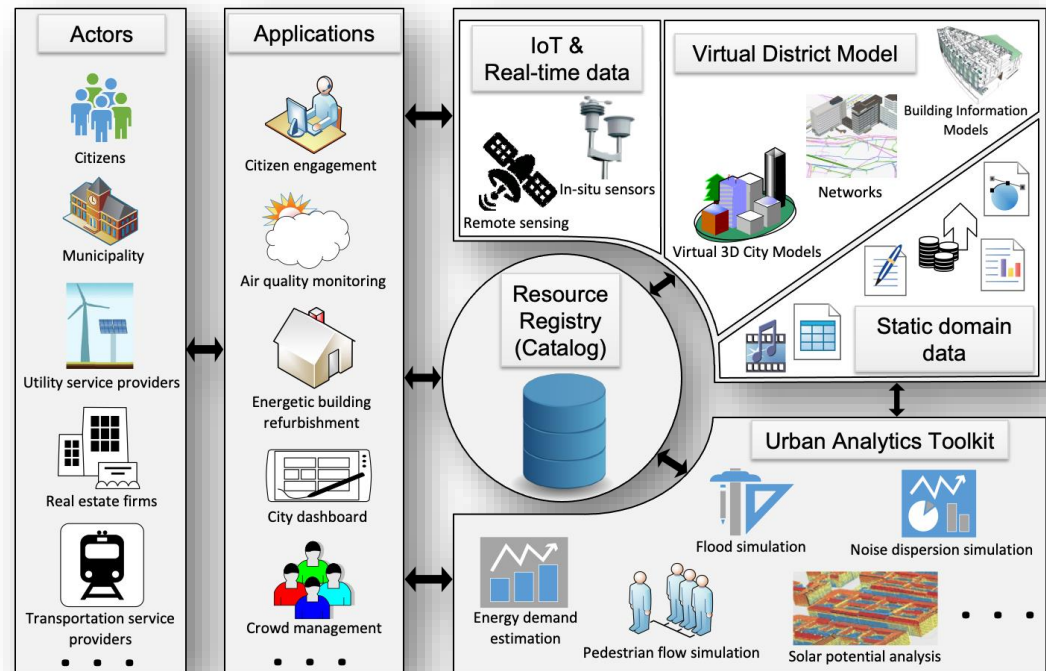# Key Elements of Urban Digital Twins

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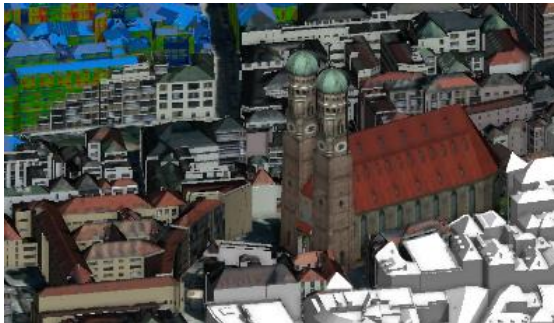Technical University of Munich

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

3D GeoInfo 2023, Munich,
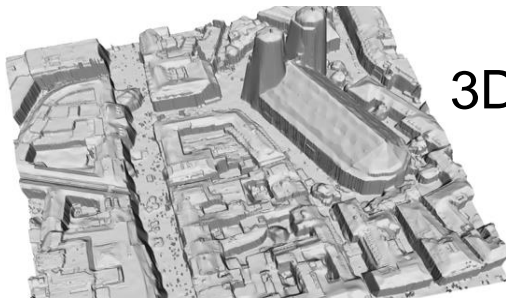12th of Sept. 2023

Digital 3D Models of the City
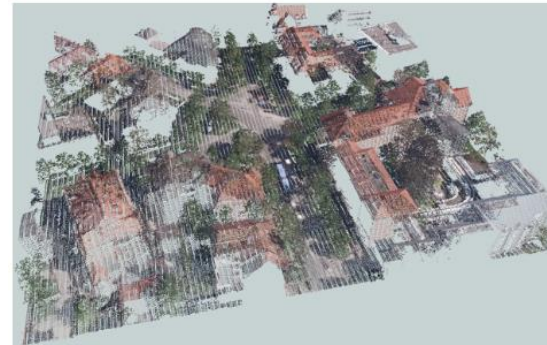
► There are different types, for example:

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*)**
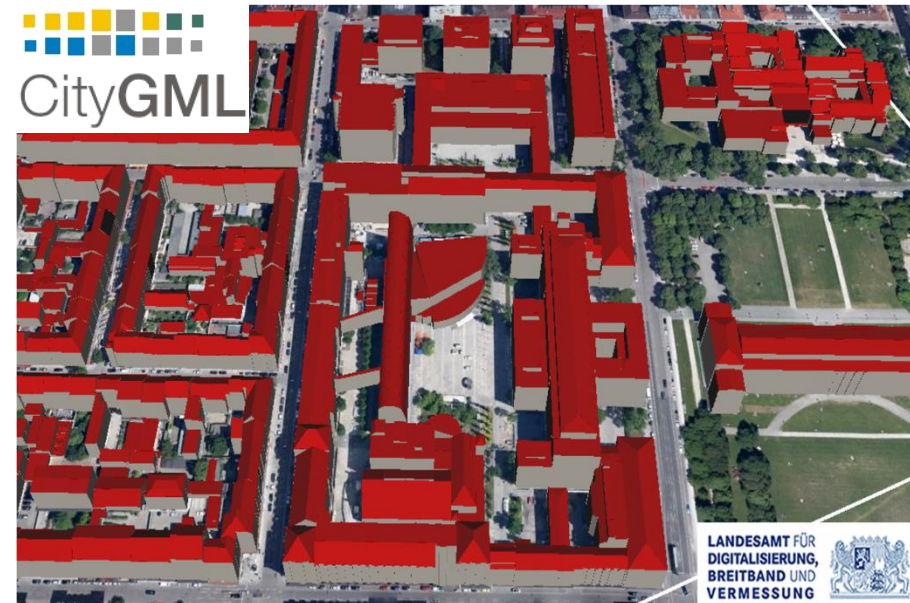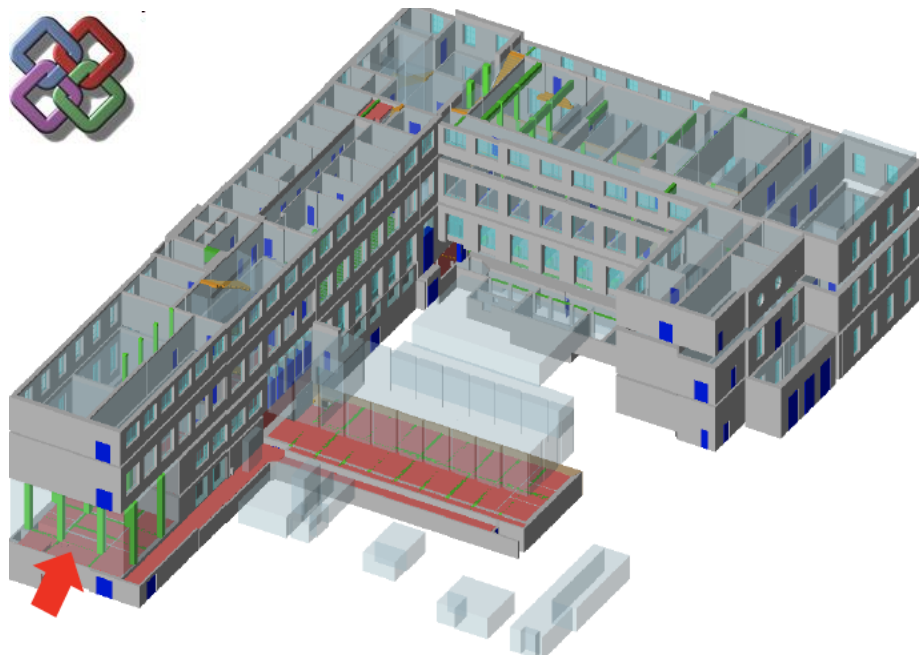
Is this it?

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
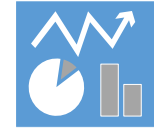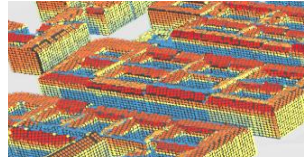

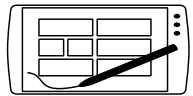Noise dispersion simulation
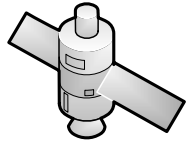
Satellite sensors
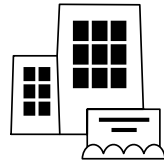

Citizens

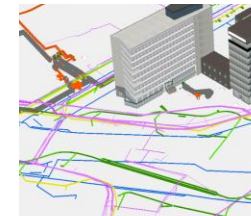Solar potential analysis

Municipality
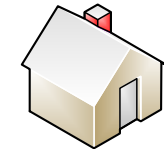

Weather sensors

City Dashboard
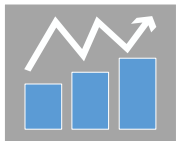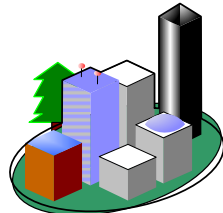

