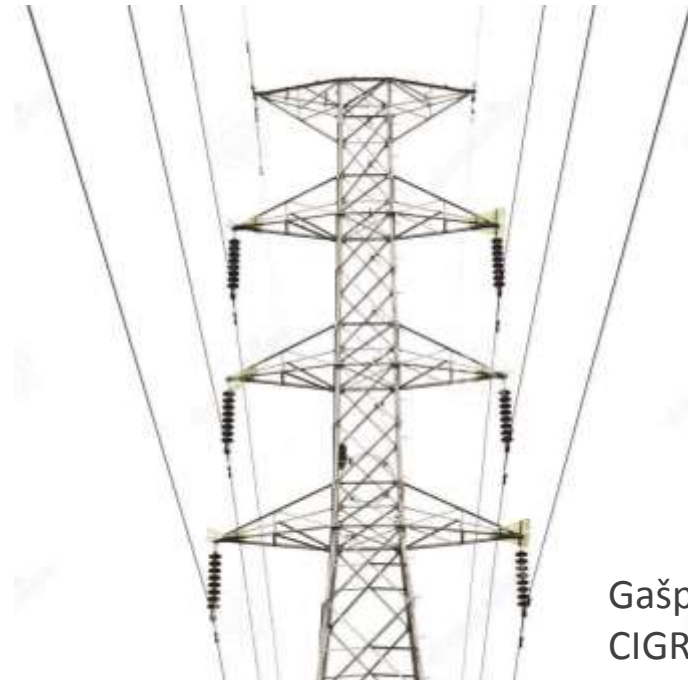


System for real-time and short-term forecast assessment of power grid operating limits



