SALS – Smart Adaptive Load Shedding

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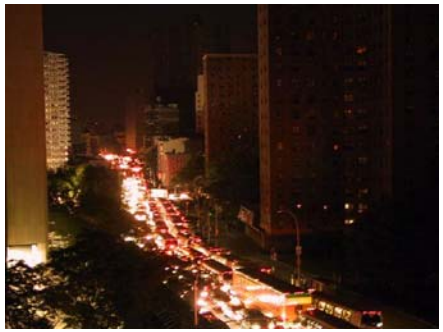
27 February 2017

Renewable Energy Sources

Power System Stability

Decentralized Protection



Blackout

Presentation outline

- SALS Introduction
- Project Objectives & Deliveries
- Offline Simulation
- Real Time Simulation
- Field test
- Conclusion

Project Partners

AALBORG UNIVERSITY

SALS

SALS PARTICIPANTS

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AALBORG UNIVERSITY

DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

INOPOWER

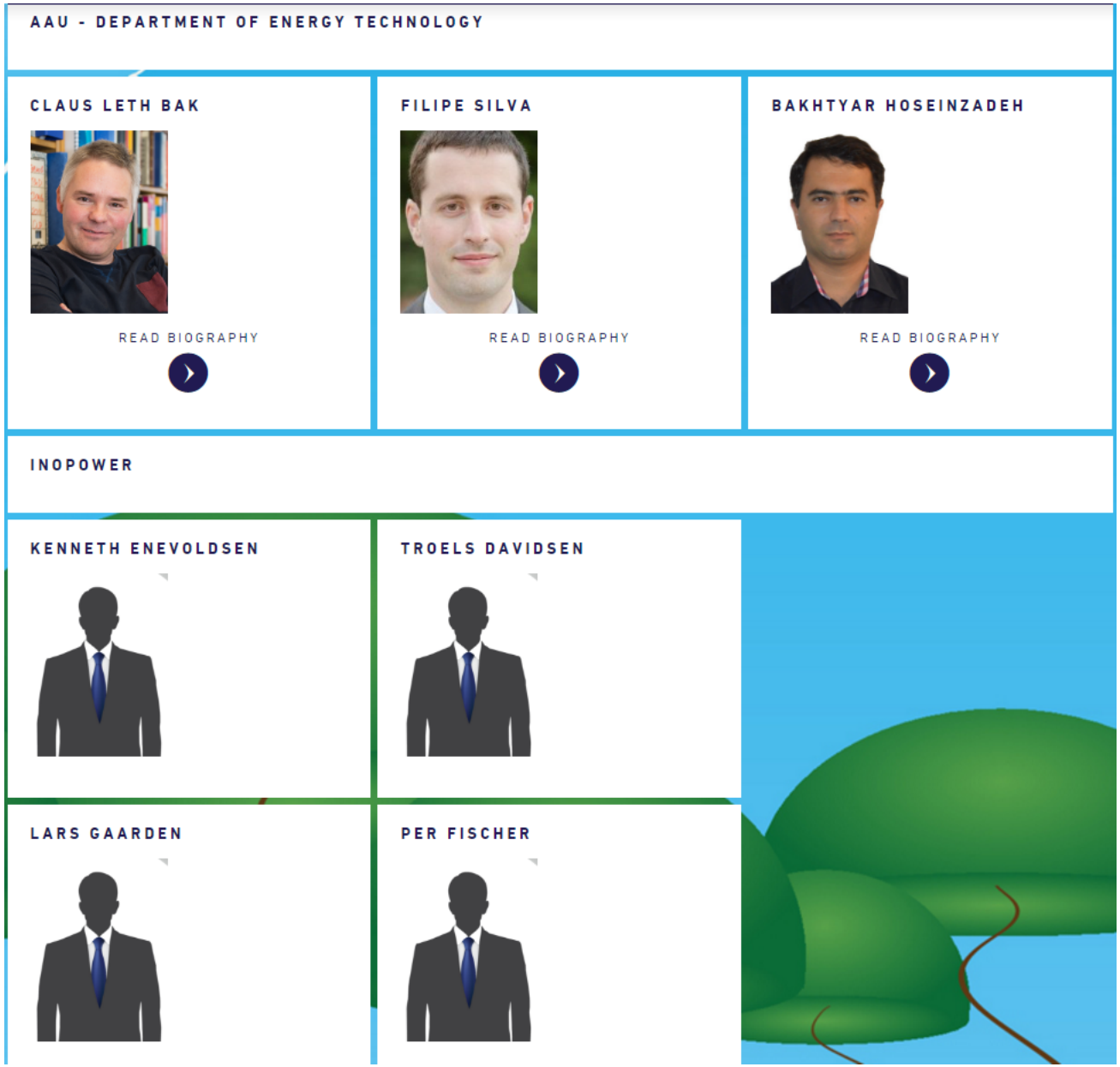
INOPOWER
INNOVATIVE POWER AUTOMATION

NORD ENERGI NET

nord energi

[1] http://www.sals.et.aau.dk/

Project Team Members



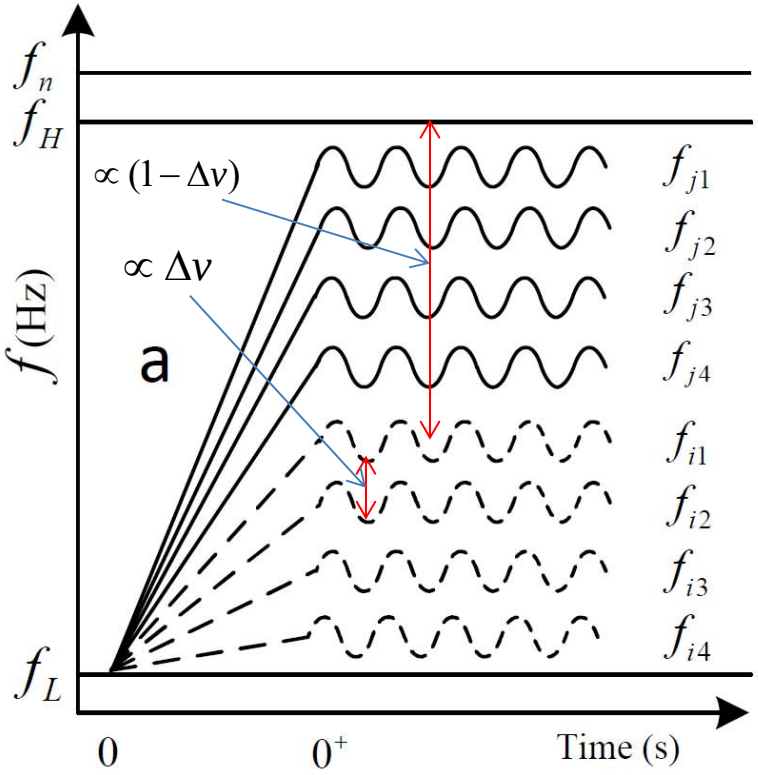
[1] http://www.sals.et.aau.dk/

Project Objectives

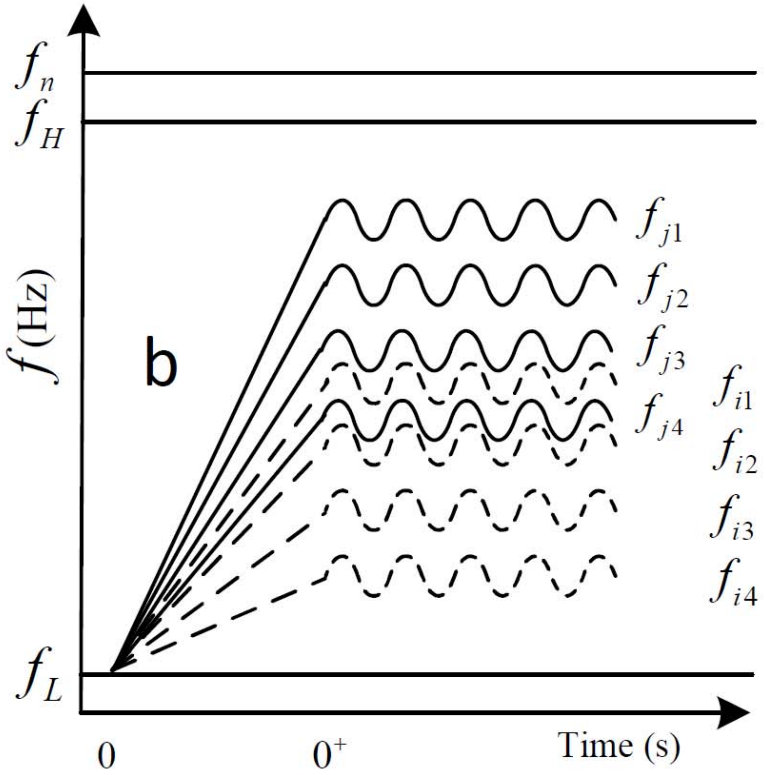
- Enhancing the stability of power system
- Ready for any scenarios (+ renewables -)
- Minimizing costumer power interruption during emergency state
- Decentralized & automatic self-healing power system

