QUANTA TECHNOLOGY

PRC-027-1: How Ready Is Your Team?

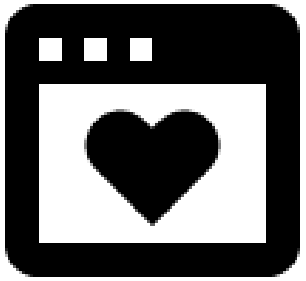
a Quanta Technology

Knowledge Sharing Webinar

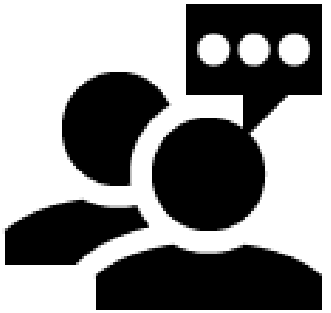
April 2, 2020

COVID-19 Update

Stay Safe



Stay Healthy



Stay Connected

https://www.cdc.gov/coronavirus/2019-ncov/index.html

https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19.html

Quanta Technology Knowledge Webinar Series

Time	APRIL 9, 2020 11:00 AM-12:00 PM	APRIL 16, 2020 11:00 AM-12:00 PM	APRIL 23, 2020 11:00 AM-12:00 PM
Topic	RESILIENCY OF ELECTRIC POWER SYSTEMS	VALUE OF DER	STATE OF THE ART ON 100% RENEWABLE SYSTEMS
Speakers	DR. JULIO ROMERO-AGUERO & DON HALL	DR. RALPH MASIELLO	DR. HISHAM OTHMAN & RAHUL ANILKUMAR

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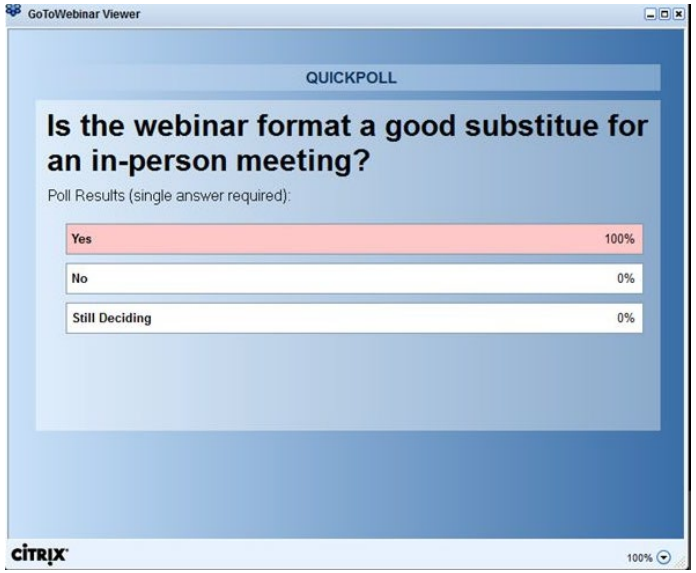
Webinar Format

Audio for attendees will be muted.

Questions will be answered at the end of the session.

Submit your questions throughout the presentation (if applicable, note the slide number).



We will be conducting a series of interactive polls throughout the presentation.

You will have 30 seconds to answer.

The results will be presented instantly.

Subject Matter Expert Speakers

Juergen Holbach, PhD, *Senior Director of Automation & Testing,* has more than 25 years of experience in the design and application of protective relaying. An IEEE member and chairman, he has published over a dozen papers and holds three patents. In 2009, Juergen received the Walter A. Elmore Best Paper Award from the Georgia Tech Relay Conference. Juergen's areas of expertise include Automation & Protection, Transmission Protection, RTDS Testing, and IEC 61850 Compliance.

Saman Alaeddini, MASc, *Director of Engineering Automation and Software Development,* is a specialist in protection system modeling, database management and analysis, autonomous systems design, robotics, and industrial processes. His experience includes real-world automation system implementation and maintenance, and advanced data analytical techniques. Saman has been involved in wide-area protection projects for over 8000 transmission lines with 10 large electric utilities internationally in the past decade. He has been involved in primary and secondary system modeling, protection and control settings analysis, compliance studies, data management, software tool evaluations, and process improvement initiatives.

Background

- NERC standards are continually updated to help reduce misoperations and improve power system reliability
- New standards also put additional burden on engineers to perform studies and demonstrate compliance
- Utilities are leaning towards compliance solutions that are comprehensive and provide long-term efficiency
- NERC PRC-027-1 is an opportunity for utilities to adopt the industry-leading protection-analysis practices and benefit from an automated solution

NERC PRC-027-1 Standard

What is PRC-027-1?

- NERC Reliability Standard with stated purpose: “To maintain the coordination of Protection Systems installed to detect and isolate Faults on the Bulk Electric System (BES) Elements, such that those Protection Systems operate in the intended sequence during Faults.”
- Comes into effect October 2020

PRC-027-1 Requirements

The standard has three main requirements:

- **R1. Establish a process** for developing new and revised protection system settings for BES elements such that the protection systems operate in the intended sequence during faults
- **R2. Perform protection system coordination studies** periodically, as per options described in the standard
- **R3. Develop new protection system settings by following the process** developed in requirement R1

NERC's Response to COVID-19

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Recommendation to Industry

Coronavirus Disease (COVID-19) Pandemic Contingency Planning

Initial Distribution: March 10, 2020

Coronavirus Disease (COVID-19) is a respiratory disease caused by the SARS-CoV-2 virus, which was first identified in Wuhan, China on December 8, 2019. The virus has since spread internationally to include confirmed cases in the United States, Canada, and other countries. The U.S. Centers for Disease Control and Prevention (CDC) and Public Health Agency of Canada (PHAC) both assess the current risk to the American and Canadian public as "low" as of March 4, 2020, although it is anticipated that the number and geographic dispersion of infected patients will increase in the coming weeks to months. To ensure reliability through the potential range of future developments, organizations should understand and consider the actions discussed in the Recommendation.

Why am I receiving this? >>
About NERC Alerts >>

Status:	**Acknowledgement Required by Midnight Eastern on March 12, 2020** **Reporting Required by Midnight Eastern on March 20, 2020**
	PUBLIC: No Restrictions More on handling >>
Instructions:	This Level 2 NERC Alert provides specific recommended actions that NERC registered entities should consider in response to a particular issue. Pursuant to Rule 810 of NERC's Rules of Procedure, NERC registered entities shall (1) acknowledge receipt of this advisory within the NERC Alert System, and (2) report to NERC on the status of their activities in relation to this recommendation (as provided below). For U.S. entities, NERC will aggregate the responses and provide an anonymized report to the Federal Energy Regulatory Commission. This Level 2 NERC Alert is not the same as a Reliability Standard nor does it create a mandatory obligation to take the recommended actions. Your organization will not be subject to penalties for failure to implement the recommendations. Issuance of this recommendation, however, does not alter the requirements of any approved Reliability Standard nor excuse the failure to follow the practices discussed in the recommendation if such failure constitutes a violation of a Reliability Standard. Registered entities must continue to comply with applicable Reliability Standards.

https://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC_Alert_R-2020-03-10-01_COVID-19_Pandemic_Contingency_Planning.pdf

Federal Energy Regulatory Commission

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

March 18, 2020

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FERC, NERC Provide Industry Guidance to Ensure Grid Reliability Amid Potential Coronavirus Impacts

The Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) announced today they are taking steps to ensure that operators of the bulk electric system can focus their resources on keeping people safe and the lights on during this unprecedented public health emergency.

