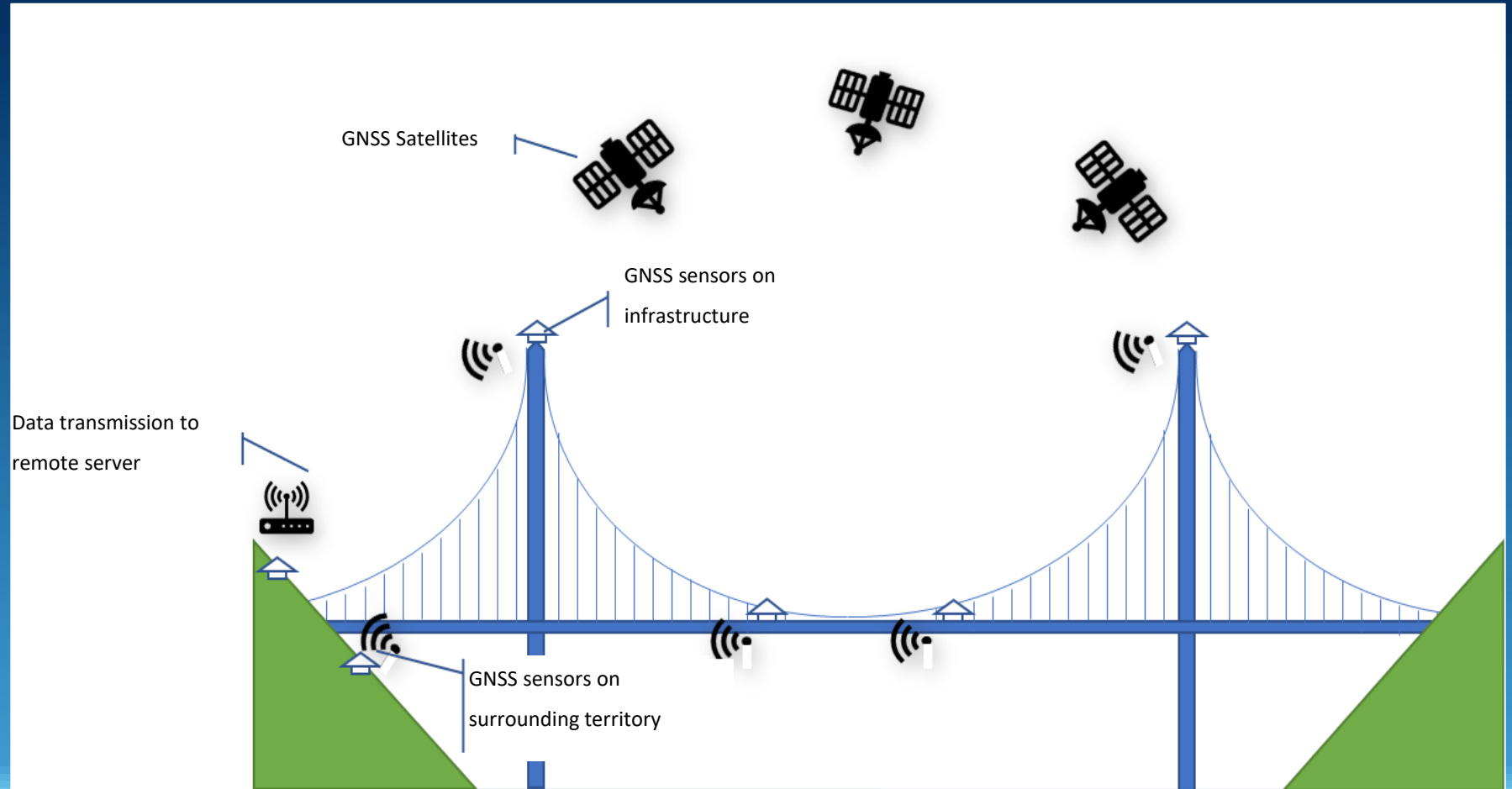


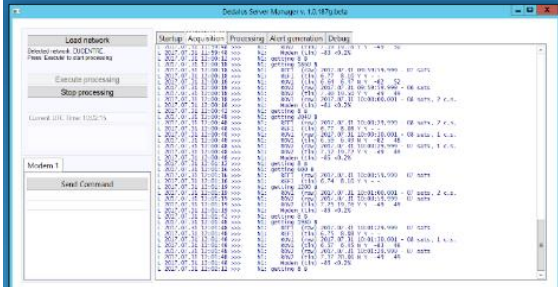
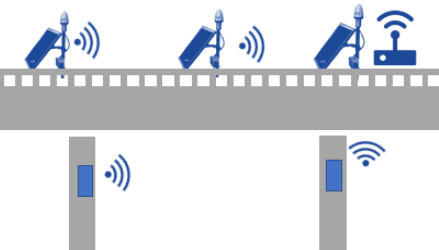
Critical Infrastructures Monitoring Using GNSS (Global Navigation Satellite System): Practical Experiences

Massimiliano Chersich: Co-founder and C.E.O. - YETITMOVES

- GNSS (Global Navigation Satellite System) is considered the optimal solution to monitor slow surface movements as it works 24/7 in all wheater conditions
- The monitoring solutions on the market are based on **high costs** multipurpose professional equipment
- We must also consider the infrastructural impact (and costs) of bulky, heavy and power consuming sensors that have to be permanently placed in places often difficult to reach
- These considerations are the main reasons of the, up till now, **low market uptake** of GNSS technology in SHM

