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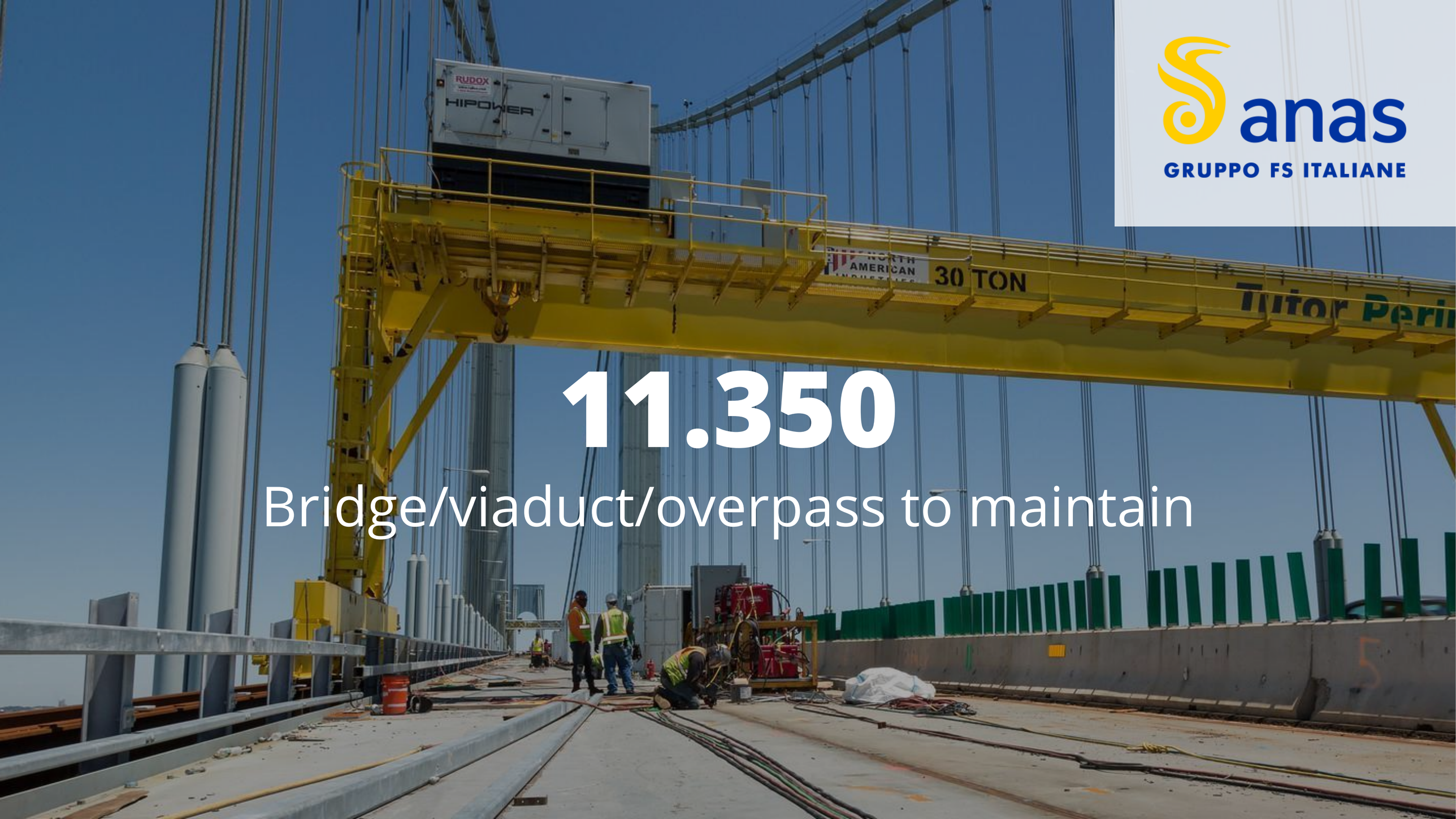
Sentetic SmartBridge

The voice of road infrastructures

Sandro Bovelli
CEO and Founder



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11.350

Bridge/viaduct/overpass to maintain

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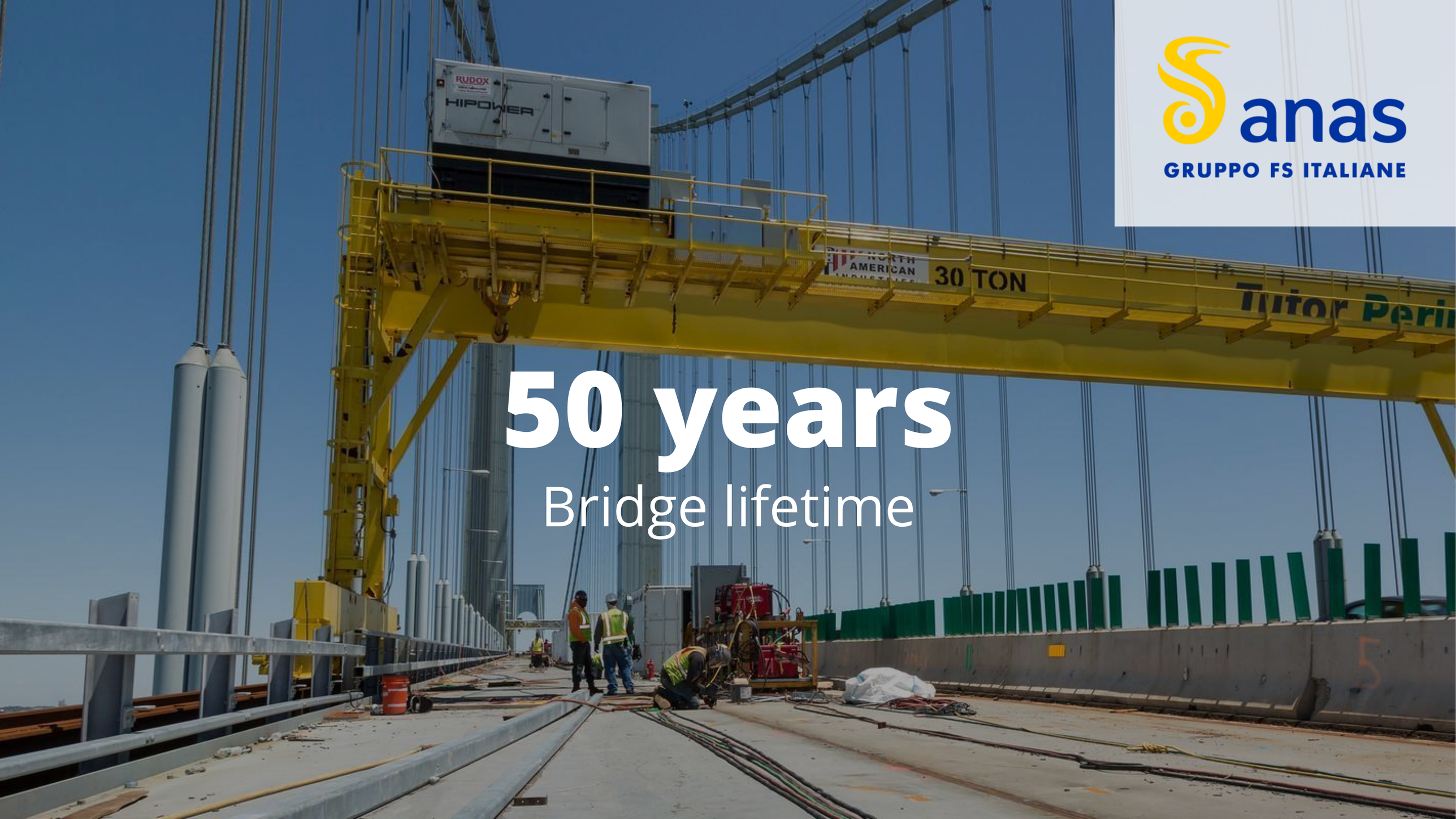
1950/1960

