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Faculty of Electrical Engineering  
and Computer Science

# Potentials of (geo)spatial intelligence for Recovery of Ukraine

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UM - FERI

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## Statistics:

- Over 30 staff
- Currently 5++ Horizon projects, 4++ National research projects, and many +++ industrial project

### ■ Strategic partners



### ■ Basic research



### ■ Applied research (... only few ...)





# (Geo)Spatial intelligence

*OBJECTIVE: Capturing spatial patterns of behavior*

**END-TO-END Platform with location-based data enrichment:**

■ Monitoring

- Satellite, UAV, IoT, Thematic maps, lab measurements, ...

■ Diagnostics

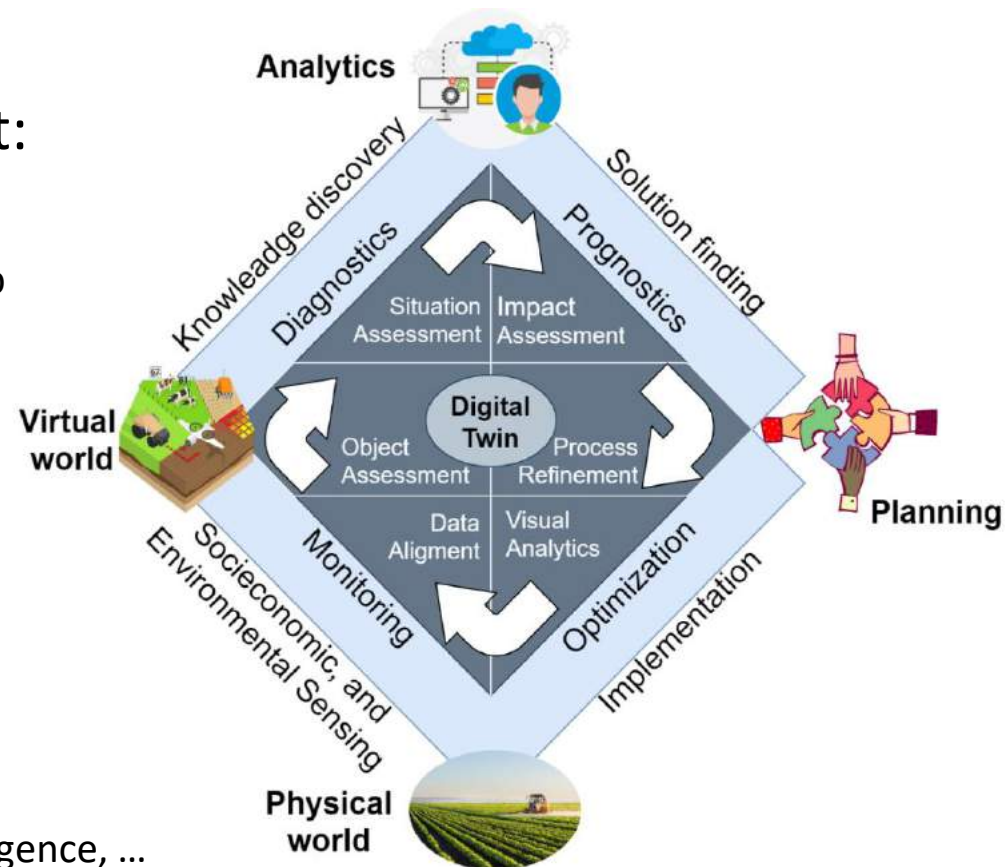
- Classifiers, explainable feature learning, visual analytics, ...

■ Prognostics

- Spatiotemporal regressions, context learning, ...

