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Analysis Of Cascade Tripping & Blackout And Modern Defense System

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Abstract — This paper proposes generalize scenario of cascading disturbance, types of events, traditional stability techniques for power system and modern real time analysis technique with validating relay operation. The strategies consist of neural network based fault detection and classification(NNFDC), event tree analysis(ETA) and the most efficient wide area monitoring and analysis protection -control (WARMAP). By proper actions using appropriate technique how can we deal with cascading failure is illustrated in this paper.

Keywords — event tree analysis, neural networks, synchronized sampling, cascade system emergency, cooperative defense framework, adaptive optimal stability control, developments and application.

I. INTRODUCTION

Modern power systems experience many disturbances and majority of that are eliminated by relay protection and emergency control system. According to historical data , relay miss-operation is one of the contributing factor of 70% of major disturbances in the power system. With rapid growth of loads , transmission distances , HVDC and FACTs devices , the dynamic behaviors of power system are getting more and more complicated. A single fault is unlikely to destroy a modern power system , but information deficiency , hidden failures of relays , faults of other secondary system or human errors may be the cause of cascading events and the system, however strong may evolve in to power calamity. Cascading outages may happen in AC lines, DC lines, AC-DC line, sending area and receiving area etc,

Its evolvement process can be divided as :

1) Slow cascading outage stage
2) Fast cascading outage stage
3) Short stage of oscillations
4) Breakdown stage
5) Long stage of restoration

Hence it is advisable to advance a defense system to SCADA/EMS , On-line quantitative stability analysis , decision making and adaptive optimization of preventive control , protection relays , emergency control , corrective control, and recovery control and coordinate them on the concept of RISK. Cascading emergencies in power system survivability is defined as the ability of the system to resist disturbances. Catastrophic development of emergency may take place due to Marginal state of power system. Marginal state is determined by unacceptable values of system parameters. Development of cascading system emergencies was made after introduction of Marginal state and Triggering event. Triggering event is an irreversible development of emergency situation. In fact triggering event takes place near the marginal state of the power system.

There are several ways used to defend blackout such as:

a) Real-time analysis of system
b) Event tree for relay operation
c) Traditional stability techniques
d) Modern stability techniques
e) WARMAP framework
f) Smart grids etc,

II. TYPES OF EVENTS

Redistribution of active and reactive power in the network are related to change in voltage and frequency of power system. Accordingly there are three types of changes :

1) Negative change (Deterioration)
2) Positive change (Improvement)
3) Imperceptible change (Negligible)

Based on these definitions all events taking place in power system can be
divided as:

(A) Group I : Accidental events

It includes disturbances , wrong actions and faults. These events correspond directly to a specific element in power system and lead to the change in its capacity.

(B) Group II : Control actions (Purposeful events)

These include correct and successful control action at a planned change in the power system and are performed by relay protection and emergency control by switching specific generating , load & transmitting elements of the power system.

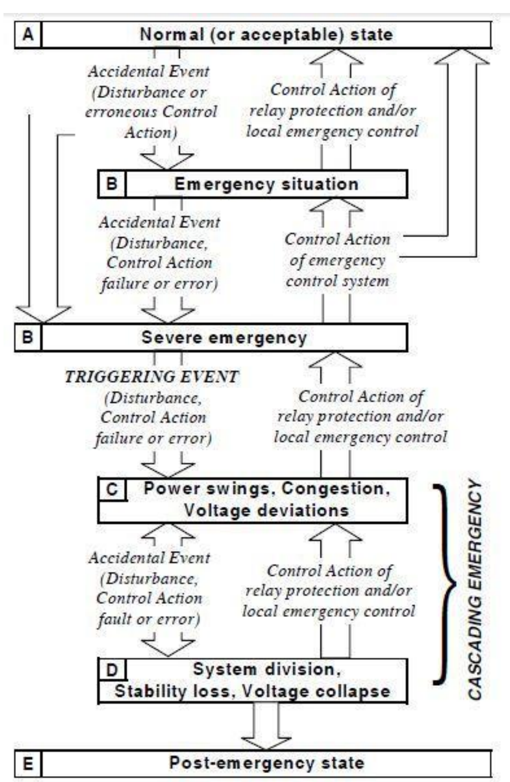
(C)Group III : Regular (Natural) events

Regular events may be of any type i.e. positive/improve , negative /deteriorate and imperceptible/negligible type.