FERC and NERC are using regulatory discretion to advise all registered entities that they will consider the impact of the coronavirus outbreak in complying with Reliability Standards as follows:

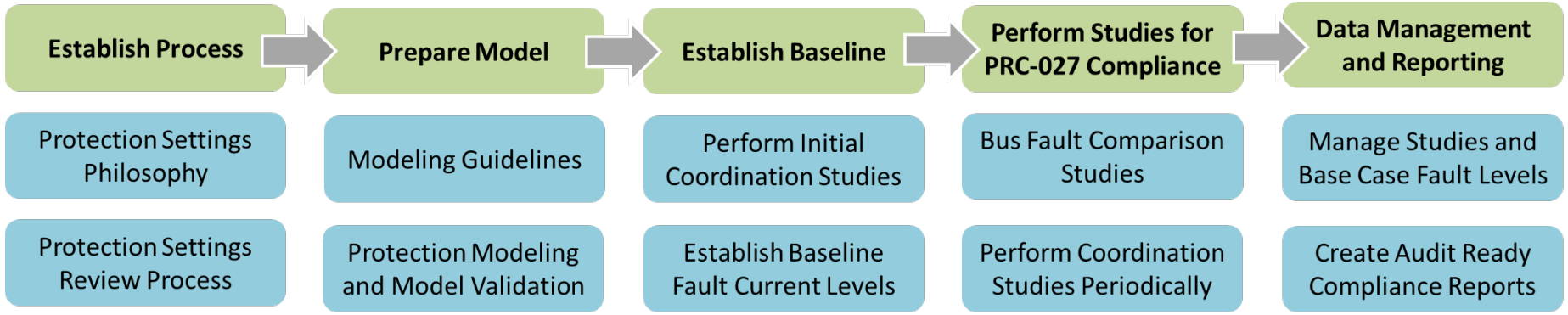
- The effects of the coronavirus will be considered an acceptable basis for non-compliance with obtaining and maintaining personnel certification, as required in Reliability Standard PER-003-2, for the period of March 1, 2020 to December 31, 2020. Registered entities should notify their Regional Entities and Reliability Coordinators when using system operator personnel that are not NERC-certified.
- The effects of the coronavirus will be considered an acceptable reason for case-by-case non-compliance with Reliability Standard requirements involving periodic actions that would have been taken between March 1, 2020 and July 31, 2020. Registered entities should notify their Regional Entities of any periodic actions that will be missed during this period.
- Regional Entities will postpone on-site audits, certifications and other on-site activities at least until July 31, 2020. Registered entities should communicate any resource impacts associated with remote activities to their Regional Entities.

FERC and NERC recognize the uncertainties regarding the response to and recovery from the coronavirus outbreak and will continue to evaluate the situation to determine whether to extend these dates. Our shared goal is to ensure all registered entities balance the concerns for the health and welfare of their workforce while staying focused on the mission of supplying power to consumers across North America.

https://www.ferc.gov/media/news-releases/2020/2020-1/03-18-20.pdf

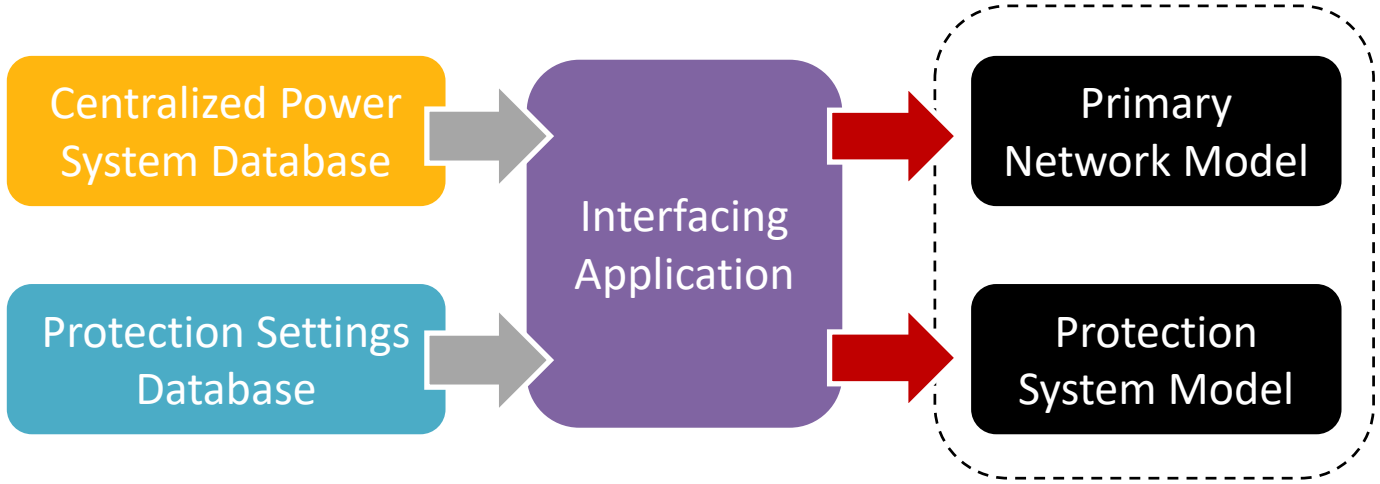
Key Aspects of PRC-027-1 Compliance

- Establish Overall Process and Guidelines
- Prepare System Model
- Establish Bus Fault Baseline
- Perform Studies
  - Fault Comparison
  - Identify Equipment Requiring Coordination Review
  - Coordination Studies
- Data Management and Reporting



Primary Network and Protection System Modeling

- PRC-027-1 evaluations will require access to accurate and up-to-date primary network and protection system models
- Utilities are moving towards maintaining system parameters in centralized databases and protection data in asset management applications
- Protection simulation software platforms allow creation of primary and protection system models in an automated way



Primary Network and Protection System Modeling

- Access to the centralized data is only part of the puzzle…
- Interfacing application relies on:
  - Standardization of naming across data sources
  - Processes to maintain accuracy and the usefulness of the data
- Automated modeling tools are limited by the data available; therefore, some manual customizations may still be required

Even if manual customizations are required, investment in centralized databases and interfacing applications that convert this data into simulation-ready models is highly valuable

