# Wimbex & Lowri Beck Case Study

## Wimbex Technology Project

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**During December 2011 to January 2014 Lowri Beck was a consortium member of an EU funded project exploring and developing technology for an Ultra-low Power Wireless Sensor Network for Metering Applications particularly in the field of water metering.**

Lowri Beck's contribution to the EU consortium was market intelligence, customer requirements, client engagement and dissemination of the Wimbex project results.

The WMBUS technology was trialled in both urban and rural water metering scenarios in Great Britain (Huntingdon, England) and Ireland (County Meath, Ireland). This case study examines the programme and results from the deployment of the technology within boundary box (underground) scenarios.

### Project Objectives

The Wimbex AMR system used wireless technology based on previous work done in the EU funded Syncsen Project combined with novel hardware and software to produce a cost effective water AMR solution for European clients. Lowri Beck was in a key position to test this type of solution in a practical environment due to our experience in field operations and our understanding of the UK market along with good working relationships with a number of UK Water Suppliers.

The objectives of the two trials of AMR Motes (Mote – metering device at a metering point) were:

- To deploy a number of Motes at water metering points and capture the metering data via a central gateway. This data was communicated over the internet to the Consortium's operational server in Barcelona. The trial was to be measured over a period of two weeks.
- To explore the capability of the 169MHz frequency band to communicate effectively from within the boundary box constraints (underground and flooded).
- To measure the effectiveness of an energy harvesting module.
- Explore rural and urban scenarios.
- To enable the Consortium to develop the final AMR technology solution.

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### Innovation

The design of the Wimbex network was devised to explore the capability of the 169MHz communications frequency (and compare with earlier trials using the 868MHz communication frequency) and the enhancement of battery powered devices with an energy harvesting module based on water flow. The AMR Motes operated in a 'sleep / wake-up' mode of operation and at the 169MHz communication frequency, which meant that they entered a deep sleep phase with ultra-low energy consumption until the next data collection. A synchronisation mechanism was developed to maintain synchronism with a new multi-hop networking and routing software package for the wireless WMBUS technology.

The network operated in three phases:

1. The network remains inactive between data processes.
2. All the meter Motes in the network wake-up simultaneously.
3. A multi-hop network was formed, and consumption data is collected from all meter Motes.

Wimbex utilised the wireless metering bus (WMBUS) technology. The data from the metering device Mote at each of the premises was collected by a centralised data collector.

The data collector converted the data and sent the information over the internet to an operational server in Barcelona. The data information was analysed and the test results obtained.

### Trial Parameters

Urban Trial – Water Utility, England

The WiMBex urban trial was conducted in the Huntingdon area of England (during January 2014). The trial aimed to test the technology using the 169MHz radio frequency, and to measure the coverage capability using 23 Motes, a single Mote

fitted into each domestic house boundary box.

The Mote technology was placed below ground in the existing boundary boxes at a number of homes spread across a housing estate and connected to Elster V210 water meters. As water flows through the meter, a pulse is generated for every litre and picked up by the WiMBex device. These meter readings were then transmitted via a synchronised wake-up network hopping arrangement to the data concentrator gateway.

Rural Trial – Meath Hill Group Water Scheme Society, Ireland

The Rural Trial was conducted in the County Meath area of Ireland during December 2013 using the same technology and in the format of two networks with each Mote fitted to a meter post at each water meter location.

### Lessons Learnt

Urban Trial

In the urban trial in Huntingdon, England 23 Motes were deployed in a domestic property housing estate with below ground boundary box metering point locations.

A summary of the trial result was;

- 125 metre maximum single hop distance from Mote in boundary box to Data Collector Gateway.
- 80 metre maximum distance Mote to Mote in boundary box.
- 218 metre maximum three hop distance from Mote in boundary box to Data Gateway.
- Regular meter reads obtained from 12 of 23 Motes.
- Motes were often submerged in water.

In the urban trial only12 out of the 23 Motes managed to connect permanently with the data collector due to water ingress that was observed during the measuring and decommissioning activity.

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These results indicated that the wireless communication range of the Motes was satisfactory based on the urban scenario in Huntingdon but would be challenging outside of urban housing estate topography. The power of the RF transceiver was set at a high level to enhance the capability of a Mote to reach the nearest next Mote.

This had the negative result of using more battery power during the ‘awake’ period. The transmission path between the Data Collector and the Motes was heavily affected by the below ground level of the boundary box and in many cases submersion in water. Finally, testing for the optimum communications range with test Motes was carried out and gave the Consortium practical measures for boundary box scenarios.

