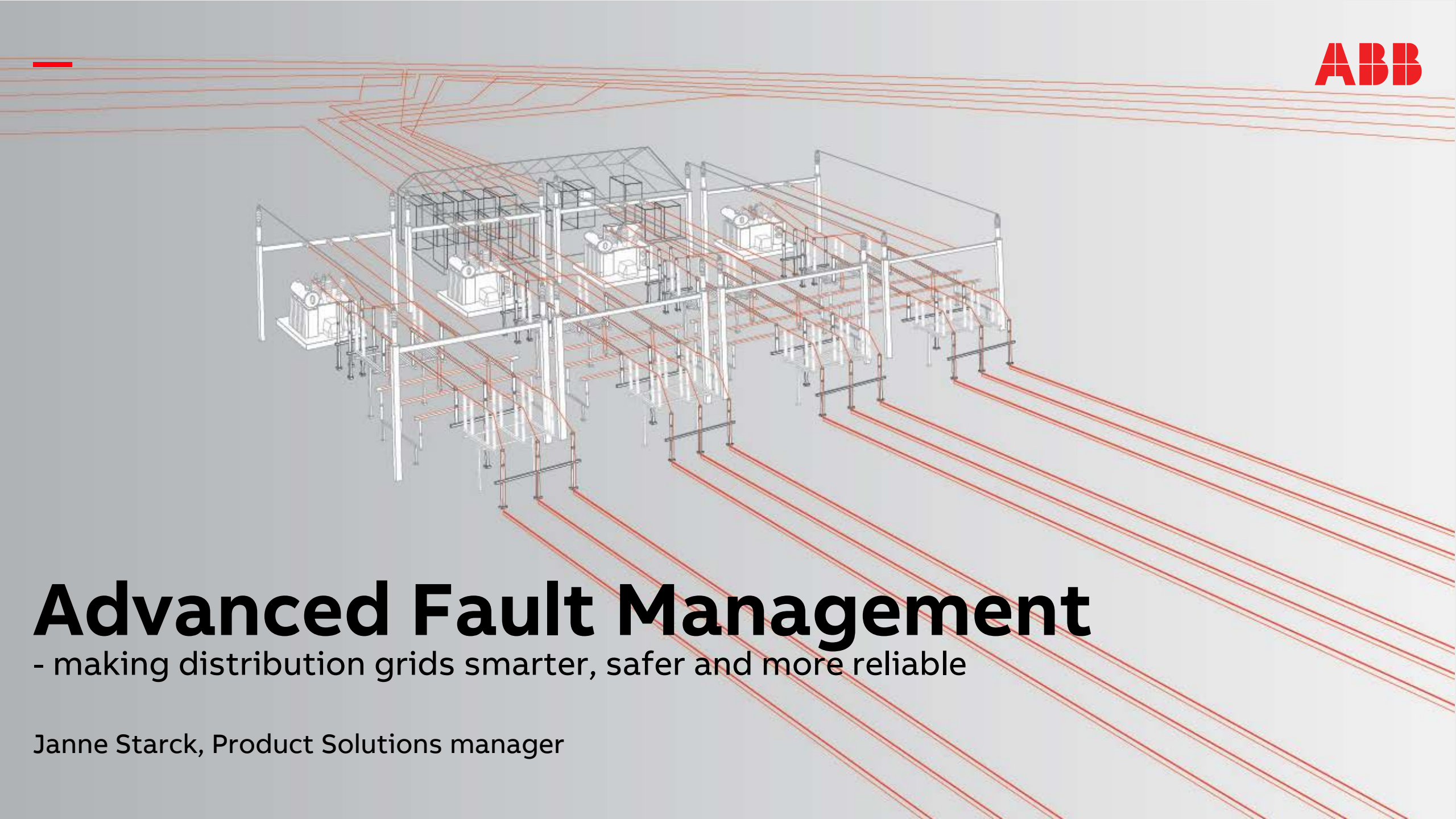


Advanced Fault Management

- making distribution grids smarter, safer and more reliable

Janne Starck, Product Solutions manager

Agenda

Grid automation introduction

Fault management

Communication

Advanced fault management

Conclusion

Grid Automation

Introduction

Problem to solve

Faults in the distribution network needs to be handled

- Flashover to earthed parts or parts with contact to ground
- Trees or vehicles touching overhead lines
- Isolators with weak insulation
- Cable insulation faults caused by aging or physical damage
- Cable joint and bushings failures
- Overhead line fallen to ground
- Faults between the phases
- Etc...

Grid automation helps to solve the faults in distribution network in efficient way

Grid automation

Introduction

Drivers

Quality of power supply

- Legislation and regulator demands
- Customer requirements
- Less and shorter outages
- Voltage quality

Operational efficiency

- Improved tools for network operators and field crews
- Limited own personnel in operation and maintenance -> chain of contractors
- Minimize the network losses

Distributed Energy Resources (DER)

- Increased need to measure power flows/quality due to increased distributed generation

Safety of utility personnel

- Less need to travel to places difficult to reach
- Less need to work in dangerous environments