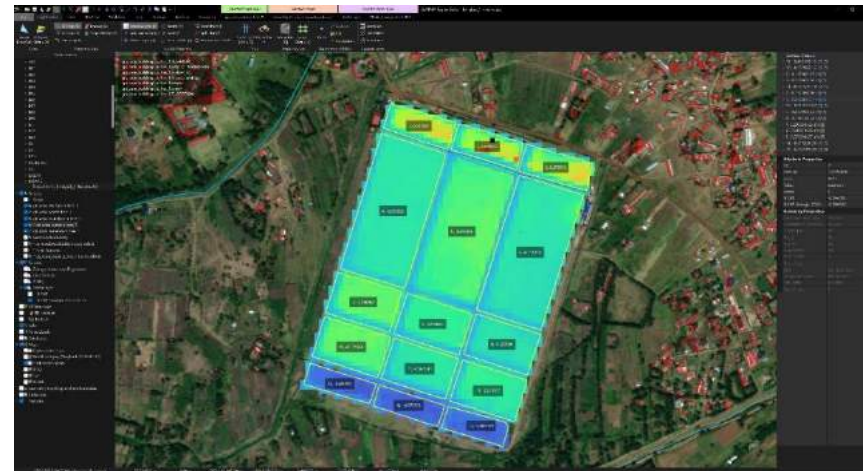
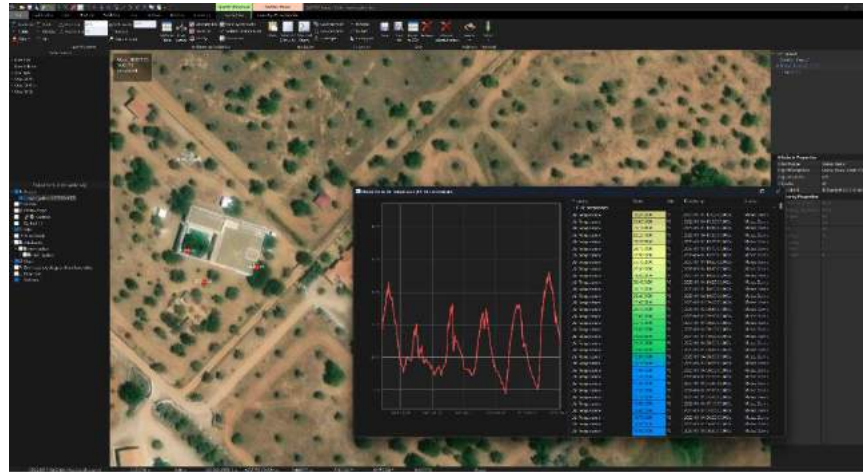
■ Optimizations

- Evolutionary algorithms, swarm intelligence, ...





## *Improving Agro-ecological practices in East Africa with a focus on Circular water-energy-nutrient systems*



### Global indicators:

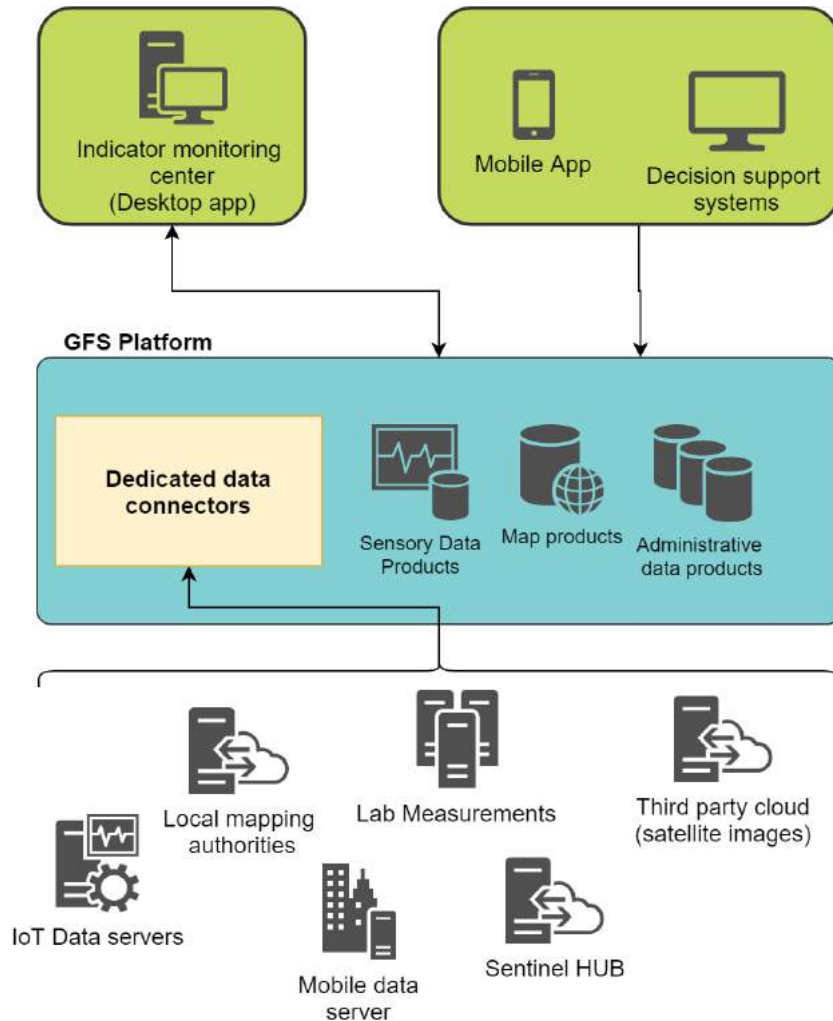
- GHG emissions, soil health status, organic matter, crop development, ...
- Data sources: Sentinel, LandSat, ...

