electricity north west

Bringing energy to your door

NIA ENWL019
Interface

Closedown Report

31 July 2023

VERSION HISTORY

Version	Date	Author	Status	Comments
V0.1	23/02/23	Steve Davenport	Draft	
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REVIEW

Name	Role	Date
Ben Ingham	Innovation Technical Manager	26/07/23
Andy Howard	Innovation Programme Manager	26/07/23

APPROVAL

Name	Role	Date
Victoria Turnham	Head of Network Innovation	30/07/23

CONTENTS

GLOSSARY

Term	Description
API	Application Programming Interface - computing interface which defines interactions between multiple software intermediaries
CoTS	Commercial off The Shelf
DNP3	Distribution Network Protocol 3 - communications protocols used between components in process automation systems
DMZ	Demilitarised Zone
HV	High Voltage
GRP	Glass Reinforced Plastic
GSM	Global System for Mobile communication
IoT	Internet of Things
LoRaWAN	Long Range Wide Area Network – radio based low power communication protocol generally used in IoT applications
LV	Low Voltage
MQTT	A messaging protocol for small sensors and mobile devices
NMS	Network Management System
OT	Operational Technology
REST	Representational State Transfer - architecture style for designing networked applications
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SD_WAN	Software-defined Wide Area Network
SIM	Subscriber Identity Module

1. EXECUTIVE SUMMARY

1.1 Aims

This project will investigate the feasibility of connecting multiple devices into the same communications interface using varying protocols and communications mediums whilst maintaining data security.

1.2 Methodology

The project will investigate the various interfaces, communications mediums and protocols needed to support the transition to a future network. Trials will be conducted to ensure all the different devices work together whilst maintaining security.

1.3 Outcomes

Interface produced two designs – one based on using a public communications network and one based on using a private communications network.

The project explored the need for “Big Data” and highlighted how it could be shared but due to recent and enhanced cyber-attack to critical national infrastructure the decision to progress the original project intention was scaled back.

1.4 Key learning

Cyber security requirements are constantly changing and can affect the delivery and implementation of new technologies and processes. It is important that Innovation teams involve the cyber teams throughout the project so that issues can be raised and addressed in a timely manner.

1.5 Conclusions

The project explored a number of options for communicating with multiple devices in one substation but the changing cyber security requirements has paused the trialling of these options. If the cyber issues are resolved we will revisit the learning from this project.

1.6 Closedown reporting

This project was compliant with Network Innovation Allowance (NIA) governance and this report has been structured in accordance with those requirements.

This report and the associated documents are available via the Energy Networks Association’s Smarter Networks learning portal at www.smarternetworks.org or via the Electricity North West website.

2. PROJECT FUNDAMENTALS

Title	Interface
Project reference	NIA_ENWL019
Funding licensee(s)	Electricity North West Limited
Project start date	October 2018
Project duration	3 years
Nominated project contact(s)	innovation@enwl.co.uk

3. PROJECT BACKGROUND

Currently DNOs have multiple RTU / communication interfaces installed in distribution substations to allow remote operation of HV switchgear and LV switchgear as well as collecting analogues such as voltage, current and temperature. In some cases there can be 4-5 communication devices which all communicate independently with the central systems over the mobile network.

As we move towards a low carbon economy consumers are going to be more reliant on electricity for transport and heat resulting in thousands of devices, such as electric vehicles and heat pumps, connected to the low voltage network greatly increasing the demand on the network. As an alternative to reinforcement for the demand increase DNOs could enter into contractual arrangements to manage these devices on behalf of the consumers and to benefit both the customer and the DNO. To facilitate this management the DNO would need to directly interface with the devices thereby further increasing the number of communications devices in a substation.

It is anticipated that the transition to a low carbon economy could result in up to ten individual communication devices being installed in a distribution substation. To carry out effective Smart Grid management a single communications hub would be beneficial. This hub could interface with the Network Management System, DNO owned equipment and customer owned equipment. The hub should transmit both monitoring data and fault data to the NMS as well as operational commands to both DNO and customer owned equipment.

This project will investigate the feasibility of connecting all these devices into the same communications interface using varying protocols and communications mediums whilst maintaining data security.

4. PROJECT SCOPE

The project will investigate the various interfaces, communications mediums and protocols needed to support the transition to a future network. Trials will be conducted to ensure all the different devices work together whilst maintaining security.

5. OBJECTIVES

The project objectives are as follows:

- Identify all existing and planned communications mediums and protocols for the monitoring and control of the DNO and customer's equipment.
- Trial interfaces between the DNO and customer equipment.
- Develop control methodologies for managing customers' and DNOs' equipment to resolve local constraints.

6. SUCCESS CRITERIA

- Production of functional specification for a communications hub to transfer monitoring data and controls between the NMS and DNO / customer owned equipment.
- Production of control methodologies for managing customers' equipment.
- Successful trial of a communications hub, its various interfaces and associated control methodologies.

7. PERFORMANCE COMPARED TO THE ORIGINAL PROJECT AIMS, OBJECTIVES AND SUCCESS CRITERIA

To enable a more thorough review of possible solutions for communications with distribution substations and the handling of the vast amount of data they can produce Electricity North West employed IBM to research the options. IBM conducted several workshops with relevant Electricity North West staff to gain an understanding of the requirements and challenges.

