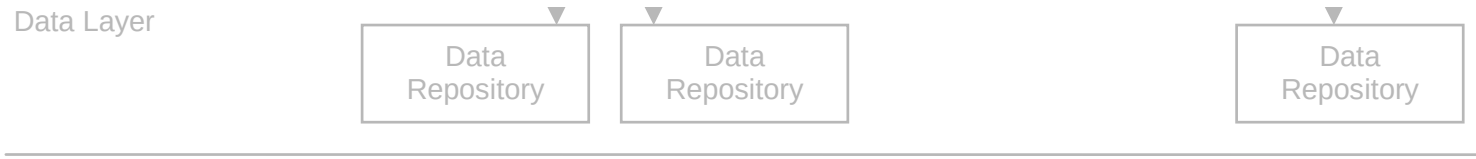


- **Web Interface** / process metadata standard-compliant **runtime environments**
- **User interfaces enable:**
  - **Raising context-awareness** through gradual refinement of situation, (automatic detection/user-driven definition of situation parameters)
  - Presentation of **process…** (generic or metadata standard-compliant XML representations)
  - …and **resources.**



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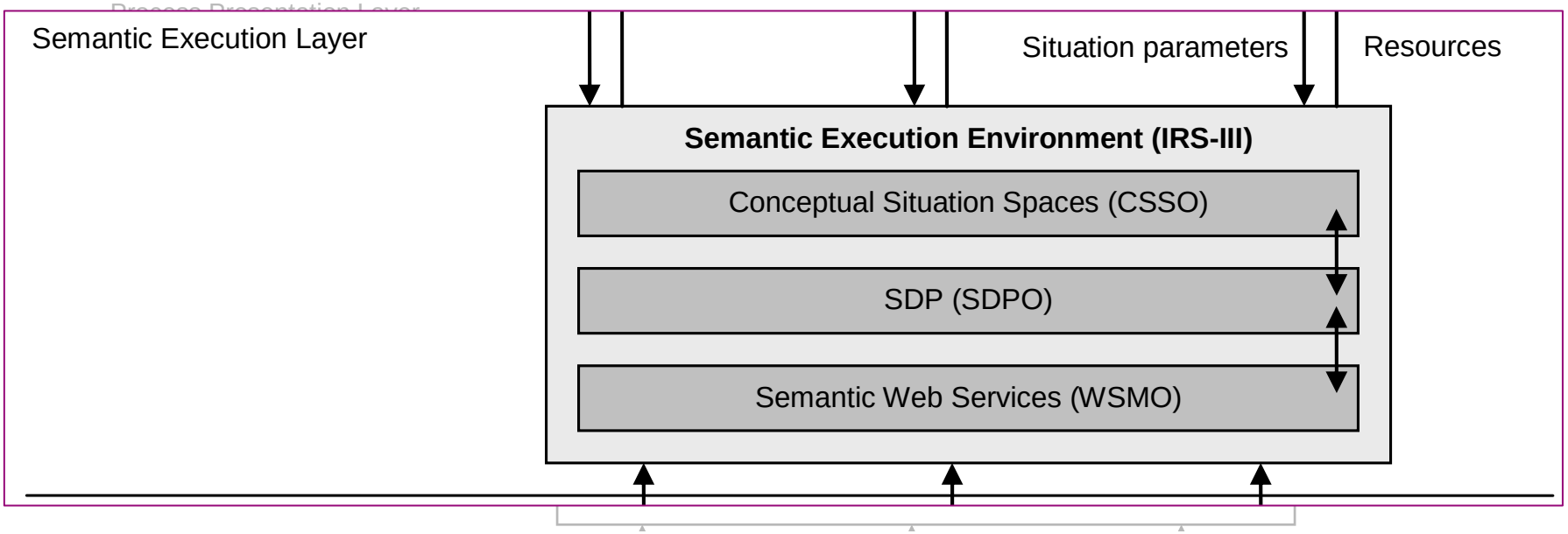

1. **Detection of most similar prototypical situation parameters.**
   (based on distance-calculation within CSS(O))