### Socio-economic:

- Number of farmers, income, farm sizes, biodiversity, ...
- Data sources: UN, world bank, national environmental agencies, mapping authorities, ...

### Farm data:

- Water PhD, nutrient compositions, Water use efficiency...
- Data sources: IoT, lab measurements, farmers' assessments, ...



*OBJECTIVE: Energy-efficient  
AI-ready Data Spaces*

## ■ Computer Understandable Data Catalogue

- APIs to all data sources
- Metadata with data schemas, access rights
- User management and data selling/buying services

## ■ Autonomous data producers

- No data harmonization
- Data distribution responsible for QA

## ■ Data users

- Obtain a „token“ for accessing the data
- Apply their own data transformation to feed the data in their own AI



This project has received funding from the Horizon Europe research and innovation programme under the GA 101070416.



# Smart farming and water management

*OBJECTIVE: Optimize usage of fertilizers, pesticides, and water in farming*

## ■ Monitoring

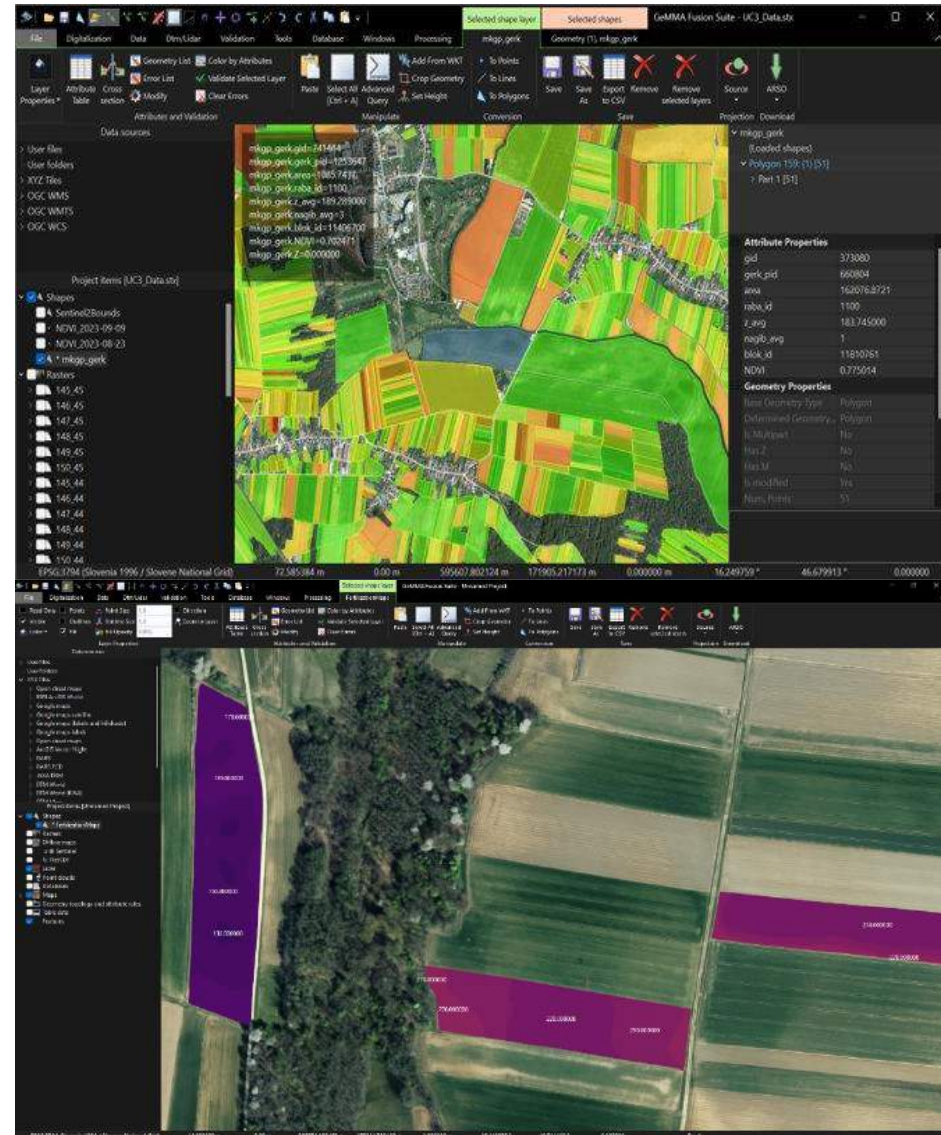
- Satellite images, weather data, soil lab test, IoT water monitoring, ...

