



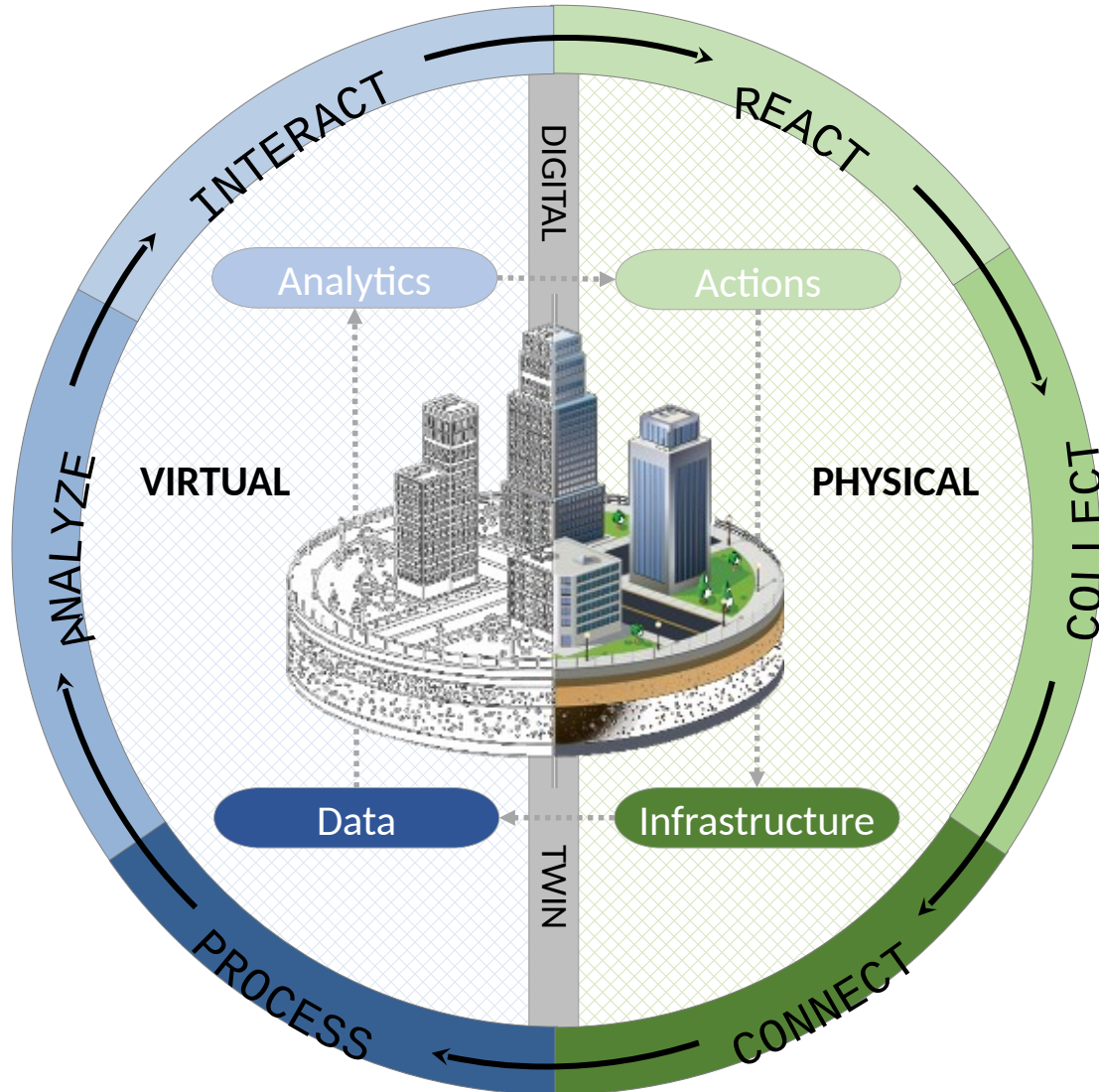
# Urban Digital Twins and Data Spaces: Shaping the Future of Sustainable Cities

