Energy Networks Innovation Process

Project Closedown Report Document

Date of Submission: 10/07/2024

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Project Title (*This cannot be changed once registered*)	Project Reference
Synaps 2 – Fault Detection, Classification & Location Solution	NIA_SSEN_0051
Funding Licensee(s)	**Project Start Date**
Scottish Hydro Electric Power Distribution Southern Electric Power Distribution Eastern Power Networks London Power Networks South Eastern Power Networks	December 2020
Project Duration	**Year**
3 years 4 months	2024
Nominated Project Contact(s)	
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1. Scope

The Project will be organised into two trial stages:

- Basic Fault Location (3-4 months duration) will be trialled on two sets (four units) of the existing generation of prototype sensors to collect more data to improve the algorithm model for the advanced fault location stage

- Advanced Fault Location (8-9 months duration) will be trialled on ten sets of next generation sensors to continue collecting the data while improving the algorithms on different cable architectures and fault scenarios. There will be a project review after 6 months.

2. Objective(s)

Basic Fault Location

This continued from the previous SYNAPS 1project — the installation of the Metrology and Communications Unit (MCUs') on LV feeders with known faults to determine their location. This work focussed on optimising the network calibration procedure and tuning the location technology to improve accuracy of the fault information and minimise the time required to generate it. Once a fault was identified the equipment was moved between feeder locations at regular intervals after liaison with UK Power Networks (UKPN). This allowed continued collection of fault data in multiple cable type environments. Fault location information was communicated to asset teams for investigation and validation.

DNO Operational IT System Connection Specification

Development of a specification for an interface between the Synaps cloud server and DNO operational IT systems to enable DNO operational staff to be informed in real time when LV faults are detected on specific feeders and to provide fault location information when this is available. The target system will be determined through mutual discussion between the NIA partners and could include iHost or similar platform.

Advanced Fault Location

Based on ten sets of the next generation Synaps MCUs. These are divided between SSEN and UKPN and the installation of the sensors is on LV feeders with known faults and fault history or both.

In addition to increasing the number of data collection sites, this work package also tested and validated the technology in support of the following use cases:

- Low voltage networks that run in parallel known in the industry as fully meshed networks.
- Long Term Fault Evolution - Investigation of the network disturbances noted in SYNAPS1 project to:
    - Determine which are early faults.
    - Follow their evolution into permanent faults.
    - Seek to determine at what stage they can be located.
    - Ascertain the scope for predicting the time before they become critical.
- Investigate if faults can be identified as either cable or joint faults.

Prototype DNO Operational IT System Connection

Based on the "DNO Operational IT System Connection specification" developed above, implementation and testing of a working interface between the SYNAPS system and the DNO Operational IT system.

Business as Usual Demonstration

A successful demonstration of the final TRL8 commercial prototype was carried out on the SSEN distribution network to demonstrate the solution in a network environment and to evaluate the data connectivity. Twenty multi-port COPPsystems have been delivered to SSEN and are being deployed on the SSEN distribution network in both SEPD and SHEPD.

3. Success Criteria

The Synaps 2 NIA project achieved the following Success Criteria:

- Demonstration that the Synaps system locates faults on an LV network with a precision similar to or better than existing technologies.
- Improvement in the accuracy of the fault position estimate with specific emphasis on calibration procedures.
- Improvement in the speed with which the location can be determined.
- Validation of the technology on a wider range of feeders and cable types, including fully meshed networks (UKPN).
- Identification that a fault is either a cable (main cable or spur) or a joint fault.
- Specified and demonstrated a basic interface between the Synaps system and DNO IT systems.
- Investigated long term fault evolution on faulty cables (asset management and overlay strategy).
- Improvement in deployment procedures and exposed more operational staff to the technology.
- Demonstrated installation on an operational meshed LV network (UKPN).
- Implemented a pilot trial, with limited documentation, in an operational environment taking the Synaps solution from TRL6 to TRL7.
- Demonstrated data connectivity of the final TRL8 commercial prototype, multi-port COPPsystem, with the DNO network.
- Documented network trials, DNO Operational IT System Connection specification and learnings.

