PRE-FIX

Six Monthly Progress Report

April 2022 – September 2022

Electricity Distribution

nationalgrid

Version Control

Issue	Date
0.1	12/10/2022
0.2	13/10/2022
0.3	14/10/2022
0.4	04/11/2022

Publication Control

Name	Role
Paul Morris	Author
Ryan Huxtable	Reviewer
Yiango Mavrocostanti	Approver

Contact Details

Email

wpdinnovation@nationalgrid.co.uk

Postal

Innovation Team

Western Power Distribution

Pegasus Business Park

Herald Way

Castle Donington

Derbyshire DE74 2TU

Disclaimer

Neither NGED, nor any person acting on its behalf, makes any warranty, express or implied, with respect to the use of any information, method or process disclosed in this document or that such use may not infringe the rights of any third party or assumes any liabilities with respect to the use of, or for damage resulting in any way from the use of, any information, apparatus, method or process disclosed in the document.

Contents

Contents		2
Executive Summary		3
1.	Project Background	4
2.	Project Progress.	5
3.	Progress Against Budget	16
4.	Progress towards Success Criteria	16
5.	Learning Outcomes	17
6.	Intellectual property rights	19
7.	Risk Management	19
8.	Consistency with Project Registration Document (PEA)	21
9.	Accuracy assurance statement.	21
10.	Glossary	22

Executive Summary

Project Pre-Fix is funded through Ofgem's Network Innovation Allowance (NIA) funding mechanism and has a budget of £1.64M. It was registered in autumn 2021 and will be complete by March 2024.

We are conducting this project with the intention of being able to improve our customer's experience of power cuts. We think that the Pre-Fix project can achieve this by enabling faster restoration and potentially intercepting defects before they occur. Innovation funding is being spent as this project seeks to overcome the barriers to wide-spread High Voltage (HV) pre-fault capability represented by developing alternatives to a vendor tie model in that is associated with proprietary software. Overcoming vendor tie in will mean that National Grid Electricity Distribution (NGED) can interoperate pre-fault sensitive devices. This interoperability will translate into a lower unit cost to deliver this capability.

This project will utilise HV pre-fault capture capable devices from different manufacturers to demonstrate how they can all contribute into a common data platform. This project will also demonstrate how existing network devices, such as power quality monitors and protection relays might also help contribute to HV pre-fault detection in addition to their typical function. The project will also show how consistent operational dashboards and reports can be developed from this platform to enable a consistent policy driven approach to be implemented across an organisation. Key activities that will be carried out during the project include:

- Use of trial data from other DNO's to inform platform design and support testing
- Architecture specification for the Common Distribution Information Platform (C-DIP)
- Interoperability specification and setting of pre-fault gathering devices
- Design of common operational user interfaces
- Live trial of devices, platform and reports

This project is a partnership between NGED and Nortech Management Ltd.

This report details progress of the project, focusing on the last six months from March 2022 to September 2022.

For further information please contact:

Paul Morris
Innovation Engineer

nged.innovation@nationalgrid.co.uk

1. Project Background

We are conducting this project to build a capability that will enable us to react more efficiently to faults that have occurred or defects that are about to occur. To enable this, we will need to be able to share information with operational staff about these defects; but to obtain this information, we will need to be able to gather and process information from devices on the network. Building a DNO platform rather than relying on vendor platforms means that we will be able to ensure that different devices can all inter-operate and drive consistent operational policy.

Over an 18-month project duration, Pre-Fix is planned to deliver a pre-fault and disturbance information platform. The extent of the platform is depicted in Figure 1.

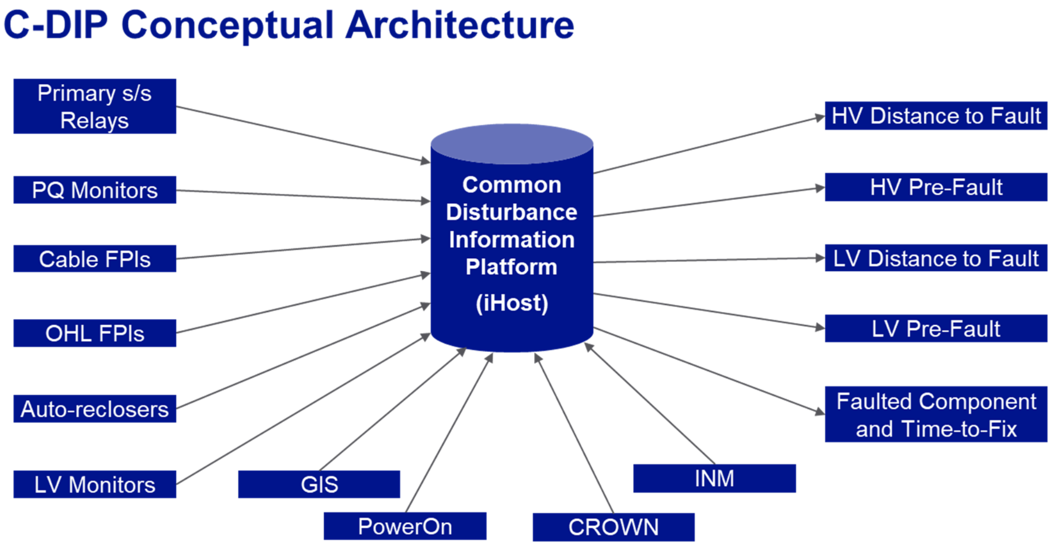

Figure 1: Overview of Common Disturbance information Platform

The overall aim of the project is to develop a common disturbance information platform (C-DIP) that can gather disturbance information from various network devices (PQ monitors etc.). By running automated analysis on the data gathered from network devices and aligning it with network information operationally, useful information would be shared with field staff and fault restoration managers.

This project seeks to establish whether devices already in NGEDs supply chain can deliver HV pre-fault data. Demonstration of this feature would help keep the unit cost of introducing a pre-fault capability lower than using bespoke pre-fault devices and potentially help increase the accuracy.

2. Project Progress.

The project is structured into to five Work Packages as summarised in Table 1. The trial specifications for Work Package 1 are competed and will be revisited at the end of the trial. The following sections provide updates on the other work packages.

