Challenges in relay protection

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Present challenges

- **DC lines in parallell with AC lines**

Faults on DC line cause induced DC currents in the AC systems and AC earthing systems.

Challenging for distance protection relays

  - Saturation in conventional P-class CT's
  - Initial simulations show large induced currents with duration >100ms in nearby AC-line
  - Distance relay functions not responding as required; affects phase-selection, direction determination and distance to fault
  - Statnett is investigating use of air gap CT's, type TPY

- **Data quality – Accuracy in calculation model**

Statnetts PSS/E Nordic grid model have some unaccuracies

  - Transformer data - data collection programme ongoing
  - Generator data - data collection programme starting up
  - Line impedance - impedance measurement staring up

Present challenges

- **Extensive use of system protection schemes**

The power system is characterized by high utilization, SPS is used to increase transfer capacities

- Many separate SPS's, complicated structure:
  - 50 generators (7300MW), 1500MW load, 100 transmission lines included in SPS
  - Load or production disconnection initiated by relay operation on critical components
  - Fast ramping of HVDC interconnections (emergency power control/runback)
  - Net splitting
- Mal operation -> Large consequences
- Monitoring and coordination

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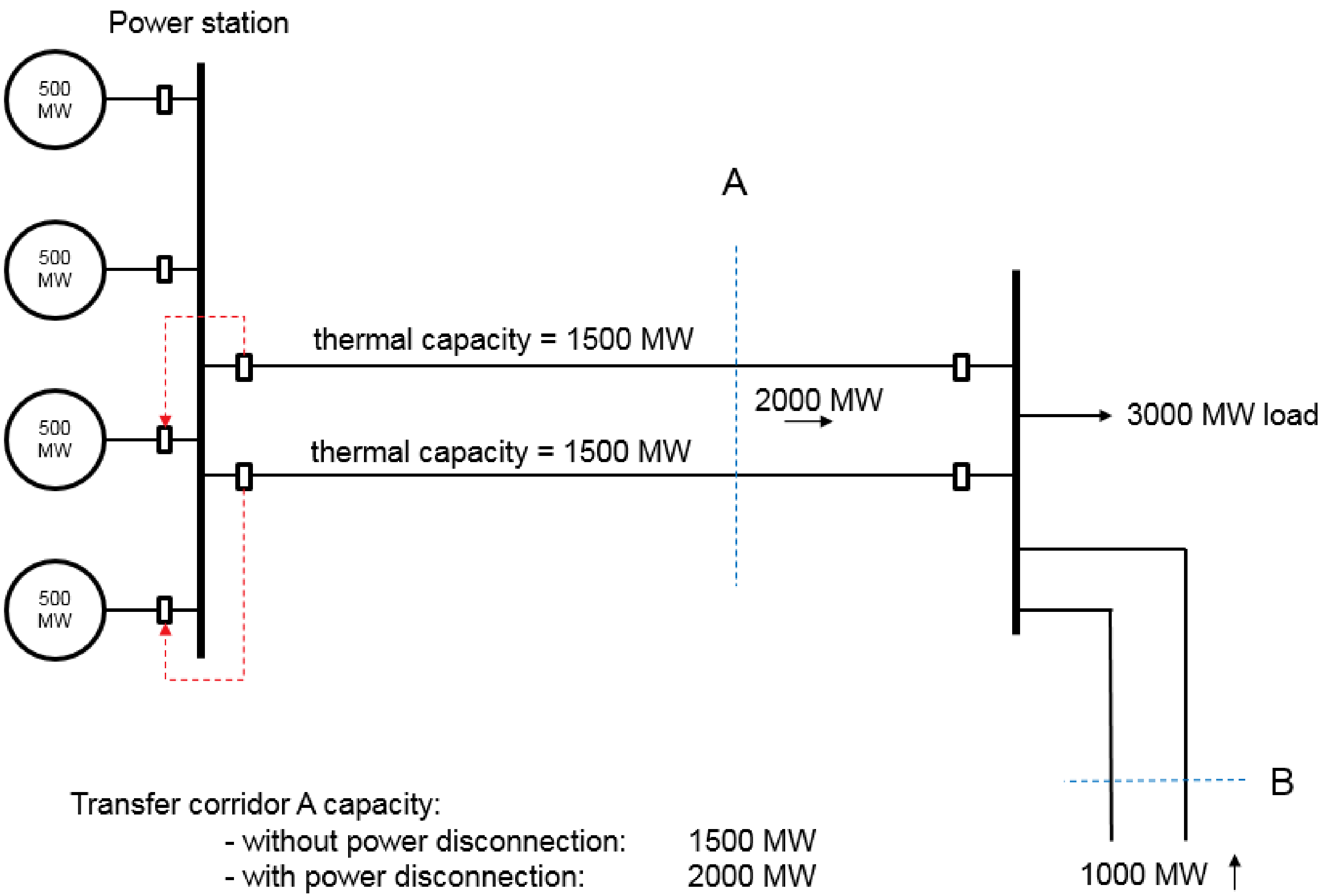

