



Transformers | Motors | Generators

| 19-21 May 2026

● A Hyve Event

Integrated Asset Intelligence for Next-Generation Transmission Systems: SAMSTEO

LoRaSi d.o.o | Crnogorski Elektroprenosni Sistem AD (CGES)

The Agenda

- 1. Introduction**
- 2. Montenegro's Power Grid**
- 3. The Edge Layer**
- 4. The Cloud Layer**
- 5. Impact, Results & Future**

CWIEME
BERLIN

Transformers | Motors | Generators

19-21 May 2026

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Who we are



365 days

From Research to
Pilot

1 year, 2 grants

Two national
fundings

Live PoC

Anomaly detection
of Montenegro HV
lines

Our Partners and Affiliations



Meet the Team - LoRaSi

Milan Marić, CEO @ LoRaSi

- M.Sc in Electronic Engineering from University of Montenegro
- 40+ years of work on Digital Transformation projects
- 20+ years of leading and implementing projects such as e-Government, electronic identification, National IDs, e-Trust, e-Chamber, Parliament of Montenegro etc.
- 10+ years of contribution to the academic community, presenting innovative projects at scientific conferences (CIGRE, Horizon4Poland, MIPRO, CEGD Bled Forum, Forum on Europe, CeDEM in Austria, NATO workshops, ICEGOV '11 etc.)
- Co-author of Strategy for Digital Transformation Montenegro 2020-2024.
- Montenegro Chair Node of the Millenium Project Washington and board member of the Montenegro-German Business Club DMW
- Granted patent for the project for Electronic identification of voters



Meet the Team - LoRaSi

Danilo Marić, CTO @ LoRaSi

- M.Sc in Electronic Engineering from University of Bologna
- 8+ years of technical and leadership experience in HW-SW development of AI-powered embedded systems, targeting medical, industrial automation and IT sector
- Member of the OPEL Steering Committee of MIPRO Conference
- Technical background includes development of bare-metal projects, complex Linux Stack software, as well as ML on embedded devices
- Co-author of SAMST project and patent in Montenegro



Meet the Team - CGES

Milena Andelić, Transmission Line Maintenance Engineer @ CGES

- Transmission Line Maintenance Engineer at Crnogorski Elektroprenosni Sistem AD (CGES) since 2021
- Graduated from the Faculty of Electrical Engineering at the University of Montenegro in September 2021, specialising in Electrical Power Systems.
- Fluent in English and Russian
- Recognised for her strong team spirit, organisational abilities, and effective communication skills, which she brings to her role in maintaining and supporting Montenegro's transmission network.



Montenegro Transmission System Operator



Crnogorski Elektroprenosni Sistem (CGES)



25 Electrical Substations



59 POWER LINES



1549 km TRANSMISSION NETWORK



190

Employees in
System
Maintenance

48

Employees in
Transmission
Line
Maintenance

23

Employees in
Substation
Maintenance

3

Every third year
for overhaul of
Transmission
Lines

2

Inspection of
Transmission
Lines twice a
year

SYSTEM MAINTENANCE IN CGES

Maintenance of transmission lines is carried out through regular inspections and overhauls. Attention is also given to corridor maintenance due to risks from vegetation and nearby structures. Identified issues are remedied based on condition assessments.

Maintenance of electrical substations is carried through regular overhauls and inspections of circuit breakers and disconnectors. Identified issues are remedied based on condition assessments.

Challenges in Transmission Line Maintenance



Hard-to-reach terrain



**Adverse weather, heavy snowfall,
high frequency of lightening strikes**



Illegal construction in the corridor



**On-corridor and off-corridor
vegetation**



Steps To Enhance System Maintenance



**Implementation and utilization
of new technologies**



Drone utilization



Real-time asset monitoring



Actual Issues That Required A New Approach

Following the LiDAR scanning and software data processing, it was discovered that the tower on OHL 110 kV Podgorica2-KAP vod 2 had deviated from its vertical position.