Gašper Lakota, Solvera Lynx d.d.
CIGRE RU B5, 2.6.2015, Sochi, Russia

OVERVIEW

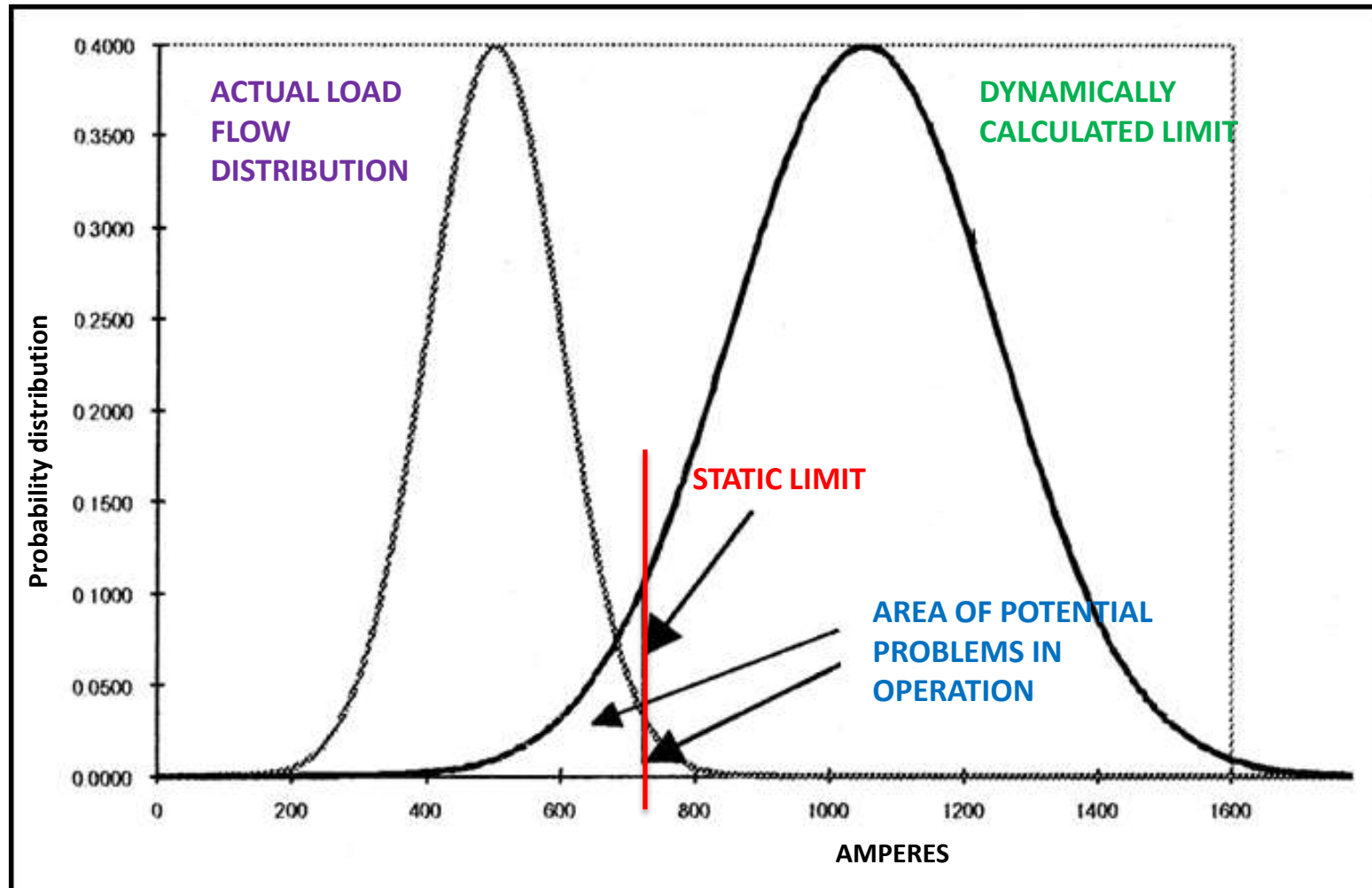


WHY SUMO?

1. Avoid re-dispatching and load sheds when possible
 2. Allow **existing infrastructure** to **acommodate changing power flow** levels and their patterns due to a large increase in **distributed and renewable** generation
- What is an **operating limit**?
 - **highest allowed flow of power** through an **element** of the power grid
 - For each element it is predominantly a function of **weather** (ambient) conditions in which the element operates