4. Performance compared to the original project aims, objectives and success criteria

Details of how the Project is investigating/solving the issue described in the NIA Project Registration Pro-forma.
Details of how the Project is performing/performed relative to its aims, objectives and success criteria.

Project background

The SYNAPS 1 (NIA_UKPN0037) project was successful in trialling a solution which predicted fault locations from waveforms gathered prior to any noticeable LV activity, detecting transient fault events of short duration and low energy that did not rupture a fuse or trigger an LV network circuit breaker or recloser. The SYNAPS 2 project has demonstrated that the SYNAPS2 solution reached a technical readiness level (TRL) to be a commercially ready solution.

Project progress

Procurement and legal activities have been completed regarding the contract with the Energy Innovation Centre (EIC), who co-ordinated the project on behalf of the Distribution Network Operators (DNOs).

Over the duration of this project, ten sets of next generation Chameleon MCUs (Metrology and Communication Unit) have been developed by Powerline Technologies. The existing first generation of prototype MCUs from the SYNAPS 1 NIA project have remained

installed on the low voltage underground network in the Southern Region of the Southern Electric Power Distribution (SEPD) distribution network; used to collect further data to improve the algorithm model. The information collected informed the development of the second-generation multi-port COPPsystem MCUs.

Twenty pre-commercial prototype multi-port COPPsystem MCUs have been developed, manufactured and deployed on the SSEN distribution network to demonstrate and prove the Business As Usual (BAU) process, to prove scalability of deployment and operational procedures and to collect further data to improve the algorithm model.

Technology Acquisition by Lucy Electric

The original COPPsystem and Synaps technology was developed by Fundamentals Limited, based in Swindon, and Fundamentals initiated the Synaps and the SYNAPS 2NIA projects. In July2023 the COPPsystem and Synaps technology was acquired by Lucy Electric and integrated into the Lucy Gridkey business, with the agreement of all parties, assumed the role of the Innovation Partner in the SYNAPS 2 NIA project.

Project Objectives

Basic Fault Location - The monitoring of previously installed MCUs has continued, with two first generation sensors installed on SSEN's network and two first generation sensors installed on UK Power Networks' network. This work focused on optimising the network calibration procedure and fine tuning the location technology to improve accuracy of the fault information and minimise the time required to generate it. The objective was that once a fault is identified the equipment was moved between feeder locations at regular intervals after liaison with the DNO. This allows continued collection of fault data in multiple cable type environments. Fault location information is communicated to asset teams for investigation and validation.

I.T Connectivity - Connection specification development for a specific interface between the Synaps cloud server and DNO operational IT systems to enable DNO operational staff to be informed in real time when LV faults are detected on specific feeders and to provide fault location information when this is available. This was proof of concept demonstrated within SSEN.

Advanced Fault Location - based on the next generation Synaps MCUs (Chameleon MCUs). These MCUs have been divided amongst both DNO's networks and installed on feeders with known faults and fault history or both. A total of five sets of MCUs have been installed on SSEN-D's network and five sets of MCUs installed on UKPN network.

Double Ended Fault Location – This is utilising the method of installing fault monitors on two parts of the network to enable a triangulation of fault monitoring. The sites that are being monitored are focused double ended events, meaning that the events were recorded by two MCUs, one at each end of a feeder. These events are a combination of load events, calibration events, early transient faults and hard to locate faults.

Event History - Starting in October 2023 twenty pre-commercial prototype multi-port COPPsystem MCUs were ordered for deployment on SSEN's network, by March 2024 ten pre-commercial prototype multi-port COPPsystem MCUs had been installed. These ten COPPsystem MCUs had detected 7,382 single ended events, 475 fault events were classified as fault events all other events were either load events or unclassified events. The remaining ten installations will be carried out after the NIA Project has been completed.

