

# Remote monitoring in open water

## Case study

### The challenges of open-water moorings

In every marina there are only a limited number of shore moorings available, and securing one is a competitive, costly and time-consuming exercise. Therefore many owners choose (or are forced to use) cheaper, more readily available open-water moorings. Whilst this solves one problem, it leads to others.

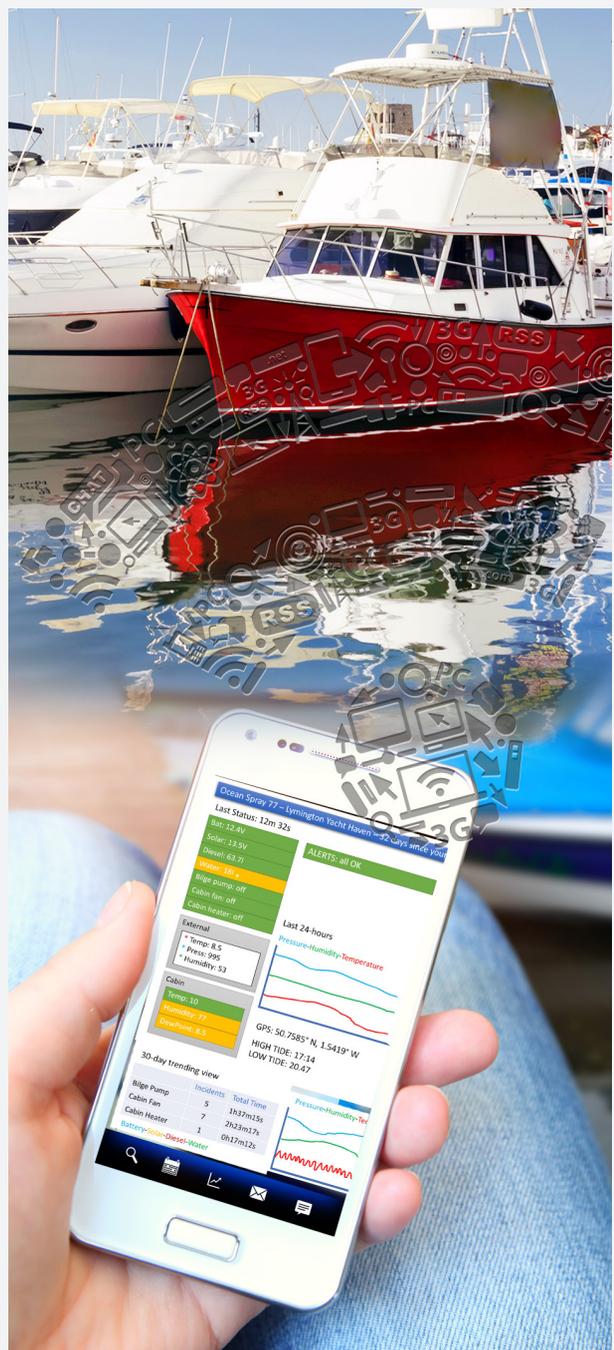
With open-water moorings, owners cannot directly access their boat from the land nor can they monitor their vessel's condition, which can quickly deteriorate if left unchecked. As boats typically remain stored for up to 90% of their lifetime, monitoring and maintenance is an essential part of boat ownership, therefore owners, understandably, much prefer shore moorings.

The result is marinas full of static boats, with marina operators unable to fully utilise the valuable land-side space available and owners frustrated by the cost, competition and compromise of mooring spaces.

### Solving the issues by addressing owner concerns

Thinnovation, an IT solutions and services provider, realised these issues could be resolved if owners were able to check and monitor the condition of their boat without physically being onboard. The need for direct access would be greatly reduced, enabling more boats to be moored in open waters.

When Thinnovation started to formulate its *Remon* remote monitoring solution, the team faced conflicting design requirements.



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## Complex design requirements

Remote monitoring is one of the greatest challenges faced by IoT system designers. Solutions are often required to operate in harsh environments with limited resources, and Thinnovation's *Remon* solution was no different.

