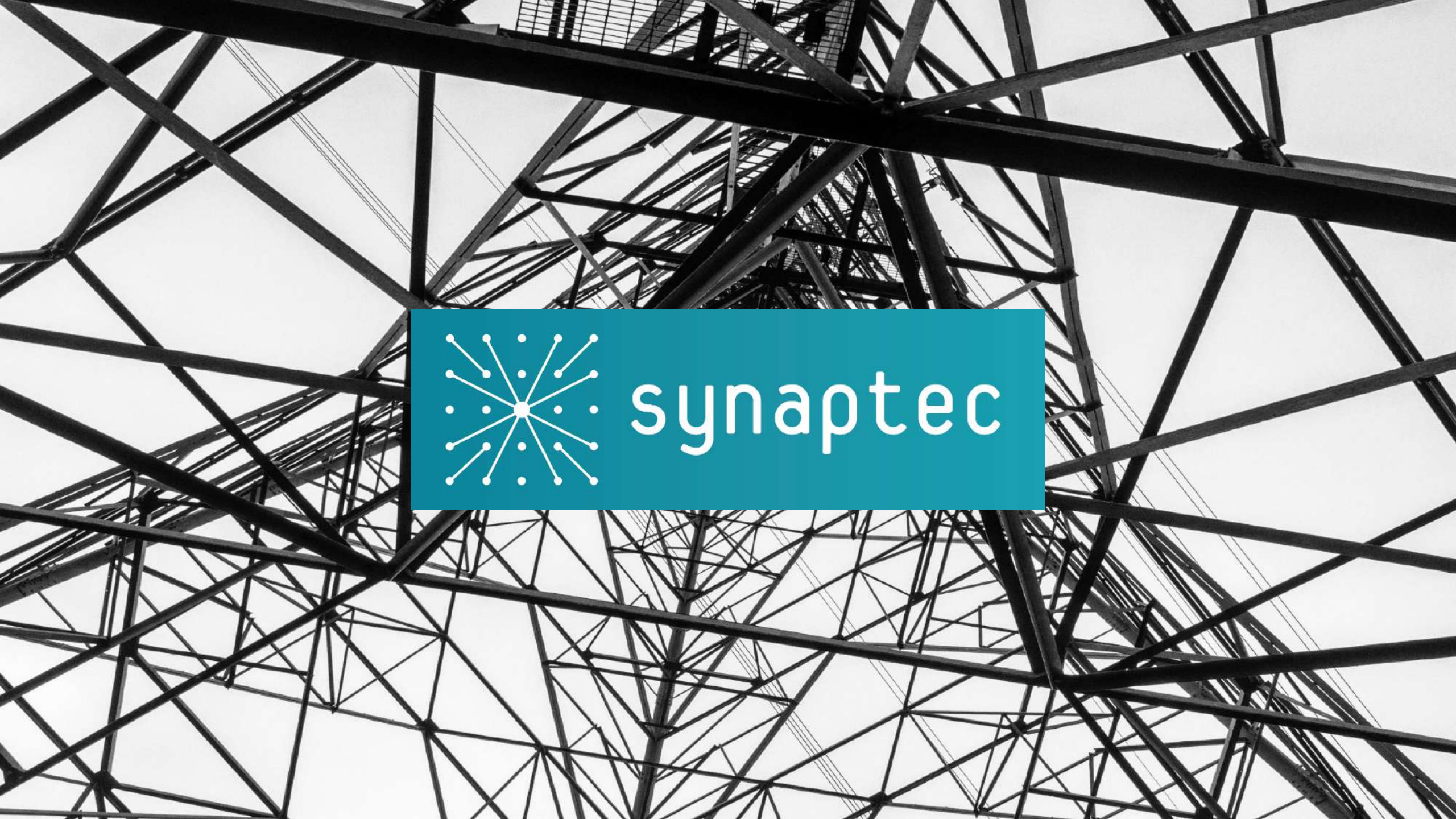
synaptec

Centralised Protection and Monitoring using IEC 61850

Dr Steven Blair

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Challenges in substation protection & monitoring

1. Complex multi-domain systems
2. Many physical IEDs to configure and maintain
3. Lack of data-driven maintenance



Light-speed power network insights

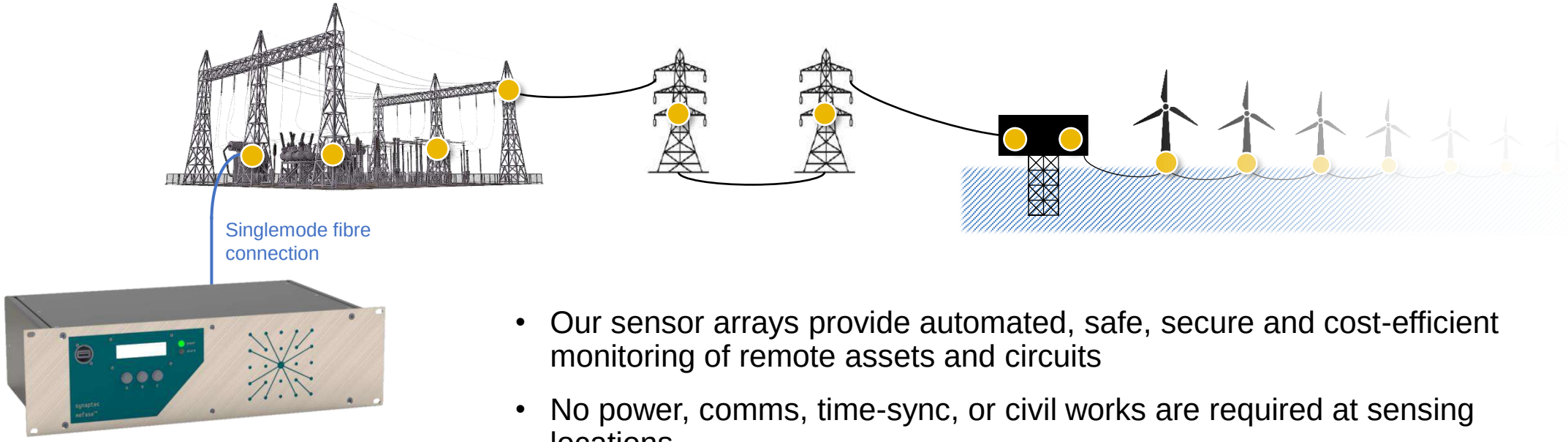
- Synaptec developed the first **completely passive** solution for distributed electrical sensing
- Unified electrical and mechanical visibility and control of power systems at **unprecedented speed, range, and price**
- Proven in mission-critical transmission applications, it is uniquely able to perform **wide-area protection instrumentation** on remote MV and HV assets