In addition to increasing the data collection sites, work has been done to test and validate the technology in support of the following use cases:

- Low voltage networks that run in parallel configuration.
- Long term fault evolution of network disturbances to determine which are faults and monitor their evolution into permanent faults.
- Determine at what stage faults can be located and to ascertain the scope for predicting the time before they cause supply interruptions.
- Investigate if faults can be identified as either cable or joint faults.
- Prepare an Operational IT System Connection Specification Document.
- Optimise the network calibration procedure.
- Basic Fault Location Report.
- Reduction in time required to generate the fault location information, i.e., from weeks in Synaps Phase 1 project, to less than four days.
- Installation of two sets of next generation COPPsystem MCUs on two radial networks in the SSEN distribution network.
- Demonstration of advanced fault location on radial and fully meshed (interconnected) networks.
- Demonstration of advanced fault locating.
- Improve fault location accuracy.
- Prototype interface based on DNO Operational IT System Connection specification Demonstration & document and demonstrate prototype as a BAU solution on DNO network Demonstration. This was proof of concept demonstrated within SSEN.
- Develop a digital model for Concentric Mains type cable which was not originally in scope of the Project.

Transient faults verified by RINALabs on SSEN Network

In December 2021/January 2022 SYNAPS 2 identified events, at Trojan Way, Waterlooville. SSEN removed a length of the cable circuit, including cable and two joints, from the identified location. These were sent to RINA (https://www.rina.org,) is an independent organization specialising in failure analysis & validation for electrical testing and examination (RINA report 2022-0117). The testing and examination identified the following learnings: -

- A fault was identified in the service joint exposing cores with burnt/broken tape.
- Arcing had occurred between two phases within the joint.
- The fault occurred at a position where the cable cores separate to allow connection of the service cables.
- Resin filler had penetrated along the interstices between the cable cores to a point where the cores had started to separate.
- Small relative movements between the cable cores and the resin filler occurred during thermal cycling.
- The small relative movements between the cable cores and the resin filler led to abrasion and mechanical fatigue of the paper insulation and resulted in a reduction in its dielectric strength, which in turn resulted in the fault.
- SYNAPS located the fault before a supply interruption occurred.

In 2023 Synaps 2 identified events, at Penn Hill Avenue/Oakwood Drive, Bournemouth. SSEN removed two branch joints from Penn Hill Avenue, two branch joints from Oakwood Drive, a straight joint from Oakwood Drive and a length of cable from Oakwood Drive. These were sent to RINA for electrical testing and examination (RINA 2023-0005). Conductor continuity tests and conductor and insulation resistance measurements were done on the joints and the length of cable. High voltage tests were carried out on three of the joints. As a consequence of the electrical testing and measurements, four joints were stripped down and examined in the laboratory. All of the examined joints showed degradation. Two joints would have failed in the near future. Two joints might have continued to function satisfactorily for a longer duration.

Electrical testing identified four joints with likely faults.

- As a result of the electrical testing, one joint (Joint 4) was not examined.
- As a result of the electrical testing, the length of cable was not examined.
- All four of the examined joints showed degradation.
- Two joints (Joint 2 and Joint 3) would have failed in the near future.
- Two joints (Joint 1 and Joint 5) might have continued to function satisfactorily for a longer duration.

SYNAPS located the fault before a supply interruption occurred. **Transient faults verified by RINA Labs on UK Power Networks Meshed Network**

In 2024 SYNAPS 2 initially reported a potential fault location 51-57m from Baker Street substation and this was based on voltage only waveforms with source impedance estimated through calibration events. Voltage and current waveforms were then used directly and reported a small shift to the previous estimation to a location of 60m from Baker Street substation. The location was excavated and verified by UKPN and the cable submitted to RINA for further verification (RINA report 2024-0761). Inspection of the cable and joint samples suggested that that the cable sample had previously been attached to the joint. The position of the damage was estimated to be approximately 600 mm from the end of the joint. The date of manufacture of the PILC cable was not stated on the cable suggesting it pre-dated 1966. Examination of the section of cable found it to be in reasonable condition away from the fault location.