Installed on a vessel up to 10km away from land, *Remon* would need to monitor almost every element of the vessel – from cabin temperature and humidity, to fuel and water levels – and be able to transmit this data to the Cloud wirelessly for owners to review and manage.

With sensors positioned around the vessel, Thinnovation's design brief required data to travel wirelessly from the boat in open water to the Cloud, covering a vast distance with only a battery power source in a cost-effective design.

### Design requirements

	433 MHz	Bluetooth	Wi-Fi	LoRaWAN	Cellular	Ethernet
Wireless	✓	✓	✓	✓	✓	
10km range				✓	✓	
Very low power	✓			✓		
Very low cost	✓					✓
No data subscription	✓	✓	✓	✓		✓
1-year battery life	✓	✓	✓	✓		
Always on	✓	✓	✓	✓	✓	✓
Reliable with obstacles / objects in data path	✓			✓	✓	
Flexible / expandable	✓	✓	✓	✓		
Plug and play	✓			✓		✓

### New design requirements

15m range	✓	✓	✓	✓		
10-year battery life	✓			✓		
Self sufficient	✓	✓	✓	✓		
Transmit large amount of data		✓	✓		✓	✓

From the table above, it is clear that there is not one wireless technology that could meet Thinnovation's initial design brief. Those which were most suitable still involved significant design compromises, such as having too short a range or being too costly. Having considered multiple wireless technologies and failing to find one suitable for their design, Thinnovation approached Acal BFi to find a solution.

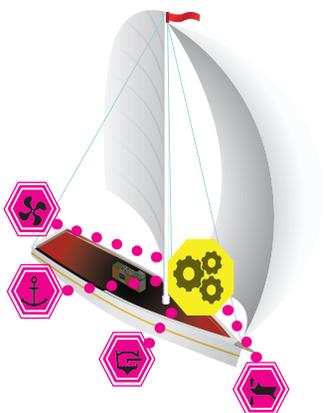
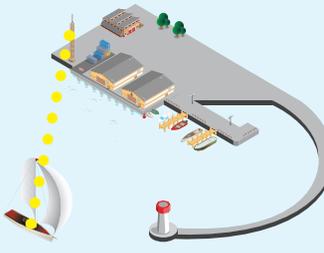
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## Overcoming technical barriers with innovative design

With his extensive experience in wireless technology, Acal BFi's Field Application Engineer, Alan Reed, was assigned to the project. Reviewing Thinnovation's design and application requirements, Alan agreed that there was no single wireless technology available that could deliver against every design parameter. However, it could be solved if the team used a different approach – splitting the data journey into smaller stages, each with a suitable wireless technology.

Working as their design partner, Acal BFi supported Thinnovation in finding the perfect balance between design and technology with the *Remon* solution, building on the strengths of each wireless technology throughout the data journey.



Stage requirements	Solutions considered	Final solution
<p><b>Collecting data from multiple onboard sensors</b></p>  <ul style="list-style-type: none"> <li>• Small amounts of data being collected</li> <li>• Strong signal strength</li> <li>• Battery life of up to 10 years</li> <li>• Strong penetration through solid walls/objects</li> </ul>	<p>Wi-Fi and Bluetooth – however, both technologies had range and reliability issues, and consumed too much power to operate over a 5-10 year period with only a battery power source</p>	<p>Alan's application experience meant he was able to recommend the perfect solution – a long-standing, cost-effective and established technology used for garage door remote controls. 433MHz radio technology, it operates reliably for long periods whilst only using a tiny amount of power</p>
<p><b>Transmitting data from the boat to the marina gateway</b></p>  <ul style="list-style-type: none"> <li>• Use battery as power source</li> <li>• Must last at least one year</li> <li>• Long range (up to 10km)</li> </ul>	<p>Cellular – short battery life and requires a monthly subscription</p> <p>Wi-Fi and Bluetooth – however, neither could cover the distance</p>	<p>Alan recommended LoRaWAN (Low Power, Long Range, Wide Area Network) technology. The modules only power up when a data package is ready or the information contained within it has changed</p>

Once the data has been uploaded to the Cloud, owners can access it at any time and from anywhere in the world through their *Remon* account. The account can be set up to send an alert should a break in, fire or flood be detected. It can also analyse data over long periods to identify potential trends, for example if bilge pump activity is slowly increasing or is greater than normal, owners can investigate this with preventative maintenance to reduce costs, increase safety and avoid potential issues, especially when out at sea.

