

Tank monitoring white paper

How wireless connectivity is driving new efficiencies in remote tank monitoring

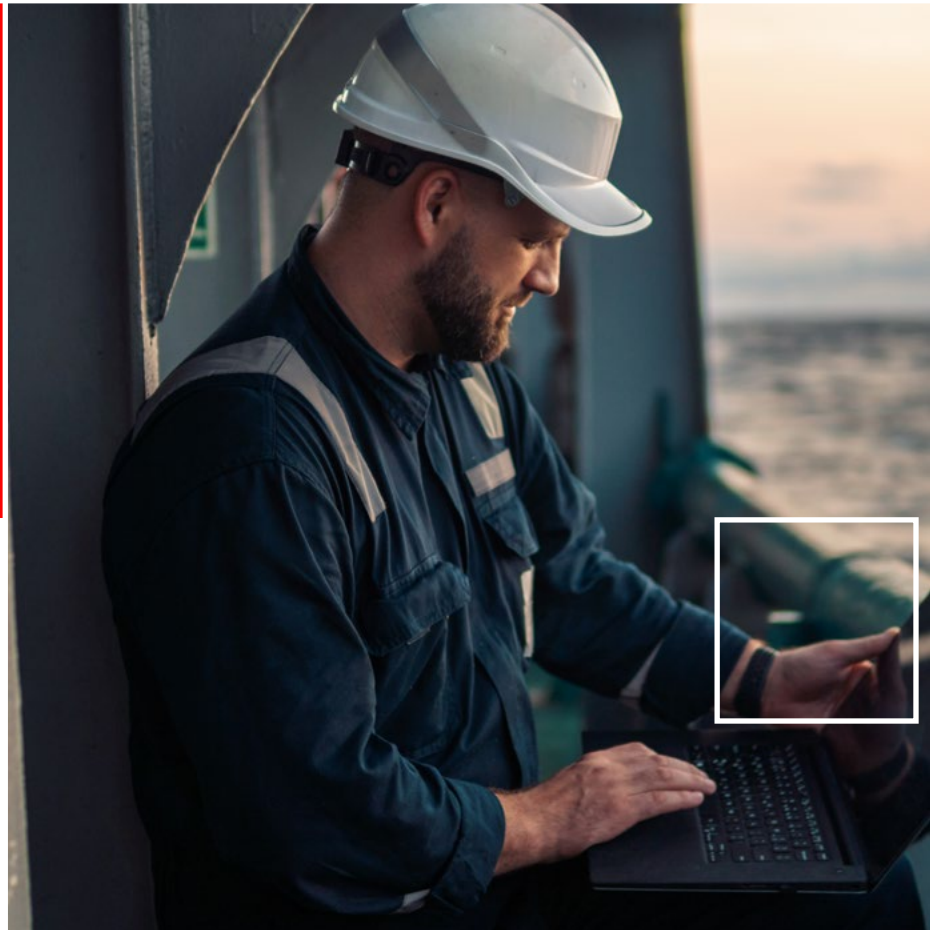


Table of contents

— Introduction	3
— Make the connection	5
— From the gateway to the data	6
— Unleash the business benefits of mass-market localization	7
— Keep critical infrastructure secure	8
— An example use case	9
— Conclusion	10
— APPENDIX I: How Quectel helps remote tanking monitoring solutions	11

Introduction

Tanks and the substances they hold are a critical part of many business processes with downtime an unacceptable risk if levels run low or, in the case of waste tanks, capacity is filled. Traditionally, tank monitoring has been an inefficient process involving sending a person to check the level of a tank by visually inspecting the level. Alternatively, loose estimates have been used so trucks have been sent to refill tanks that do not need filling or to empty tanks that are not yet full. This is highly inefficient leading to wasted truck journeys, repeated trips and keeping money tied up in excess inventory.

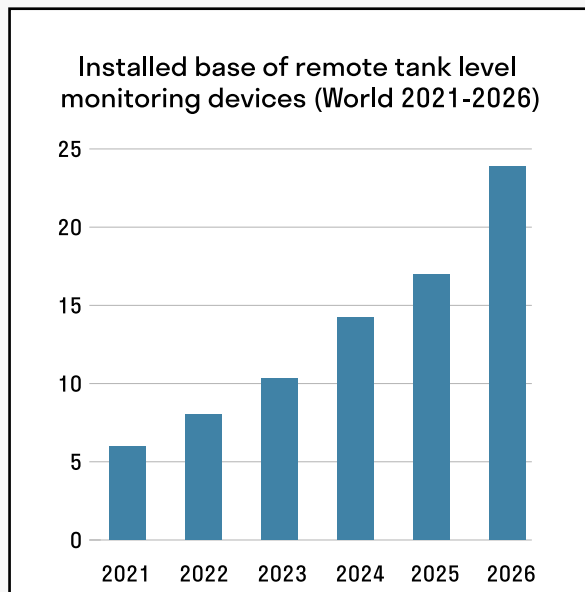
For organizations that utilize tanks for fuel, water, waste liquids and sector-specific substances such as both fresh and used cooking oil, this inefficiency is being eradicated thanks to Internet of Things enabled tanks that can be monitored remotely. The relatively simple addition of a sensor or multiple sensors for different inputs and a gateway to a tank can allow it to communicate its status in real-time, thereby enabling far greater precision to be applied to refilling and emptying schedules. In addition, the need for physical checks is removed and anxiety about the amount left in a tank is taken away by the ability to provide exact, current data.

