

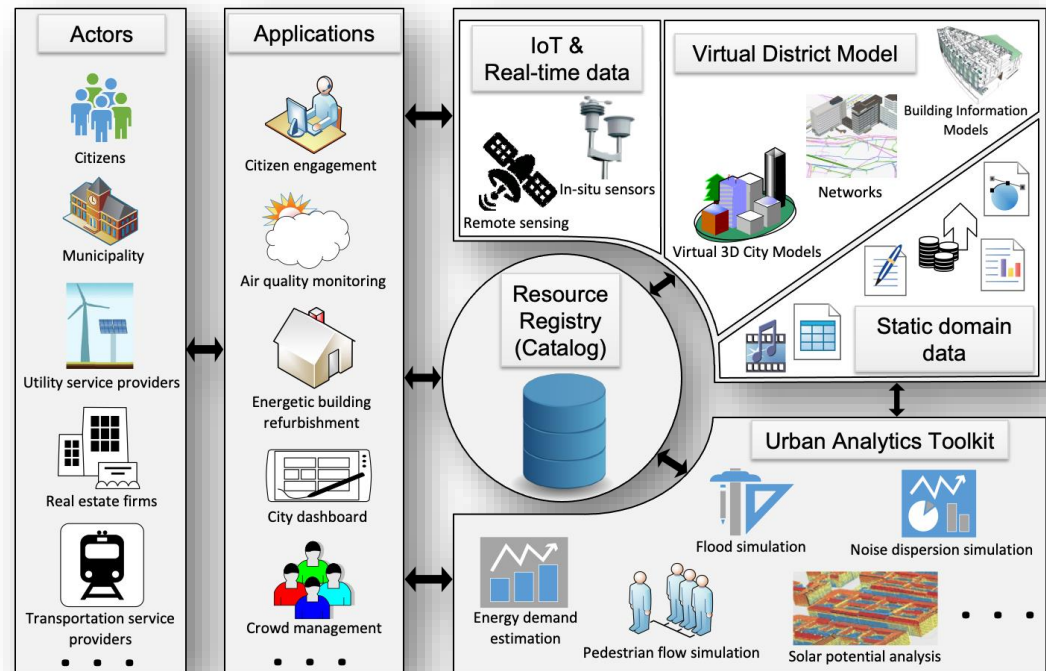
# Key Elements of Urban Digital Twins

Thomas H. Kolbe

Chair of Geoinformatics  
Dept. of Aerospace and Geodesy  
TUM School of Engineering and Design  
Technical University of Munich

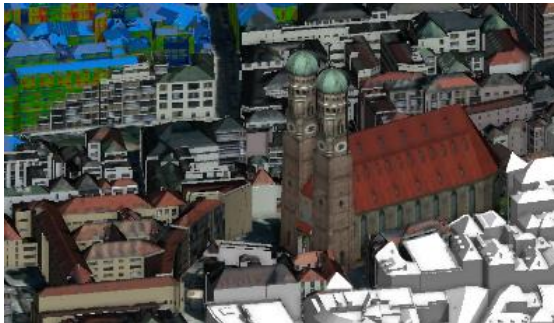
<https://www.asg.ed.tum.de/gis/>

3D GeoInfo 2023, Munich,  
12<sup>th</sup> of Sept. 2023



# Digital 3D Models of the City

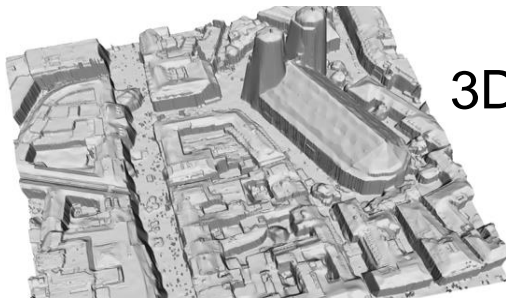
- ▶ There are different types, for example:



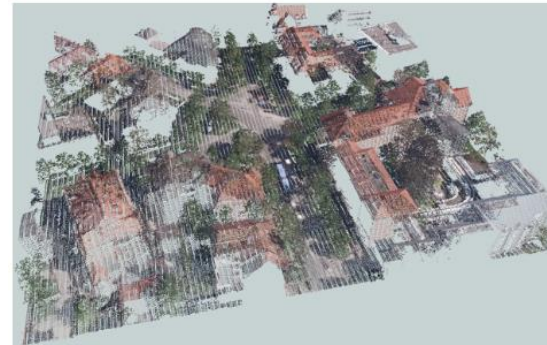
Semantic  
3D City Models  
*e.g. CityGML*



Building  
Information  
Modeling  
*e.g. IFC*



3D Mesh  
Models

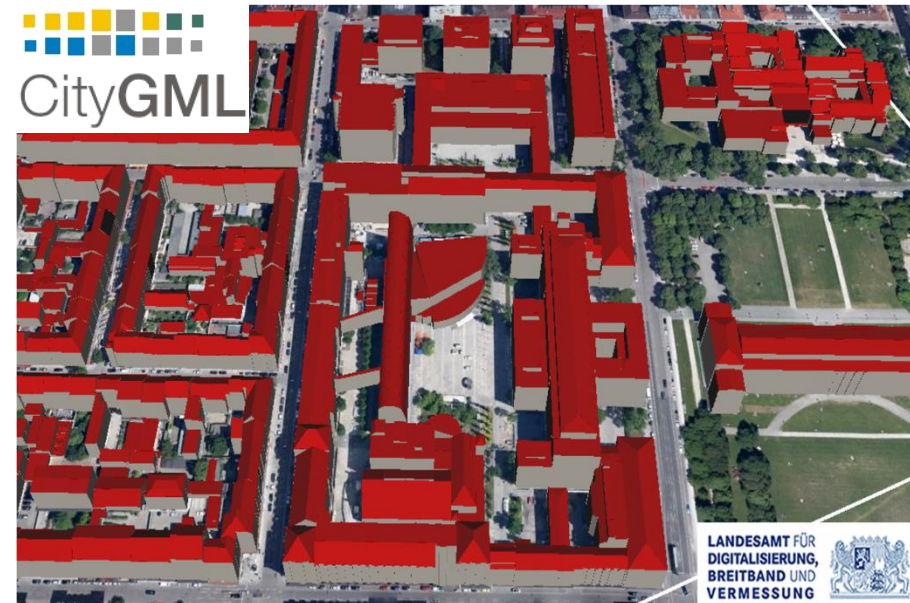
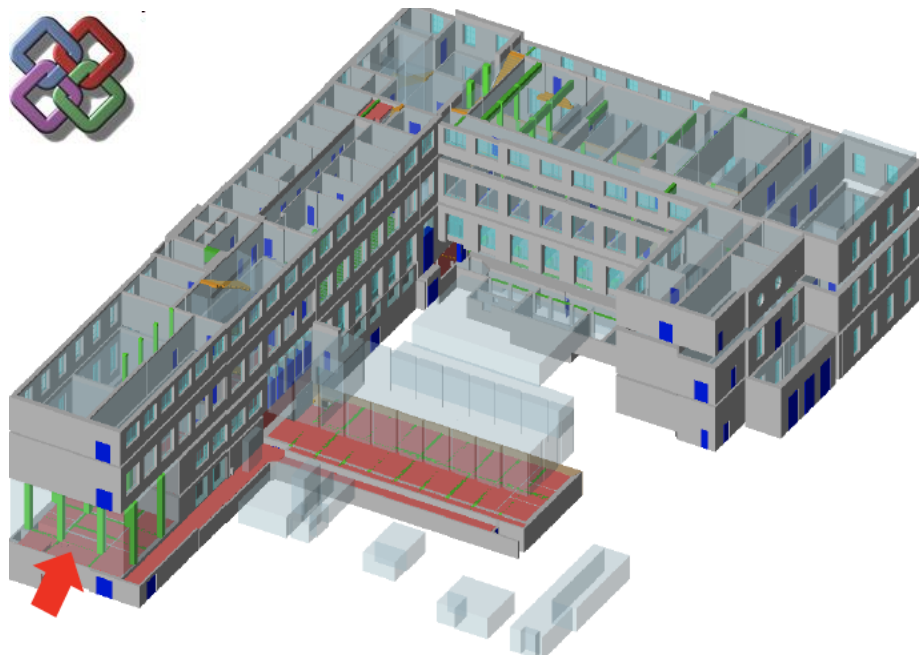


