LoRaWAN® and Multi-RAN Architecture Connecting the Next Billion IoT Devices

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Introduction

As IoT is embraced across industry verticals with a growing number of connected devices, the connectivity technology landscape remains complex and fragmented. To address the wide spectrum of vertical Internet of Things (IoT) applications, use cases, and device types, IoT connectivity must be flexible. The growth in IoT and connected devices can be broadly segmented into three categories: massive IoT, broadband IoT, and critical IoT. The vertical applications and use cases in each of these IoT segments have distinct network communication requirements that need a Multi-Radio Access Network (Multi-RAN) architecture. This white paper focuses on massive IoT applications that use multi-RAN architectures to connect IoT devices with limited processing power, transport small amounts of sensor data infrequently, and be expected to operate in the field over long periods, often with device autonomy over 10 to 15 years.

The massive IoT connectivity landscape is fragmented, as no single IoT connectivity technology has ubiquitous coverage and is capable of addressing all vertical IoT use cases. Notably, IoT vertical applications benefit from the broad diversity of available connectivity technologies that are chosen depending on various factors, including availability, network technology characteristics, commercial environment, business model, and implementation environment. Today, IoT connectivity technologies are served by heterogeneous/hybrid networks of Personal Area Networks (PANs), Local Area Networks (LANs), Neighborhood Area Networks (NANs), and Wide Area Networks (WANs). As the industry cautiously waits for the standards and commercial availability of 5G technology, there is a growing dilemma whether 5G will be the panacea for massive IoT connectivity and will co-exist with other network connectivity technologies.

The 5G Conundrum

As 5G technology standards are ratified by The 3rd Generation Partnership Project (3GPP) releases, over the next few years, phased rollouts of 5G technology are expected with some telcos already deploying citywide or campus networks in 2020. 3GPP's Release 17 of the 5G specification, which standardizes the New Radio (NR)-Lite specification, is expected to be ratified by the end of 2021. The 5G NR-Lite specification that is positioned to address some of the massive IoT applications is expected to be a simpler version of 5G NR, that will be able to deliver higher throughput of around 100Mbps and from a technical function, perspective sits between cellular LPWA network standards (NB-IoT and LTE-M) and 5G NR. However, 5G networks and, subsequently, the device hardware supporting the Release 17 specifications will not be commercially available until early 2024. Since the ratification of 3GPP Release 15 in 2019, along with several additional enhancements to cellular Low-Power Wide-Area (LPWA) network technologies; Narrowband (NB)-IoT and Long Term Evolution for Machines (LTE-M), also ensured that the cellular LPWA network technologies ratified in 3GPP Release 13 will co-exist with 5G NR and will also seamlessly communicate with the 5G core. 3GPP Release 16 includes further enhancements and adds new features to LTE-M and NB-IoT, provides and performance improvements in terms of NR co-existence with cellular LPWA network technologies and support to connect to the 5G core.

When 5G networks are commercially available, telcos will be able to offer differentiated connectivity that brings to the fore new cellular network capabilities in the form of deterministic networking, network slicing, and high-throughput, low-latency connectivity that will enable a broad array of vertical IoT applications across industries. However, unlocking the full potential of 5G will take longer than anticipated, as the technology standards are ratified, and the technology ecosystem matures. ABI Research estimates that 5G connection growth in tens of millions is expected only by 2023 with IoT verticals, such as Original Equipment Manufacturer (OEM) telematics and industrial IoT use cases driving early adoption.

NON-CELLULAR LPWA NETWORKS AND LoRaWAN®

Non-cellular LPWA network technologies have been in existence for decades in the form of proprietary Radio Frequency (RF) solutions. Vendors like Plextek, Cambridge Consulting, Texas Instruments (TI), OnRamp Wireless, Sensus, and Telensa have been enabling various niche Machine-to-Machine (M2M) applications through private network deployments across oil & gas, utility, mining, and smart city applications.

Semtech Corporation first announced its LoRa® portfolio of transceivers in 2012, initially addressing the demand for IoT applications using private networks that use LoRa®. In March 2015, the LoRa Alliance®, a non-profit association, was formed to manage and promote the LoRaWAN® protocol as an open LPWA network standard. In the last 5 years, the LoRa Alliance® has reached more than 500 global member companies. The LoRaWAN® extends into 162 countries served by 148 network operators. The LoRa Alliance® aims to develop an open interoperable LPWA network standard supported by a strong ecosystem as a response to the growing fragmentation from proprietary IoT technologies.

ABI Research estimates that, by 2026, LoRa® will be the leading non-cellular LPWA network technology and will account for over a one-fourth share of all LPWA network connections and more than half of all non-cellular LPWA connections. Total non-cellular LPWA connections in 2026 will reach 1.3 billion. Cellular LPWA connections, which include NB-IoT, LTE-M, and 5G, will reach 1.5 billion connections by 2026.

Certainly, LoRaWAN® and 5G will co-exist in the future in the form of hybrid networks or Multi-RAN architectures like cellular and Wi-Fi, which have demonstrated to be complementary in the past. Similarly, the complementary nature of LoRaWAN® and Wi-Fi is becoming evident in various IoT applications. Today, LoRaWAN® is a leading license-exempt LPWA network technology addressing massive IoT vertical markets, such as smart metering, smart city, asset tracking and logistics, commercial building automation, smart home, and other key vertical IoT markets. As millions of LoRaWAN®-enabled IoT devices are connected and continue to grow in the future, 5G networks will complement LoRaWAN® both as an access network technology and to backhaul data from gateways to the cloud or head-end systems.