III. GENERALIZE SCENARIO OF CASCADING DISTURBANCES

Based on the analysis of sequences of events at development of system emergencies occurred in power system we can suggest a generalized scenario of a cascading process of emergency development that contains cyclically repeating changes in power system states. These states are:

1) Normal/Acceptable state
2) Emergency situation
3) Critical state
4) Division of system
5) Post emergency state



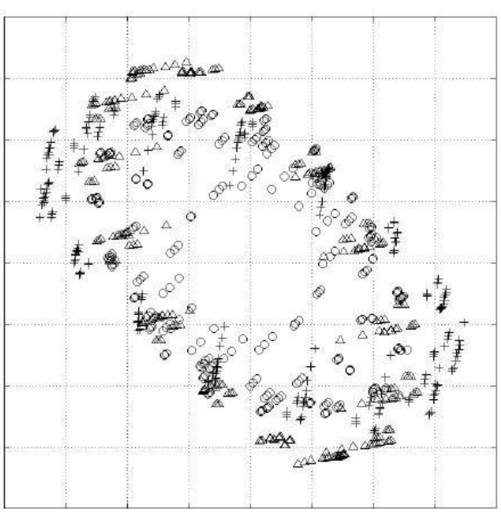
IV. Modern real-time analysis to prevent cascading disturbances :

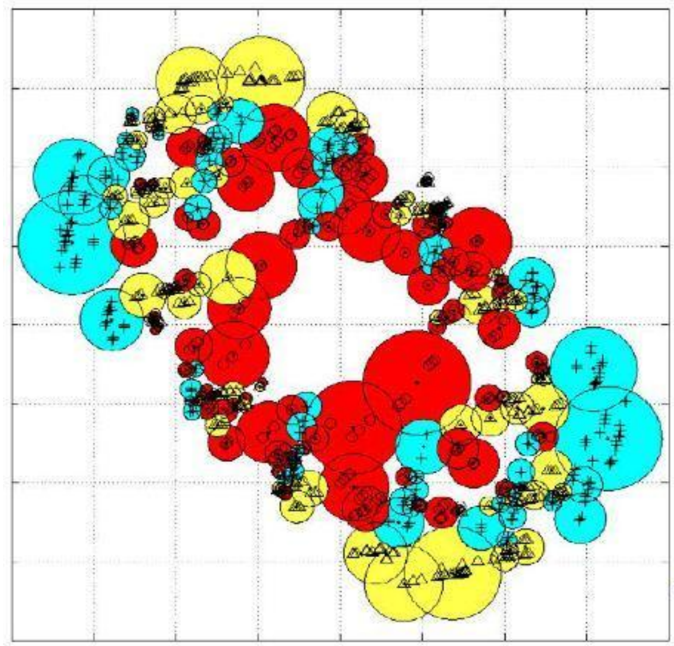
The system protection schemes , synchronized measurements and better real-time analysis tool are very helpful to prevent the blackout with the availability of advanced computer , communication and measurement technologies , new real time analysis tool can be developed at a local substation level to help the implementation of wide area protection and control system. There are basically two techniques and one more is combination of these two. First is :

(A) Neural network based fault detection & classification (NNFDC)

It is extensively studied in recent years because of its intelligence and adaptability. Instead of phasor calculations , the time domain measurements from transmission lines are formed as patterns. The fault detection and classification task than becomes a issue of pattern recognition.

The advantage of this technique is that the neural network can form its knowledge as it can "see" , and does not need to rely on the compromised settings of conventional distance relay. With this approach , the accuracy of fault detection will be improved under all circumstances.





(B) Synchronized sampling based fault location (SSFL)

SSFL is developed to implement the precise fault location and requires raw samples of voltage and current data synchronously taken from both ends of transmission line.

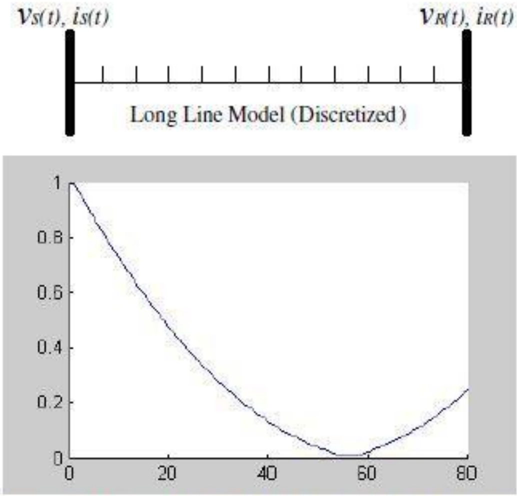
It is more attractive now because the use of GPS time-synchronized data acquisition units.