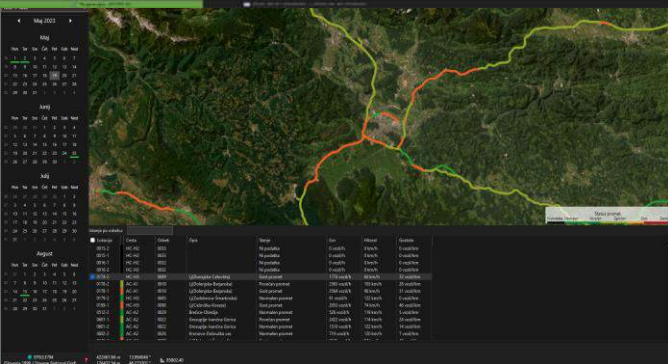
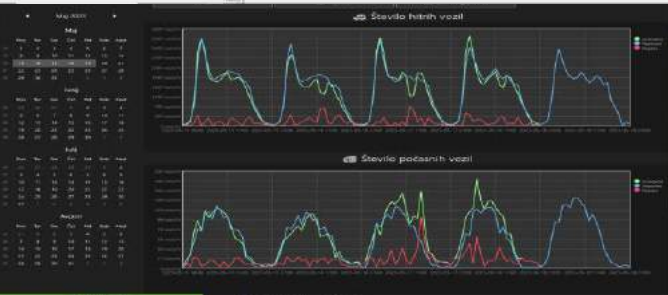
## ■ Diagnostics

- Water health status
- Soil organic matter
- Crop pests and disease detection

## ■ Data products and services

- Spraying maps
- Irrigation parameters





## Traffic prediction services

*OBJECTIVE: Improved maintenance planning and passenger information services*

### ■ Monitoring

- Real-time traffic counters, video traffic speed monitoring, weather data, national holidays in neighboring countries, ...

### ■ Diagnostics

- Real-time traffic jam detection

### ■ Prognostics

- Traffic and travelling time prediction

### ■ Data products and services

- Prediction maps as input into planning
- Notifications to passengers

## Vegetation management in powerline corridors

*OBJECTIVE: Reducing costs of asset management*

### ■ Monitoring

- LiDAR, soil-health index, shadow maps, whether, work prices,...