The recovered cable sample and joint to identify the location and the severity of any electrical activity or material degradation which may be present. The following conclusions were made based on the investigation findings:

- The cable sample provided appeared to be the section from adjacent to the joint.
- The cable sample contained a fault, which would have been located approximately 600 mm from the end of joint.
- The cable was found to be in an aged but serviceable condition away from the fault location.
- No defects were identified which may have facilitated failure of the cable, however any localised evidence would have been destroyed by the fault event.
- It is considered most probable that a localised defect or damage caused the failure.

- Any defect or damage is likely to have been introduced relatively recently, possibly when accessing or manoeuvring the cable for the nearby jointing operation.
- The inspection of the joint did not reveal any signs of electrical activity or performance degradation.
- The cable failure was considered unlikely to be related to the cable joint (other than as in point 6.).
- The paper insulation of the PILC cable within the joint exhibited signs of ageing and degradation.
- Signs of minor corrosion in the conductor and insulation surface discoloration were found in the stripped grey core without the cable outer layers.
- Inferior connection between the tinned copper mesh and the lead sheath was found on the PILC cable side. However, no signs of overheating were observed during the inspection.

5. Required modifications to the planned approach during the course of the project

The Network Licensee should state any changes to its planned methodology and describe why the planned approach proved to be inappropriate. Please confirm if no changes were required

Concentric Cable

Concentric cable installed on SSEN's network requires a new digital model, which may need development from first principles – if the existing cable model envisaged with symmetrical components for the impedance parameters proves unsuitable. This approach has been validated in principle by a recent Knowledge Transfer Partnership between Powerline Technologies (Fundamentals Ltd) and the University of West England (UWE). Given the low numbers of split phase networks, this open-ended research item was deprioritised in the project. There is no obvious reason that the modelling principles used in the SYNAPS cannot be successfully applied to edge cases such as this, and if proven successful, will illustrate the versatility of SYNAPS technology.

Project Change Request

Change requests were submitted and approved to build on the success of the project and investigate additional criteria. The project was extended to 31st March 2024. This bridged the gap between the NIA project and BAU deployment in the following areas:

Consolidating the learnings from Advanced Fault Location trials and continue BAU stakeholder engagement.

Additional Learnings Achieved

The following were Investigated and documented as enhancements and further learnings:

- Alternative sampling rates.
- Fuse failure detection & monitoring.
- Fault level in meshed networks.
- Single-ended fault location.
- Detection of voltage events due to cable degradation on parallel feeders connected to the same transformer. Such events are characterised by a similar voltage collapse at both ends but far less fault current on the feeder of interest.
- Current-based early transient triggering for implementation in the detection algorithm.
- Modelling principles for concentric split phase networks, and other network/cable types.
- Energy to fault calculation and the likelihood of gas readings in certain situations (a matrix study).
- Improvements in calibration process.
- Use of complementary equipment such as Megger 'Fault Sniffer 2' non-intrusive gas tester, 'Thermal imaging Observation techniques for Underground Cable Networks (TOUCAN)' and EA Technology 'ALVIN' Reclose to confirm SYNAPS 2 pre-fault location, improving asset management and cable health analysis.
- Fault prediction, time to failure.
- Network topology mapping.

Pot-end Solution

To support the detection of events and double-ended location of faults at pot-ends[1] it was agreed that a cabinet should be installed above ground, adjacent to the pot-end, and to extend the three-phase cable to the cabinet. The cabinet houses a three-phase cut-out, to terminate the cable, and the Lucy Gridkey COPPsystem MCU with all the required connection and communications equipment.

Lucy Gridkey MCU 318 Support

After the acquisition of the COPPsystem and Synaps technology by Lucy Gridkey in July 2023 the project was expanded to include the existing Lucy Gridkey monitoring solution MCU 318 and the future monitoring solution MCU 632.

Number of Units, Sampling Rate and Resolution

Three areas were investigated:

1) Effect of reducing sampling rate.
2) Effect of reducing number of units.
3) Effect of reducing resolution.