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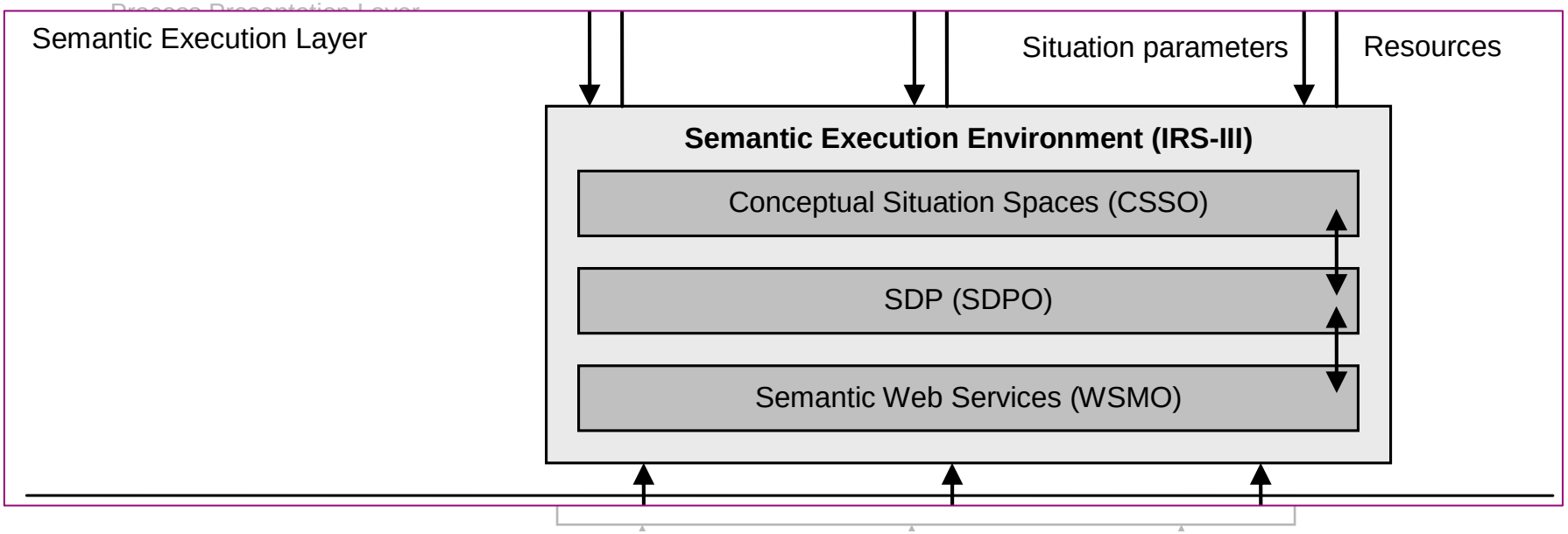

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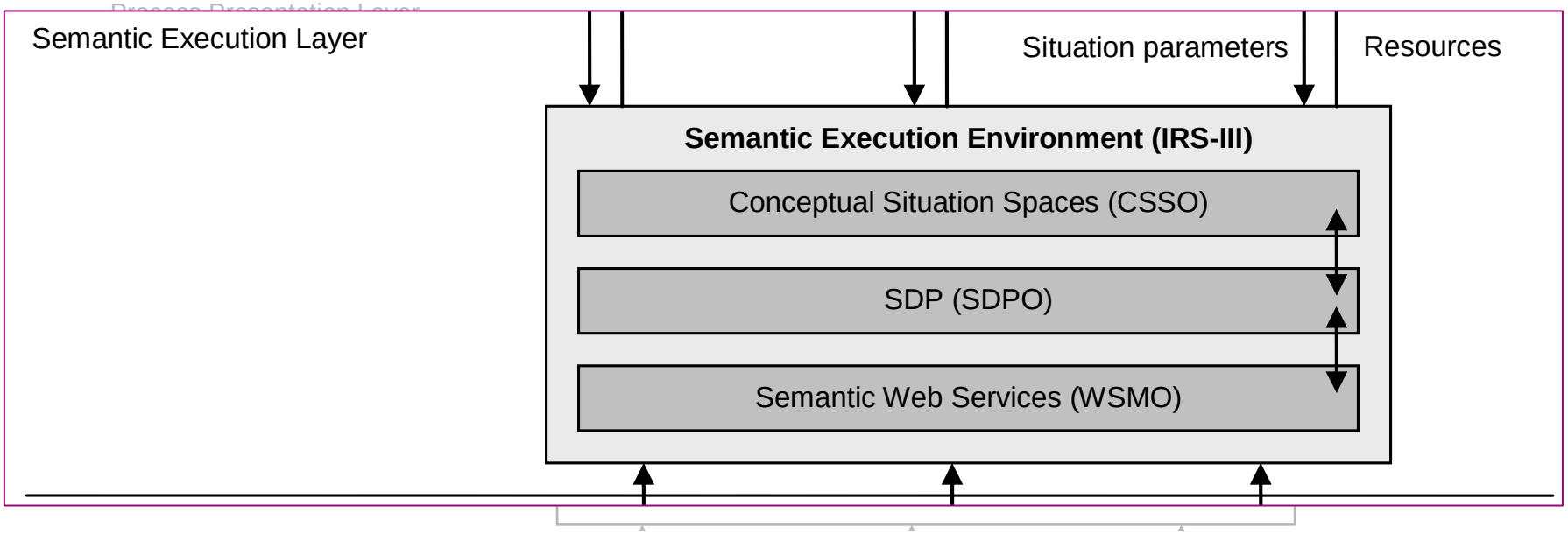

