Distribution Automation for electrical grids

Fault and outage management

Alain Aurus, Theodoros Oikonomou, Yasmine Vögele
Introduction
Use the “detach” button to detach the question panel. It will come up as a larger window.

When you do not need the questions anymore. Use the “attach” button to bring it back to the panel. (Do not use the little “X”).
Introduction of the team

Theo Oikonomou
Global Product Manager
Distribution Automation

Yasmine Vögele
Marketing Manager
Substation Automation

Alain Aurus
Distribution Automation Initiative owner
Grid Automation

Leading the way within the Power Grids division

Worldwide presence

ABB
- 132,000 employees
- $34B revenue

ABB Power Grids
- 39,000 employees
- $11B revenue
- 100 countries

ABB Grid Automation
- 6,000 employees
Distribution Automation

Enabling you to see inside your grid
Trends and challenges
Distribution Automation Trends

Increasing demand for Smarter Distribution Grid

**Trends**

- Distributed Energy Resources resulting into new integration challenges
- Larger and more complex Grids
- Increased demand for higher
  - Power Quality Delivery
  - Power Delivery Reliability
- Digitalization enabling to see deeper inside the Grid
- Cost pressure on Operation and Maintenance
- Increased focus on safety
## Distribution Automation

### Challenges

<table>
<thead>
<tr>
<th>Quality of power supply</th>
<th>Operational efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Legislation and regulator demands</td>
<td>– Improved tools for operators and field crews</td>
</tr>
<tr>
<td>– Customer requirements</td>
<td>– Reduced CAIDI [Customer average interruption duration index] and SAIDI [System average interruption duration index]</td>
</tr>
<tr>
<td>– Less and shorter outages</td>
<td>– Limited own personnel in operation and maintenance</td>
</tr>
<tr>
<td>– Voltage quality</td>
<td>– Minimize the network losses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distributed Energy Resources (DER)</th>
<th>Safety of utility personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Increased need to measure power flows /quality due to increased distributed generation</td>
<td>– Less need to travel to places difficult to reach</td>
</tr>
<tr>
<td></td>
<td>– Less need to work in dangerous environments</td>
</tr>
</tbody>
</table>
ABB Distribution Automation offering
Distribution Automation Systems

Application overview

- Monitoring, Control and Measurement
- System Protection
- Fault & Outage Management
- Volt-Var Management

Basic applications
Advanced applications
# Distribution Automation

## Portfolio

<table>
<thead>
<tr>
<th>Systems</th>
<th>Engineered packages/DA solutions</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered Distribution Automation Systems, from control center, to primary, down to secondary substation automation.</td>
<td>Secondary and communication equipment packaged together and factory tested</td>
<td>All the essential distribution automation products for medium to low voltage</td>
</tr>
<tr>
<td></td>
<td>Primary equipment packaged with automation fully integrated and factory tested</td>
<td>All the essential distribution apparatus products for medium to low voltage</td>
</tr>
</tbody>
</table>
Distribution Automation

Portfolio & architecture

See inside the grid

The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products.

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products.

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
Distribution Automation
Portfolio & architecture

See inside the grid

The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products.

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products. The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products.

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.

See inside the grid

Distribution Automation
Portfolio & architecture

Enterprise
- Customer information system
- Geographical information system
- Billing system
- Asset management
- Reporting and statistics

System Engineering Software Tools
- IET600
- PCM600
- ITT600

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
Distribution Automation
Portfolio & architecture

See inside the grid

The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products.

The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level to for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.

©ABB
1 September 2017 | Slide 19
Distribution Automation
Portfolio & architecture

The automation offering comprises complete engineered systems, ready-to-use engineered packages and high-class loose products. The automation can be applied at the field level for existing pole-mounted reclosers, disconnectors and breakers, at substation level for secondary switchgears and ring main units (RMU), or at the SCADA level in network control center.
Fault and Outage Management
Introduction and concepts
Fault and outage management

Closing the loop: Automation - SCADA - Analytics - Work force & Asset Performance Management

Substation A
Protection trips when internal fault
Isolation by opening the switches
Restoration by transfer to other power sources

Substation B
LV Smart meter
Restoration

Outage Management Analytics
Disturbance Analysis
Asset Performance Management

Advanced Distribution Management System
Web HMI
Mobile Devices
Mobile Work Force Management

Outage Management Analytics
Disturbance Analysis
Asset Performance Management
Fault management

Fault detection, isolation and service restoration

FLISR. Fault Location Isolation and Service Restoration
FDIR. Fault Detection Isolation and Restoration
FPI: Fault Passage Indicator
**Fault Management**

Overview of the concepts

---

**De-centralized/FDIR**
- Quick response to problematic feeders
- Easy step-wise approach
- Fastest restoration time

---

**Semi-centralized/FDIR**
- Combination of conventional DMS and flexibility of de-centralized solution
- Modular step-wise approach
- Faster restoration time

---

**Centralized/FLISR**
- Single solution for entire grid
- Standardized field devices
- Advanced DMS functionality
- Overall system performance may limit the speed

---

Advanced application for your distribution network with standardized devices for maximum reliability and performance
Fault Management
De-centralized concept

Automation logic is running distributed at secondary substation level.
DMS is just informed.

