SIF Discovery Round 2 Project Registration

Date of Submission

May 2023

Project Reference Number

10061243

Project Registration

Project Title

CommsConnect

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10061243

Project Licensee(s)

UK Power Networks

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

innovation@ukpowernetworks.co.uk

Project Budget

£122,376.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£110,138.00

Strategy Theme

Optimised assets and practices

Challenge Area

Improving energy system resilience and robustness

Lead Sector

Electricity Distribution

Other Related Sectors

Funding Licensees

Lead Funding Licensee

UKPN - South Eastern Power Networks Plc

Collaborating Networks

UK Power Networks

Technology Areas

Comms and IT, Resilience, Substation Monitoring

Equality, Diversity And InclusionSurvey

Yes

Project Summary

The project addresses Challenge 3, improving energy system resilience and robustness. Communication networks have been designed and provisioned by the electrical utilities themselves and optimised for their needs. Electricity networks require robust and resilient communications systems, with failover and black start resilience a minimum for the most critical infrastructure. Using a single commercial network for power systems would not satisfy the resilience requirements (e.g. current communication systems can be disturbed during a natural event/human error), improving the resilience of such systems would require high levels of investment and increase the carbon footprint. This project will provide communication resilience using combinations of standard commercial networks along with private provision where required, offering cost savings while delivering the same or better Quality of Service (QoS) as existing approaches.

The primary focus is to propose innovative adaptations to the design of standard communication networks (including a combination of fibre, cellular, low power wide area radio and satellite networks) to improve power resilience. CommsConnect will look at more efficient ways of providing communication resilience using more standardised network provision. This will improve the grid efficiency by reducing power outages and reducing restoration time.

The hybrid public/private approach leveraging existing networks will benefit networks through:

- Better resilience and fewer network outages;
- The delivery a reliable network at a fraction of the cost of a private network;
- Balancing the trade-off between private and public provision to meet service needs, cyber security requirements and company culture;
- The use of Commercial off-the-shelf technology to reduce costs;
- Network combinations supporting normal/degraded operations; and
- Opportunities for feedback benefits to public networks of increased private provision.

The team at PNDC provides power and comms experience, with specialisms in 5G, resilience and security. They are currently focussing on next-generation communication frameworks, cyber-attacks, and provides in-depth knowledge of security and privacy in smart grids.

UK Power Networks provides several potential use cases and network topologies for validating concepts developed in this project. They contain an experienced contingent of engineers dedicated to the monitoring, management, and development of its telecommunications networks; as well as the required institutional knowledge and experience in maintaining both public and private telecoms networks.

The proposed solution will be used by the DNOs as a tool to improve the power network resilience and reduce capital and operational costs. However, the main learning from this project can be also applied in other critical infrastructures such as water and gas.

Project Description

The Problem

Modern commercial communication networks often lack power resilience. Providing power resilience is feasible but expensive (e.g. a roof top comms site might require 1.5 tonne of batteries). However, combining multiple networks can provide a much more robust solution at far lower cost than hardening a single network.

Proposed Solution

Over the past thirty years, communication network architectures have become more standardised but more focussed on large scale customers, as utilities only form a very small fraction of their customer base. While standardisation bodies such as 3GPP have sought utilities sector knowledge for new standards like 5G, creating an aligned industry approach and market to entice manufacturers to develop such products has proven challenging.

This project will look at cost savings against resiliency and efficiency improvements by using existing communication network components but optimising their interconnection, including the opportunities of partnering limited private network provision in conjunction with public networks. With new technologies such as network slicing in the latest 3GPP releases, such optimised architectures could be cost effectively provided by commercial operators. In addition, the project will allow for degraded operation either over time or fault severity while maintaining key network functionality (for example by graceful fail over from higher bandwidth technologies to either lower bandwidth or higher cost alternative.) The output will be an approach to communication network provisioning that uses a combination of commercial networks with utility network provided additions.

SIF Primary Focus

The primary focus is to propose adaptations to the design of standard communication networks (including a combination of fibre, cellular, low power wide area radio and satellite networks) to improve power resilience in a cost effective, resilient, and future proofed way. Traditionally, communication networks for utilities have been designed and provisioned by the electrical utilities themselves and optimised for their needs. As commercial networks are used instead, the required levels of resilience may be cost prohibitive, if they can be provided at all.