Prof. Dessislava Petrova-Antonova  
GATE Institute, Sofia University

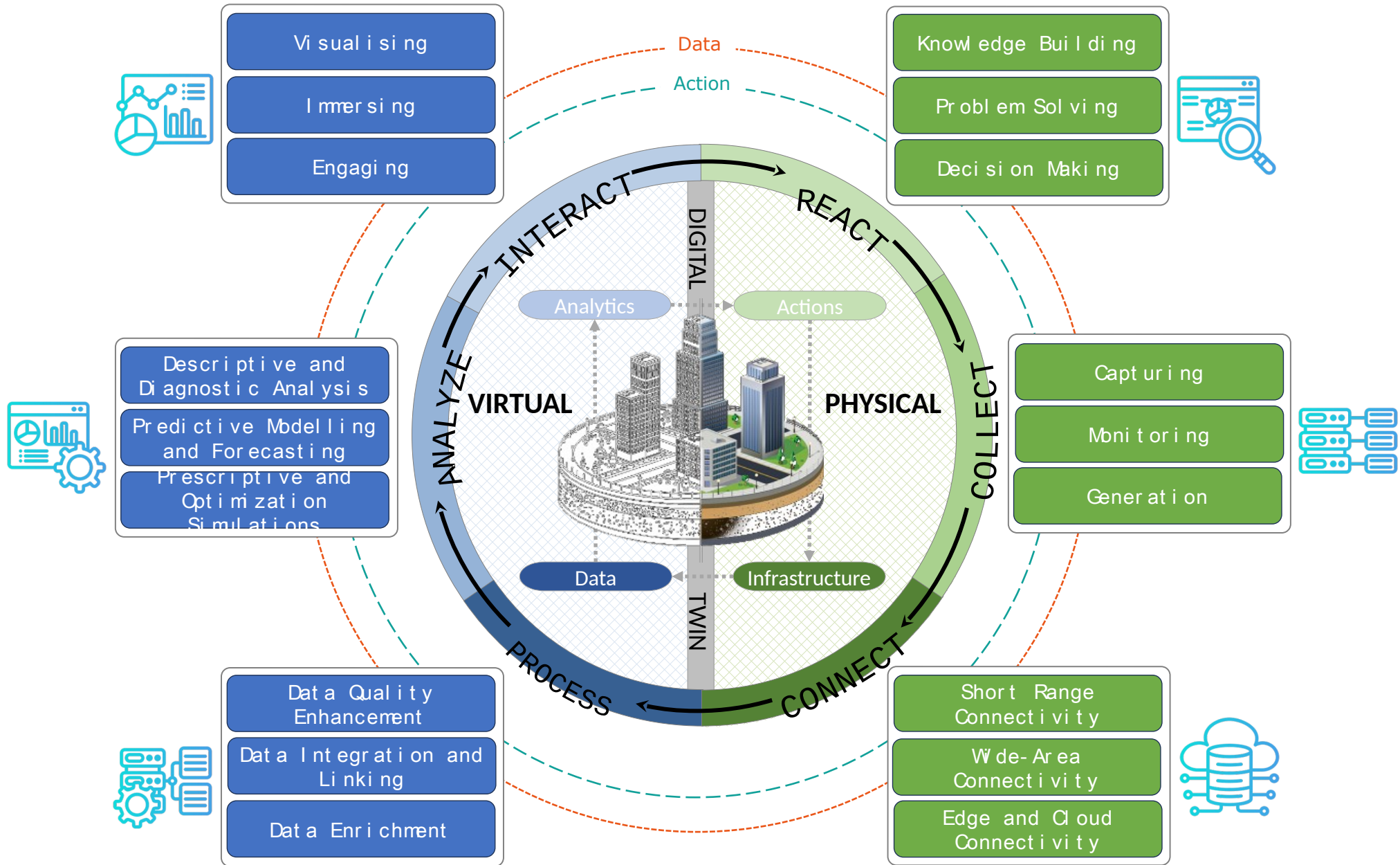
1 May 2026



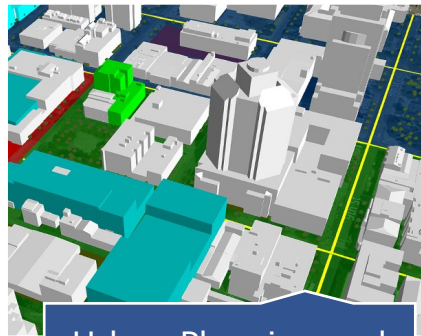
# Urban Digital Twin in Action



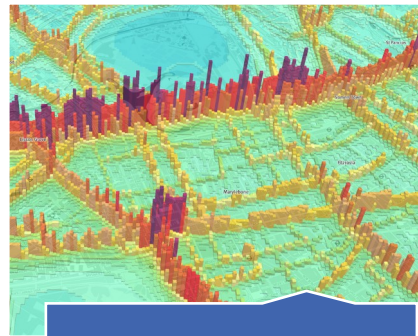
**to be  
reactive  
to near-  
real-time  
changes**