SP ENERGY NETWORKS · Statnett · WILLIAMS ADVANCED ENGINEERING · CATAPULT Offshore Renewable Energy · sse · VATTENFALL

Founded in 2015 — 2020

- UK's first digital substation
- Centralised busbar protection
- Proof of concept for offshore wind
- "No-build" grid connections
- First scale offshore deployment

How our sensor arrays are deployed



- Our sensor arrays provide automated, safe, secure and cost-efficient monitoring of remote assets and circuits
- No power, comms, time-sync, or civil works are required at sensing locations

- Our sensors measure **voltage**, **current**, **strain**, **vibration**, **temperature**
  - Electrical sensors are primary or secondary-connected and IEC compliant (**0.2** metering, **5P** protection)
  - Installed new or retrofitted safely and quickly using **existing installation techniques**

- Leverages standard telecoms fiber available (e.g. in OPGW and cables)
  - **50 sensors** per **100 km** of fiber
  - Measurements are **immune to EMI** and **inherently secure**

Application: centralised digital substations

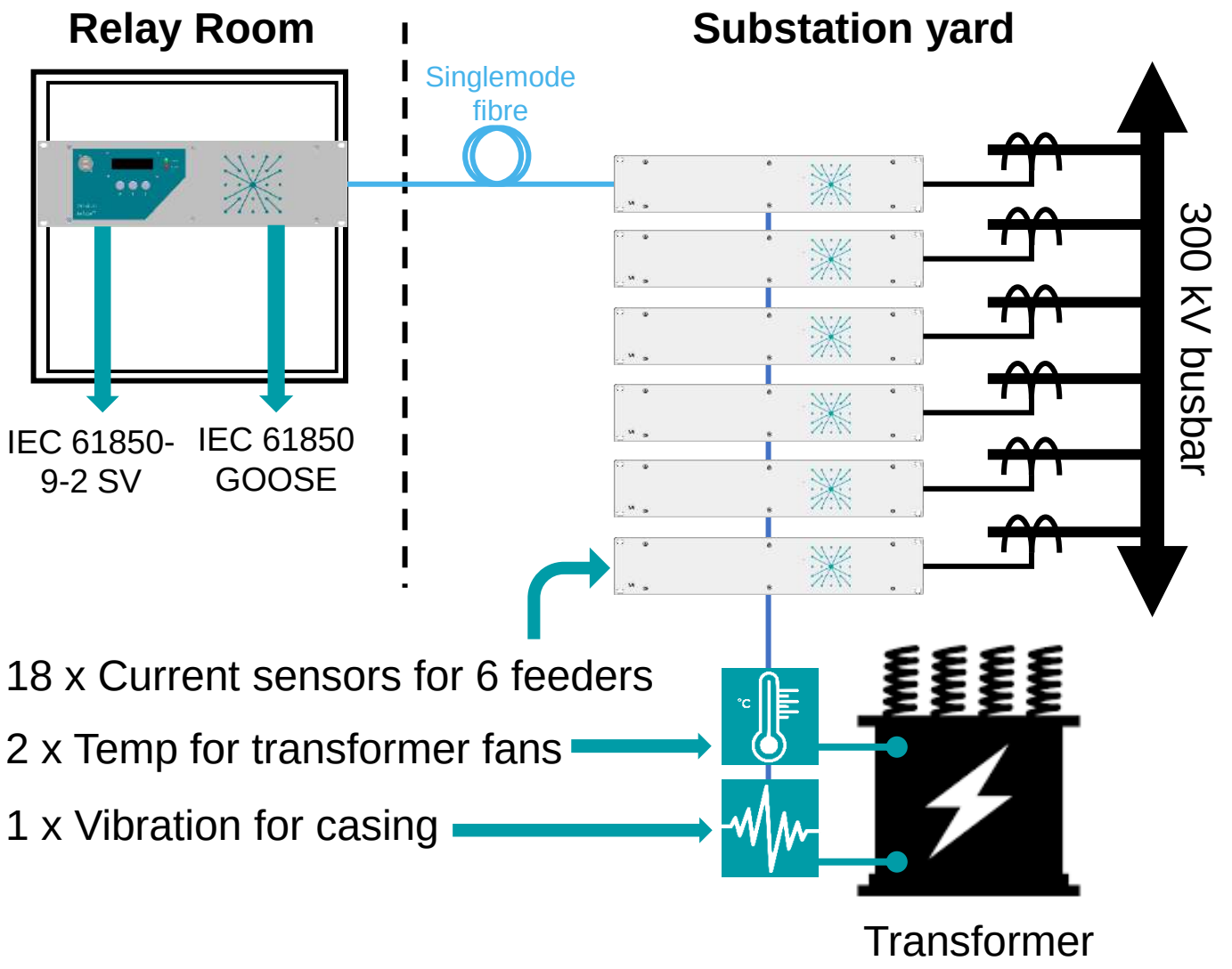
Statnett

Protection and control system

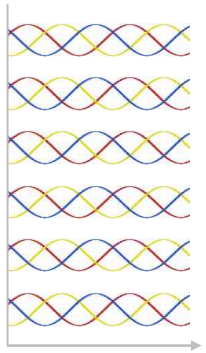
- Six-feeder busbar protection scheme, retrofitted to existing CTs in each bay
- Integrated protection algorithm
- Continuous Point on Wave (CPOW) via 4 kHz IEC 61850 Sampled Values
- Trip signals using IEC 61850 GOOSE
- Synchrophasor and Power Quality outputs