3D Point  
Clouds

- ▶ All have certain advantages and disadvantages, and cities nowadays employ more than one type to compensate for the weaknesses of the others

# Semantic 3D Models of the Built Environment

- ▶ On the scale of individual sites:  
**Building Information Modeling (BIM)**
- ▶ On the scale of city quarters up to entire regions:  
**Semantic 3D City Models (*Urban Information Models*)**



**Is this it?**

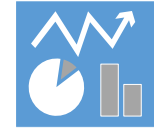


**Are these models  
the Urban Digital Twin?**

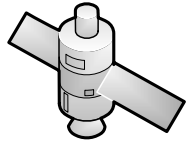
## No, of course not!

- ▶ **Digital models** of the physical environment are just one **key element**
- ▶ But what about
  - the actors and stakeholders?
  - use cases and applications?
  - processing and analytical tools / simulators?
  - real-time measurements using sensor devices and services?
  - the many different sectors / thematic domains like mobility, energy, living, social aspects, environment, finances?
- ▶ The **Urban Digital Twin** is the set of **all digital resources about the city**, **distributed** across **all resource holders**.
  - clearly cannot be managed explicitly in a platform or a single database  
→ We need an infrastructure. And SDIs are a very good starting point!

# City / District as a Complex System



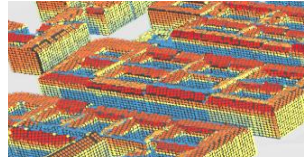
Noise dispersion simulation



Satellite sensors



Citizens



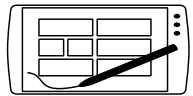
Solar potential analysis



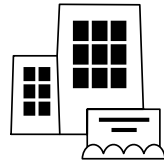
Municipality