# Digital Twin Use Cases



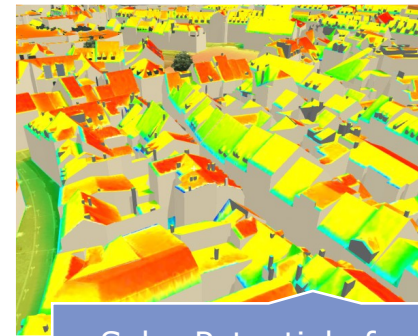
Urban Planning and Design



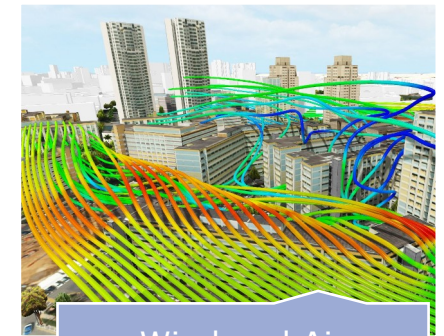
Air Quality Prediction



Energy Demand of Buildings



Solar Potential of Buildings



Wind and Air Pollution Simulations



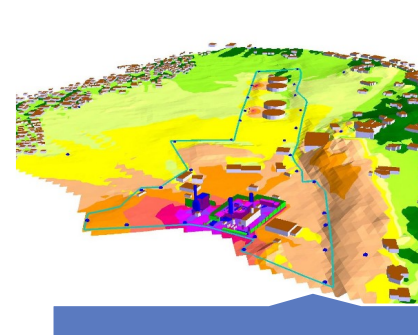
Urban Heat Island



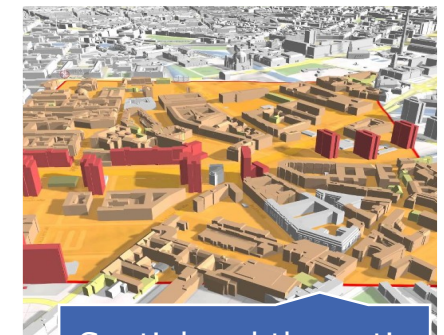
Accessibility and Walkability



Transportation Planning and Impact