<u>Rural Trial</u>

**In the rural trial in County Meath, Ireland** two networks were deployed with 30 Motes in the North Network and 25 Motes in the East Network. The network topography of both North Network and East Network were similar.

The 30 Motes in the North Network all communicated with the Data Collector gateway but in the East Network only 14 of 25 Motes were able to reach the Data Collector gateway. Distances of 1.5km with 7 hops were achieved.

Following project analysis it was discovered that two technical issues affected the operational effectiveness. The integrity of the sealing of the Mote housing had been compromised allowing water ingress, and certain landfall contours required the introduction of bridging nodes ('Repeaters') to be installed in strategic locations in the East Network.

In practice, to install bridges nodes ('Repeaters') is a limitation since strategic locations may not always fall on utility company property. The installation of 'strategic' bridging nodes requires, in many cases, permission from a public entity (e.g. a local council) which can lead to other types of problems.

Another solution would be to increase the transmission power of the Motes. The disadvantage of using a higher power is that the power consumption is significantly increased. Another drawback is that the maximum power stipulated by the existing regulation (0.5W – 27dBm) will be surpassed.

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Another technical requirement that was observed during installation is the positioning of the Mote antenna. This was found to be critical for wireless range especially in underground level installations. A lower positioning or slight tilt of the antenna from the perpendicular axis can signify degradation of the radio and in many cases loss of signal. For the deployment in Ireland, the Motes were fixed to a meter post. It was important to install the Motes containing an internal aerial in an upright position with the antenna perpendicular to the ground.

## Conclusions

### Power Output

Based on the Motes being battery powered and no re-generation capability, power is then a major limiting factor to the overall design of the Mote.
The Licence Exempt Radio Specification in the 169MHz frequency band allows a maximum power output of up to 500mW (27dBm). However, this level of power usage, necessary to transmit from boundary boxes, will limit the overall life expectancy of the battery pack. This therefore becomes a ‘critical design factor’ in the final product version of the Mote.
Recommendation - This will require the design team to optimise power requirement vs wireless range.

### Aerial Design

The Motes were configured with the standard integrated 15cm stub aerial, underground in the boundary box and in many cases immersed in water. This would have had a detrimental effect on the radio signal being propagated from the boundary box.

Recommendation - An aerial separate from the Mote should be fitted in an optimum location; for example in the boundary box lid.

### Clock Synchronisation / Routing Protocol

The original SyncSen design utilised the RDS clock synchronisation signal, but this was considered to be a limiting factor with the expected phasing out of the RDS service. A new crystal/synchronisation and routing protocol solution was developed for the WiMBex design but this was not available during the trial. Without this software stack the Motes lost synchronisation which resulted over a period of time in the failure of data being transmitted to the gateway.

Recommendation: Introduce the new synchronisation and routing protocol software stack which will ensure that the Motes continue to communicate with the gateway via the most efficient route.

### Mote Housing IP Requirement

Following decommissioning of the Motes it appears that a number of the communication failures were due to water ingress.
Recommendation: Final product must meet IP68 specification

