„Was machen Digitale Zwillinge des Waldes im Datenraum?“
What are digital twins of the forest doing in the data space?

Frank Heinze, RIF Institut für Forschung und Transfer e.V., Jürgen Roßmann, Institute for Man-Machine Interaction, RWTH Aachen University, Frank.Heinze@rt.rif-ev.de

In forestry, data is generated in many different places. In general, forest data is not accessible. It is usually not publicly available and there are no rules for sharing the data. Typical forest-related data includes forest inventory data, harvested timber data, environmental data from sensors etc. Currently, there are legal and technical barriers to making this data usable. Even if these barriers are overcome, it is difficult to link the data because it is available in different, mostly incompatible formats, sometimes not even in digital form, but e.g. as written data.

The use of digital twins (DT) together with data space technologies addresses this problem. While data spaces pave the way for legally and technically secure data sharing, where the data provider retains sovereignty over his data as far as this is technically possible, digital twins can manage the data sharing process.

Figure 1 provides a conceptual overview of the combination of data space technology and digital twins in the Data Space Forestry 4.0 as it is currently developed in the CO2For-IT [1] project.

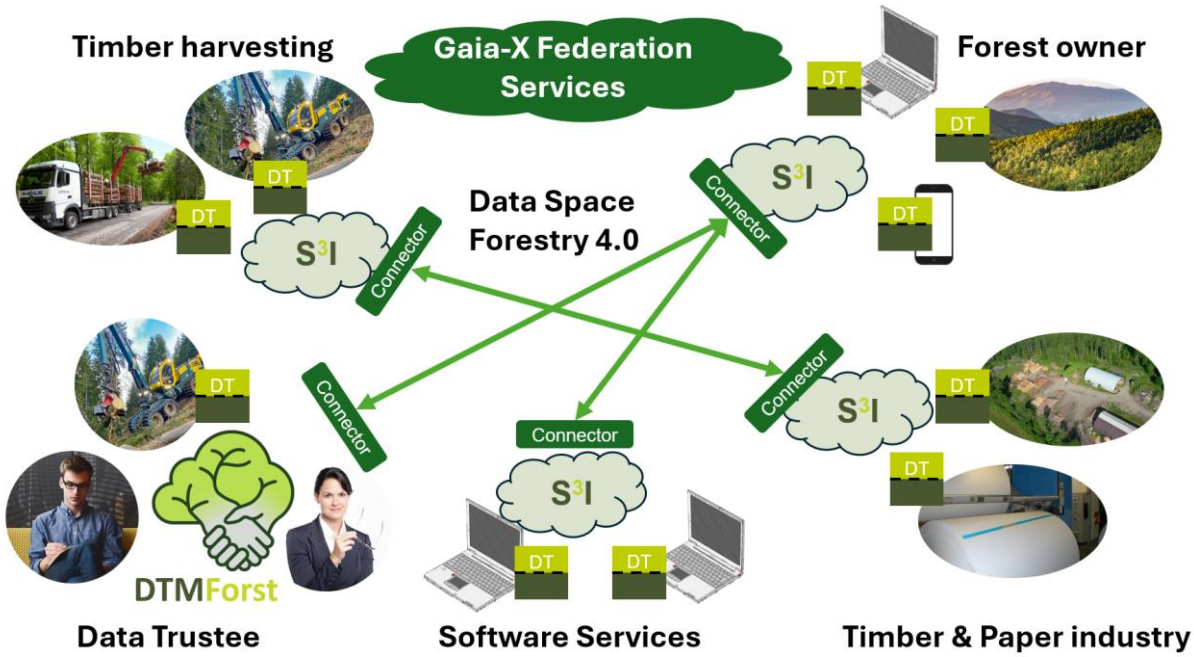

Figure 1: Conceptual model of the Data Space Forestry 4.0 including the data trustee DTMForst. Picture references: Rhenus Forest Logistics (Timber truck), HSM (Harvester 2x), Pixabay (9x)

The Gaia-X Federation Services provide a general framework for cooperation in the data space. The Data Space Forestry 4.0 consists of several smaller subnetworks. A subnetwork can comprise a single company or even several companies. For example, several companies working closely

together may operate their own infrastructure as a subnetwork. E.g. in the figure companies in the timber harvesting sector or in the timber and paper industry operate their own subnetworks. One way of implementing a subnetwork is the open-source solution of the Smart System Services Infrastructure (S^3I) [2]. Communication within these subnetworks takes place via the representation of all communication participants by digital twins. The subnetworks can in turn be connected to each other via connectors, e.g., based on Eclipse Dataspace Components (EDC).

Individual network participants without their own IT infrastructure can connect to a data space through a data trustee. The data trustee takes care of the rights and wishes of the data provider and provides an access point to the world of data sharing. An example of a data trustee for the forest-based sector is DTMForst [3], which is currently under development. Data providers can access a data trustee via their digital twin or directly, e.g., via a web portal or an app. In turn, individual data trustees can be connected to the data space via a connector. See the work of Schinke et. al [4] for an overview of data trustees in the forest-based sector and Hoppen et al. [5] for a usage scenario of the Data Space Forestry 4.0.

A digital twin is always associated with a real asset. The asset can be a machine, a forest stand, a single tree trunk, a sensor, a person or even a process. The digital twin connects its asset to the digital world and provides access to vital information about the asset. It can also take an active role, with active data processing on the digital twin as an independently acting entity. For example, a digital twin of a forest stand could suggest maintenance activities. A visual representation can include the visual aspect of the asset, such as a point cloud of the forest stand or a surface model. Examples of digital twins using visual representations of forest stands are the Virtual Forest project [6] and the Digital Twin Germany, which is currently being developed by the Federal Agency for Cartography and Geodesy [7].

Often the visual representation of an asset is seen as the main feature of a digital twin, but in fact it is far more important that a digital twin is an independently acting entity. This processing capability enables a digital twin to merge disparate data sets into a single entity. It can turn unused data into usable information and provide a single point of access to that information. In this way, the digital twin becomes responsible for all compatibility issues.

In summary, the combination of digital twins with data space technologies and data trustees opens new horizons for legally and technically secure data sharing without anyone having to worry about compatibility issues.

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