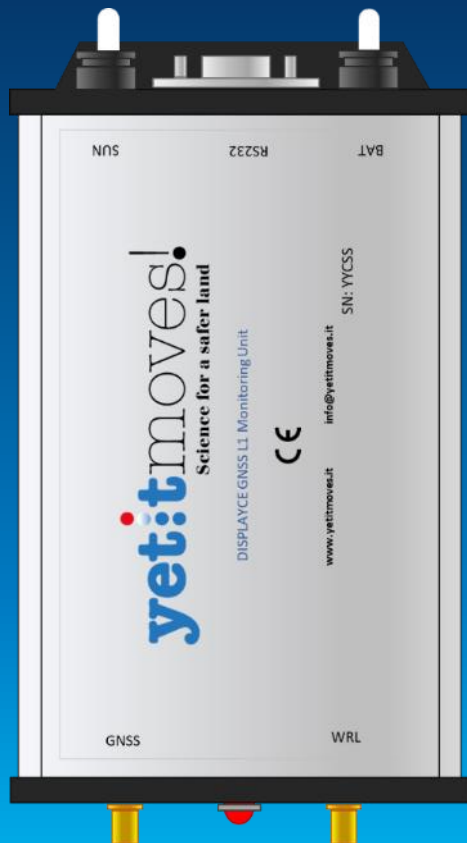
- To respond to these market needs, **dedicated monitoring solutions** have been developed.
- IoT solutions with a **high technology/cost rate** based on GNSS sensors and devoted to the monitoring and early-warning of displacements of areas subject to deformation and of critical infrastructures
- Designed to work in **continuous and fully automated** mode
- Capable to detect tiny and slow movements (low frequency domain) of an infrastructure with respect to the surrounding environments (subsidence, landslides, etc.). But **not deformation** of a rigid structure!





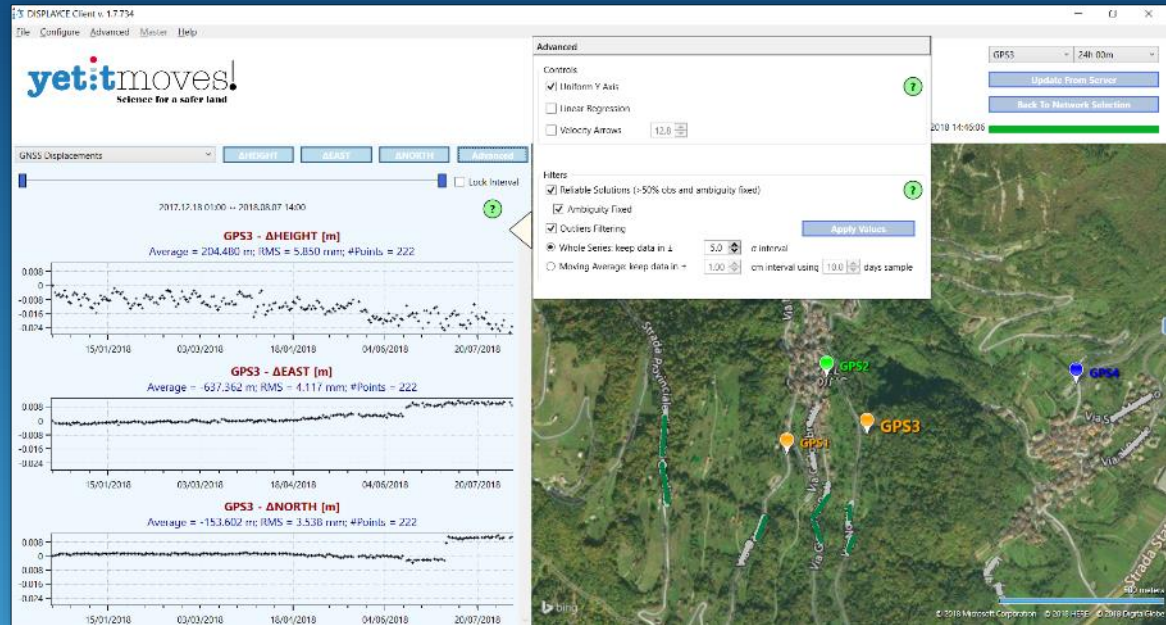
- The monitoring points must integrate all necessary elements: GNSS antenna and receiver, modem, batteries, photovoltaic modules, etc.
- Quick and easy installation (light monumentation)
- Electrically autonomous and capable of working in absence of sun for days