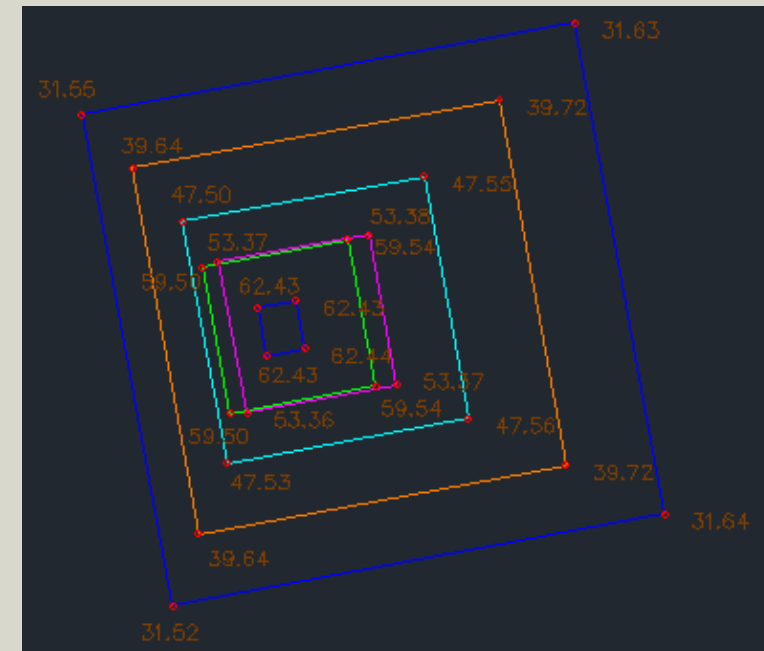
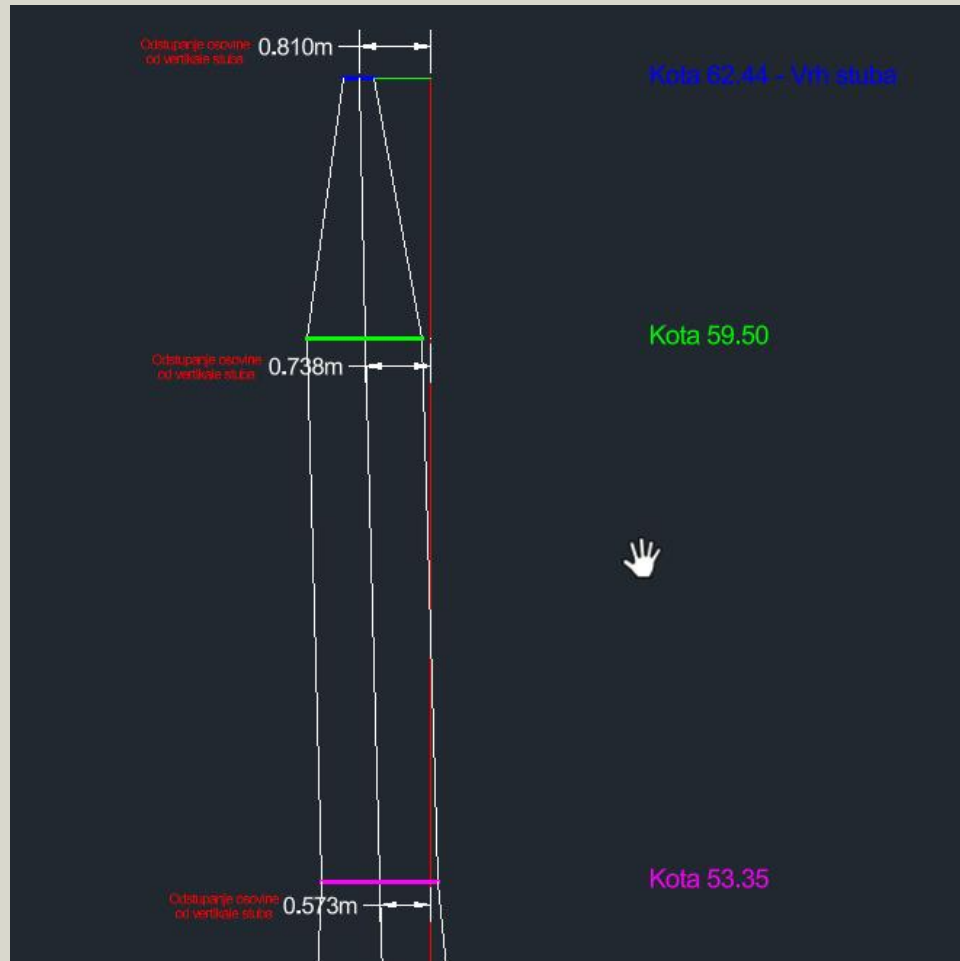
This issue was difficult to detect through ground inspection (on foot inspection).

To monitor the situation, periodic geodetic measurements were performed.

But to enable real-time tracking of the deviation, solution from the company LoRaSi was used.