Project Deliveries

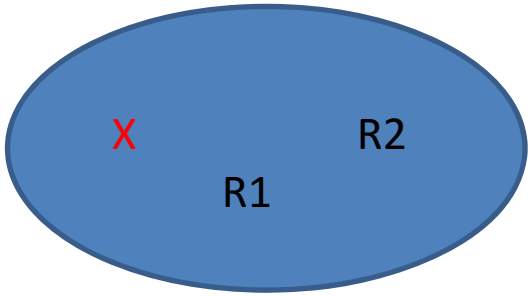
Adaptive Frequency Thresholds Using Voltage Drop Data



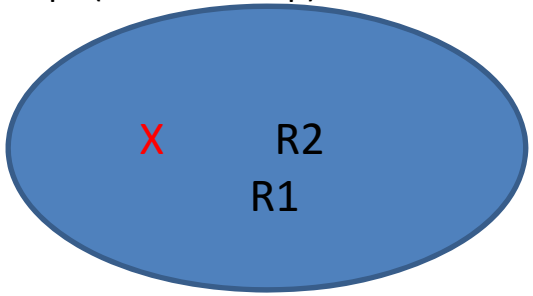
Distant→more voltage drop (no overlap)



Close voltage drops (some overlap)



$v\downarrow \Rightarrow f_{ij}\uparrow$



Project Deliveries (Cont'd)

Relay Comparison

Item	UFLS	AUFVLS
ROCOF & inertia	Dependent	Independent
LS locations	Predefined	Event region
Relay setting	Manual	Adaptive
Voltage dynamic	No	Yes
Concurrent trigger	Yes	No
Smooth frequency profile	Not always	Yes
Over LS	Sometimes	Rarely
Over voltage	Sometimes	Rarely

Relay Advantages ✓

- Detection of both Under Voltage (UV) & Under Frequency (UF) events
- Fault location oriented ↔ Adaptive to the event location
- Robust against uncertainty in :
  - ☞ Network Topology
  - ☞ Network parameters

  →(Renewables)
- Plug & Play (PnP) installation ↔ Simple installation and maintenance
- Adaptive / automatic setting ☞ Setting less ↔ No tuning and calibration
- Communication
  - ☞ Decentralized: No communication ↔ Cyber security
  - ☞ Hierarchical: Supervised by control center
- Low cost ↔ Affordable hardware changes + software upgrade

