Computer simulations and analysis of real objects or phenomena require models, which are simplified in order to perform efficient computation. Very often complex models are oversimplified, which influences the quality of results. However, rapid development of computer technologies allows for big data processing and sophisticated computation methods. Many solutions, still used in research and commercial applications, are outdated. There is a need for development of new models and complex analysis methods suitable to modern computing infrastructure. Once implemented, they will bring improvement of computation time and result quality.

The aim of this project is to develop a comprehensive approach for building modelling including multi-scale spatial representation of complex objects in a four dimensions using a new primal-dual topological structure. It is anticipated that methods developed in this project will provide an intuitive spatial model construction and update mechanism with automatic topology reconstruction. In order to test the applicability of research results, a city model consisting of a digital terrain model and buildings represented in various levels of detail will be developed.

The proposed solution goes far beyond a basic geometry representation, which allows only visualisation. It is based on a new topology-rich data structure able to incorporate spatial relations among objects. At the same time it maintains a very simple implementation based on two atomic elements, which put together can build complex structures. It is ideally suited for spatial representation, as its topology (internal connectedness) may be rapidly and locally modified, as new information about changes is received. Thus, necessary analysis may be immediately performed.

Another envisaged breakthrough of the project will be spatial integration of multi-scale models, where connections among entities represented in a different scale are implemented as an additional spatial dimension. It will put new foundations for new types of complex analysis, which can be performed smoothly among interconnected model parts depending on required granularity, from the rough to very detailed representation.