Actual Issues That Required A New Approach - Geodetic Measurements



The Edge Layer



SAMSTEO Hardware

Precision Sensing: The Grid's Ground-Level Nervous System

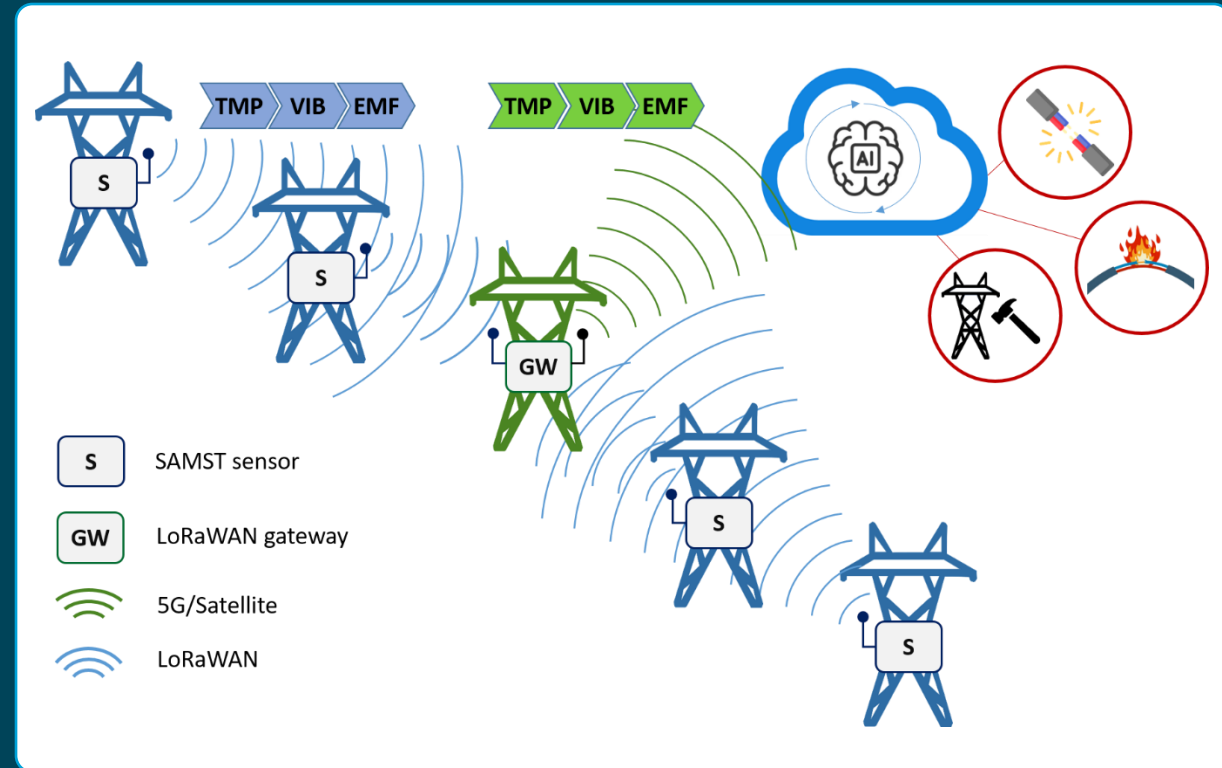
-  **High-Fidelity Multi-Modal Sensing:** Continuous 3-axis vibration analysis, EMF current tracking, temperature and motion detection.
-  **Non-Intrusive Deployment:** Rapid installation on active assets with zero service interruption.
-  **Mission-Critical Ruggedness:** IP67-rated enclosure designed for high electromagnetic interference and arctic alpine conditions.
-  **Maintenance-Free Lifecycle:** Optimized for 10+ years of autonomous operation, eliminating the need for periodic physical inspections.



Connectivity Without Boundaries

LoRaWAN: The Resilient Backbone for Extreme Topographies

-  **Immunity to Signal "Shadows":** While 4G/5G signals are blocked by peak terrain, LoRaWAN mesh penetrates deep valleys with 15km+ line-of-sight.
-  **Ultra-Low Power Footprint:** Consuming 100x less energy than cellular modems, enabling 10+ years of operation on a single battery cycle.
-  **Fail-Safe Data Continuity:** Engineered with multi-layered backhaul redundancy to ensure that high-priority "Asset Intelligence" always reaches the control center, even in case of blackouts.
-  **EMI Robustness:** Specifically engineered to maintain data integrity within the intense electromagnetic fields of 400kV corridors.



The Cloud Layer



SAMSTEO: The Celestial Lens



Orchestrating Earth Observation for Macro-Scale Grid Resilience

-  **Copernicus Sentinel Integration:** Seamless data fusion from Sentinel-1 (Radar) and Sentinel-2 (Optical) for daily, high-frequency environmental auditing.
-  **Corridor-Wide Observability:** The 1GW Submarine Link: Custodian of the record-breaking 433km subsea interconnector with Italy, a flagship for EU market integration.
-  **InSAR Structural Analytics:** Detecting millimeter-scale foundation shifts in transmission pylons caused by landslides or seismic activity from orbit..
-  **Multi-Spectral Analysis:** AI-driven identification of vegetation health and "danger trees" encroachment within safety corridors using NIR bands.