Prepare Protection Model

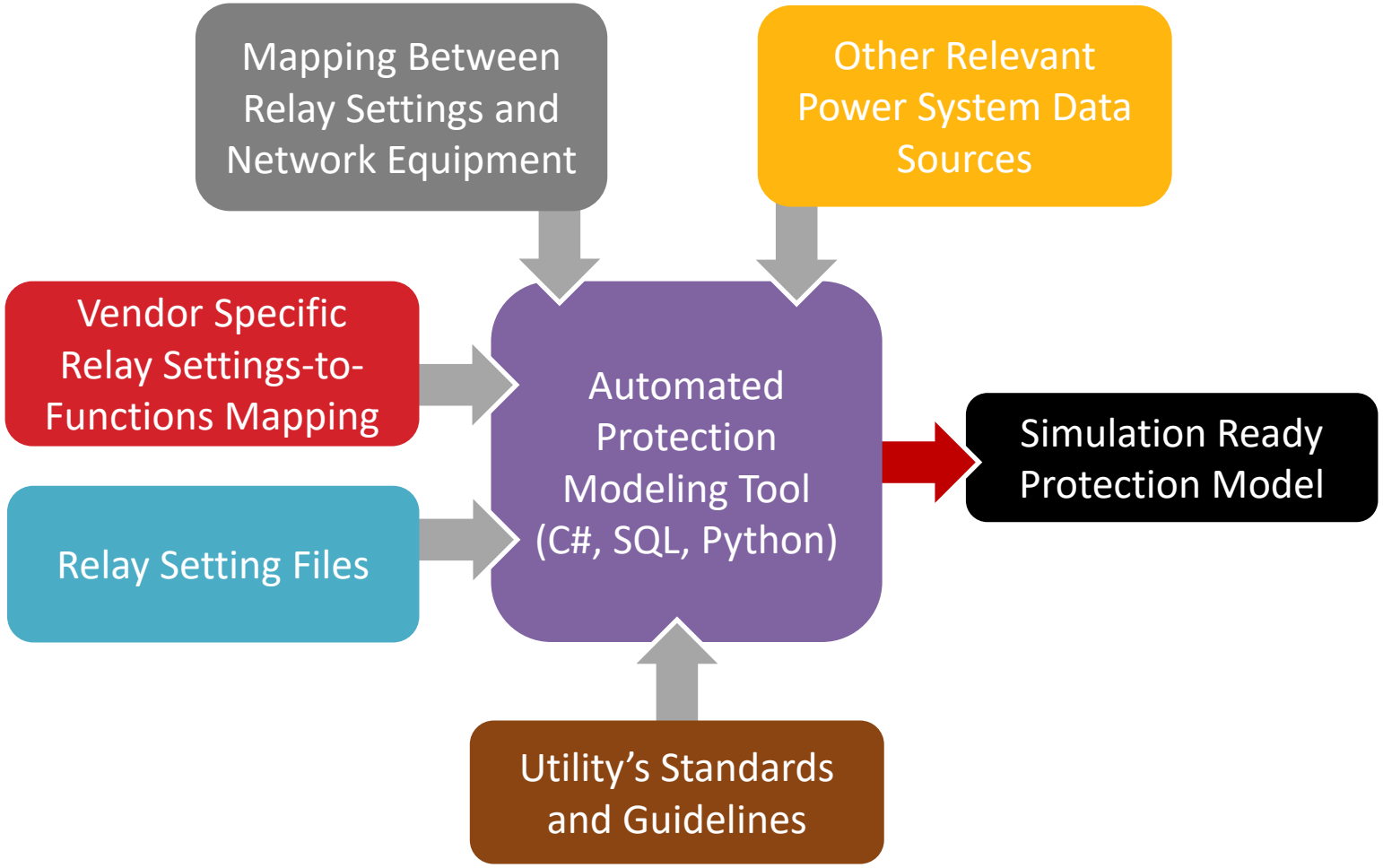
- Retrieve setting information from relay settings database/folder structure
- Determine location in model to where the data should be transferred
- Model protection devices: 21, 50/51, Teleprotection (87, POTT, DCB, TT, …)
- Import settings
- Parse relay trip logic in the settings file, and prepare the model to be simulation ready

Maintaining a detailed protection model can be challenging.

Utilities must invest in automated modeling tools that directly retrieve relay data (type, setting file, location) from Asset Management database and prepare simulation-ready protection model.

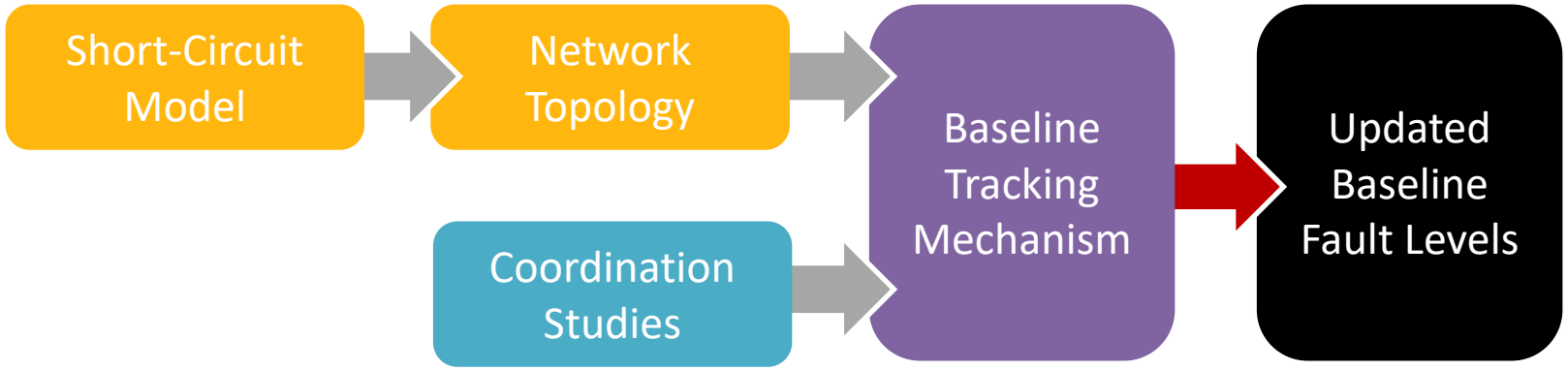
Primary Network and Protection System Modeling

Maintaining a detailed protection model can be especially challenging



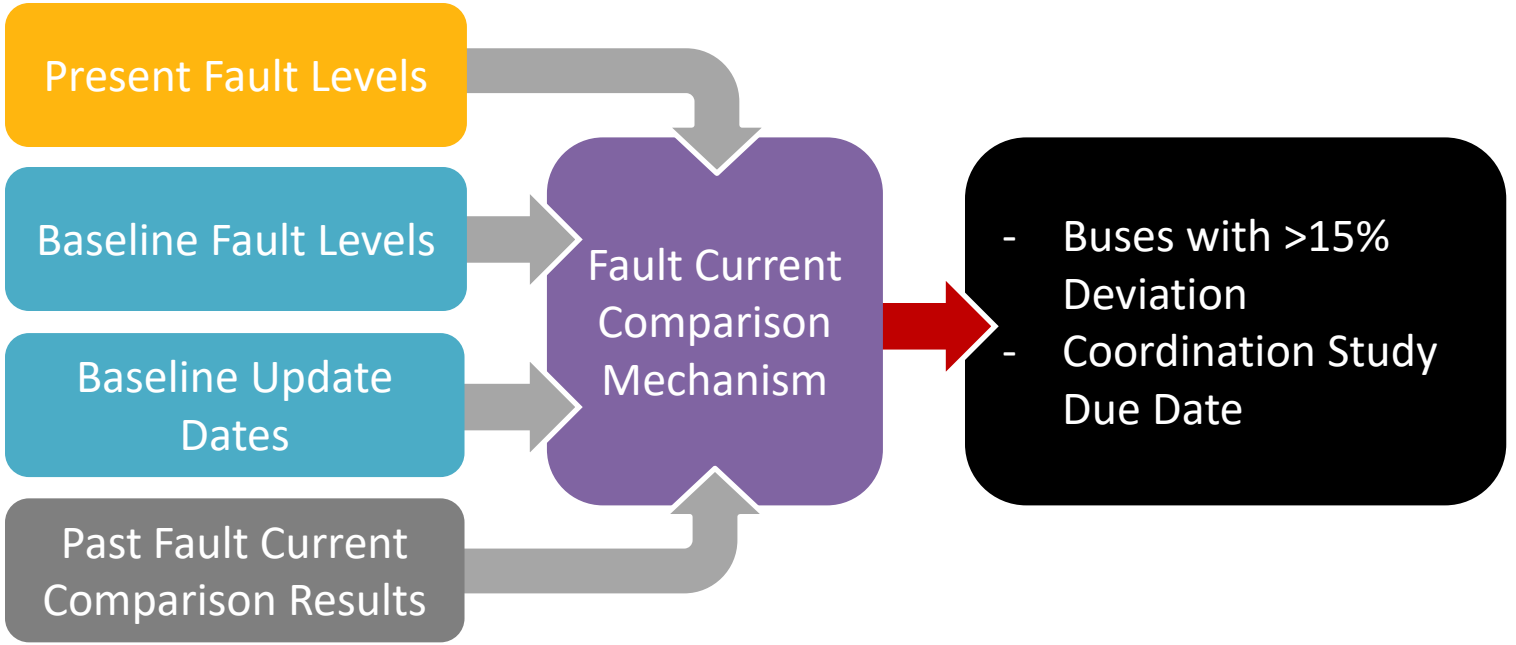
Determining and Tracking Bus Fault Baseline