Condition monitoring

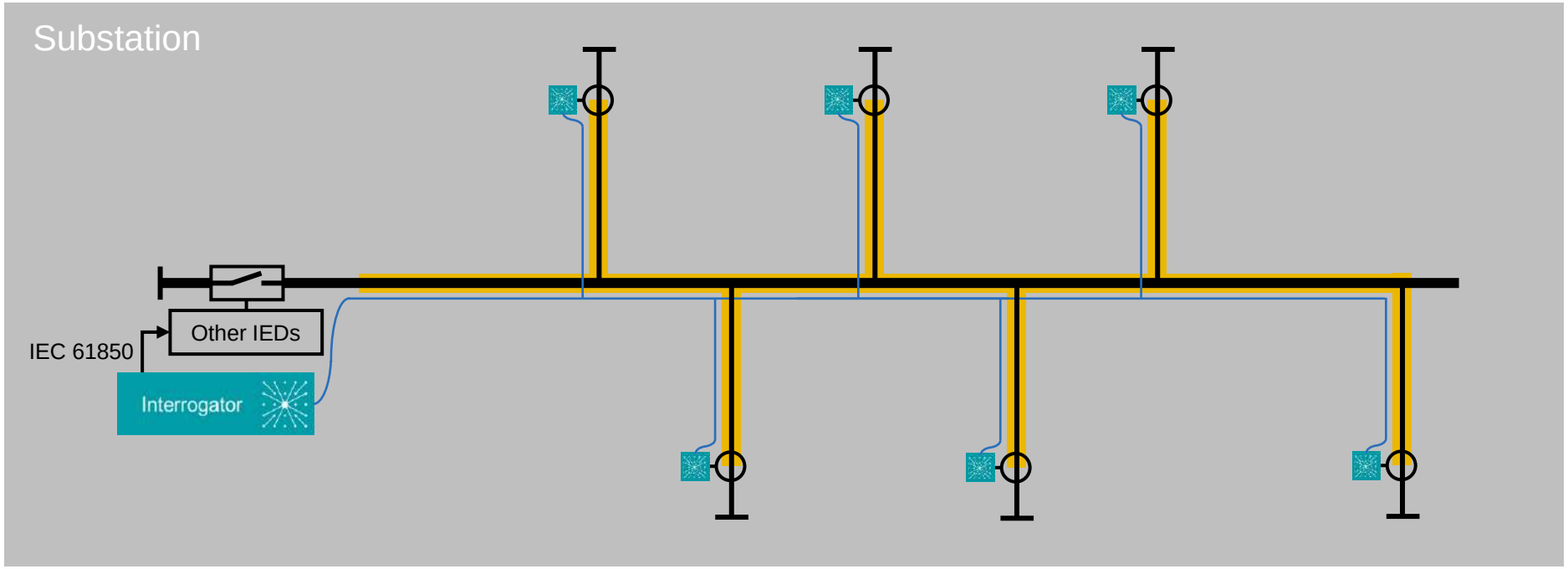
- Mechanical monitoring of HV transformer for temperature and vibration