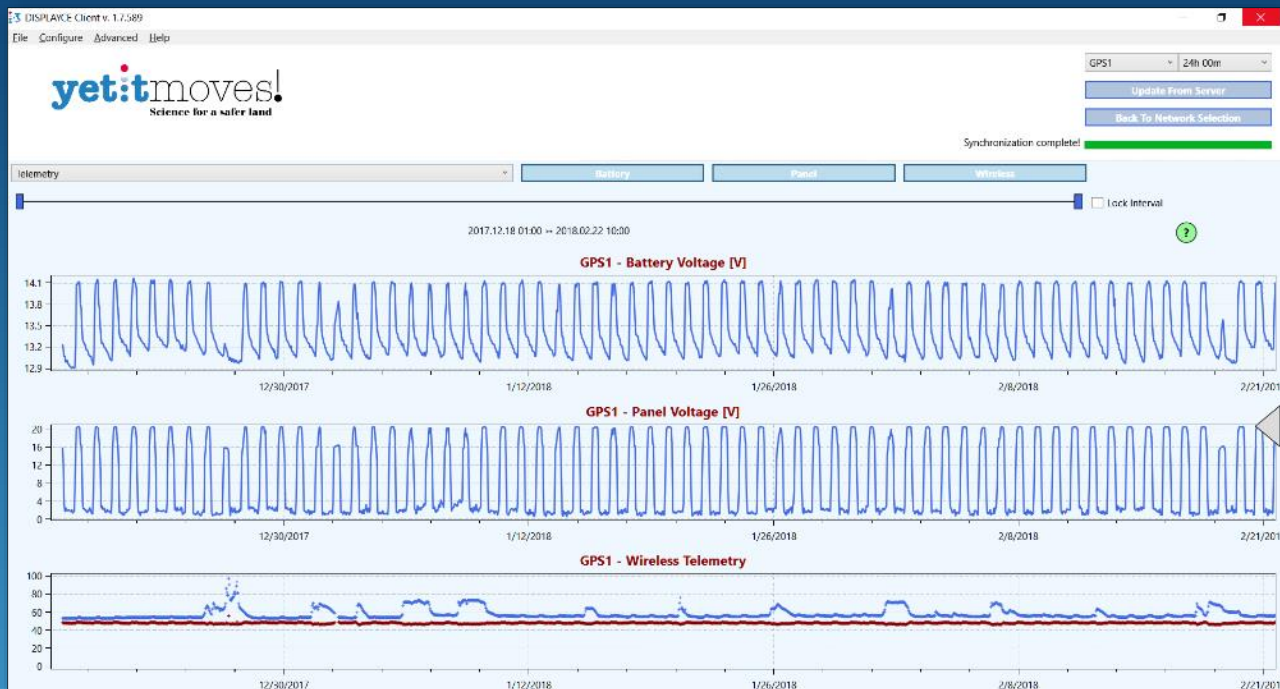


- Chipset U-Blox NEO-M8T (L1) or ZED-FP9 (L1/L2) multi-constellation
- Memory card uSD 4GB
- Integrated 868MHz modem for local data transmission up to 4 Km LOS
- Internal power regulator for direct feed from photovoltaic solar modules (20 – 50 W)
- Power consumption < 1 W → one 12V-12Ah Pb-AGM battery allows power continuity up to 5 to 10 days in the dark!

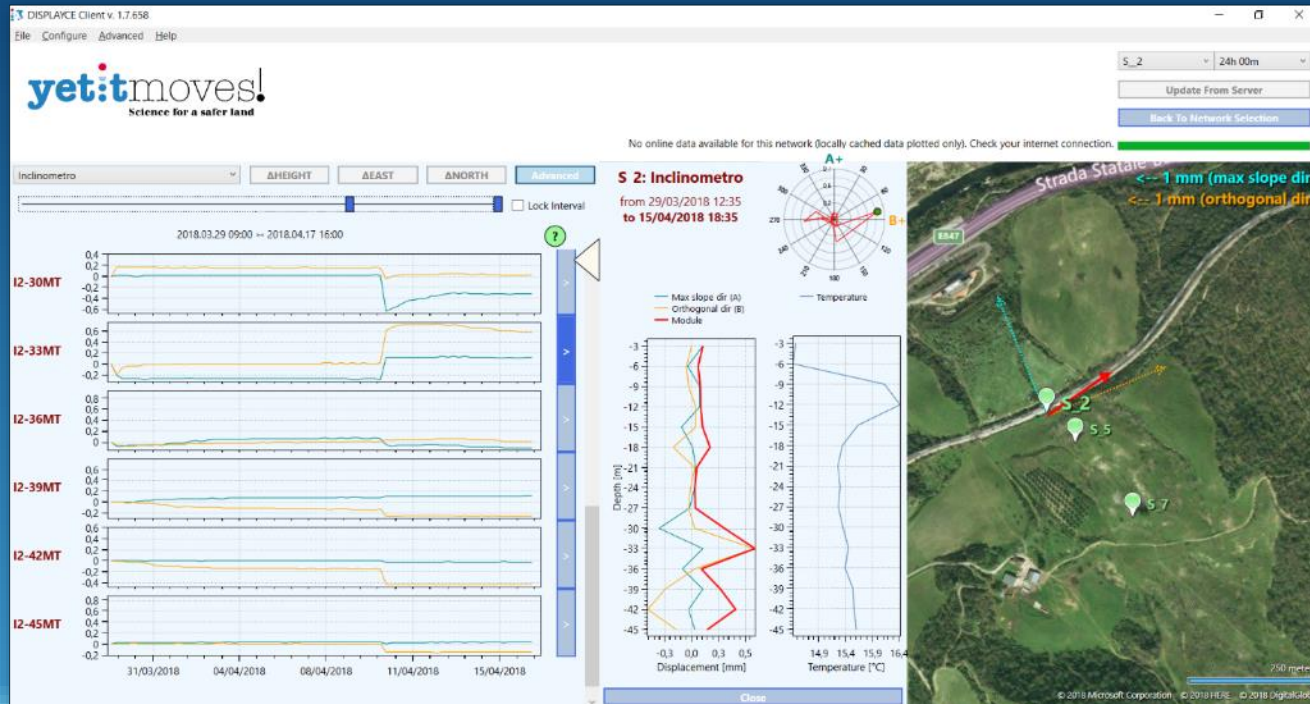
- Shows 3-D **historical series of displacements** on graphics
- Show monitoring points and information on a map
- Filters, computes and shows statistics on displacements, velocities and network health
- Allows the user to select **thresholds** for generation of possible warnings or alarms
- Generates **PDF reports**



Telemetry data for each monitoring point (solar modules and battery voltages, local data transmission quality, GNSS data quality, etc.)



Integrate data coming from other sensors (accelerometers, piezometers, extensimeters, clinometers, meteo stations, etc.)