The following architectural principles were adopted by IBM to ensure the recommendations were scalable, future-proof and used industry standard security guidelines. They were also used to guide the design and to assess each of the solution components.

1. Distributed Energy Resources/ Low Carbon Technologies would be controlled via native applications and be connected via a cloud environment and/ or proprietary solutions e.g. REST APIs.
2. The solution should be designed in a modular fashion to allow components to be brought together to best fit each geographical location and substation configuration. It is expected this shall include sensors, aggregation, local data store and compute capability, a communications hub, a cloud environment, and a gateway to Electricity North West environments.
3. The edge devices will be scaled to match the level of connectivity available.
4. The system should have appropriate levels of security, which will include device management and device registry. The system should also be capable of monitoring the edge devices for irregular transaction information.
5. Electricity North West will use Commercial Off The Shelf (COTS) products as much as possible to comply with the industry standard approach and utilise existing security standards.

6. Electricity North West will use a cloud first approach for data storage infrastructure.

7. The solution should be designed to be scalable where possible.

IBM researched different architectural, design and solution component options and the various connectivity options available, along with the edge computing and data analytics required to consolidate the relevant sensor data.

Building on the work carried out with IBM Electricity North West further developed the proposed solution to ensure it would mesh with our existing architecture and systems including:

- modifying an existing substation monitor to allow ethernet based communications in addition to the existing SIM based ability. Any data would be tagged to demonstrate the data separation between command-and-control data and analytical data.

- modifying an existing substation monitoring device to allow evaluation of LoRaWan connectivity and its operational limitations when transmitting to sensors nearby such as those in link boxes. This also considers whether real time operational command signals and controls can be reliability transmitted over LoRaWan.

- exploring options for bi-directional communications and “Data Lake” solutions to enable exchange of relevant network data between Electricity North and third-parties.

- exploring a SDWAN solution; this is new technology for Electricity North West and was therefore subject to cyber security scrutiny.

- exploring “data lake” solutions to allow 3rd party read only access.

- exploring edge computing to allow local analysis before transmitting results to the SCADA system to enable a final decision, therefore reducing traffic on lower bandwidth data communications.

- exploring the challenges, solution options, and reliable integration of IoT devices into RTUs.

The use of technologies, such as power line carrier, have been reviewed and discounted as they were tested in other NIA projects and proven to be unsuitable in complicated LV networks.

Additionally, we secured and installed a GRP creating a real-world environment to house the test substation network and enable trials.

The original success criteria were achieved in principle. Interface explored technologies for data capture and transmission but due to recent and enhanced cyber-attack to critical national infrastructure the decision to progress the original project intention was scaled back. We are now exploring alternative methods of data management and transmission into our NMS SCADA system.

8. THE OUTCOME OF THE PROJECT

The work conducted by IBM produced two designs – one based on using a public communications network and one based on using a private communications network.

IBM noted that a combined solution is required that utilises different communication methods and different edge computing requirements dependent on the GSM signal strength within the substation. They also recommended using a cloud hosted IoT platform to manage the connected devices. The Cloud provider and IoT platform provider can be from different suppliers.

MQTT was recommended as the protocol to be used to collect the data due to its integration with the IoT platform and IBM suggested that Electricity North West convert MQTT into our standard protocol, DNP3, within the DMZ. For control elements DNP3 sent directly from the SCADA system should continue to be used.

Following this work with IBM, Electricity North West to procured equipment to install in our test area to test the end to end functionality including the access to data by control systems, planning staff and third parties.

The project explored the need for "Big Data" and highlighted how it could be shared but due to recent and enhanced cyber-attack to critical national infrastructure the decision to progress the original project intention was scaled back. We are now exploring alternative methods of data management and transmission into our NMS SCADA system.

Interface highlighted the risks associated with Critical National Infrastructure, and the possible cyber threats expanding the IoT to these systems.

9. REQUIRED MODIFICATIONS TO THE PLANNED APPROACH DURING THE COURSE OF THE PROJECT

Electricity North West are approaching the end of a full NMS & SCADA application change which resulted in limited resources for related innovation projects. As the delivery of Interface had a dependency on the NMS the project was extended by 12 months.

The original plan was to design and build the architecture recommended by IBM but due to recent and enhanced cyber-attack to critical national infrastructure the decision to progress the original project intention was scaled back.

10. LESSONS LEARNED FOR FUTURE PROJECTS

Cyber security requirements are constantly changing and can affect the delivery and implementation of new technologies and processes. It is important that Innovation teams involve the cyber teams throughout the project so that issues can be raised and addressed in a timely manner.

11. PLANNED IMPLEMENTATION

At this time we are not taking the outcomes of this project into business as usual. When the cyber issues are resolved we will return to the learning from Interface and investigate what can be deployed in business as usual.

12. DATA ACCESS

Electricity North West's innovation data sharing policy can be found on our website.

There has been no data gathered so far during the project.

13. FOREGROUND IPR

There is no foreground IPR associated with this project.

14. FACILITATE REPLICATION

As Electricity North West are not implementing this project there is no replication at this time. This can be revisited if we decide to implement the findings at some point in the future.

15. OTHER COMMENTS

None.