PhD Topic 4: Information Modeling and Ontologies

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Information modeling efforts in the architectural and construction domain together with the concept of establishing an information base throughout a building's lifecycle form a step forward towards better integration and interoperability of the various disciplines involved. While passing the life cycle phases, the model grows with information and becomes a reliable source of knowledge with regard to the different communities. Besides geometry and shapes, such an information model has also full parametric capabilities and keeps a detailed prototype of the building. It can be expected that once these data are already at hand they are useful for the building operation and, thus, building performance. For example, if the building layout, structure and physics are known, it can be decided in advance when conditioning rooms has to start at the latest in order to provide comfortable yet energy efficient environmental conditions during occupancy.

In parallel, as convergence in building automation progresses, there is less need in specifying physical interfaces and interoperability on the network level for data exchange. Instead, focus is on providing semantic definitions so different networking processes are able to perform seamless interaction. Thus, one task in recent research and standardization efforts is to define interaction and assign rules for control between the different domains (i.e., heating/ventilation and air conditioning, lighting/shading, safety and security-relevant systems). Missing operational and service information, like modes of operation or energy demand of a facility, does up to now hardly allow an autonomously managed building to behave eco-friendly. Furthermore, information about energy providers and tariffs is hardly ever considered. Even if knowledge about supply alternatives exists, it is often simply not used by building operators due to the variety of suppliers and high complexity of tariff schemata. Therefore, large energy reduction potentials are still present in controlled environments. Opportunities to shorten energy consumption emerge with an exact model of the energy behavior of all installed building services.

The main hypothesis of this project is that based on all above mentioned knowledge, statements about the current and future energy demand of a building, blocks of buildings, districts, and even whole city areas can be given. Only, through an adequate information model and its structured representation, optimized demand schedules can be calculated. Appliances may then be switched on or off just in time by considering peak loads on the electricity and thermal grid. This results in a harmonized energy demand over time. Moreover, in the near future, buildings will potentially act as power plants thus being able to produce at least some of the energy needed for operation and possibly even recover energy into the smart electricity grid. If the facilities of such a building are represented as intelligently linked knowledge base, on one hand control systems can extract information to synchronize energy demand and production of the building, blocks of buildings, districts, and even city areas dynamically in a nearly optimal fashion. On the other hand this information is of utmost importance for the involved supply systems since current demands can be satisfied and possible peaks even be anticipated and resolved.

The methodology to achieve such an intelligently linked knowledge base is to acquire the central information of all disciplines involved. During this highly interdisciplinary phase, all constructs will be thoroughly analyzed, and for each term essential concepts and relations will be identified. These parameters include static data, for instance, not being considered before for control strategies in the building automation area, such as building properties, but also dynamic data, such as energy demands based on the usage of buildings.

These concepts and their relations to each other will be modeled in a structured way through established technologies of the Semantic Web. Therefore, it is planned to use the Resource Description Framework (RDF) or one of its semantically richer and more restrictive incarnations like RDF-Schema or the Web Ontology Language (OWL), which allows creating formal specifications of categorizations known as ontology. Apart from interlinking the important data, this technology also allows to automatically infer new information.

The comprehensive and smart modeling of all these data is the central point of the proposed project. The information shall be represented using a mechanism sufficiently rich to model complex relations while also providing extension possibilities. Reuse of ontologies is desirable, and therefore standard ontologies as well as research ontologies for different sub-parts will be thoroughly analyzed and evaluated for integration. Potential international

cooperations involve all participating disciplines, especially between (control) information and communication technologies and energy and supply technologies.

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