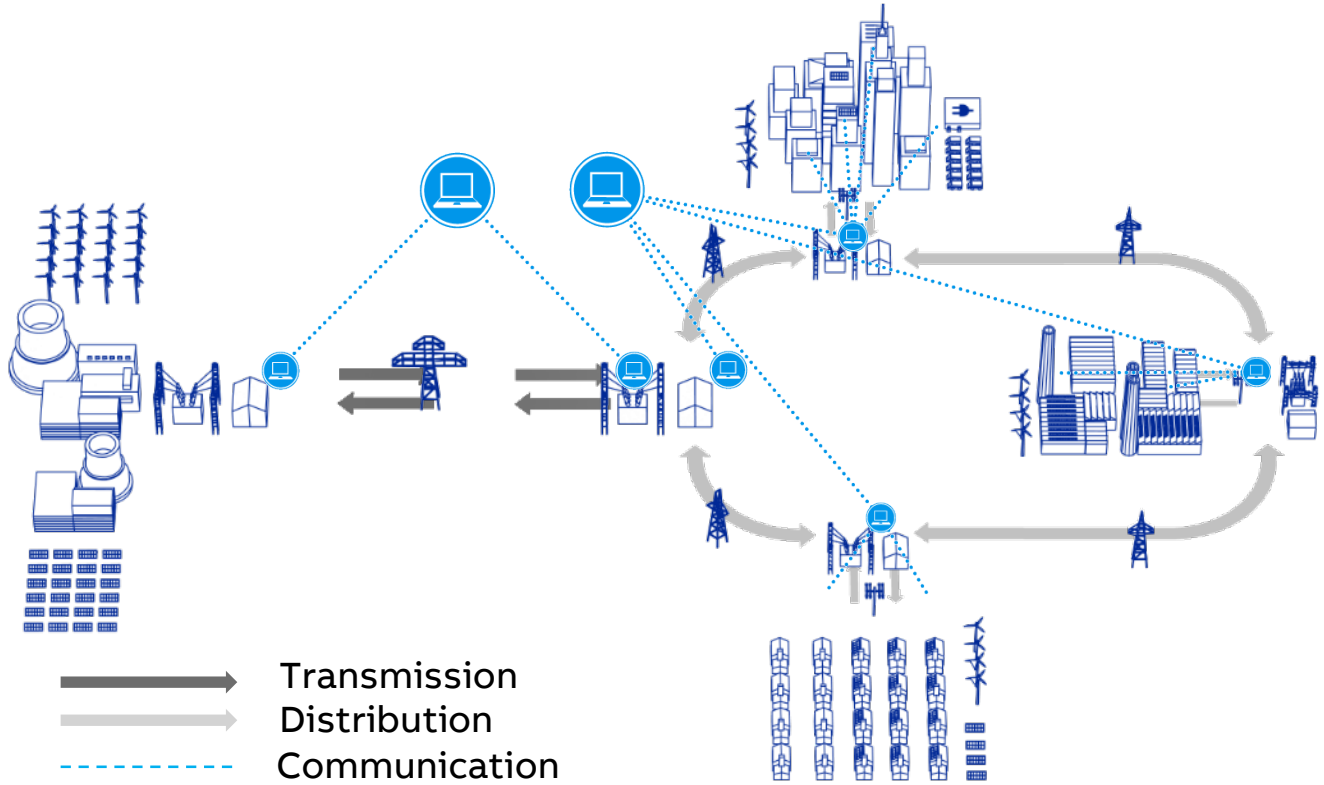
Grid automation

Definition

Automation for secondary distribution

- Power distribution operators are faced with increasing power supply efficiency and quality requirements
- Need to introduce automation throughout the entire network, also to secondary distribution
- Distribution grid automation solution combines advanced protection, monitoring, control and management to a complete holistic system
- Automation is the key contributor and a prerequisite to building smarter grids

Intelligence to grid



Grid automation

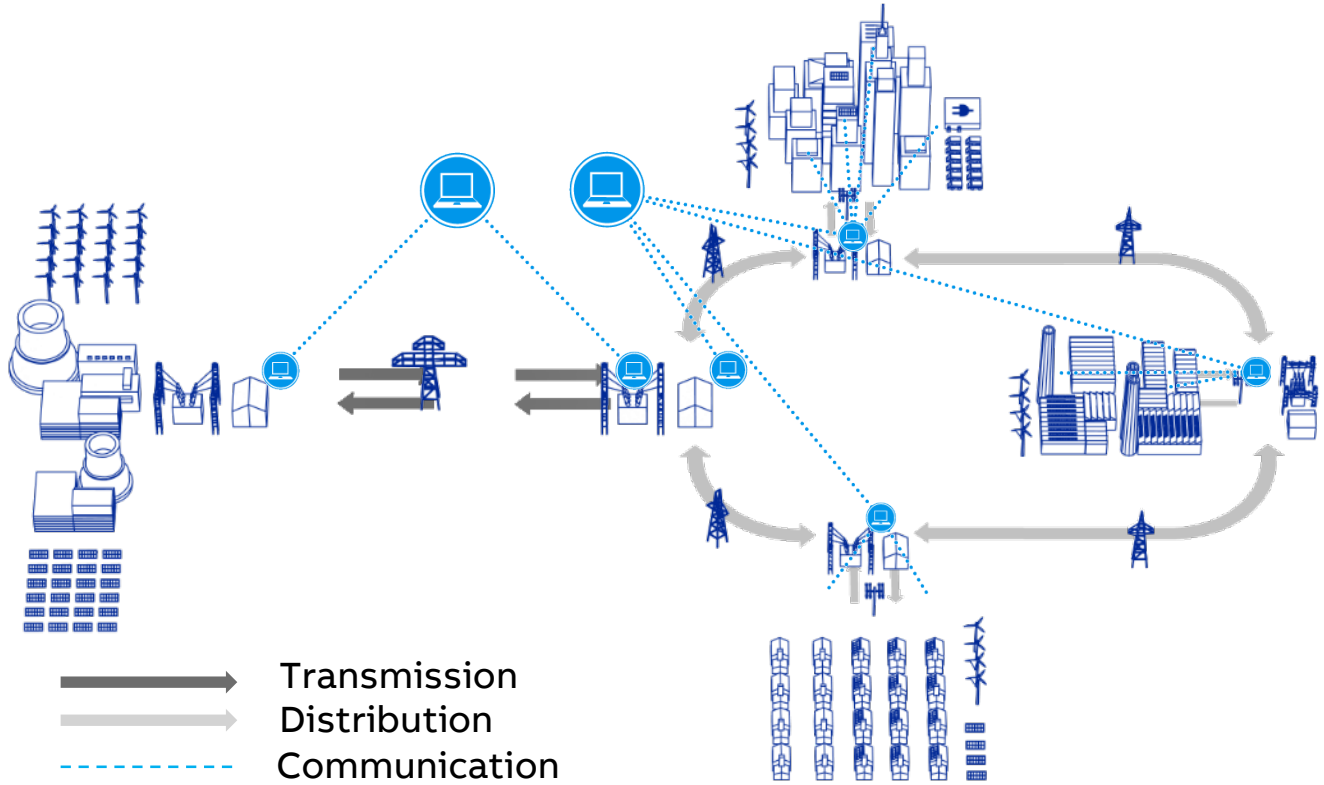
Definition

New automation areas

Secondary distribution - MV network
- Selective protection with breakers
- Monitoring of voltages and currents
- Advanced fault passage indication
- Remote Control of switches

