Nederland

23 maart

Themadag CIGRE B2

LIJNEN een kwestie van VERBINDEN

Dynamic Line Rating: maximalisatie van de belasting d.m.v. omgevingsomstandigheden metingen

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Agenda

- Dynamic Line Rating (DLR)
    - Solution description
    - Sag from conductor vibration
    - Wind measurement
    - Rating forecast
- New Developments
    - Conductor monitoring

System description

Sensors

Enterprise software solution

Highly available, redundant solution

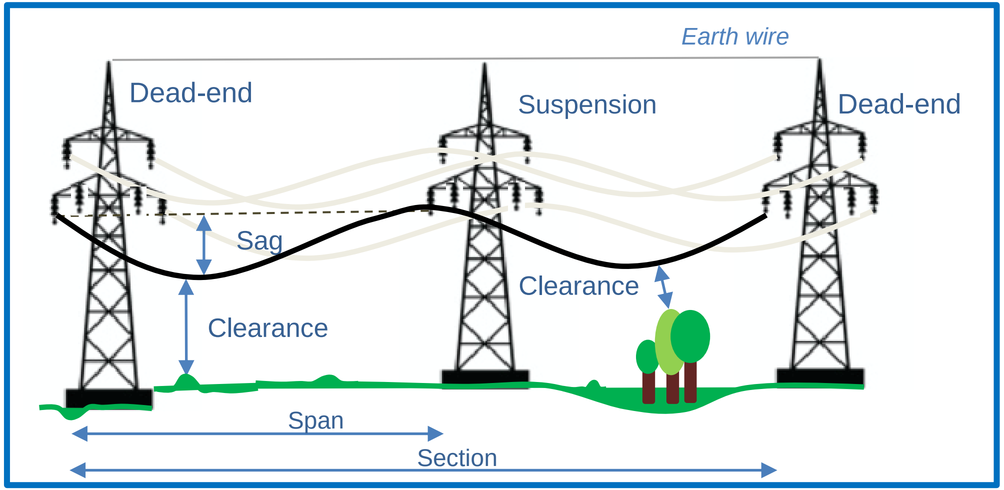
EMS/SCADA full integration

Cybersecure (ISO-27001)

User interface, restAPI, sFTP

Cloud/on-prem installations

Line capacity is limited by Sag and Max Conductor Temperature



Thermal limits

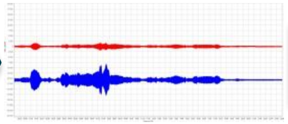
- Maximum Conductor Temperature
- Maximum Sag

Rating (maximum load current)

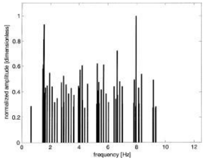
- Static (SLR) based on fixed/seasonal, conservative ambient conditions, no field information
- Dynamic (DLR) based on variable, real-time ambient conditions, with field information

Implementing DLR

ADR Ampacimon
AMPACIMON DYNAMIC RATING

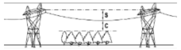


3D Accelerations
measured with high sensitivity accelerometers

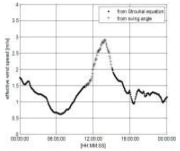


T- Line Vibration Frequency Spectrum
(up to 100 Hz used for sag & wind speed measurements)

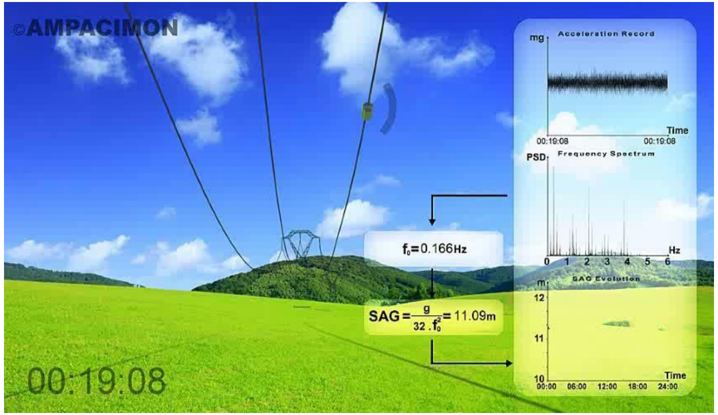
Sag Measurement



The fundamental frequency defines the span's signature



Wind Speed measurements
Effective perpendicular component
Swing Angle
Aeolian Vibrations