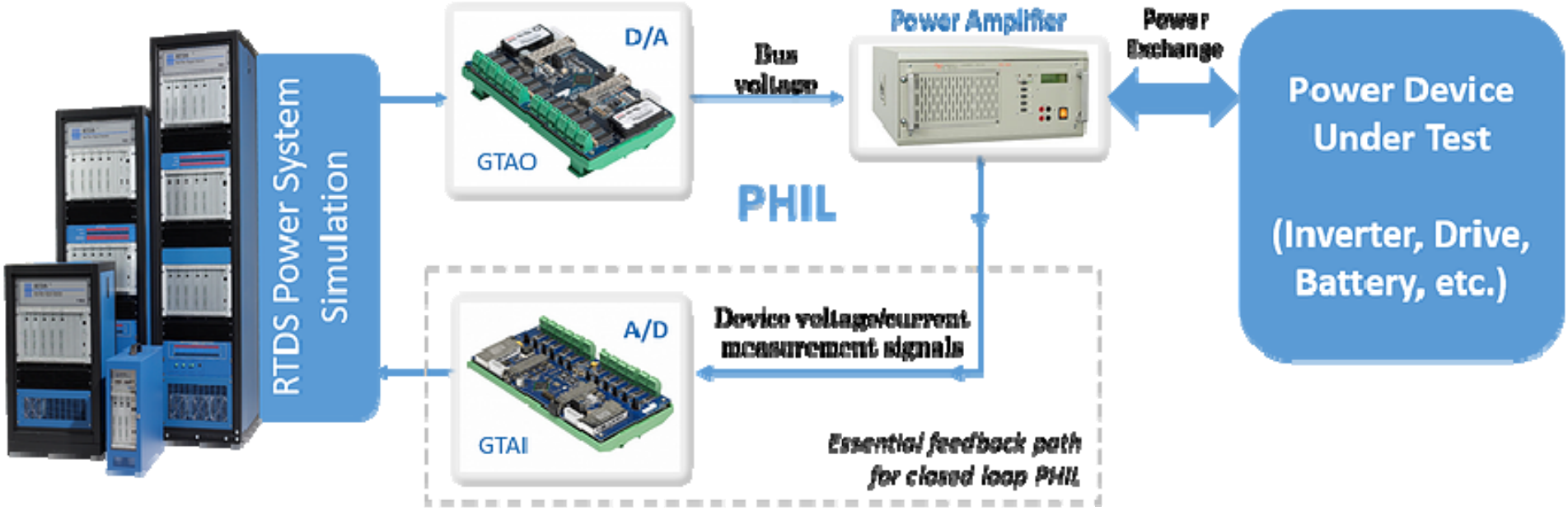
Offline simulation

- Algorithm development
  - Test with distinct benchmark models
  - Sensitivity analysis and algorithm limitations
  - Reliability improvements

- Different Simulator Softwares:
  - RMS simulation, frequency domain (Power Factory)
  - EMT simulation, time domain (PSCAD)
  - Real time simulation, time domain (RSCAD)

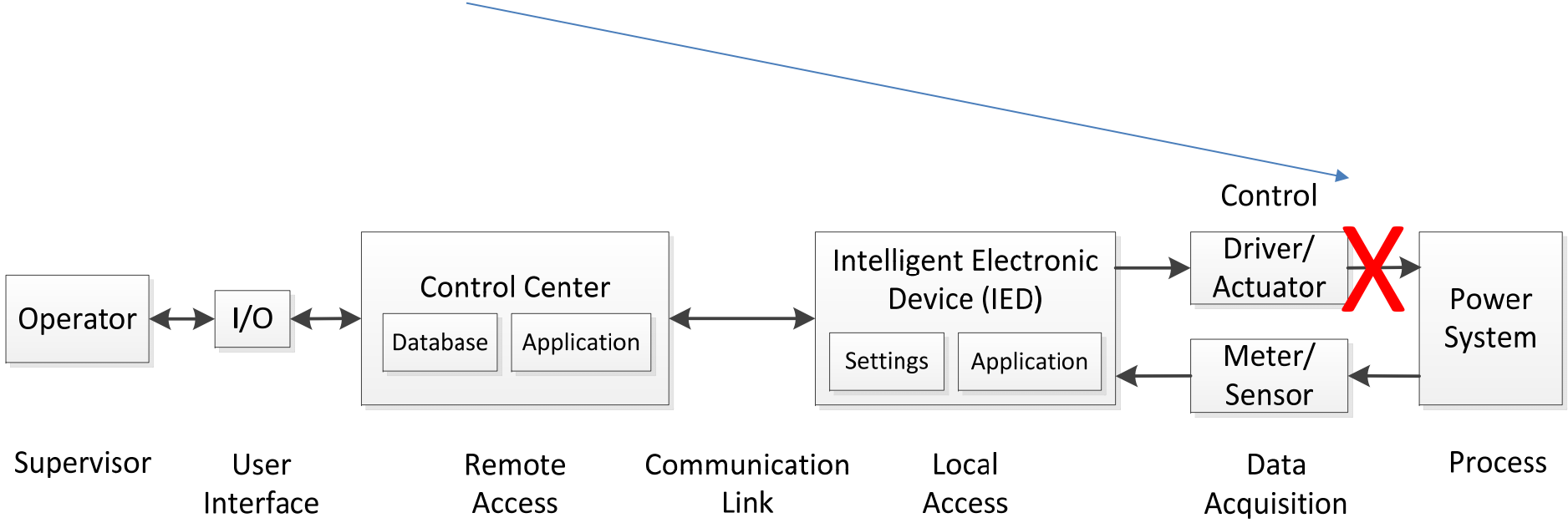
Real Time Digital Simulation (RTDS)

☞ Online test (close loop): RTDS + HIL



Field test

☞ Online (open loop): Real system + HIL



Thank you