Table 1: Work Package Summary

	Column heading
WP1 Specification:	This Work Package records the requirements that must be delivered from all of the systems to be developed within this project
WP2 Design/Development	This Work Package conducts the deeper design requirement to deliver WP1, including design documentation and operational protocols, which will explain: (i) Deployment and application guidelines; (ii) Design and setting Documentation (for permanent fit devices); and (iii) Communication philosophy and requirements.
WP3 Build and Install	This Work Package constructs the systems required to deliver the functionality, installs the trial infrastructure and tests ahead of trial.
WP4 Testing	This Work Package tests the components and system ahead of trials
WP5 Trial	This Work Package conducts a system trial prove the system requirements in an operational context.

Work Package 2 Design and development.

During this period, the following work has been undertaken

Distance to fault development

The methodology, which implements the requirements of the distance to fault (DTF) functional specification, has been developed. This entailed reviewing review state of the art learning to recommend approaches, which can be used in the distance to fault module. The development of this module is discussed further under sub heading "Work Package 3 Build"

We have developed and reviewed a distance to fault methodology document. This has then been implemented in WP3. This methodology is based upon analysis of the reactive loop and can be applied to phase faults and earth faults. This methodology was selected to minimise the uncertainty associated with the fault resistance, arcing resistance and fault return path.

Nortech have also recently presented on an additional methodology, which seeks to de-risk the DTF method dependency on voltage waveforms. We will be reviewing the risks and benefits of this method.

Data Dictionary

The first instance of the data dictionary has been released. This document is expected to grow as subsequent integration of third party devices is explored.

Device Settings

Since placing equipment onto the system, we have been able to review the performance of different waveform capture triggers and settings. This learning is to be captured into trial settings approach document, which will evolve during the trial.

We have developed an overall setting philosophy for pre-fault detection. Some of the key influences are explained beneath.

Baseline sensitivity in underground networks

Since commencing the roll out of the earliest installations, we have observed some of the types of transient that occur on underground cable systems. We have used this learning to form a baseline opinion on what type of transient we need to be able to instigate triggers to capture.

Our overall philosophy was to develop a suite of settings that could capture the archetype wet joint peck with an amplitude of 40 Amps above baseline (as depicted in Figure 2). This baseline is being used to ensure that pre-fix category one and two [1]devices all capture voltage and current waveforms (as applicable) for the same system event.

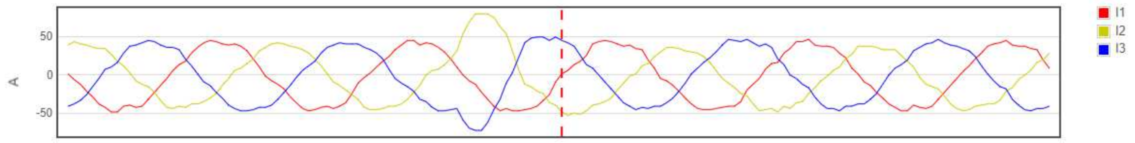

Figure 2: Baseline sensitivity for Peck Detection

We undertook works to select a trigger and setting threshold to ensure that the PQUBE would capture the voltage and current waveforms at the same time as the downstream current peck trigger. This was done using a trigger referred to by the PQUBE manufacturer (Powerside) as the "current inrush trigger". We initially set this trigger to activate at 20 Amps, but observed that this setting did not always provide the desired sensitivity. Because of this, we sometimes missed capturing voltage records for pecks that occurred downstream.

To investigate the impact of reducing this sensitivity, we reduced the setting to 5-amp inrush, but this setting led to PQUBE buffers filling up leading to a loss of monitoring. From this exercise, we concluded that overcurrent based triggers can be used to capture large pecks or fault disturbances, but were unlikely to consistently meet the baseline sensitivity requirement As a contingency solution, we are presently using the trigger referred to as the "Inrush Trigger" set to a 20 Amp magnitude.

Powerside have recommended to a methodology to us that would allow a more discriminating trigger. This would be based on observed distortion to the waveform rather than current magnitude. This would require some changes to the PQUBE firmware, and would be made available to the project as a BETA release rather than the Business as Usual PQUBE. This beta release is expected to be available to the trial in 2022.

Baseline sensitivity in overhead line networks

[1] To enable wider integration into the supply chain, the Pre-Fix approach has a hierarchy of device duty. Category 1 devices gather voltage and current disturbance records, Category 2 devices gather current disturbance records only, Category 3 devices gather and present fault information that are not disturbance records.

Data and analysis of network observations are ongoing to determine whether there are reliable indicators for overhead line pre-fault instances. This will be used to determinate the minimum trigger sensitivity in overhead line networks.

Work Package 3 Build and Install & Work Package 4 Testing

Progress in these WPs are summarised in the following sub-headings. The reporting from WP3 and WP4 has been merged to allow combined commentary on the development work and quality testing to fall in the same section.

IHOST Enabling works

To enable the project to deliver its required functionality, new functionality was added to the IHOST system. These new capabilities are as follows:

- Comtrade File Viewer and Improvements

  This enables Comtrade files from three physical devices that are spread across the individual phases of a circuit to be combined into one view rather than three separate records. An example of the physical application of this would be to link the output from smart devices placed on the phases of overhead lines. A new capability has also been developed which enables IHOST to output Comtrade information into .CSV format.

  To overcome the limitations of the original Comtrade file used in IHOST, there is now a .CFF file option that avoids the issues we were having associated with Comtrade 2 part file structures.

  Bulk Data Handling

  To enable the bulk data handling of disturbance files that will be required for Pre-Fix, there is now a capability for the IHOST platform to complete build transfer of IHOST files between IHOST instances. To enable data ingestion, there is now a capability to ingest network models from SINCAL and Scalable Vector Graphics (SVG) files or Passive Network Graphic Files (PNG).

  These features are essential to enable the project team to automate the data and analysis phase of the project.

- Automated Trial Reports

  To enable ongoing review of the platform performance, a capability to email periodic reports, outside of the C-DIP has been developed. These reports give a summary of:

  - Which devices have been triggering upon waveforms. This will enable the trial team to understand which devices are capturing the most events and then investigate.
  - Which devices are working acceptably and which need attention to resume acceptable trial performance.

