Case Study: A Subtransmission-Level Fault Location, Isolation, and Service Restoration (FLISR) Scheme

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***Abstract*—Fault location, isolation, and service restoration (FLISR) solutions can efficiently improve reliability indices by rapidly identifying and responding to outage events. As soon as a fault occurs and protective actions are exhausted, a FLISR scheme uses field device measurements and the network topology to properly locate single or multiple faults. Through optimal switching maneuvers, the faulted area is isolated and the network is reconfigured to restore as much as possible of the remainder of the system. As reliability indices are directly related to the extent and duration of the power interruptions, FLISR decisions and actions must be achieved within a couple of seconds to minimize the outage impact extension and duration. Being designed to operate in networks with meshed topology and radial configuration, FLISR has been primarily applied to distribution systems, but such a solution is not limited to medium-voltage levels. This paper presents how Huntsville Utilities has been developing and implementing a project for Redstone Arsenal, in Alabama, USA, in which a FLISR scheme is applied to a 46 kV subtransmission system. This case study presents the phase-by-phase approach used to securely achieve a fully deployed and operational FLISR in a 46 kV system. The technical challenges and solutions of such an implementation are presented along with the perspectives of the involved companies.**

***Keywords*—Distribution automation, distribution management systems, network reconfiguration, outage restoration, and radial networks.**

I. Introduction

The electric power system is commonly divided into generation, transmission, and distribution due to the intrinsic characteristics of each system. At a basic level, generation systems contain power plants, which are usually located remotely where the potential for generation is higher. As more load centers are built in locations that are different from the generation plants, transmission systems are used to transmit power over the long distances that separate generation from consumption. Near the load centers, the transmission network is stepped down to distribution systems, which are responsible for distributing the energy to the end users in urban and rural areas. The subtransmission systems are an intermediate level between distribution and transmission, which allows power with higher voltages to be transmitted to the areas surrounding the cities before stepping it further down to traditional feeder voltage levels. Subtransmission systems can be operated in a meshed or radial configuration, and voltages of 34.5, 69, 115, and 138 kV are commonly used in these networks. On the other hand, distribution networks are typically operated in a radial configuration and can assume voltage levels, such as 4.16, 12.47, 23.8, and 34.5 kV. Such power systems may be described by their topology and by their operational configuration. The two are related and dependent on each other, but they are not the same thing. Topology refers to the construction of the network that dictates which configurations are possible, while configuration refers to the way in which the system is operated within the confines of the constructed topology at a given time. Fig. 1 illustrates how different network topologies can assume different configurations.

While a radial network topology can only be operated in a radial configuration, as shown in Fig. 1a, a meshed network topology can be operated either in a meshed or radial configuration, as shown in Fig. 1b and Fig. 1c, respectively. Moreover, a meshed topology with a radial configuration has the flexibility to achieve different configurations within its meshed topology, as shown by Fig. 1c. Even though most distribution and subtransmission systems are operated with a radial configuration, due to the lower complexity in operation, protection and fault location, these networks are usually built with a meshed topology, as the capability of changing configurations over time can significantly increase the system's reliability.