year of construction



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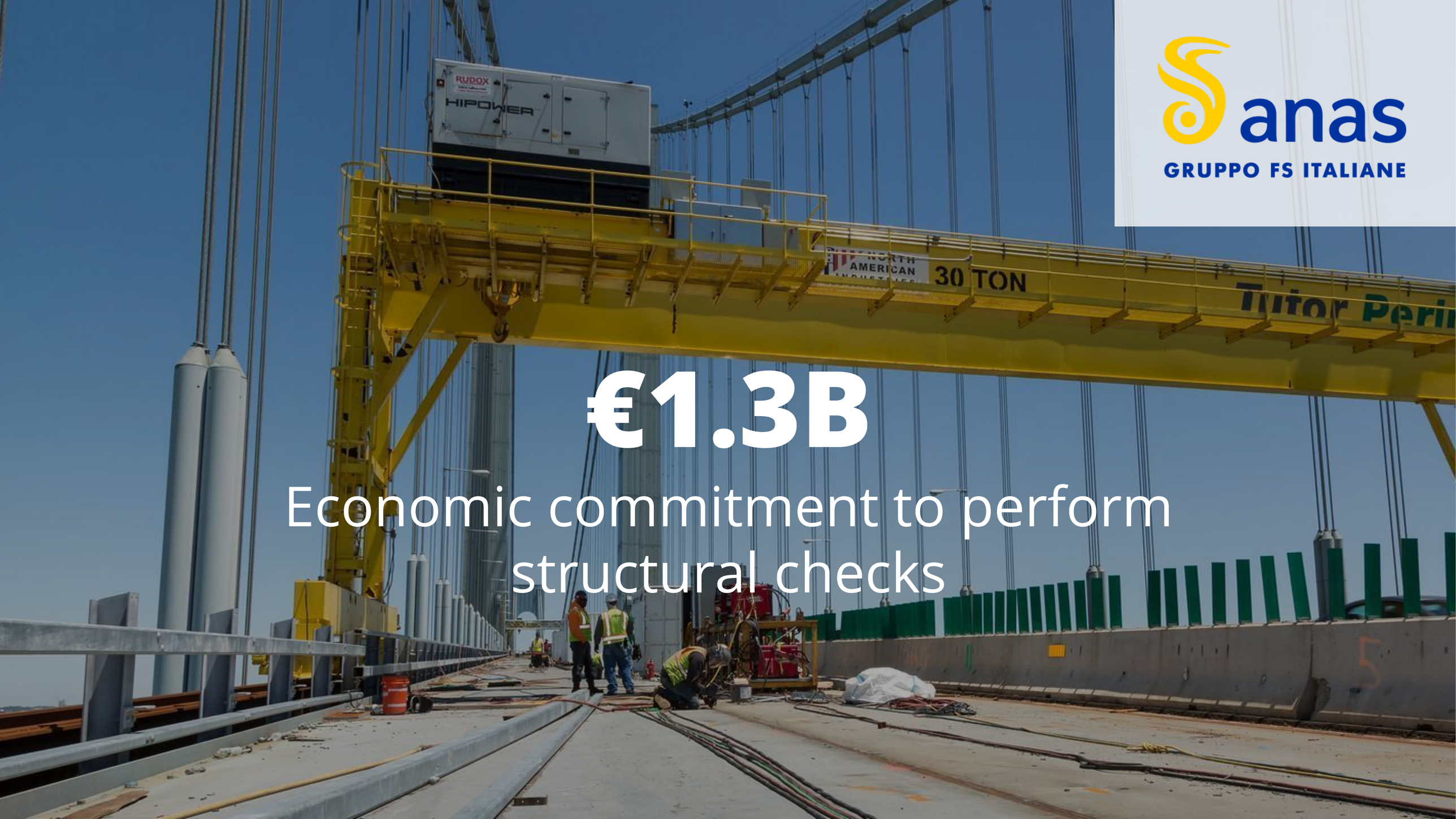
50 years

Bridge lifetime



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€1.3B

Economic commitment to perform structural checks

“7% of 200.000 French bridges have damage that could eventually result in collapse if not addressed”

France’s transportation ministry

In Germany, 10.6% are in a condition that is not satisfactory, and 1.8% are in “inadequate” condition

Federal Highway Research Institute

This year, 14 Dutch bridgeswere considered at “unacceptable risk of collapse” in Noord-Holland province alone

Financieele Dagblad

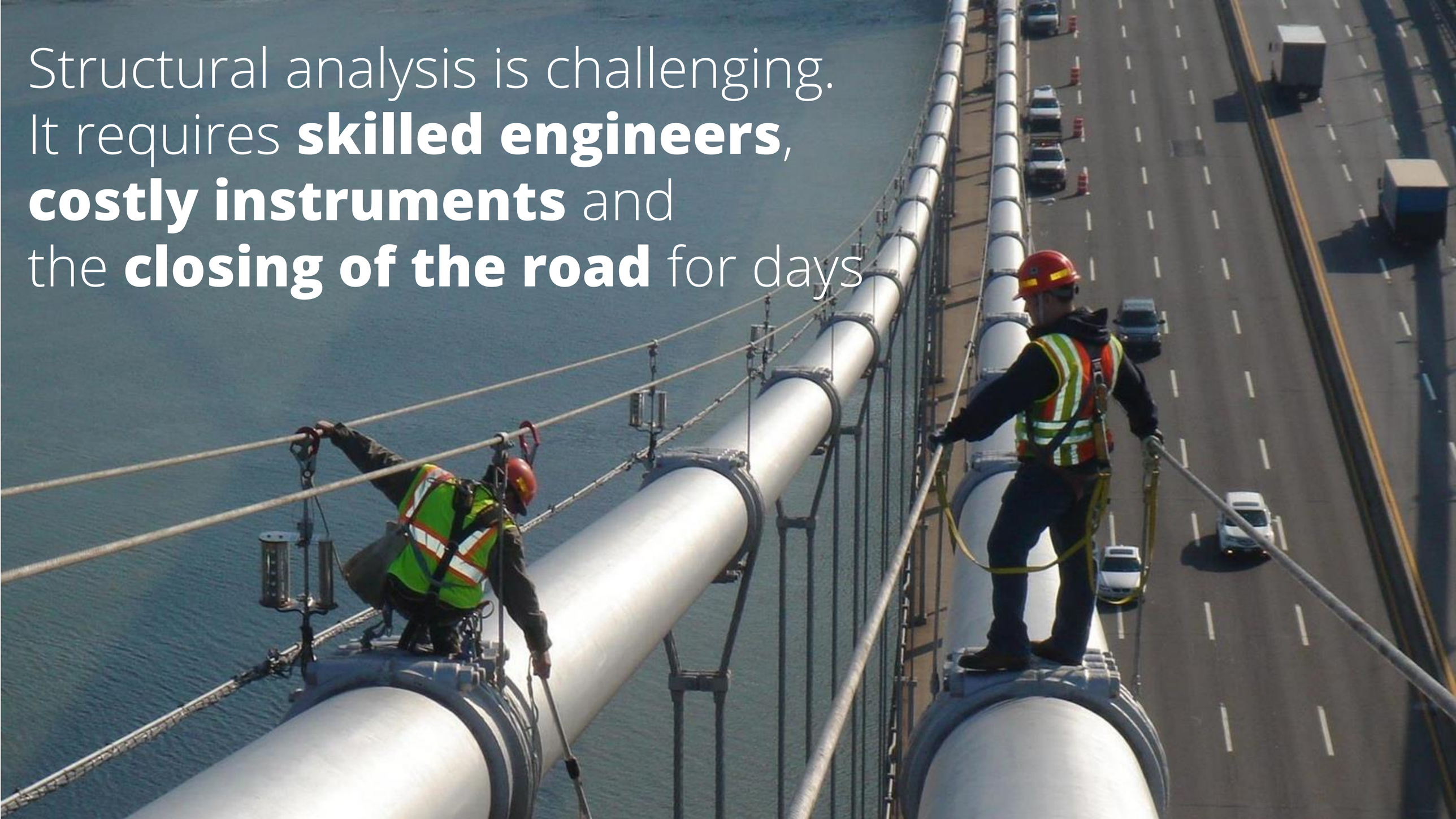
In Netherland, the bridges are inspected every six years.

1B euros/year

Bridge Maintenance costs in Europe

10x increase

in the next 10 year!


Structural analysis is challenging.
It requires **skilled engineers**,
costly instruments and
the **closing of the road** for days

INSPECT

Sentetic SmartBridge

The AI based solution for Real time Infrastructure Anomaly detection

Traffic detection

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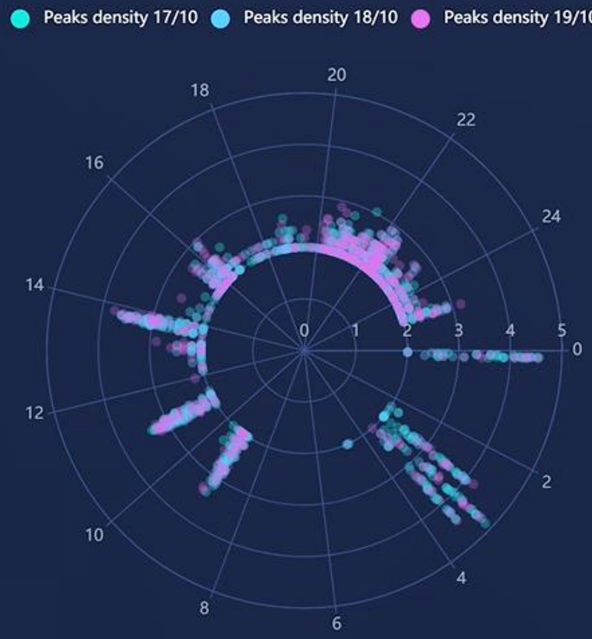
Real time Monitoring

Tens of thousand parameter per second,
hundreds infrastructures monitored...

For the cost of a coffee/day.

