OE Visualization and Controls Peer Review

FAULT VISUALIZATION

Integration of Substation IED Information into EMS Functionality

Washington DC,

October 2006

Outline

- Programmatic Goals
- Background
- Existing Approach
- New approach
- Benefits
- Conclusions

Programmatic Goals

- Electric T&D Programs:

  a) Expansion of Monitoring and Control capabilities using GPS,

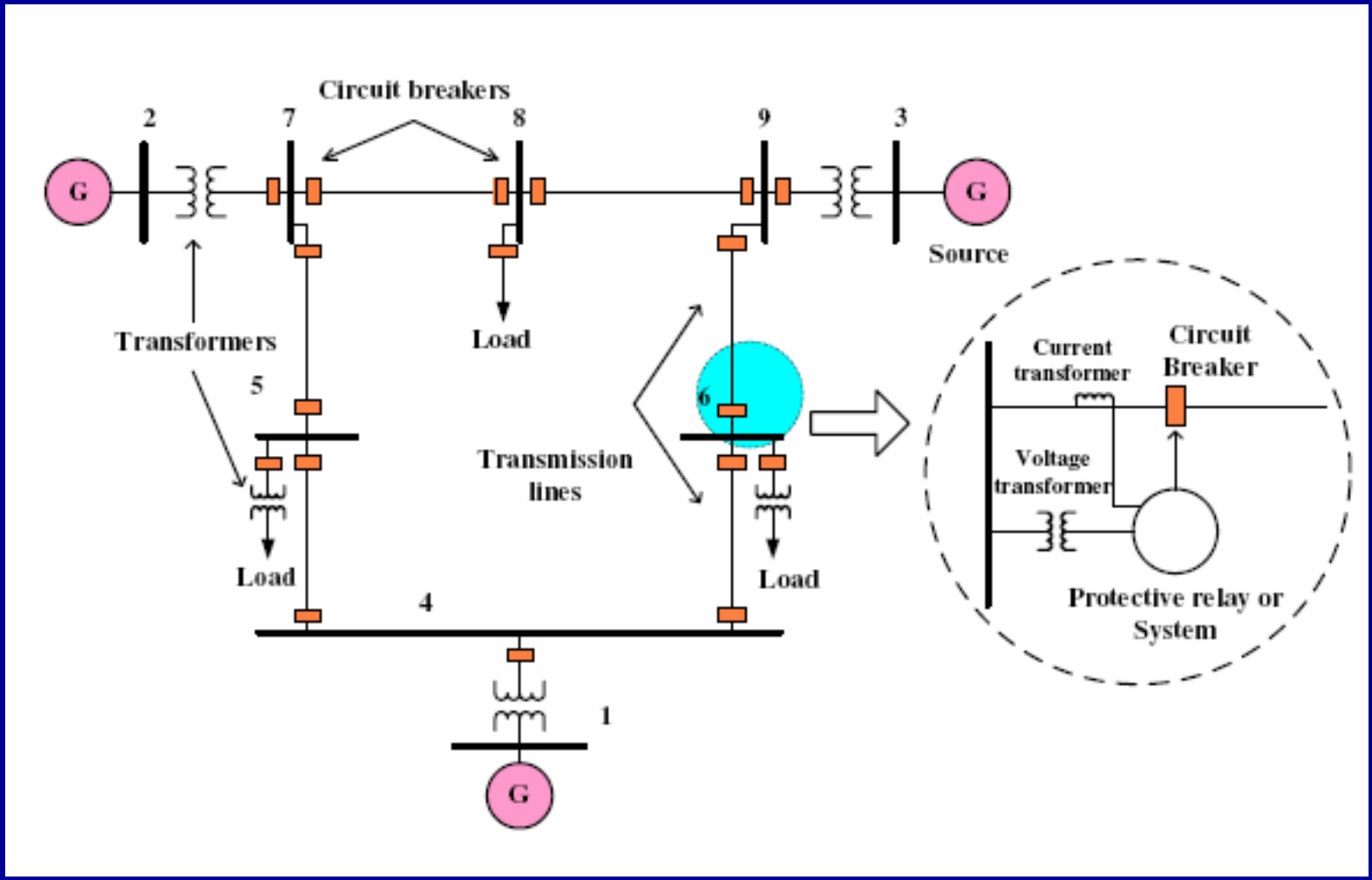
  b) Deployment of time-synchronized measurements