Innovation / Project Benefits

As the electricity network continues to be upgraded to become 'smart', the requirement for a robust and reliable communications network will increase. Successful implementation of this project will enable electricity networks to benefit from the latest telecommunications technologies to deliver a robust and reliance communications network in a cost-efficient way.

Third Party Collaborators

University of Strathclyde

Nokia

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Project Description And Benefits

Applicants Location (not scored)

UK Power Networks -- Newington House, 237 Southward Bridge Road, London, SE1 6NP, UK

University of Strathclyde - 16 Richmond Street, Glasgow, G1 1XQ, Scotland, UK

Project Short Description (not scored)

The project addresses the challenge of providing reliable and resilient high-quality communications for future grid operations at lower capital and operational costs by combining public and private communication networks.

Video description

https://www.youtube.com/watch?v=kEJ8jnmFlgk&list=PLrMOhOrmeR6ldr-EVoT8ABGhTCxgyBKqs&index=30

Innovation justification

Historically, electricity networks were dependent upon bespoke communication solutions but as networks have become smarter and their reliance on telecom solutions has increased, there has been a shift towards more commercial solutions due to the limited availability of high-tech industry specific solutions and their high associated costs. This has now introduced an inherent risk into both the telecoms and electricity networks, due to their high interdependency, with the latest communications technology requiring even more power outputs and expensive network upgrades to support them.

This project will develop an advanced solution that combines various networks to enhance the grid resilience and boost its security. In addition, the solution will:

- Improve cellular provision thus providing more availability;
- Leverage a 5G network design (more edge intelligence, network slicing) to provide opportunities to combine networks with increased quality of service (QoS);
- Propose adaptations to the design of standard communication networks (including a combination of fibre, cellular, low power wide area radio and satellite networks); and
- Provide further resilience by combining low power wide area radio and LEO (Low Earth Orbit) satellite.

PDNC, UK Power Networks and other DNOs have collaborated on many projects and initiatives that have examined the latest communications cyber security challenges and have proposed improvements for smart grid applications and utilities. The Constellation NIC project will be trialling the use of public 5G infrastructure for site-to-site communications, but comms resilience does not form part of the project scope. For this submission, the proposed solution proposed will evaluate and trial methods of improving the resilience of systems such as Constellation. Learnings from these workshops, discussions and projects shall be used to support this solution development.

Network resilience will support long-term benefits for the power utility networks in terms of sustainability, efficiency, and cost savings. This will be achieved by developing appropriate solutions to provide sufficient resilience connectivity to the main distributed power assets. Such resilience connectivity will be used by the DNOs in case of any power failure or loss in one of the communications networks.

The solutions being assessed here is at a nascent state and requires significant development, in a collaborative environment, to determine what a feasible solution could look like for the industry. The SIF mechanism and its phased approach provides project partners the opportunity to focus on the development, collaboration, and feasibility of the solution during discovery phase, which will significantly de-risk the Alpha and Beta Phases.

Benefits Part 1

Environmental - carbon reduction – direct CO2 savings per annum against a business-as-usual counterfactual
Financial - future reductions in the cost of operating the network

Benefits Part 2

Financial - future reductions in the cost of operating the network

- Target output: Reduction in the cost of network operations
- Calculation: This will be determined by comparing the costs of developing and maintaining a bespoke communications solution against the costs of developing and maintaining the proposed solution for the required levels of Quality of Service (QoS) and resilience.
- Justification for target output: As the grid becomes smarter, an increasing proportion of costs move from the power network to the communications network that supports it, as communication requirements grow. It therefore becomes more important to keep communication costs low.
- Timeline to achieve target output: End of Beta Phase

Improved network resilience and fewer outages

- Target output: A reduction in the number of outages caused by loss of communications.
- Calculation: This will be determined by comparing the number of unplanned outages that currently occur using the existing communications solutions against a modelled view of the number of unplanned outages that occur under the proposed communications solution
- Justification for target output: The increasing dependence of the grid on advanced communications means that loss of telecommunications may result in part of the network going down triggering electricity network outages, which may in turn trigger further telecoms network outages. By implementing a more resilient solution, that reduces the risk that the electricity networks are negatively impacted by commercial telecoms outages.
- Timeline to achieve target output: end of Beta Phase.

A full cost benefit analysis would depend on the resilience requirements of different smart grid communications, and the resulting reduction in infrastructure requirements compared to deploying a fully private network, which will be quantified in WP2 based on the results of WP1.