  These reports are not the planned user interface, but are necessary to enable the trial team to verify ongoing performance of the platform and inform planning of subsequent data and analysis to enhance the platform.

IHOST Single Line Diagram Annotator

A new IHOST capability has been developed to present a geographical view of the circuit and then overlay the location of pre-fault sensitivity devices onto it. Figure 3 shows an example of this functionality with one feeder from Okehampton being highlighted and one Fault Passage Indicator (Smart Navigator 2) being placed on this feeder and linked to the IHOST database, This geographic view also uses the output of the DTF module to:

1. Plot the predicted fault location in the event of a trip/reclose with a colour coded search zone

2. Plot the locations of pre-fault pecks on the network.

In both cases, these will be conditioned by which devices observed the path of the fault or peck current.

We have developed the opportunity to import these geographic views from EMU using .SVG's.

"Nominal Path" testing based on real world events is presently underway for this functionality progressing into integration testing.

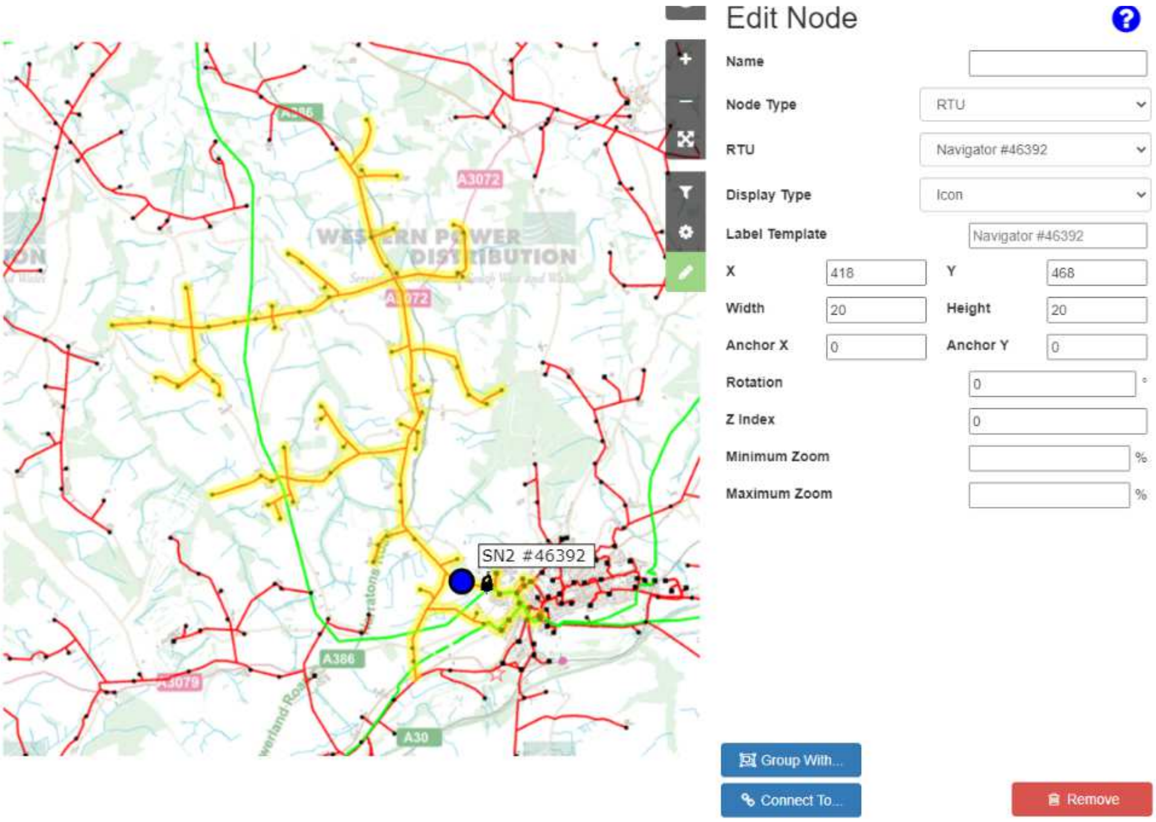

Figure 3: Example of IHOST Single Line Annotator function.

When the Distance to Fault module is integrated into this system, we will be able to plot pecks as per Figure 4. The yellow dots signify a disturbance that was not cleared by protection. The orange dot indicates a defect cleared by protection.