State Change Equation

Mean conductor temperature

Weather Variables
- Ambient temperature
- Solar radiation

Line Information
- Line Current
- Conductor parameters

Line Tension
- w/ Tension Monitor within Sensor (for ice detection)

Transmission Line Performance
- Real-time Sag monitoring
- Real-time mean conductor temperature monitoring
- Real-time Dynamic Line Rating
- Transmission Capacity forecast
- (Intra-day, Day-ahead)
- Ice Detection
- Galloping Detection

Applicable standards and guidelines for calculation of line ratings

Calculation methods are based on Cigré and IEEE standards

- IEEE 738
- Cigré TB 207
- Cigré TB 601
- Cigré TB 498

https://e-cigre.org/
https://ieeexplore.ieee.org/

- IEEE Standard 738-2012, “IEEE Standard for Calculating the Current-Temperature Relationship of Bare Overhead Conductors,” 2012. (IEEE 738) (13)
- CIGRÉ Technical Brochure 207, “Thermal Behavior of Overhead Conductors, Working Group 22.12,” 2002. (CIGRÉ 207) (14)

- WG B2.42: TB 601 -- **Guide For Thermal Rating Calculations Of Overhead Lines**

Electra #262, TB #498 - June 2012	**Guide for application of direct real time monitoring systems on OHL (WGB2.36)**

Applicable standards and guidelines for calculation of line ratings

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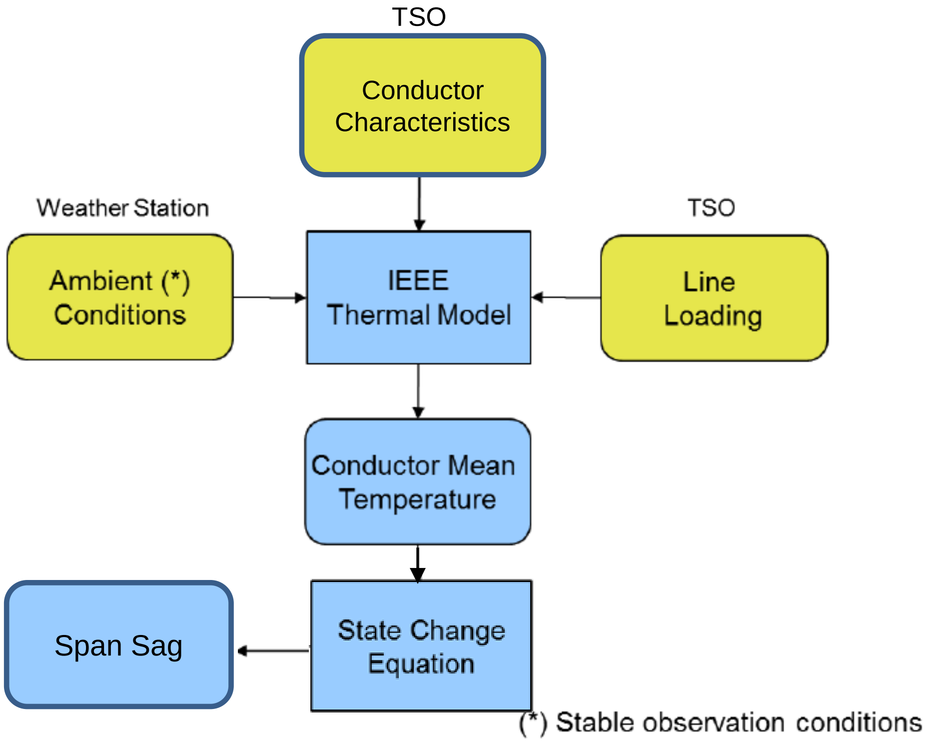

