ELEKTROINŠTITUT MILAN VIDMAR

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Univerza v Ljubljani
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SUMO - a system for real-time assessment and short-term forecast of operational limits in the Slovenian transmission network

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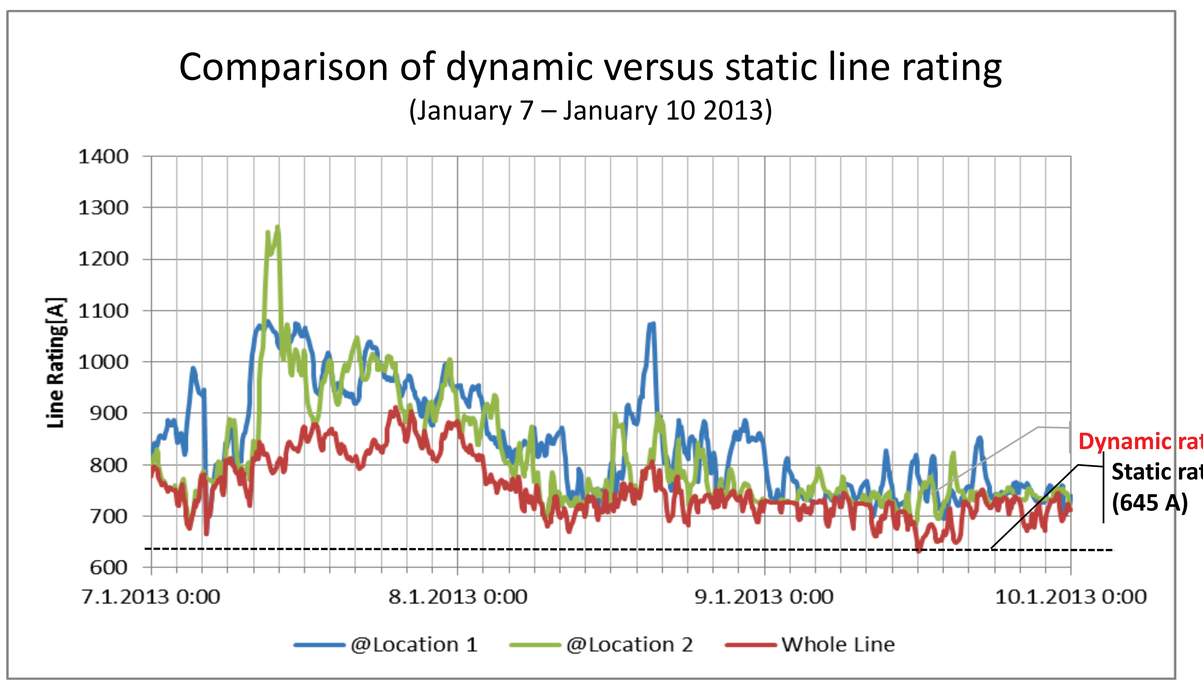
The key goal of the SUMO project was to establish a system for assessing real-time and near future operating limits based on atmospheric conditions for N and N-1 topology. Operating limit is the highest allowed flow of power through an element of the power grid.