LV measurements
- From LV side in secondary distribution substation

Asset management
- On-line condition monitoring
- Device Management

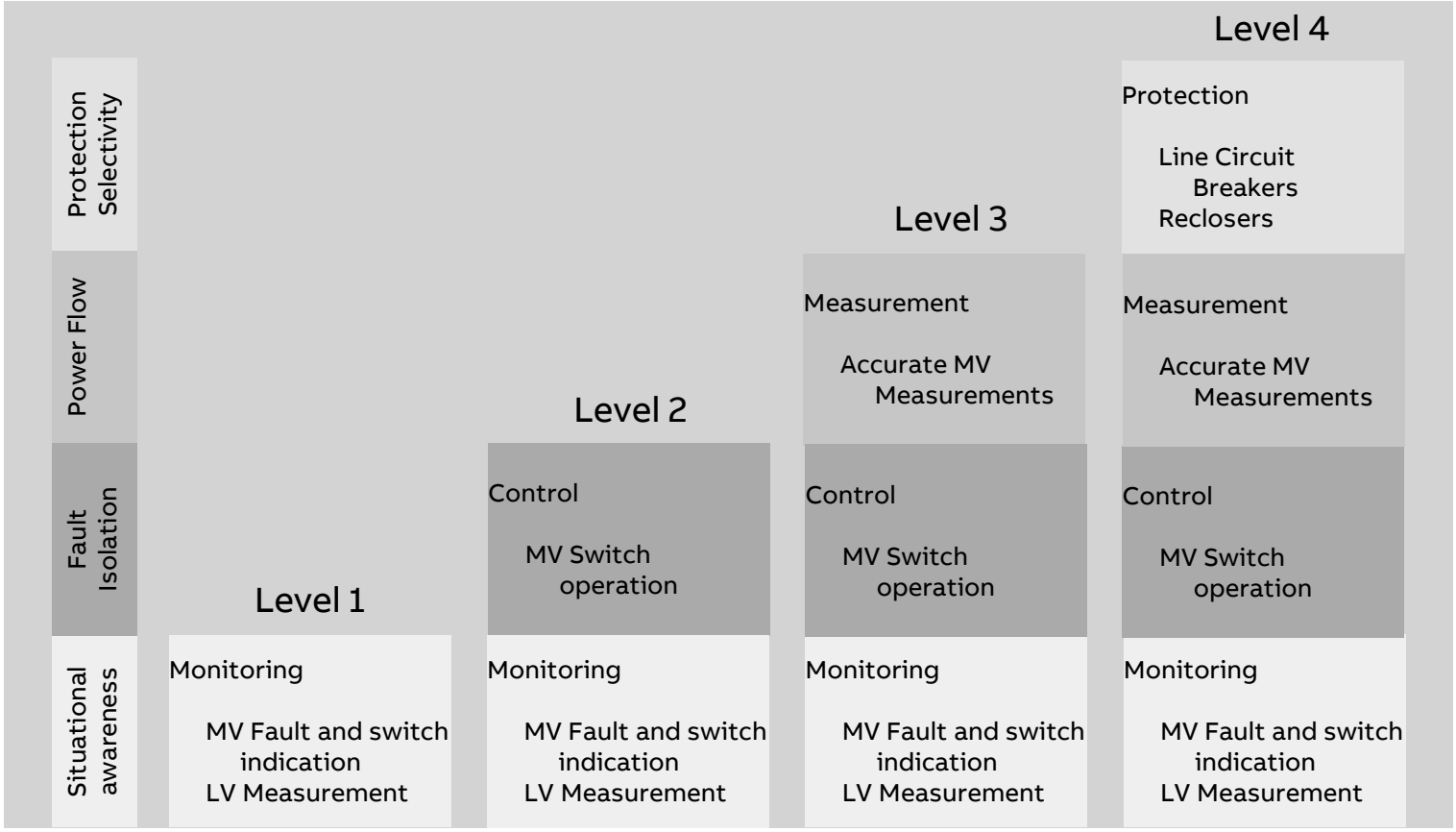


Grid automation

Basics

Grid automation levels

- Automation of secondary distribution can be done in multitude of ways
- We can divide solutions to four general levels
- Different levels are for: situational awareness, fault isolation, power flow management and protection
- Used level depends on required functionality
- Automation retrofits more basic due existing primary equipment
- New systems with higher level of automation



Grid automation

Basics

Benefits of levels

Level 1, Monitoring

- MV Fault and switch indications
- LV Measurements

Benefits

- Faster fault localization
- Network switching status information

Level 2, Control

- Remote switch operations

Benefits

- Fast fault isolation and power restoration

Level 3, Measurements

- Accurate measurements (U, I, f, P, Q, S, cosϕ)
- Advanced fault indication algorithms

Benefits

- Network power flow status
- Trustworthy fault indication

Level 4, Protection

- Advanced protection algorithms

Benefits

- Selective protection
- Integration of distributed generation

Grid automation

Products

REC615

Relion® protection and control relay for secondary distribution substations

- Extensive fault location functionality
- Control of one circuit breaker and up to eight disconnectors
- IEC 61850, IEC101/104, DNP3
- All features inherited from 615 series

RER615

Relion® recloser relay for utility reclosers

- Extensive fault location functionality
- Control of one circuit breaker or switch
- IEC 61850, IEC101/104, DNP3
- Sectionalizer/mid-point recloser
- Tie-point recloser with synchro-check

RIO600

Remote I/O for grid automation

- Modular real-time I/O for Relion® relays using IEC 61850 GOOSE
- Generic purpose I/O using ModbusTCP
- Fault Passage Indicator (FPI) using ABB sensors

Grid automation

Arctic family

Scalable communication solution

- Utilization of mobile networks
- Cost-efficient solution to connect hundreds or even thousands of remote stations that need a reliable and secure remote access
  - No new infra required to be built
  - Robust and inherently redundant
  - Secured end-to-end communication
  - Device asset management from central location

Grid automation

Arctic family

Secure wireless communication over mobile 2G/3G/LTE networks

ARG600

- Protocol converter
- TCP/IP router
- Serial over TCP/IP
- VPN and firewall
- Single and dual SIM variants

ARR600

- Integrated I/O
- Protocol converter
- TCP/IP router
- Serial over TCP/IP
- VPN and firewall

ARC600

- Control and indication of three switching devices
- Protocol converter
- Battery charger and monitoring
- TCP/IP router
- VPN and firewall

ARM600

- Central communication server
- VPN concentrator
- Firewall and routing
- Arctic Patrol for device asset management