These benefits enable organizations to optimize their tank operations to ensure maximized uptime, minimized cost, efficient inventory management, enhanced environmental sustainability and enhanced safety thanks to minimized supply journeys and manual inspections. In addition, the gateway can be utilized to enable other activities such as sensors that monitor the conditions of the tank both inside and outside to ensure the substance it contains is not being affected by extreme cold, heat or moisture. This is a critical consideration for tanks that store volatile substances such as chemicals or gases and for sensitive materials such as grain or fertilizer.



It's therefore no surprise that remote tank monitoring is a growing and substantial global market. Research firm, Berg Insight, estimates that the global installed base of active remote tanking monitoring systems exceeded 6.2 million units at the end of 2021 and is growing at a compound annual growth rate of 29.9% with the firm expecting the active installed base to hit 23 million units in 2026. The North American market leads current adoption with more than 2.6 million active remote tank monitoring units deployed. It is followed by Europe with 1.5 million and the APAC region which has 1.4 million units deployed.

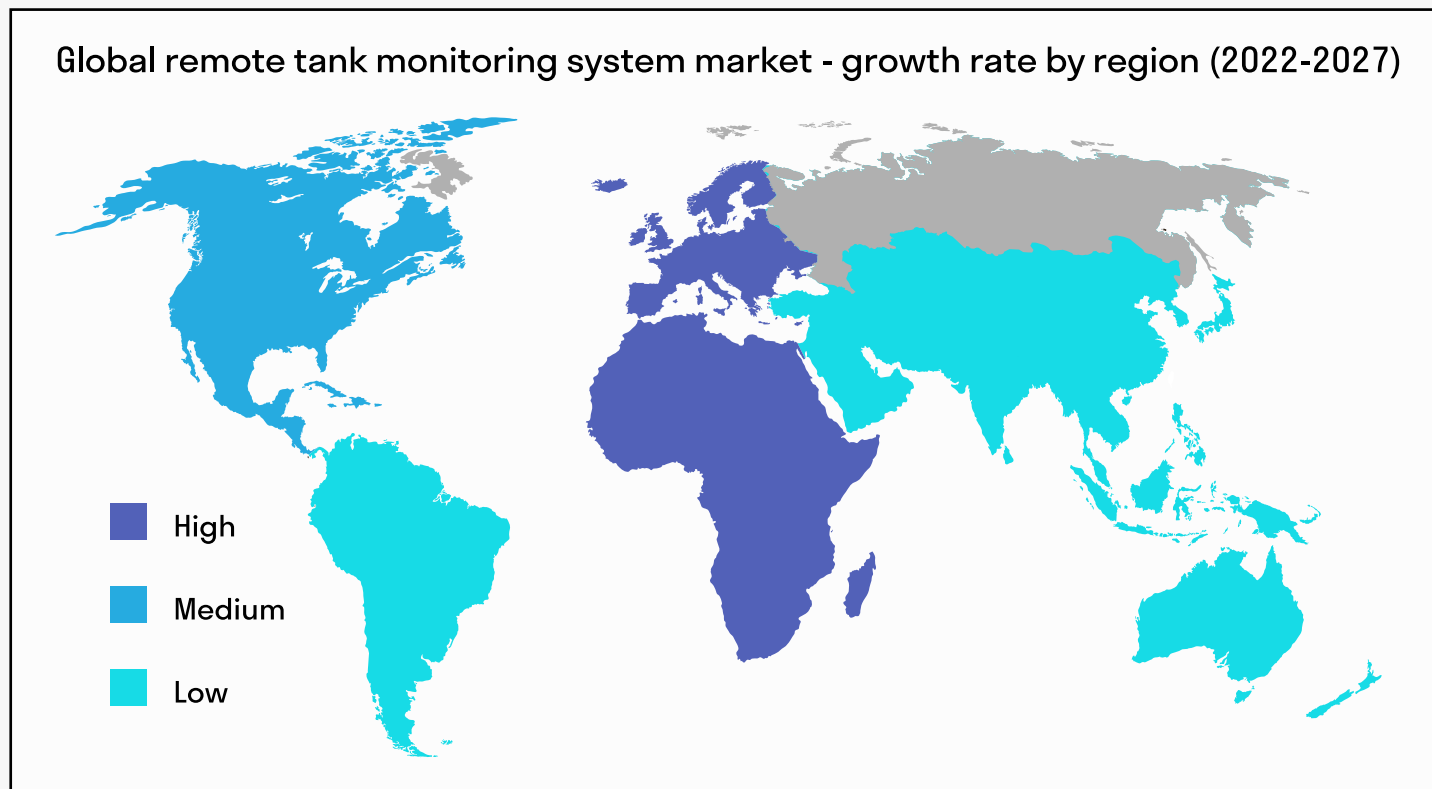
FIGURE 1:



Source: Berg Insight

These figures demonstrate a market that is at a relatively early stage. If you consider the sheer number of tanks in the world, a vast volume still need to be connected across industries as diverse as: water and wastewater, fuel oil storage, residential oil tanks, propane gas tanks, chemical distribution, liquid fertilizer, groundwater and septic tanks, welding gas distribution and beverage carbonation. Now, organizations are seeing the value of enabling remote tank monitoring and deploying a variety of solutions to power their systems.

FIGURE 2:



Make the connection

Although the technology involved in remote tank monitoring is well-established and relatively simple, there are several choices for organizations to make concerning the technologies they adopt. A baseline requirement is to select the sensors that each use case needs to deliver value. Basic examples include a liquid level sensor to report and monitor the amount of the substance left in the tank and these can be augmented with additional sensors to report on heat or moisture and potentially shock or vibration as a means to secure tanks and prevent thefts.

The critical enabler of the “remote” part of remote tank monitoring is the network connection that enables the sensor data to be communicated to the back office. This typically involves installation of a gateway device that contains a wireless module at the tank. Tanks typically utilize cellular networks for wireless communications because they are cost effective, have wide coverage and offer low set up costs. Connecting to a 4G network, for example, requires no wiring and can be a very cost effective method of delivering the low bandwidth connectivity that tank monitors require. With the ongoing retirements of 2G and 3G networks across the globe, 4G in the form of LTE Cat 1/LTE Cat 1 bis is expected to be the most popular network selection for tank monitoring.

Alternatives include other low power wide area (LPWA) networks, such as narrowband-IoT (NB-IoT). These are dependent on network coverage increasing but they will easily be able to cope with the demands of common remote tank monitoring applications.

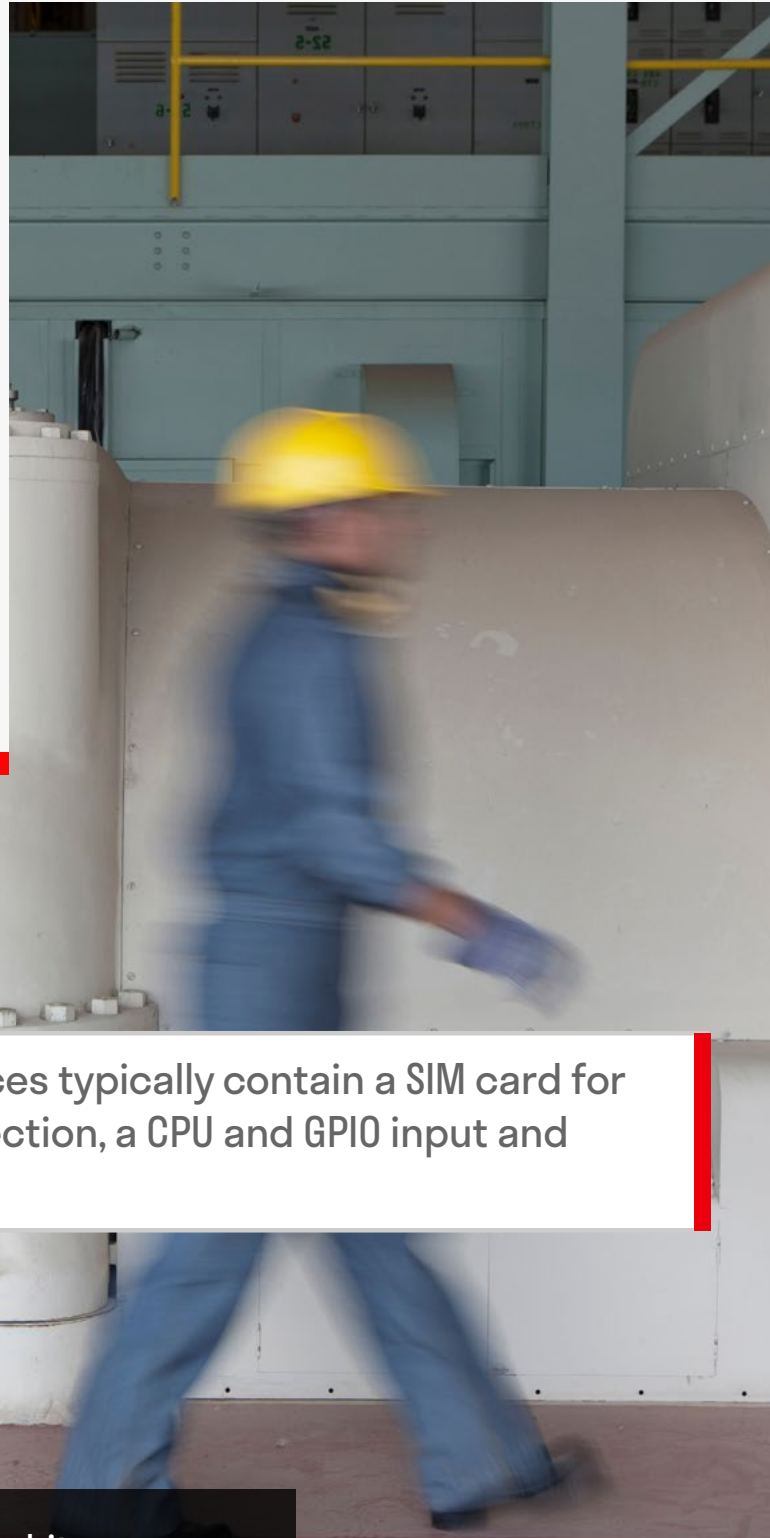
The mainstream of the tank monitoring market is well-covered with connectivity options but, away from population centers, further options are needed. Remote mining sites that have large fuel tanks for excavators and other equipment are often in remote locations that are not served by terrestrial cellular networks, for example. Organizations in markets that face coverage issues will need to consider satellite connectivity in the form of non-terrestrial networks (NTN) or other proprietary satellite communications services.