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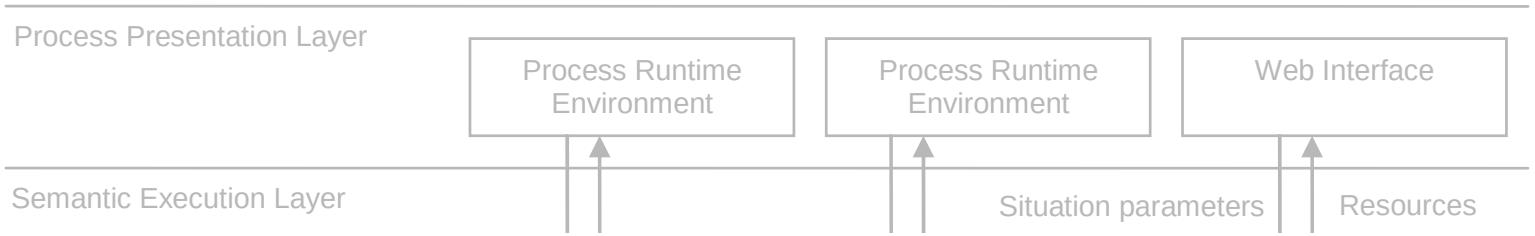
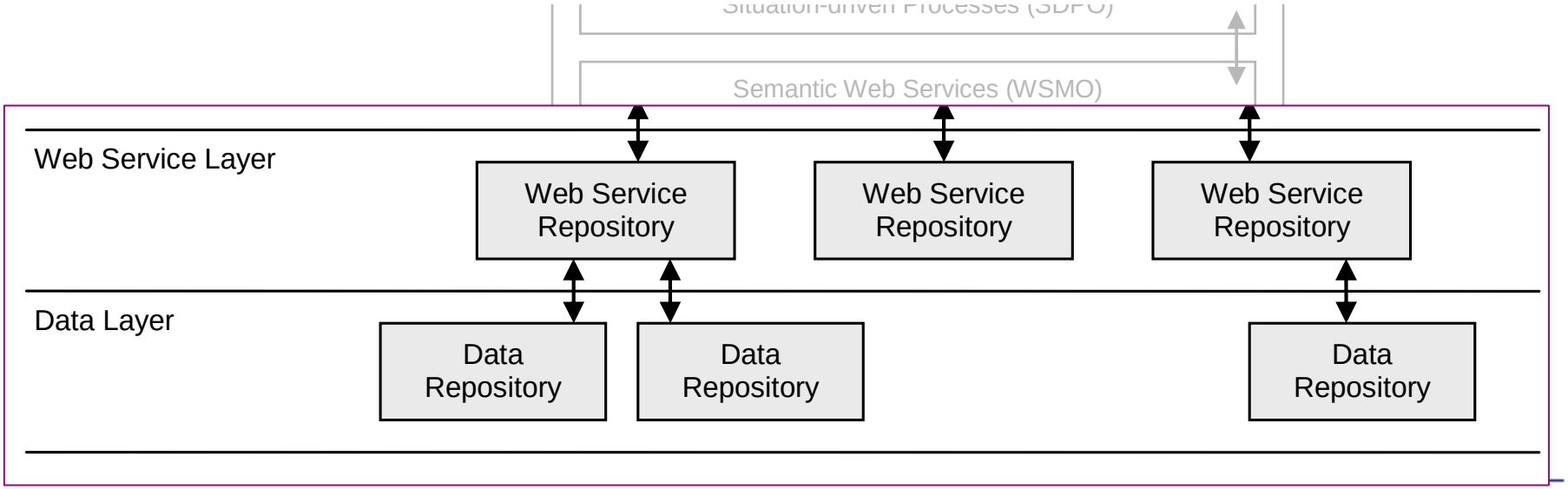
3. **Composition of SDP** in terms of **Goals and Brokered (SWS) Goals.** (SDPO, WSMO)

Reasoning on SDP/CSS: Approach based on IRS-III



Brokered Goal achievements during **process runtime:**

- Orchestration and **invocation of distributed (S)WS,**
- Context-adaptive delivery of **data resources** out of distributed repositories.