Fig. 1a

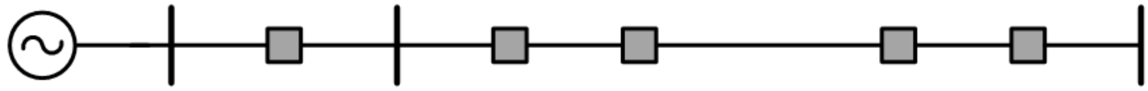

Fig. 1b

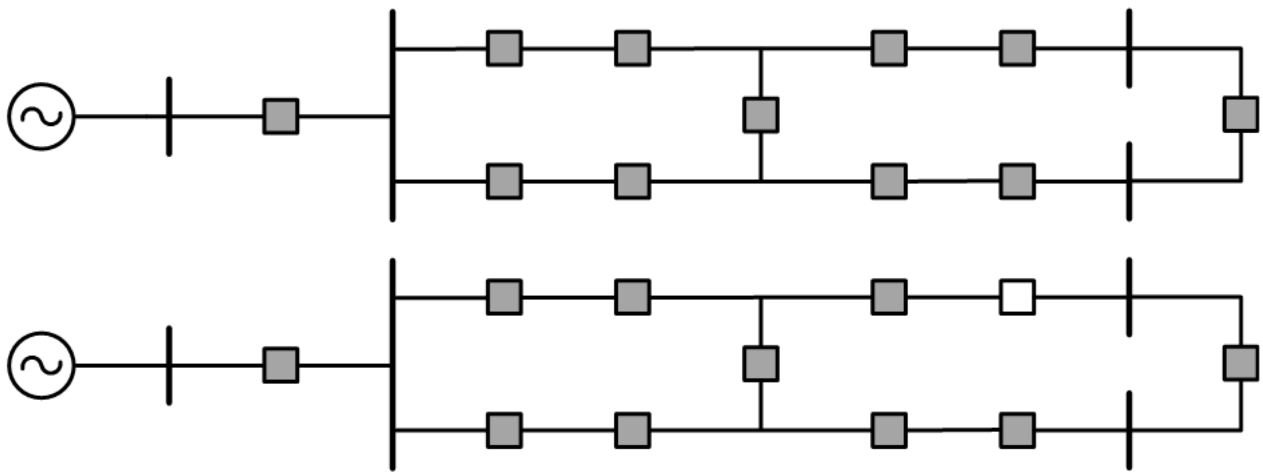

Fig. 1c

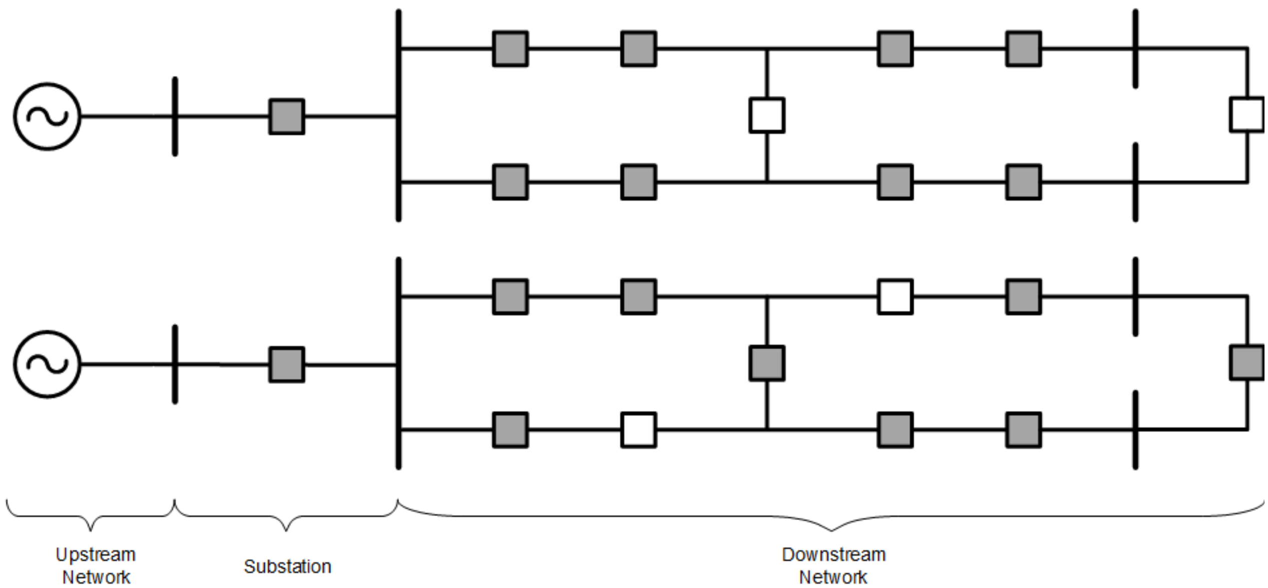

Fig. 1. Power Networks: (a) Radial Topology and Configuration, (b) Meshed Topology and Configuration, and (c) Meshed Topology With Radial Configurations

The process of opening and closing switches in a given network topology to change its configuration is referred to as network reconfiguration (NR). NR is a well-established practice and solution to manage electric networks over time through switching maneuvers. In normal conditions, the NR purpose is to optimize one or multiple electric quantities to improve power quality, losses, voltage, stability, reliability, resiliency, loading, phase balance, maintenance, or repair. Besides those, NR has also been applied during outage events to properly isolate faults and restore the power of end users through a new configuration that de-energizes the faulty segment. However, when NR is used for outage restoration, time becomes a limiting factor.

End users can be subjected to planned and unplanned power interruptions; unplanned interruptions are further divided into momentary and sustained interruptions. IEEE 1366-2022 *(IEEE Guide for Electric Power Distribution Reliability Indices)* [1] states that every unplanned interruption that lasts more than 5 minutes is sustained, while momentary interruptions last less than that. Besides the requirement for a fast response, studies have shown that operators' decisions under unplanned events can further negatively impact the system's reliability [2]. The ability to automatically identify and isolate outages and restore as many end users as possible before their power interruption becomes sustained can significantly improve a system's reliability.

A control solution that addresses the need for automated, fast, safe, reliable, and accurate decisions to restore the power of end users after an event is usually referred to as fault location, isolation, and service restoration (FLISR), but it has also been referred to as self-healing. This is an automatic scheme capable of identifying single or multiple events in the system while locating each of them through the use of field measurements and network topology information. From the event location, a FLISR scheme must define and dispatch a sequence of commands to achieve a new network configuration capable of optimally isolating the fault and restoring the power of end users.

Some benefits of using a FLISR solution are:

- Fast and accurate responses to faults.
- Autonomous and dependable decisions.
- Fault location and isolation.
- Detailed reporting for postevent analysis.
- Improved reliability and end-user satisfaction.

As FLISR is designed for a fast response in an outage event to directly address reliability, its primary application has been on distribution systems, which supply the power of most end users. However, FLISR can be employed to any network that has a meshed topology and is operated in a radial configuration. This paper presents a case study in which a FLISR scheme is applied to a 46 kV subtransmission system in the state of Alabama, USA. The project was developed and implemented by Huntsville Utilities for Redstone Arsenal, a USA army base. This paper aims to show that FLISR schemes are not limited to distribution feeders. The whys and hows of having FLISR in a subtransmission level are covered in this case study to clarify the benefits of such an application and guide future applications. The phase-by-phase approach developed by the utility and army base to securely achieve a fully deployed and operational FLISR scheme is presented along with system details and a simulation case analysis.

II. Fault Location, Isolation, and Service Restoration (FLISR)

FLISR is primarily enabled through the availability of telecontrolled switching (TCS) devices and their communications capabilities. Circuit breakers, reclosers, load breakers, and motor-operated switches may have different capabilities, but any TCS is fundamentally able to provide measurements and receive commands through an intelligent electronic device (IED) tied to it. The practice of integrating TCS devices to increase the distribution system flexibility started back in the 1970s, and it is a known approach to improve reliability and restoration granularity.

A FLISR scheme controller can be either centralized or distributed at different levels. Fig. 2a and Fig. 2b illustrate these two architectures in which the distributed scheme is at a substation level.

In a distributed scheme, FLISR instances are located at the substation level and there may be a data concentrator to facilitate the integration between field devices and FLISR. By embracing a limited portion of the network, this approach brings speed and simplicity to the FLISR response while trading system awareness and the possibility to achieve a global optimal solution. On the other hand, a centralized scheme trades speed for an improved awareness of the network topology, configuration, and statuses. This type of scheme has one FLISR instance, which is usually placed together with the utility's supervisory control and data acquisition (SCADA) system, from where all required data are easily accessed.

Independent of the scheme, a FLISR control has a well-defined sequence of processing to properly perform all of its functions. It is important to highlight that FLISR solutions commonly address shunt and series faults and loss of potential, but this study case primarily focuses on events driven by shunt faults.

Fig. 3 illustrates the sequence of actions that a FLISR solution could be performing during a shunt fault event.