  c) Development of improved fault location

  d) Improvement of operator tools for detecting physical disturbances

- OED&E, Transmission Reliability Program: Grid Reliability R&D

Transmission Line Protection



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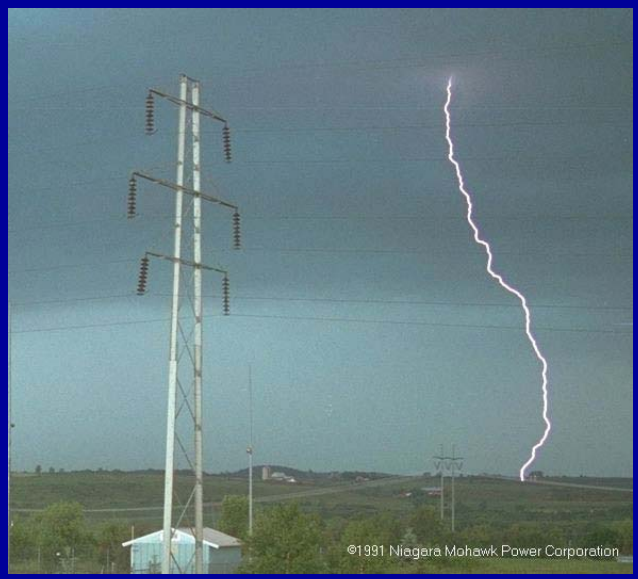
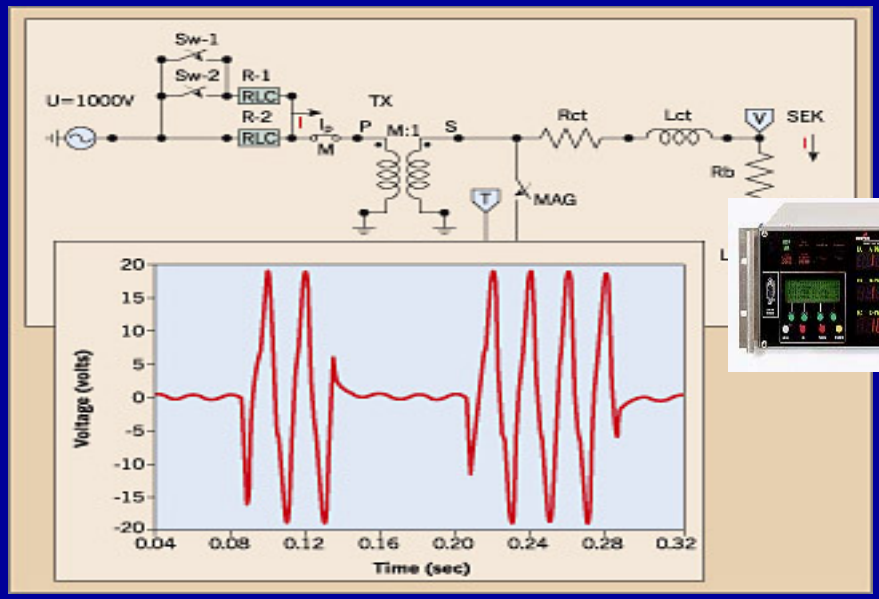
Possible causes of faults