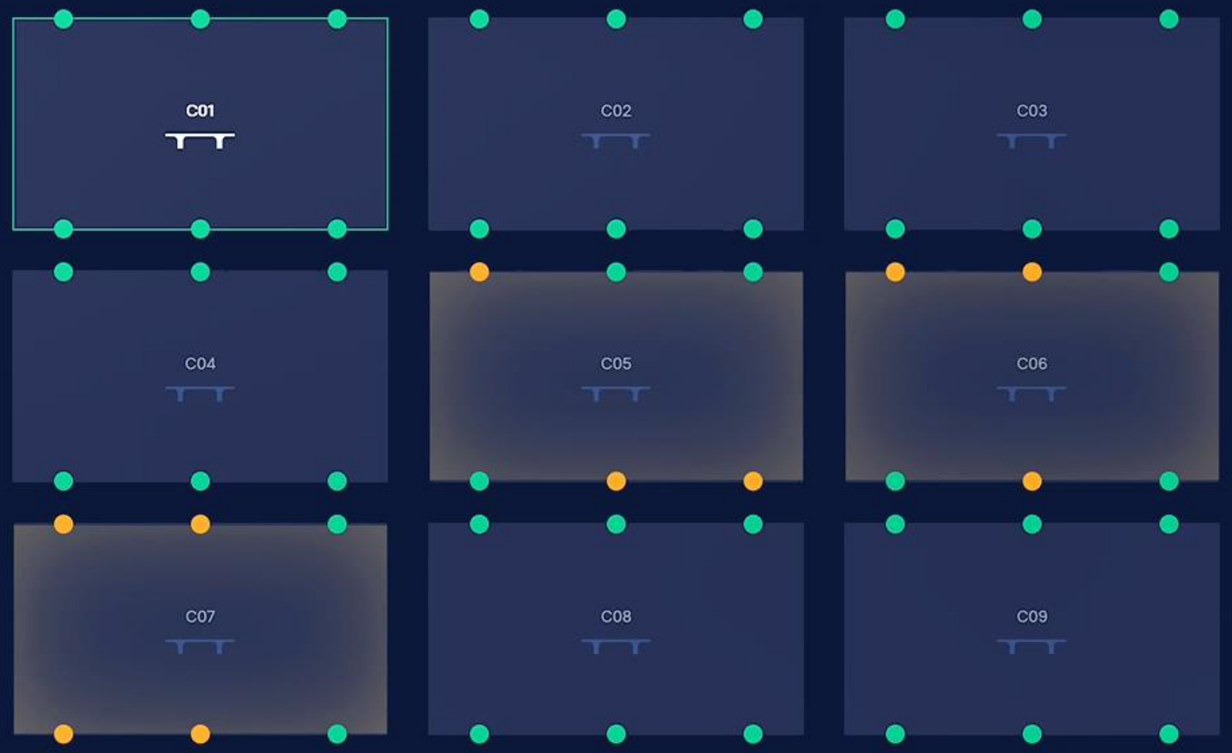


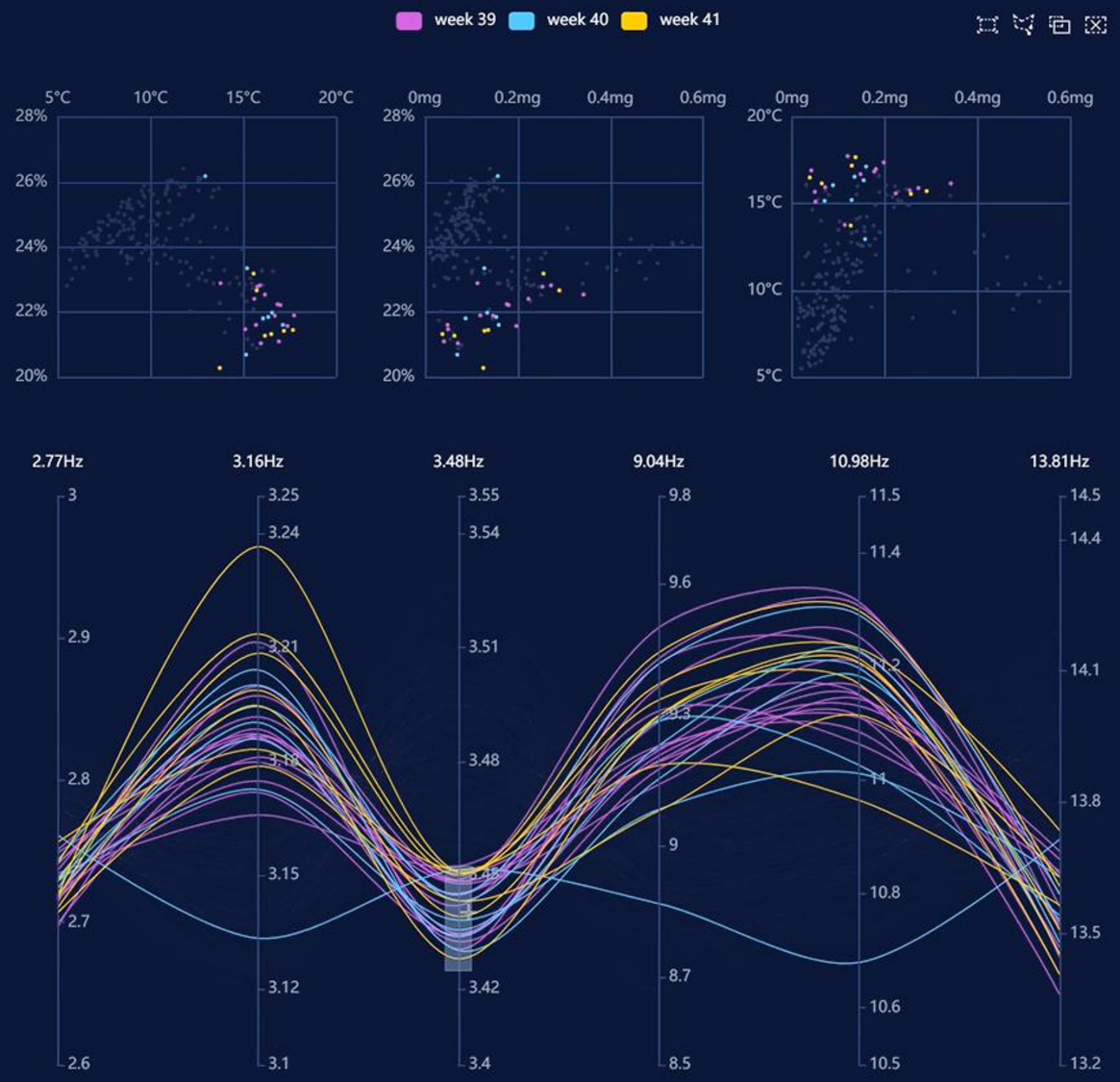
Acceleration X Acceleration Y **Acceleration Z**

Viaduct spans overview

Machine Learning based

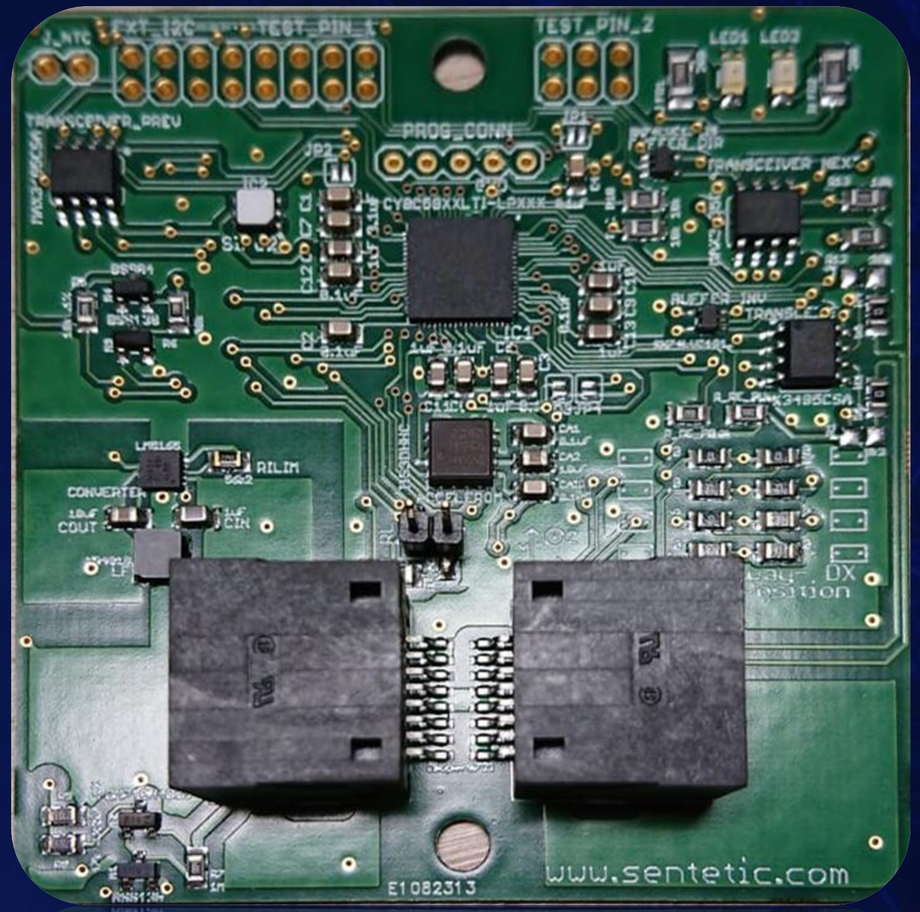
We don’t need a structural model of the infrastructure, because we «learn» the specific behaviour of the bridge.