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# The data journey from a remote vessel to the Cloud

**1 Monitoring data**  
Multiple onboard sensors monitor everything from water tank levels to boat location and movement

**2 Collecting data**  
Data from these multiple points on the vessel are collected by a central controller via 433MHz

**433 MHz**

**3 Transmitting data**  
LoRaWAN technology is used to transmit data packages from the vessel controller to the marina

**LoRaWAN™**



**4 Uploading data**  
Data is uploaded to the Cloud via the marina's secure internet connection

**5 Accessing data**  
Customers can log into their Remon account to see a full report of their vessel from anywhere in the world

**3G 4G**

**6 Adding more customer benefits**

**Wi-Fi**

To improve the design further, Alan recommended that a Wi-Fi module was added to the boat's central controller. It would remain inactive when not being used, but if the owner was onboard they could directly access their vessel data using their mobile device.

This also provided an alternative route for data to reach the Cloud whilst vessels are at sea. Using Wi-Fi to connect to the customer's mobile device, data could then be uploaded from the vessel's central controller to the Cloud via the customer's device's cellular connection, maintaining communication between the vessel and the Cloud.

## An intelligent solution from advanced design

With direct design and technical support from Acal BFi, this approach to the *Remon* solution enabled Thinnovation's concept to become a reality, despite numerous conflicting requirements.

Through intelligent design, Thinnovation's solution employed three wireless technologies on the boat and one wired connection in the marina to effectively send data from sensors to the Cloud, enabling owners to remotely monitor their vessel at any time and from any location.

- **Wireless** – using 433MHz, LoRaWAN and Wi-Fi technology
- **10km range** – via LoRaWAN, between boats and the marina
- **Very low power** – using 433MHz to communicate between sensors and the central controller, and LoRaWAN to transfer data from a power-sensitive environment (the boat) to the marina gateway
- **Very low cost** – recommending the best wireless technology for each part of the data journey, avoiding more expensive technologies
- **No data subscription** – none of the wireless technologies used have a data or access subscription cost
- **1-year battery life** – for vessel central controllers by using LoRaWAN to communicate with the marina gateway only when necessary
- **Always on** – by using the best low-power wireless technologies for each part of the data journey
- **Reliable with obstacles / objects in data path** – splitting the data journey into smaller steps using proven wireless technologies to establish secure, power-efficient connections
- **Flexible / expandable** – new features and benefits can be added without compromising the performance of the solution, with sensor modules all using 433MHz to communicate with the vessel's central controller.
- **Plug and play** – boat owners can easily install sensor modules and a central controller, and add new modules to their *Remon* system for extra functionality.
- **Transmit small amount of data** – between the sensors and the boat controller via 433MHz
- **15m range** – with strong penetration. 433MHz technology is unaffected by the boat's structure, and therefore provides reliable communication between the sensors and the central controller
- **10-year battery life** – for sensor modules by using very low-power, 433MHz radio technology
- **Self sufficient** – software updates and responses to received data can be sent to boat controllers and sensor modules via LoRaWAN and 433MHz
- **Transmit large amount of data** – from the marina to the Cloud via Ethernet

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## Why LoRa?

LoRaWAN technology typically uses a star-of-stars network topology, with data generated by and sent from end devices to a central network server location via gateways. End devices, such as sensors, use LoRaWAN technology to wirelessly and efficiently communicate with one or multiple gateways. Messages are typically very small and end-point communication is generally bi-directional.