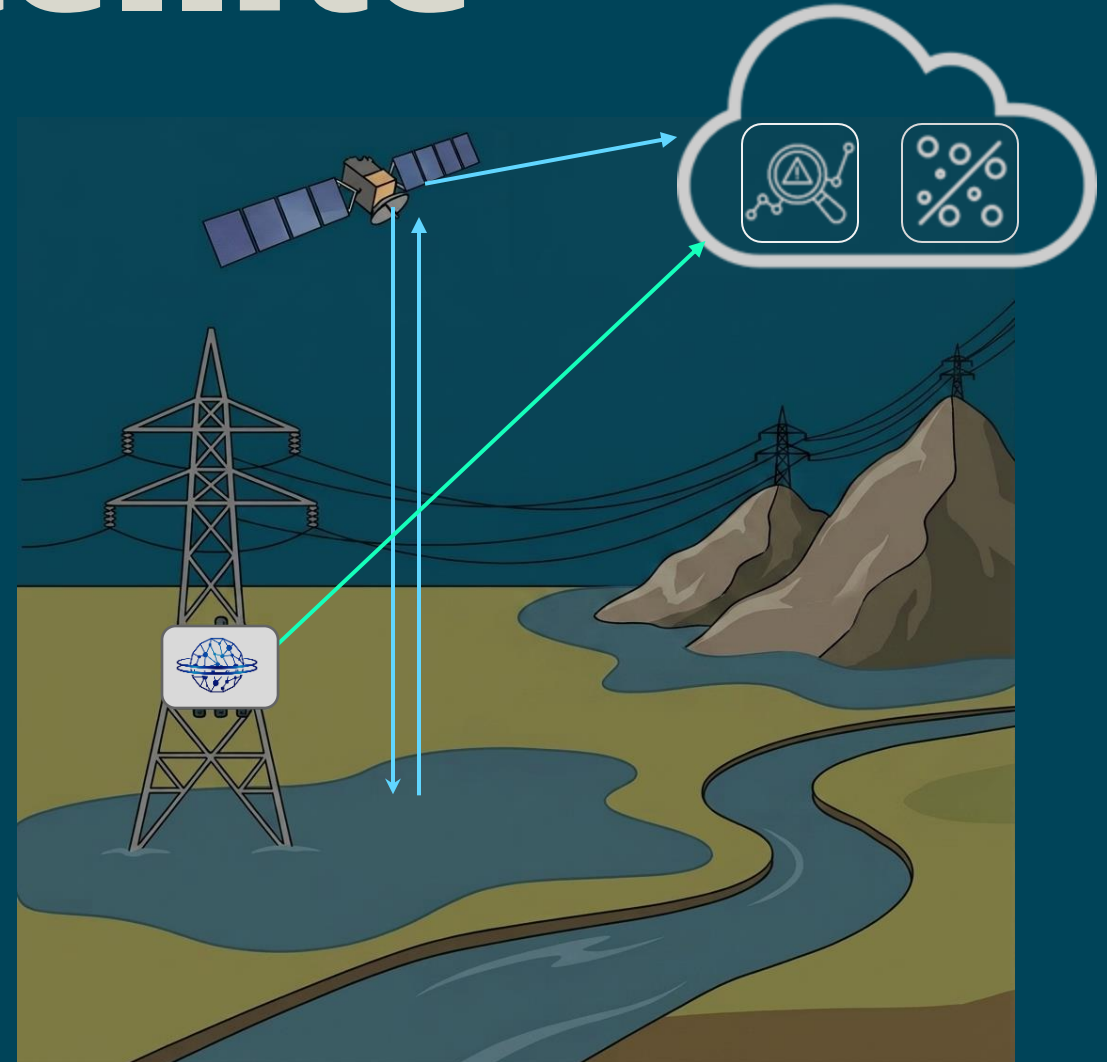
From Space to
Source: Satellite
Data for Raw
Materials



IoT meets Satellite

Autonomous Anomaly Validation Engine

-  **IoT Touch (SAMST Edge)**
Real-time detection of structural tilt, temperature, cable conditions etc. at the physical asset level.
-  **Satellite Vision (Sentinel-1)**
All-weather SAR backscatter analysis confirms soil saturation and flood extent surrounding asset foundations.
-  **The Correlation Logic**
Automated cross-referencing differentiates between structural wear and environmental catastrophe, that can cause severe grid failures.



The Digital Twin

Real-time Observability and Resilience



Total Asset Coverage

Global oversight for every asset across the 1,549 km network, ensuring 100% visibility even in the most remote Dinaric Alps terrain.



Hybrid Monitoring Architecture

Seamless fusion of localized SAMST sensor precision with global SAMSTEO persistent satellite vision.



Predictive "What-If" Simulations

Simulating grid response to emerging environmental trends by injecting real-time sensor data into dynamic global climate models.