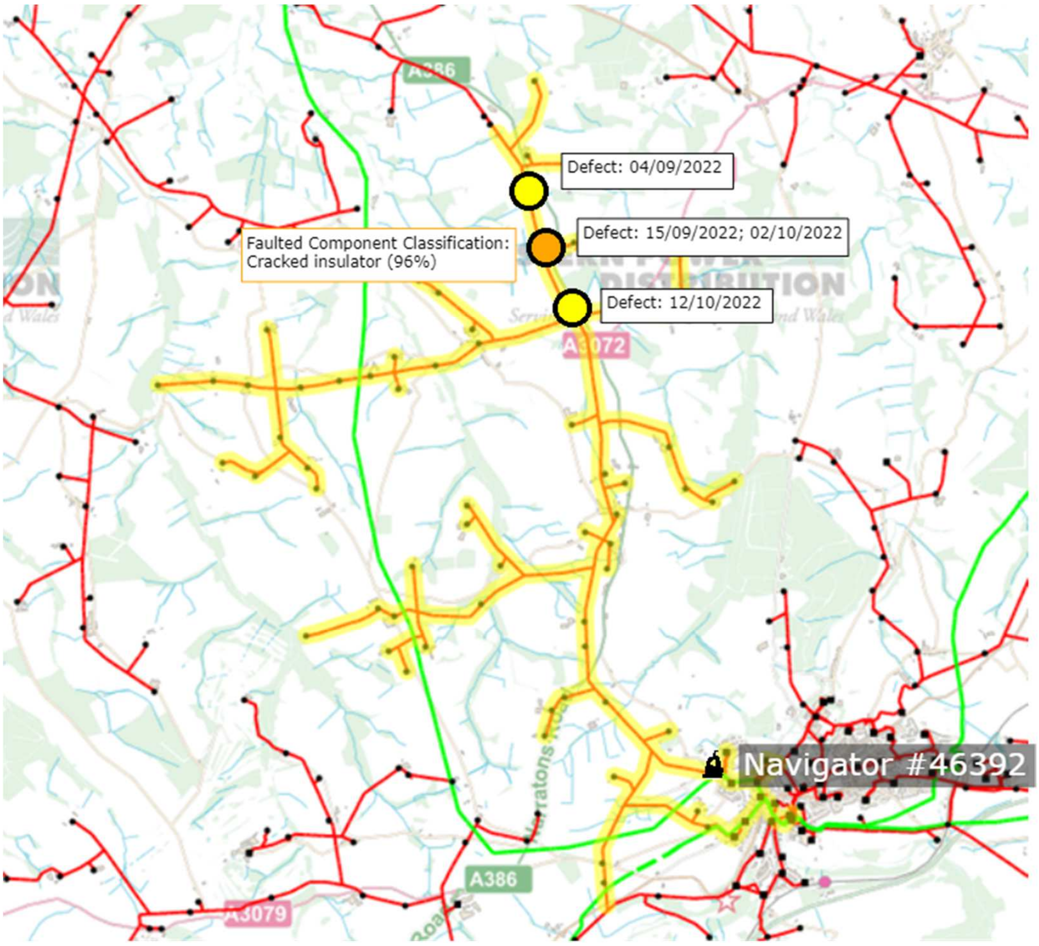

Figure 4: Example of fault and pre-fault plotting on the SLD annotator.

Distance to Fault Module

In WP1, a specification for the functionality of the Distance to fault model was established. This module should be able to range the distance to fault or defect based on data from a category 1 Pre-Fix device.

As also described in the previous performance report, we conducted works to establish our starting methodology for calculation of the impedance and then distance to fault.

These requirements are now available in a software module for subsequent system integration into the overall C-DIP. We have reviewed the prototype test book, but subsequent test books are expected when we integrate the module into the overall system.

Waveform classification module

The C-DIP has a functionality that is intended to be able to recognise distinct waveforms. These requirements were codified within the performance and functionality specification.

This feature could be used to recognise waveforms against an archetype defect signature, or to trace the progress of a distinct signature through adjacent devices. The performance expectation for waveform classification was recorded in the project specification for waveform classicisation. Within the specification, it was expected that the testing regime would follow these basic procedures:

- Providing a known fault waveform to see if the system correctly identifies it.
- Providing a waveform with multiple faults to see if the system correctly identifies multiple faults.
- Providing a waveform with an unknown fault to see if the system classifies it as a different fault type.
- Providing a waveform with no fault to see if the system correctly classifies it as displaying no fault waveform features.

This testing used external defect signatures with superimposed noise to verify whether the characterisation module was performing against specification. These tests were also expected to be passed with a signal to noise ratio of 20dB or higher and provide a confidence level of 75% or greater.

This functionality is now contained within a module of the overall platform. We have reviewed test books for this stage of testing and consider that the module testing has been completed with acceptable confidence levels.

Subsequent testing will be required at the system integration stage to verify the systems response to classifying and grouping adjacent triggers and the response to trigger events that span serval capture files.

C-DIP Fixed Data

We now have the ability to ingest the customer number data via a spreadsheet. This is pure customer number data only and does not contain any customer details.

We have also developed the capability to ingest SINCAL models and SVG maps for use.

C-DIP user dashboards

In the last performance report, we presented some of the initial designs for the user dashboards. We have begun to code and tailor the dashboards to each of the primaries within the pre-fix trial. We have provided feedback on the proposed test book for this function.

At our request, Nortech will limit the first development effort to become a binary “there is/is not” pre-fault activity. During WP5, we will conduct data and analysis to determine what indicator flags herald a pending pre-fault, at which point the criticality function of the dashboard can be instigated.

NX44 Clip on Modification

In the last six monthly report, we discussed the need to have a clip on variant of the NX44 smart FPI to allow faster and less intrusive installation. Since then, we have modified 112 NX44’s to accept a clip on current transducer rather than being hardwired into the CT secondary circuits of switchgear. This required physical modification to the circuit boards of these devices.

To allow use of these devices we have published new internal techniques explaining how to install these modified devices and power them form the 110V DC switchgear supplies, or in the case of secondary substations, power them from 230V AC auxiliary supplies.

This has enabled primary switchgear installation at a rate that would not have been feasible with the standard units. A picture of this new type of installation is shown in Figure 5

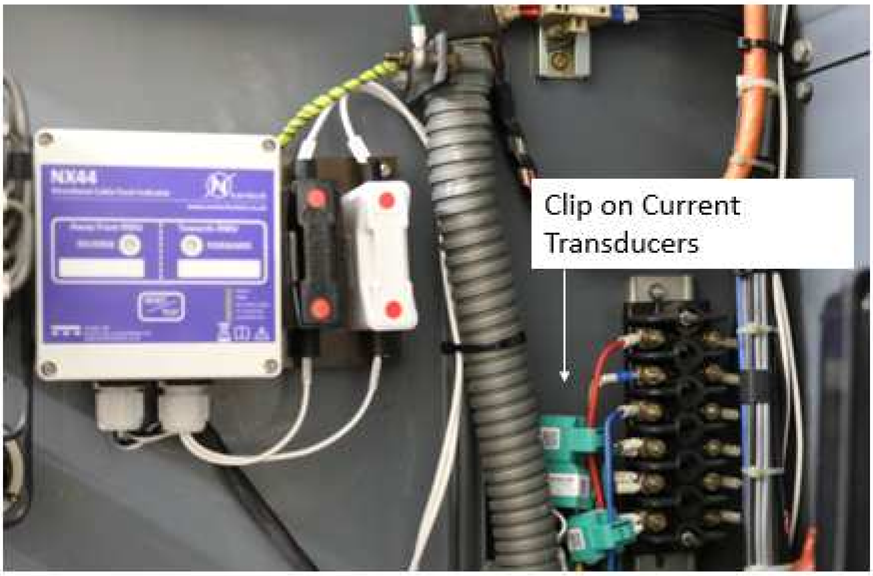

Figure 5: Clip on variant of NX44 unit installed within a primary circuit breaker.

