Use-case study: Improving the Swedish railway system

Werner Abt – SW Development Manager
werner.abt@meinberg-usa.com
The 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 measurements
- 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)

Predictive 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 manoeuvres 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