### ■ Diagnostics

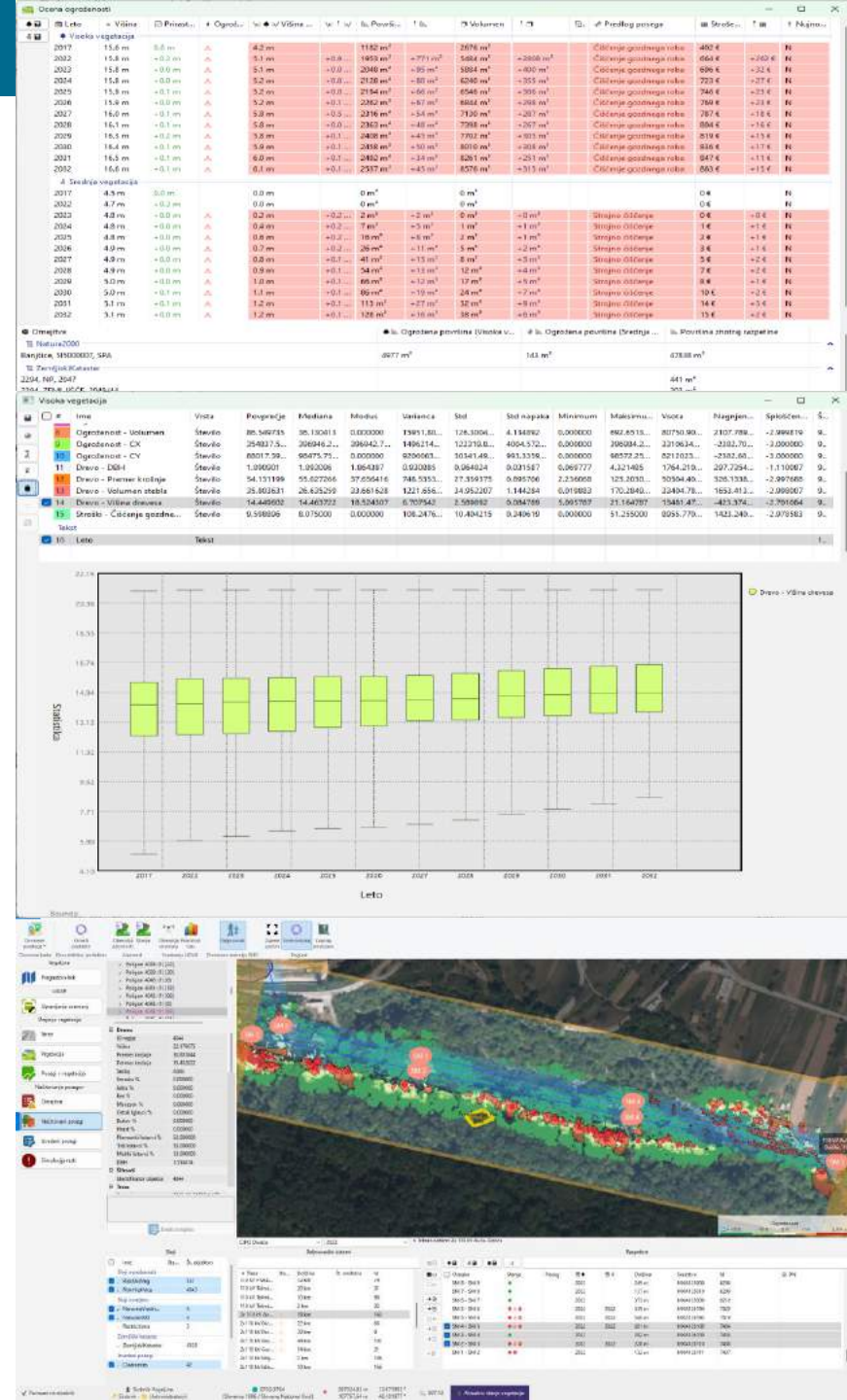
- Detection of encroaching vegetation

### ■ Prognostics

- Tree growth prediction

### ■ Optimization

- Issuing optimized working orders







## Real-time map generation

*OBJECTIVE: Improved military tactical capabilities*

### ■ Technology base

- Real-time UAV video processing
- Recognition of civil/military personnel, vehicles, and buildings
- Map generation and distribution < 3 sec.

### ■ Today's developments

- Model learning support tool
- Vertical federated learning for extending applicability to multiple video streams

### ■ Plans for tomorrow

- Support for civilian use-cases (e.g. searching for casualties)