Shielding

From the installations to date, we have observed that during a fault clearance on adjacent feeders, clip on devices installed in adjacent feeder panels will capture triggers caused by induced noise, rather than an actual fault path. To minimise this, we have developed a shielded lead for installing the NX44 units with. The beneficial effect of this shielding will be reviewed throughout the project.

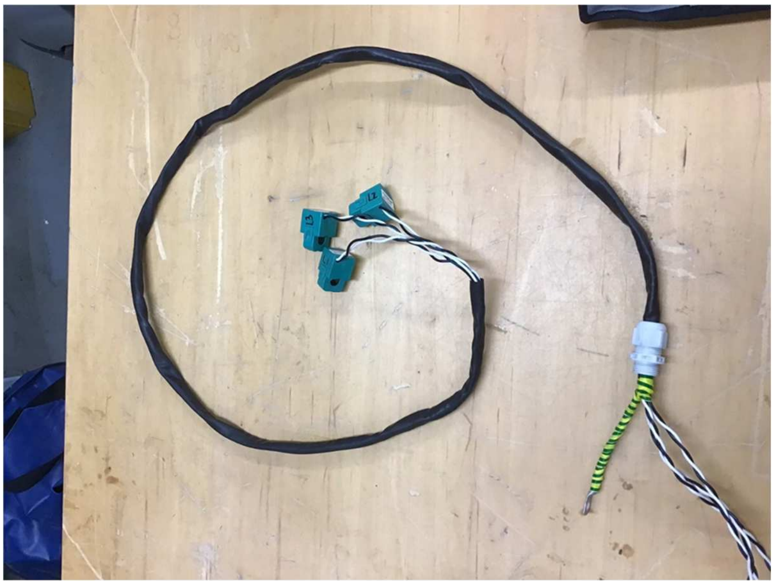

Figure 6: Shielded lead for Clip on current transducers.

Device Installation

Since the last report, we have delivered the following device installation activities as summarised in Table 2.

The NX44 installation has been delivered by a team of our fitters led by a contract Senior Authorised Person. Progress is behind expectations for two reasons. Firstly, we believe that a better device performance is available when the transducer input is matched to the Current Transformer (CT) secondary size. We have 52 sites which use 1 AMP secondary CT's, but the transducer supplier current has a delay in the supply chain. These transducers can be fitted without further outage.

For the remaining primary site, we have agreed to delay the installation until after January; this is because the fitting team were required to complete scheduled maintenance before the clock change.

Table 2 Device installation to date.

	Total Installed	Remaining
PQUBE	15	5
SN2	60	16
Clip-on NX44	33 units are fully commissioned 52 units have been installed pending transducer delivery	27
Hard Wired NX44	2	62

Work package 5 Trial

We are now gathering real world results from the data. The following two sections record our observations from two case studies.

In addition to the case studies, we have also been reviewing data to determine what good indicators of a pending pre-fault are. At this stage, due to the limited circuits that have ran to fail, we have limited evidence on what are reliable indicators of pending pre-faults, although we have determined that pecking behaviour in underground networks is strongly correlated with rainfall.

Okehampton Feeder 23 fault

At 13:33 on the 20th of June there was a power cut on feeder 23 at Okehamton primary. This feeder is almost exclusively overhead line and is depicted in Figure 7. At this stage, the SN2s FPIs as depicted in Figure 7 were active, but the PQUBE had not been installed at Okehampton primary, meaning no impedance to fault could be calculated, but the location could be inferred by the passage of the fault current through the FPIs.