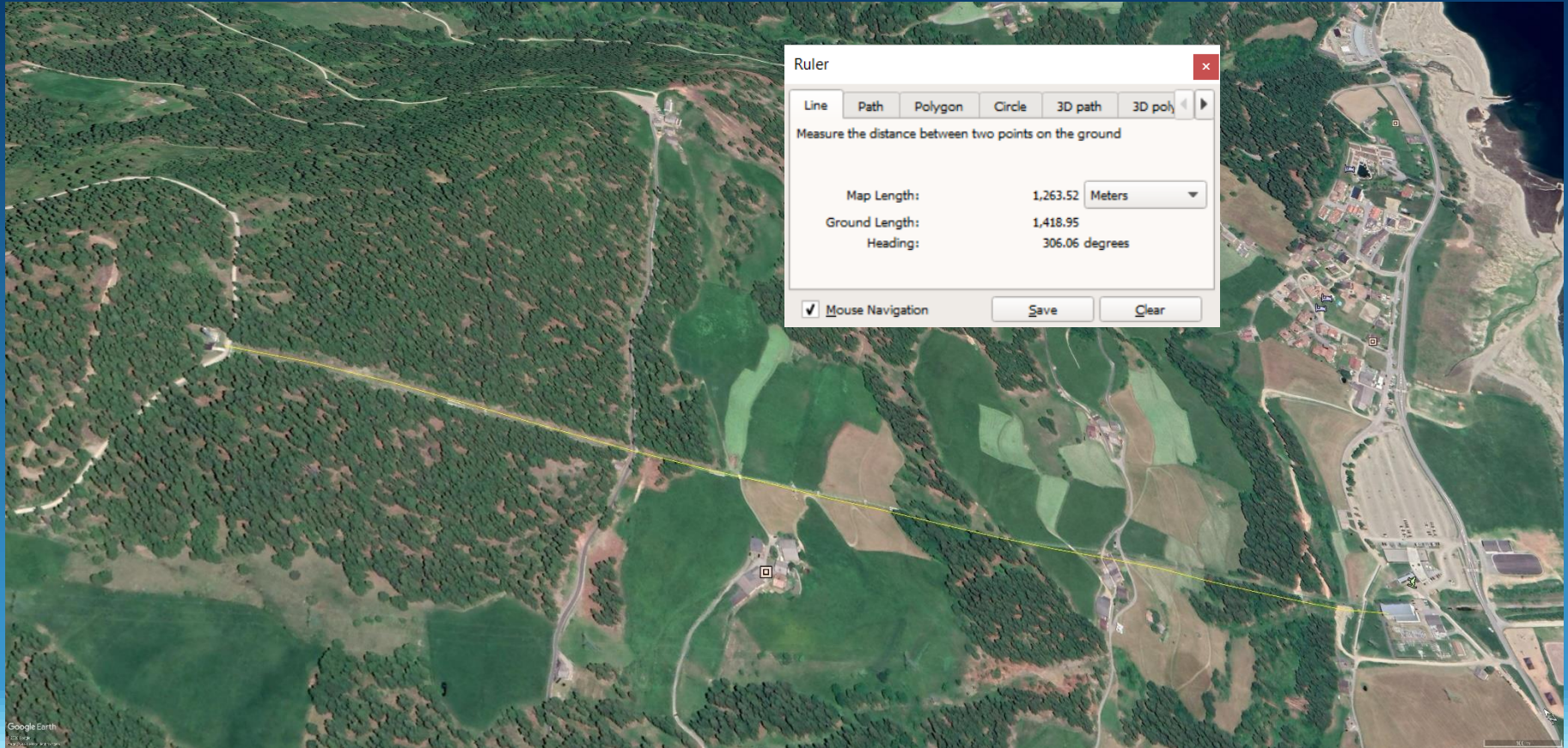
...YETITMOVES in numbers...

In 36 months:

- Over one hundred of monitoring points installed
- 17 monitoring sites, 13 in Italy and 4 in Europe (Iceland, Romania, Netherland and Greece)
- Main Customers/Users