Fault occurrence and reaction



Relays

Trip signal

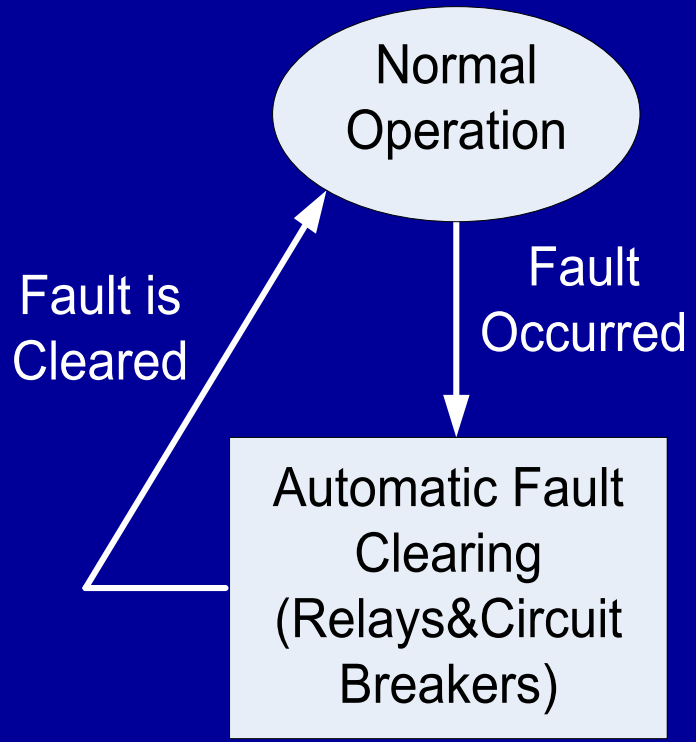
Fault is temporary

Fault is permanent

Circuit breakers

Type of fault: temporary

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



Type of fault: permanent

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

The role of personnel when fault occurs

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

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

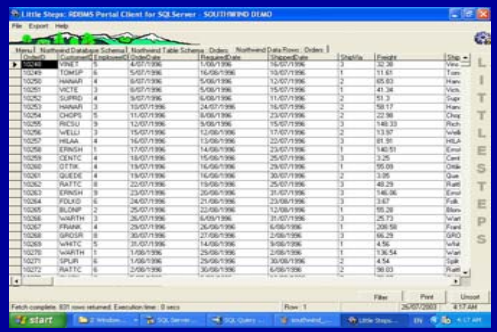
Maintenance responds to calls 24/7; inspects and repairs equipment as needed. Output: Repair report from field visits

Tools to deal with faults

SCADA

DFR

Archives



IEDs

Test equipment

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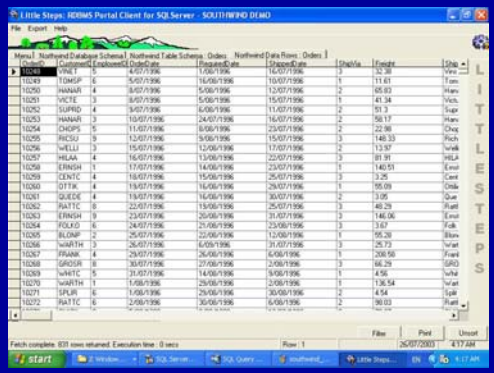
Data Flow

Archived data



Summary report

Fault Information

Fault location and/ or equipment misoperation

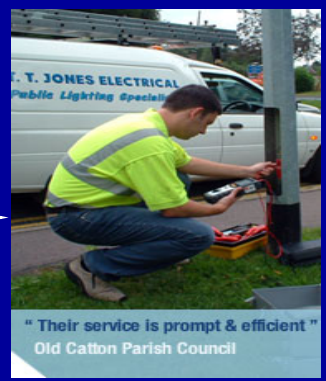
Operator

Protection group

Alarm

Fault cleared

Alarm



Maintenance

SCADA

Protection Group

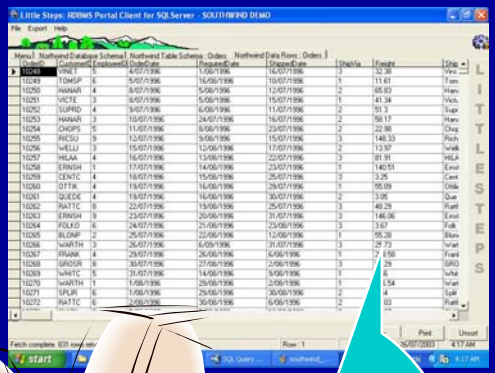
Normal Operation

Fault Occurred

Automatic Fault Clearing (Realys&Circuit Breakers)