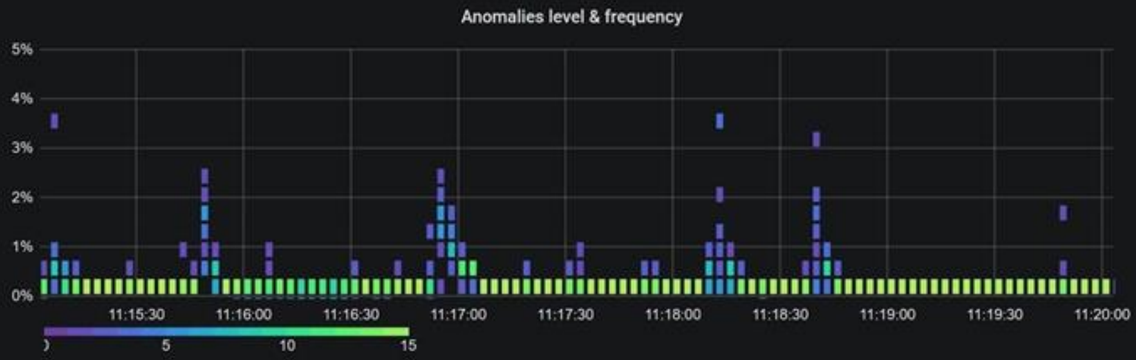


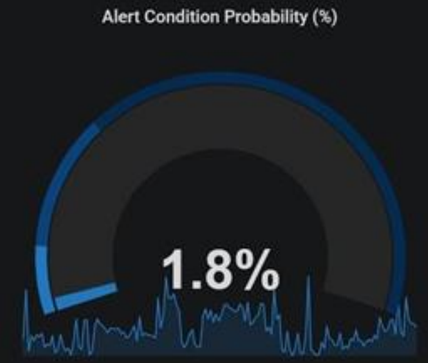
SensorCortex®
Edge technology

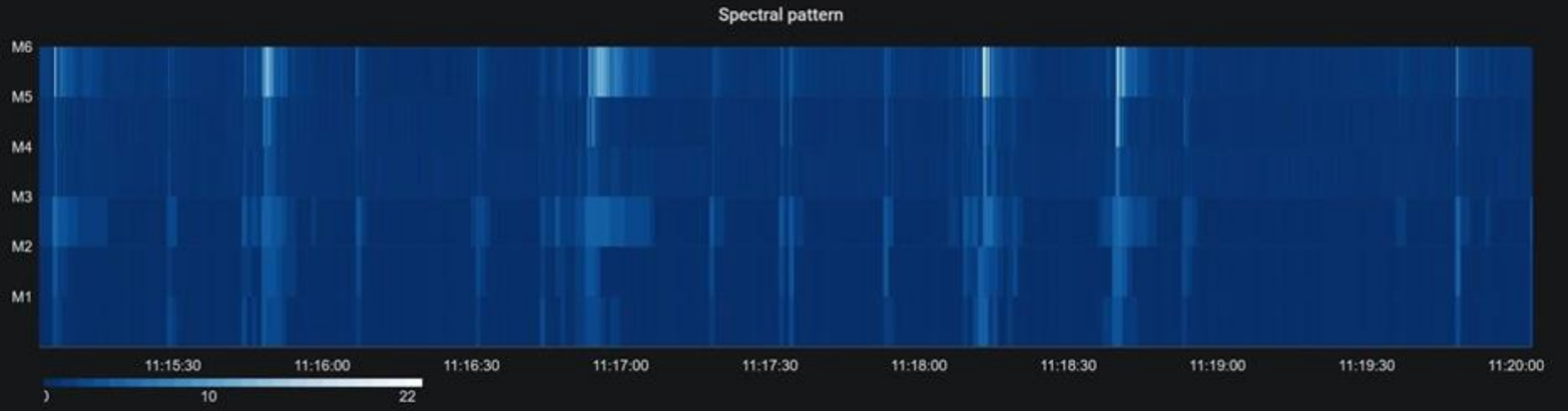
MCU + DSP/FPGA + NPU
for high frequency Signal processing
and Edge Machine learning