From the gateway to the data

Gateways for remote tank monitoring are typically powered by either mains electricity or batteries, either as a back up or to enable operations where mains power is unavailable or complicated to connect. Gateway devices typically contain a SIM card for cellular connection, a CPU and GPIO input and output ports. They also contain a cellular module and a GPS module – where required - plus an antenna to enable the connection.

Device requirements include robustness and low power consumption as well as the ability to support multiple frequency bands to maximize the number of sites in which a tank can be deployed. The gateway is then able to collect and send tank data to a central database for processing and acting upon. This typically happens via a remote tank monitoring service provider's application which can analyze and process data from all of an organization's tanks to perform trend and predictive analytics and to exchange data with third party applications, such as maintenance and other functions.



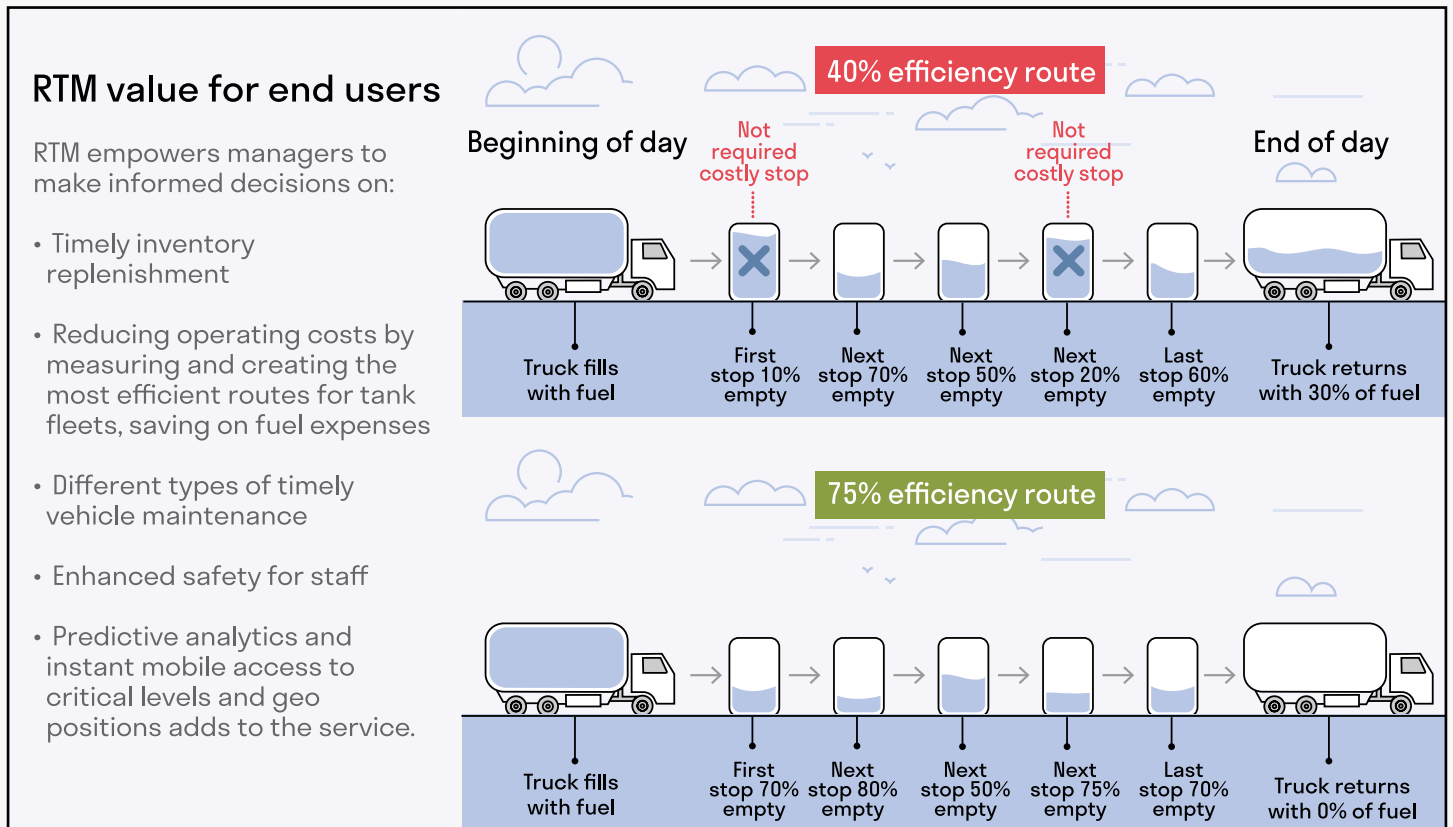
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Unleash the business benefits

