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Distance Protection Zone 3 Misoperation: The Problem and a Survey of Solutions

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*Abstract*-- Distance relay zone 3 misoperation has been responsible for major blackouts around the world. Zone 3 misoperation generally occurs under system wide cascading events that stress the system such as the 2003 Northeastern US-Canada blackout and the 2015 Turkish blackout. This paper summarizes the problem and provides a survey on the research efforts made to increase distance relay security to prevent distance protection misoperation.

*Index Terms*-- Distance protection zone 3, blackouts, cascading events, misoperation, security.

# Introduction

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HIS section of the paper will provide a general introduction to the problem of distance relay zone 3 misoperation.

The terms of cascading failure and distance protection misoperation will be first defined as given in literature and industry standards. After that some examples of major blackouts will be briefly mentioned and explained.

The paper will be organized as follows: section ‎II. will provide a general example on how a distance relay could misoperate in zone 3 even though it is set per the NERC standards. A general network topology will be used to set up a sample distance relay so that the problem of zone 3 misoperation is formulated in general terms. This is something I see most authors missing, i.e., they build solutions for distance protection zone 3 misoperation without appropriately setting up the distance relay according to NERC standards.

The literature survey will be detailed in section ‎III. which will be divided into different subsections to organize literature into logical categories.

# Distance protection zone 3 misoperation problem

This section will provide a general example on how to set up a distance relay according to NERC standards. The NERC standards that will be used to set up the relay will be mentioned, referenced and explained. Additionally, it will be shown that this sample distance relay that is set according to NERC standard may still misoperate in its third zone due to evolving system wide cascading events.

# Literature Survey

This section will provide the literature survey. It will consist of different subsections that organize the literature into coherent research paths. These subsections are listed and explained below.

## Communication Assisted Schemes

In this section, all communication assisted schemes will be mentioned. This will include a survey on both PMU as well as wide area protection methods.

## Modifications to Local Distance Protection

In this section, all methods that were proposed to modify the local function of the distance relay will be discussed. The methods discussed here will use the local data only to make a decision. This will also include a discussion on adaptive relaying as well as single-ended artificial intelligence methods.

## Detection of Zone 3 in planning stage

In this section, all methods that are used to anticipate zone 3 misoperation in the day ahead or 5-minute ahead market will be discussed.

It should be noted that the classification of literature above is unique. No single method can be classified under two subsections simultaneously. Lastly, when discussing artificial intelligence methods, I will include a comparison between different learning methods such as artificial neural networks, support vector machines, probabilistic classifiers, …. etc.

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