Fig. 2a

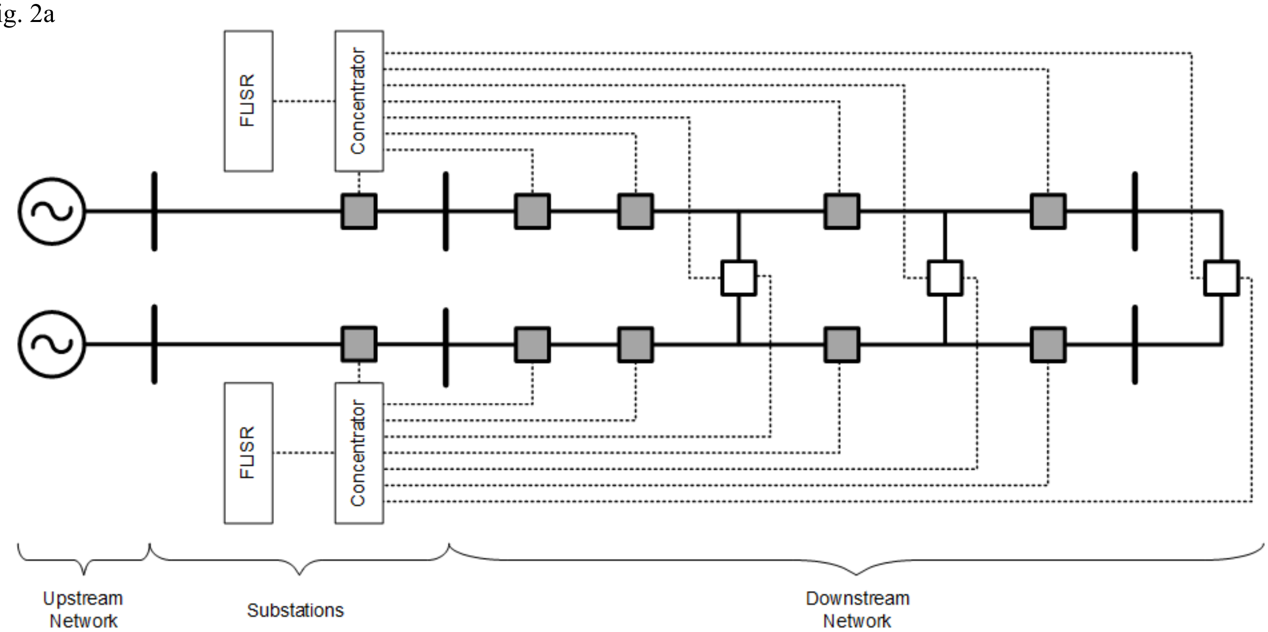

Fig. 2b

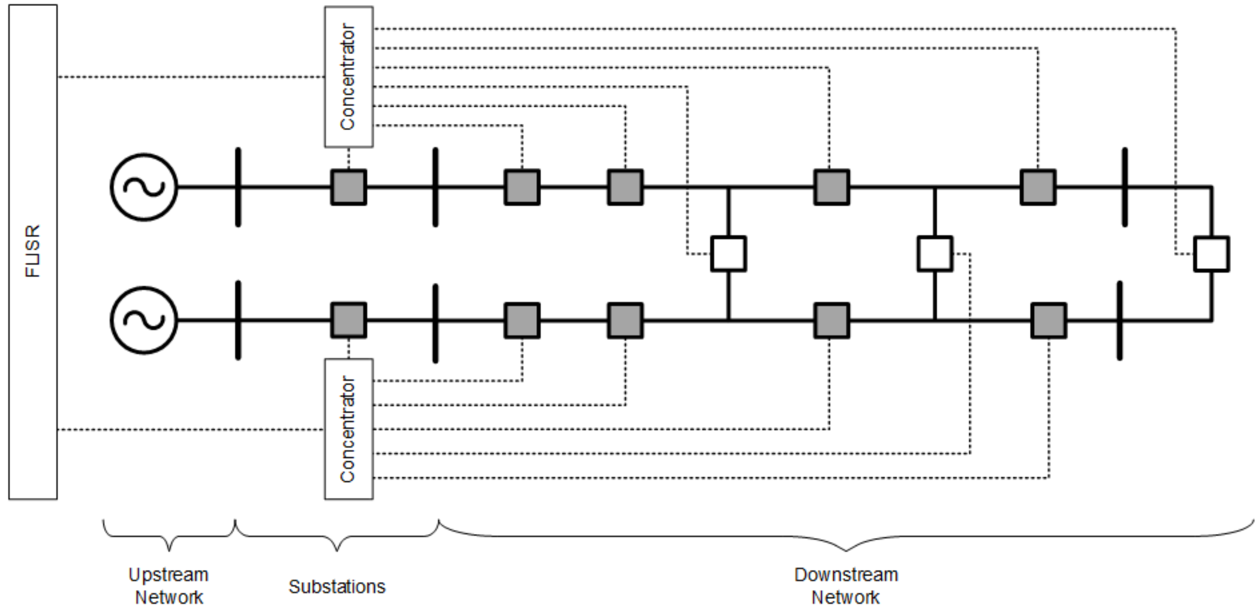

Fig. 2. FLISR Architecture: (a) Distributed and (b) Centralized

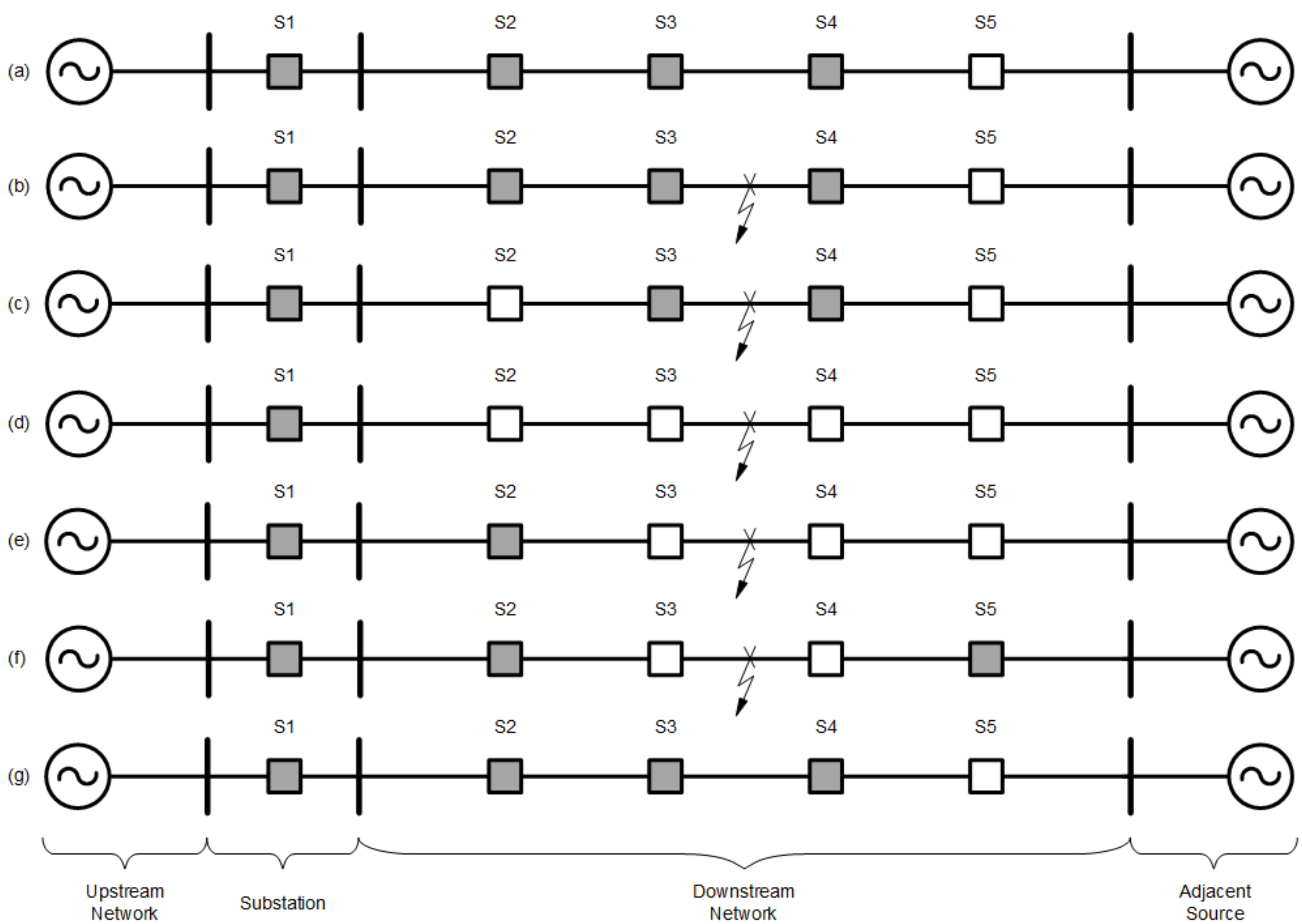

Fig. 3. FLISR Performance: (a) Normal Operation, (b) Fault Event, (c) Protection Response, (d) Isolation, (e) Miscoordination Detection and Correction, (f) Restoration, and (g) Return-to-Normal (RTN) Function

A. Normal Operation and Fault Event

Considering the system of Fig. 3, Fig. 3a shows its normal configuration. The source on the left side is supplying the feeder through S1, S2, S3, and S4; S5 is an open point connecting the feeder to an adjacent source on the right side. For this example, a shunt fault between S3 and S4 is considered, as shown in Fig. 3b. As FLISR analysis and actions must take place after the protection operations are completed, it is common to allow a time delay from the first lockout before collecting all the field data for analysis.

B. Fault Location

For the shunt fault between S3 and S4, high-current levels would pass through S1, S2, and S3, and the short-circuit currents would eventually cause a relay to trip and lock out (79LO). Protective relays are also usually set with a fault indicator (FI) flag, which is defined based on an instantaneous overcurrent element and aims to provide a binary indication that a short-circuit current passed through the switching device. For this example's fault response and miscoordination condition, S1, S2, and S3 would report FIs, while S2 would report an open status and lockout. In a system operated radially, the FI flags along with the network topology, breaker statuses (52A), and 79LO can provide enough information to detect the event and estimate the fault location between S3 and S4; in a looped or meshed configuration, the directional overcurrent element may be required to properly locate the fault.

C. Fault Isolation

Once the faulted line segment is located, it can be isolated by opening all TCS devices, electrically bounding its location. To properly locate the TCS bounding the most likely fault location, FLISR solutions can use a topology analysis based on the pre-fault network configuration. As shown in Fig. 3d, S3 and S4 are identified and opened to properly isolate the fault between them.

D. Miscoordination Analysis