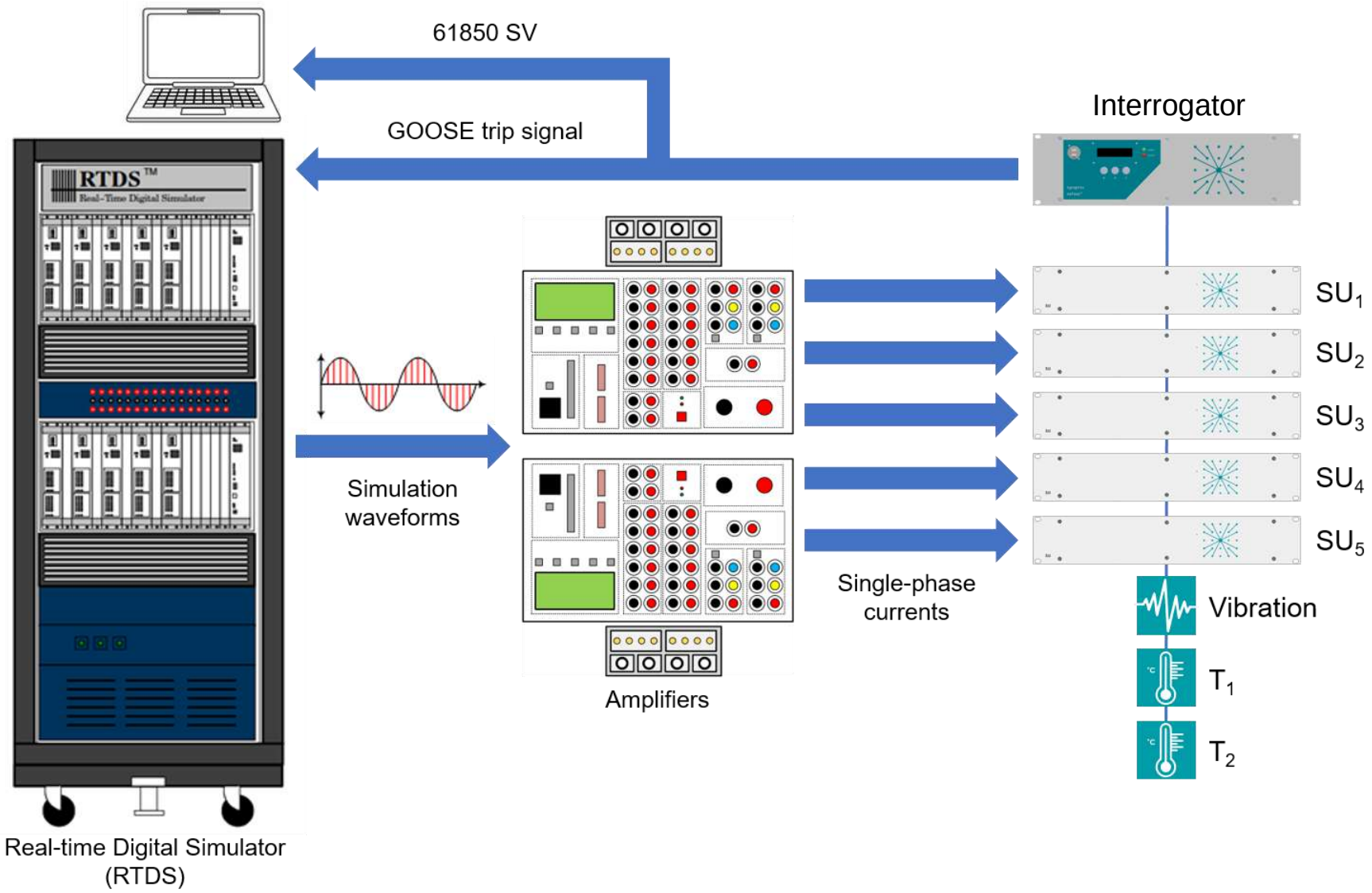
Busbar protection scheme overview



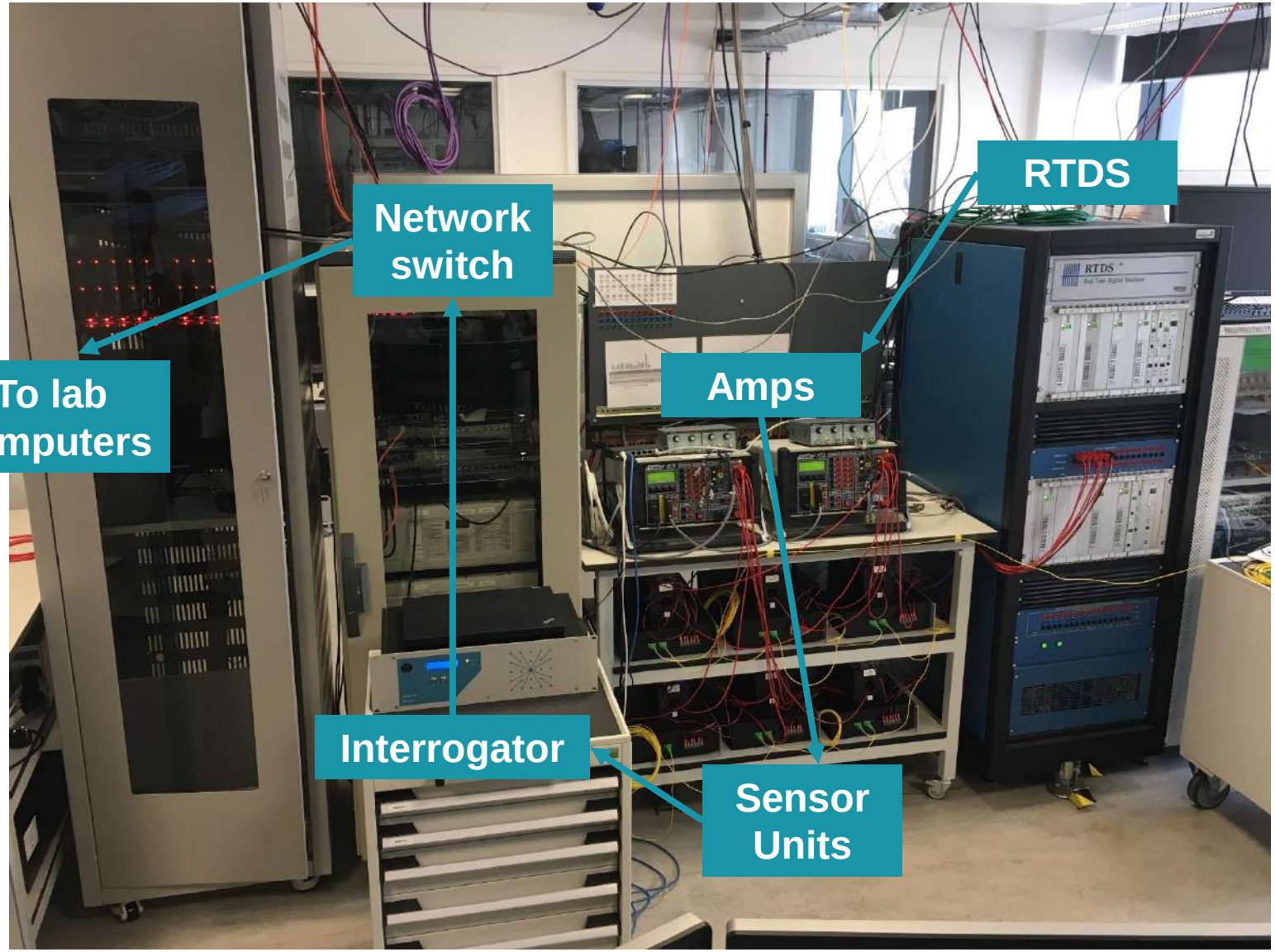
Synchronous waveform measurements



Factory Acceptance Testing – real-time simulation



FAT – lab layout



University of Strathclyde Glasgow

Dynamic Power Systems Laboratory

https://www.ulabequipment.com/facility/dynamicpowersystems