Analysis shows that, reducing the number of MCUs to one MCU, results in a larger degradation than reducing the sampling rate. A double-ended MCU approach at 6.4kHz performs far better than single-MCU at 100kHz.

In terms of the sampling rate, the degradation versus reducing the sampling rate is almost linear up to 25 kHz and at 12.5 kHz the performance is slightly worse than the linear trend. This analysis is also true for small pecking faults. Overall, for calibration events and small to medium faults, with the single ended approach the results are less reliable than double ended.

Sampling rate up to 14.4kHz, including 5kHz, 6.4kHZ and 12.8kHZ, showed a degradation of only 1% within the Mean Absolute Error (MAE) and achieved acceptable field data testing.

It has been demonstrated that Quantization resolution of 16 bits should not degrade the overall Mean Absolute Error (MAE) of the trained models.

1) Double-ended is significantly better than single-ended for smaller faults. For larger faults, results are comparable.
2) Sampling rate can go down as small as 6.4 kHz. Most of frequency content is in first 2.5 kHz (i.e. 5 kHz sampling rate)
3) In terms of resolution/quantization, going from 24 bit to 16 bit makes little or no difference.

[1] Pot-ends are cables terminated in the ground by means of a seal, sometimes with additional external mechanical protection.

6. Lessons learnt for future projects

Describe how the project (methodology, stakeholder engagement etc.) changed, or provided opportunities, from your expectation at the start of the project and therefore could be useful for a future project. In addition, please discuss the effectiveness of the research development or demonstration undertaken.

Operational Issues

Calibration Unit Failure

An issue was encountered with the operation of the original bespoke calibration unit when completing the SSEN installation1 (Trojan Way). The calibration unit was returned to the manufacturer who modified the unit to offer a higher rating and extra protection that stops network fuses from tripping out. The key learning from this is that calibration work should have been tested on the PNDC test network before using on the DNO Network.

The crocodile clip ends of the leads used with the calibration device need to be redesigned to avoid "sparking" and build-up of debris on the surface after repeated use.

Uninterruptible power source for sensors

Fuse failure detection on a heavy fault on UKPN caused a fuse operation, but unfortunately the auxiliary power socket at the substation in this case, was downstream of the fuse, so the sending end sensor experienced a loss of power at the same moment. This issue has now been solved and is an operational learning outcome for future installations. As a result of the protected mains source operational issue the installation procedure was improved to ensure an uninterruptible mains source is used, where available.

Fault Location Confirmation

Using complementary equipment such as Megger 'Fault Sniffer 2' non-intrusive gas tester, 'Thermal imaging Observation techniques for Underground Cable Networks (TOUCAN)' and EA Technology 'ALVIN' Reclose can confirm SYNAPS 2 pre-fault location improved asset management and cable health analysis. Identifying an accurate pre-fault location can be used to focus on early event identification impacting the performance and the reduction in location time after fuse/Alvin reclose operation. ALVIN Reclosers, Kelvatek WEEZAPS/Bidoyngs and VisNets from EA tech can provide useful supplementary information for pre-faults.

Early Location Identification based on Non-Intrusive Gas Testing

The DNOs in the project have carried out analysis of early fault confirmation using fault locations provided by Lucy's SYNAPS solution. This was carried out using Megger Fault Sniffer 2 non-intrusive gas tester to confirm fault locations as early as possible in the detection process. There is a need to classify notifications to indicate those which are more urgent than others.

Proactive Control Room

SSEN have created a Project Control Room team to learn how to model and interpret fault locations. This team also dispatch to fault locations, to enable operational staff to investigate and validate fault locations. Without this Team it would not have been possible to initiate investigations.

Third Party Validation

To validate that Synaps can detect faults at earlier stages than other types of fault monitoring equipment, RINA Technologies was used to examine joints that had not had any visible breakdown. Cable and joints were removed from the SSEN Oakwood substation based on Synaps fault location and low fault activity. This has proved to be a valuable exercise; without RINA Technologies the Project would not have been able to validate the fault on this installation, thus third-party validation is an important lesson learned when using new technologies like this on the operational network.