The illustrative scenario presented in Fig. 3c shows that even though the fault is between S3 and S4, S2 was the protecting device tripping and locking out for the fault, and not S3. This behavior can be caused by many reasons, such as operation preference, device capabilities, wrong settings, unforeseen operational conditions, or even a small coordination margin [3]. Independent of the motive, the segments between S2 and S3 were unnecessarily de-energized and had to be corrected before proceeding to a restoration analysis. Even though there are protection schemes capable of addressing such conditions [4] [5], the concept of miscoordination analysis is also applicable to minimize the isolated area when there are protective and nonprotective TCS devices in the network. With that, it is imperative that a FLISR solution is also able to identify and correct these types of miscoordinations. Neglecting them can lead to an incorrect fault location and isolation, which may imply a larger sustained interruption and increased chances for re-energizing the fault and initiating cascade events [6]. Once S3 and S4 are open, S2 is closed to re-energize the segments between S2 and S3, as presented in Fig. 3e.

E. Service Restoration

Once the fault is properly isolated and any miscoordination is corrected, the power grid downstream of the fault is still de-energized, even the power grid downstream of the isolated segments. In the illustration provided in Fig. 3, there is only one option to restore the power of end users downstream of S4, which is by closing S5 as shown in Fig. 3f. However, it is common that circuits may have many different options that must be properly analyzed to achieve an optimal decision. In general, a restoration process is looking to maximize the number of re-energized loads and minimize the number of maneuvers to achieve it while respecting operational constraints, such as fault isolation, radiality, capacity limits, and voltage limits.

F. Return-to-Normal (RTN) Function

When the restoration is completed, the network is in a different configuration than the initial one. Even though the number of energized end users was maximized, there is still potential damage in the network and de-energized end users within the isolation area. As soon as the line is inspected and the damage repaired, the system should return to its normal configuration, as shown in Fig. 3g. Knowing the current and the initial configuration, an RTN function can plan and perform switching operations to bring the network back to its initial configuration, often using make-before-break switching to avoid any further interruption to the power service of an end user.