Protection group is notified automatically

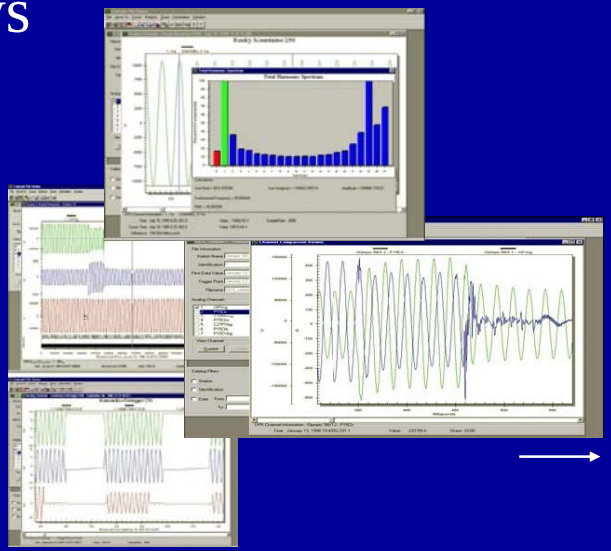
Archived data



Operator

Relays

DFR



Fault location and/ or equipment misoperation

Protection group analysis data

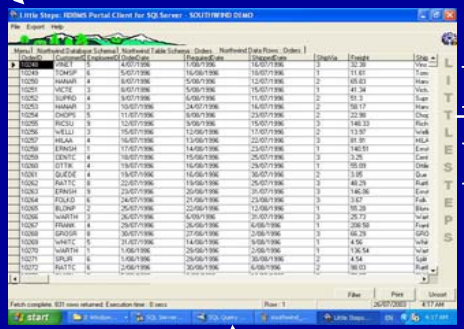
Maintenance

Operator-
Operational data

Fault Cleared
Alarm

Maintenance

Archived data

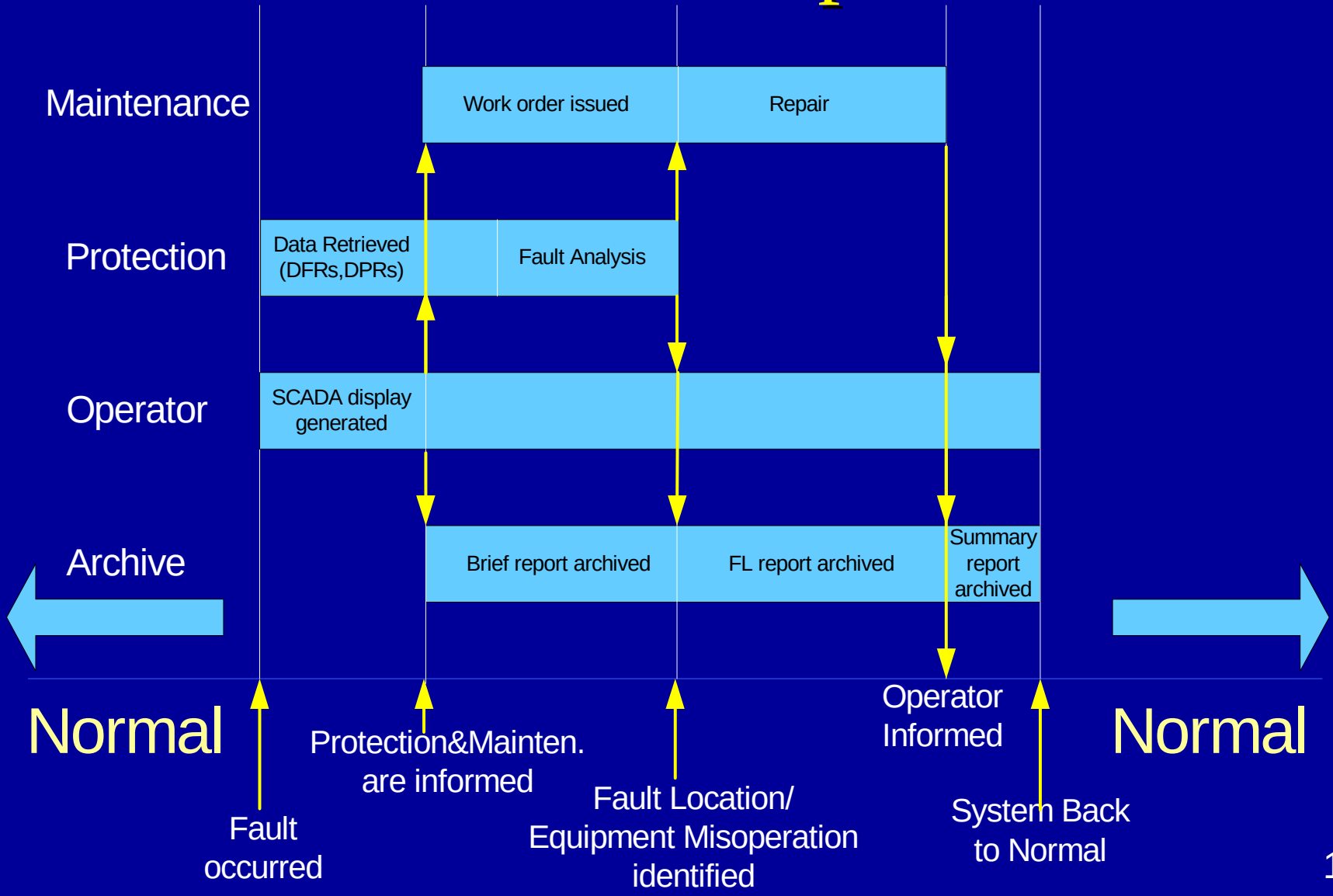


Fault
Information

Protection group-
Non-operational data

Summary
report

Timeline: Fault is permanent



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 on utility personnel
  - Long restoration time