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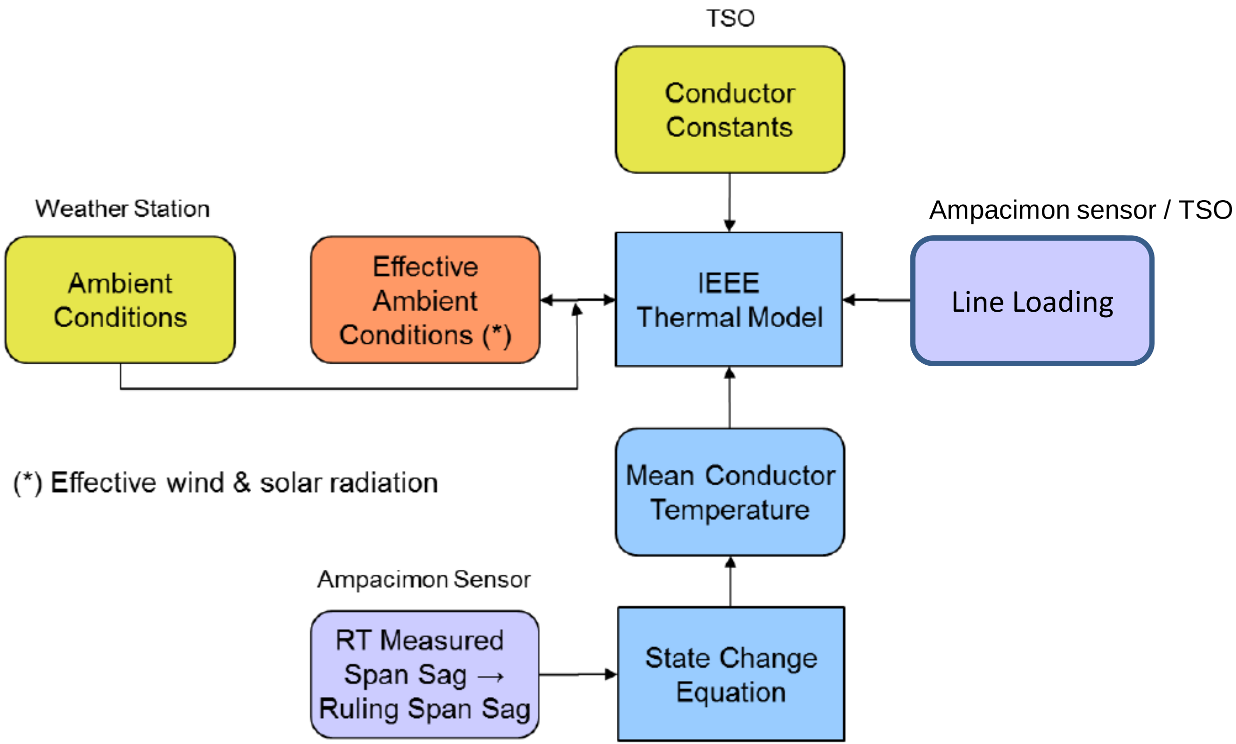
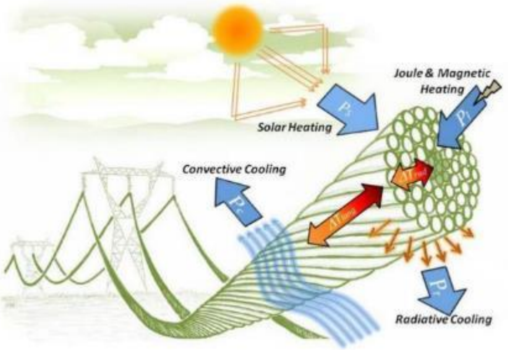
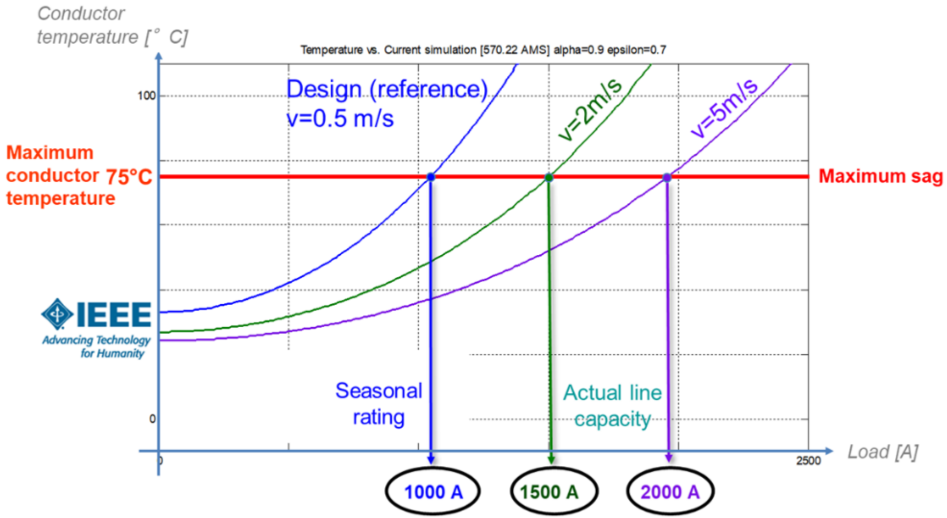