III. The Utility's System

A. Background

The utility of this case study is the provider of electricity, gas, and water to the city of Huntsville in Madison County, Alabama, USA. It is a public utility with over 200,000 electric end users, 100,000 water end users, and 56,000 natural gas end users. One of its end users is a USA army base located in Madison County. Being a critical facility that hosts 65 tenant agencies, the base has always aimed to ensure high levels of reliability and resiliency.

Based on that, the utility is mounted with a robust high-speed communications network that integrates its field assets into the SCADA system. With the already established infrastructure and automation solutions, the deployment of a FLISR scheme would be a seamless expansion of the system and became a natural step toward further improving reliability and resiliency. Considering that this was the utility's first implementation of FLISR, there was an attentive coordination and validation during the deployment process. Both the utility and army base followed a phase-by-phase deployment process to achieve a final autonomous system.

B. System Overview

The army base facility is supplied by dedicated 161, 46, and 12.47 kV substations and circuits that are managed by the utility. The 46 kV subtransmission system is compounded of more than 20 substations, some of which have connections to the 161 kV transmission system and the remainder to the 12.47 kV distribution system. There are over ten 46 kV circuits with meshed topology but operated in a radial configuration, which have a total of over 50 switching devices.

The traditional approach would have been applying FLISR to the 12.47 kV distribution feeders, but the utility and army base have found it more beneficial to initially deploy FLISR in a subtransmission-level scheme. The reason was that approaching the 46 kV system first would provide larger coverage and better resiliency improvement in the initial implementation.

The FLISR application is not limited to voltage levels, and as soon as the electric circuit has a meshed topology and is operated in a radial configuration, it is possible to deploy such a scheme. Even though subtransmission is quite different from distribution, from a FLISR perspective, only a few aspects matter. In a distribution application, the distribution substation breaker is considered the source of the feeder, while end users are connected all over the line segments and between switching devices. On the other hand, subtransmission systems that are operated radially have their source at the transmission substation breaker and their load is primarily the distribution substations.

Fig. 4 illustrates a subtransmission-level FLISR scheme. The figure simplifies the substations to one single breaker to facilitate the visualization. As it is possible to observe, both the distribution and subtransmission systems are shown with meshed topology and radial configuration. The subtransmission circuits connect the left-side step-down transmission substations to the right-side step-down distribution substations, which supply the feeders.

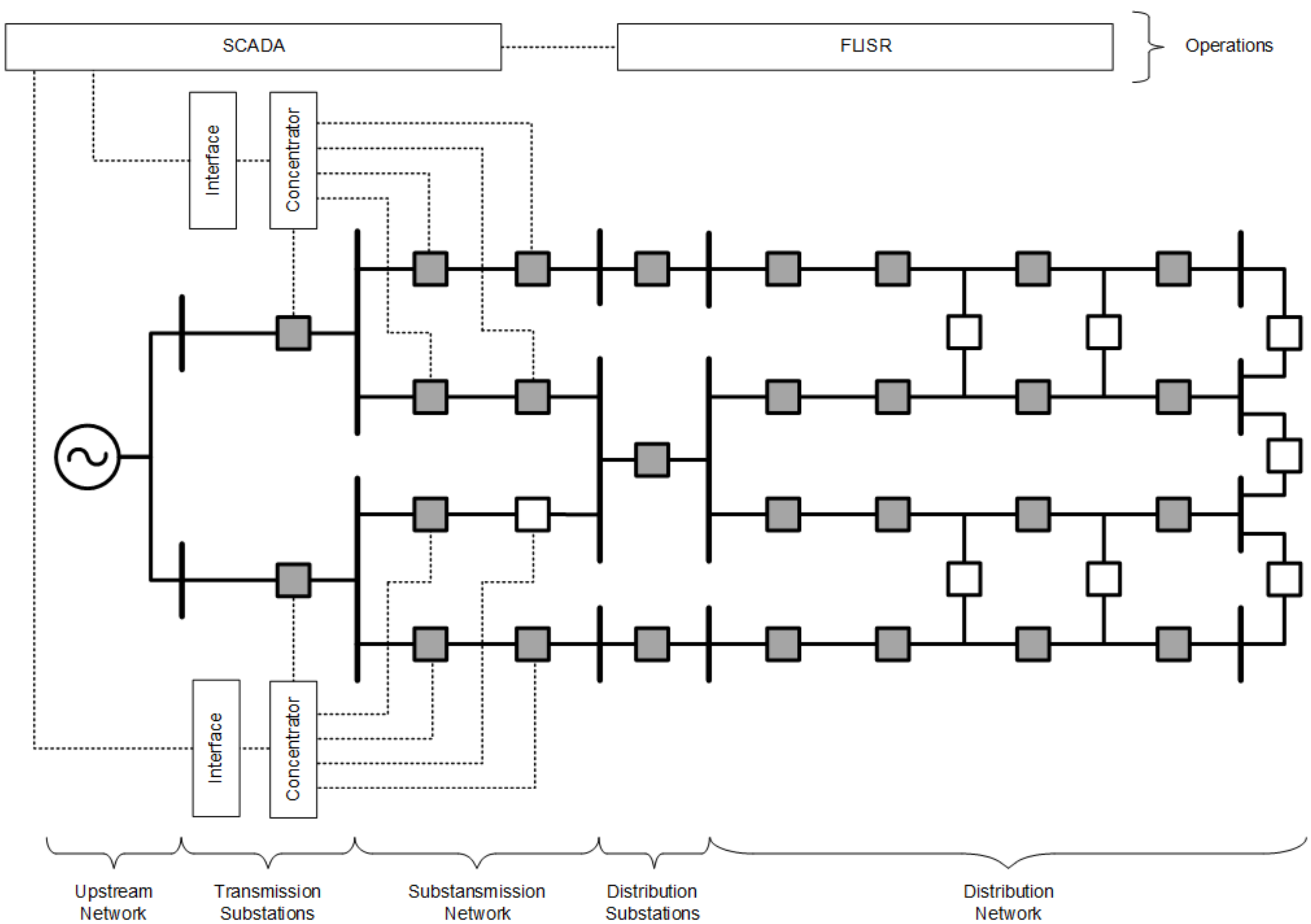

Fig. 4. Illustrative Subtransmission-Level FLISR Architecture

Each substation in the army base system is mounted with an automation controller and a communications interface. The automation controller is also used for data concentration, while the communications interface device is used as the wide-area network (WAN) multiplexer. The automation controller at the substation level collects and concentrates information from field IEDs and then sends these data to SCADA through the available high-speed communications network. With this setup already established, the utility and army base found it beneficial to follow a centralized FLISR architecture, where the solution was placed alongside the SCADA system. Fig. 5 illustrates the utility's FLISR scheme for the army base system.