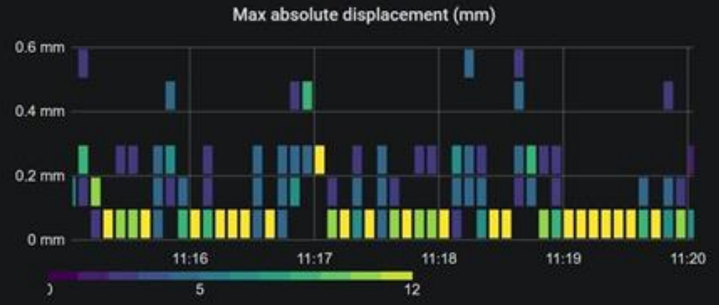


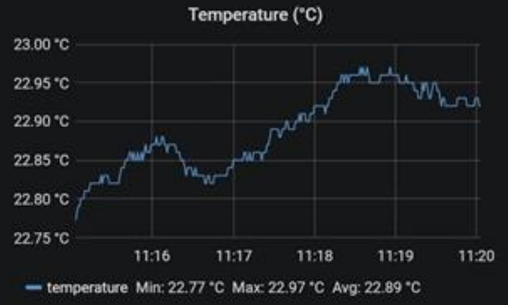
sentetic Smart BridgeMonitoring System

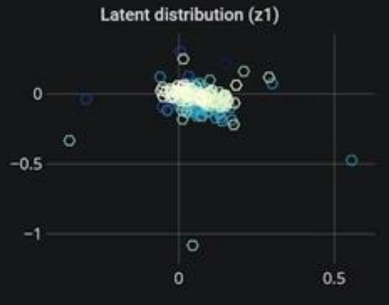


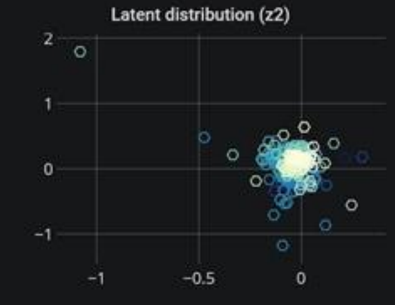


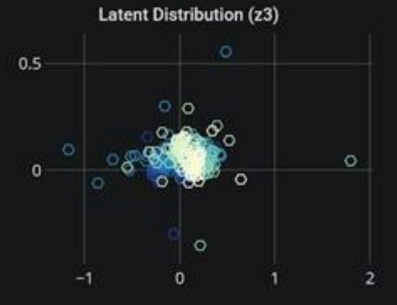




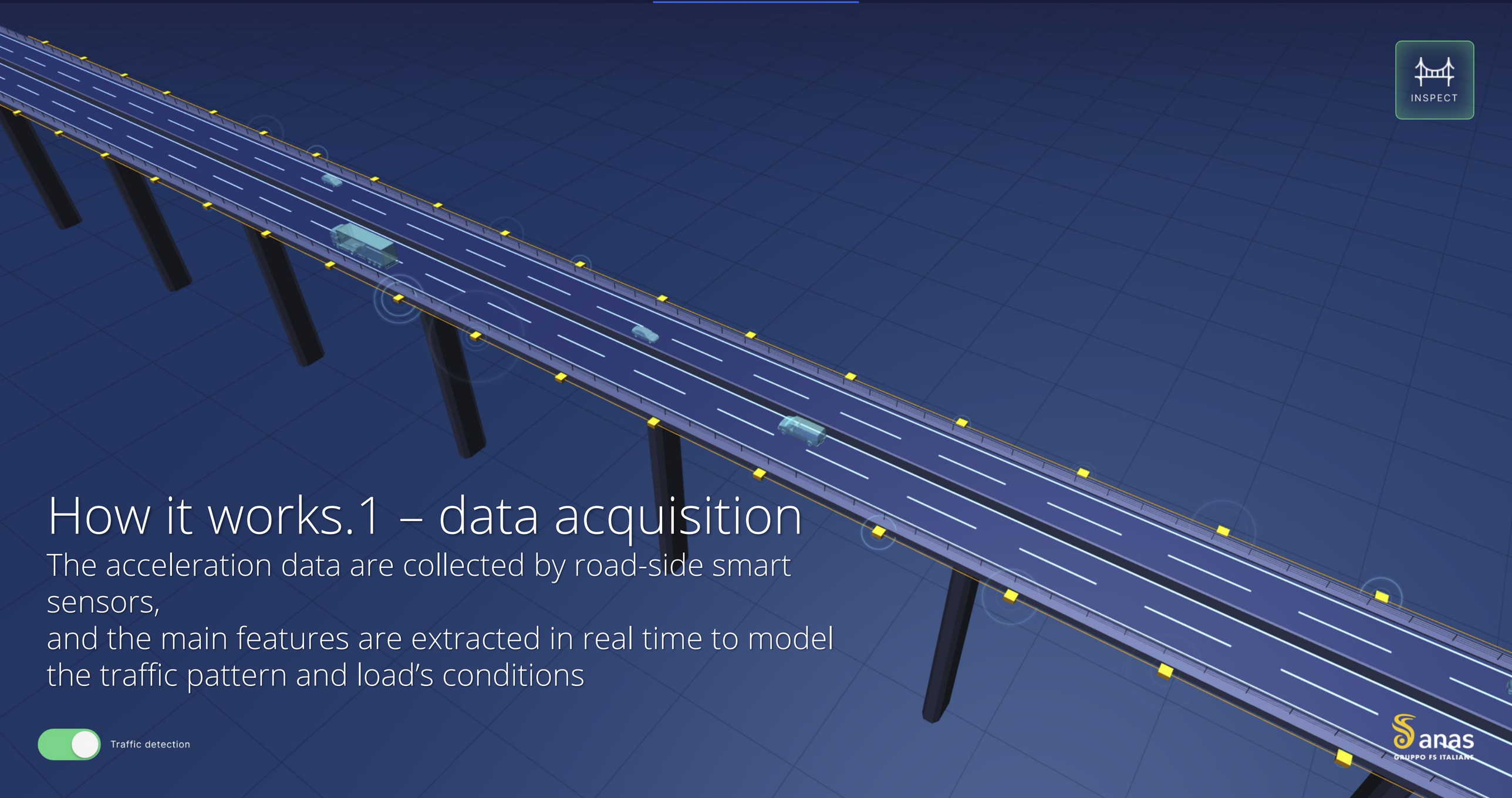








Sentetic V-DNA® – Unsupervised AI for Vibrational fingerprint identification



How it works.1 – data acquisition

The acceleration data are collected by road-side smart sensors,
and the main features are extracted in real time to model the traffic pattern and load's conditions

Traffic detection

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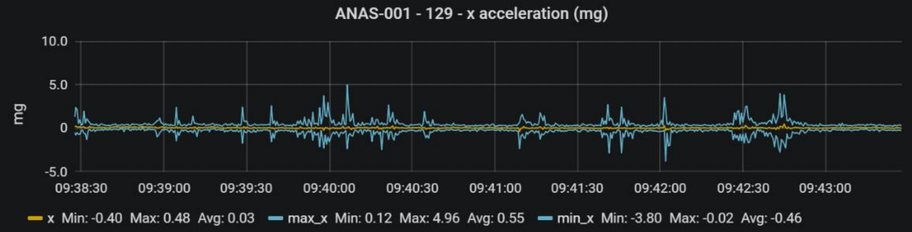
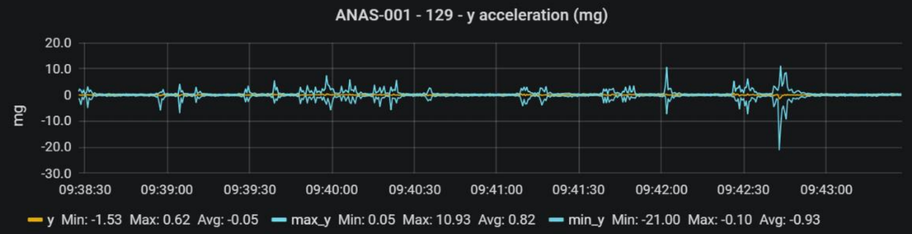
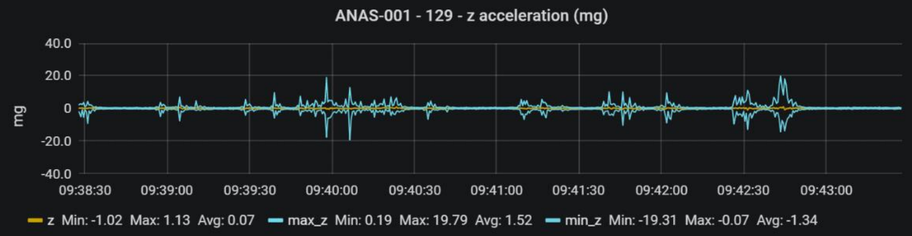
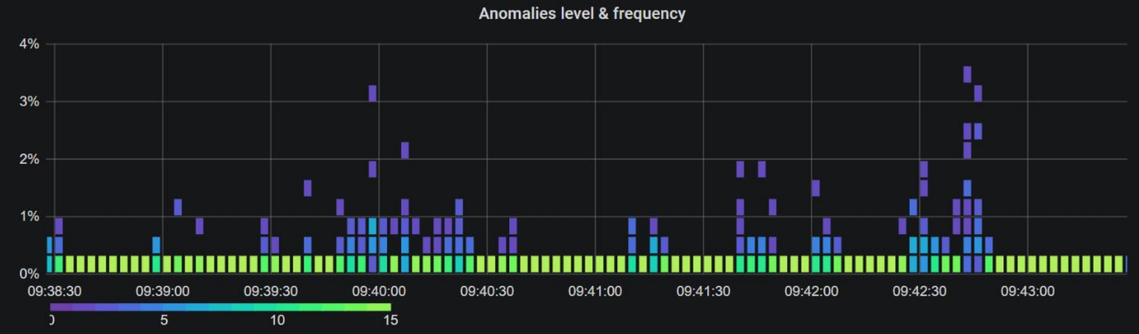
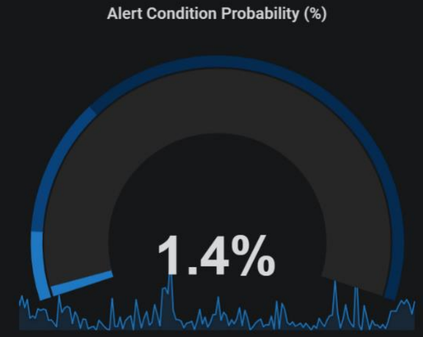
How it works.2 – data analysis

