MEINBERG

The Synchronization Experts.

Use-case study:
Improving the swedish railway system

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The Swedish transport administration

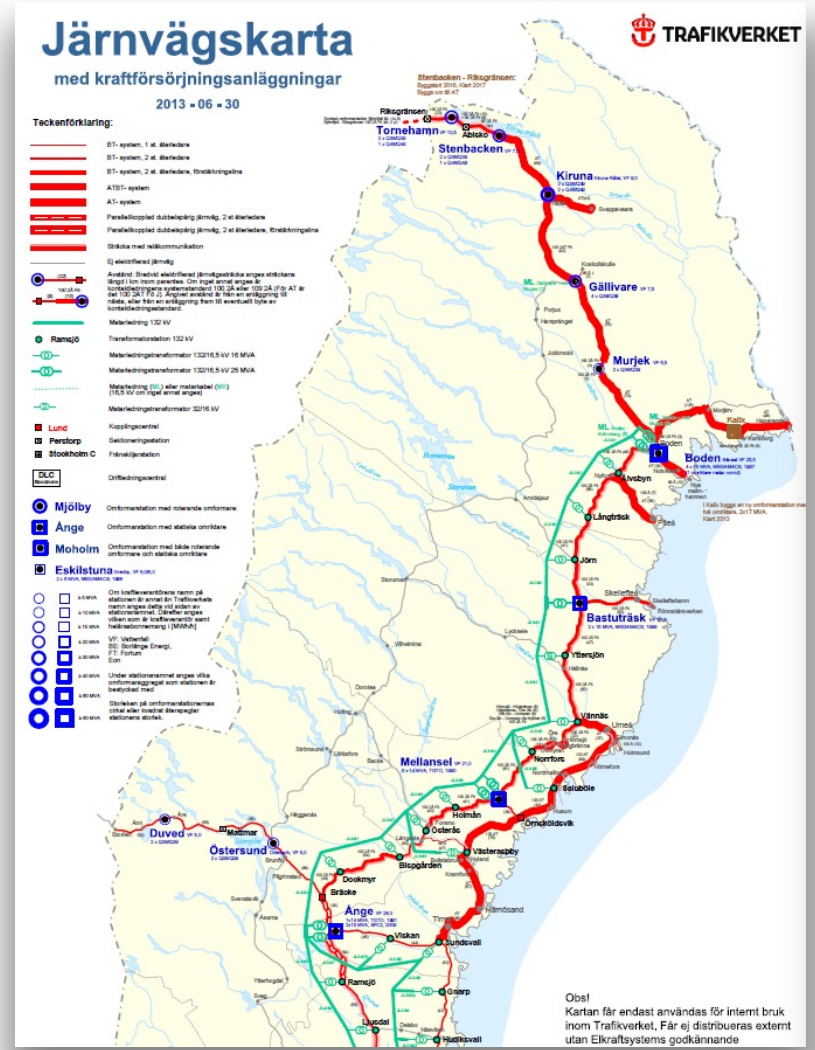
TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

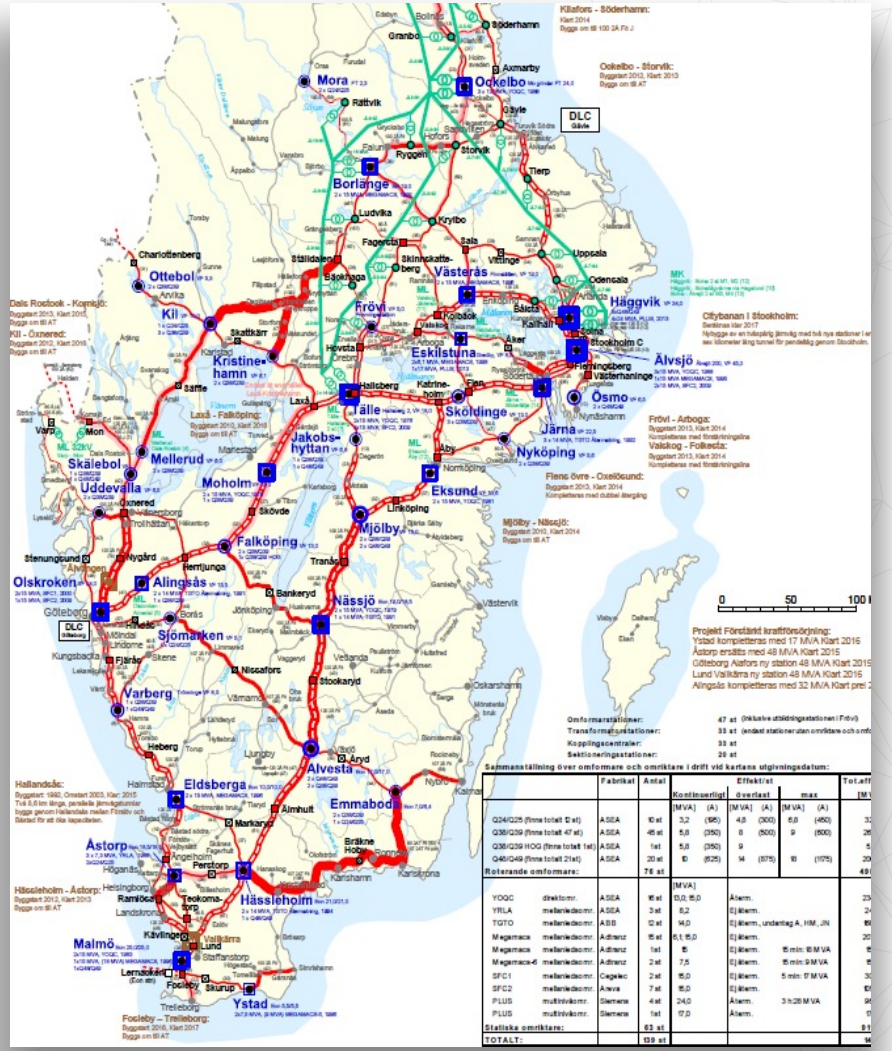
Trafikverket owns, constructs, operates and maintains