Monitoring of Penstock



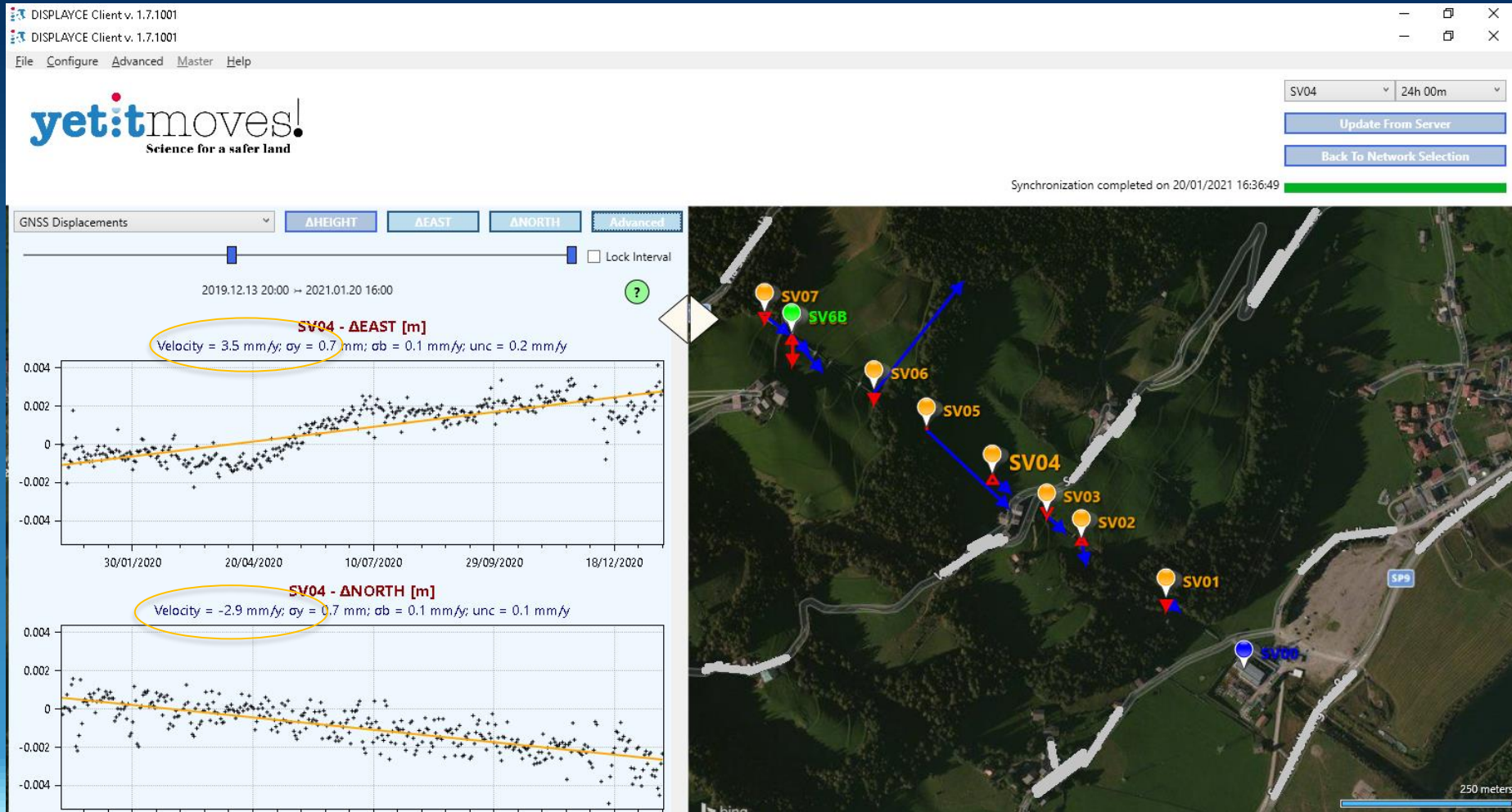
- 13 GNSS stations: one used as a reference point placed at the power plant
- Antennas and electronics in box on 8 cm square steel poles (adjustable vertical) anchored to penstock plinths. One point not constrained to the penstock.
- Medium baselines (< 1200 m)
- Electrical power from mains
- Local data transmission through fiber
- Objective of the monitoring is measuring possible slope instabilities







IL FUTURO DEL MONITORAGGIO DELLE INFRASTRUTTURE E DEI CANTIERI – January 22, 2021



DISPLAYCE Client v. 1.7.1001

File Configure Advanced Master Help

yeti:tmoves!
Science for a safer land

SV6C 24h 00m

Update From Server

Back To Network Selection

Getting GNSS quality data from remote server: SV05 (6/12)

GNSS Displacements

ΔHEIGHT

ΔEAST

ΔNORTH

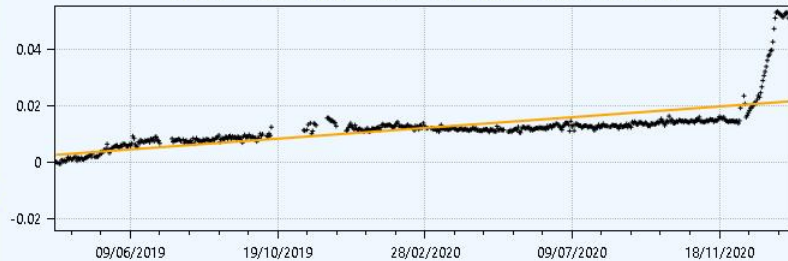
Advanced

Lock Interval

2019.04.02 17:00 → 2021.01.20 16:00

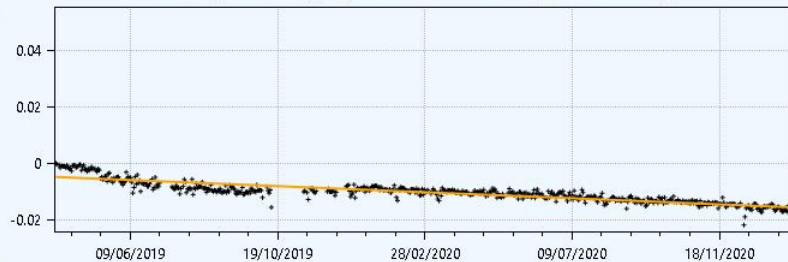
SV6C - ΔEAST [m]

Velocity = 10.5 mm/y; $\sigma_y = 6.0$ mm; $\sigma_b = 0.5$ mm/y; unc = 0.1 mm/y



SV6C - ΔNORTH [m]

