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Digital Twin Germany – a digital replica for simulation and analysis build on geospatial data

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Abstract:

Climate change adaptation, natural and man-made disasters, soil sealing, biodiversity loss, equal living conditions and demographic change are only some of the challenges that current and future government authorities face. They are characterised by their vast geographic scope, high complexity and interdependence. To address these issues in a modern, data-driven way, new tools are needed to support policy makers in finding reliable, efficient solutions. The German Federal Agency for Cartography and Geodesy (BKG) responds to these requirements with the inception of a geospatial digital twin that will allow government authorities to model, simulate and test the impacts of possible solutions and gain new insights into underlying effects.

Digital twins have long been used in industrial production to plan and monitor processes in a holistic way. The idea is that a digital replica of an object or process is used for testing and simulation without the risk and cost of trying it in the real world. A digital twin is bidirectionally linked to its real-world counterpart. This means that it is informed by the real world (such as sensors) and at the same time allows deductions about the real world in return (i.e. expected failure date of a part). Likewise, it should be imaginable to adapt this approach to a much wider scale, such as cities, an entire country or the whole world. Each level of scale levels presents its own challenges, but also bears tremendous potential which should not go unexplored.

In geoinformatics the term digital twin has not yet been conclusively defined. For BKG however, one key aspect is interoperability which promotes data integration from different subject areas and elevates insights through better context. To achieve this, Digital Twin Germany will incorporate as much authoritative data as possible from existing information systems and infrastructures of federal authorities.

A second keystone of a geospatial digital twin is a standard inventory of assets, such as buildings, topography or public infrastructure. BKG will capture the entirety of Germany within one year using high resolution airborne LiDAR. This unprecedented scope is now achievable due to recent advances in LiDAR technology, such as Geiger-mode LiDAR (GmLiDAR) or Single Photon LiDAR (SPL). The result is a unique, high-resolution dataset with at least 40 points per square metre that is characterised by its homogeneity. The entire country is captured in a temporally and methodically consistent way.

Another central characteristic of a digital twin is that it is a dynamic construct that should allow for connections between the digital and the real world. This is achieved through the integration of sensors such as Internet-of-Things (IoT) or earth observation (EO) data captured continuously by satellites. The latter is supplied as analysis ready data (ARD) through a federated structure, building on existing solutions in the domain.

BKG aims to provide access to its users to all the data through a single platform, including processing capabilities. This follows the growing requirements of its customers in government administration to fully leverage spatial analytics on a country-wide scale. Similarly, this follows the recent paradigm shift in the geospatial sector to bring users – and processing – to the data instead of transferring the data to the user. The platform will enable users of the federal administration to integrate their own data and ideas or contract BKG to implement it. On this platform, users can continuously model, simulate and monitor their use cases to gain new insights. They will be able to virtually test and compare different decision alternatives without the risks and cost of trying them in the real world first.

Digital twins are, at their core, about information exchange: sharing between real and digital worlds, methods and results, and between applications. The homogeneity of the data captured from the 3D survey builds a common ground to facilitate this within Digital Twin Germany. There are several other digital twin initiatives in the geospatial sector, such as Destination Earth (DestinE) on a global scale or Connected Urban Twins (CUT) on a city-level scale. To

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succeed, each of these projects must consider integration and continuance beyond their own particular scope. BKGs Digital Twin Germany positions itself firmly in between, on a national level, and foresees interfaces for collaboration.

In preparation for Digital Twin Germany, a demonstration project was carried out in the Hamburg Metropolitan Region. BKG tested the feasibility of a large-scale high-resolution data capture using the SPL100 sensor over an area of 8650km². The resulting dataset has a vertical accuracy of less than 10cm. The project team gained a significant understanding of the challenges and opportunities of this data. Likewise, a network was established with potential users to formally assess their needs and expectations and to foster collaboration on a national level. BKG will share preliminary findings and the challenges encountered, as well as their vision for the concept behind Digital Twin Germany.

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