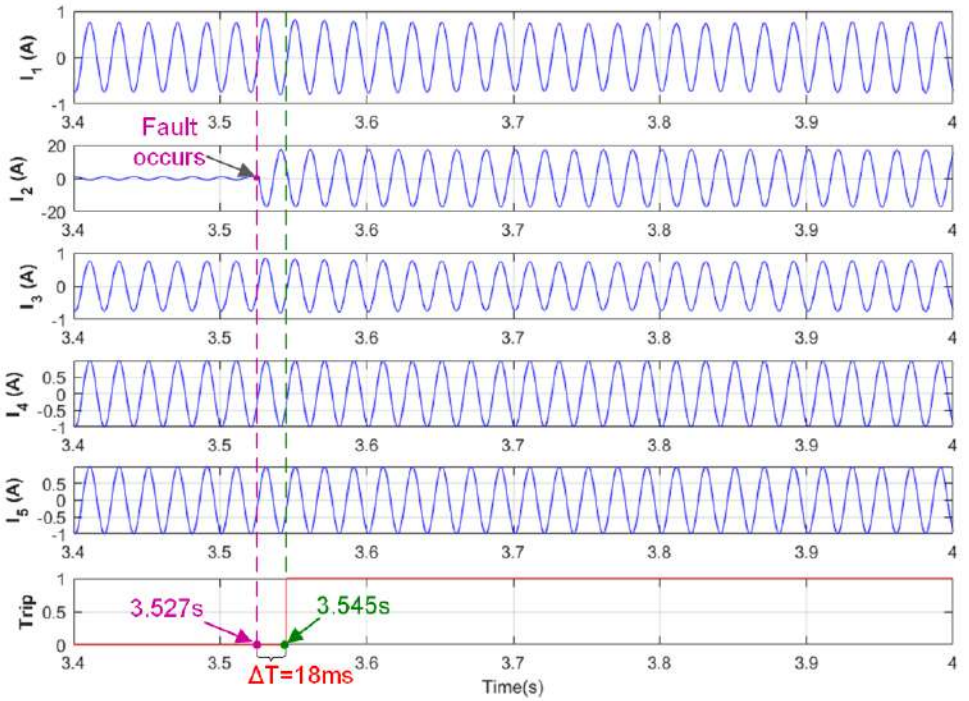
FAT – results

Testing process

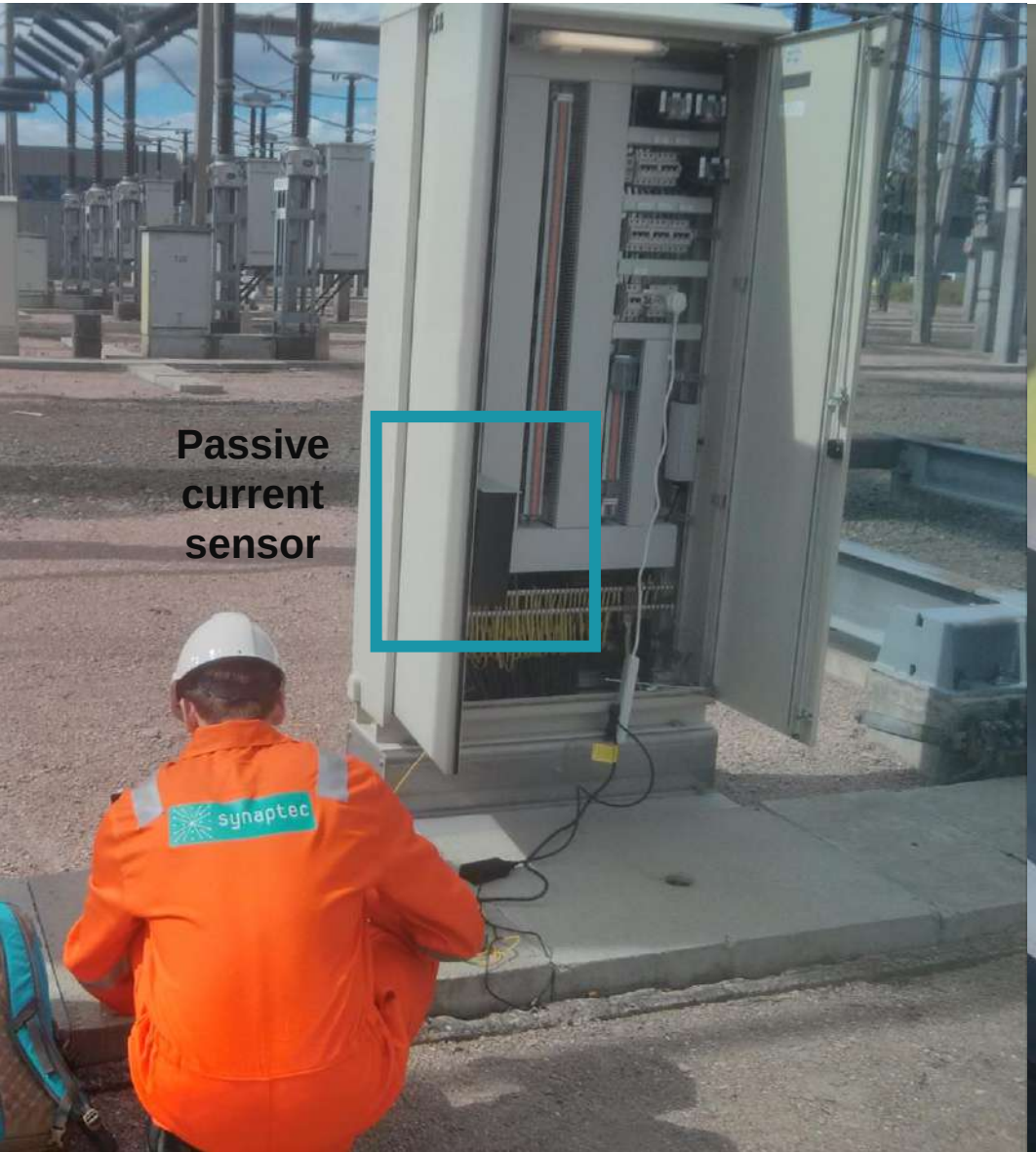
- Range of internal and external faults simulated to produce injection waveforms
- Injection by RTDS via amplifiers into six sensor units (18 currents)
- Interrogator outputting IEC 61850-9-2 SV for all measurements