Impact, Results & Future



High-Frequency Edge Sensing

Ruggedized Outdoor Intelligence



Precision Tilt ($\pm 0.01^\circ$)

Real-time detection of foundation shifts or structural leaning in the Dinaric Alps.



Motion & Vibration

Sensors capturing galloping conductors, wind fatigue, or unauthorized tampering.



Surface Temperature

Monitoring thermal stress on steel lattices and environmental anomalies.



Extreme Longevity

Ultra-low power design with 5-10 years of battery life for remote, zero-maintenance sites.



Live Demo



Sensor Anomaly Detected!

AN

AWS Notifications<no-reply@sns.amazonaws.com>

To: Danilo Maric

😊 ↩️ ⏮️ ⏭️ ⋮

Sat 1/17/2026 10:56 AM

Anomaly detected!

Device: **ts201**-temp-sens-1 at 2026-01-17T09:54:33.009029801Z

Type: temperature

Payload: {'temperature': Decimal('49.3'), 'battery': Decimal('99')}

PoC Results





Anomaly detected!
Device: pir-light-ws202 at 2026-03-07T03:32:17.658404735Z
Type: pir
Payload: {'light': 'dark', 'pir': 'trigger', 'battery': Decimal('97')}





Anomaly detected!
Device: tilt-sensor-em320 at 2026-03-07T03:33:17.144440553Z
Type: tilt
Payload: {'angle_z': Decimal('-4.39'), 'angle_y': Decimal('-85.19'), 'angle_x': Decimal('-1.93'), 'battery': Decimal('100'), 'threshold_z': 'normal', 'threshold_x': 'normal', 'threshold_y': 'trigger'}



IoT Reliability

Weather-validated Sensor Data



Strong Winds

Sensors detect temporary tilts of the tower and the enclosure fixture does not affect the inclination measurement.



Heavy Rain

Sensor enclosure resists against water leakage with no risk of malfunctioning or interruption of service.



Floods

Water in the foundation of the tower causes slight vertical drift, detected both by the sensors as well as surveyor's measurement.

Podgorica Weather History for 17 February 2026

Time	Conditions			Comfort
	Temp	Weather	Wind	
00:00 Tue, 17 Feb	10 °C	Thunderstorms. Partly cloudy.	20 km/h	↖
00:30	10 °C	Rain. Partly cloudy.	24 km/h	↖
01:00	10 °C	Light rain. Partly cloudy.	24 km/h	↖
01:30	10 °C	Light rain. Partly cloudy.	37 km/h	↖
02:00	10 °C	Rain. Partly cloudy.	35 km/h	↖

From

 AWS Notifications

<no-reply@sns.amazonaws.com>

Feb 17

To

lorasi.anomaly@proton.me





Anomaly detected!
Device: em320-tilt-sn017 at 2026-02-17T01:31:43.878325694Z
Type: tilt
Payload: {'angle_z': Decimal('-3.77'), 'angle_y': Decimal('-85.83'), 'angle_x': Decimal('1.75'), 'battery': Decimal('100'), 'threshold_z': 'normal', 'threshold_x': 'normal', 'threshold_y': 'trigger'}

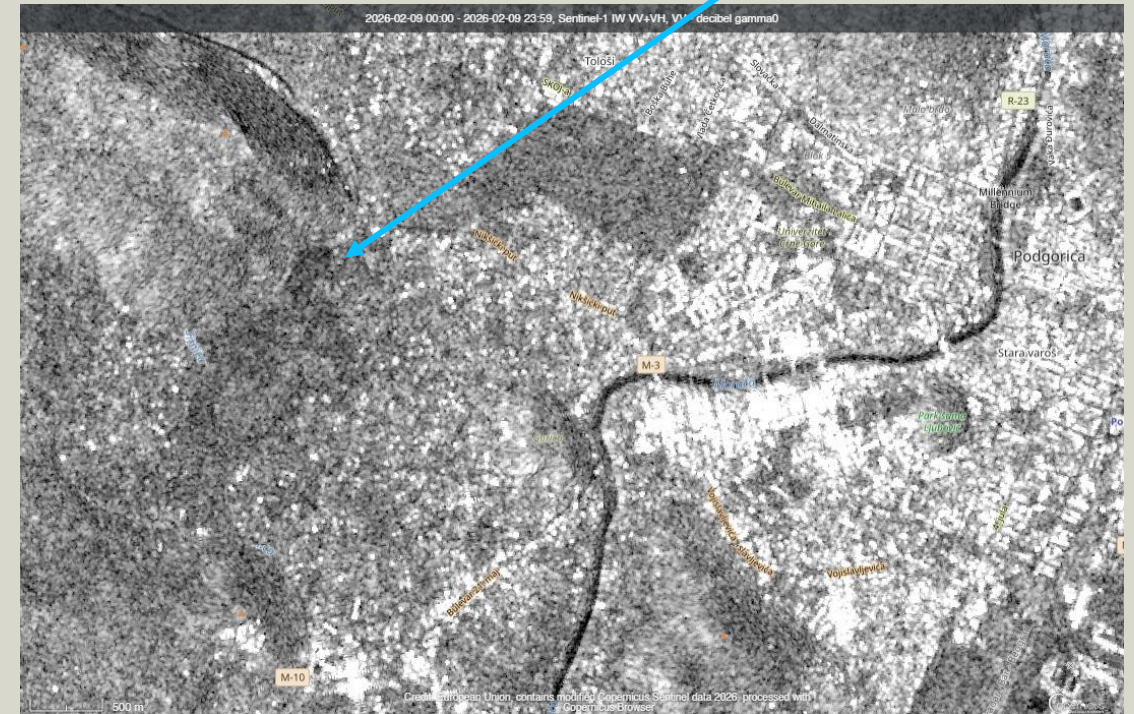
EO Performance Metrics: Podgorica Grid Corridor