Line capacity is sensitive to weather

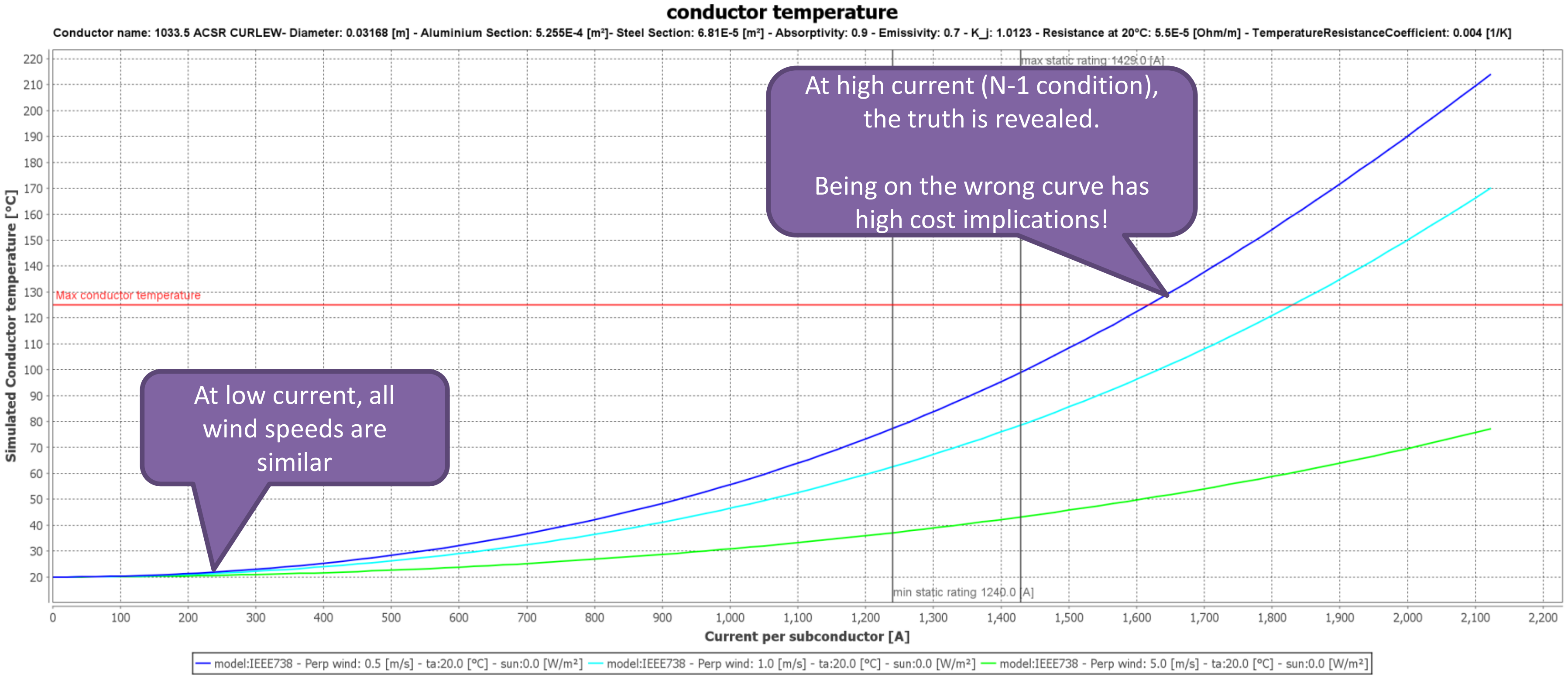


Ambient conditions impacting rating:

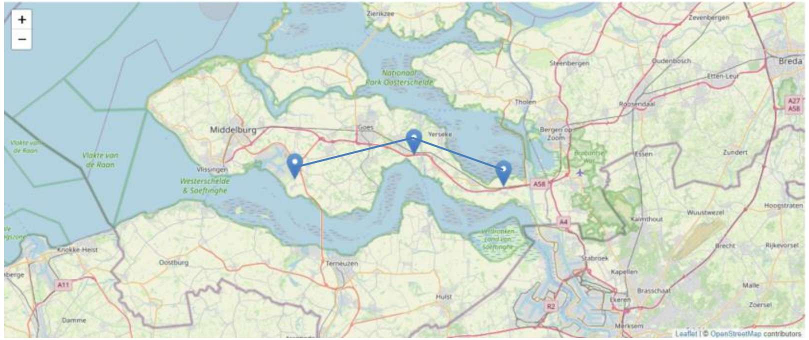
- *Wind speed*
- Ambient air temperature
- Solar radiation