Grid automation

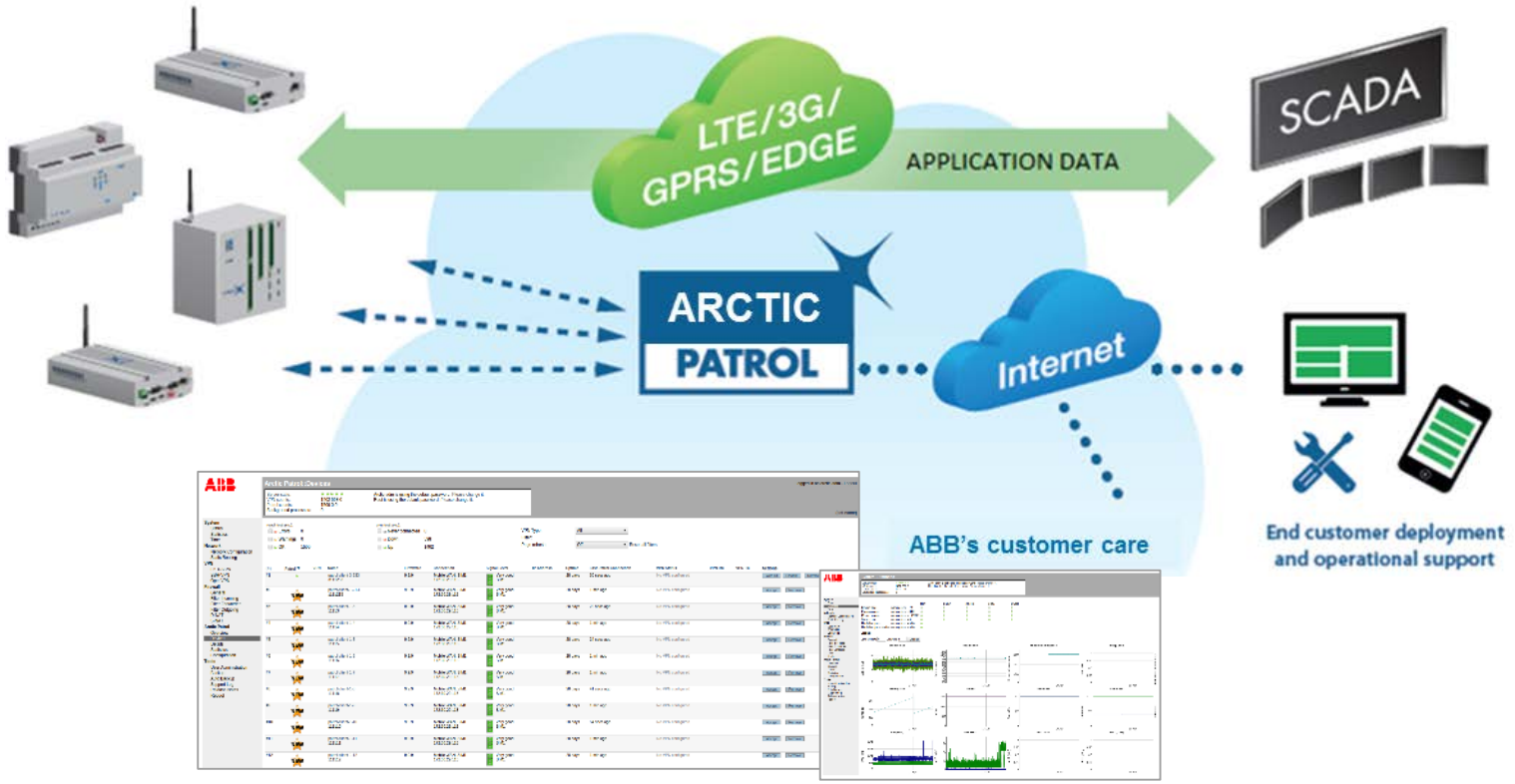
Device asset management

Arctic Patrol in ARM600

Integral part of ARM600 M2M Gateway to handle large installed base of devices

Device asset management:

- Device status
- Signal strength
- Real-time alarms
- Monitoring of the network and device performance
- Remote configuration update
- Remote firmware update
- Automatic back-up of configurations

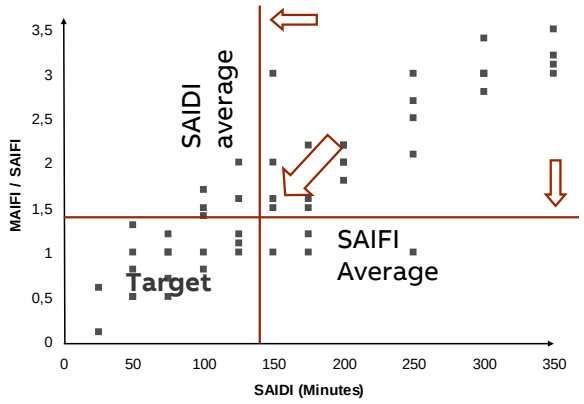


Grid automation

Drivers for advanced fault management

Power quality

- Demands for better power quality and supply increasing
- Reduce SAIDI and SAIFI
- More investments



Underground cabling

- To improve quality utilities are increasing underground cabling
- Requires compensation due increased earth fault current

Network compensation

- Compensation decreases earth fault current and improves safety
- Demanding application for protection and fault indication

Fault handling

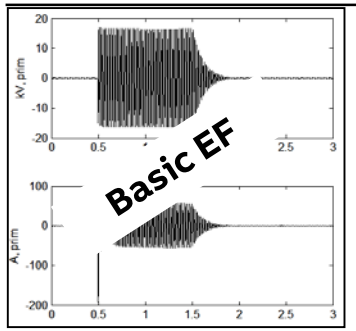
- Accurate fault detection with intelligent protection and indication functions
- Minimizing in fast way fault consequences

Source: Suur-Savon Sähkö

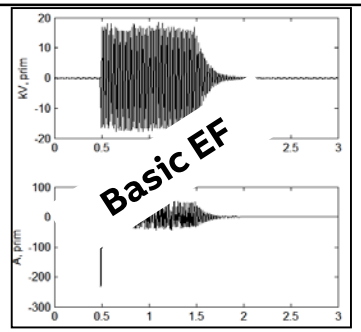
Grid Automation

Fault management

Traditional earth fault protection and indication



SOLID EARTH-FAULT I



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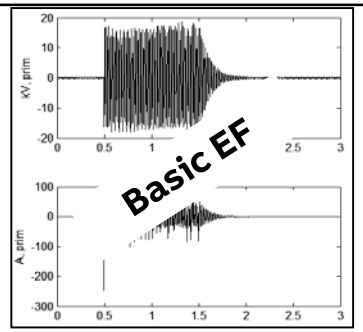

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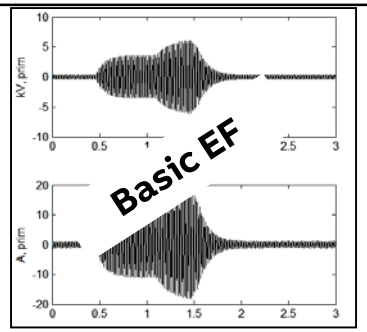
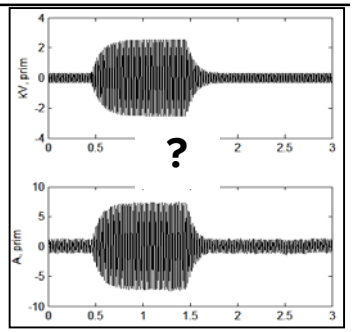


HIGH(ER)-OHMIC EARTH-FAULT I



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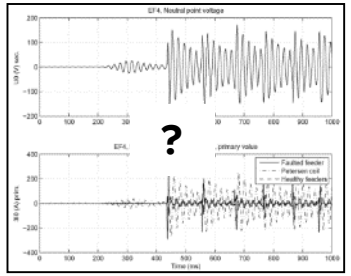

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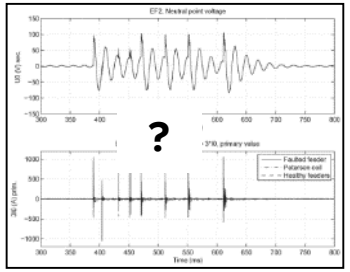

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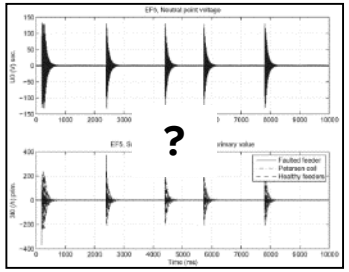

