A Paper Presentation

on

RECENT TREND IN DISTRIBUTION SYSTEM

(Distribution Automation System)

Presented

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ABSTRACT:

The demand on electric power supply in the world has increased drastically both quantitatively and qualitatively. This necessitates increases need for a steady power supply with minimum power interruption and fast fault restoration. To meet these demands computer-aided monitoring, control and management of electric power distribution system are to be adopted. Therefore research and development activities world wide are being carried out to automate the electric power distribution system by utilizing recent advancement in the area of Information Technology[IT] and data communication systems.

An attempt is made in this paper to describe the functions of AUTOMATED DISTRIBUTION SYSTEM(a recent trend in distribution system), which is modular in nature. These modules may be implemented in stages.

1. PREAMBLE:

There are a number of tasks that must be repeated in operating a utility. For the electric distribution system these tasks include: reading Kilowatt-hour and Kilowatt-demand meters, reading temperatures, taking load checks at distribution substations and along the feeders, opening and closing feeder circuit switching devices etc. Distribution Automation is used to do these repetitive tasks in a systematic way with minimal human intervention.

1.1Definition of Distribution Automation: (DA)

"Distribution Automation is a system that enables an electric utility to remotely monitor, co-ordinate and operate distribution components in a real-time from remote locations".

DA based on integrated technology which involves collecting data and analyzing information to make control decisions implementing the appropriate control decisions in the filed and also verifying that the desired result is achieved.

1.2 Components of DA:

The Distribution Automation contains:

- Computer Hardware
- Computer Software
- Remote Terminal Units(RTUs)
- Communication Systems
- Consumer Metering devices

1.2.1 Computer Hardware:

The function of Distribution Automation Systems[DAS] is to provide open loop or closed loop communication, to monitor and control of devices at the substation, distribution feeder and customer levels.

1.2.2 Computer Software:

DAS application software programs contain the necessary equations and computational distribution system performance.

1.2.3 Remote Terminal Units(RTUs):

RTUS are designed to acquire data and transfer the same to the Master Station through a communication link the RTU is usually designed to monitor parameters, such as bus line volts, current, active power, reactive power, status of circuit breaker, switches and isolators etc.

1.2.4 Communication Systems:

Communication System provide an effective communication system to transmit control and data signals between control centres and a large number of remotely located devices. It is desirable that a communication system for DA have following characteristics.

- Communication reliability.
- Cost effectiveness.
- Meet present and future data rate requirements.

- Two-way capability.
- Ability to communicate into power outage areas/faults.
- Ease of operation and maintenance.
- Confirming to the architecture of dataflow.

1.2.5 Consumer Metering Devices:

Customer metering, whether residential or non residential is accomplished by replacing the traditional meter with one that contains a transponder for two-way communications. The meter also contains a microcomputer that controls the schedules for the type of metering function, i.e. kWh, kW demand etc. This device can also be used to detect energy theft and provide remote customer connect/disconnect when equipped with a whole house disconnect relay.

2. DISTRIBUTION AUTOMATION FUNCTIONS:

DA functions provide a means to more effectively manage the minute-by- minute continuous operation of a distribution system.

A DAS has three basic capabilities:

1. Monitoring
2. Control
3. Protection

2.1 Monitoring:

Monitoring refers to the ability of the automation systems to be determined the state of the distribution system including status (contacts opened or closed etc), analog values (voltage, current etc) etc.

2.2 Control:

Control refers to the ability of the automation system to alter the state of the distribution system, so that the system operates to achieve utilization and quality of service objectives.

2.3. Protection:

Protection refers to the ability of the automation system to detect and identify the location of distribution system faults and to isolate the faulted circuit or equipment from the distribution system by the operation of fault interrupting devices.

3. AUTOMATION SYSTEM COMPUTER FACILITIES:

Successful performance in executing all of the DA functions is dependent on the adequacy of the control/ monitoring computer facilities provided. Central Processing demands will be a function of automation system complexity. System protection and similar functions will impose critical real-time constraints.

4. MANAGEMENT PROCESSES:

DAS function support a set of discrete, yet interconnected, management process. Management processes supported by DA categorized are as follows.

- Information Management
- System reliability management
- System efficiency management
- Voltage management
- Load management

A major commonality of these functions is that all require information and therefore information management is a fundamental system requirement.

4.1. Information Management:

Information management is a basic function in DAS. Even in the simplest of automation systems an accurate, timely, knowledge of state of the system is essential to permit initiation of control actions.

4.1.1 Automation System Database:

The basic element is a descriptive distribution system database. It must be initialized accurately and designed for continuous update to track all changes in the state of the system.

4.1.2 Information Dynamics:

Information management is a continuous process in DAS with ongoing activities of information retrieval and information processing.

4.1.3 Information for System Control:

Distribution computers can be used to advantage in achieving accuracy and also provide the rapid response necessary for system protection.

4.1.4 Information of Records:

Records of system behaviour become available as a by product of operating the DAS. These provide measures of system efficiency and reliability for future designs.