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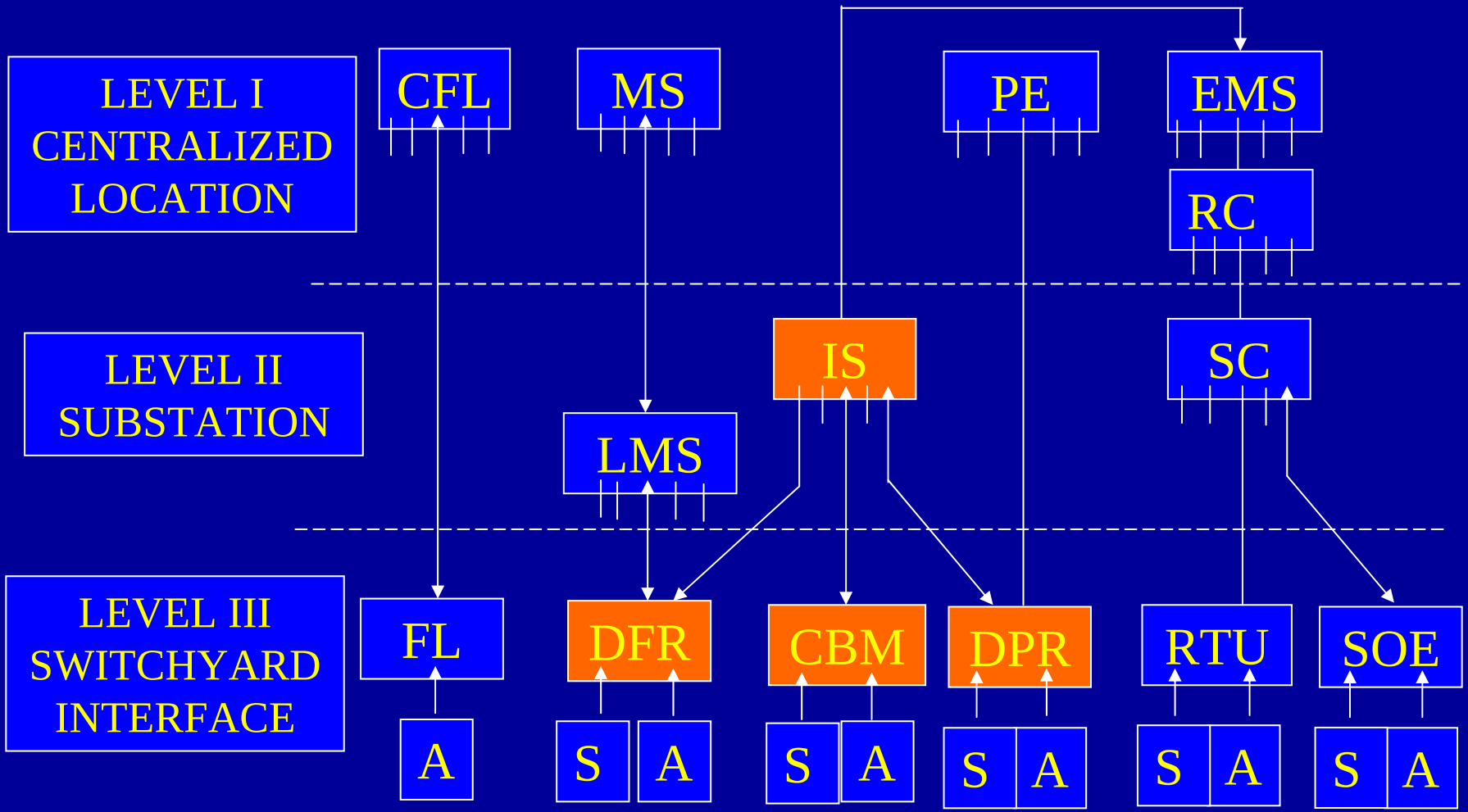
New Approach

- Data and information
  - Increased availability and precision of data
  - Automated information extraction
- Decision and action
  - Fault location algorithm with optimal accuracy
  - Specific instruction for action automatically issued
- Personnel productivity and response time
  - Less time spent for analysis and restoration
  - Less people involved

Infrastructure

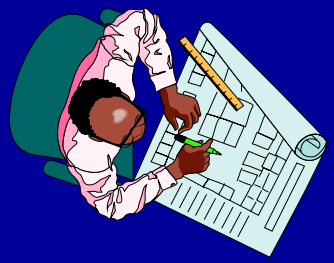


New Features

- New data from substation IEDs
- New displays for different user groups
- New quality in decision making
  - speed (decision making and data retrieval)
  - accuracy (redundant data, new algorithms)
  - automation (data retrieval and analysis)