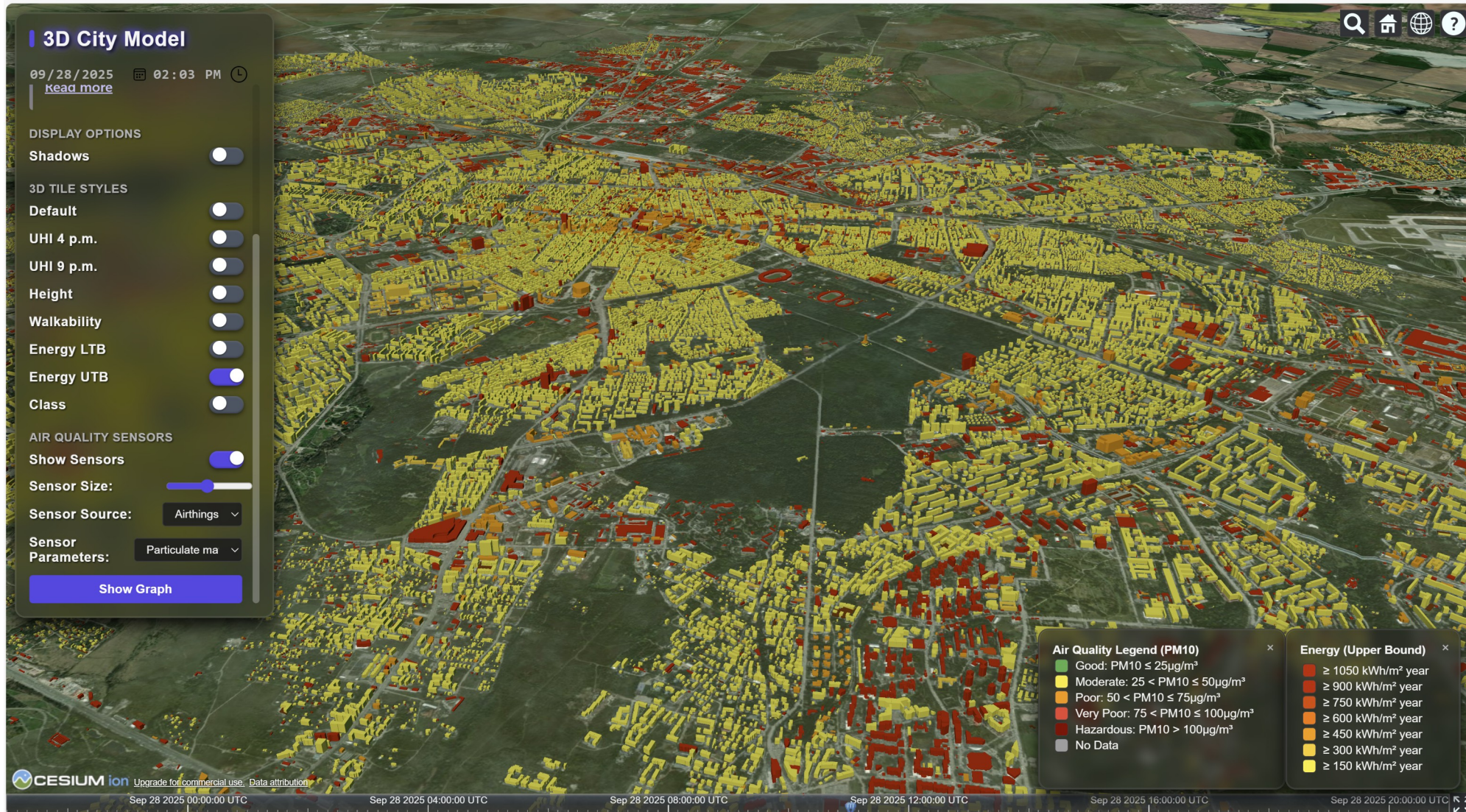


Noise Propagation

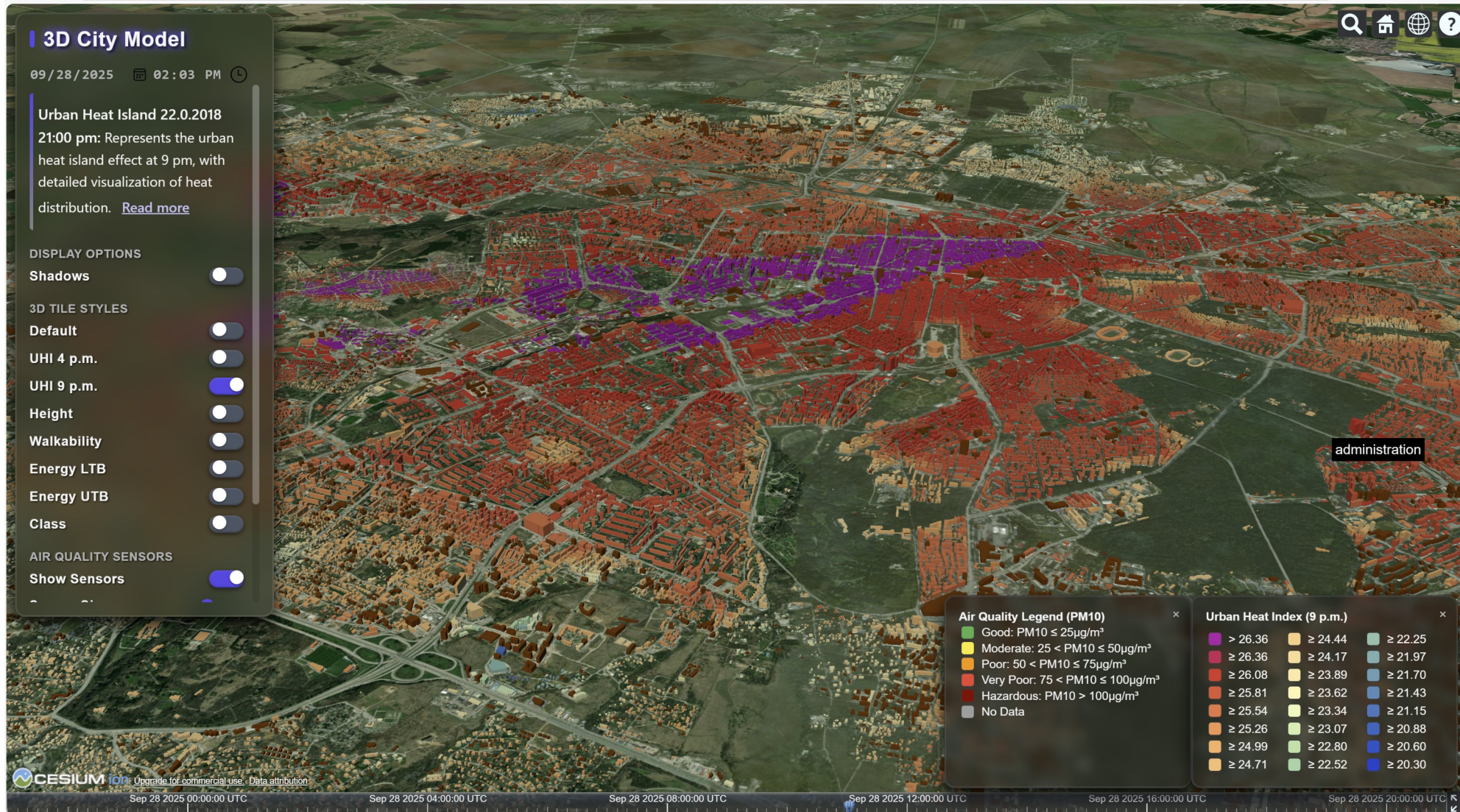


Spatial and thematic queries

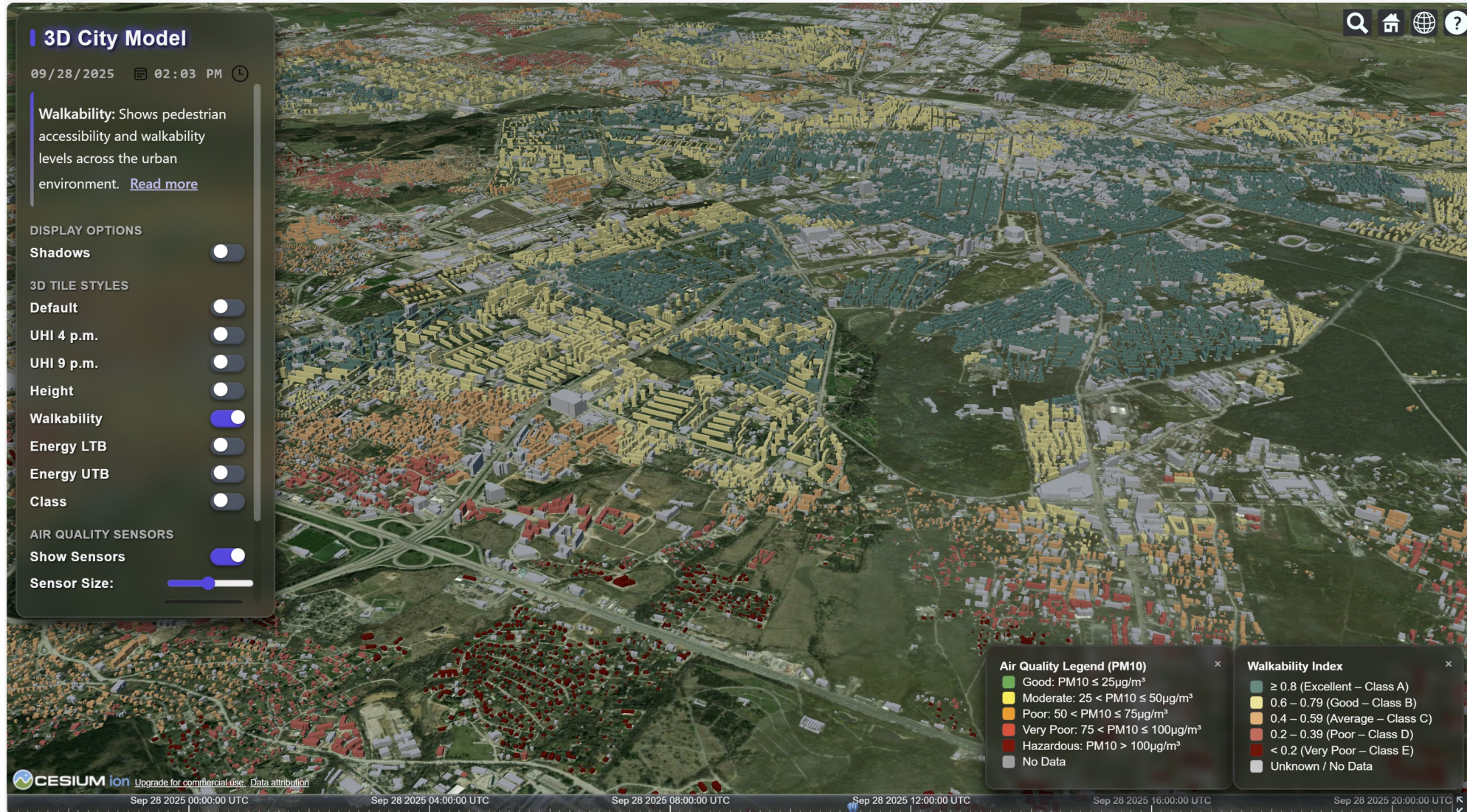
# Energy Consumption @ 3D City Model



# Urban Heat Island @ 3D City Model



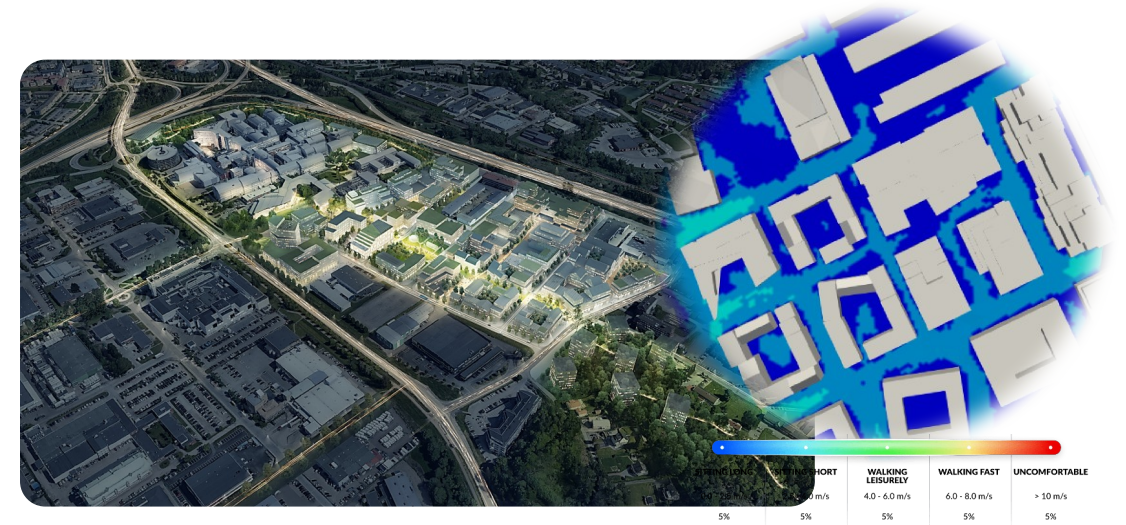
# Walkability @ 3D City Model



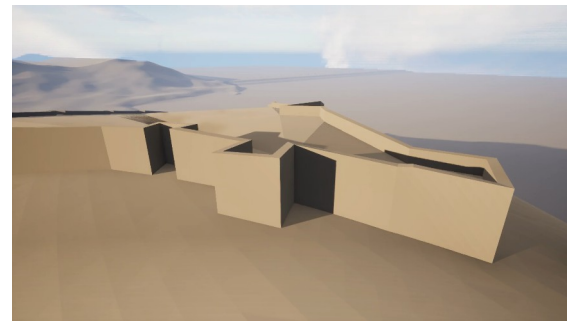
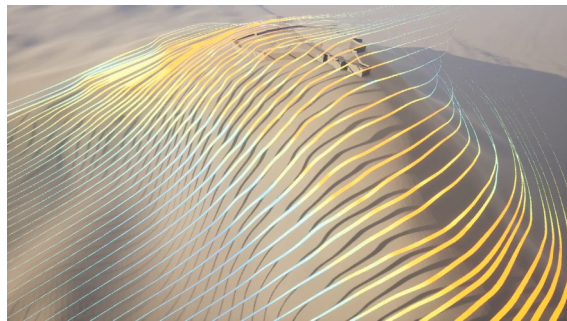
# Urban CFD Applications and Use Cases