The principle of SSFL relies on the fact that the voltage and current at the faulted point can be represented by sending and receiving end data using certain relationship. If there is no fault then such point can not be found.

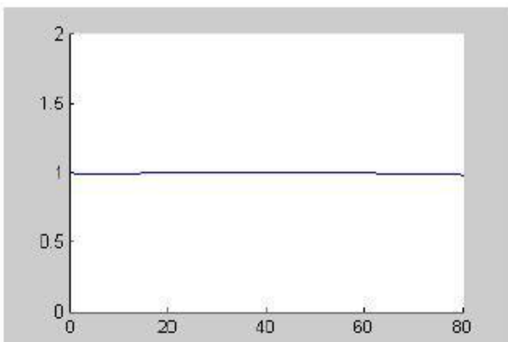
The advantage of SSFL is that it confirms whether a fault indeed occurred on the transmission line of interest.

The algorithm doesn't depend on any assumptions about system operating condition fault resistance , waveforms ect.

Using SSFL , the protection system can be kept from tripping on overload , power swing and other no-fault abnormal conditions.



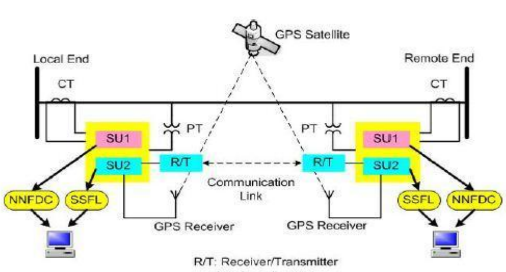
(a) Fault can be located when fault occurred within the primary line



(b) Fault can not be located for a healthy line

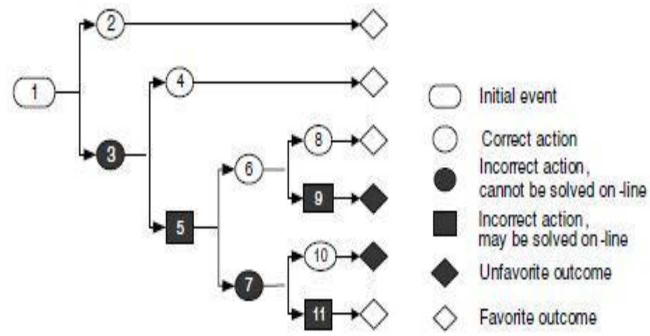
(C) Combination of both the techniques :

The combination of these two algorithms as an integrated real-time fault analysis tool can provide more satisfied solution because each algorithm has its own focus. NNFDC can quickly detect the fault and provide the exact fault type but can not distinguish the faults occurring around the zone boundaries. SSFL will take over this job and the combination of both will be very accurate and reliable. Such scheme is shown as a model in below diagram.



V. Validating relay operations to prevent cascading blackout :

A relay monitoring tool at a local level is needed to provide the event analysis about the disturbances. Event tree analysis (ETA) is commonly used as event/response technique. For example :



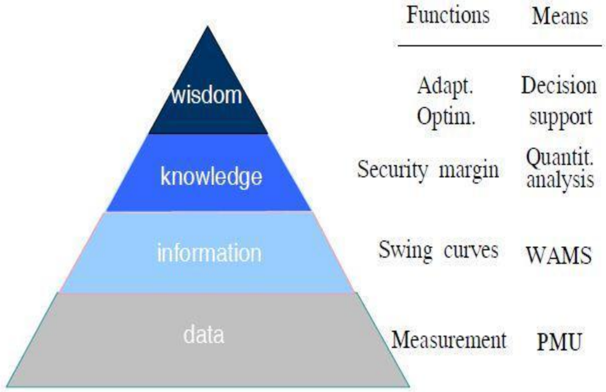
Node	Scenarios	Reference Action
1	No fault in preset zones	Keep monitoring
2	Relay does not detect a fault	Stand by
3	Relay detects a fault	Check the defects in relay algorithm and settings
4	Trip signal is blocked	
5	Trip signal is not blocked	Send block Signal if necessary
6	Circuit breaker opened by the trip signal	
7	Circuit breaker fails to open	Check the breaker circuit.
8	Autoreclosing succeeds to restore the line	
9	Autoreclosing fails to restore the line	Send reclosing signal to the breaker
10	Breaker failure protection trips all the breakers at the substation	
11	No Breaker failure protection or it doesn't work	Check the circuit of the breaker failure protection.