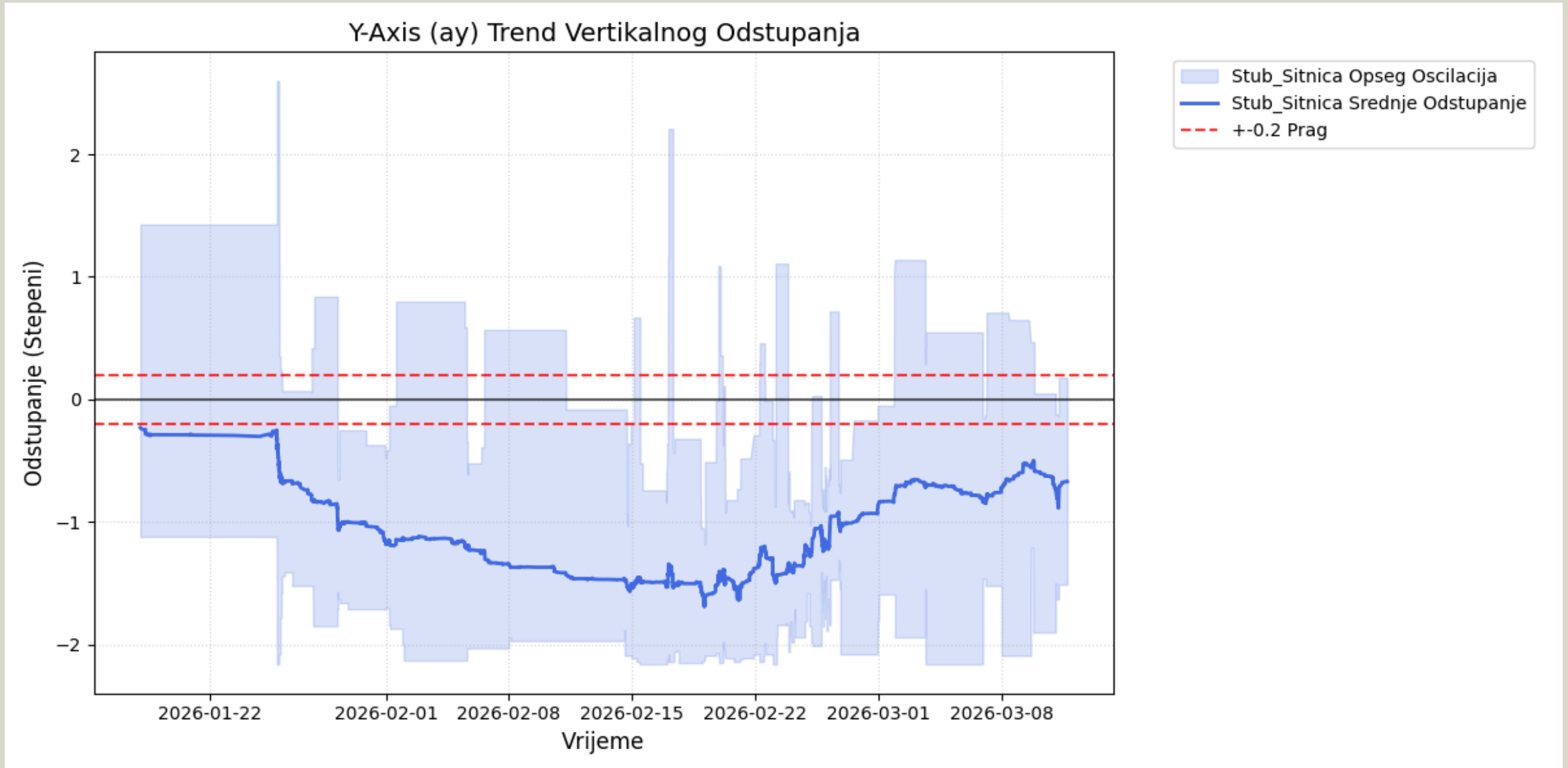
Satellite-Based Flood Detection System fused with SAMST sensors

