How sensor data interpretation could benefit from description logics: Position paper

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In many areas the interest in real-time and content-based data dissemination is increasing. Sensor data might be sent to an interested client automatically (via publish/subscribe facilities) or might be downloaded on demand by sending a query (pull model). Data dissemination and data access are important aspects in a sensor-based environment and both have a wide influence on the architectual design for an individual sensor data supply. Even simple sensors provide individual records of data by supporting web service calls (maybe via a proxy). In this scenario web service architectures are faced with high data rates, large profile population, variable query life span and high result volume. Technical details and an implementation of a service-based publish/subscribe communication architecture is described in detail in [2].

Content-based publish/subscribe systems support the required flexibility to interpret complex queries. Figure 1 illustrates a publish/subscribe system for sensor data information.

Sensors deliver sensor data like multimedia data to the broker system which is a service. Based on the content of information and the user profiles (called demand

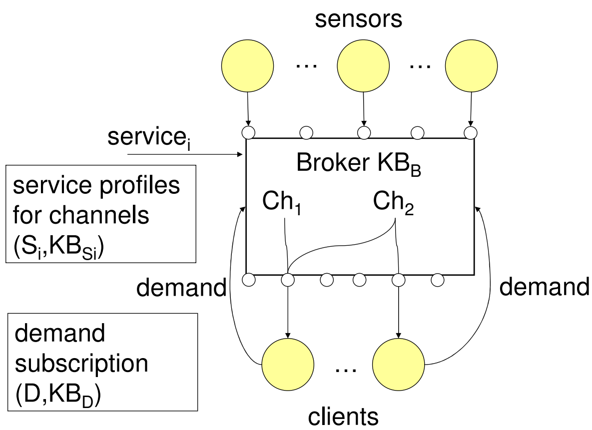

Figure 1: publish/subscribe system

subscriptions, or demands D for short) the broker system delivers information to the client. Clients subscribe to the service with their demand profiles. After low-level filtering, aggregating, and combining raw sensor data, the broker component provides certain sensor data information channels (Ch_i). Channels are described with some profiles (called service profiles (S)) as well. Both parts, services and demands are described with tuples (S_i, KB_{S_i}) or (D_i, KB_{D_i}). All knowledge bases $KB_{S/D}$ refer to some broker-specific background knowledge base KB_B.

If a certain demand subscription is sent to the broker, the problem is to find relevant channel-based services such that match with the demand specification. In the literature, several formalizations of this process are discussed [1, 3]:

- Satisfiability of the conjunction $S_i \sqcap D_i$ of supply and demand description with respect to $KB_{S_i} \cup KB_{D_i} \cup KB_B$.
- Subsumption $S_i \sqsubseteq D_i$ between supply and demand descriptions w.r.t. a background ontology $KB_{S_i} \cup KB_{D_i} \cup KB_B$.

In our scenario, the situation is slightly more complicated because some demands can only be fulfilled if some channels are combined (see the combination of Ch_1 and Ch_2 for the left client in Figure 1). In addition, maybe some filtering has to be done at client-side because there is no perfect match with existing services (channels) and incoming demands. In this context a feedback process (i.e. output data is fed back to the input of the system), currently discussed in BOEMIE[1], proves that clients get more relevant and enriched information because of the evolution of knowledge bases and the fusion of information from different channels in a bootstrapping fashion. In the e-commerce literature, service and demand adaptions have already been investigated in terms of service negotiation. According to this view, abduction and contraction operators can be used to configure supplies such that they match modified demands. This theory also provides a foundation for channel fusion (service modification) and a posteriori client-side filtering (demands taylored towards available services).

References

[1] Lei Li and Ian Horrocks. A software framework for matchmaking based on semantic web technology. *Int. J. of Electronic Commerce*, 8(4):39–60, 2004.

[2] Sylvia Melzer. A content-based publish-subscribe architecture for individualized sensor data supply (in German). Master thesis, Hamburg University of Technology, January 2006.

[3] David Trastour, Claudio Bartolini, and Javier Gonzalez-Castillo. A semantic web approach to service description for matchmaking of services. In *Proceedings of the International Semantic Web Working Symposium (SWWS)*, 2001.

[1] BOEMIE (Bootstrapping Ontology Evolution with Multimedia Information Extraction) is an IST 6th Framework Programme Project (FP6-027538)