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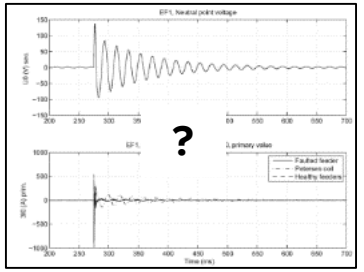
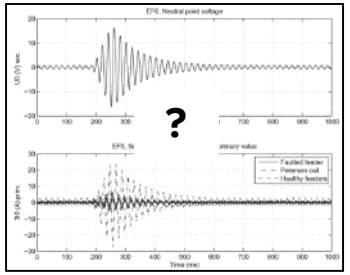


TRANSIENT EARTH FAULT I

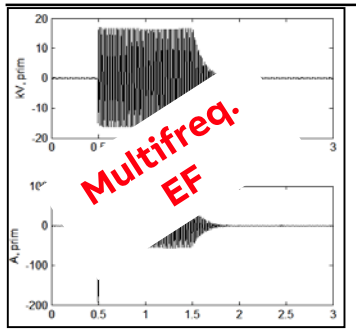


TEMPORARY EARTH

Grid automation

Advanced fault management

One earth fault protection and indication function for all fault types



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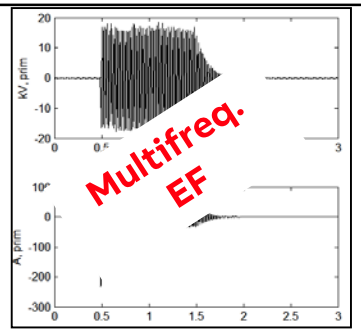

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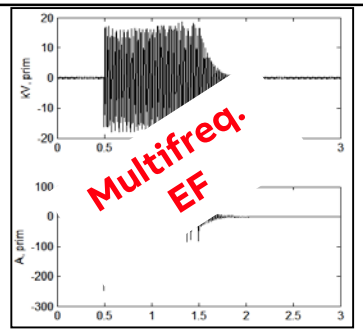

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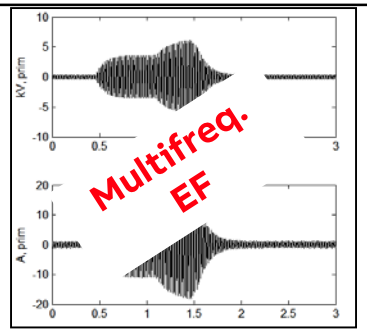

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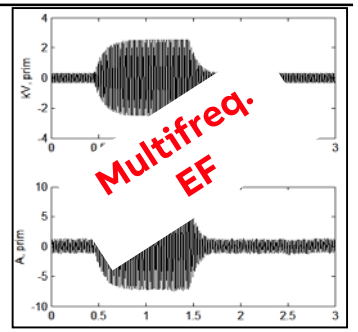

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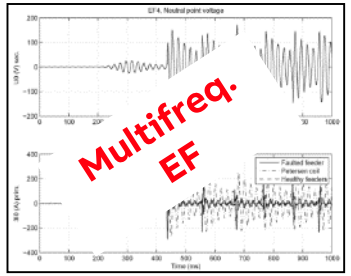

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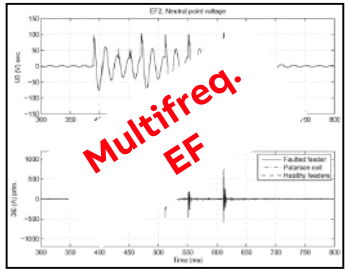

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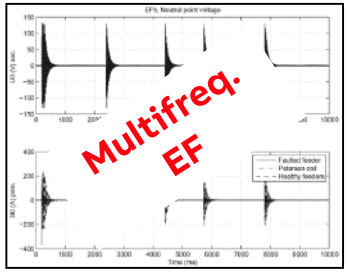

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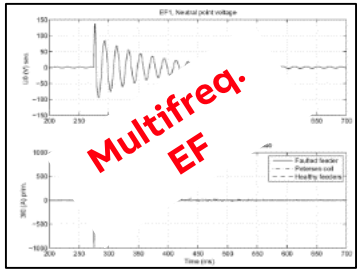
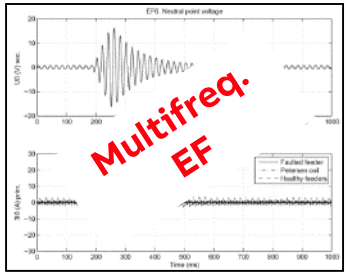


TRANSIENT EARTH FAULT I



TEMPORARY EARTH

Grid automation

Advanced fault management

RIO600 as fault passage indicator

FPI with support of ABB combisensors as well as current and voltage sensors

- Measured phase current and voltage: 4A-8kA and 480V-48kV
- Power measurements: P, Q, S and cos φ
- Frequency measurement
- The typical accuracy of line voltages, currents and active power is < 0.5% and for other power measurements < 1%
- Active/reactive energy counters
- Capability to detect accurately directional and non-directional overcurrent and earth faults
- Phase power flow indications
- Phase voltage absence/presence
- Advanced earth fault detection based on new algorithm

