Defense Plans against Extreme Contingencies

C2 is one of 16 Study committees of CIGRE. Its scope is to facilitate and promote the progress of protection and automation.

Since the shock of the 1965 North American blackout, other multi-million-dollar blackouts have continued to occur throughout the world. Though each event is analyzed carefully, and targeted corrective actions are identified, additional comprehensive system-wide measures are still needed to protect against severe unforeseen fast-developing cascading events. The CIGRE Technical Brochure C2.02.24 provides a roadmap for the development of defense plans to mitigate extreme contingencies with the intent to lead power system professionals to improve electric system reliability and security of the grid. The basic premise for protection against extreme contingencies is that a failure in one area of the grid should not result in blackouts elsewhere, and that such situations could be minimized by well designed, maintained, operated and coordinated power grids.

Many considerations and elements from concept to application of defense plans—including engineering, design, implementation, documentation, operational training and maintenance—are covered in-depth in the report. It offers best industry practices to make use of such schemes. The industry has implemented this concept in several parts of the world. However, the advantages of these schemes have not been fully recognized due to perceived drawbacks such as impact on operation and

unintended Special Integrity Protection Schemes (SIPS) action, complex technical training for operators and technicians, perceived high costs, etc. New technologies enable cost-effective coordinated wide-area monitoring, protection, and control systems, while offering user-friendly operational tools to system controllers.

The initial chapters of the report describe the evolution of the power system with its increasing dependence on the interconnected transmission grid, and explain how this dependence has introduced many challenges. The most pressing concern is improving power system operational security. In this context, the Defense Plan concept is introduced to provide effective measures that will reduce the likelihood of blackouts. Several of these schemes are then described, showing the wide application of Defense Plans on transmission systems throughout the world.

The continuing advances in development of analytical tools and study procedures for various types of disturbances are discussed. The values of sound system design, improved substation layout, operational readiness and training are highlighted as basic measures to mitigate extreme contingencies.

The report then presents all possible means of action that could be used in a defense plan. Practical techniques using available technologies with implementation examples are presented. Finally, advanced technology will play an important role providing enhanced security that recognizes the unique attributes of electricity infrastructure.

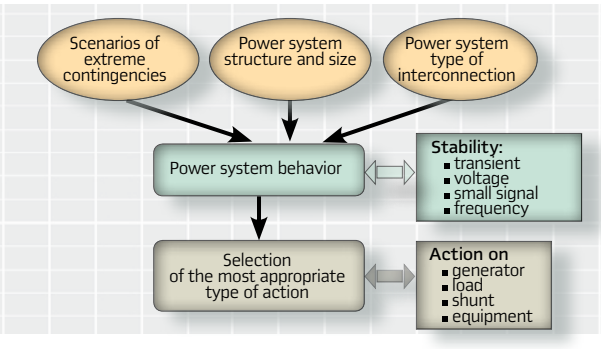
The report also includes a wealth of references in each chapter and can be viewed as a complete bibliography on any of the subjects.

The contributors to this report believe that recent blackouts, in a number of countries, have reinforced the need for the implementation of defense plans. The basic philosophy is that large-scale cascading outages could be reasonably avoided, or when they occur, the systems should be quickly restored.

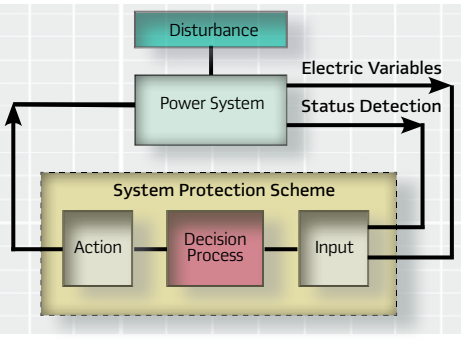
The CIGRE C2.02.24 Report Defense Plans Against Extreme Contingencies consists of:

- **Chapter 1:** Concept and Definition of Defense Plan
- **Chapter 2:** Overview of Existing Defense Plans
- **Chapter 3:** Analysis of Extreme Contingencies: Modeling of Power Systems, Analytical Tools and Study Procedures
- **Chapter 4:** Decreasing the Rate of Incidents: System Design and Operating Strategies
- **Chapter 5:** Selection of Means of Actions to Mitigate Extreme Contingencies
- **Chapter 6:** Design and Deployment of a Well Coordinated Overall Defense Plan
- **Chapter 7:** Defense Plan: Engineering , Development and Implementation
- **Chapter 8:** Future directions in Power System Defense Strategies

1 Factors in the selection of SIPS actions



2 General structure of a SIPS



NASPI North American SynchroPhasor Initiative

The North American Synchro-Phasor Initiative (NASPI)

The North American SynchroPhasor Initiative (NASPI) is a joint effort between the U.S. Department of Energy (DOE) and the North American Electric Reliability Corporation (NERC). The goal is to improve power system reliability through wide-area measurement, monitoring and control. This will be achieved by facilitating a robust, widely available and secure synchronized data measurement infrastructure for the interconnected North American electric power system. It also includes associated analysis and monitoring tools for better planning and operation, and improved reliability. This article provides an overview of NASPI, including recent accomplishments, current status, and planned activities.