- **Tier 1**
  - Control center
  - SCADA/DMS

- **Tier 2**
  - Primary distribution substations

- **Tier 3**
  - Secondary distribution substations and Remote controllable line switches

Control → Information

Communication  |  Control  |  Protection
Fault Management
Semi-centralized concept

Automation logic is running at primary substation level.
DMS is just informed.

Tier 1
Control center
SCADA/DMS

Tier 2
Primary distribution substations

Tier 3
Secondary distribution substations and Remote controllable line switches

Control Information

Communication Control Protection
Fault Management

Centralized concept

Automation logic is running at control center level.

Tier 1
Control center
SCADA/DMS

Tier 2
Primary distribution substations

Tier 3
Secondary distribution substations and Remote controllable line switches

Control
What is the Zone concept?

The Zone concept minimize affected area and maximize power supply restoration
What is the Zone concept?
Reducing the fault tracing time from hours to minutes

Zones P1, P2 & P3 didn’t have outage
Zones C1, C2 & C4 suffered an outage of <2min
Zone C3 suffered an outage of ~100 min

Without automation, the fault would have been located with time consuming trial & error method, total outage in Zone 3 ~200 min

The Zone concept minimize affected area and maximize power supply restoration
What is the Zone concept?
Dividing distribution networks into zones

81% Reduction in outages times*
50% Up to 50% shorter time till restoration

The Zone concept minimize affected area and maximize power supply restoration
Fault and Outage Management

References
Pudong Smart City
Decentralized - Fault Detection, Isolation and Restoration

Pudong, China

Challenge
High reliability and reduced recovery time needed

Solution
Automatic FDIR with fast fault detection
Each device participate in the Fault Analysis action, independent from SCADA system - use of RTU540 series
Use IEC 61850 GOOSE to transfer the necessary information for fault isolation
Use IEC 104 to transfer the events to SCADA System

Benefit
Reduced fault investigation and patrol time
Reduce the recovery time to 15 seconds only
Providing solution which can be easily extended
Irish Utility

Semi-centralized – Fault Detection Isolation Restoration

Irish Utility

- Responsible for MV and LV grid infrastructure in Ireland
- 1.7 million electricity customers
- 160,000 km power lines
- Mainly overhead lines

FDIR SCADA project

- Two SCADA systems with FDIR application
- ABB ARP600 (Artic gateway and protocol converter IEC 101/104)
- Dual SIM with secure GPRS communication via VPN tunnel
- Remote control of disconnectors and reclosers

Benefit

- Significant decrease in operating and maintenance costs
- Penalty costs were cut by 54% from 20 M€ to 8 M€ p.a
## Centerpoint Energy

Centralised / Semi-Centralised (mixed)

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve power quality and reliability</td>
<td>ADMS (DMS/OMS/SCADA)</td>
</tr>
<tr>
<td>Develop a self-healing grid</td>
<td>Phase 1: SCADA, Phase 2: OMS, Phase 3: DMS</td>
</tr>
<tr>
<td>Reduce operation costs</td>
<td>Implement Volt-VAr and Self Healing (Auto Restoration) capability on the distribution grid</td>
</tr>
<tr>
<td>Extend life of electrical assets</td>
<td>Service Suite integrated with ADMS for faster crew deployment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solution</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Manager ADMS with SCADA, DMS (VVO, FLISR), OMS, Service Suite and Focalpoint business analytics</td>
<td>Restoring power to nearly 1.2 million customers without a phone call</td>
</tr>
<tr>
<td></td>
<td>Avoiding over 102 customer outage minutes</td>
</tr>
<tr>
<td></td>
<td>Improving power reliability by over 28%</td>
</tr>
</tbody>
</table>
Implementing ABB Distribution Automation inside your grid will allow you to:

- Improve reliability of your Grid
- Maximise availability of electricity to your customers
- Improve customer satisfaction
- Reduce your operational cost – optimized utilization of scarce resources
- Increase safety
- Unlock smarter system and asset analytic enabling you to optimize your fleet utilization and life cycle

Various levels of Automation can be implemented:

- Centralised
- Semi-Centralised
- Decentralised

Depending on business requirement.
Distribution Automation
Enabling you to see inside your grid

- **81%**
  Reduction in outages times*

- **50%**
  Up to 50% shorter time till restoration

- **100 Years**
  of know-how in power automation, communication and protection