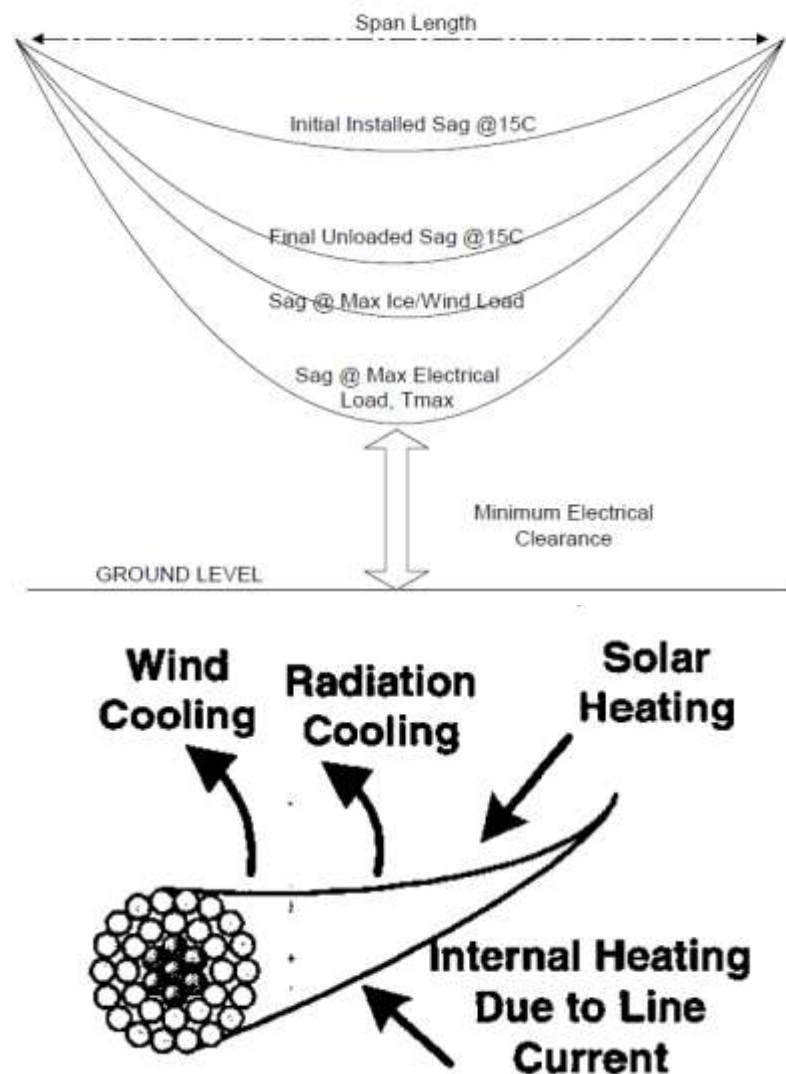
- • www.solvera-lynx.com • • • • •

1. REPLACE STATIC OPERATING LIMITS WITH DTR



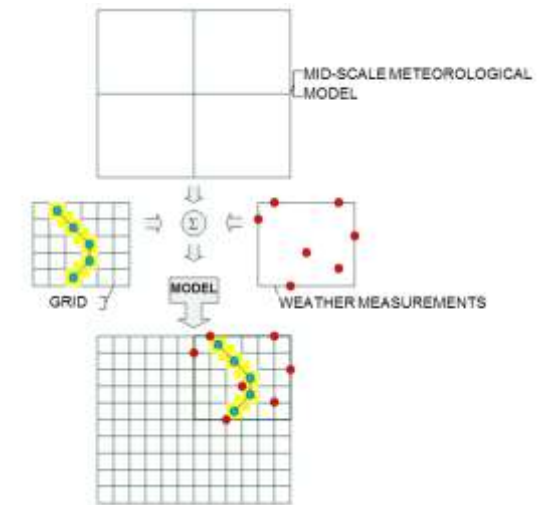
1. REPLACE STATIC OPERATING LIMITS WITH DTR (about DTR)

- **DTR** – Dynamic Thermal Rating (of any equipment)
 - **DLR** – Dynamic Line Rating – rating of powerlines
- Rating is limited by:
 - **Maximum operating conductor temperature** T_{cmax} (e.g. 80° C for ACSR conductors)
 - **Safety clearance** -> Sag -> $f(T_c)$
- Conductor temperature T_c is a result of **energy balance** in the conductor