Gateways act as transparent bridges to relay messages between end devices and a central network server. They also support operations such as multicast, enabling software upgrades over the air or the mass distribution of messages. Gateways are connected to the network via standard IP connections such as Wi-Fi, Ethernet or cellular.

## Boat controller: USI LoRaWAN module

**Product: WM-SG-SM-42**

The USI LoRaWAN module offers customers one of the highest levels of integration in a compact, lightweight package. It can connect to multiple sensors and actuators with 20 general purpose input/outputs. The U.FL connector allows an external antenna to be used, enabling use in harsh environments and metal boxes.

Operating on both 868MHz and 915MHz frequencies, this one module covers global sub-1GHz spectrums, providing Cloud connectivity for *Remon*-equipped vessels in marinas around the world.

### Features

- Frequency range 868MHz (Europe) - 915MHz (USA)
- High sensitivity of -137dBm
- Wide temperature range, from -40 to 85°C
- CE, FCC, IC and LoRaWAN certified
- U.FL connector for external antenna, enabling use in harsh environments and metal boxes
- Dimensions: 12 x 13 x 2mm



## Marina gateway: Embit LoRaWAN gateway series

**Product: EMB-GW1301-O**

The EMB-GW1301-O outdoor LoRaWAN gateway is a multi-service platform which provides LoRaWAN connectivity with optional Wi-Fi, IEEE, ZigBee, Wireless M-Bus and Ethernet technology. The gateway can connect to thousands of end devices, enabling Cloud connectivity via LoRaWAN for multiple vessels in the marina.

The gateway can be preloaded with customer firmware and configurations, and can securely share updates from the Cloud to manage boat controllers and sensor modules over the air.

### Features

- Full compliance with LoRaWAN network protocol on 868MHz radio band
- Embedded web server for system supervising
- Secure communication protocols support
- Fully supports the LoRaWAN 1.0.1 specification



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## A great solution all round

### For boat owners – a more convenient way to monitor their boat

With the *Remon* solution, boat owners have greater access and visibility of onboard conditions wherever they are in the world. This reduces the need for direct access to vessels, enabling more boats to be moored in open waters – a cheaper and easier option. Owners can be sure their valuable assets are safe, secure and protected without being onboard.

### For marina operators – the ability to fully utilise all of the available space

*Remon* successfully resolves owner concerns with open-water moorings, enabling operators to successfully market and utilise all of their available mooring space, increasing revenue by using both open-water and land-side mooring spaces.

### For Thinnovation – bringing a class-leading product to market

Acal BFi's direct support enabled Thinnovation to bring a better, more sophisticated product to market in a shorter time frame for a lower cost. By breaking the data journey into smaller connections, every application requirement – wireless range, battery life, variety of monitored elements – was met or exceeded. By using the latest technology in their design, Thinnovation had the leading edge in a competitive market.

### For Acal BFi suppliers – inclusion in the latest designs and solutions

Acal BFi's suppliers were able to support a brand new product which could be implemented across multiple sectors, markets and geographies. Their solutions can be used in more applications, ensuring the very best technology is deployed in as many markets and sectors as possible.



Nic Burkinshaw,  
Director, Thinnovation

"Acal BFi were instrumental in the *Remon* solution. They provided access to the latest technology with fantastic technical insight to give us a leading edge in the marketplace. Without their support it could have taken years to develop the features the *Remon* solution now includes.

"*Remon* brings to market a more complete solution which appeals to a wider audience. Acal BFi directly supported us with our design challenges, with their technical expertise turning design compromises into competitive features."



Alan Reed,  
Field Application Engineer,  
Acal BFi

"The *Remon* solution is a brilliant piece of design which solves the many issues faced by marinas and boat owners. However, to be truly effective it needed to overcome numerous technology challenges itself. The design requirements could have prevented Thinnovation from bringing an innovative product to market.

"Working closely with the team we were able use our extensive IoT knowledge and expertise to recommend and supply the latest technologies. This effectively resolved the design issues and brought a host of new features, advantages and enhanced performance to the product."

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