- ❑ Roads
- ❑ Railway system
- ❑ Shipping
- ❑ Aviation

The Swedish railway system

- 11000 km tracks
- They operate their own electrical grid
- Grid operated on 16.67 Hz
- 1900 km high voltage lines
- Connected to the national electrical grid via converter substations





Pilot Project

- ❑ 4 PMUs measure phase and frequency
- ❑ 4 transformer substations in south of Sweden
  a) Eldsberga
  b) Astorp
  c) Haessleholm
  d) Malmoe
- ❑ Implement logic to react on the measuremements
- ❑ Metrum PQ122 PMUs
- ❑ Synchronisation by M500 Meinberg GNSS clocks
- ❑ Synchronisation accuracy < 100 nsec

Pilot Project findings

Trains are consuming power
- ❑ Accelerating
- ❑ Uphills

Trains are producing power
- ❑ Deaccelerating
- ❑ Downhill

Dynamics
- ❑ Moving energy consumer
- ❑ Moving energy producer
- ❑ Complexity similar to regenerative energy sources (weather dependability)

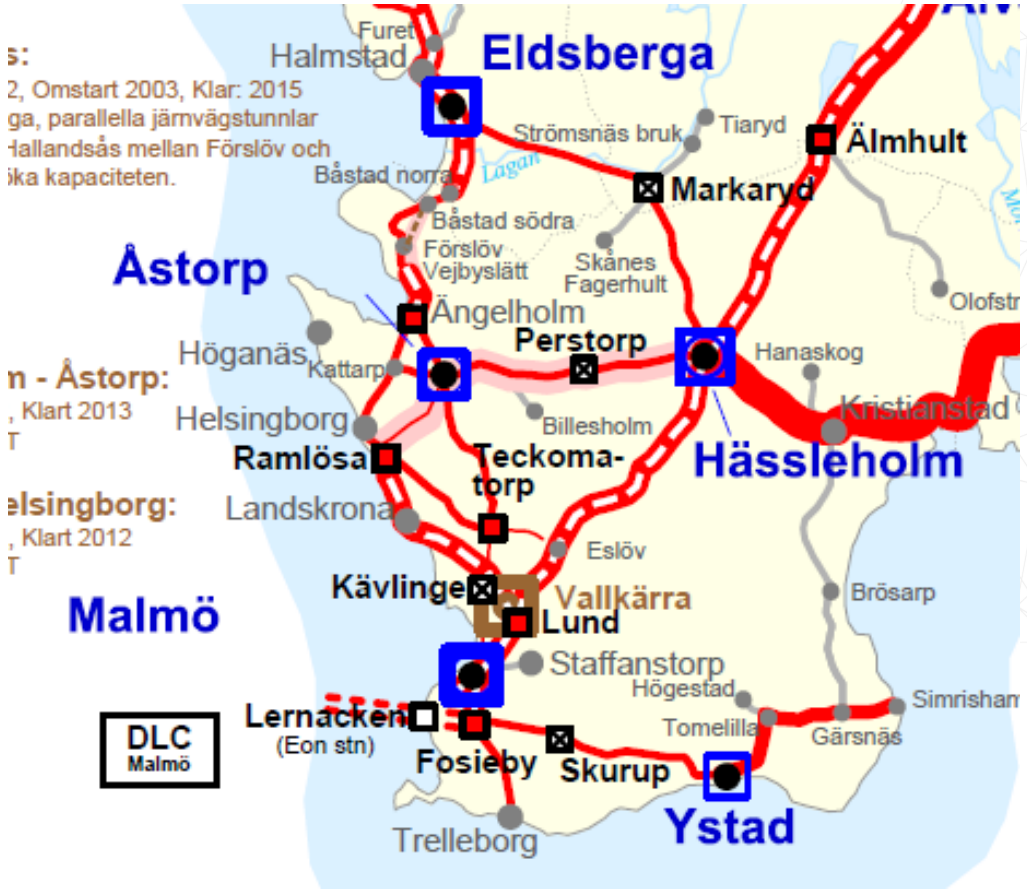
Predicitve maintenance

Side result

Pilot Project results

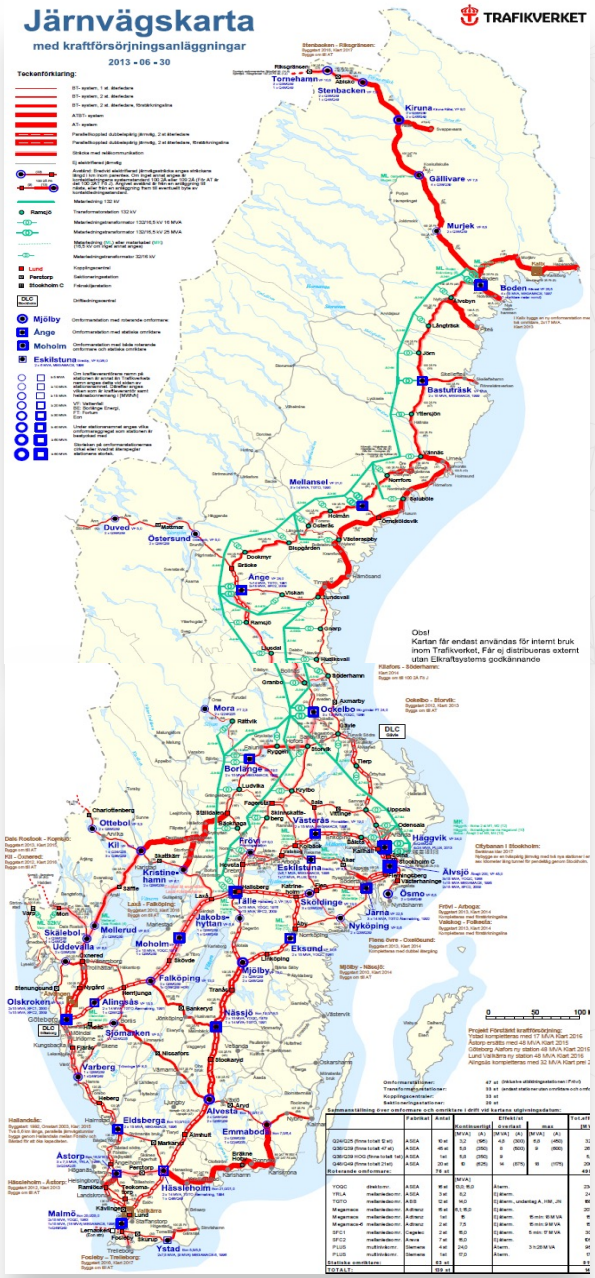
- ✓ 20 GWh/year power consumption decrease
- ✓ 1 million EUR per year less spendings
- ✓ -7% of total power consumption

➔ Huge impact on power sustainability



Follow-up project

- ❑ System was extended over entire Sweden
- ❑ 100 PMUs implemented
- ❑ Overall savings 1TWh/year
- ❑ Includes the Kiruna train – iron ore transport over the mountains



Future steps

- ❑ The entire smart logic depends on the PMU measurements
- ❑ Their measurements context strongly depends on the measurements time precision (< 1 usec)
- ❑ Time synchronization is under attack – Scandinavians know that (Russian manouvers at the borders)

➔ Next project step is clock synchronization hardening

Conclusion

- Smarter usage of power can improve the sustainability of our societies
- Smart control of power grids requires precise measurement of the status quo via PMUs
- PMU measurements require high precision time synchronization
- Time synchronization must be hardened against cyber attacks and GNSS spoofing/jamming