Grid automation

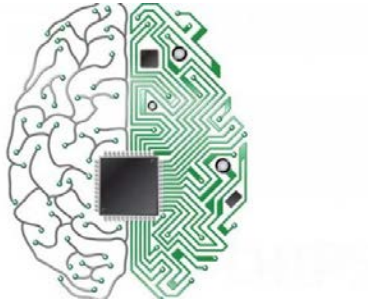
Benefits of sensors

Fast design process

Quick delivery time

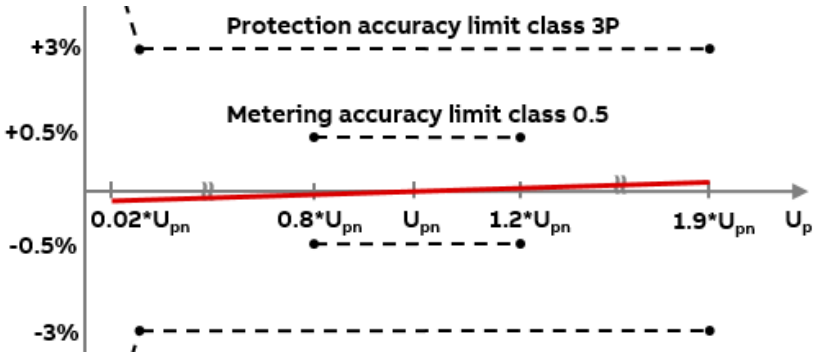
Minimized costs

Flexibility



Safety and reliability

Accuracy

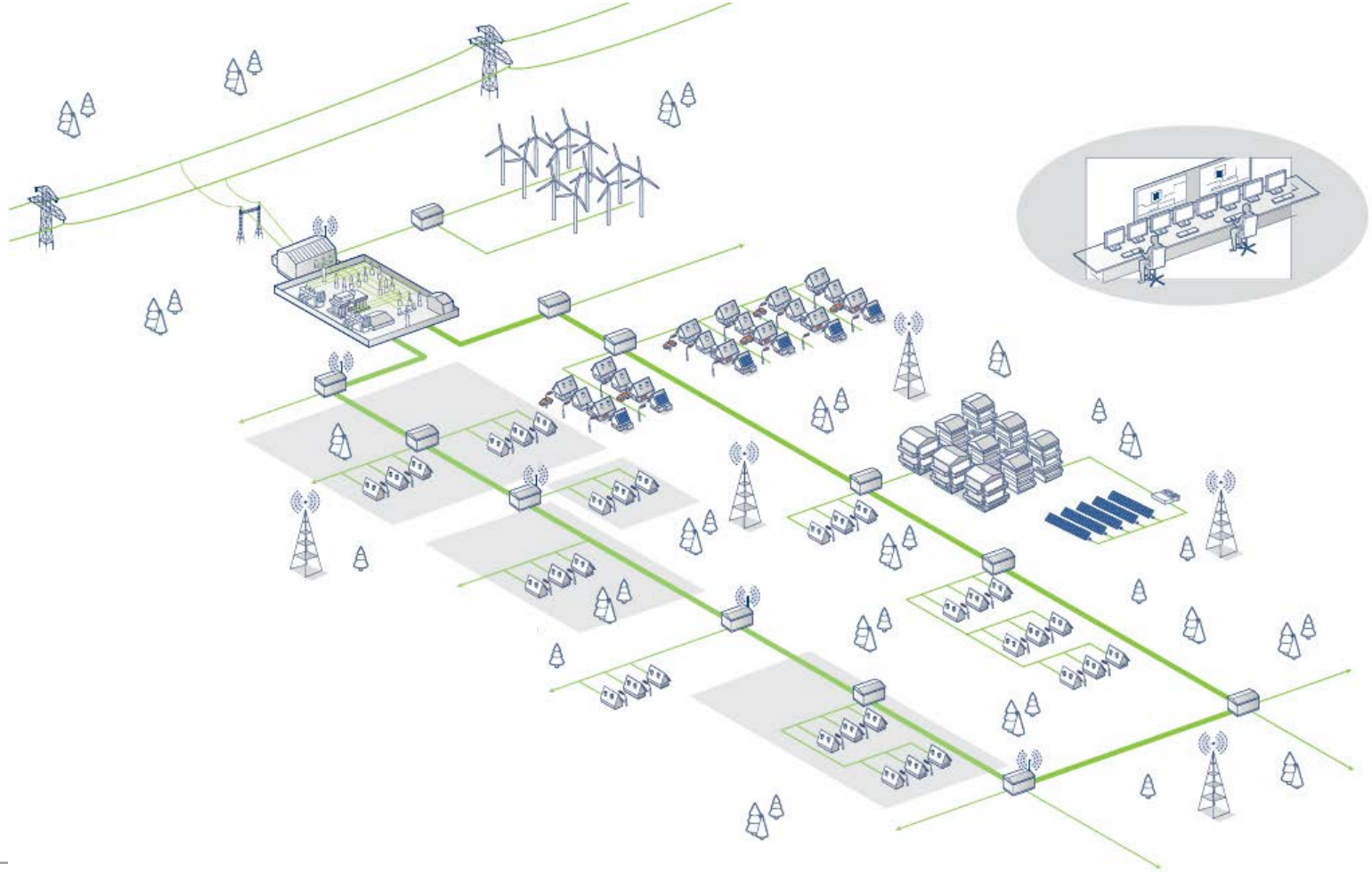


Grid automation

Fault management

Example

- Open ring cable network with coupling points from other feeders/rings
- Feeder is divided to zones
- Protection in primary switchgear
- Fault passage indicators in secondary substations
- DMS controls automatically the restoration process in case of fault

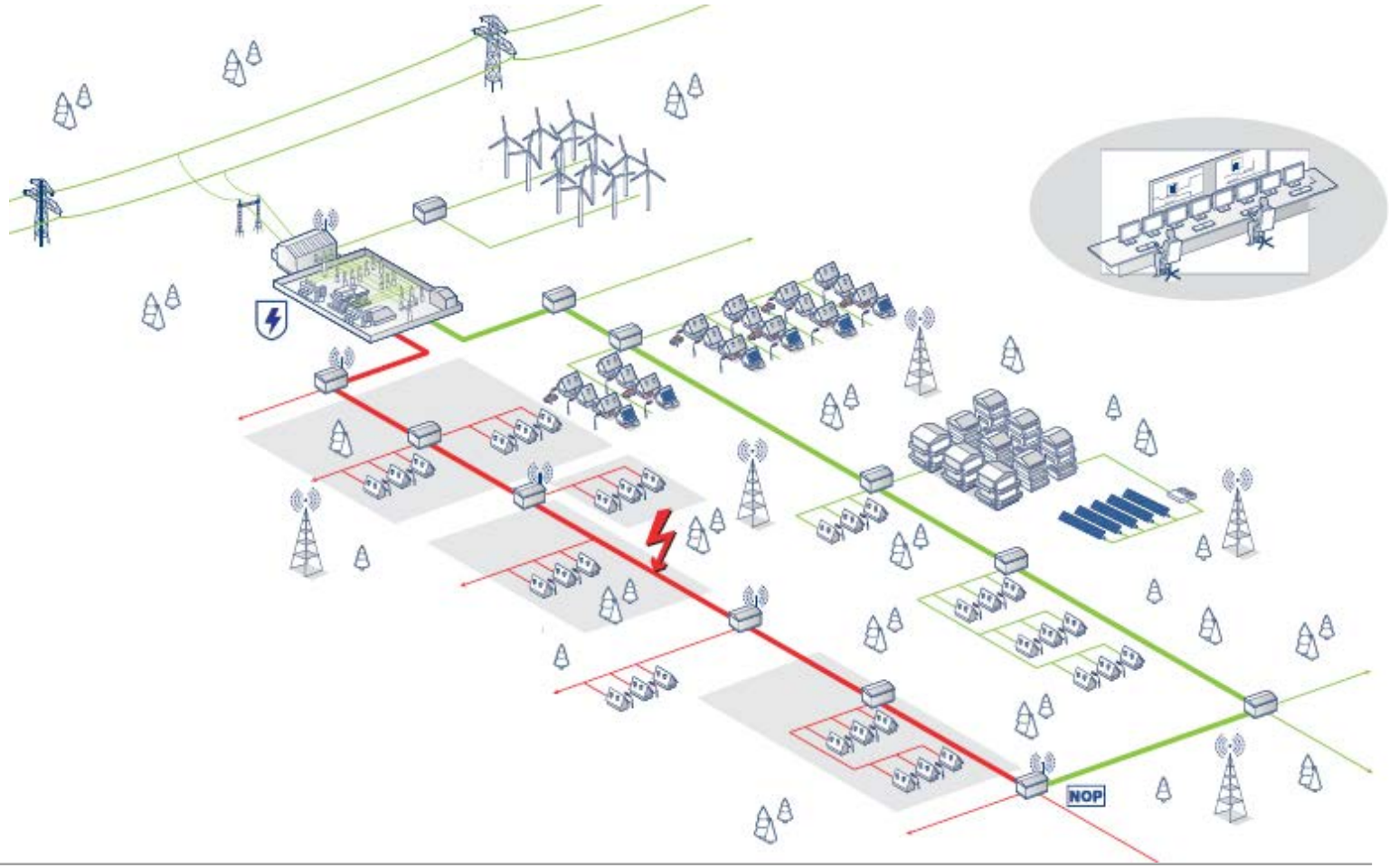


Grid automation

Fault management

Example, protection

– When a over current or earth fault occurs in the feeder protection in the primary substation trips the feeder