Transfer corridor A capacity:

- without power disconnection: 1500 MW
- with power disconnection: 2000 MW

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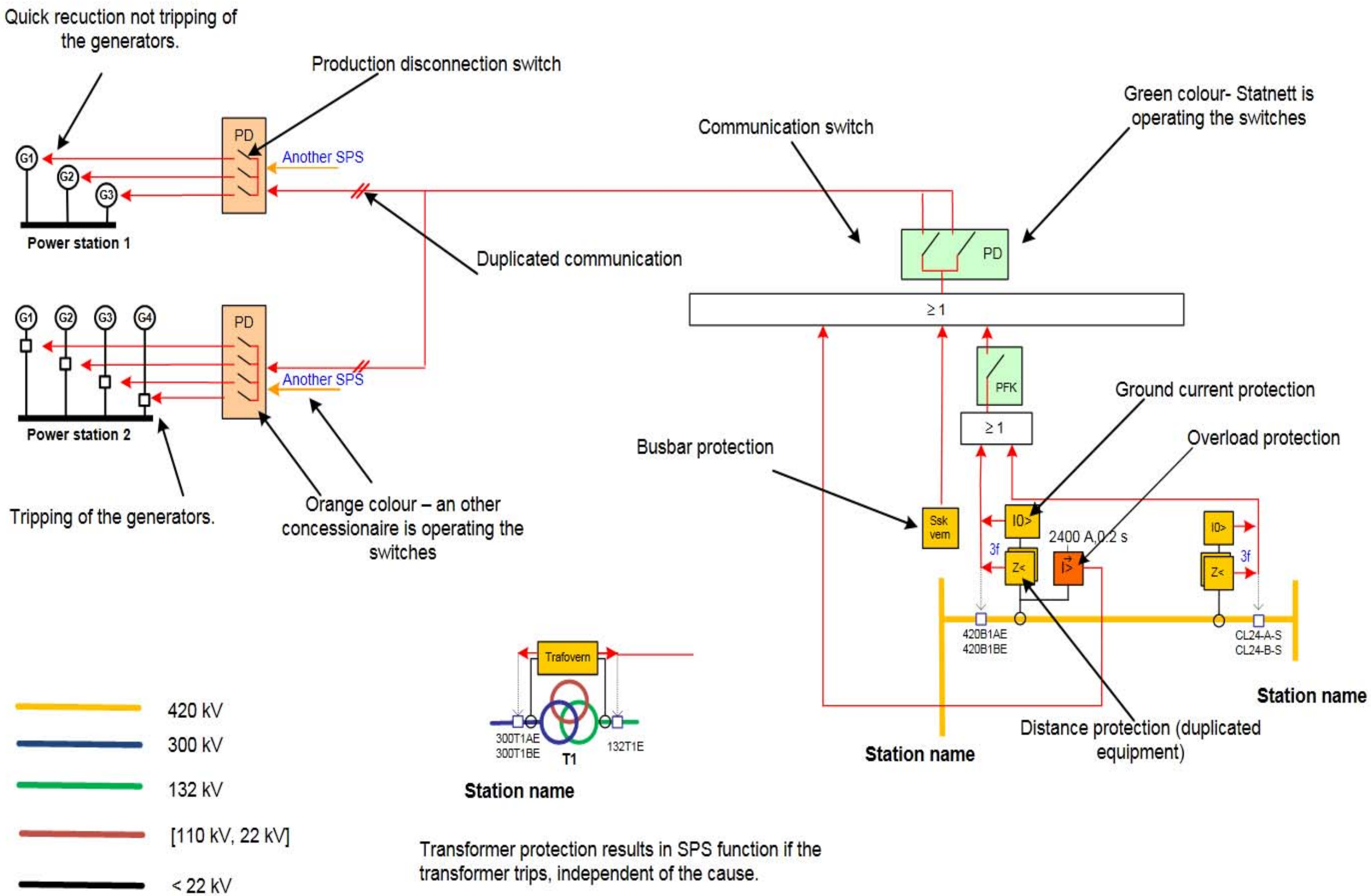
SPS - Principle drawing



Future challenges

- **Increased share of produced energy from renewable energy sources/HVDC/small power**
  - Missing/delayed relay protection operation
  - Voltage quality/frequency quality/stability
  - ⇒ Potensial need/marked for spinning reserves?