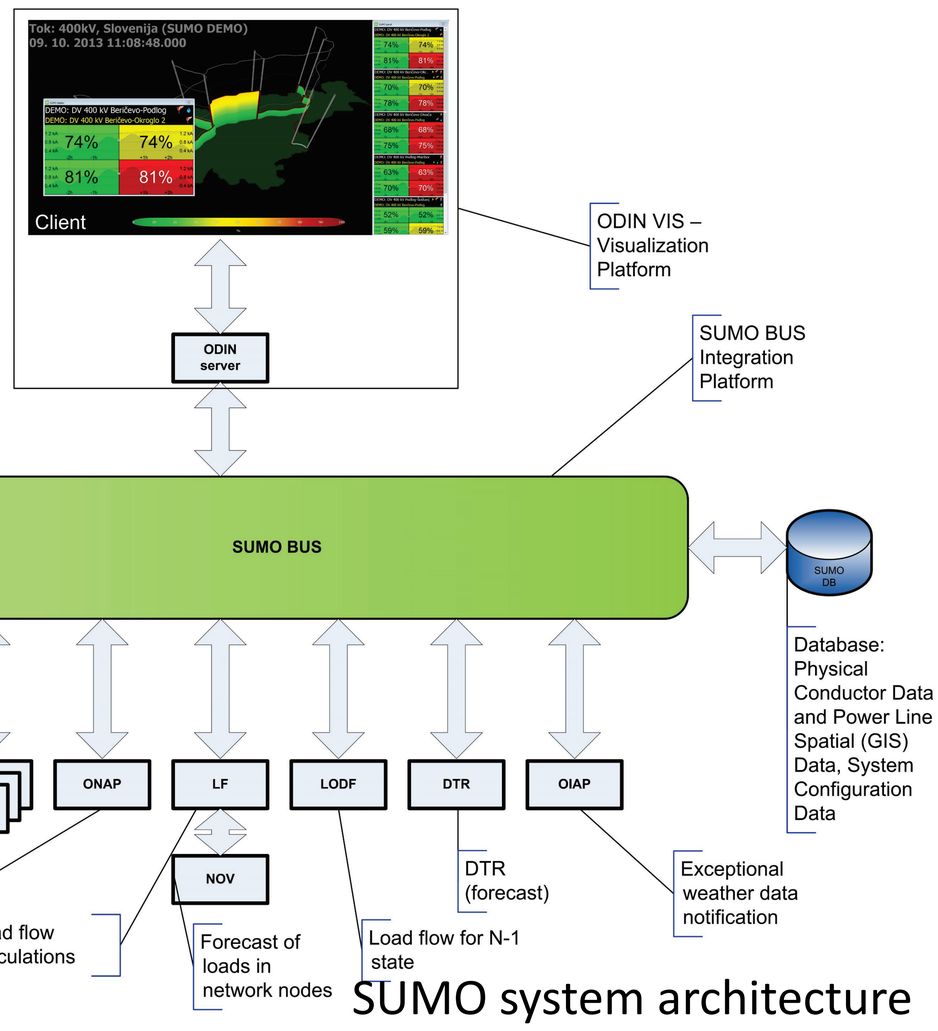
One of the key features of SUMO is that the line transmission capacity is determined dynamically based on atmospheric condition along the whole line.

Rating is limited by:

- Maximum operating conductor temperature Tcmax (e.g. 80° C for ACSR conductors),
- Safety clearance -> Sag -> f(Tc).

Comparison of dynamic versus static line rating based on real data:



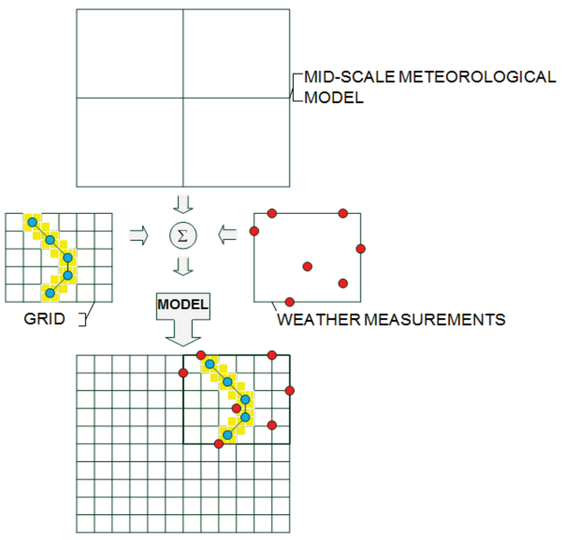


SUMO system architecture

The SUMO BUS is an integration platform, which provides efficient data exchange between SUMO subsystems. It is based on the concept of a service-oriented architecture. There are 17 online services implemented with a total of over 120 methods.

SUMO is an integrated IT system composed of several modules.

The ONAP subsystem enables usage of meteorological models to evaluate weather conditions along the power line routes for t0 time and forecast weather conditions for t0+Δt time.