Project Plans And Milestones

Project Plan and Milestones

WP1 Communication requirements for future grid operations (Strathclyde/UKPN)

- Assess requirements for communications over a 5, 10 and 20-year window, categorising these requirements in terms of resilience, to provide scenarios under different levels of degradation.
- Deliverable: Create a report detailing minimum communication network requirements for future utility network operation under different scenarios.
- SIF Funding: £5,762.

WP2 Public network resilience (Strathclyde)

- Assess current commercial and private network solutions in terms of resilience, looking at different points of failure, and in particular different options and costs involved in power autonomy.
- Success criteria: Create a report assessing the resilience of public network infrastructure under differing scenarios, as well as evaluating the cost and resilience trade-offs between different levels of public and private network provision.
- SIF Funding: £42,400.

WP3 PoC Hybrid Network CPE Demonstrator (Strathclyde)

- Build a CPE (Customer Premise Equipment) capable of failing over between two 5G networks where overall control of the device remains with the power network operator, either directly through one network, or as an over-the-top provision on the second network. Overall operation, QoS control and performance during failover scenarios will be demonstrated.
- Success criteria: Demonstration prototype and evaluation report of prototype operation under single and dual network operation and final report submission.
- SIF Funding: £62,176.

Main Project Risks

- Risk: Staff unavailability due to unforeseen circumstancesSolution: The university has access to a large resource of staff with relevant expertise; therefore, staff members can be replaced if required.
- Risk: Delayed equipment orders due to supply chain issues
Solution: Any equipment required will be ordered early to avoid potential supply chain delays. We also have good relationships with existing suppliers to approach for this.

Describe your risk management strategy

In line with PNDC's Risk Management Procedure, the risk register produced as part of this submission takes into consideration any technical, commercial, and financial risks associated with this project. This will be reviewed and updated accordingly at regular review meetings with project delivery personnel.

There are no constraints identified at this stage but constraints relating to the ongoing inflation which could impact the actual costs of any new equipment required. Such constraints are out of control but could affect the project management, however, previous experience help to overcome these obstacles. We will ensure there are frequent project meetings to flag any upcoming issues early on and will work with the team to mitigate these as the project progresses.

Regulatory Barriers (not scored)

Regulatory barriers may hinder long term application

Access to mobile spectrum on at least a regional basis, to allow for harmonised spectrum access across a whole DNO region. We believe that there would be further economies of scale for UK energy system operators by harmonising this spectrum access across the whole of the UK -- such an approach requires less spectrum than alternative approaches, but a transition to BAU would need to achieve long-term certainty around this to make it viable.

Evidence to influence future policy and regulations

There is a need to ensure regulatory mechanisms around value-for-money also considers cyber-security and resilience, since an open

market will always (and rightly) deliver cheaper solutions which lack resilience and/or security features. We propose to evaluate Value for Money (VFM) between public and private networks, leveraging learnings from past projects and connectivity solutions to build evidence that a new approach to policy is required here.

Policy consideration for long term implementation

There is a need to enable a level of cooperation at the edges and boundary zones between DNO regions, since DNO regions don't necessarily correspond to where you would deploy infrastructure. We do not see this as a blocker, rather as an enabling opportunity, but (for example) getting DNO A good coverage at an optimal price may be best delivered by installing a site within DNO B's region. Enabling both DNOs to use the site would be sensible, but this will require technically oriented rather than business-oriented separation of systems.

There are other opportunities for DNOs to provide resilient comms to other CNI (Critical National Infrastructure) users (e.g. water utilities), which would be constrained by their own regulatory requirements. There will need to be research into implications of this, specifically where Ofcom and Ofgem regulatory areas may overlap. There may also be potential regulatory overlap between the Telecoms Security Act.

Derogation

The project does not require any derogation.

Exemptions

(Ofcom-regulated) and the NIS directive (Ofgem-regulated, for a DNO) which will require careful evaluation from a DNO perspective, before exploring opportunities to work with other sectors in realising wider community benefits. This is likely to require a more joined-up approach to regulatory policy across the private sector CNI ecosystem, delivered through outcomes-based regulation, which recognise the need to holistically consider complex systems like energy networks which are dependent on both communications assets and energy assets.

Commercials

Route To Market

The proposal aims to help electricity networks enhance their network resilience; creating the framework required to implement such a solution, without being prescriptive on the specific vendors that would be required to deliver it, thus enabling a competitive marketplace.

