A Multi-Level Space Unit Framework for 3d Buildings to Facilitate the Development of Digital Twin

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SUMMARY

In recent years, the development of digital twins and smart cities has received wide recognition. The introduction of 3D geospatial technology overcomes the limitations of 2D geographic information and makes many innovated applications possible. Building data has been considered as an essential type of 3D information for urban development. The integration of cross-domain data about buildings, however, is an extremely complicated issue due to the variety of perspectives and demands from related stakeholders. Despite there have been web-based applications providing realistic 3D building data, many of them are nonetheless restricted to visualization only. We argue an effective strategy to facilitate cross-domain integration of building data must be based on the common geospatial reference of meaningful spatial units with unambiguous specifications and unique identifiers. The multiple representation approach based on the LOD concept of CityGML 3.0 further increases the modelling capabilities of the proposed common geospatial reference. To determine the primitive set of spatial units for buildings, this study examines the building laws and specifications of Taiwan and proposes a primitive set of spatial units of buildings from the legal perspective. For every selected spatial unit, its distinguished semantics, roles, characteristics and the relationships with respect to the other types of space units are further analyzed. The 3D geometric representation (including LOD) and thematic attributes are then formally defined according to the surveying technology used and the source data provided by the stakeholders. A hierarchical identifier system is developed to enable the unique identifications of individual space units and the links between different space units as well as the multiple representation of the same space units. This integrated common geospatial reference framework hence provides a feature-based mechanism not only used for illustrating the 3D buildings, but also facilitating the management and selection of building information according to the government legal requirements and the chosen applications. For the development of digital twins, the most significant impact for the common geospatial reference is to provide a reliable and consistent reference to spatially enable the 3D representation

of domain data via standardized identifiers. This design tremendously expands the inter-connection of data from different sources and supports the development of 3D analysis and applications. As the framework comprehensively considers the various aspects of descriptions for meaningful spatial units of buildings and provides enabling mechanism to expand the development of 3D applications, it provides the advantages of interoperable integration and flexible expansion for the GIS-based digital twins.