Fault Location and Fault Visualization

M Kezunovic

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Outline

• Background
• Goals
• New approach
• Implementation
• Benefits
• Conclusions
Possible causes of faults
temporary fault

Equipment reacts automatically. Fault is cleared. No need for operator action, but event is recorded and archived.

Normal Operation

Fault Occurred

Fault is Cleared

Automatic Fault Clearing (Realys&Circuit Breakers)

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Permanent Fault

Automatic fault clearing makes decision to disconnect faulted part of the power system without any more attempts to automatically recover disconnected part ➔ LOCKOUT

→ Disconnected part must be returned to working state MANUALLY
Equipment Affected
Goals

Existing responsibilities
Shortcomings
Improvements
Existing responsibilities

**Operator** tracks system 24/7; coordinates other groups as needed. Output: Event report

**Protection** Group analyses events 8am-5pm; identifies fault location and equipment misoperation. Output: Comprehensive analysis report

**Maintenance** responds to calls 24/7; inspects and repairs equipment as needed. Output: Repair report from field visits
Shortcomings

• Data and information
  - Incomplete and imprecise data
  - No automated information extraction

• Decision and action
  - Inconsistent accuracy of fault location
  - Lack of specific instruction for action

• Personnel productivity and response time
  - Burden from routine tasks
  - Long restoration time
Improvements

• Data and information
  - Increase availability and precision of data
  - Automate information extraction

• Decision and action
  - Use optimal fault location algorithm
  - Issue specific instruction for action automatically

• Personnel productivity and response time
  - Spend less time on analysis and restoration
  - Involve less people in the process
New Approach

Infrastructure

Data Flow

New Features
Data flow

Fault location and/or equipment misoperation

Protection group

Alarm

Operator

Alarm

Fault cleared

Maintenance

Summary report

Fault Information

Archived data

SCADA

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New Features

• Automatic access to new IED data
• New displays for different user groups
• New quality in decision making
  - speed (faster decision making and data retrieval)
  - accuracy (redundant data are available, new algorithms)
  - automation (data retrieval and analysis)
New Features

Protection Group
Comprehensive Report

Operator
Brief Report

Maintenance
Summary Report

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Implementation

Fault Location Module
Visualization Module
Visual-Interactive-Distributed (VID) Spreadsheet
Fault Location Module

Optimal FL algorithm selection

Single-end fault location

Two-end fault location

Fault location using sparse measurements

Updating:
- Branches
- Generators
- Load

- Interpretation file
- COMTRADE file
- DFR Fault Report

Line Model

PSS/E Short Circuit Program

DFR Assistant

SCADA EMS PI Historian

Case data

System Model

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System Architecture

PSS/E
Short Circuit Program

Fault Location

DFR Assistant

Visual-Interactive-Distributed VIDSpreadSheet

Fault Report

Power World

SCADA EMS PI HISTORIAN

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AB Fault is
39 miles from bus 48219
line length is 98 miles
inception time:
may 19th / 06 3:45:18:472
clearance time:
may 19th / 06 3:45:19:128
Benefits

Data and Information
Decision and accuracy
Personnel productivity and response time

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Data and information

- Data are collected automatically
- Availability of information relevant to each group
- Automatic report retrieval and archival using central repository
Decision and accuracy

• Automatic analysis speeds up decision making

• Optimized Fault Location Algorithm increases accuracy

• Automation helps avoid possible human mistakes
Productivity and response time

- Less people are involved
- Less individual’s time spent on routine tasks
- Less overall time is spent on fault analysis
- Less time is spent on repair and restoration
Time response improvements

- Maintenance
- Protection
- Operator
- Archive

Normal

Fault occurred

Protection & Maintenance are informed

Fault Location/ Equipment Misoperation identified

System Back to Normal

Data Retrieved (DFRs, DPRs)

Fault Analysis

Work order issued

Repair

Brief report archived

FL report archived

Summary report archived

SCADA display generated

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Conclusions

• **Value regarding goals**: more reliable monitoring using new data
• **Value regarding accuracy**: new fault location algorithm with better accuracy
• **Value regarding performance**: less time to accomplished tasks
• **Value regarding productivity**: personnel spends less time on routine tasks