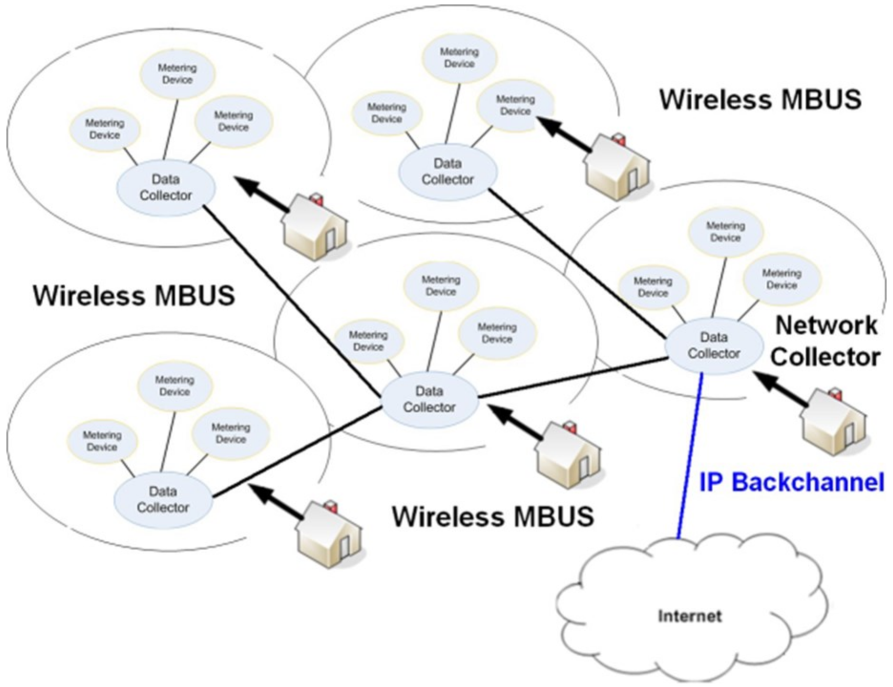
### Battery Pack / Energy Harvester

For the test trial the battery pack was designed for short term operational use. The Energy Harvester unit (EH Unit) was testing in both a test environment and in the rural field trial. It was noted that the flow/energy harvesting technique was successful and the EH Unit matched well with the Mote design enhancing the battery power arrangement. Some further work was required to measure the effect and compatibility of the Mote and EH Unit with a range of domestic meters. Analysis of the decommissioned Motes provided usage information for the design team.

Recommendation: Long life lithium battery pack to be developed for optimum power output and battery life and further work on the EH Unit.

The Huntingdon, England trial was invaluable in highlighting the issues with the Motes and the technology, within an urban environment and in boundary box environment.

The Meath Hill, Ireland trial highlighted issues for the Motes and the technology within a rural environment with changes in topography.




The results and findings from this trial, as well as the recommendations and suggested functional requirements will be used by the Project Team in the next phase of the development of this AMR solution. Implementation of these recommendations should increase the technology design effectiveness, through both single or multi hop routing techniques, and will aid a cost effective water AMR metering solution to meet the requirements and needs of water companies and other users in the UK and across Europe.

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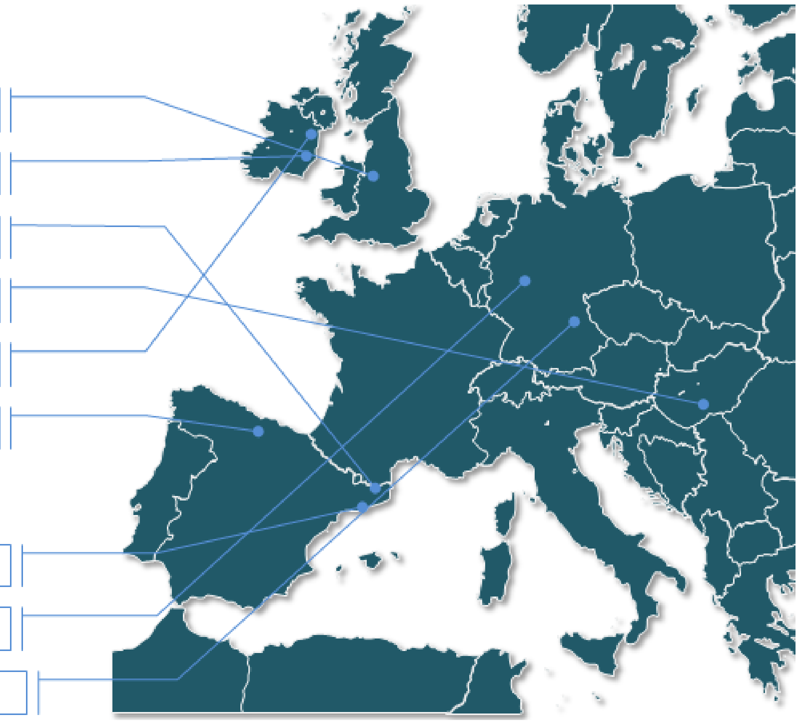
| 6 Companies | |
|---|---|
| Lowri Beck Systems Ltd | (UK) |
| OSSIDIAN Technologies Ltd | (Ireland) |
| JCB Electromecànica S.L. | (Spain) |
| CASON Engineering Plc | (Hungary) |
| Meath Hill Group | (Ireland) |
| Mecánica Industrial Buelna | (Spain) |

| 3 Research Centres | |
|---|---|
| CRIC (Project co-ordinator) | (Spain) |
| HSG-IMIT | (Germany) |
| HOCHSCHULE OFFENBURG | (Germany) |



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