ProcessGeoResultsImage — Execution Report

PRE scene	2026-02-08T04:55:25Z
POST scene	2026-02-09T16:41:19Z
Query method	Point sampling (50m x 50m)
Scene footprint	~250 km × ~170 km
Analysis point	42.44°N, 19.20°E
Δ backscatter	-4.22 dB
Total execution time:	17,572 ms



Sitnica Tower Structural Drift



Controlled “Attack”

Timestamp	Anomaly	Trigger	Ax	Ay	Az
2026-03-05 08:14:43.72	Hit	True	1.99	-84.96	-4.61
2026-03-05 08:25:51.05	Hit	True	5.18	-82.45	5.47
2026-03-05 08:26:19.46	Hit	True	1.08	-84.28	-5.6
2026-03-05 08:30:45.98	Intruder	True	N/A	N/A	N/A
2026-03-05 08:33:20.96	Intruder	True	N/A	N/A	N/A



99.9%

Data packets
delivered to
SAMST platform

8

Different types
of anomaly
classes

49

Anomalies
detected and
validated with
maintenance
team

>100K

Data packets in
three months
time for AI-
based trend
prediction

< 1 min

Latency of
anomaly
detection trigger

From Telemetry to Actionable Intelligence

The integrity of our data pipeline is the foundation of the LoRaSi strategy. Achieving a 99.9% packet delivery rate across the Dinaric Alps validates the resilience of our LoRaWAN edge network in extreme topography. This high-fidelity stream, totaling over 100,000 packets in just one quarter, provides the deep historical context necessary for our AI engines to accurately map long-term degradation and predict maintenance needs before failures occur.

Real-time responsiveness is critical for high-voltage grid stability. With a sub-minute latency from event detection to system trigger, we have successfully identified and validated 49 critical anomalies alongside CGES teams. This rapid turnaround allows a transition from costly scheduled inspections to targeted, event-driven interventions, ensuring that potential structural issues are addressed with absolute precision and zero operational delay.

Vision 2030

The Autonomous Smart Grid



Absolute Data Sovereignty

Ensuring that the European grid remains independent, with all sensor and satellite data processed within secure, sovereign infrastructure.



Self-Healing Infrastructure

A grid that identifies, reroutes, and initiates its own maintenance protocols—reducing human exposure to hazardous remote environments.



Zero-Waste Operations & Maintenance

Reducing unnecessary field inspections by 60% through high-fidelity remote verification.



Questions?

LoRaSi d.o.o

lorasi.me

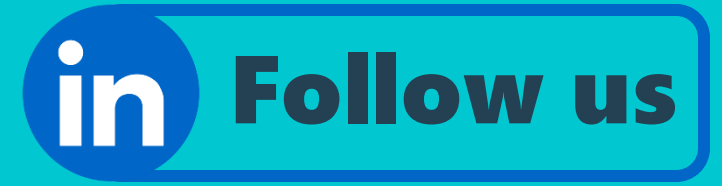
milan.maric@lorasi.me

danilo.maric@lorasi.me

CGES AD

cges.me

milena.andjelic@cges.me



CONNECT
@CWIEME

KVADRANTI 200m x 200m
KORIDOR TRASE DALEKOVODA
CENTAR KVADRANTA = STUB DALEKOVODA

REFERENTNI STUB S (KOORDINATA)