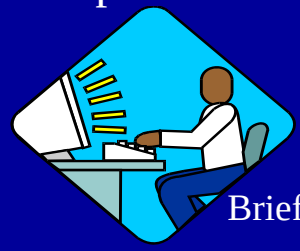
New Features

Protection Group



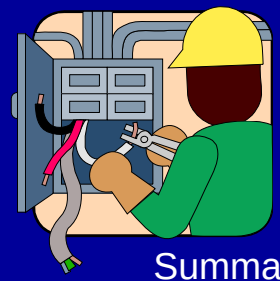
Comprehensive Report

Operator

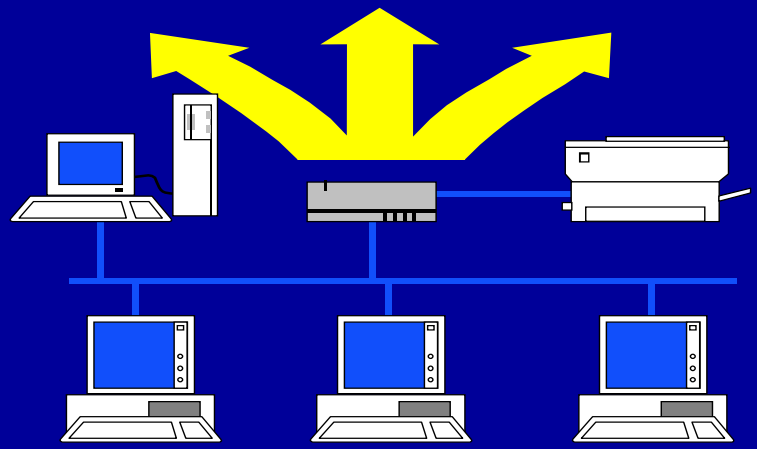


Brief Report

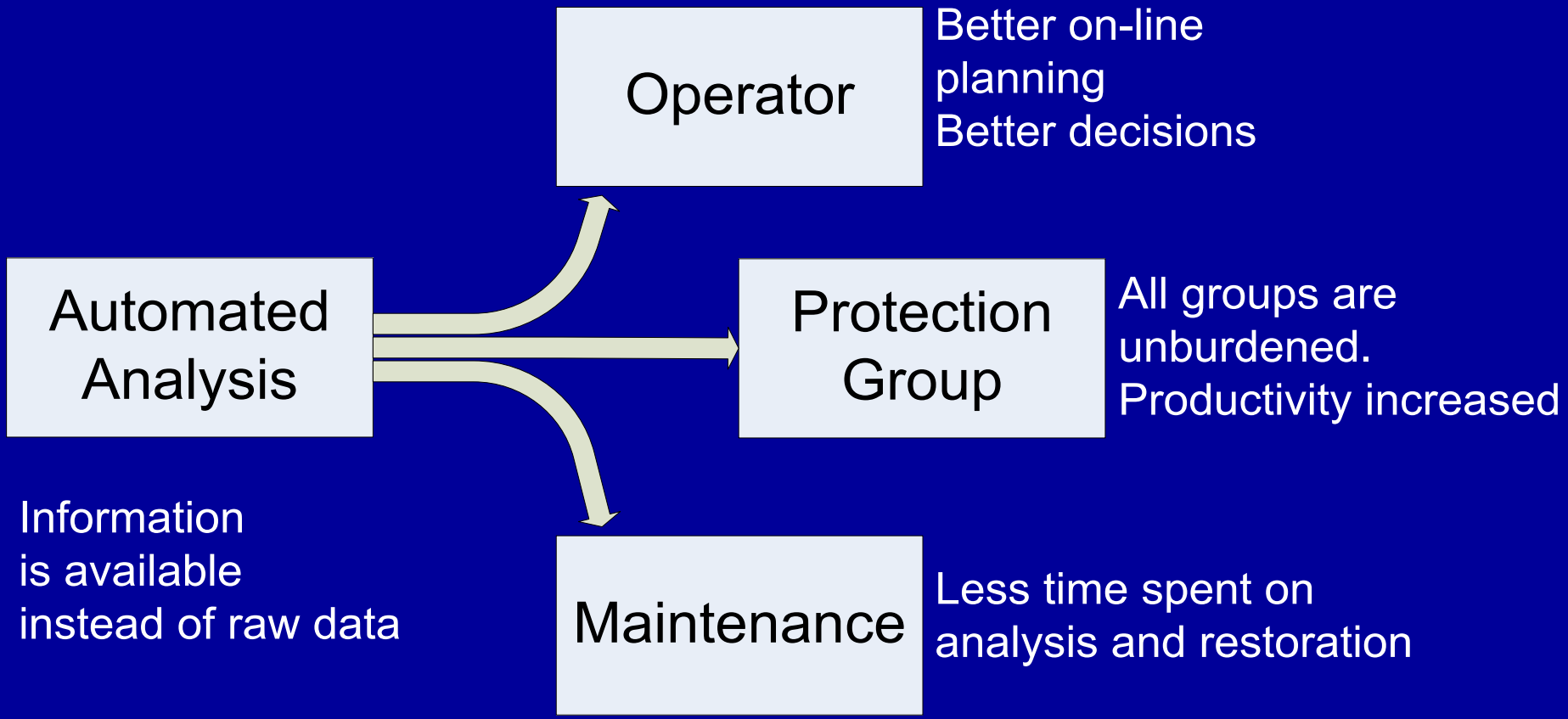
Maintenance



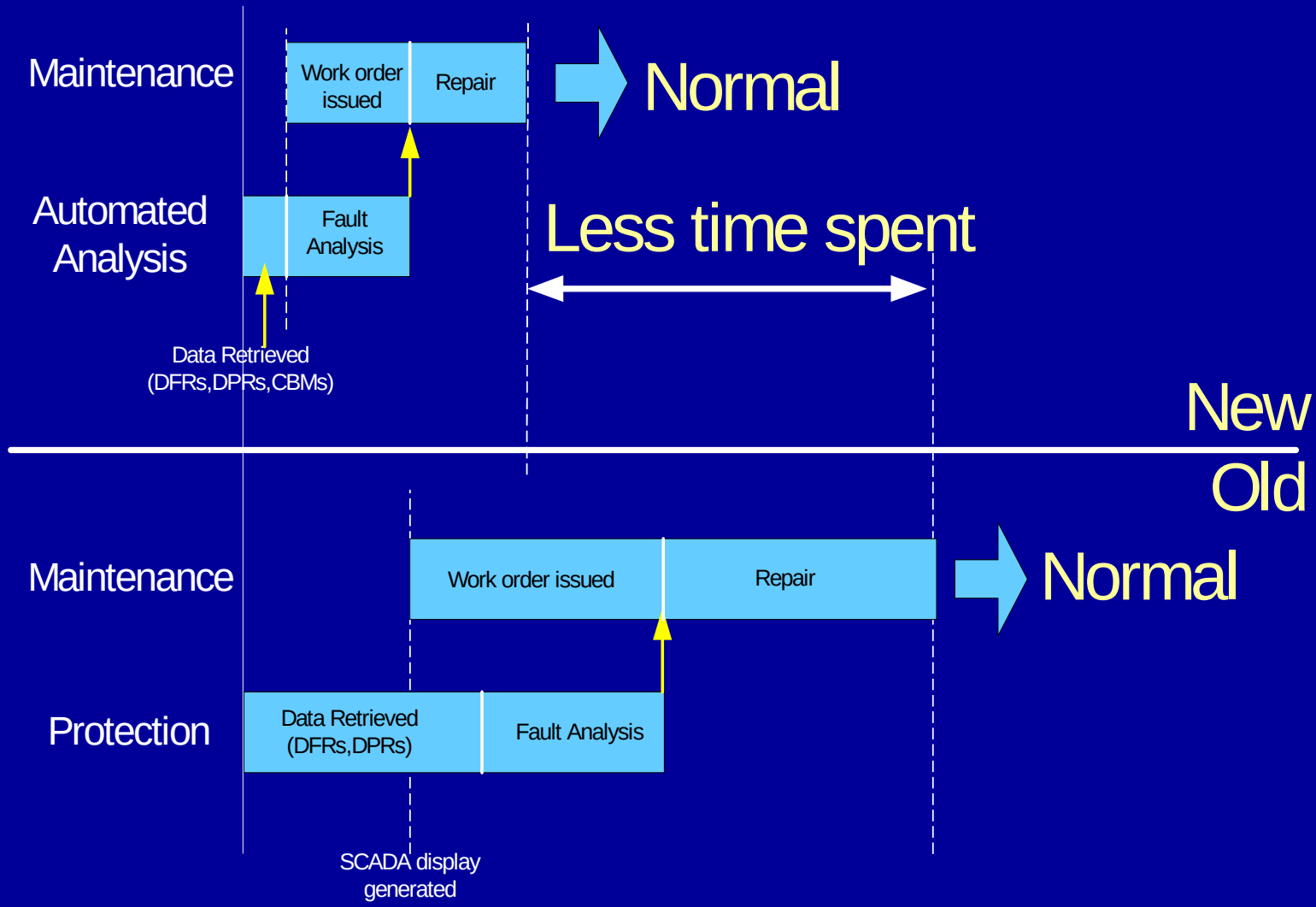
Summary Report



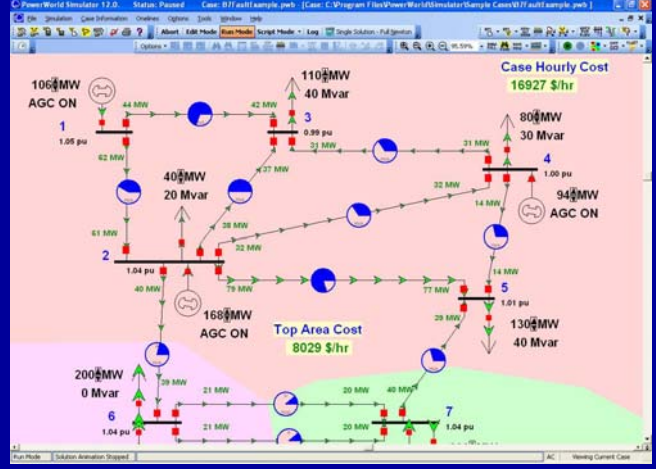
New Features



Timeline: Fault is permanent

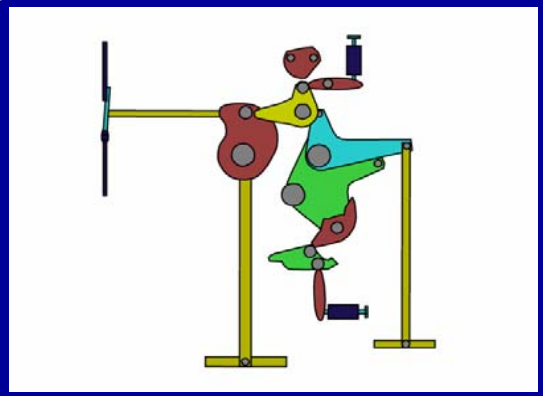


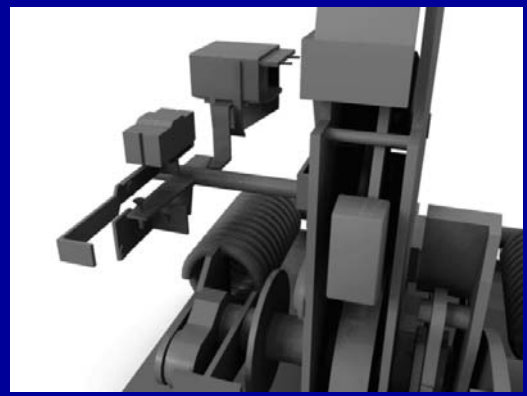