GATE Institute area, Bulgaria



GoCo area, Sweden



Mytilene Castle, Greece



Wind tunnel testing experiment



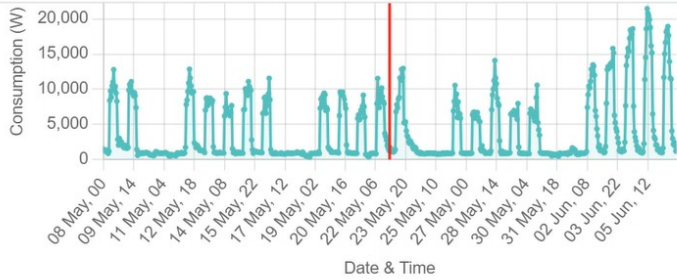


# CFD Wind Simulation @ Unreal Engine

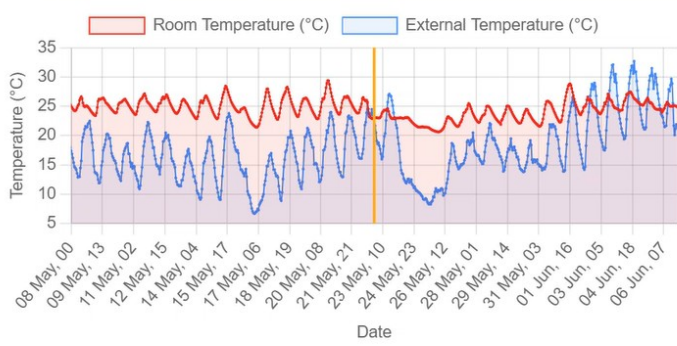




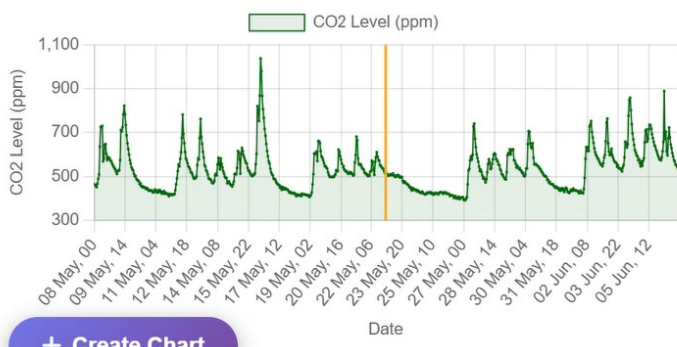
# GATE Building Digital Twin



Temperature history: ДЕЛОВОДИТЕЛ И ДОМАКИН



CO2 Levels: ДЕЛОВОДИТЕЛ И ДОМАКИН



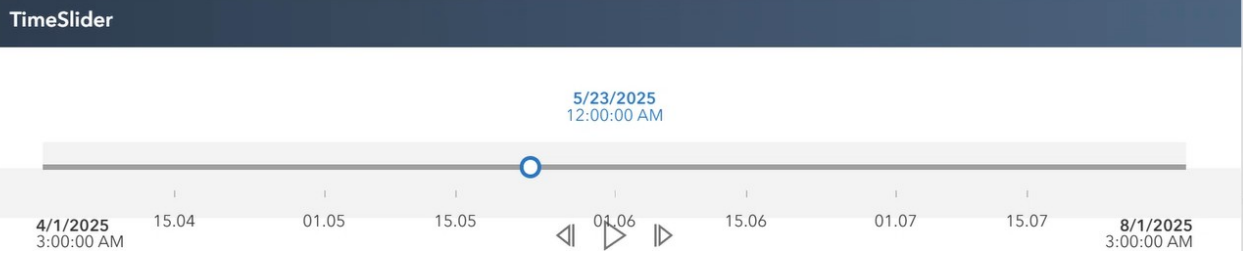
+ Create Chart

- Layer selection
- Temperature
  - CO2
  - Solar radiation
  - BIM model
  - Shadows
  - HVAC points
  - HVAC Lines

Temperature  
**External: 21.9 °C**  
**Room: 23.03 °C**



Esri, TomTom, Garmin, GeoTechnologies, Inc, METI/NASA, USGS | Sources: Vantor, Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, N... Powered by Esri



### GATE BUILDING IN NUMBERS

RESEARCH BUILDING

<b>50 kWp</b> PV SYSTEM	<b>60 kWh</b> BATTERY	<b>25</b> SERVERS
----------------------------	--------------------------	----------------------

**ENERGY SYSTEM**

Panels	92 x 548 W
Orientation	East-West, 15° tilt

**IT INFRASTRUCTURE**

- 25 Servers for GATE Data Platform
- Sensor Data (CO2, temperature, humidity) via 41 measurement points.

**AUTOMATION**

Integrated BMS including 67 presence sensors, 84 blind controllers, and 58 local control modules with manual adjustment buttons and/or activation of predefined scenarios. Includes 450 communication power supply units for the existing lighting fixtures.

Heated Area	3002 sq.m.
Occupancy	~ 60 Employees



GATEBOT



What is the weat... (x)

What is the reas... (x)