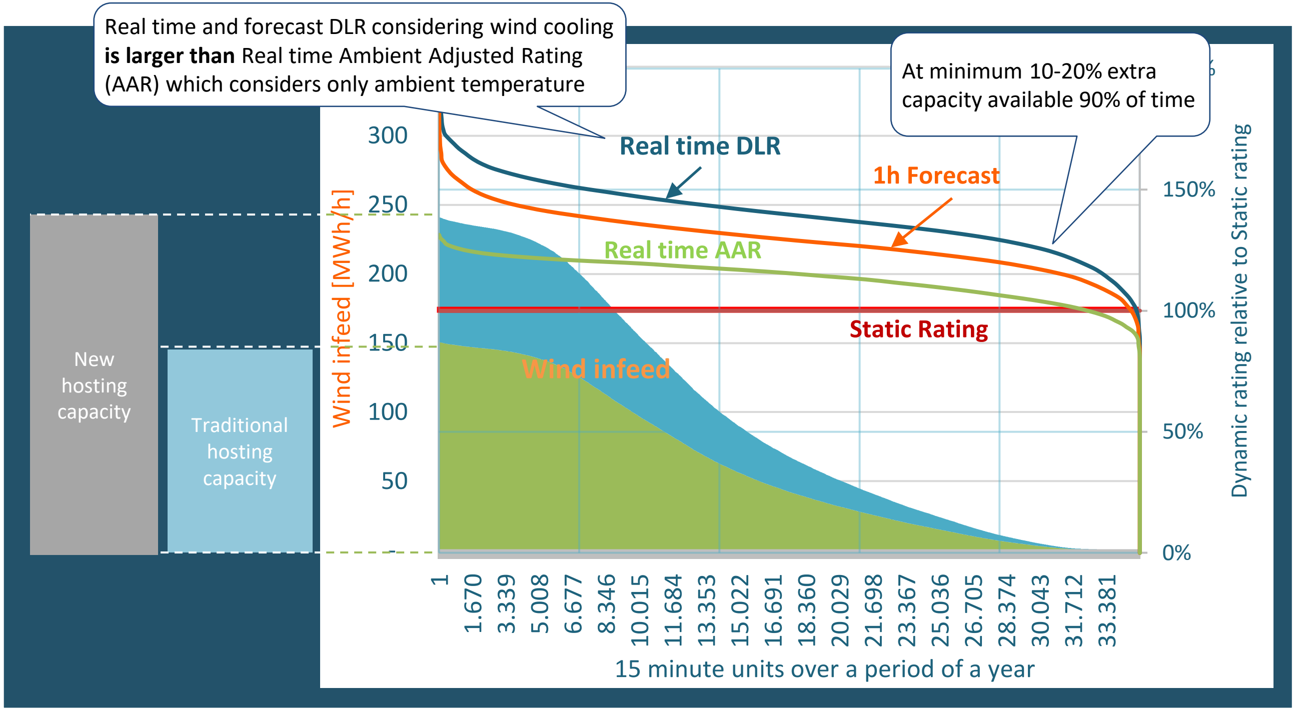
Line load & wind forecasting



Tennet 380KV – Borselle/Rilland Rating Forecasting



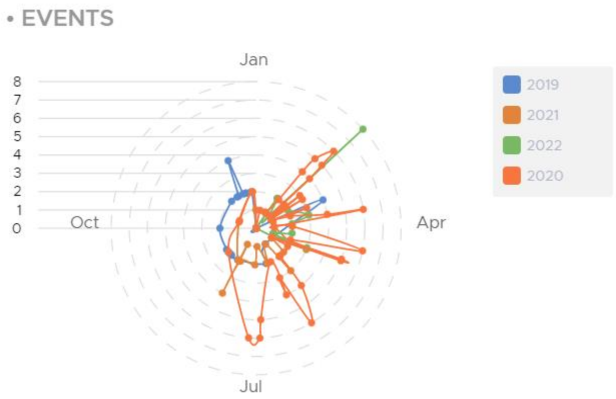
Line Rating Gains – Static vs. AAR vs. DLR

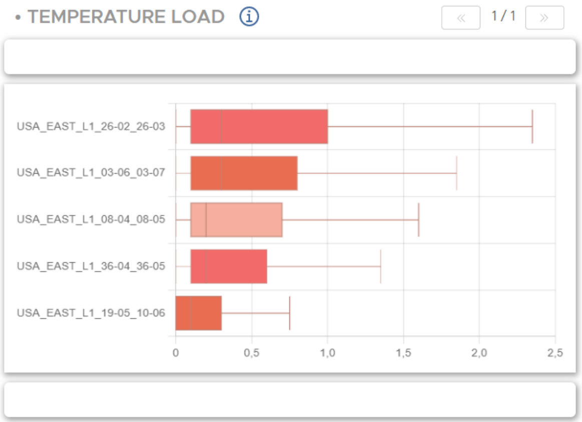


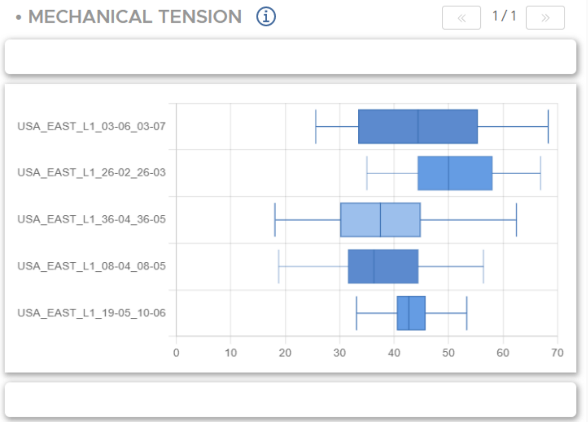
- New Developments
    - Conductor monitoring