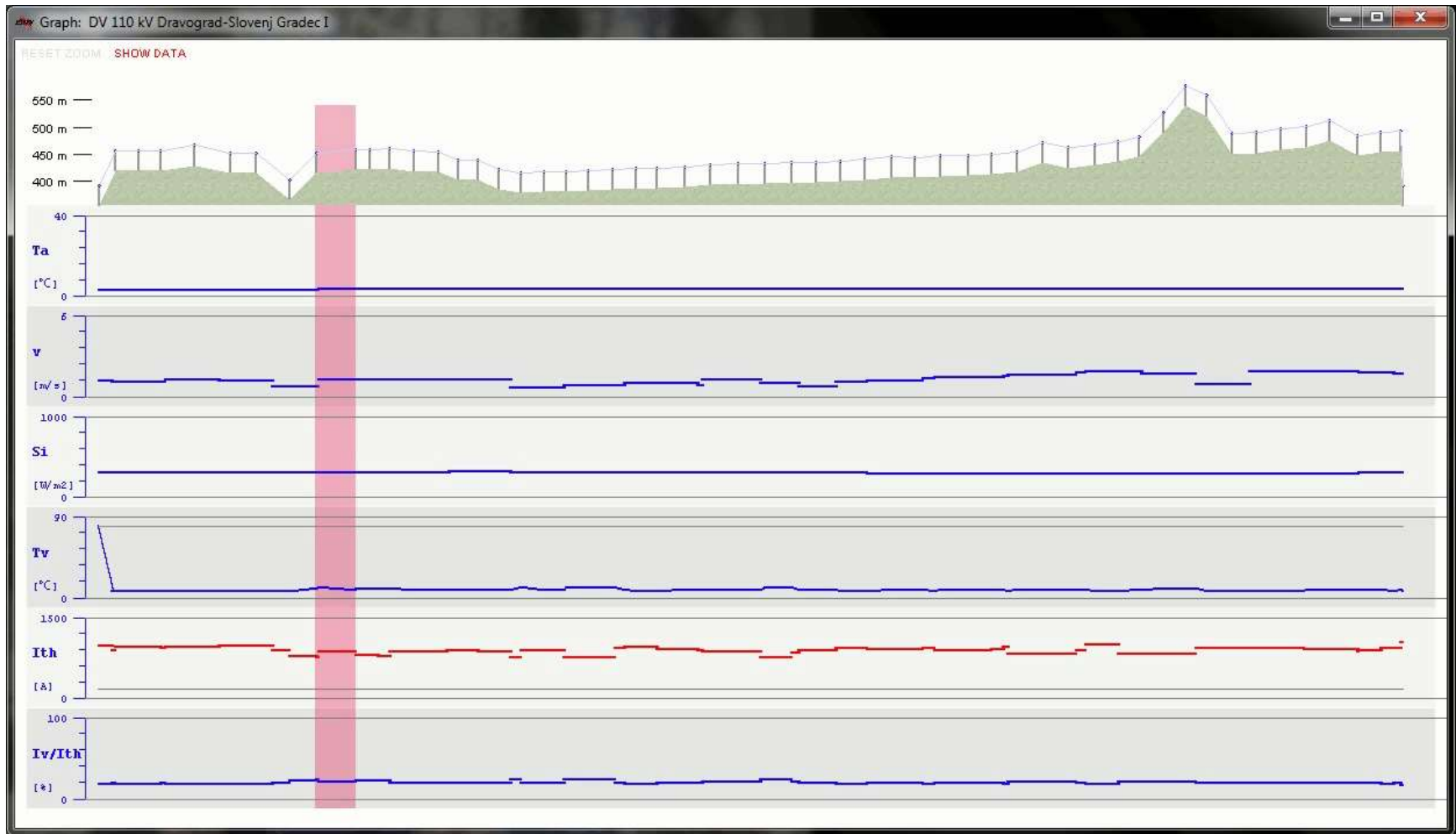


2. USE WEATHER MEASUREMENTS AND MODELS

- Measuring
- Modeling
- Forecasting



EXAMPLE OF DTR RESULTS OVER TIME



3. FORECAST WEATHER AND POWER FLOWS (t_0+3h)

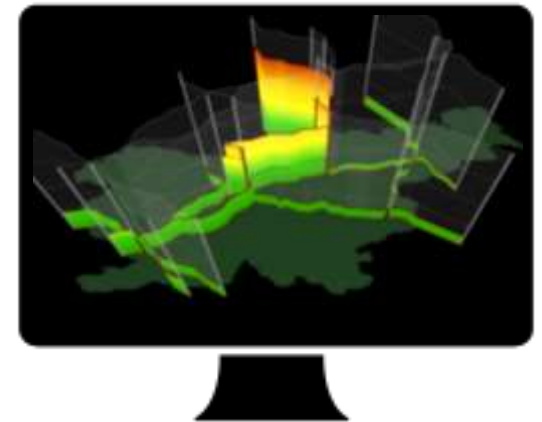
- Weather forecasts
 - From meteo providers
 - **Mid-scale** forecast -> **micro-scale** using meteo **model** and **terrain data**
- Power flow forecasts
 - **Nodal power injections** (autoregression and timetable)
 - **Interconnection load flows** (DACF)
 - **Network topologies**