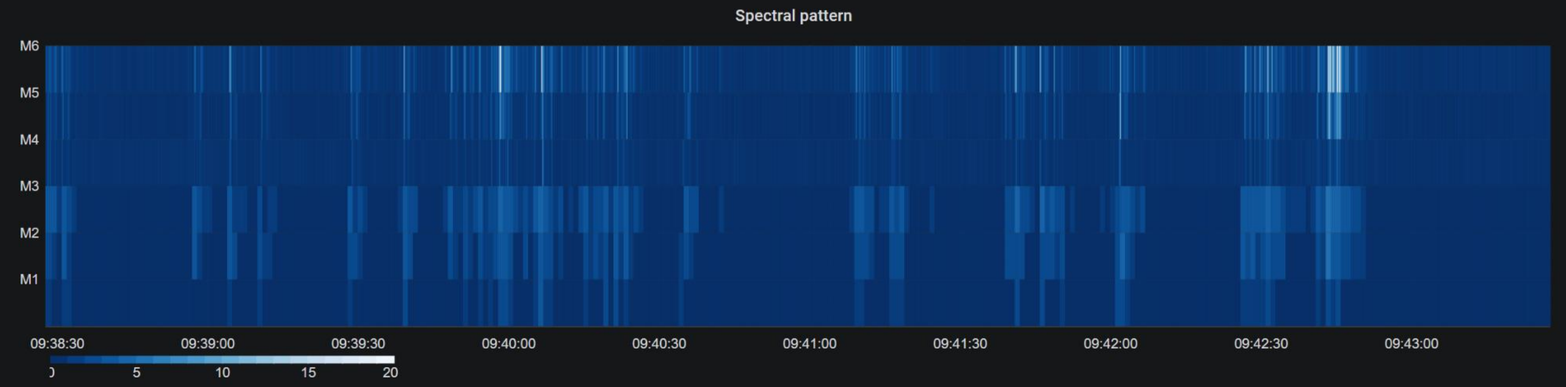


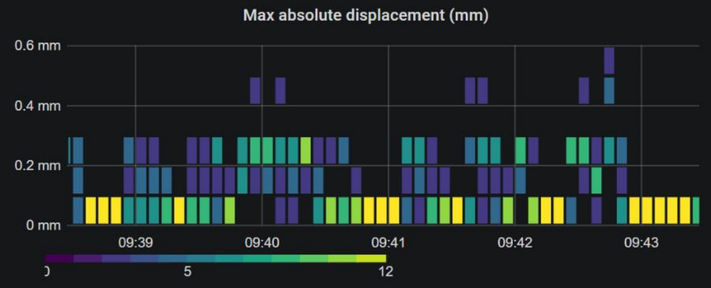


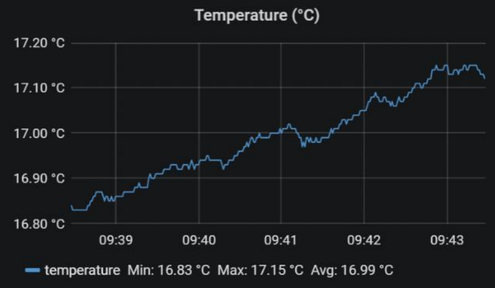


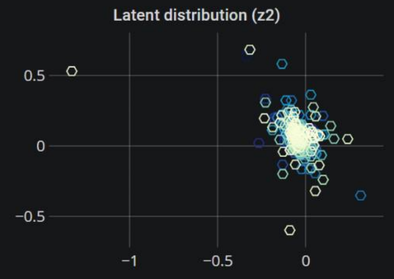


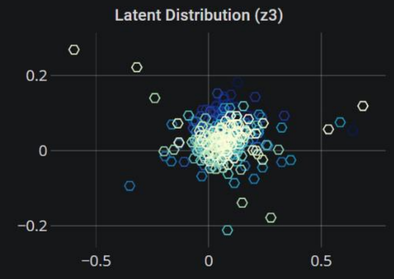








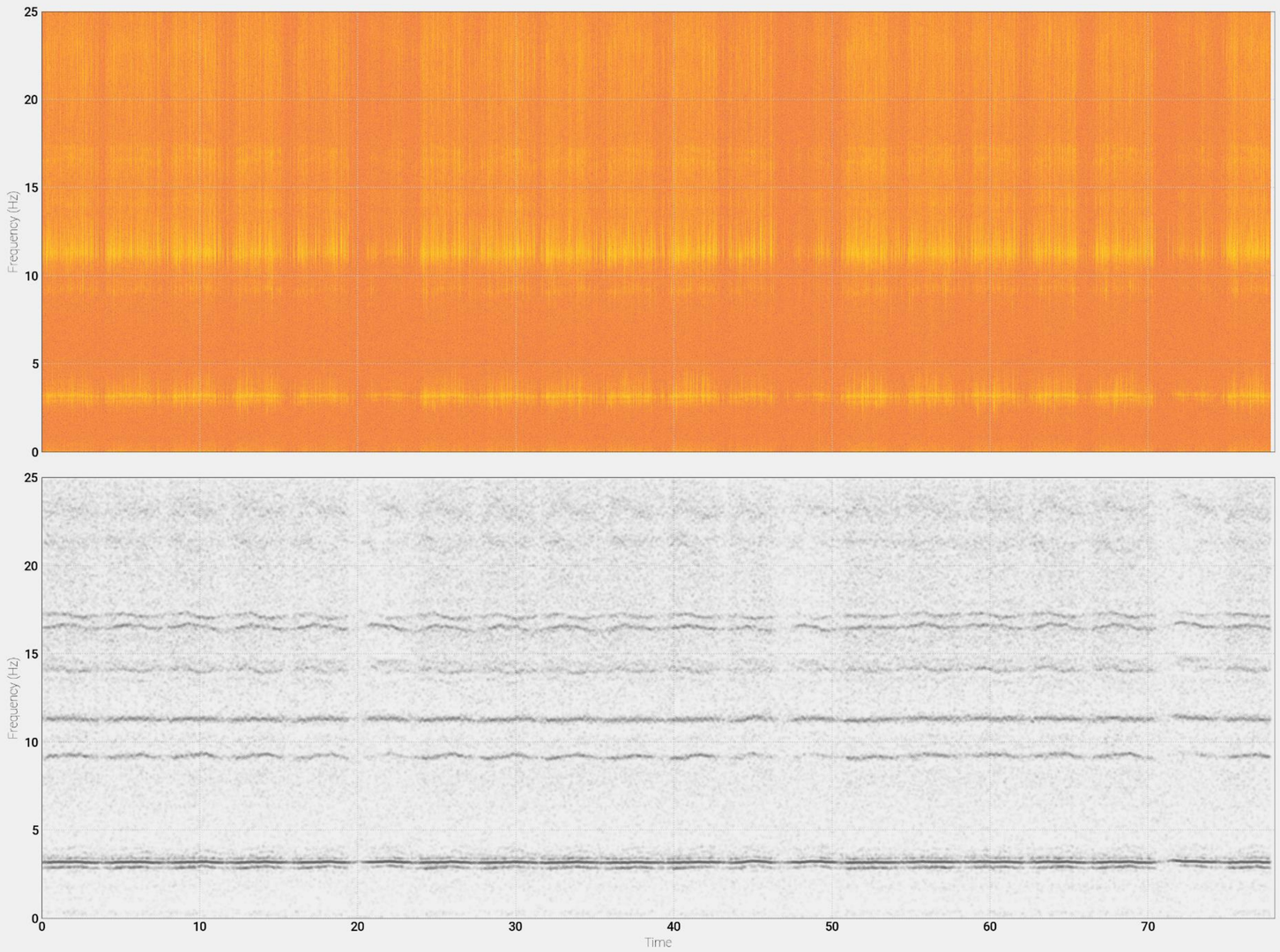




How it works.3 – feature extraction

The acceleration data are used to extract the main modal frequencies, and analized with Sentetic V-DNA® proprietary algorithms to extract the characteristics Vibrational Pattern of the bridge.

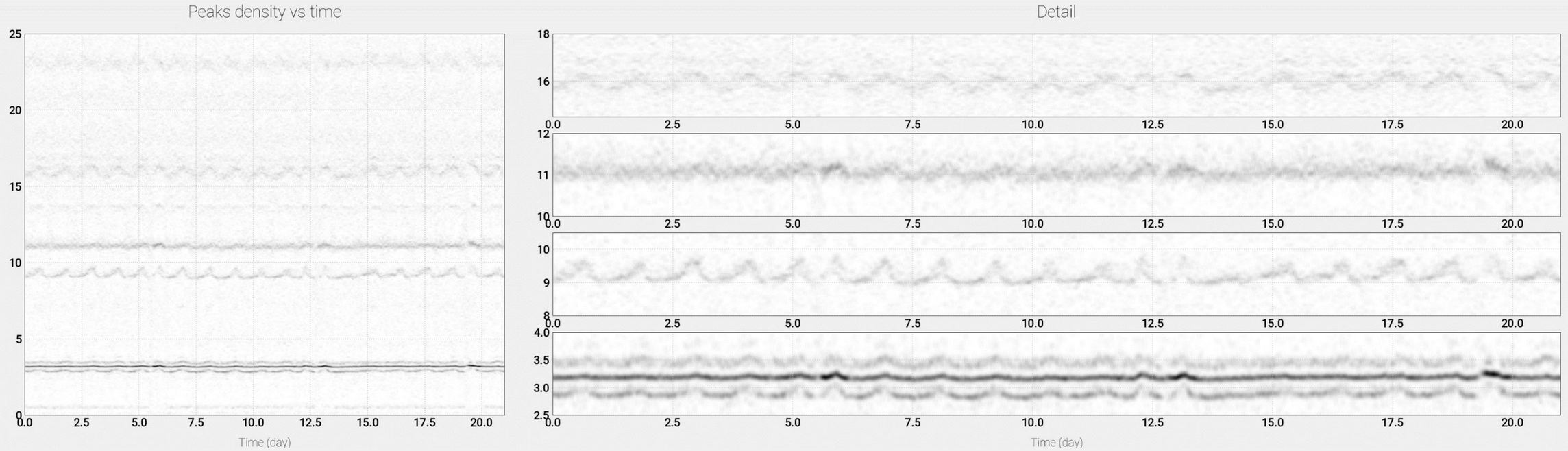
AI Feature extraction



Measured Spectrum

AI augmented Spectrum

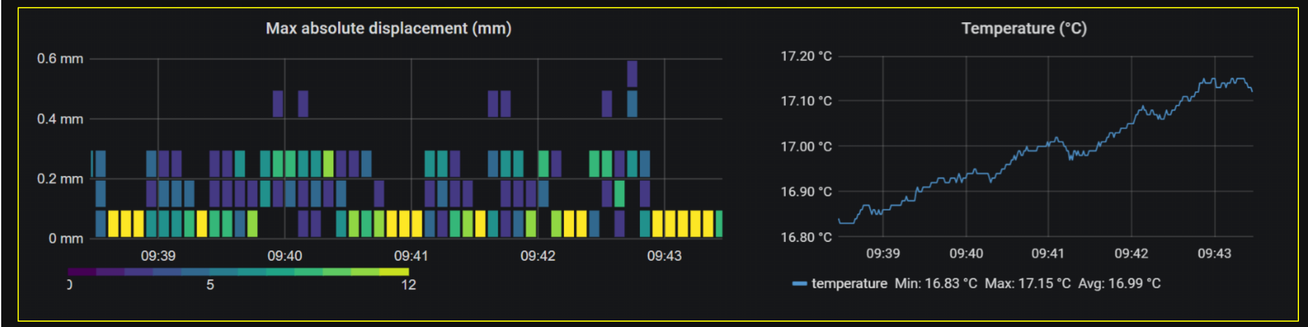
AI Feature extraction



Using **Variational Conditioned Autoencoders** and **Generative Models** we can learn the **Main Vibrational Modes dynamic**, feeding the Anomaly Detection algorithm with uncorrelated, noise-free data.