- Initial baseline fault current levels can be determined based on:
  - Past records of coordination evaluation
  - Performing an initial system-wide coordination study
- Continuously update baseline
  - Baseline fault current levels can be updated as coordination studies are completed for network equipment connected to BES bus
  - The topological relationship between BES buses and connected equipment is determined from the short-circuit program



Determining Buses with >15% Current Deviation and Study Due Dates

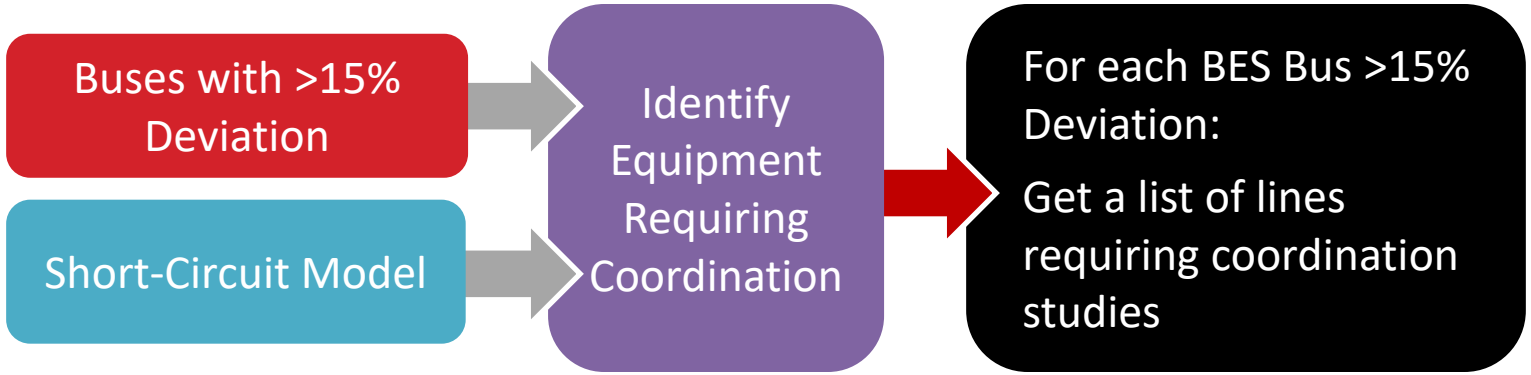
- Two Main Fault Current Comparison Outputs:
  - Buses with >15% deviation
  - Coordination study due date
- Key Inputs



Coordination study due date is not only a function of present fault comparison date, but it also depends on the results of previous fault comparisons and when baselines were last updated.

Determining Equipment Requiring Coordination Studies

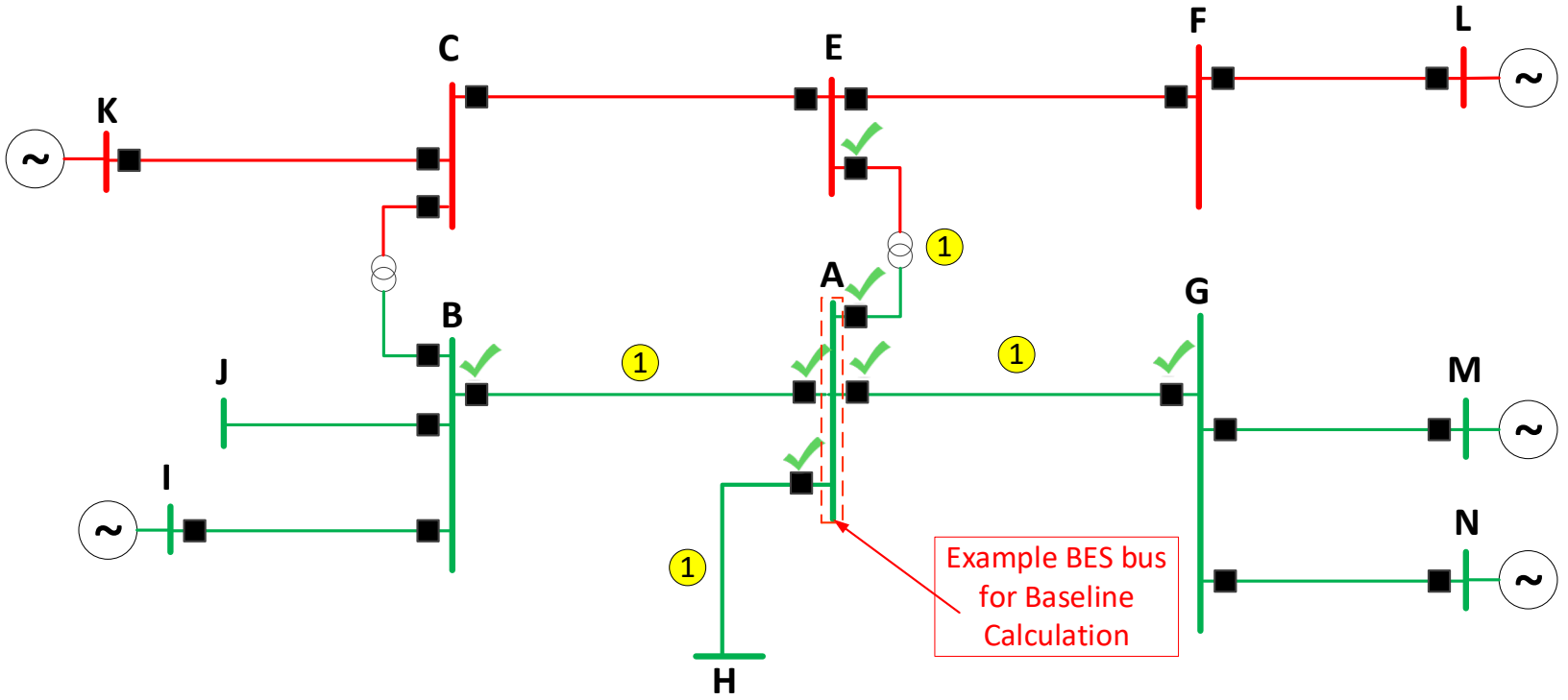
- Modern protection simulation software applications allow topological searching to identify equipment requiring coordination studies
- The list of lines can also be used to start batch coordination studies



Determining and Tracking Bus Fault Baseline

When should the baseline bus fault be updated?