Real estate firms

Citizen engagement

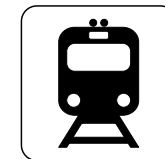Networks

Energetic building refurbishment

Energy demand estimation

Virtual 3D City model
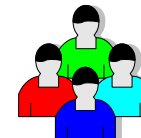

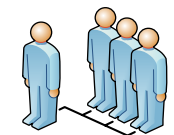Flood simulation

Transportation service providers
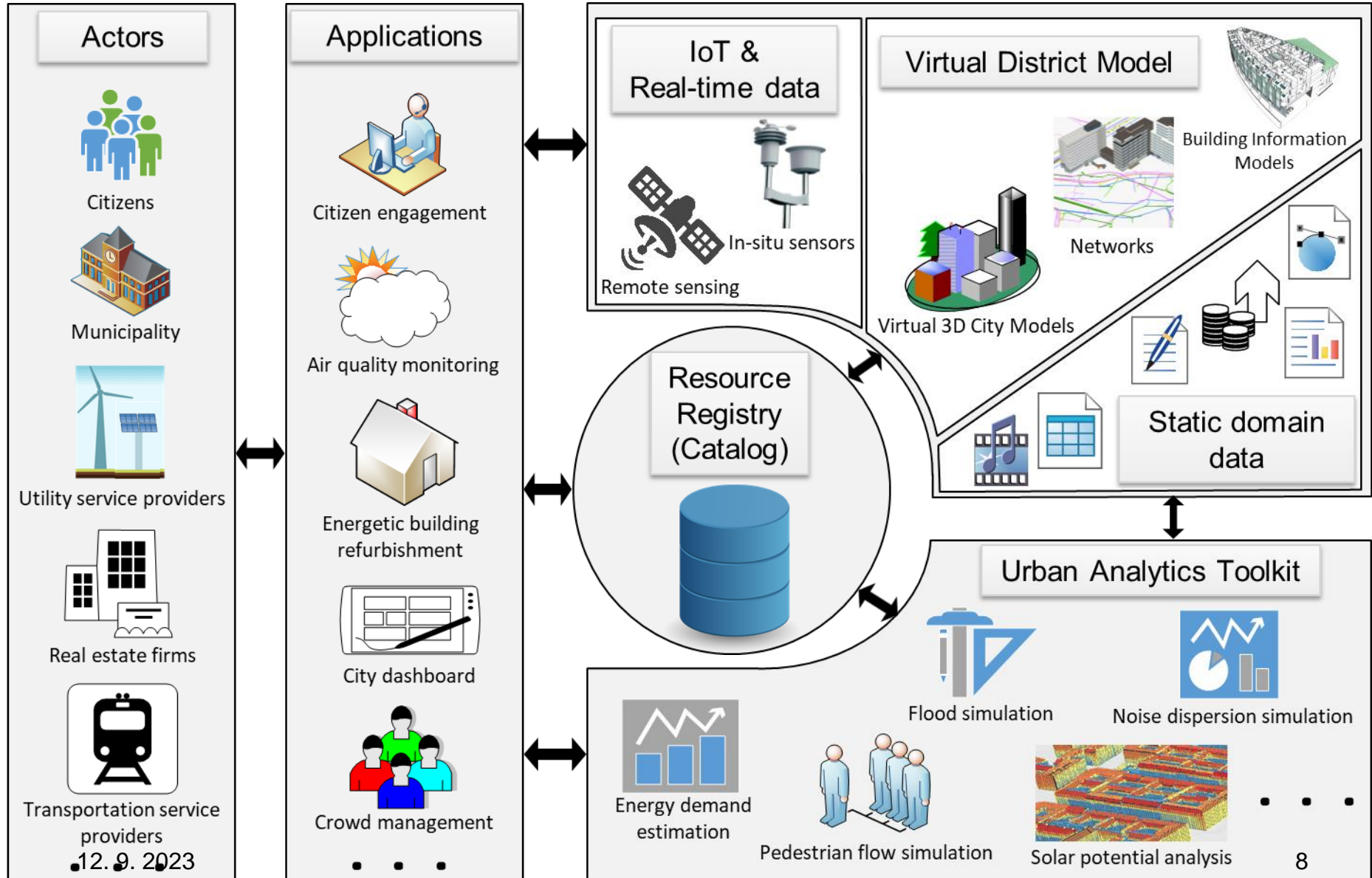

Air quality monitoring

Utility service providers
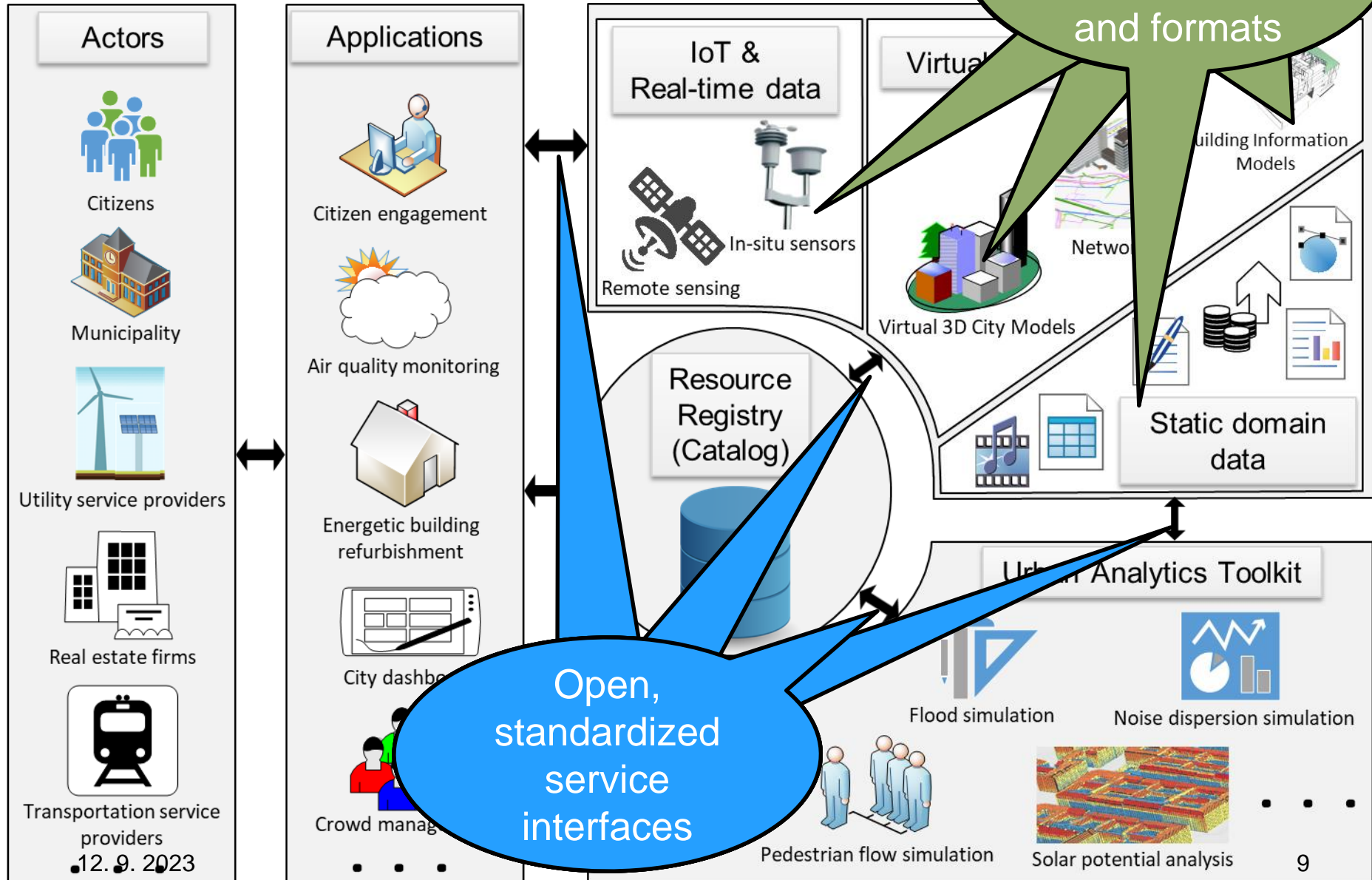

Crowd management

Pedestrian flow simulation

Smart District Data Infrastructure (SDDI)