Velocity = -6.0 mm/y; $\sigma_y = 1.7$ mm; $\sigma_b = 0.1$ mm/y; unc = 0.1 mm/y



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SV06 24h 00m

Update From Server

Back To Network Selection

Synchronization completed on 20/01/2021 16:36:49

GNSS Displacements

ΔHEIGHT

ΔEAST

ΔNORTH

Advanced

2020.08.20 05:00 → 2021.01.20 16:00

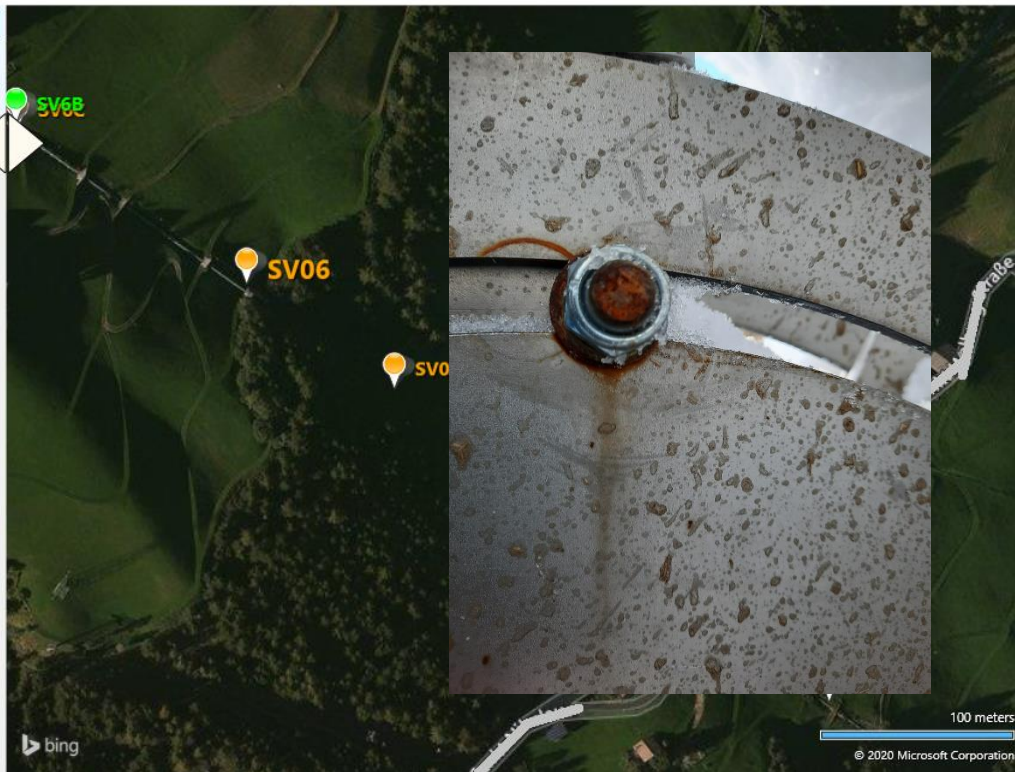
SV06 - ΔEAST [m]

Average = -539.736 m; RMS = 11.4 mm; #Points = 150

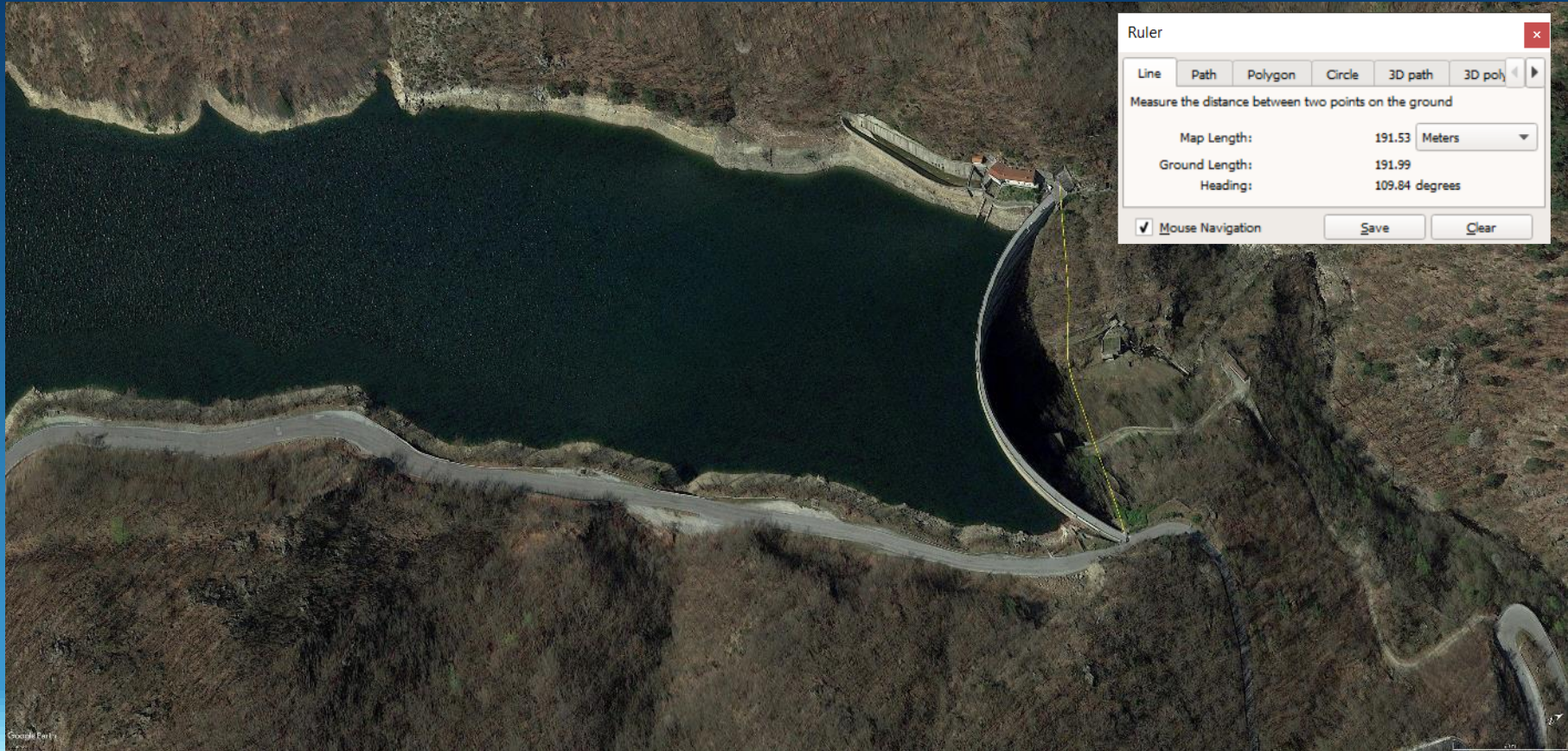


SV06 - ΔNORTH [m]