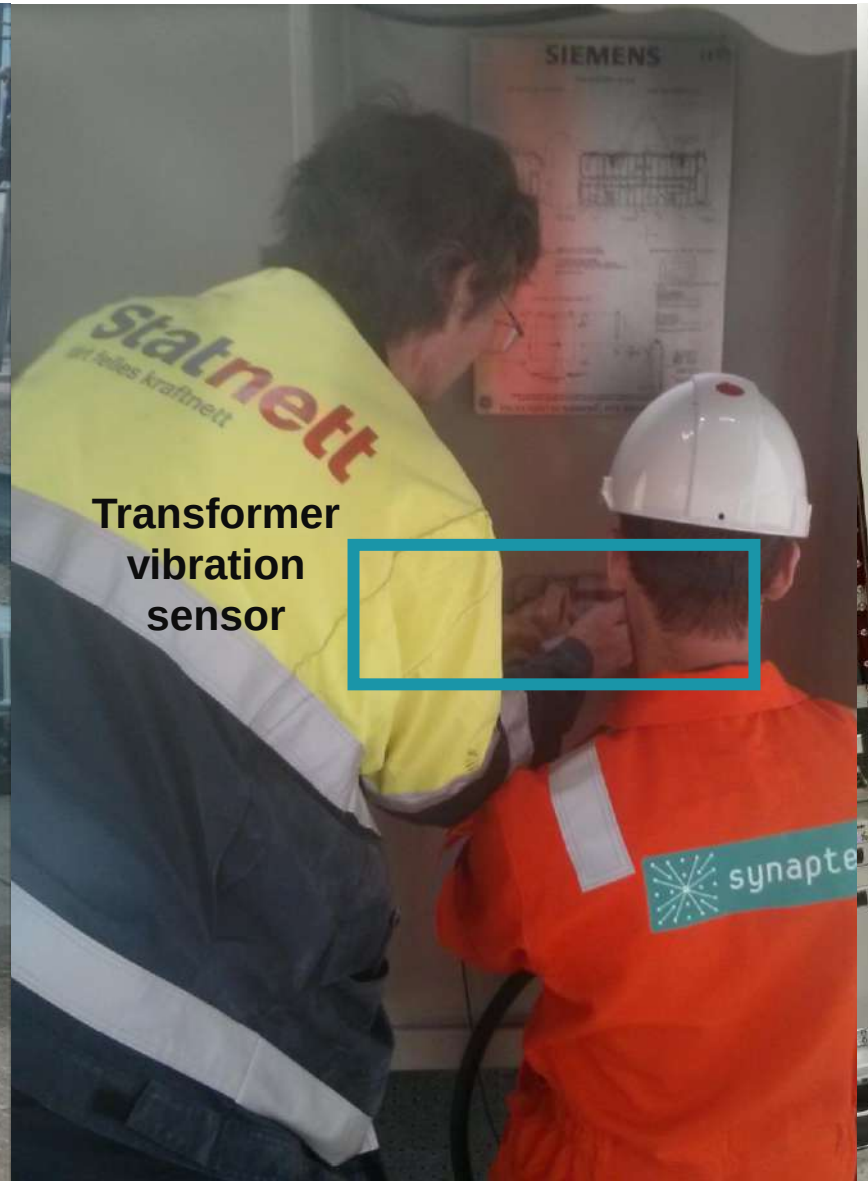
Outcomes

- Custom SV dataset for temperature and vibration measurement payloads – integrated into same data stream
- System operated correctly for all internal and external fault scenarios



Installation and commissioning





Synthesis: holistic automation and insights

Timescale

Days, months and years

Minutes

Milliseconds to seconds

Asset management

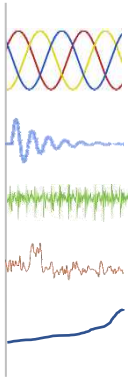
Identify changes and outliers over time to predictively maintain, avoid failure, and extend asset lifetime

Real-time monitoring

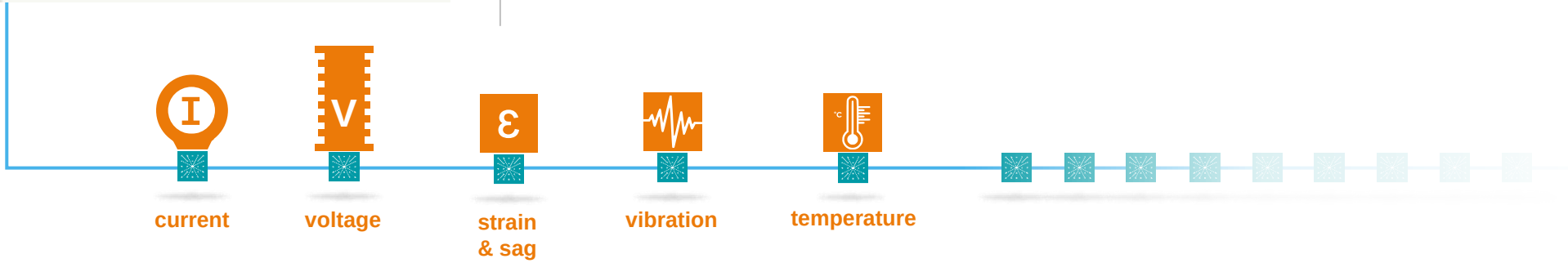
Real-time thermal rating, sag monitoring, oscillation detection, overheating alarms