Remote tank monitoring has now matured to the extent that hardware in the form of sensors and the gateway is now available for less than US\$100 per unit with costs for integration and software running at under US\$1 per month, per unit. This makes remote tank monitoring increasingly viable for even lower value use cases. If you consider the average cost of a cargo drop is around US\$65, having risen substantially due to increased

fuel costs, it is clear to see how rapidly remote tank monitoring solutions can generate a return on investment. The figure below details how a fuel delivery truck can optimize its route by utilizing remote tank monitoring data to understand which tanks need filling. The model suggests an increase in efficiency from 45% to 70%.

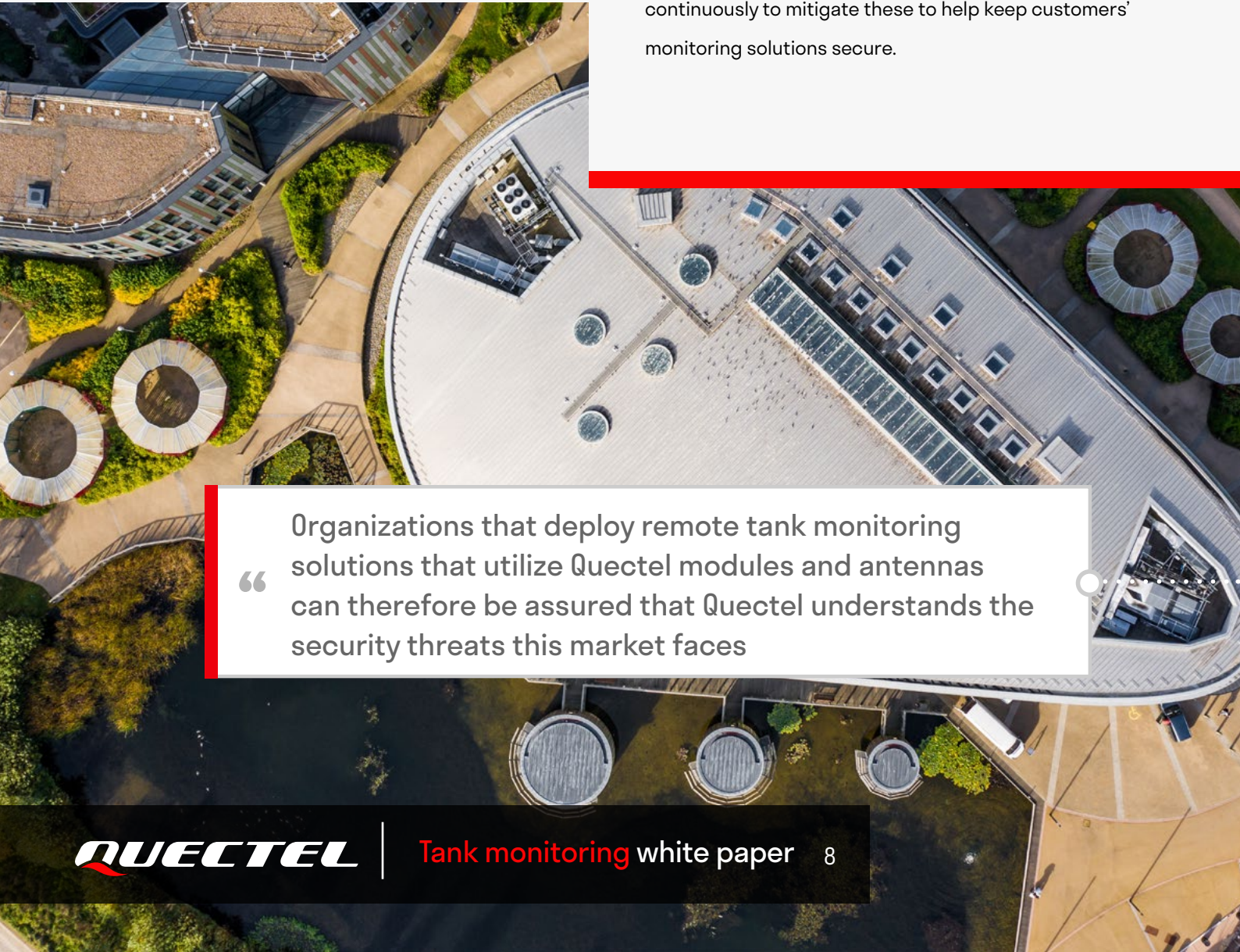
FIGURE 3:



Keep critical infrastructure secure

Tanks are not only fundamental to the smooth operations of numerous business processes, in many cases they are also critical infrastructure. Tanks that hold diesel to power generators at hospitals or factories are obvious examples of situations in which continuous power supply is essential but water tanks and heating fuel tanks are also critical to a wide variety of situations. Security is therefore a fundamental consideration for remote tank monitoring and an area that Quectel has focused on intently.

Quectel implements rigorous security measures to ensure the integrity of its products and services alongside customers' privacy and data management. As a member of industry bodies including GSMA, CTIA, CTA, 5GAA, 3GPP and GSA, Quectel actively participates in working groups to advance the IoT sector and security standards. Quectel modules conform to the network access standards of global operators and follow all the necessary network security specifications. Organizations that deploy remote tank monitoring solutions that utilize Quectel modules and antennas can therefore be assured that Quectel understands the security threats this market faces and is working continuously to mitigate these to help keep customers' monitoring solutions secure.



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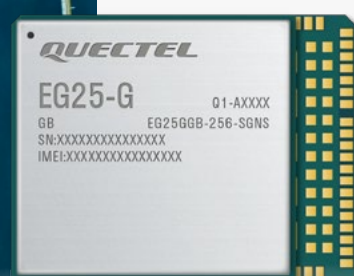
An example use case



LevelCon is a pioneer in the field of monitoring and tracking using advanced low power wide area (LPWA) networks. The company has been in the telemetry business since 2002, when it launched its first remote monitoring application using 2G and SMS, and is a full service provider IoT company for critical data acquisition. The company focuses on providing monitoring solutions with a tracking feature and has recently introduced its StarPin product series, which utilizes the Quectel BG95-M2 module.

StarPin is a Class I Division 1, group D-certified device capable of satisfying asset monitoring and tracking use case requirements of hazardous and non-hazardous materials at any location. StarPin is completely solar powered and helps industries in reducing their carbon footprint. In addition, the product is easy to use and can work indefinitely without any need for human intervention on solar power. StarPin is capable of bi-directional communication which enables remote provisioning and remote configuration, allowing industrial organizations to configure the unit without having personnel enter a hazardous area.

StarPin can communicate with Bluetooth Low Energy (BLE) sensors with mesh capabilities. This creates a complete industry-ready sensor node capable of being deployed in any use case. Large numbers of StarPin units are deployed in use cases such as propane monitoring and hydrogen monitoring which require hazardous area Class I division 1 certifications. Facing two challenges, in the form of GNSS implementation and NIDD connectivity, LevelCon was able to turn to Quectel for guidance and, in addition to using the Quectel BG95-M2 module for all connectivity requirements, also uses Quectel GNSS antenna solutions for StarPin. StarPin is now being deployed in India, Australia, Canada and the US.



Conclusion

The large number of remote tanks that are already deployed across the globe will benefit enormously from the addition of remote tank monitoring solutions. These will remove over- and under-supply challenges, save wasted transportation costs and time and help to ensure the condition of tank contents is maintained effectively and safely. Connectivity powers this cost-effective sector that is characterized by a mature retro-fitting market and a newer market in which new tanks are shipped with sensors integrated.

The remote tank monitoring sector will only continue to grow, bringing greater benefits for connected tanks as more and more data is gathered and predictive analytics empowers more precise insights to enable greater optimization on deliveries.



To learn more about Quectel's products and services that can help turn your remote tank monitoring project into reality, visit:

quectel.com/shop



APPENDIX I: How Quectel helps remote tank monitoring solutions

Quectel brings a wide portfolio of modules and antennas to the remote tank monitoring industry backed by industry-leading R&D and support services. The Quectel range of modules includes:

> LTE Cat M1 and NB1/NB2

The Quectel **BG77** is an ultra-compact LPWA module supporting LTE Cat M1, LTE Cat NB2 and integrated GNSS which meets the 3GPP Release 14 specification. The module achieves maximum downlink rates of 588Kbps and uplink rates of 1119Kbps and is able to operate in an extended temperature range of -40°C to +85°C. The module's integrated RAM and flash memory enables ultra-low power consumption, and the ARM Cortex A7 processor (which supports ThreadX) enables an up to 70% reduction in power saving mode (PSM) leakage and 85% reduction in extended discontinuous reception (eDRX) current consumption compared to its predecessor.