4. CALCULATE REALIABILITY ANALYSES

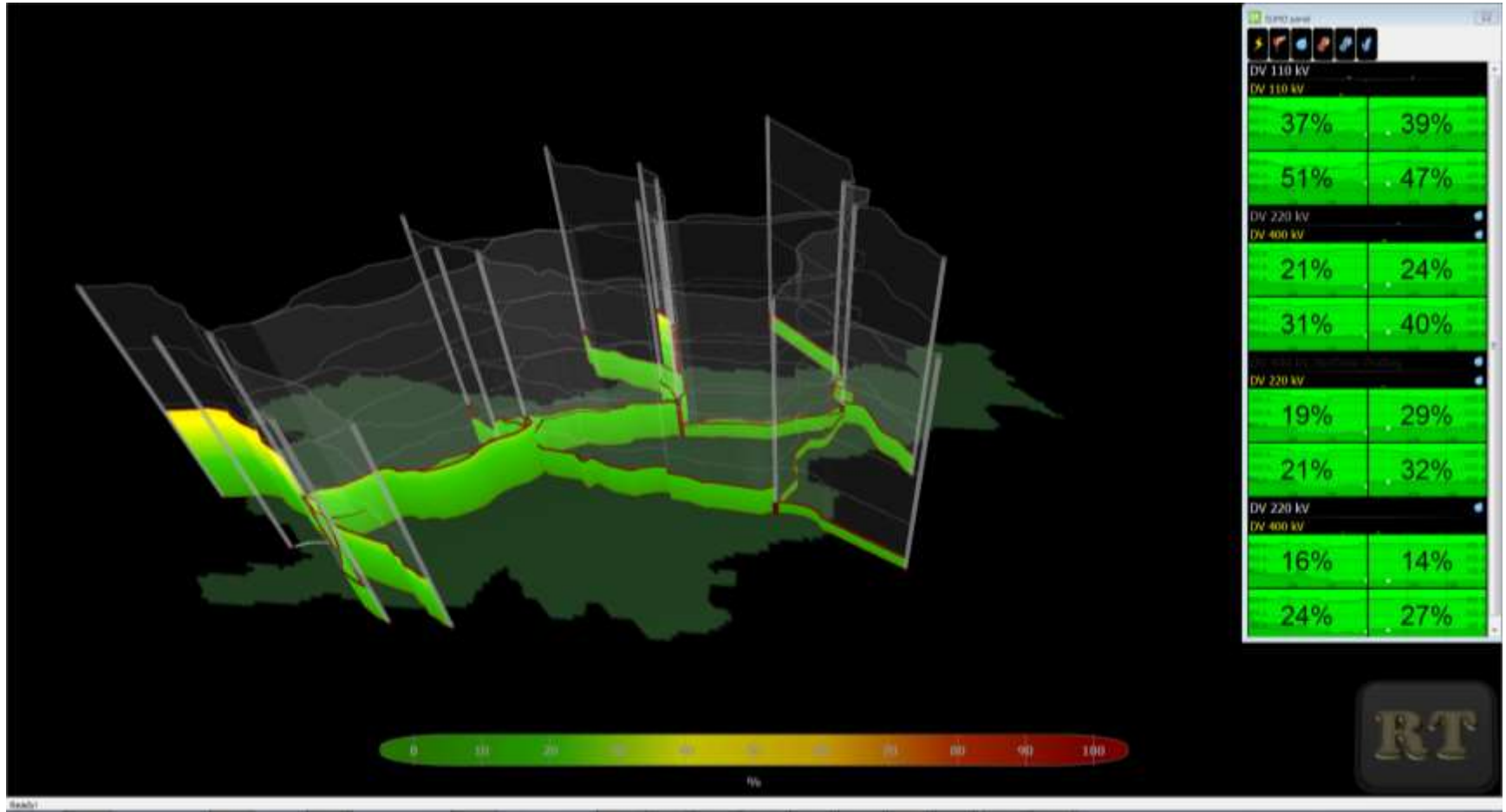
- Parallel calculation of N-1 contingency analyses
 - Now
 - Forecasted situation
- Using fast decoupled methods (LODF, PTDF)
 - Very fast compared to traditional calculations
 - No significant loss of accuracy due to its speed