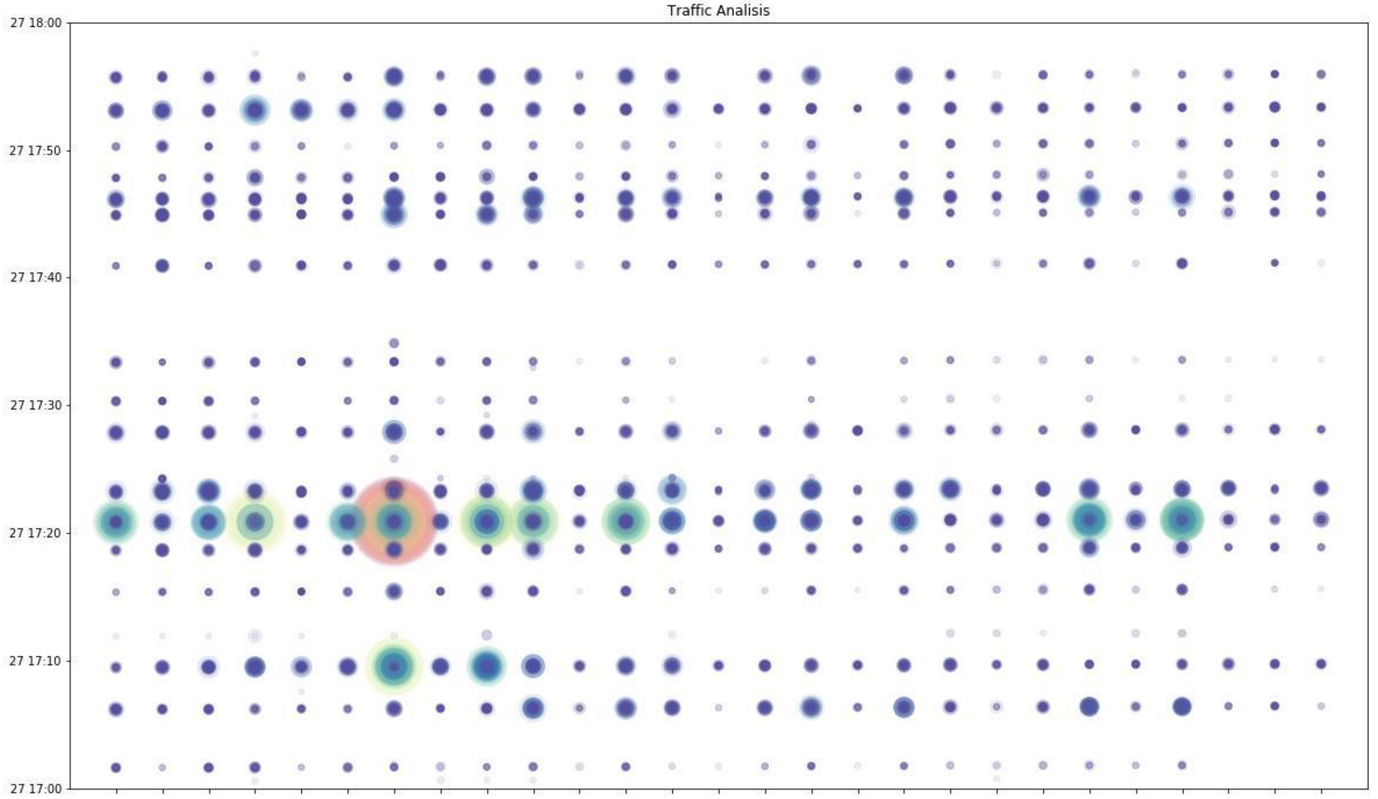
How it works.4 – model building

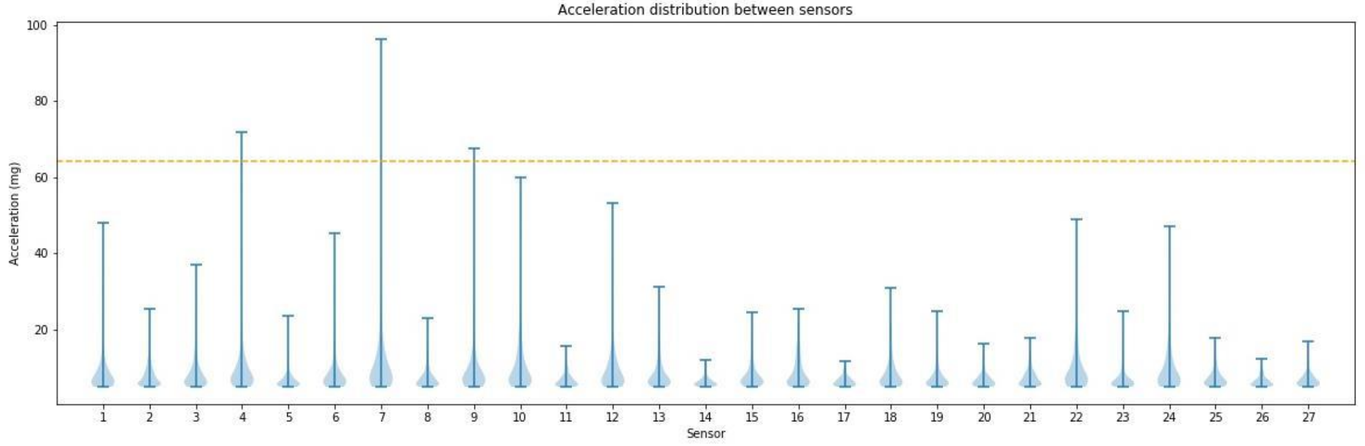
Then we use the environmental and traffic loads data to train the machine learning model to learn the correlation between modal frequencies shifts and environmental conditions.



Environmental condition clustering

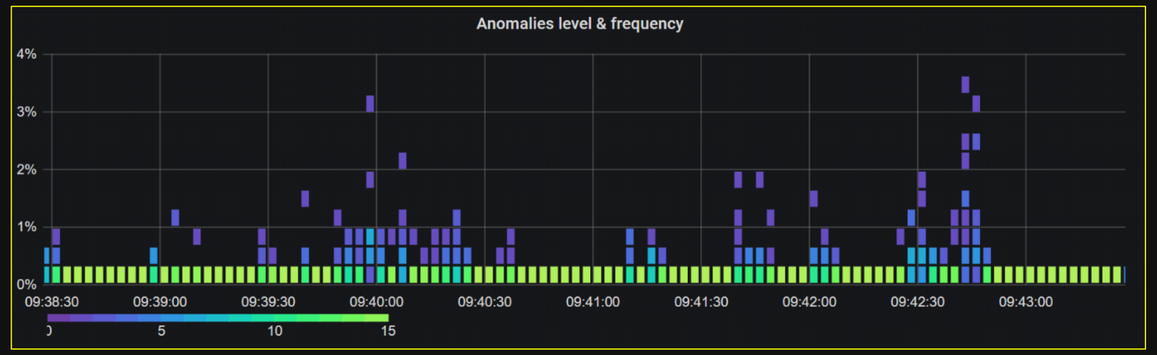
We cross-correlate **in real time** the spectral and dynamic response in different point of the infrastructure, using **custom developed unsupervised anomaly detection algorithms**, to identify localized and unexpected dynamic characteristics.

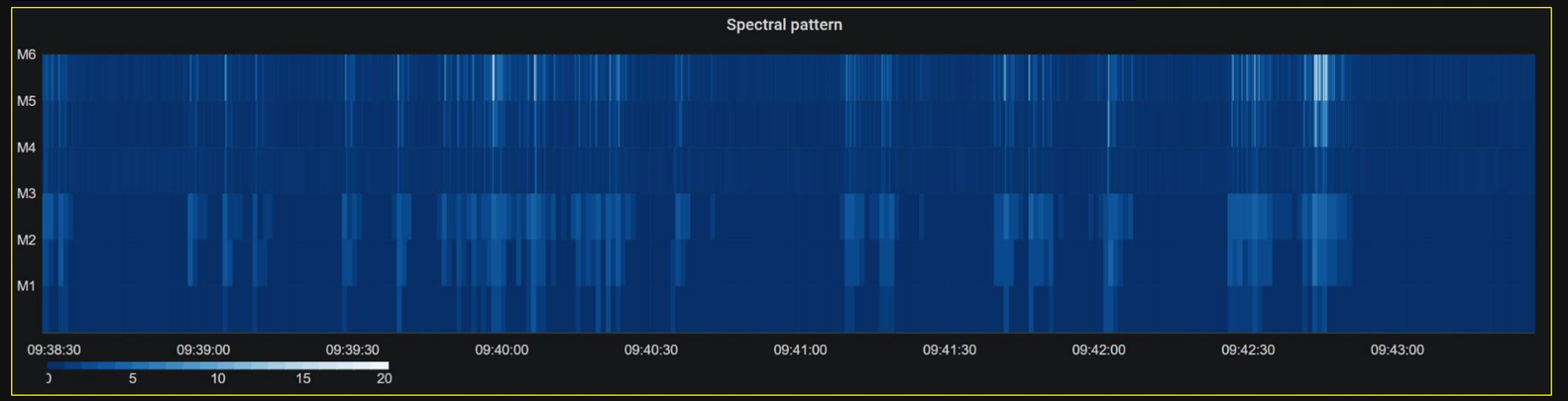


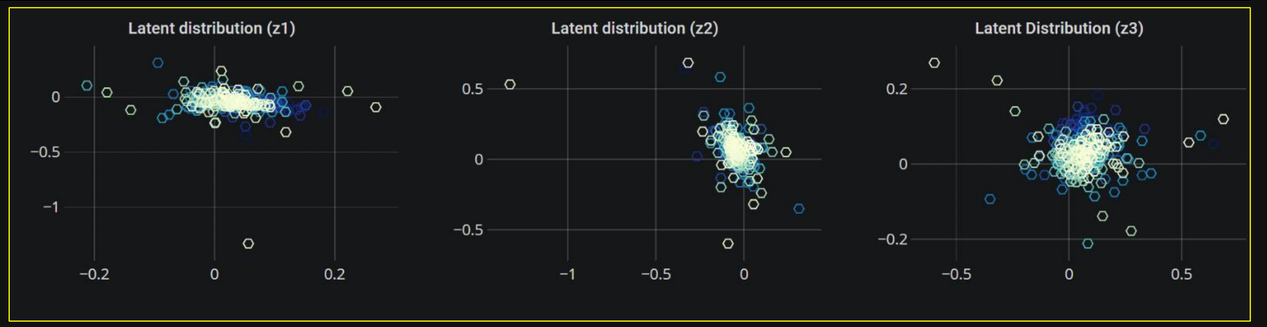


How it works.5
Anomaly detection

The spectral patterns extracted by the model are used to compare the real time data with the expected behaviour, and the differences are used to build a probabilistic model of anomalies.