## Real-time map generation

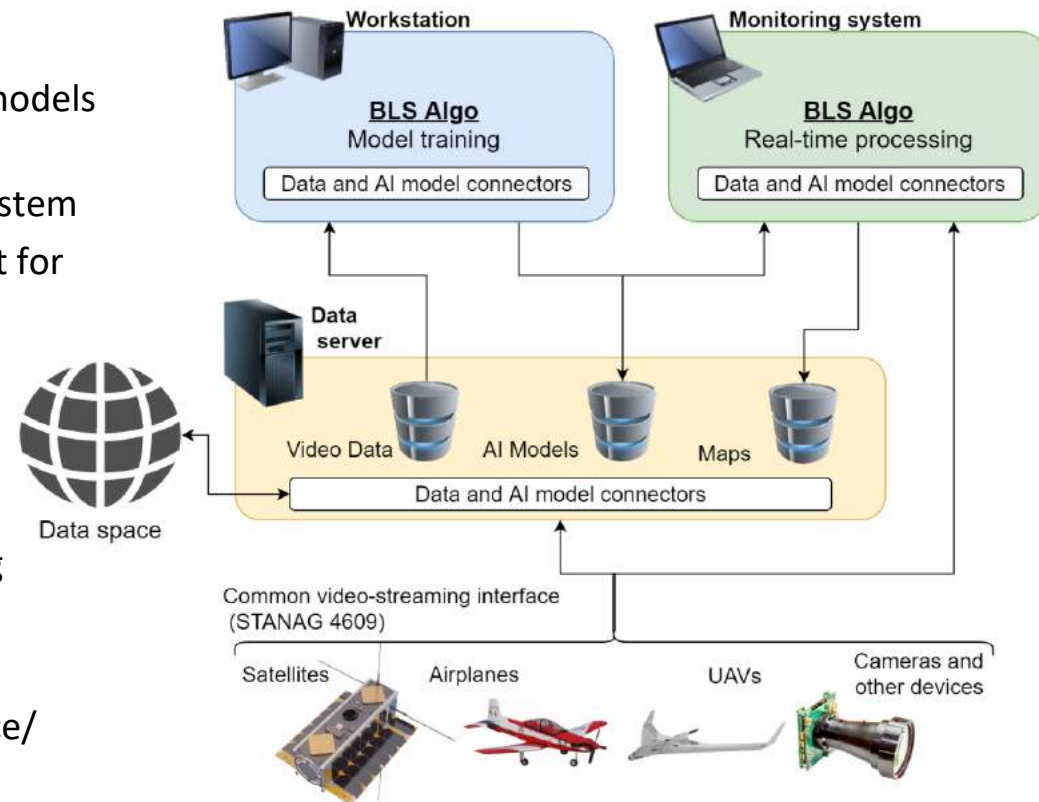
*OBJECTIVE: Improved civil operations*

### ■ Key system components

- Dedicated tool for rapid training of AI models with transfer learning support
- Full map generation and distribution system
- Edge device with run-time environment for on-board real-time video processing

### ■ How it works

- Use existing videos to generate training samples
- Tune existing or train a new AI model
- Submit the model to RTE on edge-device/laptop/workstation for processing
- Register a video stream from the UAV
- Fly UAV and a standardized map of detected objects is generated automatically





## Real-time map generation

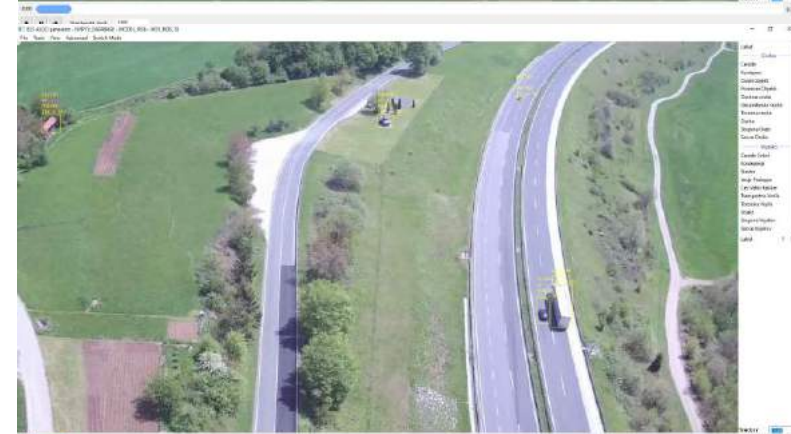
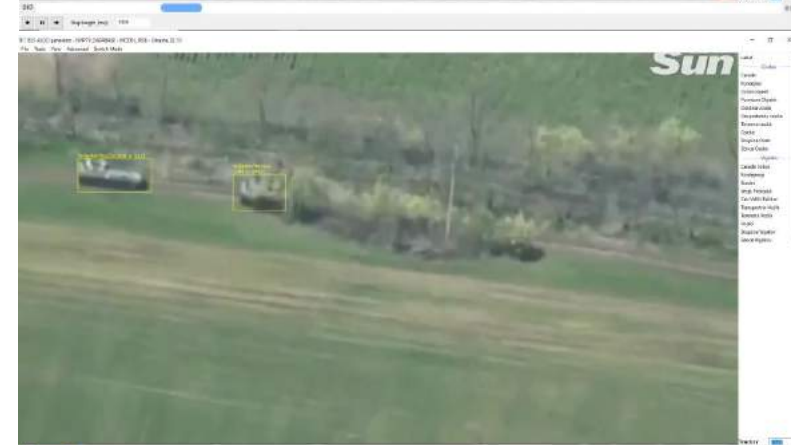
*OBJECTIVE: Improved civil operations*

### ■ Existing AI models

- Support STANAG 4609 standard
- Supported streams: RGB, IR, Thermal, ...
- Supported classes: civil and military personal, buildings, and vehicles with cannons of different calibers (S, M, or L)

### ■ Current capacities

- Over 20 frames can be processed in a second
- Over 50 objects can be detected and tracked over consecutive frames at the same time
- A new map can be generated every second
  - Distribution ensured over standardized OGC services





- Data available all over the place ...
- Solutions are (partially) available ...
- Waiting for data spaces to come to life ...

## Questions welcome...