5. VISUALIZE ...

- Rapid and easy to understand
- Visualisation in real time as well as historical data from archive
- 3D/4D visualisation
- Priority ranking
- Color display to facilitate reading



5. VISUALIZE ...



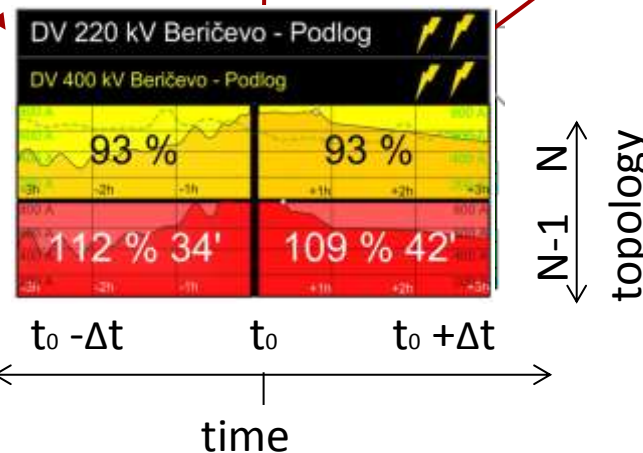
5. VISUALIZE ...

Flashing symbol in case of a weather event in the impact area of assessed transmission line

Assessed transmission line

The most unfavorable transmission line (N-1)

Quadrant I: display of the current load considering the environmental conditions

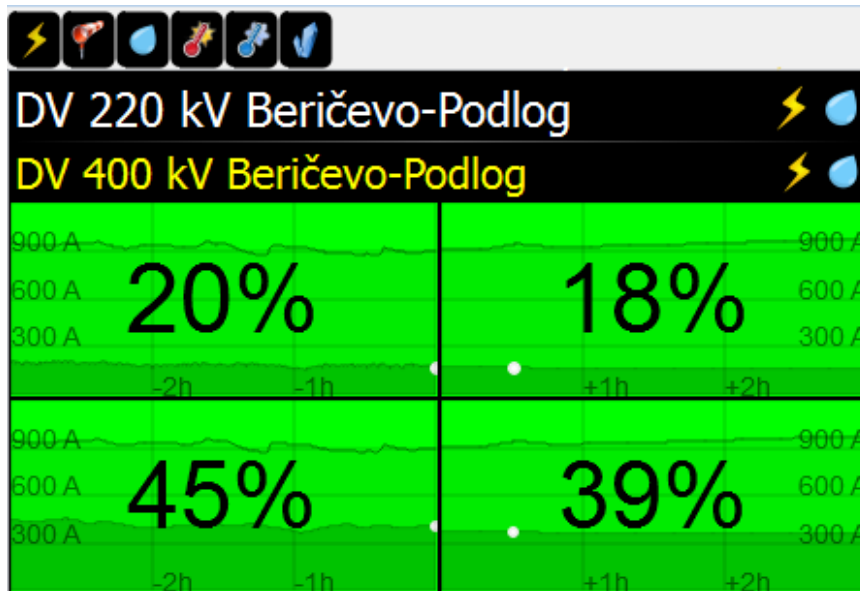


Quadrant II: Transmission line load considering the line power flow forecast and forecasted environmental conditions

Quadrant III: transmission line load at the most unfavorable situation (N-1) considering environmental conditions

Quadrant IV: transmission line load considering the line power flow forecast for the topology N-1 and forecasted environmental conditions