The BG77 is a size-optimized version of the BG95 so it is ideal for use cases in which space is at a premium. Use cases might include deployments that require modules to be embedded in tank level sensor devices that cannot exceed a specific size.

The module's highly integrated, cost-effective and compact SMT form factor of 14.9mm × 12.9mm × 1.7mm allows integrators and developers to benefit from its mechanical intensity and low power consumption and design their applications with ease, and its advanced LGA package enables fully automated manufacturing for high-volume applications. The module's comprehensive array of hardware-based security features enable trusted applications to run directly on the Cortex A7 TrustZone engine.

The Quectel **BG95** is a versatile family of multi-mode LPWA modules supporting LTE Cat M1/Cat NB2/EGPRS and integrated GNSS. Offering both NB-IoT and Cat M connectivity, the BG95 family offers variants to suit a wide range of applications at large scale. The modules are well-suited to tank monitoring deployments that involve large numbers of tanks, such as those for domestic heating fuel or for gas station networks that can involve large numbers of tanks, often with multiple tanks in the same location.



3GPP Release 14 compliant, the BG95 series offers maximum data rates of 588 kbps downlink and 1119 kbps uplink under LTE Cat M1 and an extended operating temperature range of -40°C to +85°C. The BG95 features ultra-low power consumption thanks to the integrated RAM/flash as well as the ARM Cortex A7 processor supporting ThreadX, achieving up to 70% reduction in PSM leakage and 85% reduction in eDRX current consumption compared to its predecessor.

The BG95 boasts a comprehensive set of hardware-based security features and enables trusted applications to run directly on the Cortex A7 TrustZone engine. With a cost-effective SMT form factor of 23.6 mm x 19.9 mm x 2.2 mm that enables the BG95 family to support high scalability and a high integration level, the BG95 enables integrators and developers to easily design their applications and take advantage of the module's low power consumption and mechanical intensity.

The BG770A-GL is a series of LPWA modules with an SMT form factor of 14.9mm x 12.9mm x 1.9mm and integrated GNSS engine, which supports LTE Cat M1 and LTE Cat NB1/NB2 bands. The module, which offers low cost and low power consumption and is therefore ideal

for battery powered use cases such as remote water tanks on corporate farms, is fully compliant with the 3GPP Rel-14 specification and provides global carrier band combinations. It features the MIPS 5150 processor and ultra-low power consumption by leveraging the integrated RAM and flash to achieve extremely low current consumption in various standby/hibernation modes, including 3GPP PSM and e-I-DRX. In addition, the BG770A-GL contains a GNSS and cellular-based location engine that supports GPS and GLONASS.

> NB-IoT

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The Quectel BC950K-GL takes cost efficiency even further. It supports NB-IoT connectivity in a 19.9mm x 23.6mm x 2.2mm form factor that weighs just 2.15g. Able to operate in an extended temperature range of -40°C to +85°C, the module is an effective enabler of remote tank monitoring use cases that have lower throughput demands and power consumption constraints to address. Use case examples include tanks that only need to communicate occasionally because consumption is low at their site.



> Cat 1

The Quectel EC21 is a series of LTE Cat 1 modules optimized specially for M2M and IoT applications. Measuring 32.0mm x 29.0mm x 2.4mm, the modules feature cost-effective, low-power LTE connectivity, and delivers maximum data rates up to 10Mbps downlink and 5Mbps uplink. These make EC21 series an ideal solution for numerous IoT applications that are not reliant on high speed connectivity but still require the longevity and reliability of LTE networks. The EC21 series supports an extended operating temperature range of -40°C to +85°C.

> Cat 1 bis

Further tank monitoring connectivity options come in the form of LTE Cat 1 bis, the single antenna version of LTE Cat 1, which offers 10Mbps downlink and 5Mbps uplink at a significantly lower cost than Cat 1 itself. The Quectel EG916Q-GL is an LTE Cat 1 bis module which is suitable for use in areas where NB-IoT is not available, such as parts of Africa. The EG916Q-GL also offers higher data rates and wider bandwidth than NB-IoT so it can enable applications that may for example also use a camera to supervise an area.

Designed in a compact and unified form factor, EG916Q-GL is compatible with Quectel LPWA BG95 series and BG96 modules and LTE Standard EG91 series, EG95 series and EG915Q-NA modules. The ability to add camera feeds can make a compelling addition to a tank monitoring solution especially where pilfering is an issue such as in tanks at construction or mining sites.