VI. WARMAP technique :

Three essentials for effectively preventing blackout are :

1) Wide area static and dynamic measurements
2) Quantitative analysis of security and stability
3) Optimization and coordination of the controls

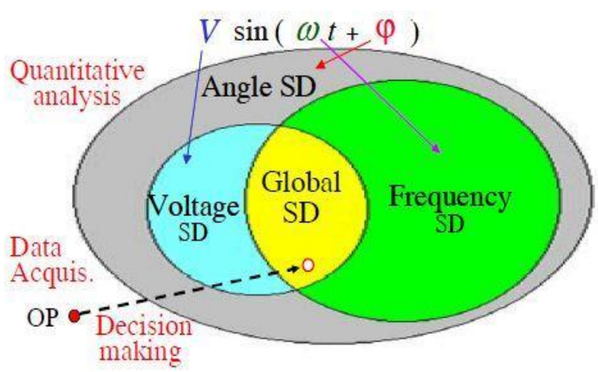
WARMAP (Wide Area Monitoring Analysis Protection Control) integrates wide area data which are of widely different time scale, including static data from SCADA system, real time dynamic data from PMU, transient data from fault recorders and data from stability control devices etc. It upgrades the information to the knowledge level, even to the wisdom level.



Its function include on-line quantitative stability analysis and pre-decision, based on risk concepts, adaptive optimization of PC, EC, CC & RC, coordination among various defense lines and that between security and economy.

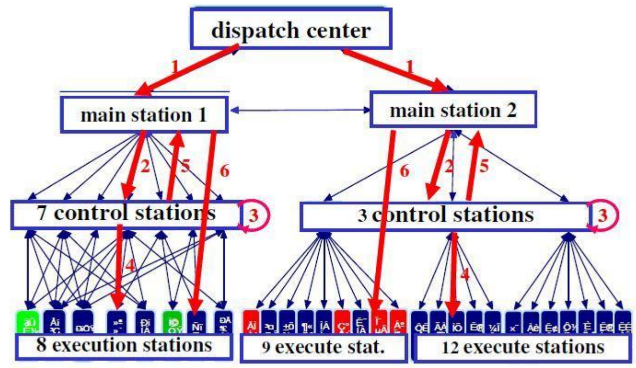
❖ **Coordination of various stabilities :**

Angle, frequency and amplitude are three essentials of AC voltage, current and power. WARMAP integrates this dynamic stability problems with the thermal one to identify the global stability domain.



❖ **Coordination of decision space :**

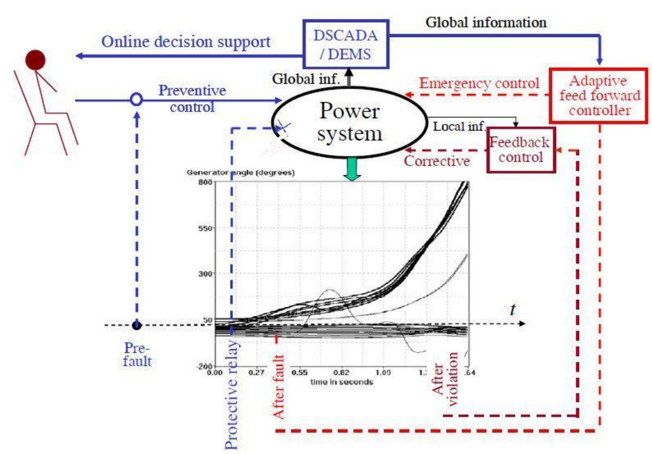
If fault occurs at two areas corresponding to different control stations ,every original system protection scheme (SPS) can only react to one fault and disregards others. Therefore the interaction between the faults can not be considered. WARMAP overcomes such limitation by exchanging information between main stations. Following fig. shows the actual scheme, which is serving well.



❖ **Coordination of activation time :**

During the evolvement of blackout, control actions can be activated at different stages to hold out blackout as already discussed earlier.

These controls have different physical features, as well as different cost property. Moreover they interacted with each other closely and therefore this coordination is very helpful. It is shown in following figure :



Moreover, WARMAP can also coordinate to :

1) Wide area information
2) Various control rules
3) Decision layers etc.

VII. CONCLUSION

From this paper conclusion that derived is, by appropriate method and coordination of various protective schemes and tools we can prevent the worst event of electrical i.e. blackout, and for this purpose we have to use modern technology and aspects.

VIII. Reference

1] Improving real time fault analysis and validating relay operations to prevent or mitigate cascading blackout (IEEE)

2] Analysis of blackout development mechanisms in electrical power system (IEEE)

3] Progresses of blackout defense system in china (IEEE)