Dr James Irvine, University of Strathclyde will be responsible for the implementation of this innovative project. James is an expert in resource management and security for wireless communication systems, has worked on several 5G design and delivery projects and is General Co-chair of Institute of Electrical and Electronics Engineers (IEEE) Wireless Communications and Networking Conference 2023 and Publications Chair of IEEE SmartGridComm 2023.

UK Power Networks will provide industry experience developed from years of managing and operating telecoms systems specifically designed for electricity networks infrastructure. This factor ensures that a suitable test bed and proving ground exists for later phases that will require a level of trialling in the network environment. The business is also leading in the development of the use of public 5G networks for critical infrastructure with the Constellation project.

Primary customers for this solution are electricity networks and other critical infrastructures who are looking to improve their network resilience. This shall enable these customers to develop and implement a scalable, resilient, future-proofed communications network to support their critical national infrastructure (CNI). In addition, we envision it will provide the following benefits:

- A net reduction in the costs associated with managing a telecoms network for the Utility companies or other CNI providers through the use of standardised technologies and the use of either commercial networks to back up private networks or limited private network coverage to provide back up for commercial network provision;
- A reduction in the likelihood of a network outage through increased network resilience a reduced risk that the loss of telecommunications within the grid may result in part of the network going down triggering electricity network outages; and
- A reduction in direct CO2 production through the re-use of existing infrastructure and taking a regional view on the level of resiliency required and how its provided.

The following partnership aspirations would support development beyond the Beta Phase:

- Nokia - Tier 1 supplier of carrier grade mobile infrastructure who could provide support and hardware for creating resilient overlapping communication networks.
- Siemens - Provider of industrial grade mobile telecoms equipment
- PNDC - A facility to safely test large-scale electrical components without risk of consumer interruption.

Intellectual property rights (not scored)

IPR arrangements for this project will be in line with the terms set in the SIF Governance Document Chapter 9 and the project participants agree to comply with the default IPR conditions.

Costs and value for money

The total project cost is £122,376, which can be broken down across partners by:

- UK Power Network - £18,000 (15%)
- PNDC - £104,376 (85%)

The partners will be providing the following 10% minimum contributions:

- UK Power Networks - £12,238

There will be no sub-contractor costs and SIF funding will be divided as follows:

- UK Power Networks: £5,762 (5%)
- PNDC: £104,376 (95%)

The project will aim to provide value for money by:

- Leveraging learnings from previous projects and assessments completed by the PNDC, and their global expertise, to accelerate the

development of a prototype during Discovery Phase;

- Use stakeholder engagement activities to design a solution that largely meets the needs of all power network companies, whilst highlighting any specific differences that cannot be addressed;
- Being hardware and technical solution agnostic at this stage ensuring that the most cost effective and appropriate solutions are developed; and
- Focussing Discovery Phase on the key gaps and learnings required to develop a solution out at alpha phase.
- PNDC, as part of the University of Strathclyde, providing a 25% discount from their commercial rates towards project outcomes. This is to both to demonstrate value for money to the customers, and to demonstrate our commitment to project objectives
- Providing access to facility investment through the expansion of the PNDC testing sites and equipment.

Emerging smart grids will become heavily dependent on communications network infrastructure. On the demand side, EVs impose sudden and dramatic changes in load, and on the supply side, distribution generation and changes in environmental conditions, e.g. wind speed or solar shade, decreases and rapidly shifts supply. To manage these rapid changes safely and efficiently, communication networks are employed. However, this creates a dependency on communication networks. To retain and ensure grid stability multiple independent communication methods should be employed to support an adaptive grid.

Nevertheless, creating two independent networks is prohibitively expensive, and inefficient. Whereas, existing public mobile networks provide a communication service, but it would not be commercially viable for them to provide 100% ubiquitous coverage and resilience for a DNO. Instead, our proposal suggests employing the best of both worlds using a hybrid network with existing public infrastructure where advantageous, and dedicated private infrastructure were imperative. Providing an overall resilient solution at a reduced cost.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

SIF Discovery Round 2 Project Registration 2023-05-30 10_28

SIF Round 2 Discovery - CommsConnect End of Phase (for upload).pdf

SIF Round 2 Discovery - CommsConnect Show and Tell (for upload).pdf

This project has been approved by a senior member of staff

☑ Yes