Continuous monitoring of weather-induced events and operational parameters

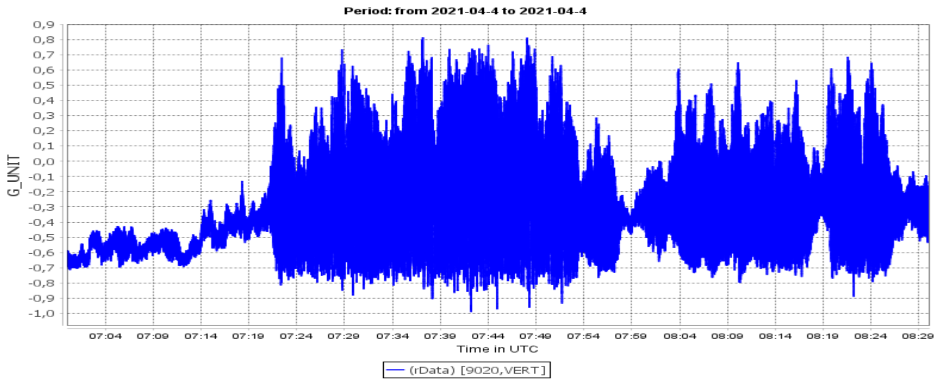
Events: tension variation, ice-weight, galloping, thermal load, sag-outliers, …