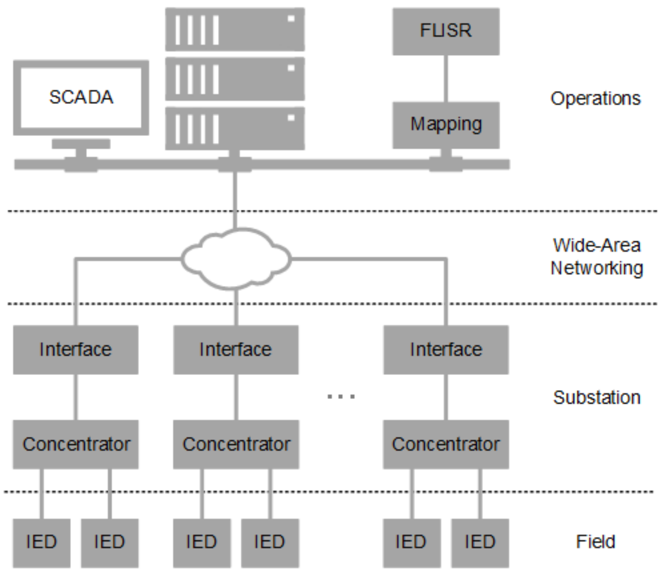

Fig. 5. Utility's Typical System Architecture

IV. Deployment Process

Dividing the deployment into stages that allow subsets of verification, testing, development, integration, commissioning, and validation has enabled a process to build learning and trust in the solution without compromising the actual system. Fig. 6 shows some of the steps defined and followed by the utility and army base to achieve a FLISR scheme on their 46 kV circuits. The following deployment steps may be beneficial for any FLISR deployment and may not be applicable to only subtransmission-level schemes.

A. System Modeling

As the first stage of deployment, the army base's 46 kV system was modeled in a FLISR platform. At this stage, the main goal was to ensure a correct and faithful representation of the network topology model into the platform. Compounded of over 50 TCS devices in over 10 circuits, devices must be properly placed and connected to each other to form the topology. At the same time, every switch must have a normal state as open or close, which guides the RTN actions. Besides, as the utility and army base's FLISR application is for a subtransmission system, the source and load connections had to be properly defined. As previously mentioned, in a subtransmission application, the circuits' sources become the transmission substation connections while distribution substation connections define the loads.

B. Offline Simulation

With the system properly modeled, the next stage was to perform offline simulations to test the response and decisions. One of the many benefits of offline simulations is to validate the model and decisions by reviewing the actions that the solution would have taken. Another benefit is to analyze potential scenarios. Different fault conditions and locations can be simulated to understand how the system would react and if the response is the desired one. This helps to build trust in the scheme while understanding its way of making decisions.

C. SCADA Integration

With the offline simulations completed and a satisfactory performance achieved, the next stage was based on mapping the monitoring and control points from SCADA into the FLISR system. The FLISR solution was supplied with monitoring data from the field, such as three-phase voltage and current measurements, 52A, 79LO, and FI statuses and control points to open and close. However, besides the essential points, the utility has also used additional points to integrate the FLISR solution with the army base's already well-established SCADA system. The following control and alarm points have been used to operate and monitor FLISR.

- Arm control
- Disarm control
- RTN control
- Loop alarm
- Event detected alarm

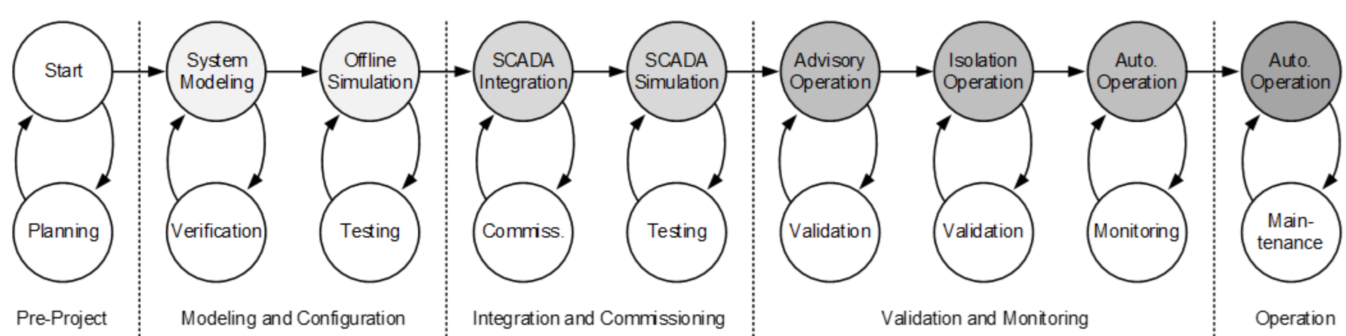

Fig. 6. Deployment Stages

- Reconfiguring alarm
- Reconfiguration completed alarm
- Reconfiguration failed alarm

This integration enabled FLISR to be monitored and operated from the SCADA system, without any need to supervise the FLISR interface along with SCADA.

D. SCADA Simulation

The army base's SCADA system is equipped with a simulation capability, which can emulate the expected behavior of SCADA points and exchange data through protocols in an isolated environment. This functionality allowed full testing and commissioning of control and monitoring points without any risk of dispatching an undesired control to field devices. Simulated or not, a FLISR system performs based on its input data. So, this simulation enabled testing the solution in an environment more realistic than the offline one; as with the SCADA simulations, protocols and communications were accounted for. Section V of this paper presents the performance of an event simulated with the SCADA system.

E. Advisory Mode Operation

Having validated that the system was properly modeled and all data were correctly mapped, the next step was to proceed to the first stage of actual deployment: the advisory mode operation. Based on that, the utility and army base added another layer of testing and initially deployed the FLISR scheme in advisory mode. The advisory mode is a function in which the FLISR solution is fully commissioned and armed but no control action is taken, and only a report is issued with the decisions FLISR would have taken. This type of operation mode allows having the system commissioned, armed, and live without any risk of having it dispatching commands. The commands listed in the report can be reviewed by system operators and then implemented manually.