Weather sensors



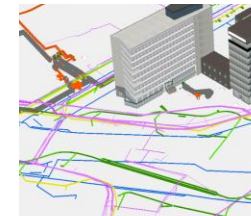
City Dashboard



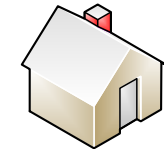
Real estate firms



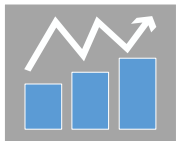
Citizen engagement



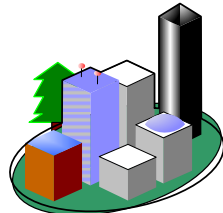
Networks



Energetic building refurbishment



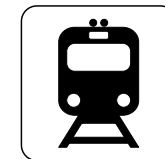
Energy demand estimation



Virtual 3D City model



Flood simulation



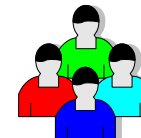
Transportation service providers



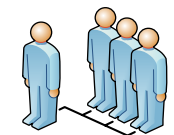
Air quality monitoring



Utility service providers



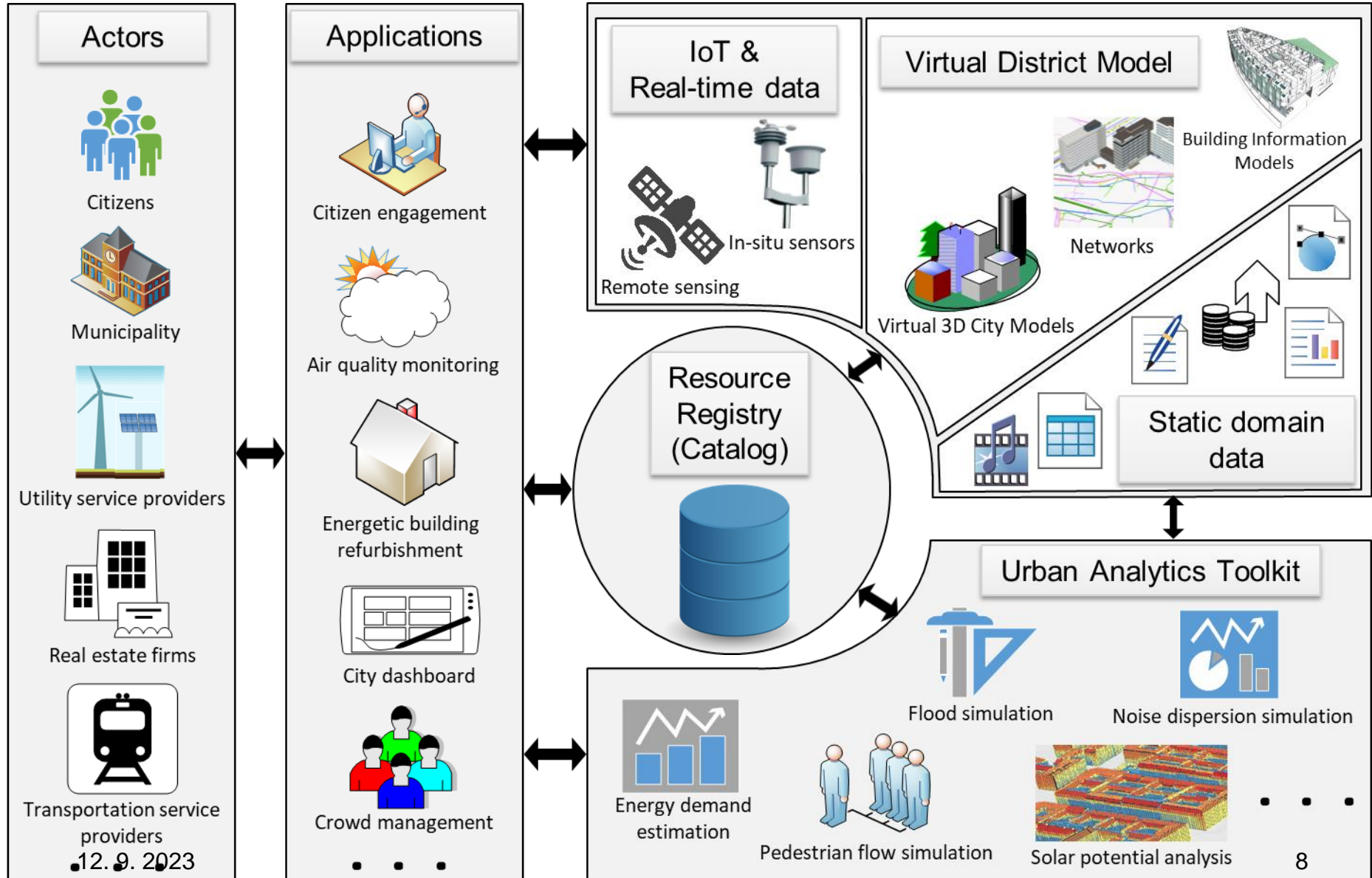
Crowd management



Pedestrian flow simulation

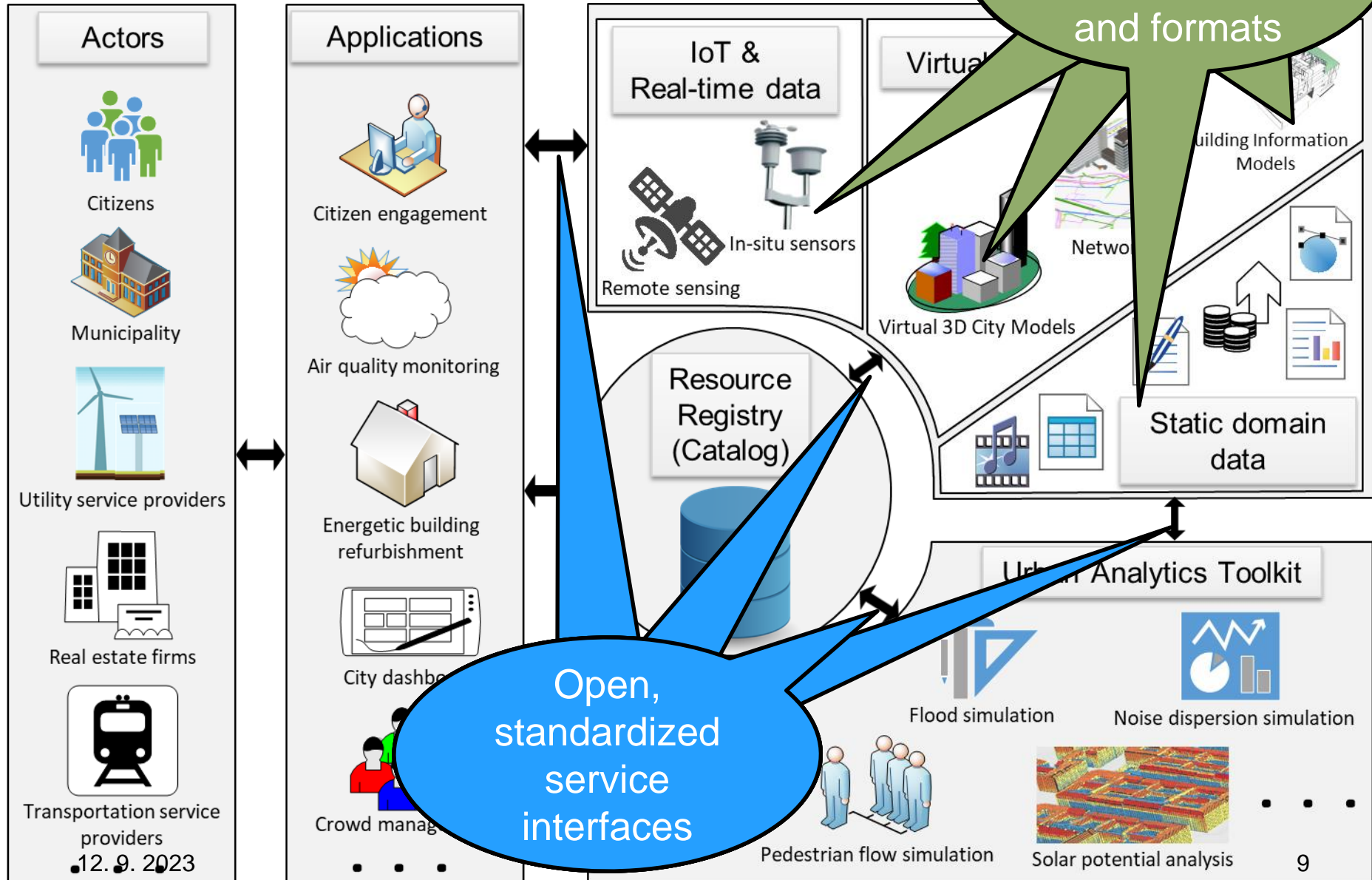
**Smart District  
Data Infrastructure  
(SDDI)**