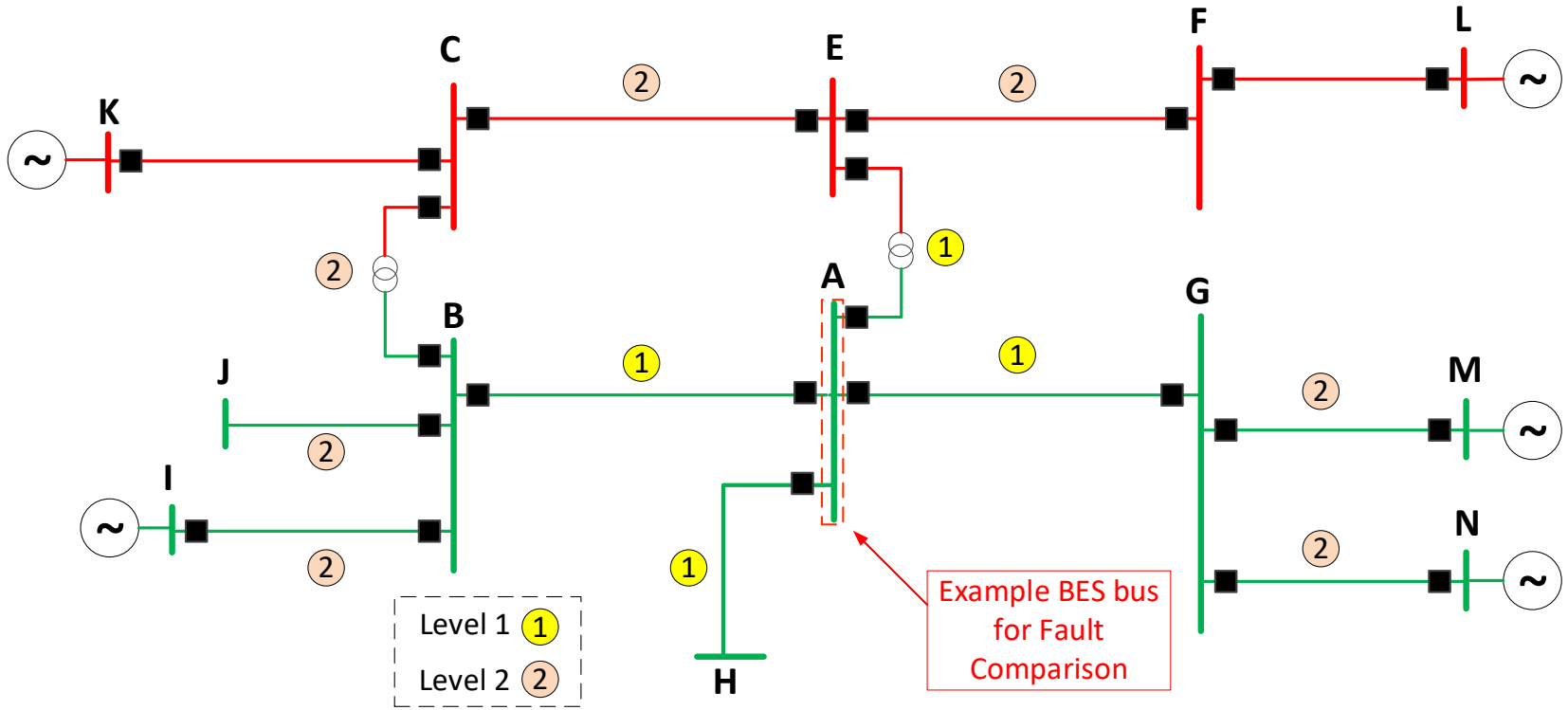
Protection Systems responsible for clearing faults on equipment connected to the BES buses shall operate in the intended sequence.



The bus fault current at which the protection systems are verified to operate as expected should be set as the baseline.

Determining Equipment Requiring Coordination Studies

- For BES buses with >15% deviation:
  - Equipment connected up-to-two levels away from a BES bus will need to be part of the coordination analysis