Smart District Data Infrastructure (SDDI)
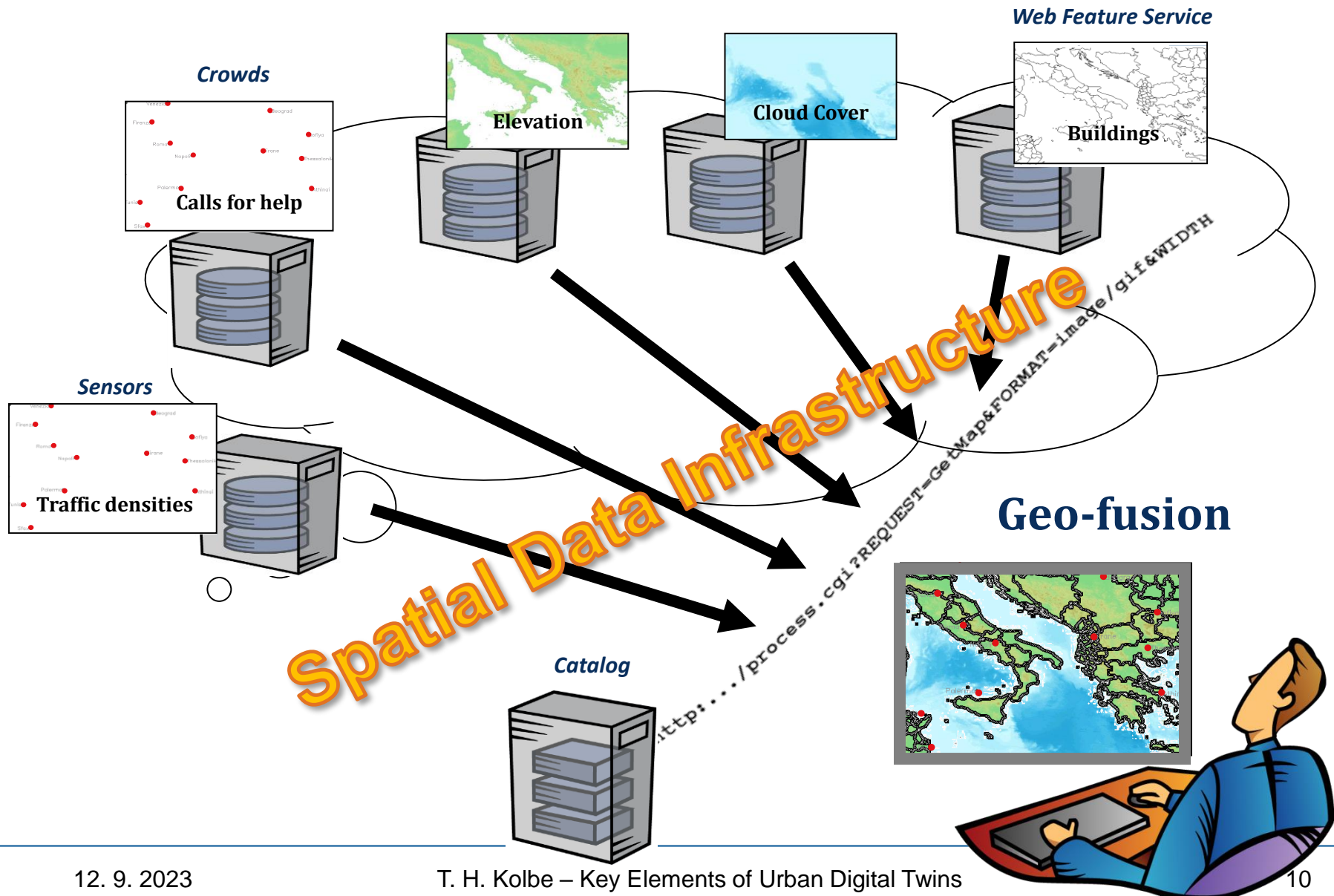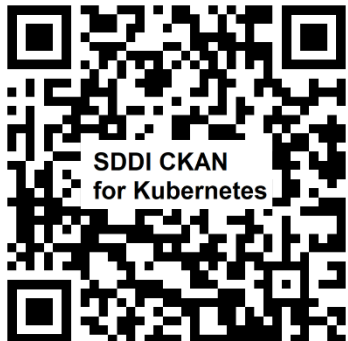
Smart District Data Infrastructure (SDDI)

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

SDDI CKAN for Kubernetes

SDDI ckan-docker

Examples for running SDDI Catalog instances

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

▶ Link to an open, running catalog for the project SAVeNoW:
https://catalog.savenow.de/ *(Give it a try!)*
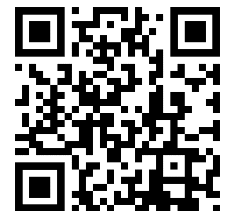
Implementation of the SDDI with model regions in Bavaria

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:

- 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**

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**