# Smart District Data Infrastructure (SDDI)

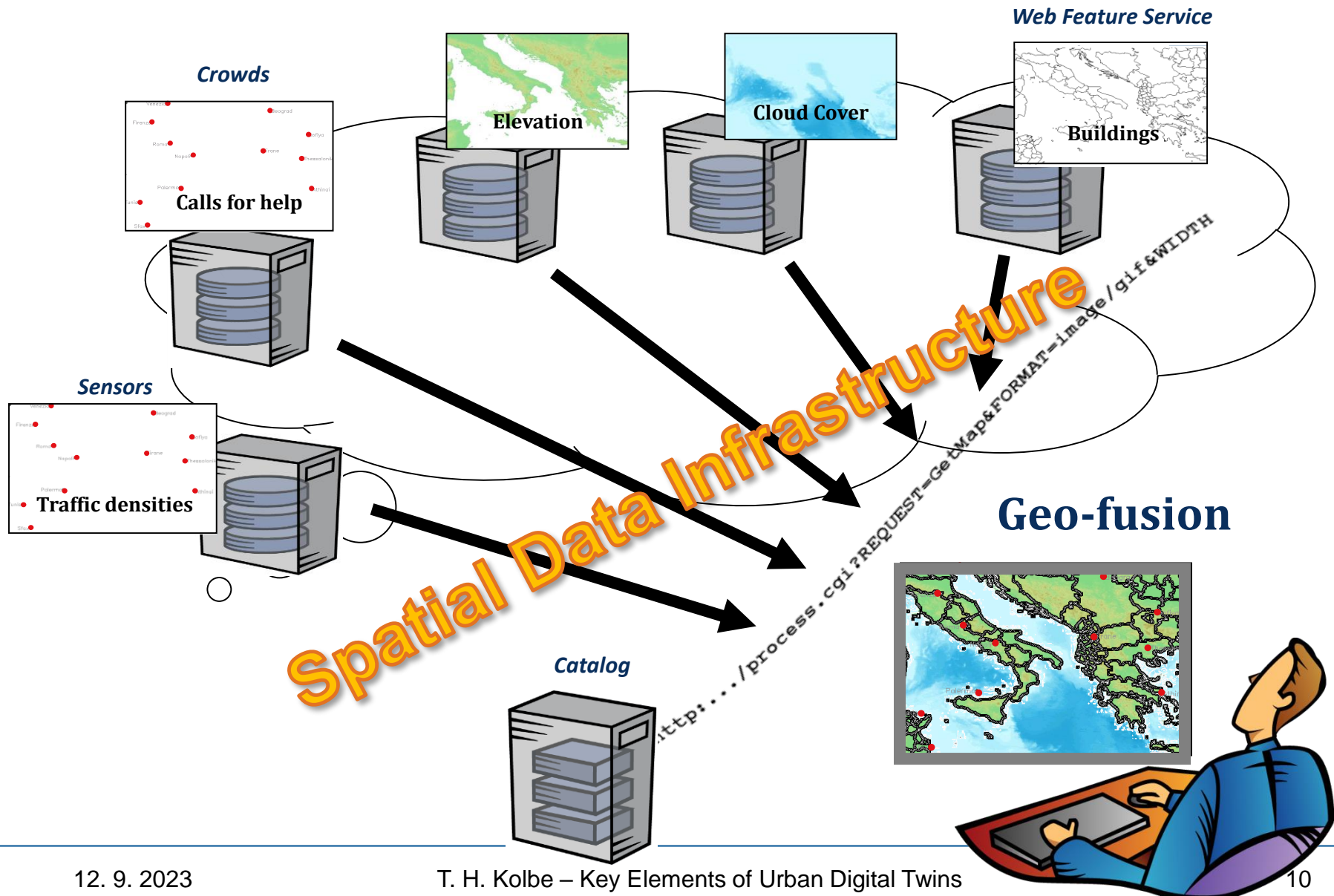




# Smart District Data Infrastructure (SDDI)



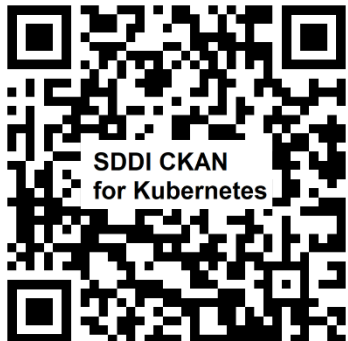
# SDDI – Realisation as a network of distributed services