Schneider Board Connection (Holdenhurst)

Connection to the Schneider distribution board at Holdenhurst could not be achieved with the available voltage clamps and/or Rogowski coils. Further investigation is required to identify a suitable solution.

Fuse Failure Detection on UK Power Networks Meshed Network

When installing the sensors at the receiving end of the meshed circuit, it was immediately apparent from the lack of current on one phase that the network fuse had already ruptured and so was only fed from the sending end. The key learning from this is the installation on this part of the DNO Network identified abnormal network condition.

7. The outcomes of the project

When available, comprehensive details of the Project's outcomes are to be reported. Where quantitative data is available to describe these outcomes it should be included in the report. Wherever possible, the performance improvement attributable to the Project should be described. If the TRL of the Method has changed as a result of the Project this should be reported. The Network Licensee should highlight any opportunities for future Projects to develop learning further.

Success Criteria

SYNAPS 2 system locates faults on an LV network with a precision better than existing technologies.

The SYNAPS 2 NIA project has made significant improvements since the SYNAPS 1 NIA Project and has demonstrated that the SYNAPS solution consistently detects, classifies, and locates events (pre-fault events) before other technologies such as reclosers and temporary fuses. COPPsystem MCUs between December 2023 and March 2024 detected 7,382 events, and classified 475 as fault events.

The event data is detected by LV Monitor units (Chameleon MCU) connected to LV circuits in the SSEN network and captured as waveform data. This data is sent to and stored on servers at the Lucy GridKey data centre and is available to, and shared with, SSEN engineers. In the data centre the events are classified as fault events, load events or unclassified events. Fault events are analysed by the AI deep learning algorithm, the location on the network is determined and the SSEN engineers are notified.

Fault accuracy improvements using calibration process.

Evidence has demonstrated that calibration assists in fault location analysis.

The requirement for calibration is minimised where the DNO has online information available about their electrical network. This has been demonstrated with GE's Smallworld Electric Office (EO) and will also be possible with the Common Information Model (CIM):

- The Common Information Model (CIM) is an electric transmission and distribution standard developed by the electric power industry. It aims to allow application software to exchange information about an electrical network. It has been officially adopted by the International Electrotechnical Commission (IEC).
- GE's Smallworld Electric Office (EO) helps utilities model network connectivity, design and build workflow management, and orchestrate infrastructure asset management challenges — throughout the entire network asset lifecycle. EO provides business applications for geospatial network modelling and design based on a proven geospatial network-based model.

The introduction of Machine Learning All Feeders (MLAF) will reduce the callibration requirement . MLAF will replace Machine Learning Single Feeder (MLSF). MLSF which requires calibration to be carried out on each individual feeder where no online electrical network data (EO, CIM etc.) is available. With the introduction of MLAF no, or minimal, calibration is required at a network level, as long as online electrical network data is available and accurate. MLAF is being trialled for both single-ended and double-ended fault location.

Improve the speed with which the location can be determined.

Speed of location has improved from three weeks in SYNAPS 1 to less than 1 day in SYNAPS 2 during 2022. The model now provides instantaneous fault locations (subject to successful validation of models).

Validate the technology on fully meshed networks.

The technology has been installed and validated on meshed networks at UKPN Technology validated in radial networks, validation on meshed networks in progress. Different cable types and network architectures covered. Enhanced calibration being investigated to improve fault locations on all types of networks.

Specify and demonstrate a basic interface between the SYNAPS 2 system and DNO IT systems.

Within the NIA project an interface was successfully designed and implemented as a proof of concept.

Improve deployment procedures and expose more operational staff to the technology.