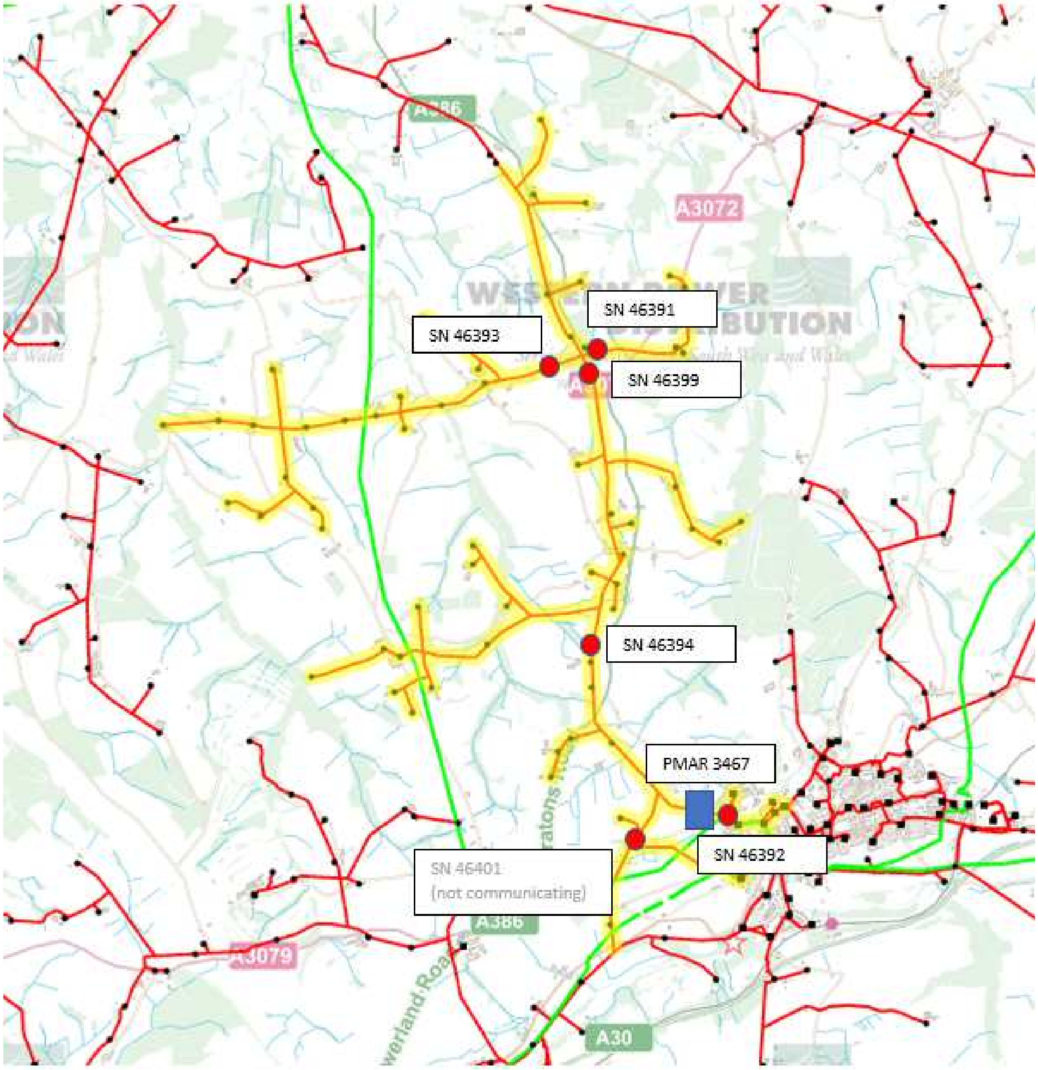

Figure 7: Okehampton feeder 23.

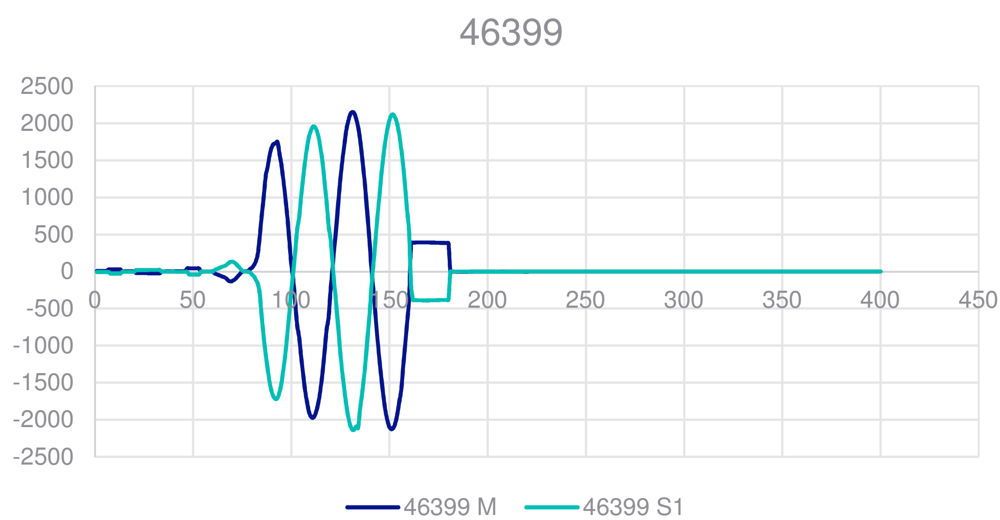

Figure 8: Observed fault current associated with SN2 46399 on the 20/06/22

From analysis fault current measurements taken by the SN2s, we observed that the fault was a phase-to-phase fault lasting two cycles, with a fault current magnitude of 2kA.

Replaying the measurements taken from all of the SN2s on this feeder thought the prototype DTF module; we were able to confirm that the module made the correct deduction about the fault location. Figure 9 demonstrates the recommended search zone from the prototype DTF module vs the actual location[2]. This case study shows how even without a DTF calculation, the area for line patrol can be significantly shrunk. Use of a separate DTF calculation would increase the confidence in the solution.

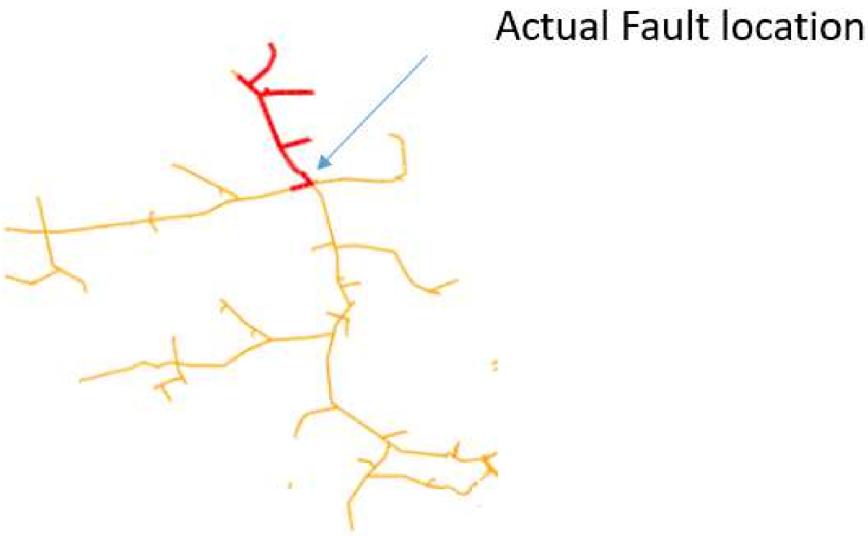

Figure 9: Recommended fault location vs actual location (using prototype system)

Courthouse Green Feeder 7 fault

We have also validated the distance to fault method on an underground fault. This tool place on the 4th of June and relates to an underground cable fault that resulted in a protection clearance of the fault.

We captured the voltage and current disturbance record for the fault event and manually passed it through the DTF module using two separate methodologies to estimate the distance (as depicted in Figure 10).

In this event, we concluded that both methods correctly identified the correct cable section. The worst location was within 189M of the actual fault location. The best estimate was within 20M of the actual fault location, this was using the reactive loop methodology. This exercise indicates that the methodology that has been selected may be appropriate for use in underground cable networks, but further work is required to demonstrate the performance over more faults.

[2] The actual fault location was pole 35MBE1 and was caused by shattered insulators. There were not pre-fault indications of this fault.

