Keeping the lights on: Utility pole monitoring made possible by Arm Mbed

Chris Snow EkkoSense: Electronics Engineer

Case Study

Company Snapshot

Name: EkkoSense Ltd.

Vertical: Smart utilities

Size: 25 employees

HQ: Nottingham, UK

Founded: 2013

Goal

In rural locations, wooden poles are used to support the electrical distribution and transmission power systems as they have several benefits, such as being highly economical and visually less intrusive then steel lattice towers. However, single wooden poles in extreme weather conditions are at an elevated risk of failure when compared to steel towers. Scottish and Southern Electricity Networks (SSEN), as part of their Research and Development program, engaged EkkoSense to design a solution which would trigger a proactive response through early warning alerts highlighting pole movements. The ultimate goal was to develop an enhanced wooden pole fault alarm system, which has the potential to improve supply restoration time if a pole were to fail.

Solution

An extremely energy-efficient pole monitored device running on Arm Mbed OS has been developed and deployed by EkkoSense. It relays data gathered by a variety of motion sensors measuring, for instance, pole tilt and vibration. These devices are self-powered, maintenance free, with a lifetime of 10+ years.

Benefits

✛ Low-powered connectivity support, ideal for devices in challenging remote locations

✛ Prolonged device lifetime reduces operational costs

✛ Ease of integration with in-house data processing application

Crucial Data Collection Powered by the Internet of Things

A single pole failure can impact 10,000 customers

SSEN provides electrical power to some of the most remote locations in the UK, with customers located throughout the Scottish Highlands and Islands. SSEN selected to trial the EkkoSense solution supported by Arm's Mbed OS on their longest wooden pole transmission circuit; which runs across the Isle of Skye. A single point of failure in this location, which requires 70km of transmission line carried by 800 poles, can impact more than 10,000 customers.

It is exposed to the harshest of Scottish elements, often subjected to extreme cold weather and high winds. Traditionally, if there is a fault on the network and a wooden pole failure is suspected, the entire route must be patrolled on foot.

EkkoSense proposed a self-powering pole mounted box containing movement sensors. The device needed to:

✦ Fit within a weather tight box that was dimensionally compact and as light as possible;

✦ Have a simple pole attachment method;

✦ Communicate the monitored data with limited electrical energy over a distance of +15km;

✦ Operate during extremely low temperatures -30°C (-22°F);

✦ Self-power via a battery and solar cells suitable to operate over the Scottish winter.

The EkkoSense solution is a way of providing SSEN with a remote 'eyes-on' wooden pole circuit monitoring system, with the primary aim of faster wooden pole break detection. The unique combination of power and connectivity constraints pointed EkkoSense towards a deployment of the devices using a low power wide area network (LPWAN). The LPWAN solution selected was LoRA; EkkoSense's pole mounted units were designed to send an hourly status report and unusual event notification signals, all web-viewable via an Internet of Things (IoT) solution.

As the testing of the EkkoSense system has progressed, analysis of the hourly pole status reports highlighted where field inspection should be focused to maintain the integrity of circuit, which is a bonus to the primary anticipated use of the information, which is the fast and efficient location of a pole break.

Low-power, robust, efficient IoT

The EkkoSense pole mounted device has the potential to detect the tilt, deformation, spring and twist of a wooden pole. It is sensitive enough to pick up an animal rubbing up against a pole through to severe physical pole breakage. The devices, combined with EkkoSense's analytics software, can distinguish between the usual weather-induced pole movements and sudden damaging impacts.

The pole mounted device collects sensor data and communicates over LoRa to collection gateways, which then forwards the information onto an application server. The EkkoSense solution sends hourly status reports and an event notification when uncharacteristic movement is detected.