4.1.5 Billing Information:

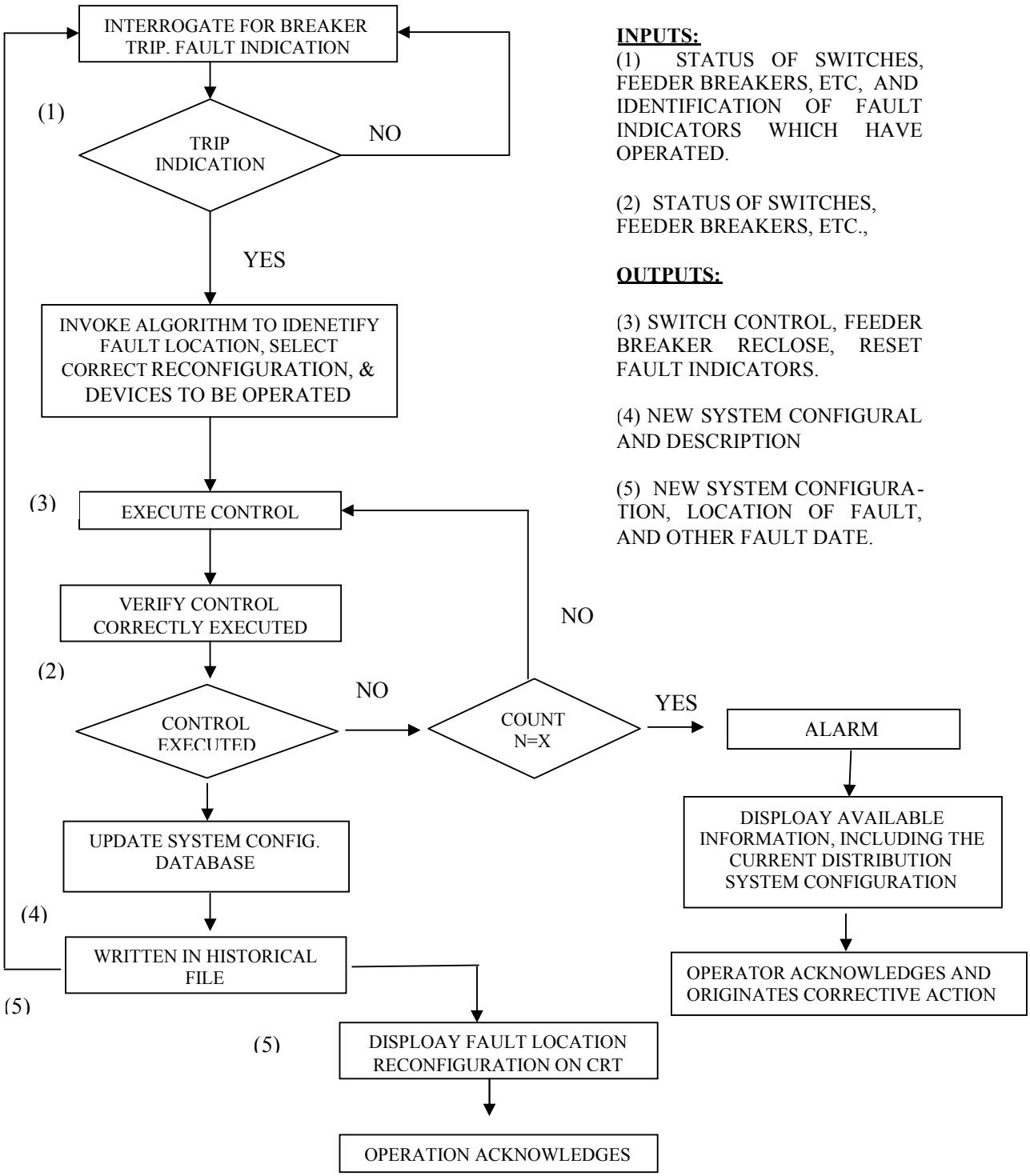
Demand and energy information can be retrieved from consumer's meters for billing purposes. Metering and signal verification techniques are used to ensure that the accuracy of the input data is not comprised. DAS can be used to switch mechanical or solid state register at consumer meters.

4.2 Systems Reliability Management:

This function is executed to minimize the impact of faults on distribution system. Minimizing outage duration following a persistent circuit fault is achieved by identifying and isolating the faulted line section, and restoring service to unaffected sections by system reconfiguration.

4.2.1 Fault identification/service restoration:

Distribution systems are operated as a set or sets of radial feeders supplied from one or more substations. Upon the occurance of a fault the feeder breaker will trip and automatically recluse a number of times. If the fault clears before the enclosure is complete, there is no further action required. However, if the breaker again trips and locks open, the automation system determines the fault location, by interference from monitored information on the flow of fault current, and insolates the faulted line section by opening appropriate line switches.