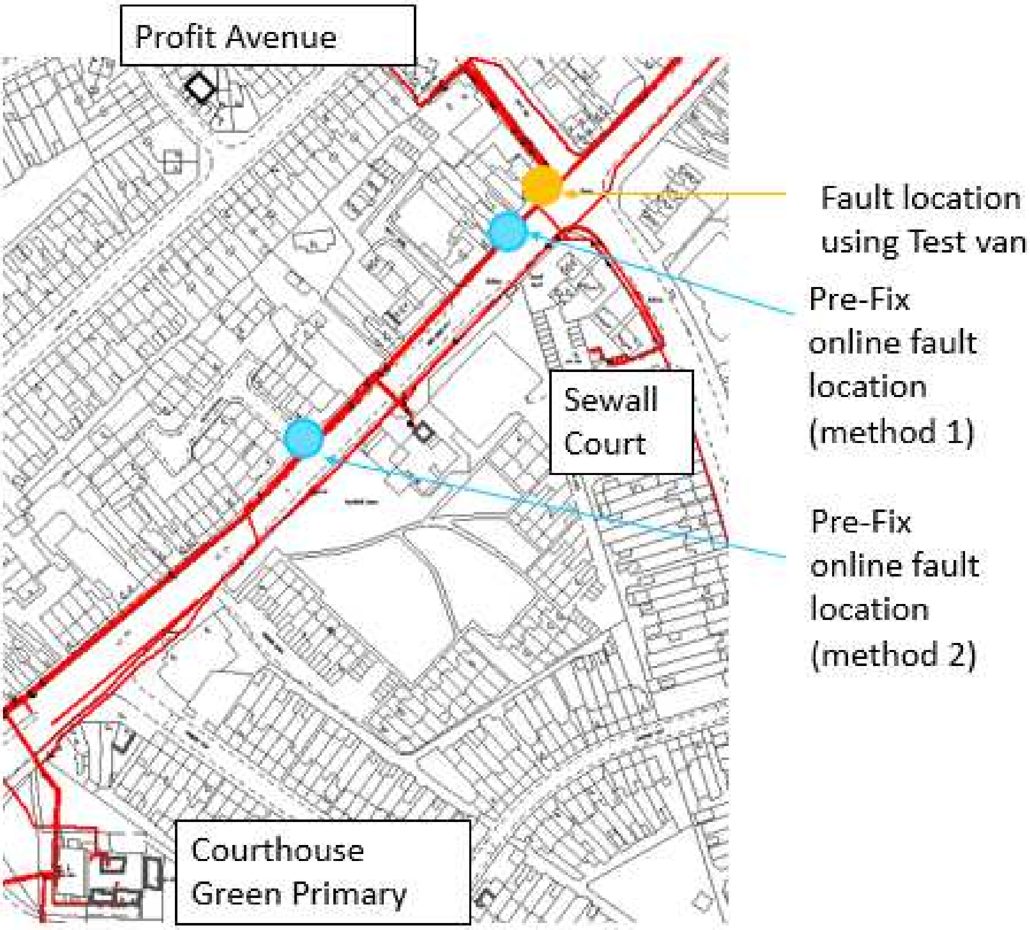

Figure 10: Recommended fault location vs actual location

3. Progress Against Budget

Table 3 summarises the project budget performance to date. This table is reflective of the recent change request which has re-baselined the project to extend it and update budgets based on installation experience to date. To date, no contingency has been spent.

Table 3: Progress against Budget

Spend Area	Budget(£k)	Expected Spend to Date (£k)	Actual Spend to Date (£k)	Variance to expected (£k)	Variance to expected %
Project Management and Technical Development	£240,916	£129,661	£129,661	£0	
Network Services	£151,815	£54,981	£54,981	£0	
Contractor Costs	£1,127,750	£799,365	£757,405	£41,960	5.2%
Supply Chain Devices	£68,133	£15,133	£15,133	£0	
Total	£1,643,604	£999,140	£957,180	£41,960	4.2%

4. Progress towards Success Criteria

Table 4 list summarises the present progress towards success criteria.

Table 4: Progress towards success criteria

Success Criteria	Progress
Demonstration of how to gather and then utilise data from existing WPD specification equipment in the pre-fault data chain, devices to include protection relays and power quality monitors.	We have shown how to gather information from smart FPI's and Power quality devices. Demonstrations with separate devices are to follow.
Demonstration of how to gather than then utilise data from temporary pre-fault monitors.	We have shown how to gather data from clip on NX44 units and temporary smart FPI's.
Demonstration of how pre-fault information from diverse devices can be gathered into a central location.	Underway. We have shown that this can be done with Nortech and Powerside devices. The specification for 3rd party capture device has been reviewed. Preparation is underway for

	bench testing of devices to verify third party contribution onto the platform.
An application guide for how, where and when to deploy different pre-fault equipment.	Not Yet Started This task is dependent on real world learning. This will be done by reviewing the operational learning developed by this project and other NIA projects.
A user interface to present pre-fault data in a manner that is useful and meaningful to operational users.	Underway, with some examples in this report
An prototype operational protocol for how to leverage technical application into operational outcomes	Not yet started, This will be done by reviewing the operational learning developed by this project and other NIA projects.

5. Learning Outcomes

We have captured a number learning points since the last performance report. Table 7 summarises some of them.

Table 5: Summary of learning points.

Package	Learning Points
Device triggers	Using overcurrent-based triggers for category 1 devices is likely to lead to missed peck records. Use of current distortion based triggers is a more reliable approach.
PQUBE settings	When using inrush overcurrent based disturbance triggers, To avoid the PQUBE event buffers filling up, consideration needed to be made to ensure that they do not trigger on load. This value is expected to be substation specific and in the region of 15 Amps or above.
Underground cable pecking Observations	Underground HV cable networks often have a distinctive signature, which is phase, to phase-phase where the magnitude jumps from the baseline to +40 to 150 Amps and self-extinguishes within a cycle. (See Figure 11). These Pecks align with international findings in IEE PES TR 73 for an incipient fault in a wet cable joint. We have observed that these events have low residual current and appear to reside mostly in the positive and negative phase sequence.