- **Tougher requirements increase building cost and technical complexity – Statnett is beeing challenged**
  - Redundancy in signal transmission cabling
  - Redundant auxiliary power
  - EMP secure control rooms
  - ICT security

How to keep the cost down and maintain a high security of supply?

Statnett R&D project: Fully digitalized substations

- How to maintain security of supply when building a fully digitalized substation?
- Different suppliers of primary components, control- and protection equipment in same substation – are the communicaton protocols between suppliers fully compatible?
- How to build a substation that can be operated and maintained easily for decades
- Data transmission and storage

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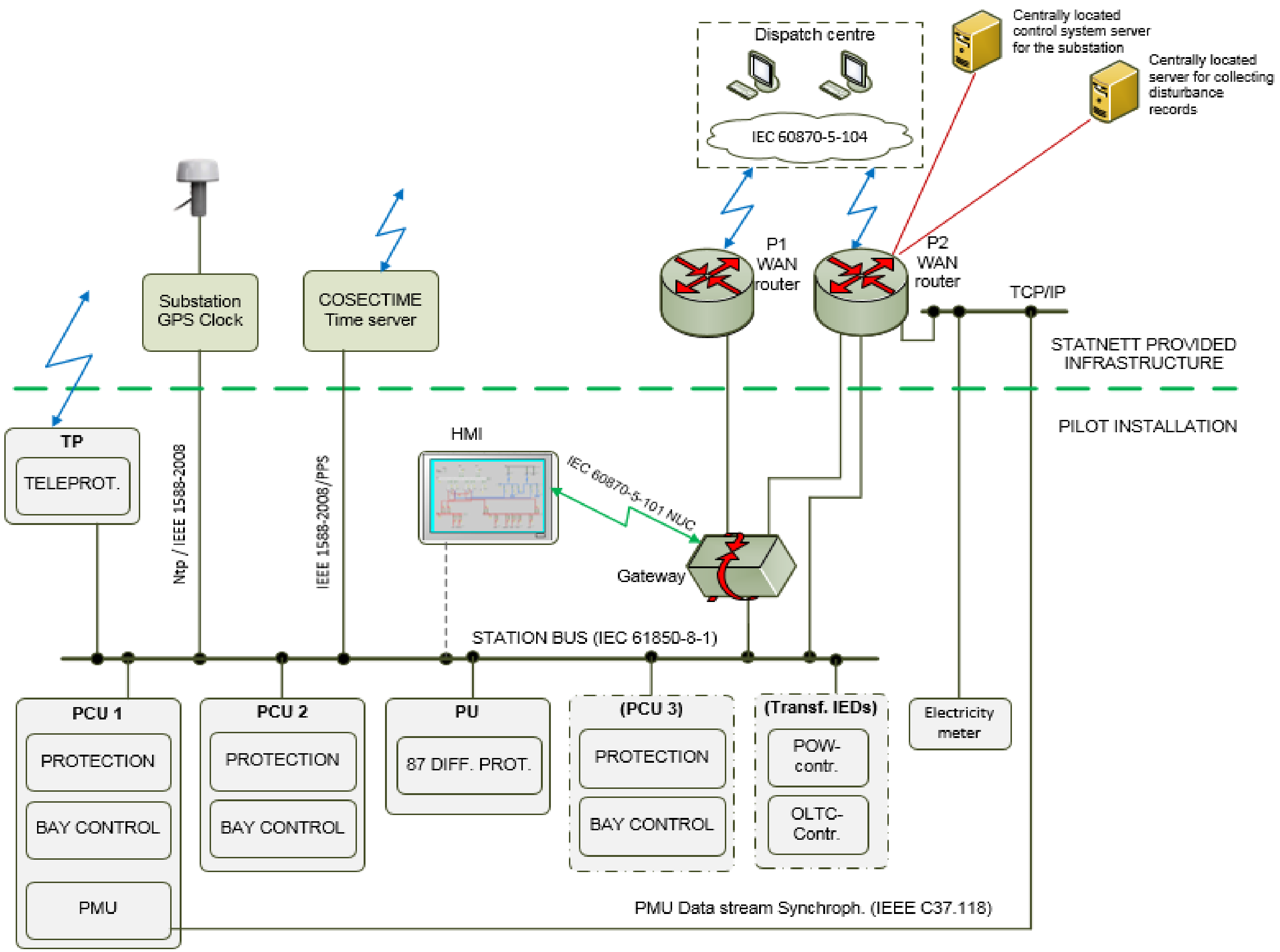
Basic configuration on station bus level



Digital substation – test configuration