Time-critical control and protection

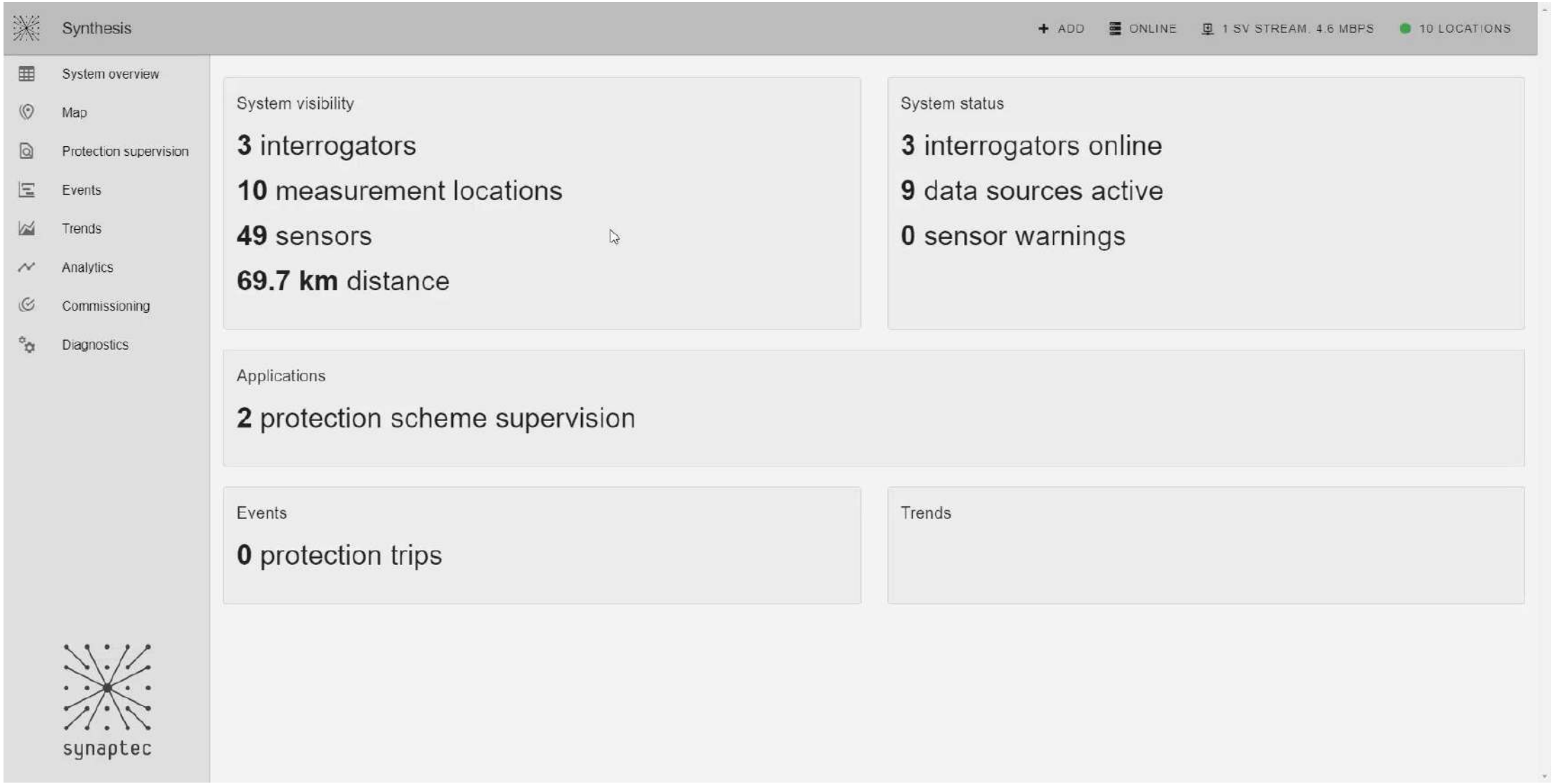
Centralised protection, wide-area protection, synchrophasor-based control



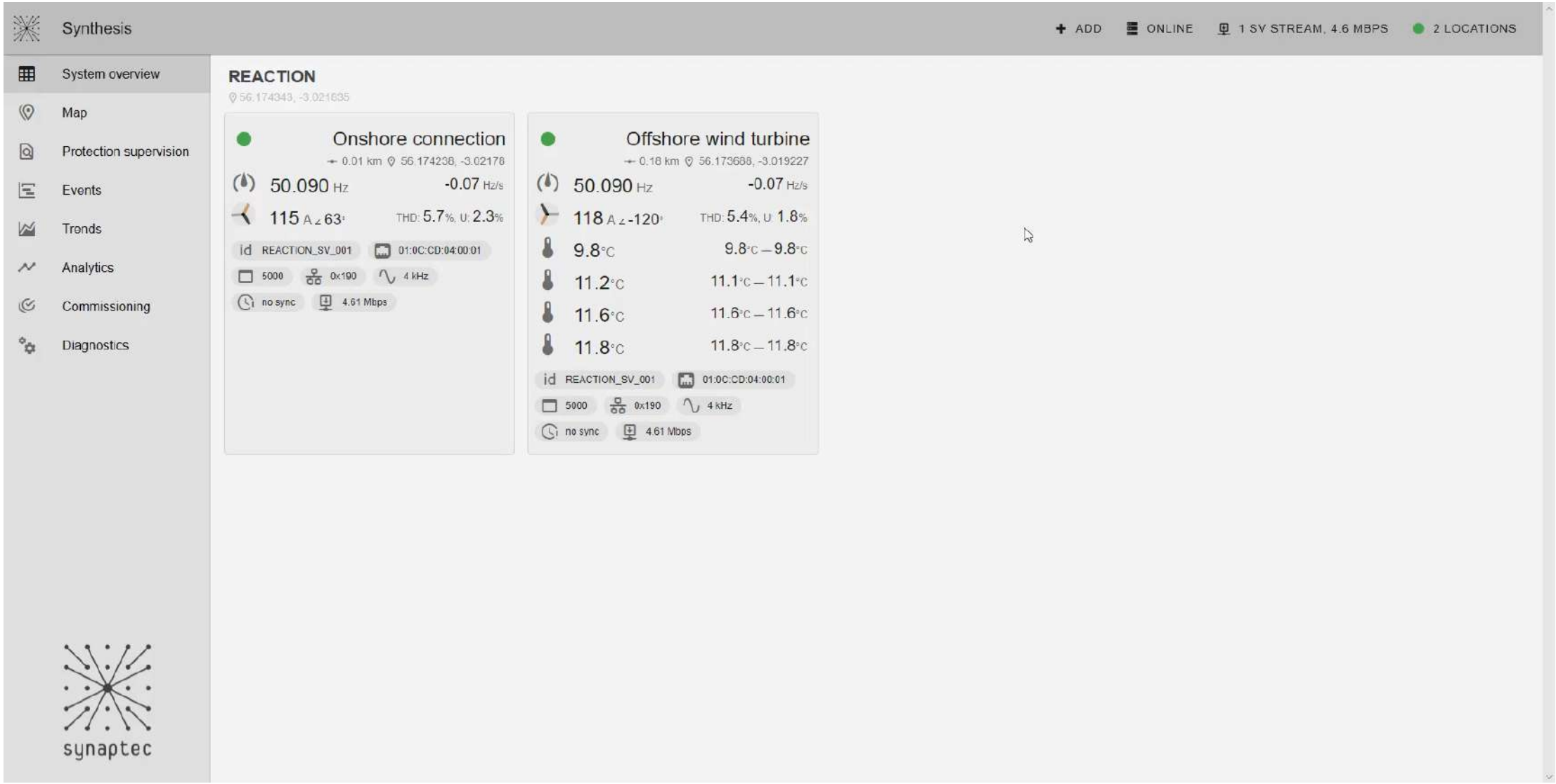
- Synchronous, continuous, measurements at **35 kHz**
- Correlated and published in one data stream
- Unified data historian and analytics platform
- Using industry standard data formats