F. Isolation Mode Operation

As a second stage of the deployment, the system was operated in isolation mode. In this mode, the FLISR solution is fully commissioned, armed, and live, and control actions are taken only to perform fault isolation. Based on that, no actions for restoration are taken. The system response is beneficial to confirm the proper command dispatch and further validate its fault location logic.

G. Autonomous Mode Operation

The final stage of deployment was the fully autonomous mode, in which the system is commissioned and armed, and control actions for isolation and restoration are taken. By initially using the advisory and isolation modes, the utility and army base have been building trust in the FLISR scheme before enabling an autonomous mode.

V. Simulation Analysis

Leveraging the SCADA system simulation capabilities, the utility and army base have simulated many different scenarios and conditions to analyze the FLISR system response. Fig. 7 shows the one-line diagram of a section of the army base's 46 kV system. The substations and devices have been renamed, but the topology has been maintained accurately. This section of the system is compounded of four substations, where Substations A and D are connected to the 161 kV transmission system and Substations B and C are 46/12.47 kV distribution substations. Substation C is mounted with a bus breaker (C-2), which is normally open and isolates the system from Substations A and D, making the system configuration radial. A shunt fault on Line BC was simulated, and Table I shows the alarm logs received in the SCADA system, where time was adjusted to the first alarm and is displayed as minutes:seconds.

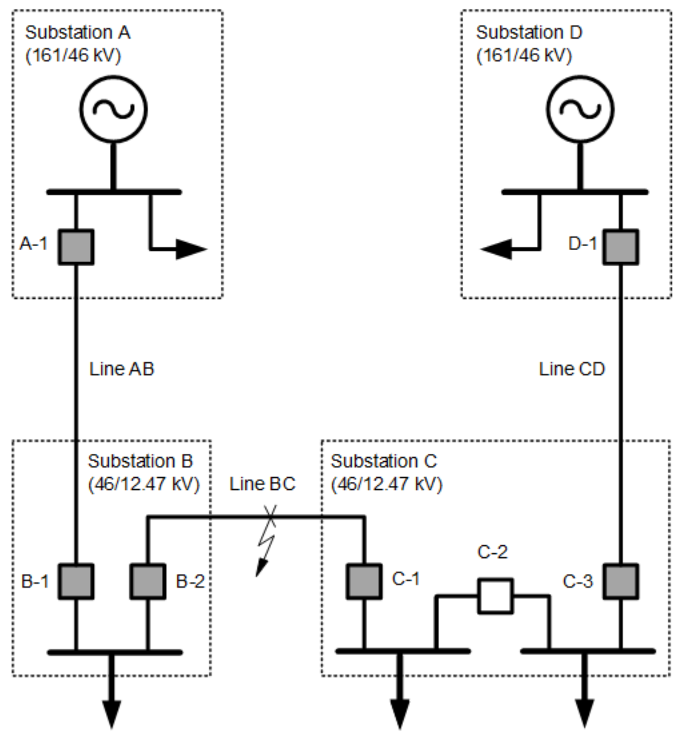

Fig. 7. Army Base System Section Diagram

TABLE I
FLISR ALARMS

Time	Source	Device	Message
00:00	Sub. A	A-1	Tripped
00:10	Sub. A	A-1	Closed
00:12	Sub. B	B-1	Fault Indication On
00:12	Sub. B	B-2	Fault Indication On
00:15	Sub. A	A-1	Tripped
00:28	FLISR	A-1	Event Detected On
00:28	FLISR	A-1	Reconfiguration Started
00:34	Sub. C	C-1	Tripped
00:34	Sub. C	B-2	Tripped
00:37	Sub. A	A-1	Closed
00:38	Sub. C	C-2	Closed
00:51	FLISR	A-1	Reconfiguration Completed
01:07	FLISR	A-1	Event Detected Off

The event was initiated by A-1's first trip, which then reclosed at 00:10, tripped again, and locked out at 00:15. B-1 and B-2 FIs picked up at 00:12. With the lockout of A-1 and FIs picking up for B-1 and B-2, the FLISR solution detected the event at 00:15. The following 13 seconds (from 00:15 to 00:28), accounted for a predefined 10-second delay, fault location computation, and isolation and restoration switching plan. The fault was located between B-2 and C-1, so both breakers were opened for fault isolation at 00:34. As restoration steps, A-1 was initially closed to re-energize Substation B, while the tie breaker C-2 was closed at 00:38 to re-energize the remainder of Substation C. After 51 seconds from the first trip and 36 seconds after the lockout, the fault was isolated, the restoration was completed, and all system loads were re-energized.

Once the simulated fault was removed, the system was brought back to its normal configuration by using an RTN command. Table II shows the SCADA alarms during an RTN operation for the same fault on Line BC.

TABLE II
RTN ALARMS

Time	Source	Device	Message
00:00	Sub. B	B-2	Closed
00:02	Sub. C	C-1	Closed
00:05	Sub. C	C-2	Tripped
00:19	FLISR	A-1	Reconfiguration Completed

The RTN followed a closed-loop approach to transit the system from one radial configuration to the other. Initially, B-2 and C-1 were closed, putting the network into a looped configuration, then C-2 was opened to bring the system back to the initial and radial configuration.

VI. FUTURE CONSIDERATIONS

The army base circuits already had advanced levels of monitoring and control due to their well-established SCADA system and high-speed communications network infrastructure, which made FLISR schemes a natural next step toward further improving reliability and resiliency. Different from the traditional applications, the utility and army base decided to initially deploy FLISR on their 46 kV subtransmission system, as it would provide larger coverage and an improvement in resiliency in the initial implementation.

With over ten 46 kV circuits fully commissioned and soon to be operated in autonomous mode, the utility and army base aim to expand FLISR applications to 12.47 kV circuits that are radially configured. The 12.47 kV system will have its own centralized FLISR instance, which will be independent from the one used for the 46 kV circuits. The instance for the 12.47 kV system will scale the deployment approach to properly accommodate the integration of more than 450 switching devices.