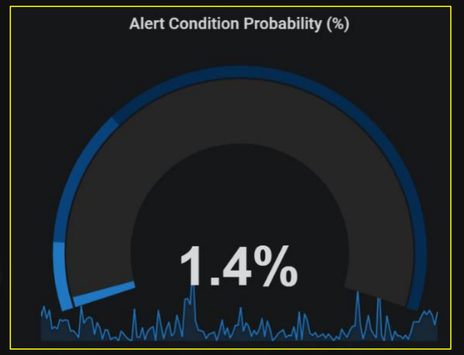




How it works.6 – real-time notification

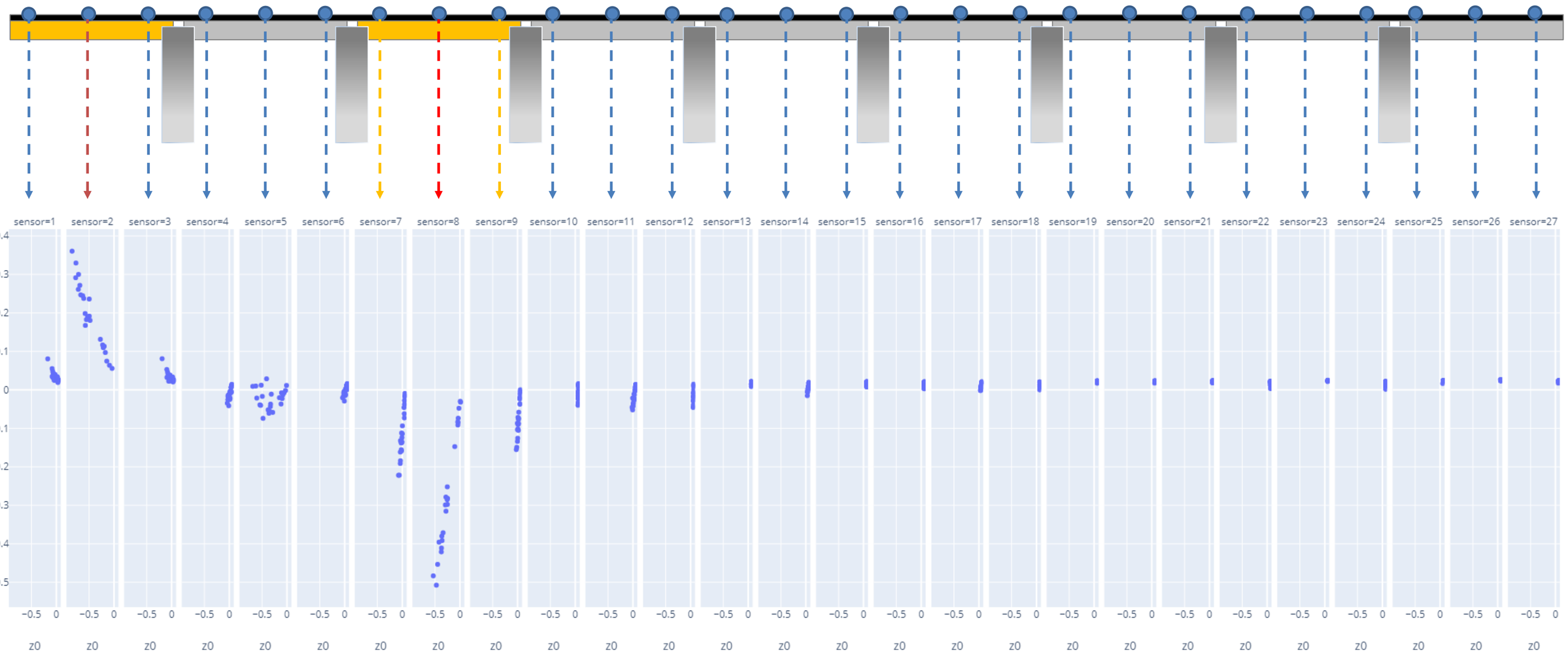
Finally, the statistical distribution of anomalies from the different sensors are reduced to a single anomaly condition parameter, that is used to provide a real-time feedback and notifications of the operating behaviour of the infrastructures.

These informations can be compared between different infrastructure to build a priority list of intervention, optimizing the maintenance activities and increasing the safety.



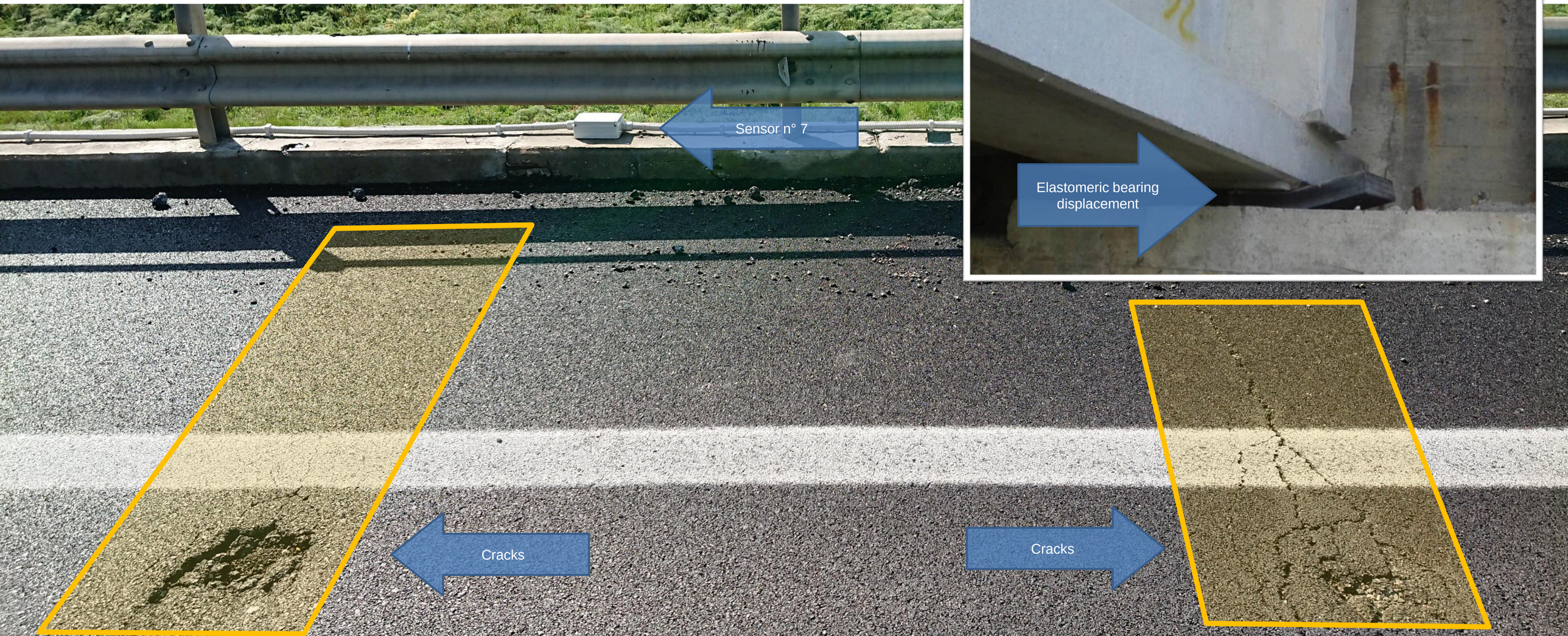
Anomaly detection - example

In this case, the probabilistic algorithm spotted a **suspect large variance of modal dynamics** on the beams 1 & 3 of a 500mt concrete bridge.



Anomaly detection - example

After an accurate inspection, a problem was found on the elastomeric bearing pad that also caused a crack on the recently restored upper surface.



Advantages

	Traditional Condition Monitoring	Sentetic SmartBridges
Reliability	Limited at the time of the survey	Higher, because it can spot trend and unusual event and correlate it with operating condition
Ease of use	Require Skilled professional and Domain specific Knowledge	Machine learning Based Automatic Anomaly detection
Costs	30K for 3 years (10K for each annual site inspection)	15K for 3 years of continous monitoring and realtime notifications

Sentetic SmartBridge

The voice of road infrastructures

Thank you

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