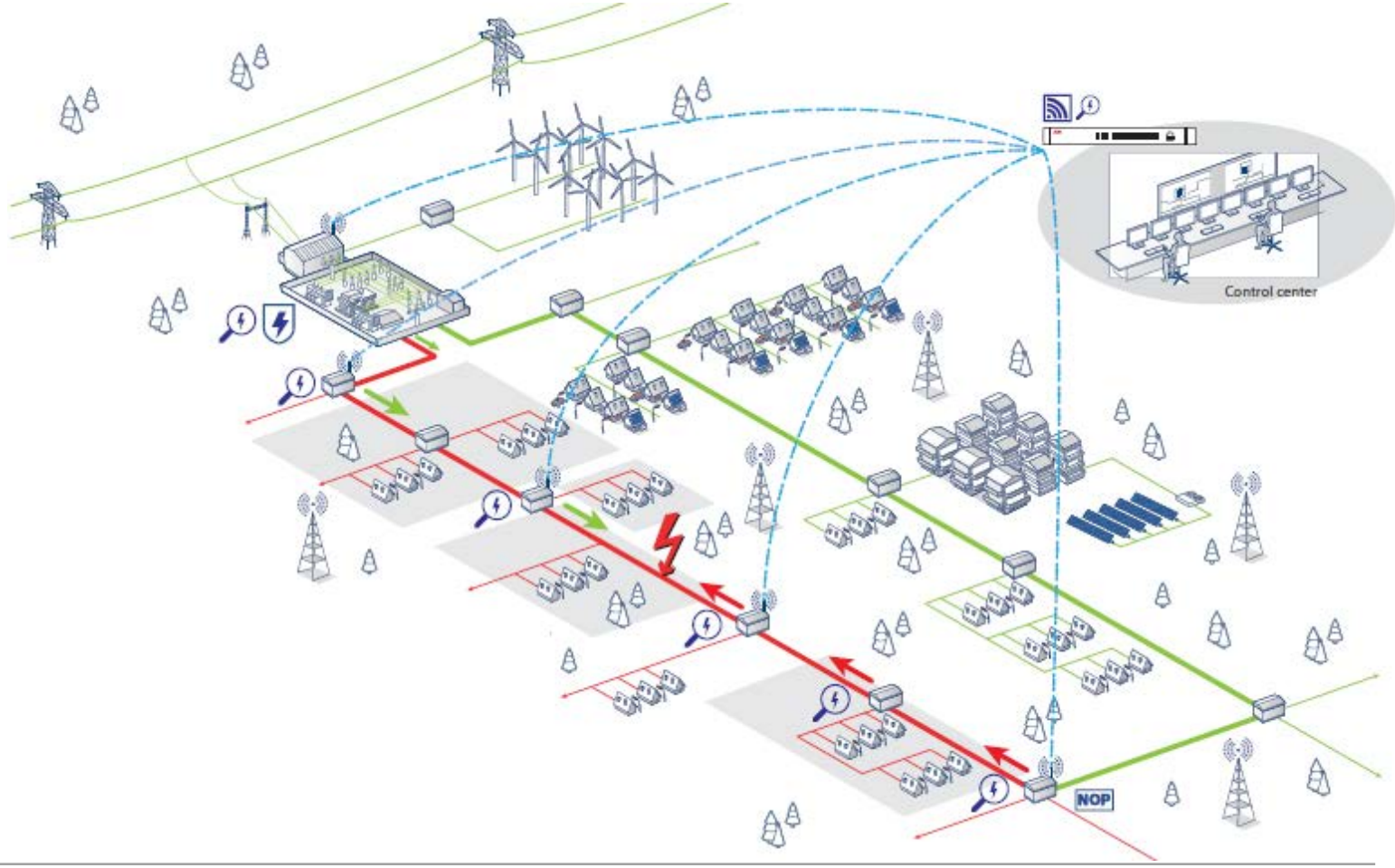


Grid automation

Fault management

Example, indication

- Fault passage indicators installed between zones indicate the direction of the fault
- Fault information from each node is communicated to DMS
- In case of over current fault protection relay can calculate distance to fault