VII. CONCLUSION

Ensuring reliability and resiliency has been a constant challenge for electric utilities. As end users are evolving to use new technologies that depend on power delivery, utilities are required to continually improve their process. The case of Huntsville Utilities and Redstone Arsenal has not been different. Continuous and reliable power delivery has always been an important requirement for the USA army base, which hosts more than 75 tenant agencies.

The primary goal of this case study was to highlight the possibility of applying FLISR schemes in subtransmission circuits and not just on distribution feeders. As transmission and subtransmission systems usually present higher visibility and controllability levels than distribution networks, it may be an option for utilities to initially deploy a FLISR scheme on those circuits while the distribution networks are being modernized for better monitoring and control.

The case study aimed to showcase the utility and army base's process to deploy a FLISR scheme with the intention of guiding other utilities and future deployments. As this was the utility and army base's first FLISR implementation, the deployment followed a phase-by-phase process, which was divided into stages and subsets of verification, testing, development, integration, commissioning, and validation to enable learning and building trust in the solution without compromising the actual system. Through modeling, simulation, integration, and advisory operation, there was a need for careful coordination and agile validation to build trust before achieving a fully autonomous system.

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IX. Biographies

Jeremy Smith serves as a SCADA engineer at Huntsville Utilities, where he oversees electric utilities at the Redstone Arsenal. Jeremy has worked in the utility industry for more than 19 years, and 2 of those years have been supporting Huntsville Utilities Engineering and Operations Departments. Jeremy graduated with a bachelor's degree in electrical engineering from The University of Alabama in Huntsville in 2010. After graduation, he worked as an electrical engineer with Wolf Creek Federal Services. His role as a distribution engineer was to ensure reliable electric service to the customers at Redstone Arsenal. Jeremy's background has been in substation automation during his career. He is currently working on implementing the Schweitzer Engineering Laboratories, Inc. (SEL) fault location, isolation, and service restoration solution into the Redstone Arsenal electrical system.

Corey Dean serves as a SCADA supervisor at Huntsville Utilities, where he oversees the development, maintenance, and operations of all components pertaining to SCADA. Corey has worked in the utility industry for 15 years, and the past 3 years have been supporting the Huntsville Utilities Operations department. He graduated from The University of Alabama with a Bachelor in Environmental Science in 2009 and a Master in Business Administration from Columbia College in 2017. After graduation, he worked as a Department of Defense geographic information system analyst, supporting utility systems at military bases across the United States. In 2014, Corey began supporting the SCADA system at Redstone Arsenal. He and his team worked to upgrade an antiquated SCADA system to a state-of-the-art system. This project included building a fiber network, building a quad redundant server cluster, and enacting standard operating procedures for operations. In his role as a SCADA system analyst, he integrated connectivity mapping into SCADA to leverage the ability to manage the entire electric grid via the SCADA system from a holistic perspective. In 2019, he was promoted to a SCADA supervisor at Wolf Creek Federal Services, at which he managed a team of engineers and analysts to continue developing the full functionality of SCADA. During this time, his team began a substation digitization project to replace aging card-based remote terminal units and electromechanical protection relays with cutting-edge real-time automation controllers, microprocessor protection relays, and digital meters. In 2021, Corey began working at Huntsville Utilities, supporting the SCADA department at Redstone Arsenal as a part of the Intergovernmental Support Agreement (IGSA). In 2022, he was promoted to his current position as a SCADA supervisor for Huntsville Utilities. In this position, Corey manages over 400 remote terminal units for Huntsville's grid and continues to manage 24 remote terminal units at Redstone Arsenal. In addition, his team finished the project to completely digitize all substations at Redstone Arsenal. His team is now currently building and implementing a fault location, isolation, and service restoration system at Redstone Arsenal.

John Mayer began his professional career as an electromagnetic compatibility test engineer at Lockheed Martin and has worked on varied space programs, such as GPS III. He then transitioned within the company to classified cybersecurity, managing the risk management framework packages for three separate Department of Defense (DoD) programs. John has also served as a special test equipment engineer on the PAC-3 program with Boeing before making the transition to Huntsville Utilities, where he has been serving as a SCADA engineer for the past 5 months. He has been working closely with the Huntsville team on the implementation of fault location, isolation, and service restoration at Redstone Arsenal.

Jerick Rowell is an electrical engineer at Redstone Arsenal, where he serves as the owner and manager of the base's electrical utility system. Jerick graduated from The University of Alabama in Huntsville with a bachelor's degree in electrical engineering in 2014. After graduation, he worked as an electrical engineer at Norfolk Naval Shipyard. In his current position, Jerick monitors and evaluates all current and future projects that impact Redstone Arsenal's electrical grid to ensure the reliability of the system and support the Army's mission.

Konrad Schmitt received a PhD degree in electrical engineering from Texas Tech University, USA, in 2023, and a BSc degree in electrical engineering from the Federal University of Santa Maria, Brazil, in 2019. Konrad is currently an associate power engineer at Schweitzer Engineering Laboratories, Inc. (SEL) in Pullman, USA, where he supports the development of distribution management system (DMS) applications that aim to improve the reliability, continuity, quality, and safety of power delivery. His technical expertise is in the field of power distribution systems, in which he has written various technical publications related to network reconfiguration, self-healing, outage restoration and management, renewable energy integration, voltage control, and hardware-in-the-loop simulations. Since 2017, Konrad has been an active IEEE Power & Energy Society member, holding positions at branch, section, region, and global levels, besides contributing to IEEE Technical Committees.

Trent Bridges started with Schweitzer Engineering Laboratories, Inc. (SEL) in 2018 as an application engineering intern and, shortly after, completed his BS in electrical engineering at Auburn University. He joined SEL full-time after graduating and has since spent the last 4 years as an application engineer with a focus in the SEL automation/integration product line while supporting customers in various states throughout the southeastern United States.

Matthew Bult is senior product manager at Schweitzer Engineering Laboratories, Inc. (SEL), where he is responsible for distribution management system (DMS) software. He has worked in Research and Development at SEL since 2021, aiding in the development, implementation, and support of DMS software components. Matthew earned a BS in electrical engineering from South Dakota State University. After college, he started working for an electrical utility in Kansas, Evergy (formerly Westar Energy and KCP&L). At Evergy, Matthew held various roles in generation, IT, and distribution, focusing on technology, operations, and strategic planning.

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