Geographic overview of sensor infrastructure

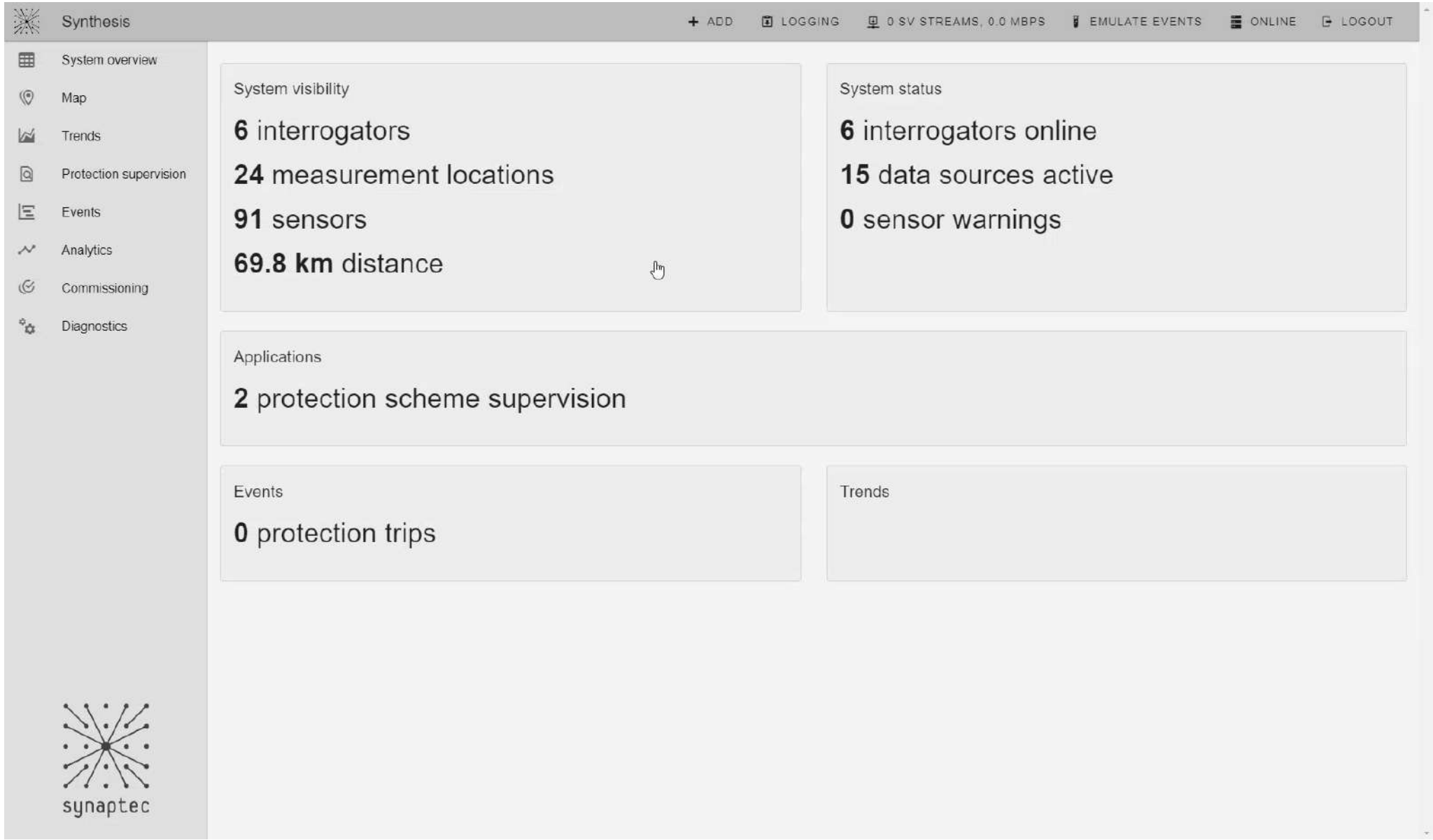


Real-time, continuous, high-resolution data



Detailed long-term trends

Scalable and flexible deployment



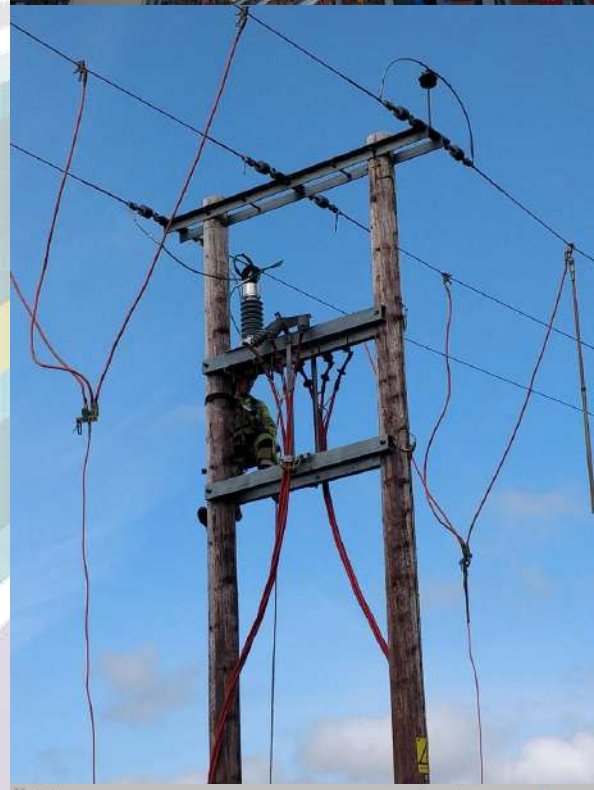
Solutions for substation protection & monitoring

1. Complex multi-domain systems
   Simplified design, centralised functions
2. Many physical IEDs to configure and maintain
   Passive sensing – fewer powered IEDs
3. Lack of data-driven maintenance
   Synchronised, multi-dimensional measurements



Summary

- Secure
- Maintenance-free
- Live, real-time data
- New, integrated data sources
- Low carbon footprint



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