5. ... AND ALERT



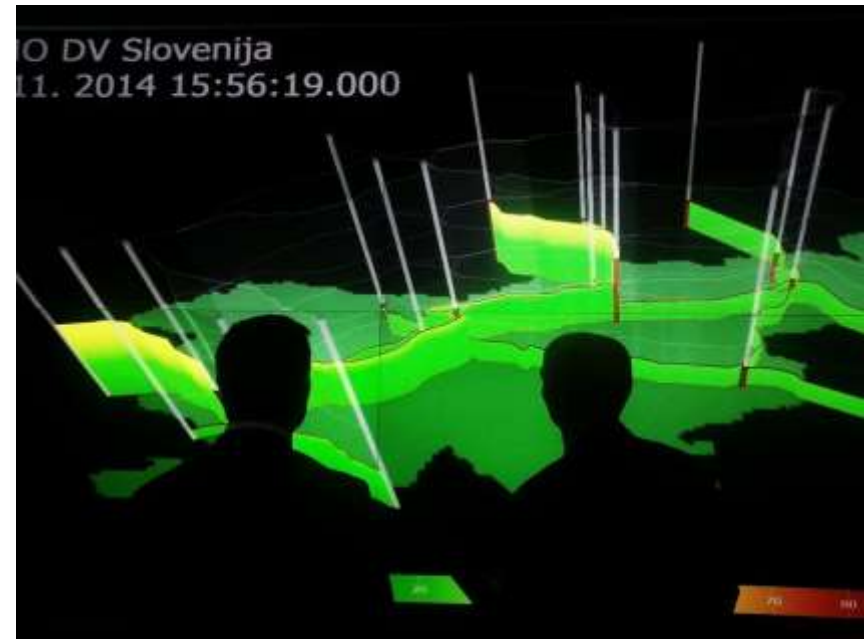
Symbol	Meaning
	Thunderstorm – lightning activity
	High wind speeds (gale or storm)
	High air temperatures
	Low air temperatures
	Extreme rainfall



IMPLEMENTATION

AN EXAMPLE OF IMPLEMENTATION

- Slovenian TSO ELES, 2013.
- Started with a pilot project with four power lines (1 x 400 kV, 2x 220 kV, 1 x 110 kV)
- 17 additional power lines are being included into SUMO
- In cooperation with
 - Milan Vidmar El. Power Research Institute
 - Faculty of El. Eng. Ljubljana, Slovenia



The logo for ELES, featuring a blue square icon with a white stylized 'E' and the word 'ELES' in large blue capital letters.