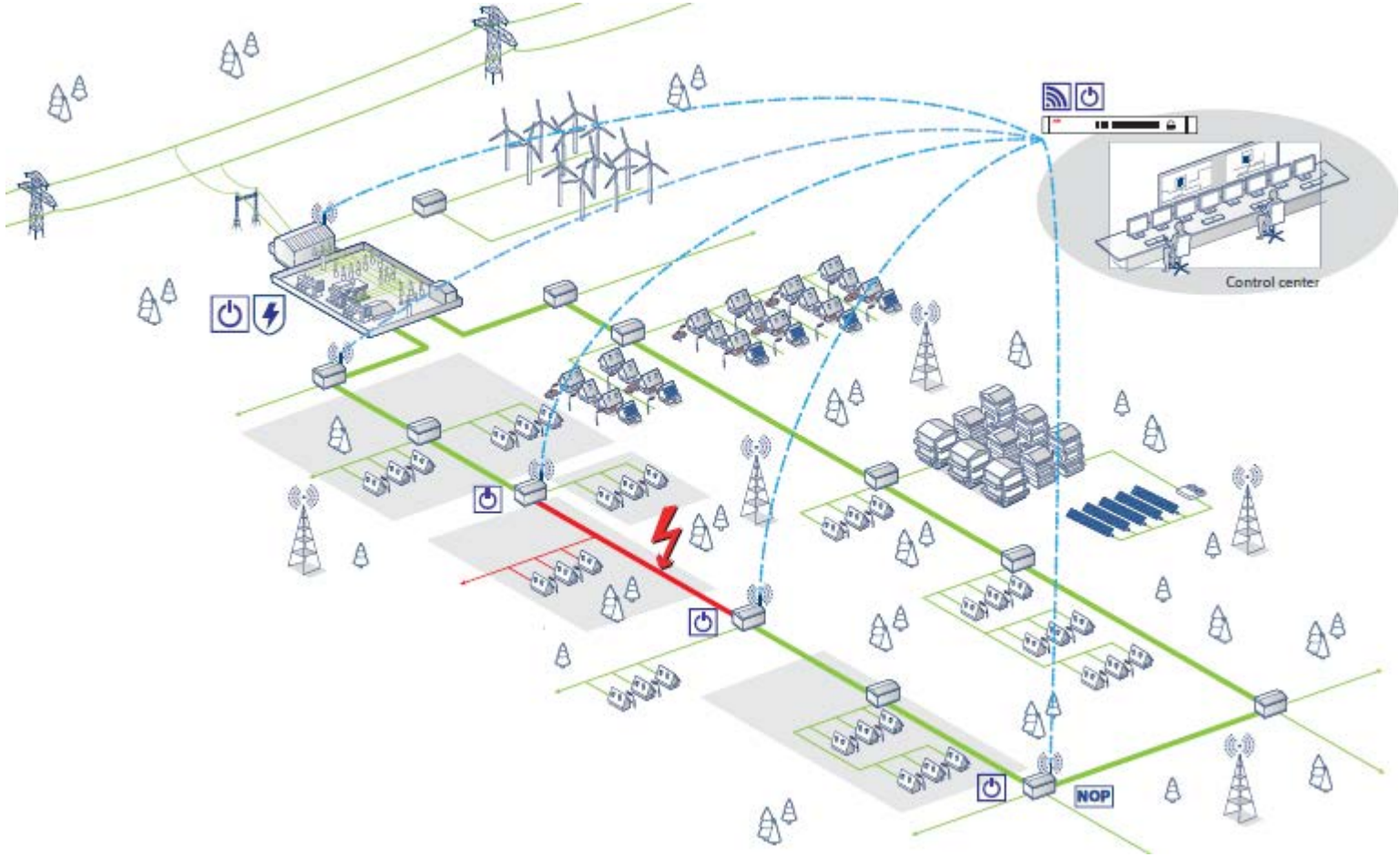


Grid automation

Fault management

Example, restoration

- Based on received fault information DMS locates the fault
- Controlling remotely the primary equipment limits the affected area
- Rest of the network is restored in fast manner
- Location of the fault given to service crew to fix the fault

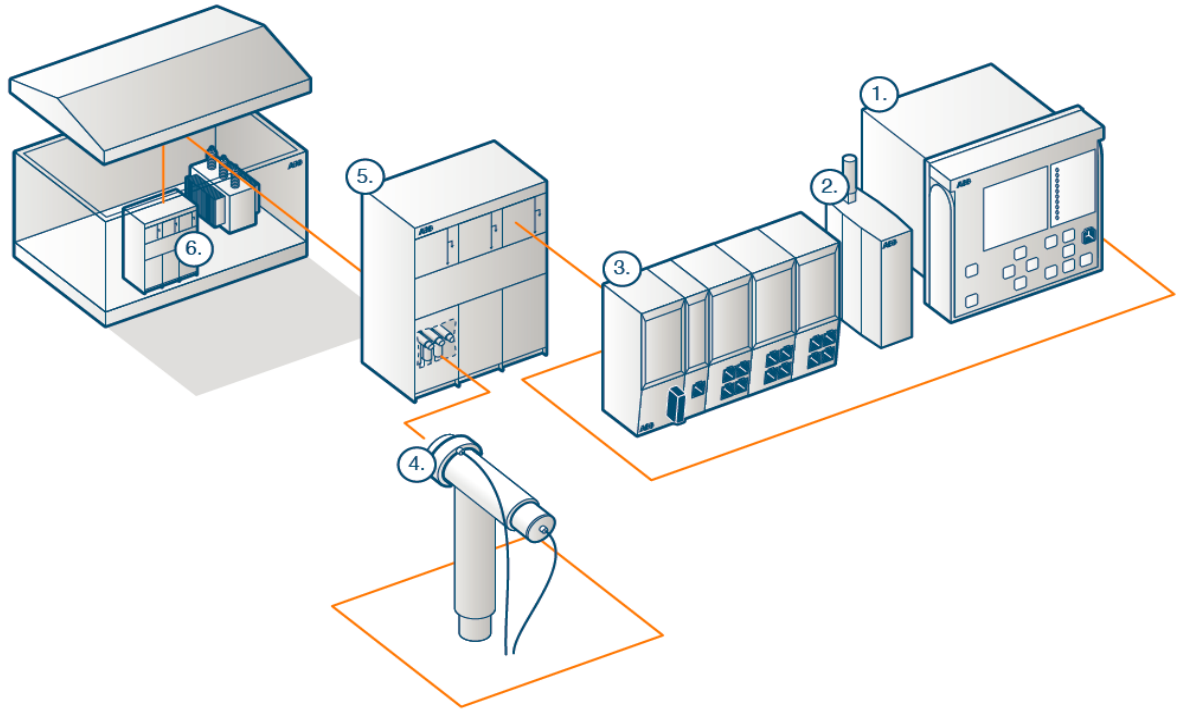


Grid automation

Fault management

Compact Secondary Substation

1. Remote Control Unit /Protection Relay
2. Communication unit
3. Fault Passage Indicator, additional I/O
4. Sensors
   - Combisensors
   - Retrofit sensors
5. RMU switchgear with motorized disconnectors
6. Scalable secondary substation



Factory ready secondary substation

Grid automation

Control cabinet example

Remote control with ARC600 and RIO600

Remote controllable load break switches on cable feeders with sensor measurement

- ARC600 enables secure wireless access to secondary substation with possibility to control primary equipment
- RIO600 offers remote communication, fault detection (FPI), control and measurement functionality needed in grid automation enabled networks

Grid automation

Secondary substation offering

Circuit breaker and recloser control solutions with REC615 and RER615

Grid automation

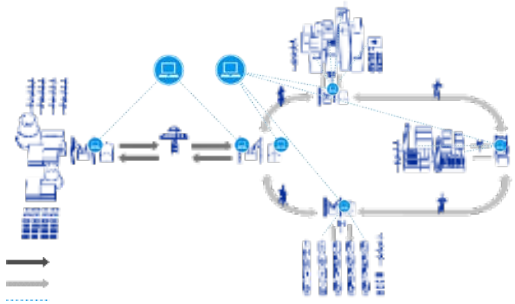
Conclusion

Protection and control

Over 1,5 million sold protection relays

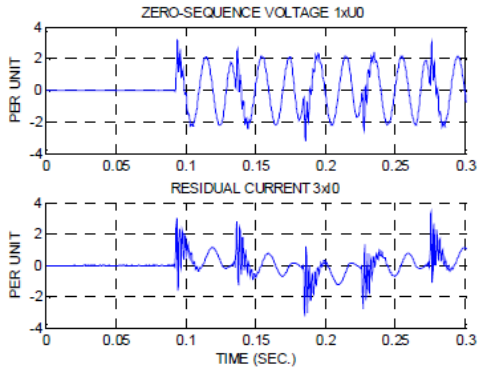
Secure remote access

Wide wireless solution range to support intelligent automation



Fault management

Worlds best fault protection and detection algorithms for secondary distribution



Solutions

From single device to fully automated secondary substations

Solid foundation for grid automation applications