Through the 1990s, utilities began to deploy phasor measurement units and investigate the ability to enhance situational awareness through improved wide area visibility. The technology

soon became very helpful in the investigation of blackouts and disturbances, particularly the western interconnection breakup that occurred on August 10, 1996. Similarly, the August 14, 2003 blackout illustrated the role of this technology for disturbance analysis. To facilitate the development of this technology, particularly to foster an environment of information exchange between utilities, the U.S. DOE initiated the Eastern Interconnection Phasor Project (EIPP) in October 2002, building on over a decade of experience in the western interconnection. In 2007, NERC formally joined DOE in the effort, and expanded it to include all interconnections within North America. At this time the EIPP was renamed to NASPI.

NASPI Organization

NASPI is structured as a working group made up of voluntary members from electric power organizations, reliability coordinators, suppliers of monitoring and communications network hardware and software, and researchers from industry, universities, and national laboratories.

The working group is composed of five task teams who focus on various aspects of developing and deploying synchrophasor measurement technology:

- Data & Network Management
- Operations Implementation
- Performance and Standards
- Planning Implementation
- Research Initiatives

DOE, through the Consortium for Electric Reliability Technology Solutions (CERTS) and in collaboration with NERC, provides technical support to the task team activities. The task team leaders, together with the DOE program manager and representatives from NERC and CERTS, make up a Leadership Committee, whose role is to plan and coordinate the working group activities. An Executive Steering Group provides oversight to the working group, engages the power industry at a senior management level to spread the word about the benefits of system-wide measurements, and enlists support for the program.

The NASPInet Concept

When synchrophasors were first deployed and networked, the network architecture relied on a centralized architecture, with point to point links interconnecting the phasor measurement units to the ultimate application. The IEEE C37.118 protocol was developed to standardize the streaming synchrophasor data traffic, and phasor data concentrators were developed to provide time alignment between the various signals. These concentrators also provided a framework for interfacing to the application(s), providing data archiving and access to historical data, and other functions such as managing specific data flows between organizations. Because synchrophasor applications are undergoing a transformation from research-grade to production-grade operations and planning applications, there exists a need to develop a new paradigm with which the synchrophasor data can be disseminated and shared between organizations.

Under the leadership of the NASPI Data and Network Management Task Team, the concept of a distributed architecture linking the providers of the data (publishers) with applications (subscribers) using a publish-and-subscribe middleware and data bus concept has been developed.

Currently, the NASPInet architecture is at a conceptual design phase, and a detailed specification is under development. The vision is that this specification can be used by hardware or software vendors to provide an interface to NASPInet, either as a publisher or as a subscriber. The unifying element that will provide this interface is a phasor data gateway.

Following the release of the NASPInet specification, there will be pilot demonstration projects to further refine and modify this specification based on lessons learned from interconnecting multiple vendors and a spectrum of applications in a common architectural framework.

NASPI North American SynchroPhasor Initiative

The North American SynchroPhasor Initiative

by Jeffery Dagle, Stan Johnson, Alison Silverstein, USA

NASPI Website Repositories

Another short-term initiative being undertaken by NASPI in 2009 is the development of multiple repositories on the NAPSI website (http://www.naspi.org/).

These include:

- The Research Repository, sponsored by the Research Initiatives Task Team, allows researchers to describe their research projects and provide links to pertinent resources that may be available and of interest to other researchers in the synchrophasor arena
- The Tools Repository, sponsored by the Performance and Standards Task Team, provides a summary description of the various synchrophasor tools currently used by industry in various stages of development, and
- An emerging (proposed) Hardware Repository, which will provide a listing of phasor-capable measurement hardware, either stand-alone phasor measurement units or other devices, such as fault recorders of programmable protective relays that can provide time synchronized phasor measurement outputs

These are currently in various stages of development.

Baselining

Both the Planning and Operations Task Teams are currently involved in baselining activities, or, in other words, determining "normal" phase angles so that abnormal conditions can be better defined and alarmed. The task teams are taking complimentary approaches to determining these "normal" phase angle separations.

The Operations Task Team is looking at observed angle separations for key phasor measurement locations, and evaluating this data over historical timeframes.

The Planning Task Team is performing model-based studies to assess the phase angle separation under known heavily stressed conditions, and correlating these angles with specific changes to the operating conditions in the basecase model study.

Between these two approaches, the goal is to develop a more rigorous methodology for determining the thresholds at which the real-time monitoring tools should be alarmed based on the observed phase angle separation between monitoring locations.

The success of NASPI is the result of the tireless efforts of the many members of the NASPI Working Group and its Leadership Team in developing and deploying synchrophasor technology in the North American electric power grid.

NASPI is helped to a great extent by the sustained leadership and support from DOE (Phil Overholt) and NERC (Stan Johnson and Bob Cummings) in facilitating collaborations. ■

1 North American SynchroPhasor Initiative (NASPI) - organization structure

NASPI is structured as a working group made up of voluntary members.