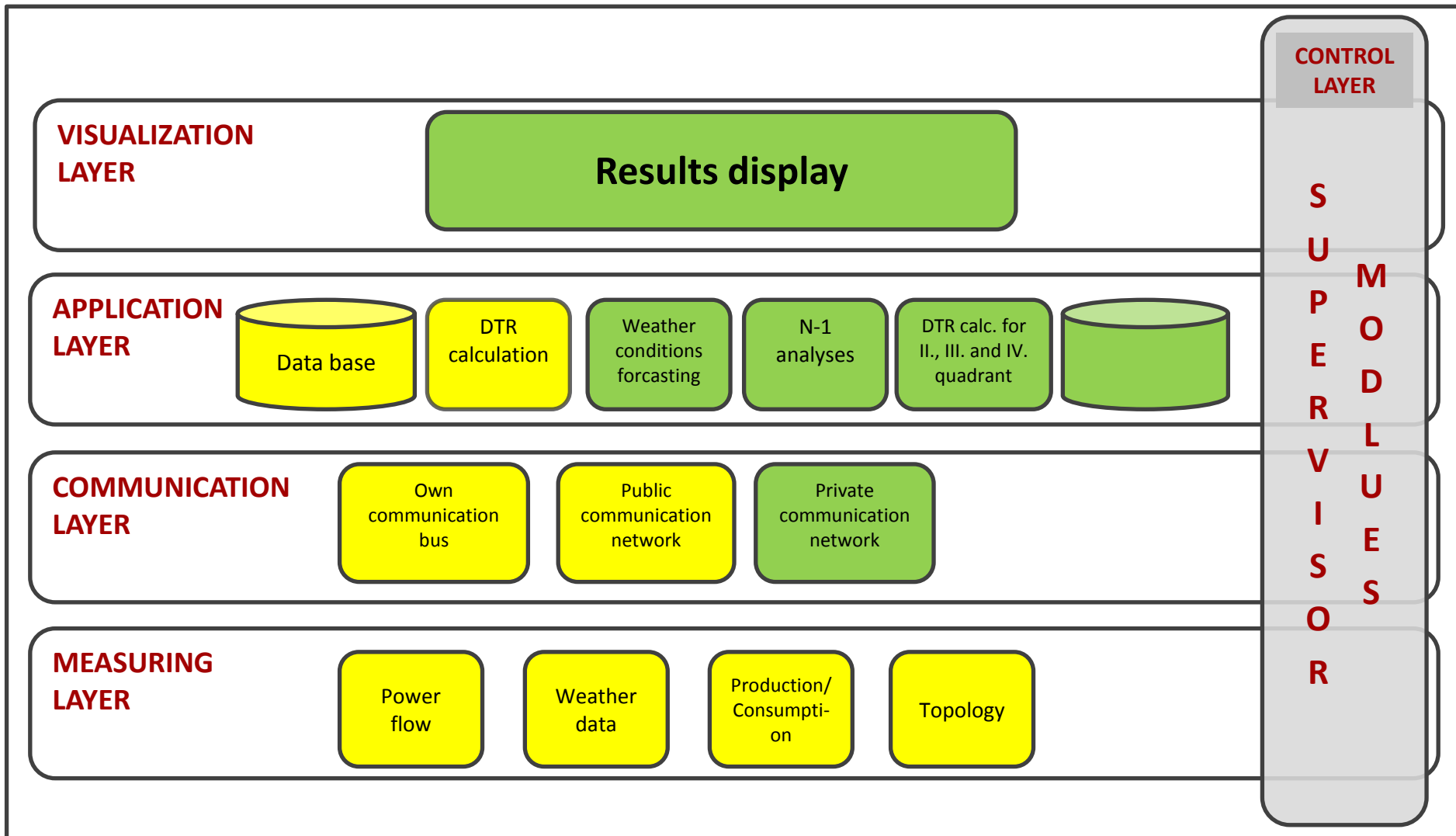
ELEKTROINŠTITUT MILAN VIDMAR



Univerza v Ljubljani
Fakulteta za elektrotehniko

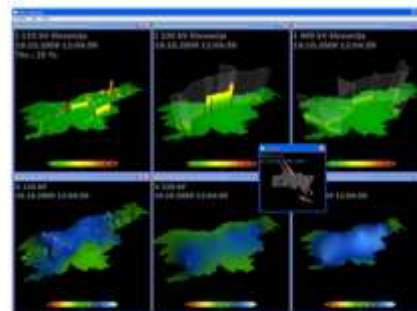
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ARCHITECTURE



INTEGRATION PLATFORM SUMOBUS

Information system
integration using Service
oriented architecture (SOA)
with Web Services
(SOAP/XML)



ODIN VIS – Visualization Platform



SUMO BUS data structures
keep measured
and calculated data from
different SUMO subsystems

SCADA

SUMO BUS



Commercially
available DTR
subsystem

DTR
subsystems

ONAP

LF

LODF

DTR

GIAP

Physical Conductor Data
and Power Line Spatial (GIS)
Data System Configuration Data

Weather assessment
and forecast

Load Flow
Calculations

Forecast of Loads
in Network Nodes

Load Flow for
N-1 state

Exceptional Weather
Data Notification

NOV

CONCLUSION



SUMO is a **modern**, complex and **reliable** information system that enables the **transmission system** operator:

1. Better utilization of existing power grid – now!
2. Same or higher level of secure and safe operation of the power grid.
3. Improved awareness of the situation in power grid.

**THANK YOU
FOR YOUR ATTENTION!**



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