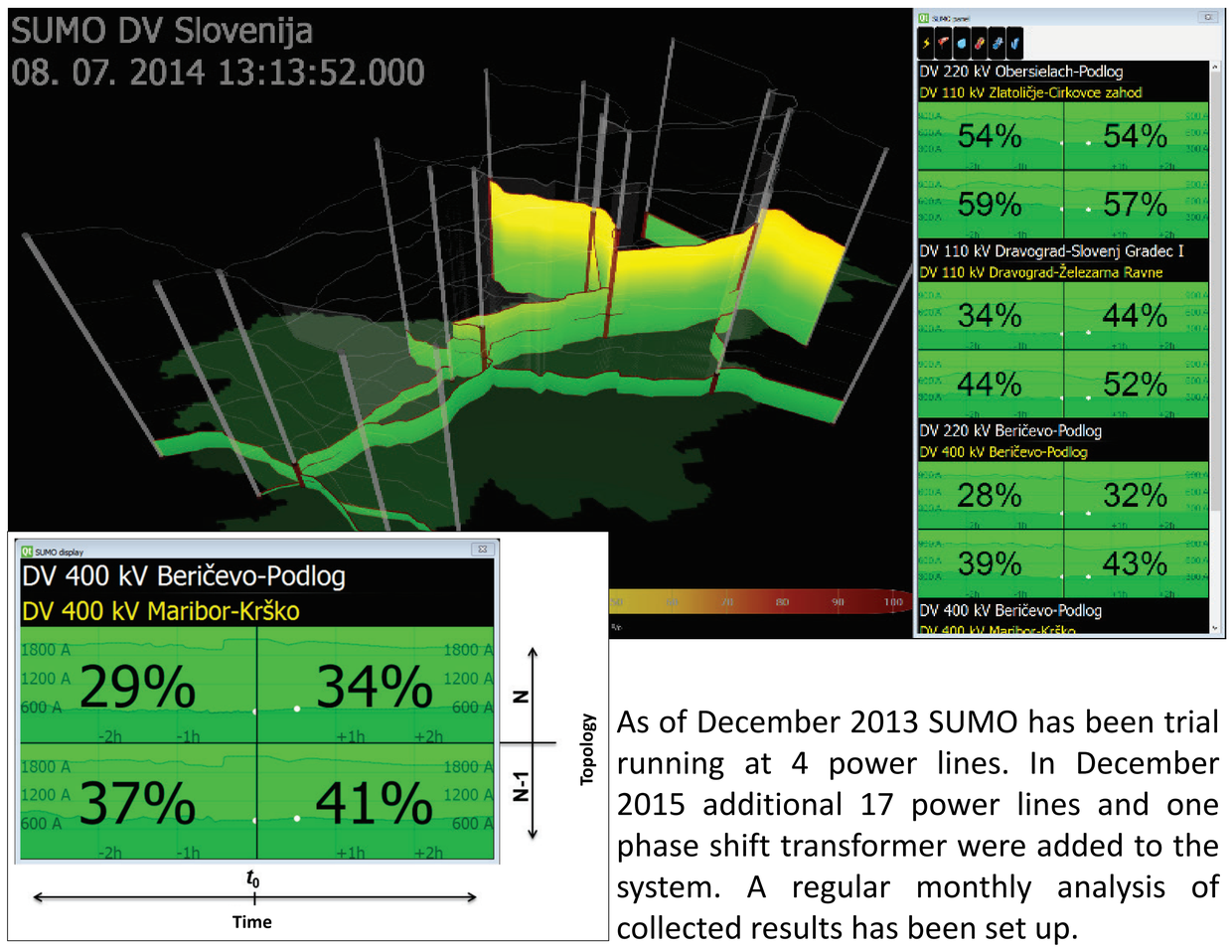
Within LF, NOV and LODF modules the following tasks are implemented:

- The evaluation of current conditions in the power system:
  - The collection of loads at all 110 kV, 220 kV and 400kV nodes.
  - The quick calculation of active power flows at power lines and transformers.
  - The calculation of active power flow for a different range of N-1 network topologies based on the use of LODF (Line Outage Distribution Factor).
- The forecast of operating conditions for several hours in advance:
  - A short-term forecast of injected real power at all 110kV, 220kV and 400 kV nodes.
  - Load forecasts at power lines and transformers for several hours in advance using PTDF (Power Transfer Distribution Factor) and load forecasts for these elements at different N-1 network topologies within safety analyses, where LODF is used to speed up the calculation.

OIAP is a subsystem, which follows weather conditions along the power line corridors and at exceeded values of weather variables it sends a message (alert) to SUMO BUS for the weather variable, which has been exceeded as well as the identification number of the overhead power line, which the alarm applies to.

ODIN-VIS is an independent visualisation platform for advanced visualisation of the power system. Within the platform is also a module for the visualisation of SUMO results, which provides the visualisation of:

- dynamic thermal ratings (current values and forecasts),
- current loads and forecast of loads at overhead power lines,
- results of N-1 analyses,
- weather conditions and
- alerting of extreme weather conditions along overhead power line routes.



As of December 2013 SUMO has been trial running at 4 power lines. In December 2015 additional 17 power lines and one phase shift transformer were added to the system. A regular monthly analysis of collected results has been set up.

Experiences so far have shown that the permissible load at transmission lines is higher than that stipulated by standards. Most power lines achieve peak load only in N-1 condition and this is why DTR is sensible for use only in combination with N-1 analysis.