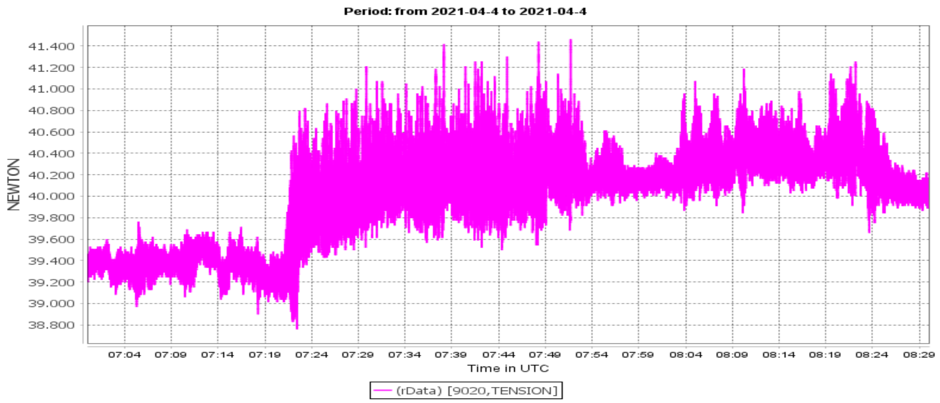






Galloping Event Analysis





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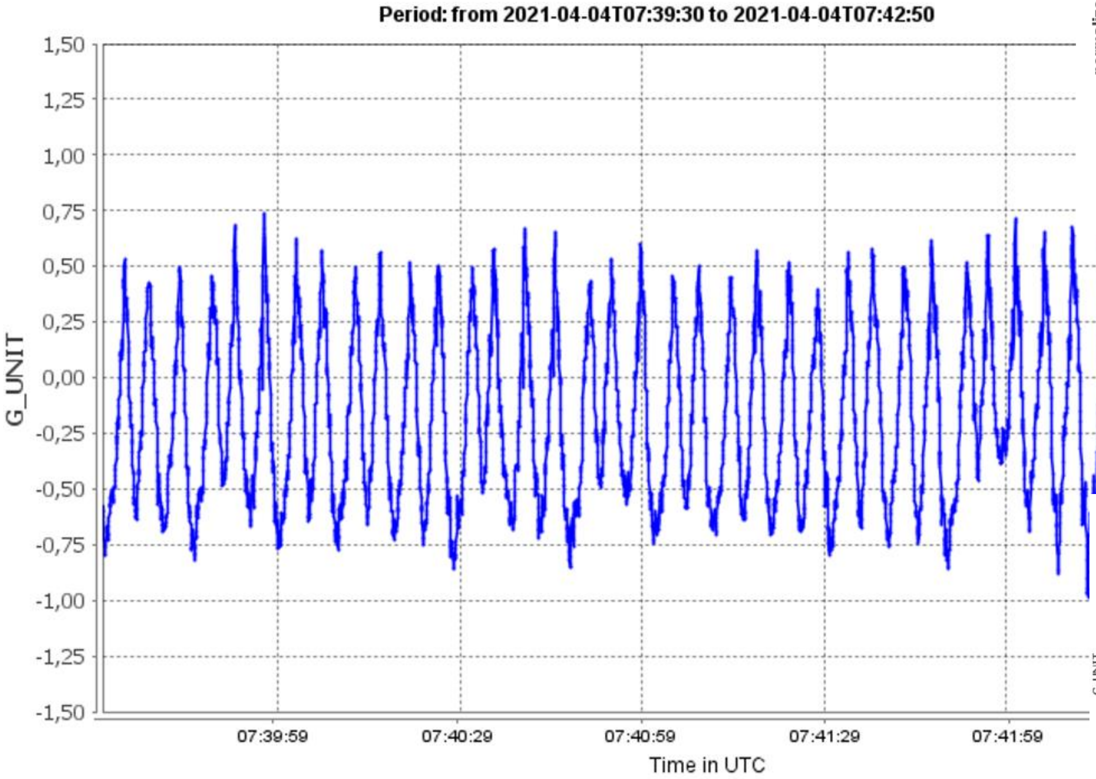

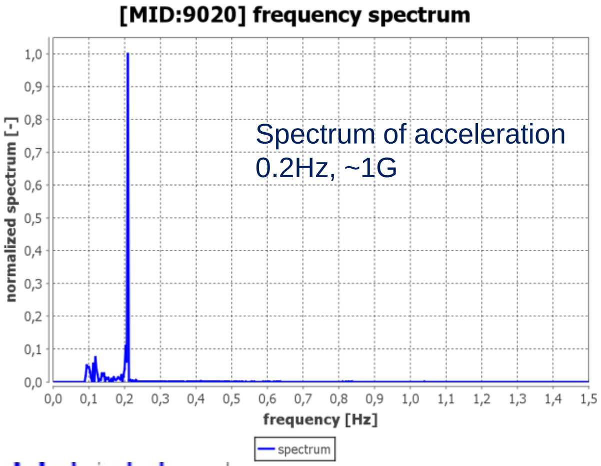

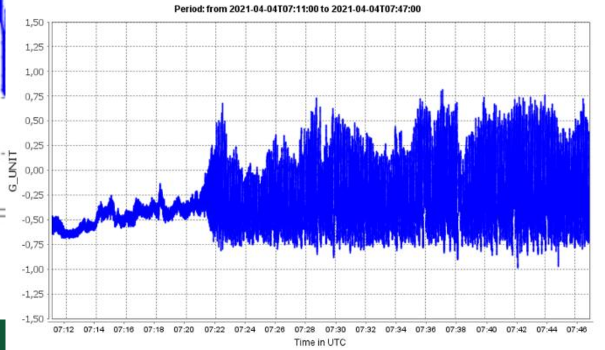

Takeaways

- DLR technologies are now well proven, sensors-based, both real-time and forecast, including SCADA/EMS, State Estimator, D2CF, DACF, IDCF integrated to optimize grid operations

- Congestion management (redispatch reduction), interconnectors optimization, renewables integration are evident use cases, with short ROI pay-backs

- Won’t replace new/upgraded lines, but can help significantly thanks to quick deployments, flexibility and low investments

- Data analytics supporting continuous monitoring applications

BEDANKT VOOR UW AANDACHT