Flow chart for Fault Identification and Service Restoration

4.2.2 Cold load pick up:

Cold load pick up describes the high magnitude short duration in-rush current, followed by the undiversified demand experience when re-energizing a circuit following an extended interruption. Fast completion of a fault isolation and service restoration operation will reduce the undiversified component of cold load pick u p considerably significant service interruption will be limited to those customer supplied from the fault line section.

4.2.3 Dispersed Storage/Generation (DSG):

DSG will have an impact on service security management. The feeder or feeders involved will no longer be radial with a single supply source. Consequently, a more complex set of operating conditions will prevail for both steady state and fault conditions.

In any fault event, a more complex distribution of higher magnitude fault currents will occur due to multiple supply sources. Also protection of personnel and the system from the consequences requires more sophisticated detection and isolation techniques than those adequate for radial feeders.

4.3 System Efficiency Management:

System efficiency management operates to maximize systems efficiency and utilization of the existing distribution system by minimizing electrical losses. Loss reduction is achieved by selecting system configurations which will most evenly distribute the loads among feeder generation where required to offset lagging reactive loads. Transformers are managed to provide for maximum capacity utilization.

4.3.1 Loss Management by Load Distribution:

Distribution system comprises a number of discrete sections of line which can be interconnected in several ways to form different feeder configurations, and that the system has multiple supply connections, then a configuration can be chosen which will evenly distribute the load between feeders, to minimize I^2R losses.

4.3.2. Loss Management by Var Dispatch:-

The distribution of flows of lagging reactive load currents in distribution systems can be predicted with reasonable accuracy. It is therefore possible to deploy and control leading reactive generators to effectively offset the lagging reactive currents.

Distribution Automation with its advanced capabilities, provides a means to monitor the state and health of the capacitors, and to apply them in response to real-time needs from a total substation and feeder perspective rather than a forecast or local information based on a single point along the feeder.

4.3.3. Transformer Load Management:-

Transformer Load Management is executed to maximize the utilization of Transformer capacity or to reduce system losses. The remote monitoring capability provides for operating a supply transformer up to its maximum allowable loading. Load can be controlled at this stage by reconfiguring the down stream system, and/or by suppressing customer loads using the load management function. When more than one transformer supplies the distribution system, transformer loads may be balanced to reduce losses, and during light load periods, one or more supply transformers may be switched out of the system for further loss reduction.

4.4 Voltage Management:

The DAS is used to monitor and manage voltage levels at key points in the system to maintain voltages with in desired limits. Voltage levels are affected by such factors as food magnitudes distributions and power factor and by circuit configurations and impedances.

4.4.1 Voltage Regulations:

Voltage regulation provides for increasing or decreasing voltage levels relative to a nominal value. A DAS provides a means of co-ordinating voltage regulation for optimum operation to satisfy voltage level requirements at all key point in the system.

4.4.2 Reactive flow control:

DAS provides a means of continuously adjusting LTC and voltage regulator positions with var generation which will optimize both voltage levels and loss reduction.

4.5 Load Management:

Load management process involves controlling systems loads by a remote control of individual customer Loads. DAS provides control and monitoring ability required for load management scenarios. It provides for direct control of customer loads and monitoring is necessary to verify that programmed levels are achieved.

4.5.1. Direct control of customer loads:-

The effectiveness of direct control of customer loads is obviously enhanced by selecting the larger and more significant customer loads. These include electric space and water heating, air conditioning, electric clothes dryers and others of comparable magnitude.

4.5.2. Customer controlled load Management:-

Customer activated load management is achieved by incentives such as time-of-use rates or customer alert to warn customers so they can alter their use.

More sophisticated customer activated load management strategies are being studied, taking advantage of the capabilities of Distribution automation and of customer installed load control microprocessor.

Summary of Accuracy, Time Imperatives & Operating Frequency

Management Process	Timeliness	Accuracy	Frequency
Information	(1)	High	(3)
System Reliability	High(2)	High	Invoked for - every fault event
System Efficiency	Medium(3)	High	Several per hour
Voltage	Medium(3)	High	< Once per hour
Load	Low(4)	High	2-3 times per day

Notes: (1) Timeliness and frequency of monitoring will be a function of the need for information. Information needed for other functions will be subject to time imperative of that function.

(2) High implies a response time in the range, < 1 second to several seconds.

(3) Medium implies response time in the range of several seconds to 10 minutes.

(4) Low implies a response time of over 10 minutes.

5. ADVANTAGES OF DA:

The benefits that accrue to the power distribution company and the customer can be summarized as:

- ✓ Improved quality of supply
- ✓ Improved continuity of supply
- ✓ Voltage level stability
- ✓ Reduced system losses
- ✓ Reduced investment
- ✓ Minimizing outage time
- ✓ Better consumer services

6. CONCLUSION:

Distribution Automation function provides a means to more effectively manage the minute-by-minute continuous operation of a distribution system. DA provides a tool to achieve maximum utilization of the utility's physical plant and to provide the highest quality of service to its customers. Obviously, both the utility and its customers are beneficiaries of successful Distribution Automation since DAs are modular; they may be implemented in stages based on financial constraints and customer needs.

References:

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