Presently, the hourly status report of the wooden poles is overlaid on a map display to indicate the precise location of pole and their health.
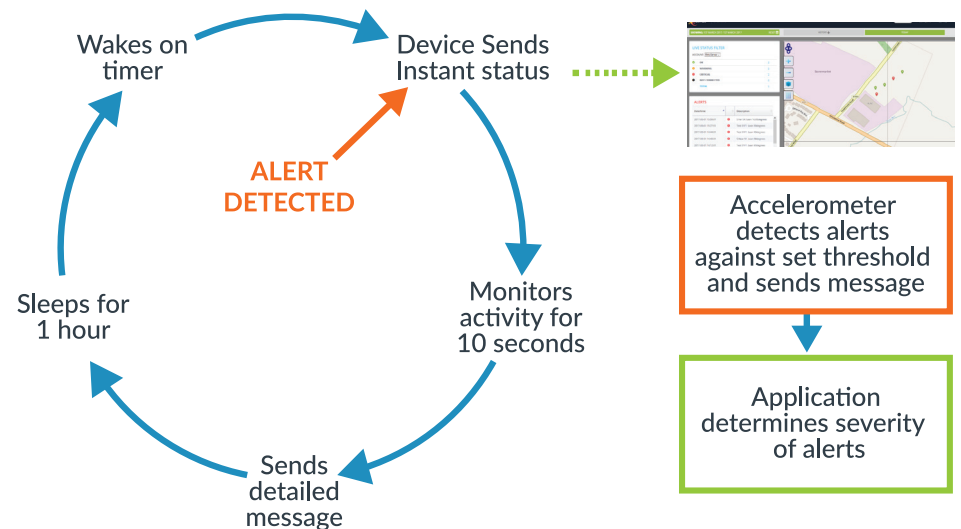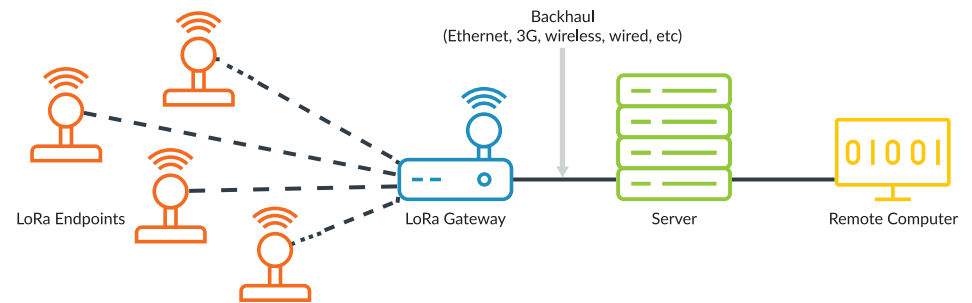
EkkoSense are working towards the categorization of the event notification signals, which will help prioritise circuit maintenance.

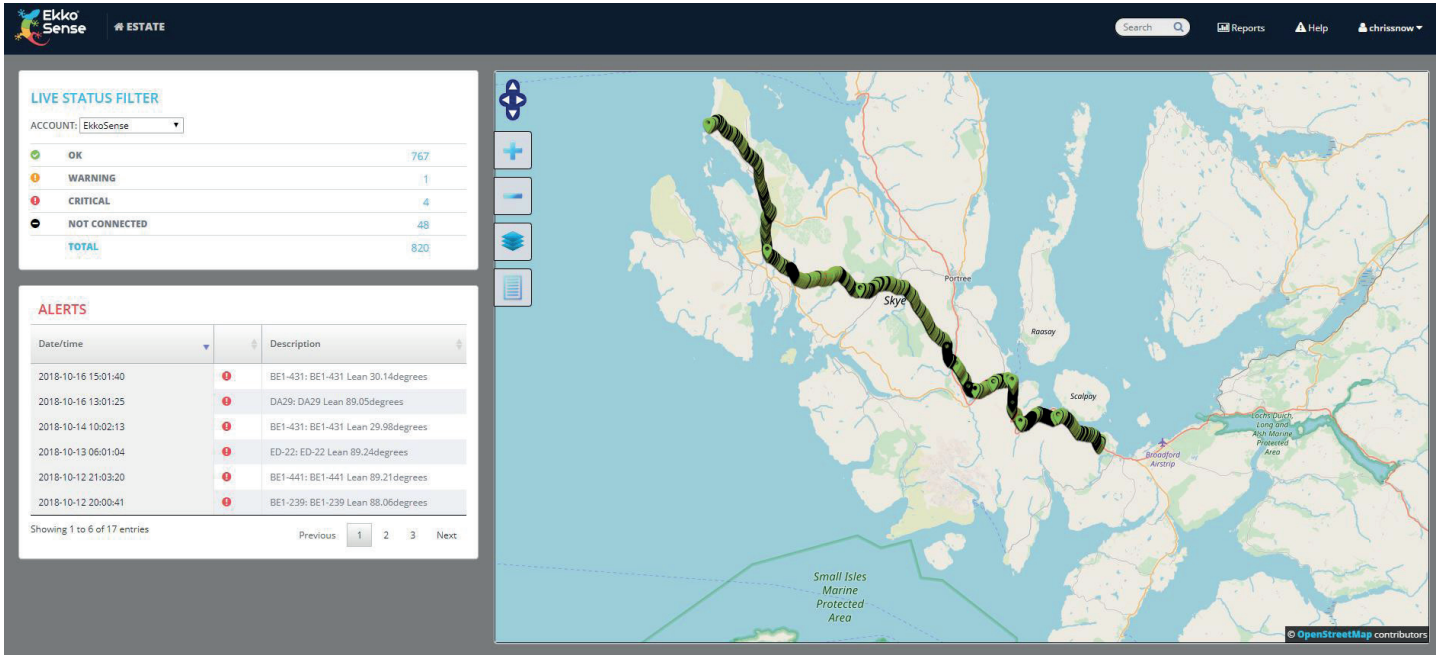The alarms are categorized into three different potential incidents:

- sudden high magnitude 'g' event indicating a pole-strike or line-strike, requiring immediate investigation.
- high magnitude movements or change in inclination, indicating that a pole has fallen over and requires immediate attention.
- low magnitude event of either vibration or tilt, indicating a change to a pole over time, which could trigger maintenance for avoiding a potential outage.

Chris Snow, Electronics Engineer at EkkoSense explains:

"We chose Arm Mbed because it allows us flexibility of silicon vendor without having to worry about low level API's and significant work should we change processor in future. There is a vast range of libraries available which can significantly reduce the development effort and let us focus on the product's features."

Backhaul
(Ethernet, 3G, wireless, wired, etc)

LoRa Endpoints   LoRa Gateway   Server   Remote Computer

Wakes on timer

Device Sends Instant status

ALERT DETECTED

Monitors activity for 10 seconds

Sleeps for 1 hour

Sends detailed message

Accelerometer detects alerts against set threshold and sends message

Application determines severity of alerts

"We needed a cost-efficient and reliable platform that could integrate LoRaWAN with the sensors while keeping energy consumption to a minimum. The Multitech xDot was perfect for us as it includes the radio module and processor along with enough IO for other components, and Mbed OS provided the right foundation to quickly prototype and scale the devices."

LIVE STATUS FILTER

ACCOUNT: EkkoSense

✓	OK	767
❗	WARNING	1
⊗	CRITICAL	4
⊖	NOT CONNECTED	48
	TOTAL	820

ALERTS

Date/time		Description
2018-10-16 15:01:40	⊗	BE1-431: BE1-431 Lean 30.14degrees
2018-10-16 13:01:25	⊗	DA29: DA29 Lean 89.05degrees
2018-10-14 10:02:13	⊗	BE1-431: BE1-431 Lean 29.98degrees
2018-10-13 06:01:04	⊗	ED-22: ED-22 Lean 89.24degrees
2018-10-12 21:03:20	⊗	BE1-441: BE1-441 Lean 89.21degrees
2018-10-12 20:00:41	⊗	BE1-239: BE1-239 Lean 88.06degrees

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Deployment Results and Looking to the Future

EkkoSense, with the support from Arm, have provided SSEN with a trial remote monitoring system providing an eyes-on web-based view of the status of the wooden poles associated with their transmission circuit that cross Skye. This will primarily be used to help pin point a wooden pole break, however it has also been discovered that field status data can aid maintenance priorities.

SSEN has indicated that proving the pole mounted device self-power set-up, along with the selected communication medium working in the challenging rural environment, with a high level of reliability is a game changer with regards to field monitoring systems.

"We're able to gather accurate statistics on the movements of wood poles and the 'g' forces they're subjected to over time. This information can be used to provide more reliable and precise forecasts for pole service life, which is invaluable data for utility companies," explains Snow.

In the future, EkkoSense's solution could easily be installed on any pole supported utility network line in the world. There may be variations in connectivity and device attachment methods, but the sensor unit itself and EkkoSense's application software will be universally deployable. They also see a huge potential in adding extra functionality to their solution and application beyond the electric utility. "We look forward to working with Arm to provide new features such as Firmware Update Over-The-Air and Cloud."