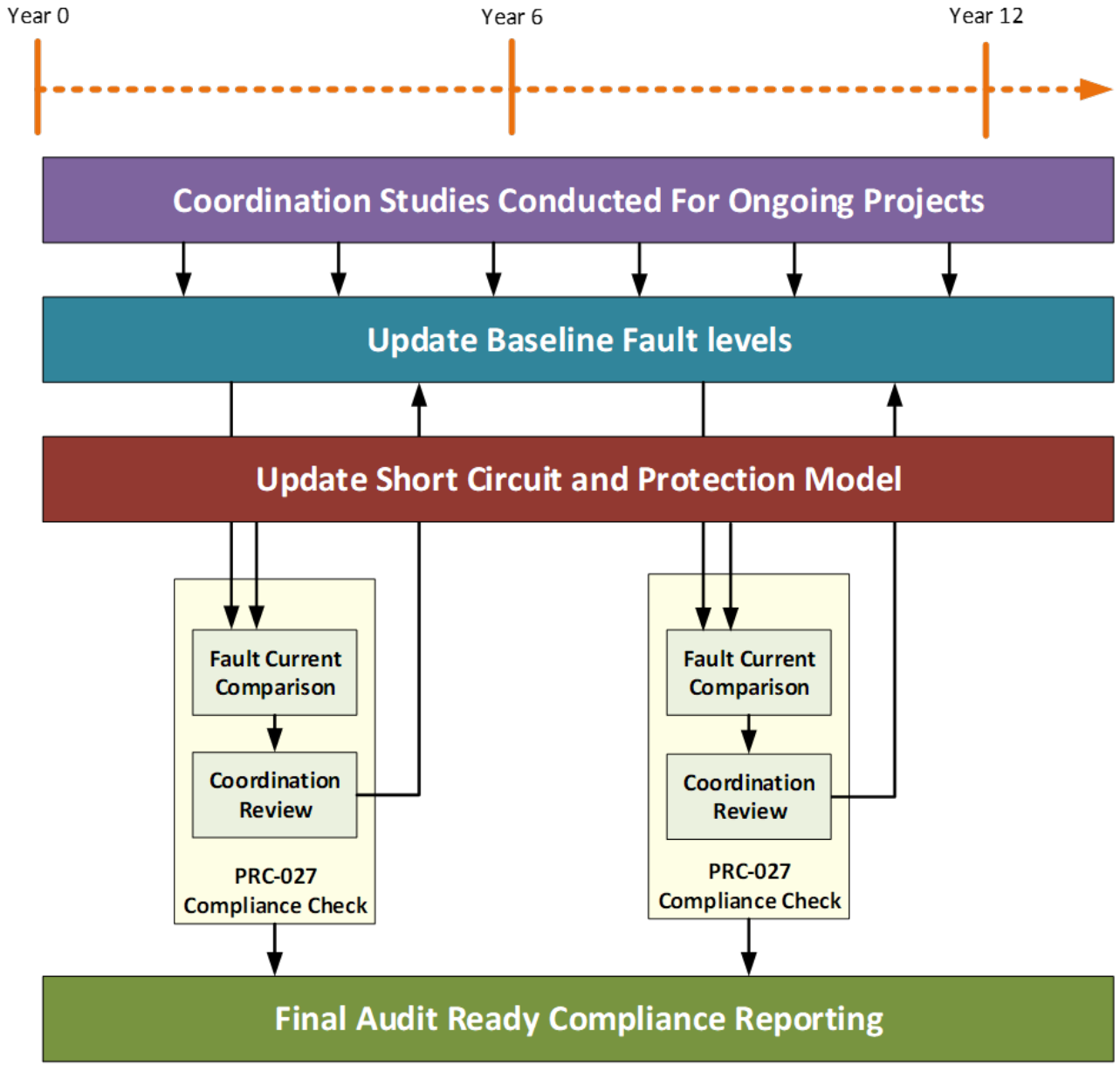
NERC PRC-027-1 Standard: R2 Compliance

R2 Compliance Options: For each BES element with protection system functions:

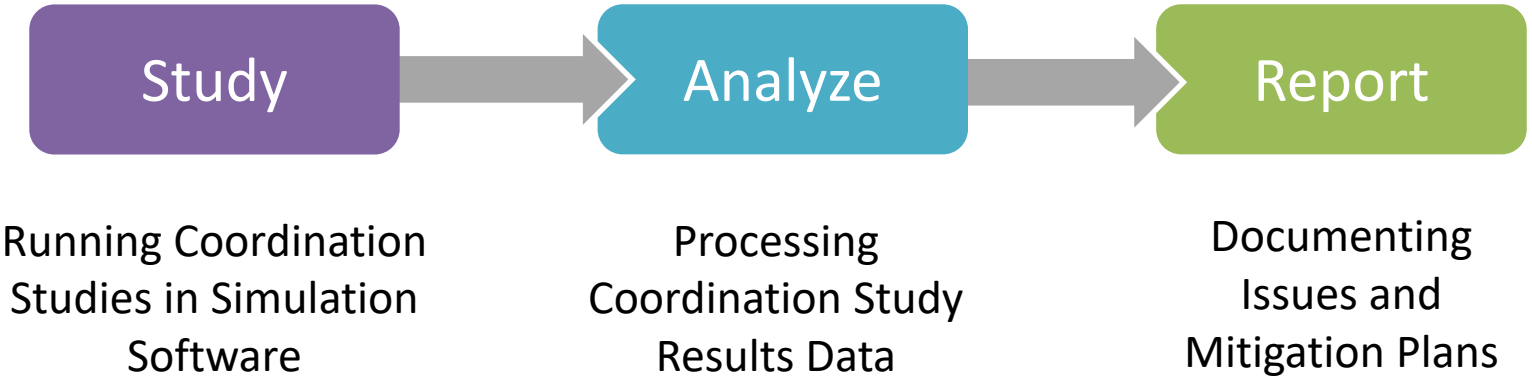
- **Option 1:** Perform a protection system coordination study in a time interval not to exceed 6 calendar years.
- **Option 2:** Compare present fault current values to an established fault current baseline and perform a protection system coordination study when the comparison identifies a 15-percent or greater deviation in fault current values (either three-phase or phase-to-ground) at a bus to which the BES element is connected, all in a time interval not to exceed 6 calendar years.
- **Option 3:** Use a combination of Options 1 and 2

The standard provides the flexibility to use different options, therefore automation tools must be designed to be flexible as well.

PRC-027-1 R2 Compliance Process Overview



Performing Coordination Studies



- Protection coordination studies can be performed in many different ways
- A systematic and comprehensive coordination review process should be adopted

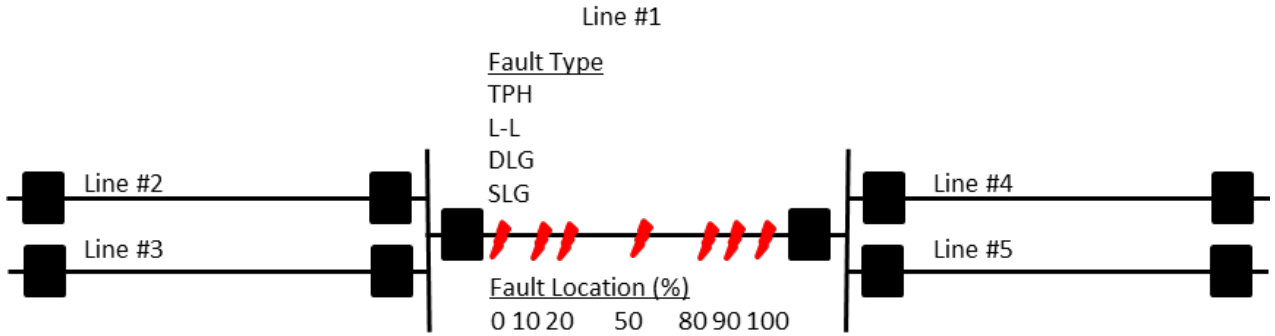
Performing Coordination Studies

Wide-Area Coordination Macros/Scripts

- Wide-area coordination study approach is designed for relay coordination across a large area within a transmission network
- Evaluates protection performance under numerous fault cases and contingencies
- Study generates sequence-of-events report showing primary and backup protection operation for faults on the network and highlighting any misoperation or coordination time interval issues
- Highly automated to relieve the protection engineer from the tedium of running the studies

Performing Coordination Studies

Wide-Area Coordination Macros/Scripts



CLASSIC

- TPH & LTL close-in fault at local bus for system normal (2)
- TPH close-in fault at local bus with strongest source out (1)
- Minimum LTL close-in fault at local bus (1)
- SLG remote bus fault at system normal (1)
- Minimum & maximum SLG remote bus fault at remote bus (2)
- LTL remote line-end fault for system normal (1)
- SLG line-end Fault (Strongest Source out) (1)
- No. of simulations per terminal = 9

AUTOMATED

- Four bolted faults SLG, LTL, DLG and TPH,
- Four resistive faults 1 & 5 ohms SLG & DLG
- Five fault locations
- Assume five local sources including mutual coupling
- Assume five remote sources
- Two protection packages, A and B
- No. of simulations per terminal =
- 8 x 5 x **11** x **2** = 880

1 System Normal

10 Source Outages

2 Packages

Performing Coordination Studies

Translate Fault Summary to Device Summary: Example

						Pilot In		Pilot Out				
Substation	Device	Element	Contact Logic Code	LZOP	Risk	System Normal	N-1 Contingency	System Normal	N-1 Contingency	Action	Action Tag	Reason/Recommendation
Ontraio TS	D60	594 TIMER "T2_GND" "1"	21G2T_A	Ontario_Line1_1000	1		CTI		CTI			
AlbertaTS	D60	11261 TIMER "T2_PHS" "1"	21P2T_B	Alberta_Line2_2000	4		CTI		CTI			
Alberta TS	LFZP111	6173 TIMER "TZ2" "1"	21PG2T_B	Alberta_Line2_2000	2	CTI	CTI	CTI	CTI			
QuebecTS	SEL-311	11260 AUX "Z2D"	21PG2T_A	Quebec_Line3_3000	5	MISOP	MISOP	MISOP	MISOP			
Quebec TS	SEL-311	6172 AUX "Z2D"	21PG2T_A	Quebec_Line3_3000	4		MISOP		MISOP			
4.17 % of faults not cleared at 1 seconds												