Average = 406.382 m; RMS = 2.5 mm; #Points = 150



Monitoring of an Arch Dam

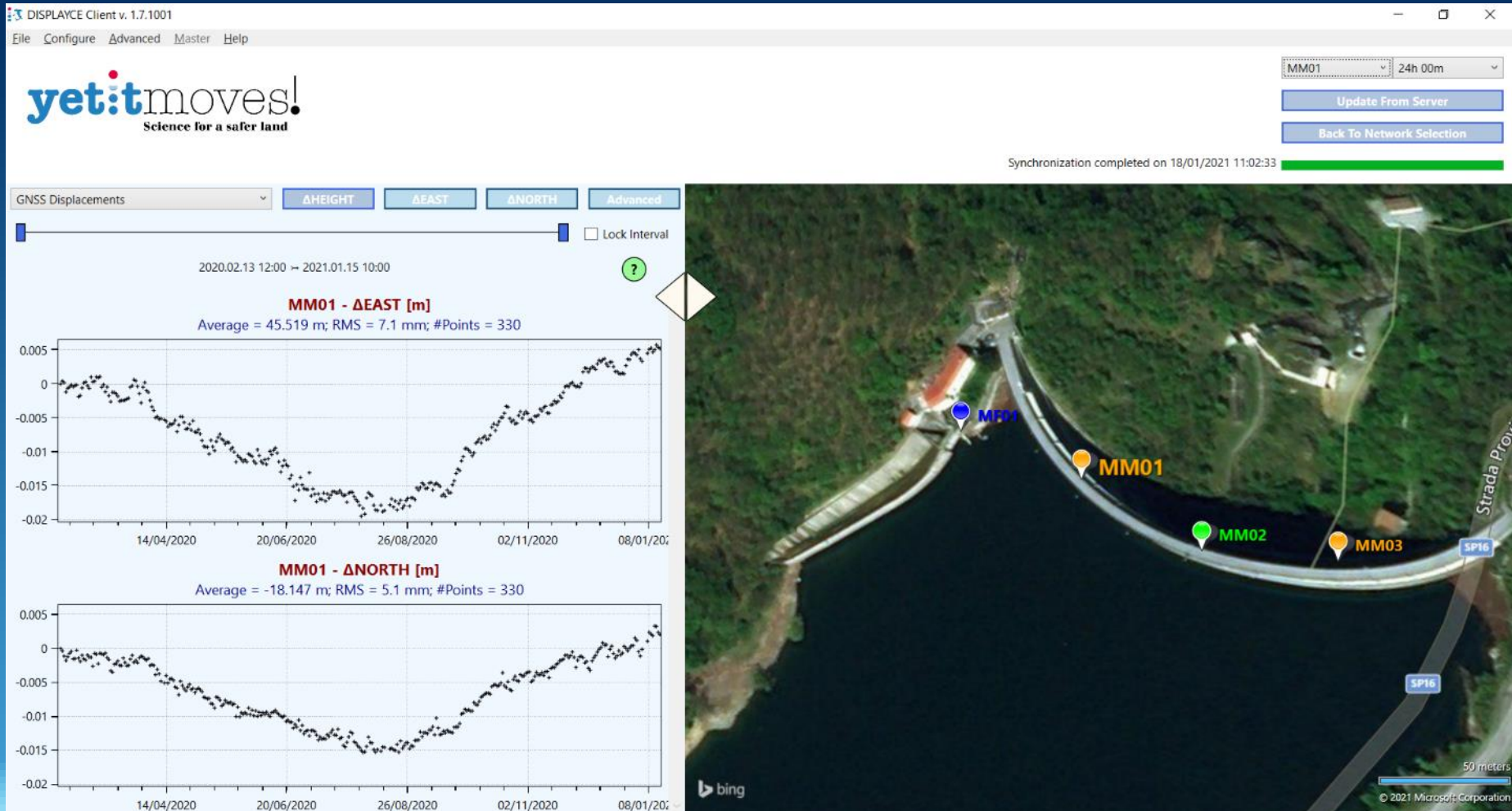


- 4 GNSS stations: one used as a reference point and three as monitoring points fixed to the top of the dam
- Antennas and electronics in box on 8 cm diameter steel poles
- Short baselines (< 160 m)
- Electrical power from mains
- Local data transmission from each point to the gateway/reference with small blade antennas
- Objective of the monitoring is measuring amplitude of displacements of the dam due to filling and emptying the reservoir





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DISPLAYCE Client v. 1.7.1001

File Configure Advanced Master Help

yet:tmoves!
Science for a safer land

MM02 24h 00m

Update From Server

Back To Network Selection

Synchronization completed on 18/01/2021 11:02:33

GNSS Displacements

ΔHEIGHT

ΔEAST

ΔNORTH

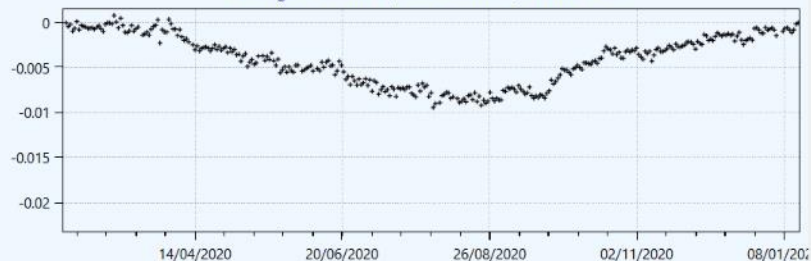
Advanced

☐ Lock Interval

2020.02.13 12:00 → 2021.01.15 10:00

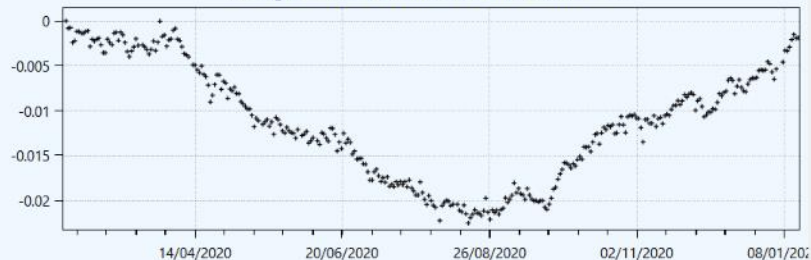
MM02 - ΔEAST [m]