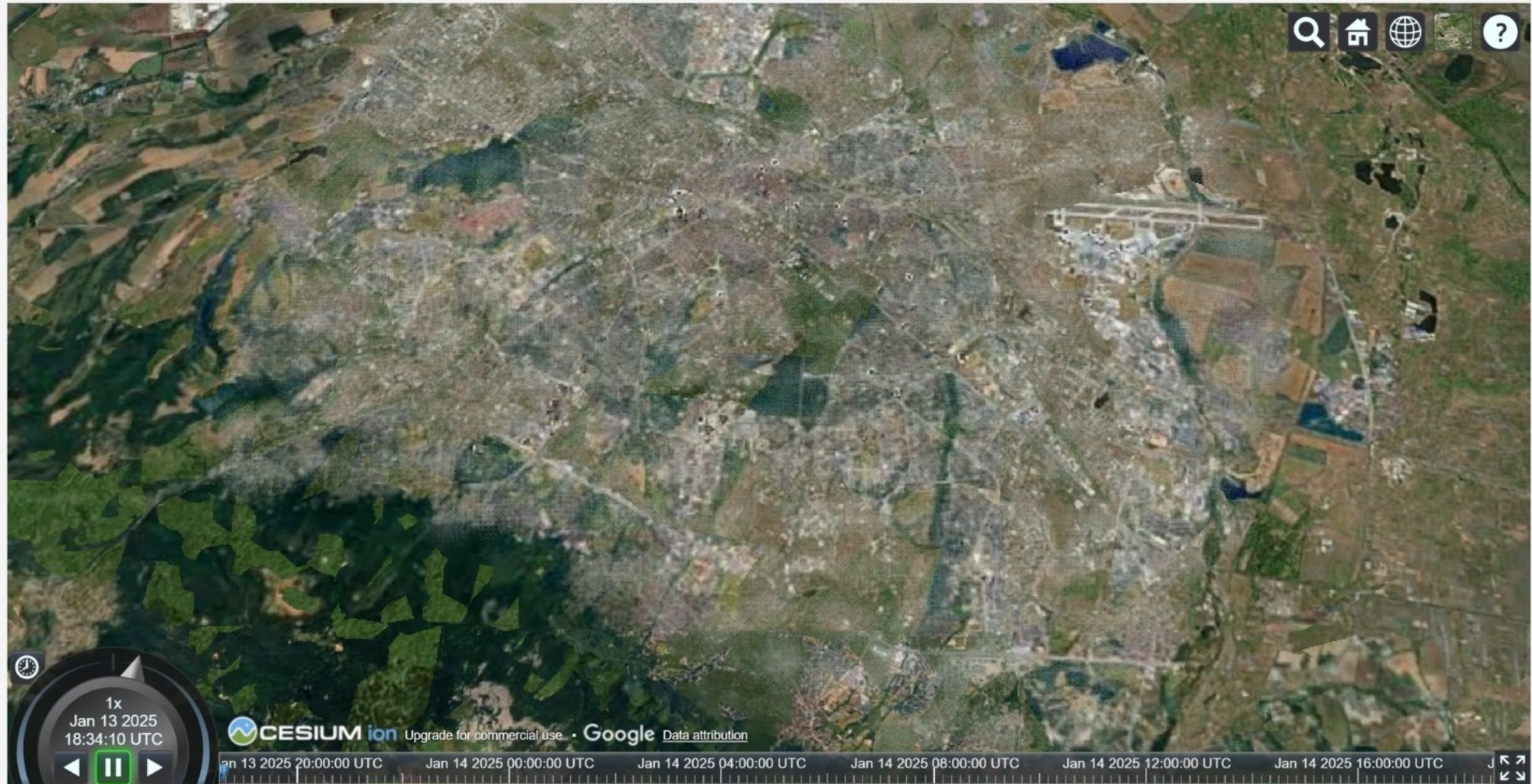
Replay the air po... (x)



Hi there, I am Mapster, your friendly assistant at the GATE Institute. What is your next map-tastic job for me?



Type here or mash the mic.



# Urban Digital Twin @ Data Space



Physical City



Data space



Virtual City

One-Stop-Shop for Data | Trust, Transparency and Sovereignty | Security | Added Value

# GATE | DSA Hub

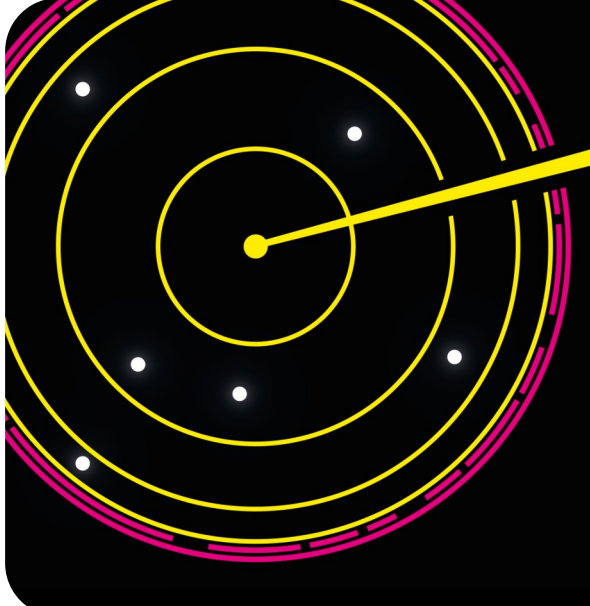
## INTERNATIONAL DATA SPACES ASSOCIATION



**Bulgaria: Big Data for Smart Society Institute (GATE)**





The IDSA Hub in Bulgaria is facilitated by the Big Data for Smart Society Institute (GATE) in Sofia. GATE is the first Centre of Excellence in Bulgaria to work on scientific excellence and innovation in big data and artificial intelligence. It was established in 2019 as an autonomous structure of Sofia University "St. Kliment Ohridski". The team around Director Prof. Sylvia Ilieva is focusing on knowledge transfer on data sovereignty and IDS components into the Bulgarian industry and research community.