Thirteen (3 carried forward from Synaps 1 project, 5 for SSEN and 5 for UK Power Networks) sites have been installed with Synaps 2 Chameleon MCUs, this involved calibration and commissioning processes. An additional ten locations have been installed with pre-production prototype multi-port COPPsystems. DNO personnel, Lucy Gridkey or Lucy Electric service personnel and third party (Freedom Group) personnel have been exposed to the technology.

Demonstrate installation on an operational meshed LV network.

Technology installed on meshed networks at UK Power Networks, six sites for 28 months.

Identify the fault as either cable (main cable or spur) and joint faults

RINA's reports provide evidence that SYNAPS can identify faults on the main cable and associated spurs that breech off the main cables.

Investigate long term fault evolution on faulty cables (Asset Management.)

Long term fault evolution at Trojan Way and Oakwood Close identified faults before a catastrophic breakdown had occurred. The early warning delivered by Synaps could help when determining the cause of a cable system fault which may otherwise be lost if a failure had occurred. This can also be used to inform future asset management planning.

Demonstration of the BAU commercial prototype on DNO network.

In preparation for BAU readiness single feeder prototypes for COPPsystem MCU have been demonstrated at SSEN and UK Power Networks. These have been built to a commercial standard and can be procured by DNO's.

Fault Locations Identified and excavated.

There have been 13 fault locations modelled. Out of the fault locations modelled 11 have been successfully excavated and validated as the cause of the fault. These have been validated at RINA or by DNO Engineers. The site locations are:
SSEN (radial):

- Trojan Way 2 locations excavated & verified (RINA report 2022-0117)
- Oakwood 3 locations excavated & verified (RINA 2023-0005)
- Penn Hill location excavated & verified by SSEN.
- Rose Street Aberdeen 2 locations excavated & verified by SSEN.
- Rose Street location excavated & verified by SSEN.
- Sheldrake location excavated & verified by SSEN.
- Knowle Village excavated & verified by SSEN.

UKPN (radial):

- Pelham 1 location verified by UKPN, and cable rerouted due to tree root damage.
- McRae Lane 1 location identified and verified by UKPN. Excavation & repair carried out at this location due to permanent fault.

UKPN (meshed/interconnected)

- Vincent Square location excavated & verified by UKPN. Initially the location given by Lucy Gridkey was about 25m out, using voltage only fault localisation, but correctly identified the spur that the fault was on. Subsequently voltage and current localisation to was applied to the original event data and the exact location was identified.
- Baker Street location excavated & verified (RINA Report pending)
- Fenchurch Street/Leadenhall Street location excavated & verified (RINA Report pending)

8. Data Access & Quality Details

A description of how any network or consumption data (anonymised where necessary) gathered in the course of the Project can be requested by interested parties. Please include a link to the publicly available data policy.

For information on how to request data gathered in the course of this project, see Network Innovation Competition (NIC) and Network Innovation Allowance (NIA) Data Sharing Procedure at https://ssen-innovation.co.uk/innovation-strategy/.

9. Foreground IPR

A description of any foreground IPR that have been developed by the project and how this will be owned.

Foreground IP resulting from enhancements will meet the default IPR arrangements, as per the original contract.

10. Planned implementation, recommendations or next steps

Please describe the next steps to implement this innovation project. What policies and standards need to be updated or created as part of this implementation.

The purchase of SYNAPS by Lucy Electric Ltd has moved the project to a TRL9 and has imbedded the solution into their products. This is a success for the project and opens the opportunity for other DNO's to deploy on their networks for the benefit of their customers.

It is the intention to deploy the SYNAPS to BAU The project will continue to be supported by SSEN/UKPN and Lucy Electric Ltd while business cases and investment are worked through in two areas.

- Fault management with the Customer Operations work stream.
- Asset underground cable overlay team.
- UKPN intends to run the existing devices for another 12 months before making BAU decisions. We are awaiting the outcome of two recent cable recoveries and investigations which will inform the BAU transition discussions.

11. Other comments

N/A

12. Standards Documents

Identify any industry standards that may require updating due to the outcomes or understanding developed from this innovation project. If no standards will need to be updated, please state - not applicable.

N/A