# **The SDDI Catalog**

# SDDI Catalog

- ▶ We (TUM-GIS) have developed an improved catalog service to manage all kinds of distributed information resources of Urban Digital Twins
- ▶ **Open Source**; based on the **CKAN** Data Platform software
  - specific extensions: spatial & temporal metadata and search, GUI to link catalog entries, navigating linked catalog entries, DCAT2
  - supported information resources: digital twin, project, thing, geoobject, method, software, online service, online application, dataset/document
- ▶ Production ready; easy deployment in Cloud Environments
  - Docker images: <https://github.com/tum-gis/ckan-docker>



- Helm charts for easy deployment of application stack in Kubernetes Cluster:  
<https://github.com/tum-gis/sddi-ckan-k8s>
- Tested & running on Azure, T-Systems Cloud, Minikube, Docker Desktop
- Branding is easy



# Examples for running SDDI Catalog instances

- ▶ Catalog platform for the Digital Twin Munich (ongoing work):

Willkommen auf der Katalogplattform Prototyp des Digitalen Zwillings München

Hier finden Sie Informationen über Daten, Dienste, Anwendungen und Projekte im Kontext des Digital Twin München Projekts und des damit verbundenen Projekts Connected Urban Twins.

Suchdaten

z.B. Umwelt

Beliebte Tags: DZM, CUT, BoulevardSonnenstrasse

**Gruppen**

Datensatz und Dokumente

3D-Gebäude\_Mesh

Vier OBJ-Datensätze, in denen 3D-Gebäude als Mesh zu finden sind. Das Gebiet des Boulevard Sonnenstraße ist in vier...

CityGML\_Gebäudedaten\_Sonnenstraße

Enthält Gebäudedaten im CityGML-Format. Jede Ressource bezieht sich auf die einzelnen Klassen der CityGML-Datet und...

Verkehrskennzeichen\_Lichtsignalanlagen\_Fahrbahnmarkierungen-Boulevard\_Sonnens...

**Organisationen**

Technische Universität München (TUM)

Lehrstuhl für Geoinformatik

3DCityDB-Web-Map-Client

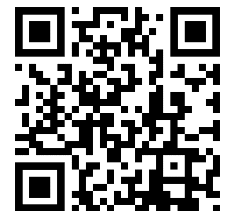
Übersicht Während der Entwicklung des 3DCityDB-Web-Map-Clients wurden verschiedene Erweiterungen für den [Cesium...

3D-Viewer Boulevard Sonnenstraße

Diese Anwendung zeigt Ihnen ein 3D Modell von Sonnenstraße in Ihrem Web-



- ▶ Link to an open, running catalog for the project SAVeNoW: <https://catalog.savenow.de/> (Give it a try!)



**Implementation  
of the SDDI  
with model regions  
in Bavaria**

# Roll-Out of SDDIs in Bavaria (TwinBy Project)

- ▶ Participants: **18 funded municipalities / installations** in Bavaria
- ▶ Funded by **Bavarian Ministry for Digitalization**

- ▶ Municipalities are supported by:



Bayerisches Staatsministerium  
für Digitales



- Qualification & education program
  - Service time from IT companies for the introduction of the SDDI process and the technical implementation
  - Open source software plus diverse commercial software applications depending on the local use cases and available data / services
  - Open data and services from the Bavarian Spatial Data Infrastructure
- ▶ Project runtime: **April 2023 until March 2024**
  - ▶ <https://twinby.bayern/de/startseite>

TwinBy  
IM!D!BA



# Summary – Key Elements of Urban Digital Twins

- ▶ **Stakeholders / Actors** (Consumers, Producers, Prosumers)
- ▶ **Distributed digital resources** of the cities/regions
  - **Digital models of the physical environment**
  - **Dynamic data** from all domains (e.g. provided by sensor services)
  - **Static data** from all domains
  - **Analytical tools** from all domains
- ▶ **Joint catalog** to register and find all resources
- ▶ **Interoperability** of all components and data representations
- ▶ **Organizational & operational framework**
  - Spatial Data Infrastructures (SDIs) and their institutional background are good starting points → existing & sustainably operated
    - **Extend SDIs to become SDDIs**