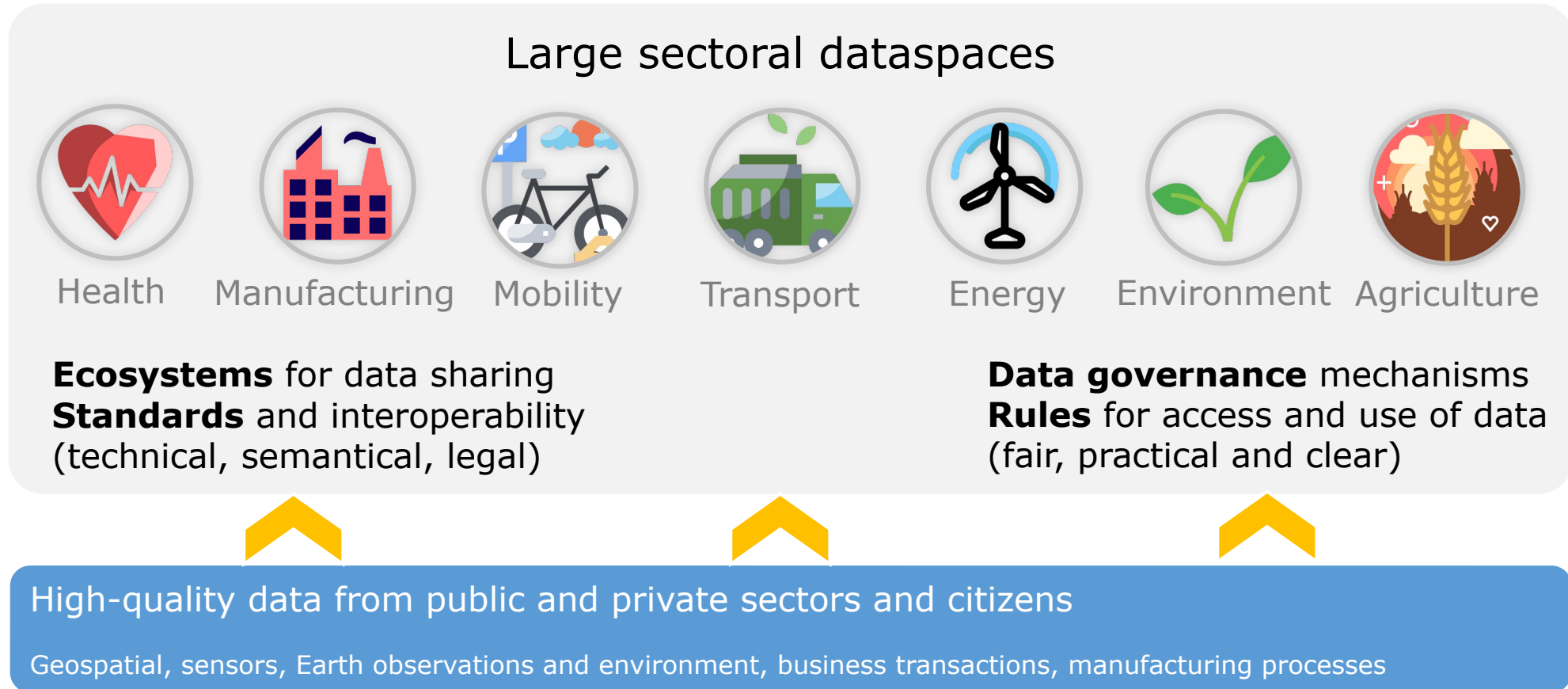


**Data Spaces  
Discovery Day –  
Business value of  
sovereign data sharing**

Sofia | November 9, 2022



# European Dataspaces



# Unique Selling Proposition

## Economic

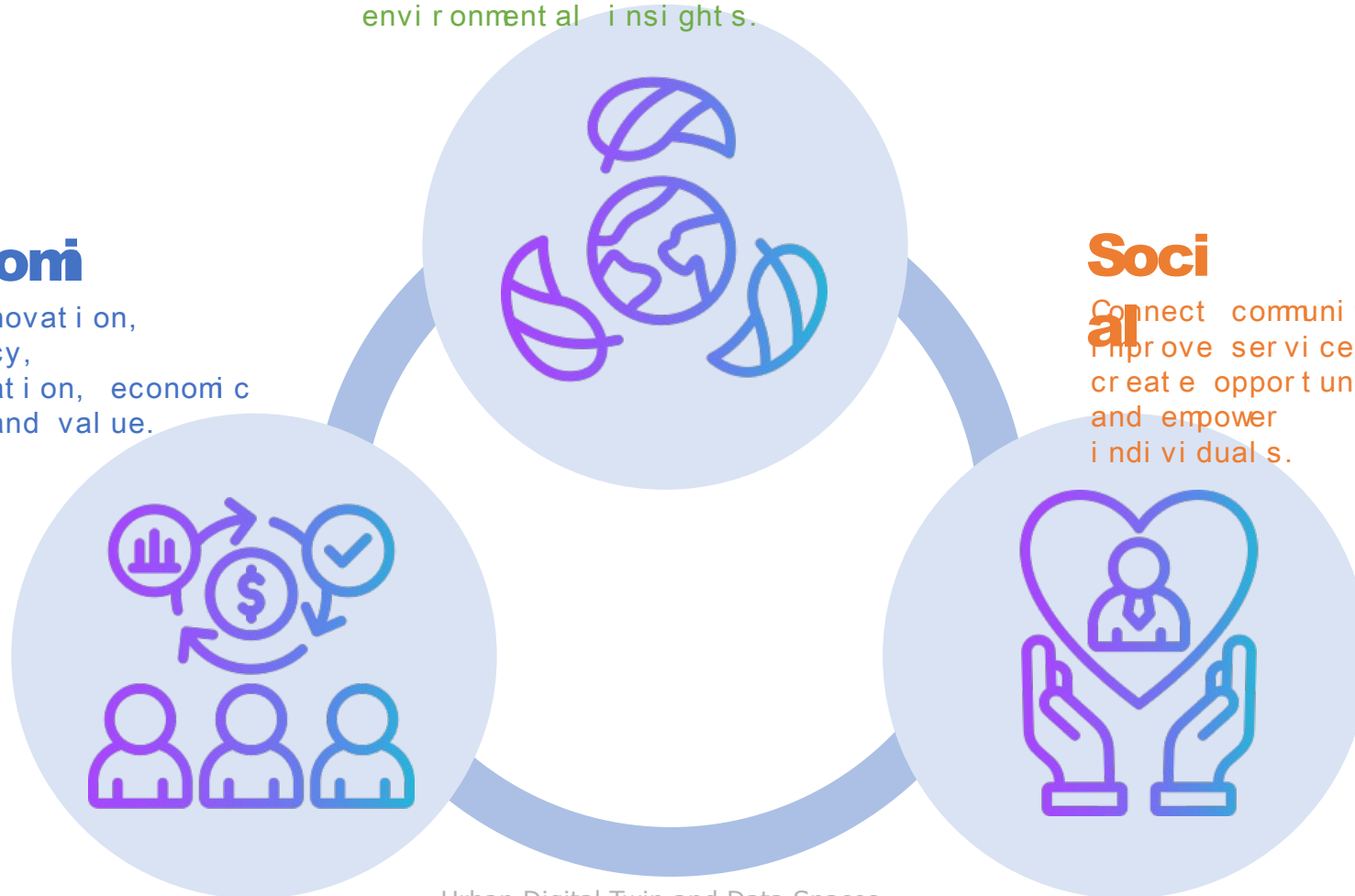
Enable resource optimization, reduced waste, sustainability, and environmental insights.

## Economic

Boost innovation, efficiency, collaboration, economic growth, and value.

## Social

Connect communities, improve services, create opportunities, and empower individuals.