	Often, especially when there has been wet weather, a sequence these wet joint pecks will initiate into a multi-cycle event as shown in Figure 12. To date, on the monitored circuits, we have observed more of these events self-extinguish than escalate into a fault clearance.
Device Installation	The use of Clip on CT's allows 2-3 NX44's to be fitted per day in a primary substation. Outages are still required to develop an 110V DC supply. A future option would be 24V DC supplies or 230V AC supplies if they were available in the switchgear.
Commissioning	A commissioning app removes the burden of record keeping when new pre-fault devices are added to the system
Current Transducers	Best practice is to match current transducers with the size of the CT secondary.
Noise triggers.	Hardwired and clip on NX44's will experience noise which can cause trigger files to be generated. In some cases, this has led to flash drives filling up before they could be purged. There is a requirement to set NX44's to reject noise-based triggers.
Distortion triggering along a radial feeder	Devices using current distortion waveform triggers will become more sensitive as they fitted along the feeder towards the open points. This is because the proportion of a "peck" any noise will become larger in comparison to the baseline load. Noise initiated triggers may increase overnight when the load is lower also.
Overhead line pre-fault indicators	There have been some anomalies during summer 2022 that saw a multi factor increase in current for a number of cycles and reduce again without any form of protection operation. There is not yet sufficient evidence to say what these events were but they continue to be monitored

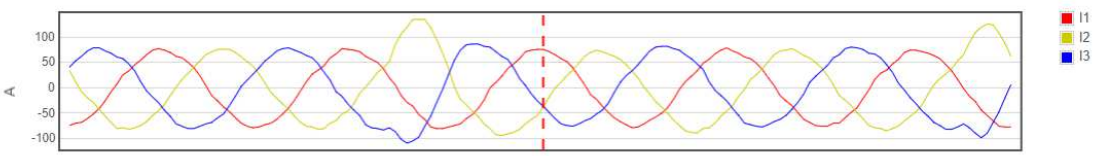

Figure 11: Wet joint Peck.

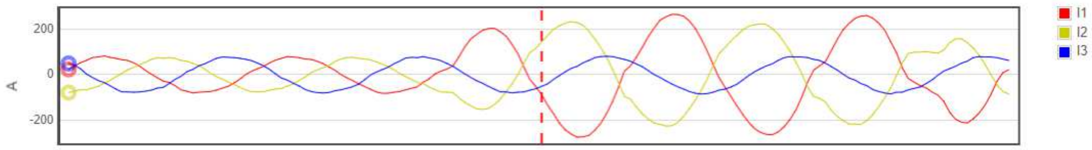

Figure 12: Multi Cycle peck

6. Intellectual property rights

A complete list of all background IPR from all project partners has been compiled. The IPR register is reviewed on a quarterly basis.

No relevant foreground IPR has been recorded within this reporting period. The majority of this learning is expected during the next six monthly period when the functionality within the C-DIP platform is developed.

7. Risk Management

Current Risks

The Project Pre-Fix risk register is a live document and is updated regularly. There are currently 18 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In Table 9, we give details of our top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Table 6: Top six current risks by rating

Details of the Risk	Rating	Mitigation Action plan	Progress
The current firmware of the PQUBE is not as sensitive as the NX44's and PQUBEs. This means that the PQUBE is blind to some PECKs	Major	Apply to Powerside for PQUBEs to incorporate the same current distortion trigger as the NX44 Alternatively, use an NX44 to trigger the PQUBE (Because it has a better trigger)	Powerside have offered a beta firmware version with a new distortion based trigger.
The earth return path and arc impedance undermines the accuracy of the planned DTF method	Major	Calibrate the model on known faults. Review performance of reactive loop methodology. Explore alternative approaches.	Testing of the reactive loop method is providing promising results

Failure of units in the field	Major	Weekly monitoring report to make sure devices are active and capturing Comtrade files	Weekly monitoring continues
To link pre-fault observations to outcomes, we will need to witness circuits run to failure within project timescales	Major	Monitoring of device health to ensure device capture availability. Consider pro-active investigations towards the end of the trial if runs to failure have not been observed.	Weekly monitoring continues
High reliance on key Nortech Key individuals.	Minor	Raised with Nortech.	Nortech are expanding their delivery team to increase resilience

Update for risks previously identified

Table 7: update on previous risks last reported.

Details of the Risk	Rating	Mitigation Action plan	Progress
Obtaining access to Current Transformers to ensure sufficient coverage and visibility of cable feeders	Severe	1. Investigate RN2C and VRN2 CT availability around selected areas. 2. To enable NX44 use at sites with 11kV automation, develop a modification that allows NX44 units to use Clip-On power quality current transducers. 3. To enable NX44 use within primary switchgear, pursue a modification that enables NX44 units to be powered by 110V DC.	The use of Clip on CT's has maximised the sites available to the trail.
Lack of activity during trial period, leading to insufficient demonstration of the platform and reduced	Major	1. Installation of data capture devices ahead of platform readiness to maximise opportunity	Pecking data is observable and locatable. This risk has now been re-scoped to consider run to failure.

learning regarding pre-fault behaviour		2. Use of data from other DNO projects to be used to help validate the platform	
Reduced Staff Availability to install units	Major	Investigate contractors	Resolved through the use of contractors
Failure to agree NIA terms with relay suppliers means that there would be a reduced validity of 3rd party demonstration of the C-Dip	Major	1. Progress negotiations with selected suppliers 2. Select additional suppliers as back up	Resolved through engagement with different manufacturers.
Additional PQubes may be required at sites than provisioned for at sites with complex incoming arrangements	Major	1. Utilise contingency funding where required	Spare PQUBEs are available at present.

8. Consistency with Project Registration Document (PEA)

To ensure that we obtain the best return on research investment possible, project Prefix has been extended to run until the end of 2023/24. The updated PEA which reflects this change can be found here (add link when ready)

9. Accuracy assurance statement.

This report has been prepared by the Pre-Fix Project Manager (Paul Morris), reviewed and approved by the Innovation Manager (Yiango Mavrocostanti).

All efforts have been made to ensure that the information contained within this report is accurate. NGED confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.

10. Glossary

Abbreviation	Term
C-DIP	Common Disturbance Information Platform
CT	Current Transformer
DMS	Distribution Management System
DNO	Distribution Network Operator
FPI	Fault passage indicator. Device for tracking abnormal current transients throughout the network
HV	High Voltage. Taken to be 11kV or 6.6kV within this report.
INM	Integrated Network Model
LV	Low Voltage. Taken to be 415V within this report.
NX44	A smart fault passage indicator that is mounted upon a ring main unit
RMU	Ring Main unit
SN2	Smart Navigator 2 – a self-powered overhead line monitoring device