CSS/SDP:
Prototype Application

- Prototype application aimed at **context-adaptive composition of learning processes** (and transformation into eLearning metadata standards, e.g. IMS LD, ADL SCORM)
- Leading to **context-adaptive delivery of learning resources** at process runtime.
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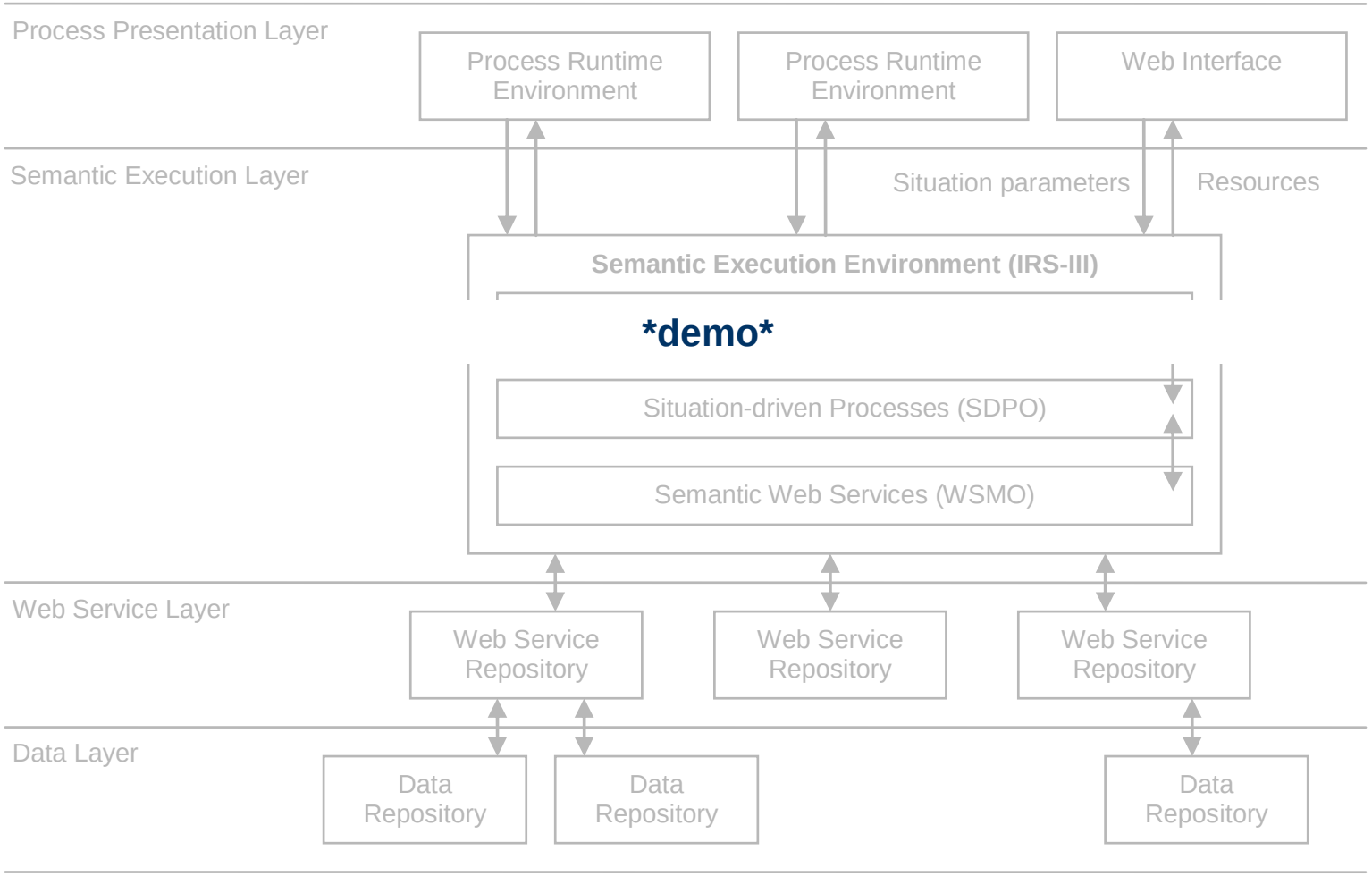
- …enabling similarity-based **selection of SWS/SDP Goals** given a set of **context parameters.**

Prototype Application:
Demo



Conclusions:
Discussion and Summary

Some issues (CSS):

- **Necessary description depth and granularity** of a CSS ?
- **=> CS(S) might just shift symbol grounding issue.**
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- Requires **measurable quality dimensions.**

…, however:

- **CSS enable fuzzy, similarity-based SWS selection** for given (runtime) context.
- **SDP** support **incorporation of SWS Goals** into **context-adaptive processes.**
- Well-suited for environments which naturally provide set of context measurements.
  (e.g. sensor-driven ones)
- Validation through initial **proof-of-concept prototype.**

Conclusions:
Future Work

Future work (CSS):

- Application of CSS to further **context parameters** / **domain contexts.**
- Incorporation of CS(S) into **SWS mediation facilities.**
  (similarity-based mediation based on CS(S)/WSMO)

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… and potentially plenty of other stuff:

- Improvement of **process planning/composition** approach.
- **Performance** tuning (SWS/WS invocations).
- Provision / reuse of **semantic descriptions.**

Thank You!

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