# Data Space Building Blocks

## Technical Building Blocks



### INTEROPERABILITY

Data Models

Data Exchange

Provenance and traceability



### SOVEREIGNTY & ATTESTATION

Identity & Attestation Management

Trust Framework

Access & usage control policies



### DATA VALUE

Data, Services & Offerings Descriptions

Publication & Discovery

Value Creation Services

## Business & Organisational Building Blocks



### BUSINESS

Business Model

Use Case Development

Data Product

Intermediaries & Operators



### GOVERNANCE

Organisational Form & Governance

Participation Management



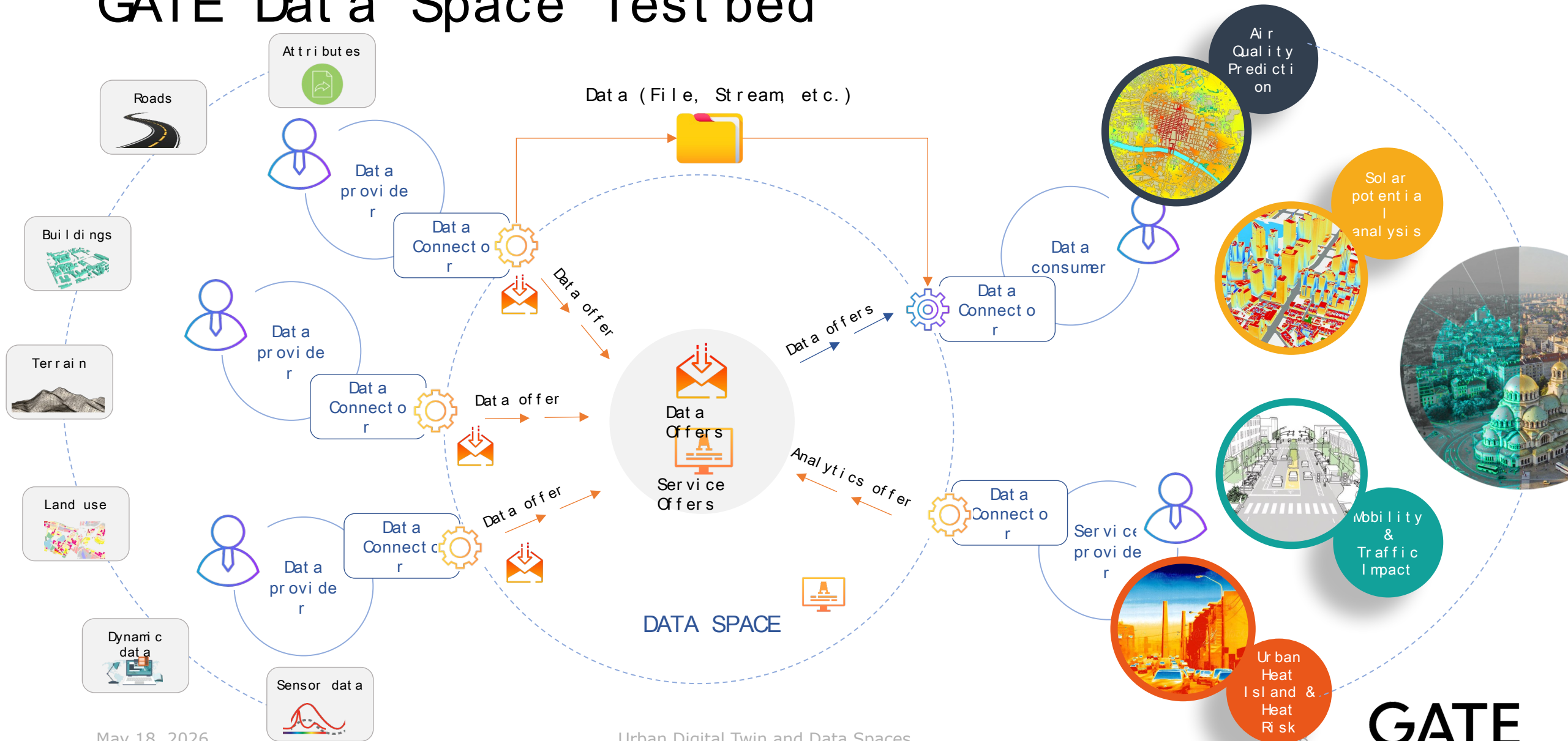
### LEGAL

Regulatory Compliance

Contractual Framework

Source: DSSC, [Data spaces building blocks](#), October 2024

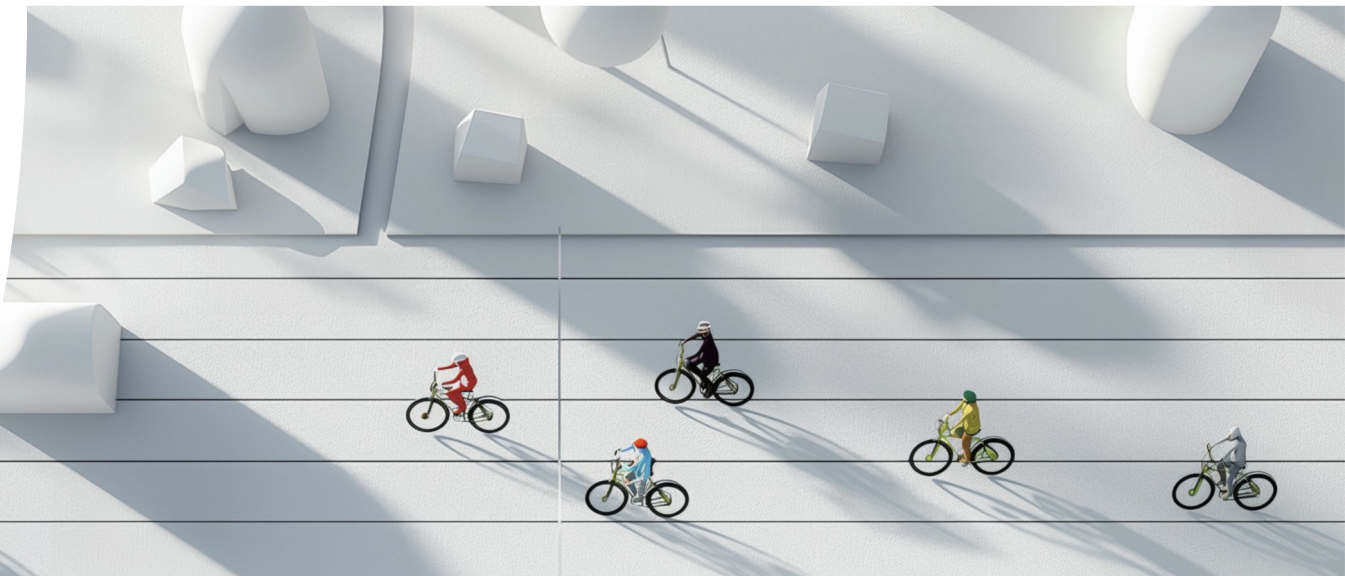
# GATE Data Space Test bed



# Urban Digital Twin Powered by Human-Centric AI

- Adapt
  - Continually learns by itself
- Think
  - Makes strategic decisions
- Talk
  - Chats with people in a natural language

..like a Human



Looking  
forward to  
the future!

Q&A