Element:	594 TIMER "T2_GND" "1"
Substation:	Ontario TS
LZOP:	Ontario_Line1_1000
Type:	D60
Tested Line:	Ontario_LineX
0% =	Bus1 (220kV)
100% =	Bus2 (220kV)

Ph-G Fault

Pilot	Package	Outages/Test	0.00%	15.00%	30.00%	50.00%	70.00%	85.00%	100.00%
Disabled	Package_A	Line : Bus 111 – 222 – 1							C0.020 (77)
	Package_B	Line : Bus 111 – 222 – 1							C0.017 (413)
	Both in service	Line : Bus 111 – 222 – 1							C0.020 (749)

Mitigation Plan

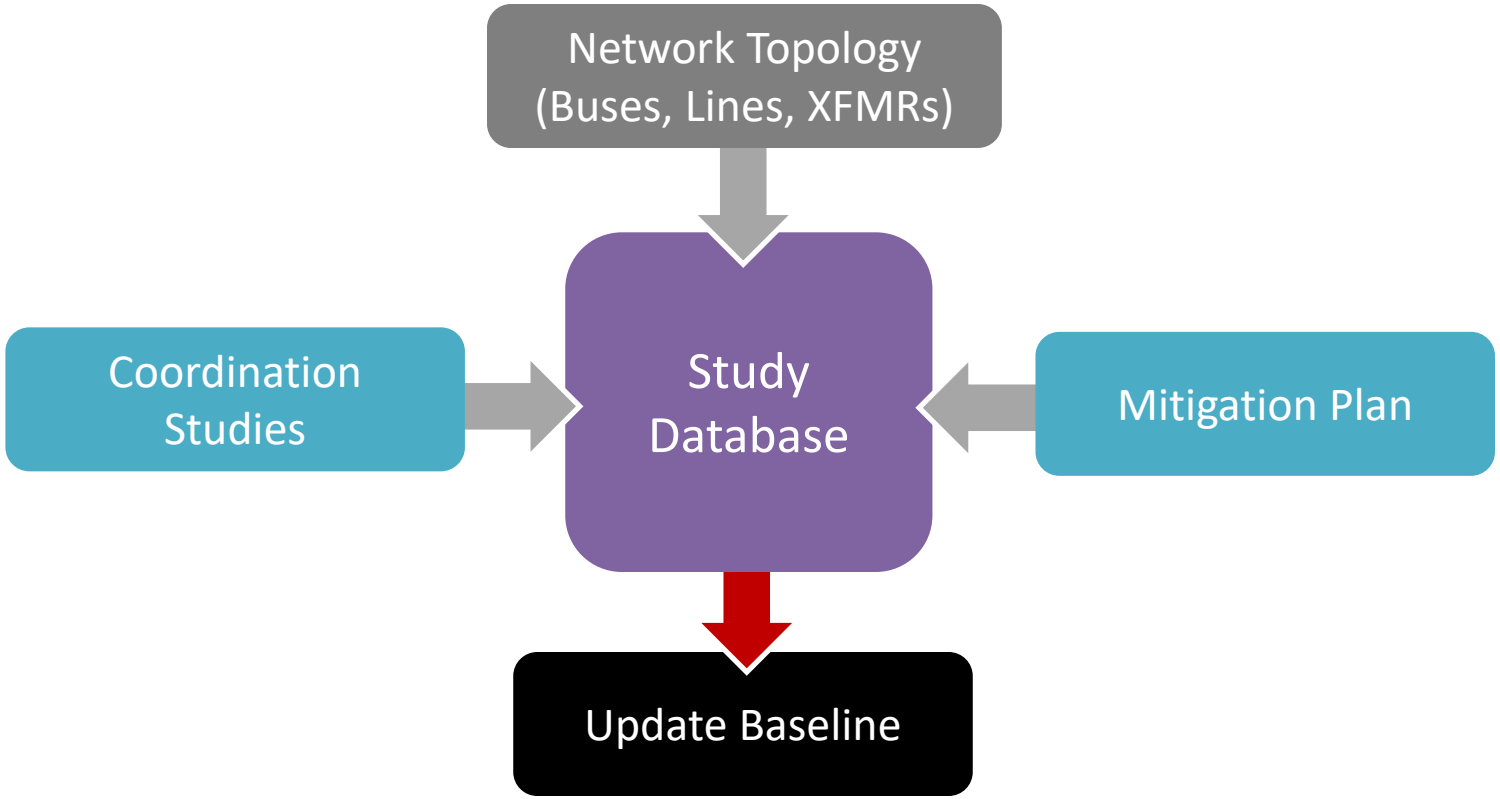
- Setting Change
- Protection Upgrade
- System Upgrade
- No Change Required

Reducing 1000s pages of results into a list of miscoordinating devices requiring investigation and mitigation plan

Performing Coordination Studies

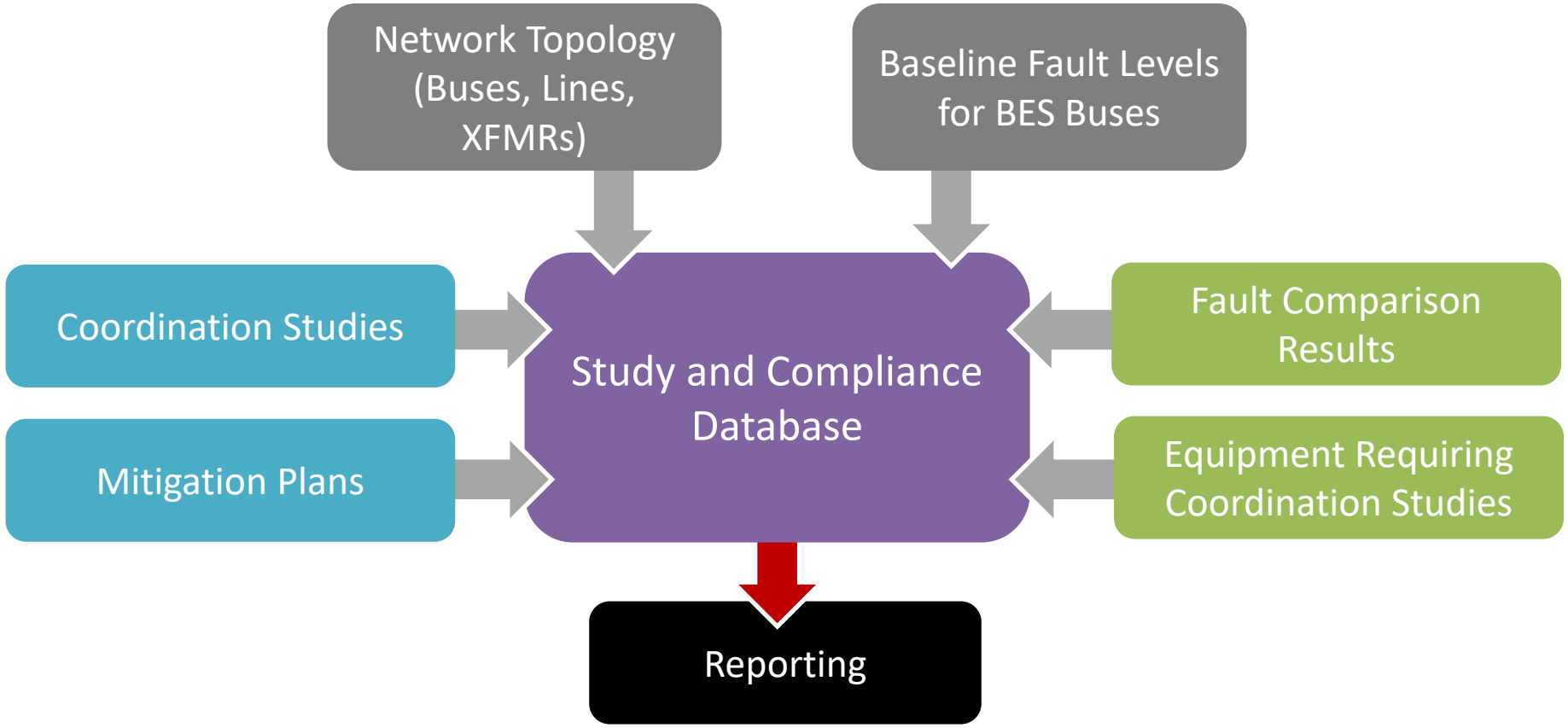
Document Mitigation Plan and Update Baseline