Average = 92.260 m; RMS = 2.8 mm; #Points = 327

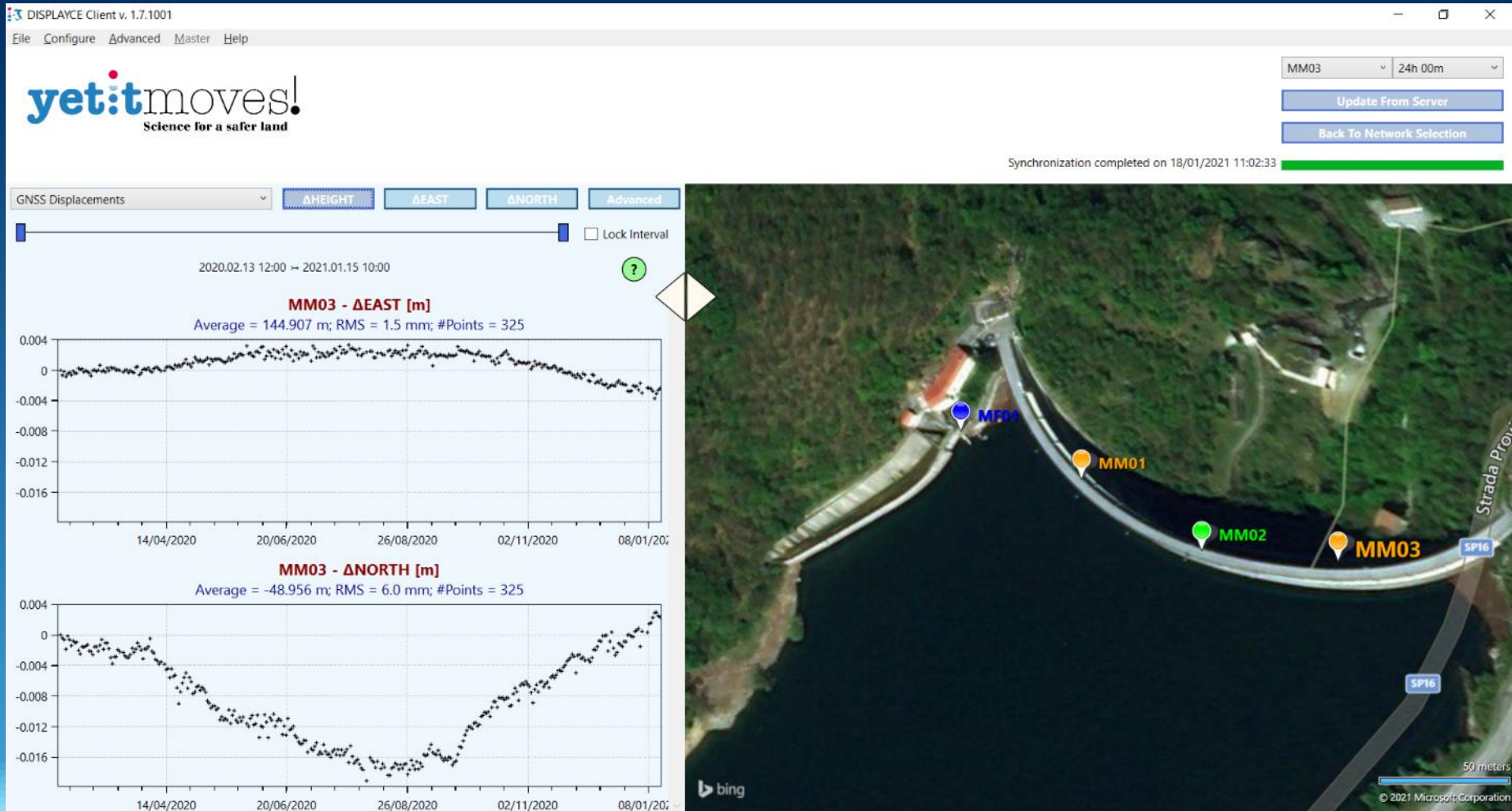


MM02 - ΔNORTH [m]

Average = -44.824 m; RMS = 6.4 mm; #Points = 327



IL FUTURO DEL MONITORAGGIO DELLE INFRASTRUTTURE E DEI CANTIERI – January 22, 2021





STORIA E NATURA



CONDIVIDI SU FACEBOOK



1.8k

, il passato riaffiora: si svuota il lago e il paese si riempie di turisti **fotogallery**

Ancora pochi giorni per vedere i resti dell'antico borgo sommerso dall'acqua



Commenta



Stampa



Invia notizia

Più informazioni su



ambiente



lago di



natura



storia





TO CONCLUDE

- GNSS is a mature technology also for the monitoring of critical infrastructures
- mm/day resolution when used in differential mode
- Works in **continuous and fully automated** mode
- Capable to detect tiny and slow movements (low frequency domain) of an infrastructure with respect to the surrounding environments (subsidence, landslides, etc.). But **not deformation** of a rigid structure

THANKS FOR ATTENTION!
Any question?