 **42.44215°N, 19.20251°E**
(WGS84)

LEGENDA

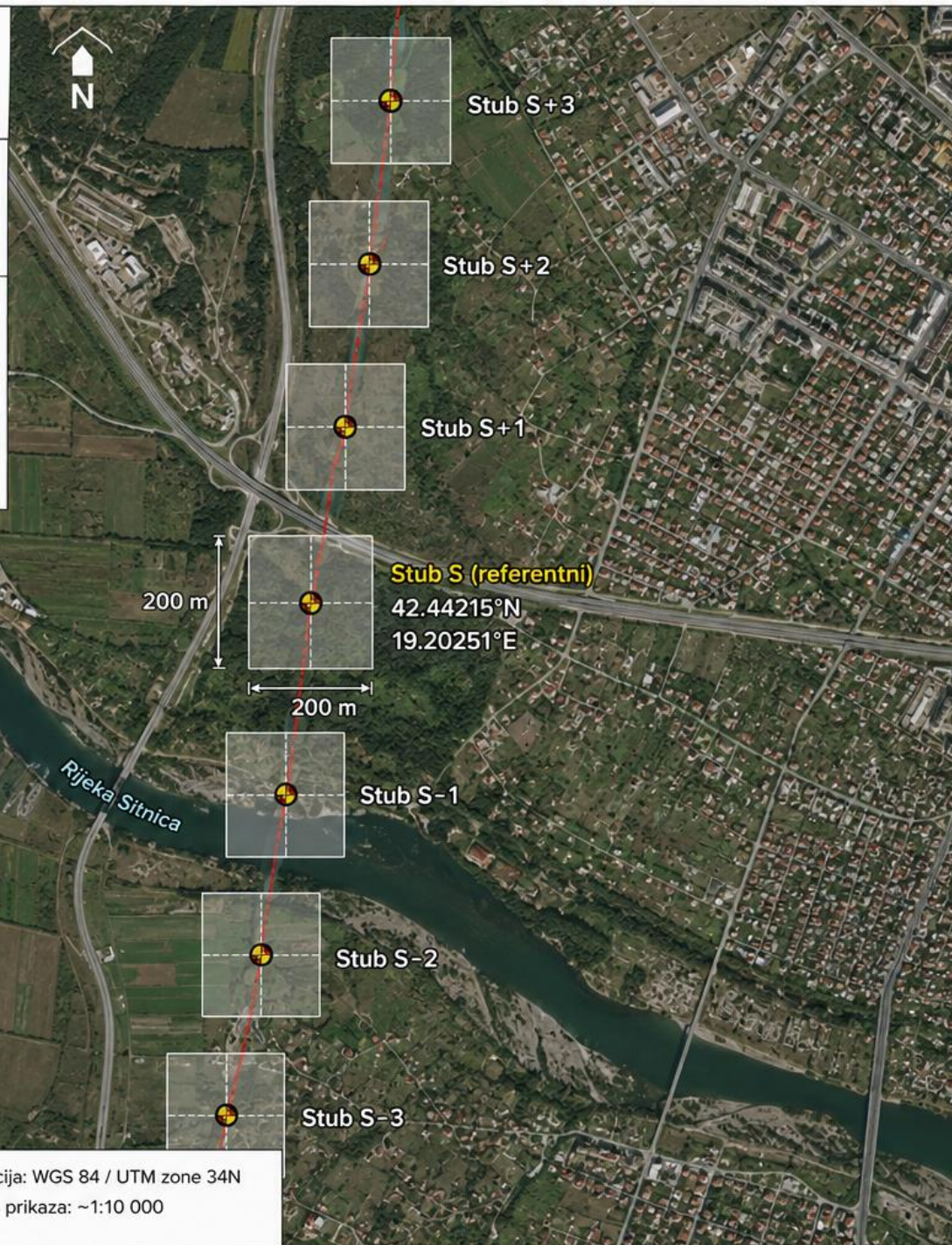
-  Kvadrant 200m x 200m
-  Podeona linija kvadranta
-  Stub dalekovoda (centar kvadranta)
-  Trasa dalekovoda (osa koridora)



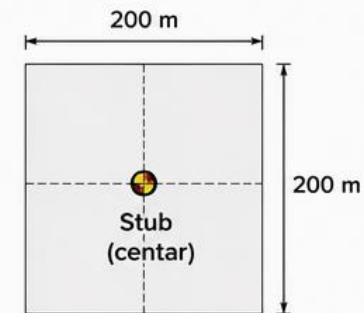
0 100 200 300 400 500 m

Referentni stub (S) – centar kvadranta
42.44215°N, 19.20251°E (WGS84)

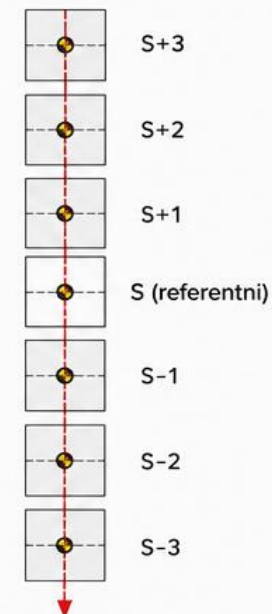
Projekcija: WGS 84 / UTM zone 34N
Mjerilo prikaza: ~1:10 000



SKICA KVADRANTA
200m x 200m



PRIMJER NIZA KVADRANATA
DUŽ TRASE DALEKOVODA



NAPOMENE

- Svaki kvadrant je dimenzije 200m x 200m.
- Centar kvadranta poklapa se sa stubom dalekovoda.
- Kvadranti prate pravac koridora dalekovoda.
- Orijentacija: sjever je prema gore.
- Pogodno za analize, nadzor vegetacije, vremenskih uslova i fizičke stabilnosti.