- A database can help manage the large number of coordination studies and the mitigation plans
- By having the network topology and coordination studies results, the baseline fault levels can be automatically updated

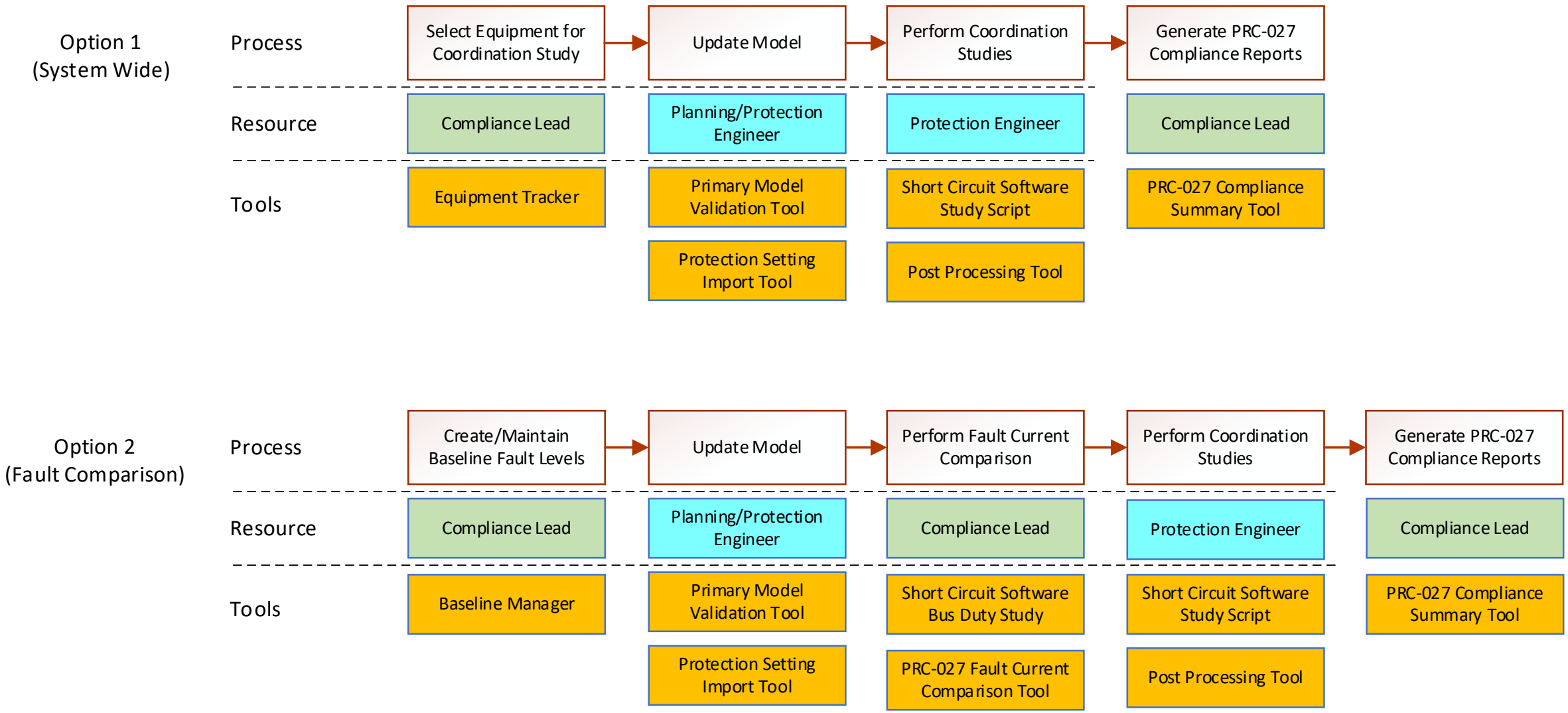


Final Audit Ready Compliance Summary Reports

- A database that can store all PRC-027-related fault comparison studies, network topology information, and coordination studies data will allow creation of audit-ready documentation showing proof of compliance.



Overall Process: Recap



Fault Comparison Approach vs. System-Wide Coordination Study

The suitability of an option for a utility depends upon the following factors:

- Expected fault level change in the network
- Effort required to perform coordination analysis
- Utilizing other benefits of system-wide coordination studies

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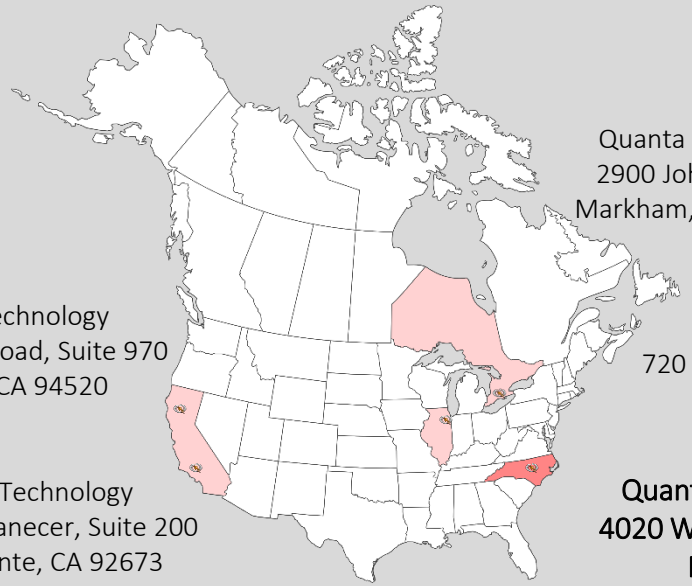
Thank you!

This has been a Quanta Technology Knowledge Sharing Webinar



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