> LTE 450 band options

For deployments that utilize the 450MHz band, the Quectel EG912N-EN ASR-based LTE Cat 1 module provides an ideal solution. It supports 450MHz and offers a maximum 10Mbps downlink rate and 5Mbps uplink rate. Designed in a compact and unified form factor, EG912N-EN is compatible with Quectel's GSM/GPRS M95, LTE Cat M1/Cat NB2/EGPRS BG95, LTE Cat M1/Cat NB1/EGPRS BG96, LTE Cat 1 EG91 and LTE Cat 4 EG95 modules, which allows flexible switching among different networks.



The robust performance of the device makes it ideal for mission critical use cases including metering and smart grid.

In addition, Quectel offers the BG95-M4 module for the 450MHz market. The module is in power class 5 and brings the characteristics of the BG95 family to the 450MHz category.

> Satellite

As the word remote suggests, many tanks that require monitoring are in inaccessible locations not served by cellular, LPWA or fixed networks. In these scenarios, such as mining sites, satellite connectivity is the only viable option. Quectel has two module families to address this need, the CC2660D-LS and the CC200A-LB.

The CC660D-LS is a 3GPP NTN (non-terrestrial network) satellite communication module which supports 3GPP Rel-17 (IoT-NTN) at L-band (B255) and S-band (B256/23) frequencies for satellite communications. With an ultra-compact form factor of 17.7mm x 15.8mm x 2.0mm, it is a perfect choice for size sensitive applications. The CC660D-LS adopts surface mount technology, which makes it an ideal solution for durable and rugged designs.

The low profile and small size of the LCC package allows the CC660D-LS to be easily embedded into space-constrained applications to provide reliable connectivity. This form factor is ideally suited to the strict requirements for cost and efficiency of mass production.

Quectel's CC200A-LB is a satellite communication module designed to provide communications in remote areas without cellular network coverage. It provides reliable global connectivity over the IsatData Pro (IDP) satellite service and features two-way communication, low latency and nearly-real-time reporting capabilities. The module has an LCC + LGA package and supports an AT command set which is very easy for customers to integrate and use. The CC200A-LB supports a wide range of industrial asset-tracking applications in poor network conditions where network connectivity is scarce or unavailable, such as transportation, maritime, heavy equipment, mining, oil and gas, and agriculture.

Of course, many tanks are not static and move from location to location, especially in the mining, construction and oil and gas sectors. In these situations, accurate location fixes are required to enable efficient refilling and to secure tanks. To address these requirements, the Quectel LC79H features a concurrent multi-constellation GNSS receiver. The LC79H can work on L1 and L5 bands for GPS, BeiDou, Galileo and QZSS satellites, L1 band for GLONASS satellite.



Compared with the GNSS modules working on L1 band only, LC79H greatly increases the number of satellites involved in tracking and positioning, thereby significantly reducing the multipath effect caused by high-rise buildings in urban environments, reducing signal acquisition time and improving positioning accuracy. Due to its low power consumption and high precision, LC79H is a popular selection for real-time tracking systems.

> Antennas

Quectel also has a comprehensive range of antennas to support remote tank monitoring deployments. For tanks that utilize LTE connections, the Quectel range includes the YC0001CA surface-mount design (SMD) antenna. This operates in the 700-960MHz and 1710-2700MHz frequency range, measures 35mm x 8.5mm x 3mm and is both RoHS and REACH compliant. Another SMD option is the Quectel YC0017DA. This 5G SMD antenna operates in the 698-3800MHz frequency range, has an antenna size of 25mm x 7mm x 3mm and is designed to be mounted directly to the host device PCB.



For deployments that require a flexible printed circuit (FPC) antenna, Quectel offers the YFCA002HA, a wideband LTE antenna designed for flexible mounting on the underside of any non-metallic housing with a cable and

connector for easy installation. Optimized for 4G, the antenna operates in the 700-2690MHz frequency band and measures 30mm x 20mm x 0.13mm, with a cable length of 75mm.

For external antennas, Quectel offers the YECT003AA LTE antenna which operates in the 698-960MHz and 1710-2700 frequency range. The YE0029FA is another external LTE monopole antenna and it operates in the 700-2700MHz frequency range.



The Quectel antenna range also addresses GNSS use cases. The Quectel YPGS001AA is a GPS PCB chip antenna measuring 7.0mm x 5.8mm x 0.8mm. The Quectel YFGA006AA is a high-efficiency L1/L2/L5/L6 FPC antenna with dimensions of 74.56mm x 24.5mm x 0.13mm. The Quectel YG0005AA is a ceramic patch GNSS L1 pin mount antenna that measures 18.4mm x 18.4mm x 4mm. The Quectel YB0017AA is an active patch external, magnetic mount antenna that supports L1 and L5 and is designed to work with various ground plane sizes or in free space. Quectel also offers the YB0031AA LTE and GNSS Combo antenna. This offers external antennas for LTE in the 698-960MHz and 1710-2690MHz and for GPS in the 1575MHz band. With a radius of 120mm x depth of 43mm and cable length 2,000mm, the screw mount antenna offers a neat solution for remote tanks that need both GPS and LTE connectivity.

For more information please visit quectel.com