Power World software Topology

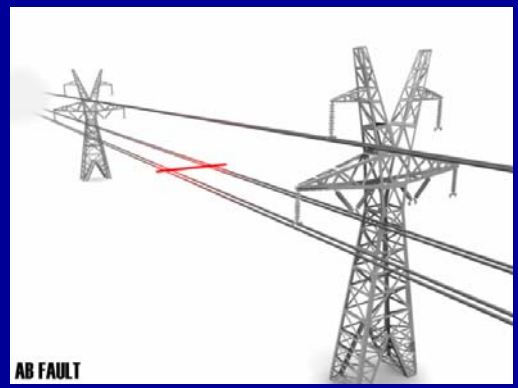


Fault Location

Equipment







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Benefits

- Data and information
  - Data are collected automatically
  - Availability of relevant data to each group
  - Automatic report retrieval and archival
- Decision and accuracy
  - Automatic analysis speeds up decision making
  - Avoiding possible human mistakes.
  - Optimized Fault Location Algorithm
- Personnel productivity and response time
  - Less people are involved (protection unburdened)
  - Less time is spent on fault clearing
  - Better and faster response

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- Value regarding programmatic goals: more reliable monitoring using GPS-related technologies
- Technical merit: new fault location algorithm based on new input data
- Emphasis on transfer of technology: CCET partnership aimed at commercialization
- Overall performance: on time, with all the goals met so far