Chart 1
LPWA Connections by Technology World Market

(Source: ABI Research)

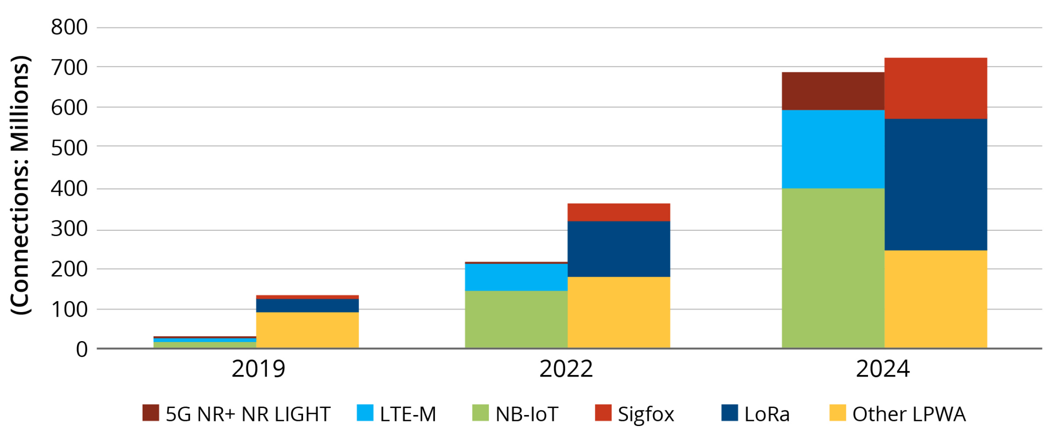

Table 1
Analysis of Massive IoT Applications' Data Consumption Trends

(Source: ABI Research)

Segment	Message Size (Bytes)	Message Duty Cycle	Message Frequency Average/24 hrs	Message Peak Frequency
Smart Meter - Electricity	1,200	3 hrs	8	10 mins
Smart Grid	100	12 hrs	2	10 mins
Smart Meter - Water	28	6 hrs	4	15 mins
Smart Meter - Gas	28	6 hrs	4	15 mins
Smart Street Lighting	280	12 hrs	2	5 mins
Smart Bins	14	12 hrs	2	15 mins
Smart Parking	10	30 mins	48	1 min
Asset Tracking	105	1 to 6 hrs	4	1 mins
Connected Agriculture	200	1 to 6 hrs	4	10 mins
Commercial Building Automation	1,450	1 to 6 hrs	4	5 sec
Home Automation and Security	2,048	30 mins	48	5 sec

Smart Meter: Energy and water utilities' smart meter rollouts account for the largest share of massive IoT deployments today, accounting for more than one-third of all IoT Wide Area Network (WAN) connections in 2019. Within the utilities' metering domain of electricity, water, and gas meters, electricity meters collect consumer usage data more frequently in the form of index reports. In the United States, utilities are gathering electricity data from smart meters more frequently, ranging from 5 to 15 minutes when compared to utilities in the rest of the world. Average usage data from electricity meters have a maximum packet size of up to 1,200 bytes, which is primarily used for meter-to-cash applications. Globally, smart electricity meters implementations are required by regulation to support the Device Language Message Specification (DLMS)/Companion Specification for Energy Metering (COSEM) protocol that can be bandwidth heavy for most resource-constrained LPWA network technologies. However, on October 23, 2020, French startup Acklio, a member of the LoRa Alliance® announced that its SCHC software stack will enable Kaifa's smart electricity meters to communicate through the DLMS/COSEM standard protocol over LoRaWAN®.

In comparison, battery-operated water and gas meters are simpler devices and not as feature-rich as electricity meters. Gas meter usage data are collected less frequently compared to electricity meters and, in most instances, data are collected a few times a day or sometimes a few times per week. Water meter index reports are collected twice per day at the least and can be as high as six data reads of 28-byte data packets transmitted four times per day. For metering applications, such as leak detection, pressure, and reverse flow data, data are typically collected at intervals of 15 minutes. Energy and water utilities are also deploying smart meters that include short-range wireless technologies, such as Zigbee, Wi-Fi, and Bluetooth, to connect to in-home display devices. The goal is that consumer interaction with real-time data will help change consumption behaviors. Smart metering is today the most deployed IoT vertical in the LoRaWAN ecosystem across various regions.

Smart Grid: As utilities' smart metering programs mature, the next wave of grid automation encompasses distributed sensor networks that are used to measure load, power quality, wire temperatures, and other condition monitoring applications to remotely monitor the health of utilities' field assets. These sensor devices are in the distribution network from the substation to the end consumers. The primary application of the sensor network deployed on the grid is to identify and trigger alarms to pinpoint fail points or outages. The data transmission from the smart grid sensor network is often event-based and the frequency of the data transmission is often a few times per day with data packet sizes not exceeding a few 100 bytes.

Smart Street Lighting and Environment Sensors: Data from street lights can include up to 20 different metrics, such as energy consumption, synchronization, and the health of the components, which are monitored and typically transmitted two or more times per day. The frequency of data transmissions and the data consumption can vary based on the customer use case and applications, such as configuration, dimming, scheduling, and settings changes, that can lead to variations in data transmissions from the endpoints.

Integration of sensors in the streetlight, such as acoustic sensors, traffic monitoring sensors, parking sensors, and environmental sensors are likely to drive an increase in frequency and packet sizes of data transmissions. Multi-radio wireless networks are being implemented in smart streetlights to automate the streetlight data collection process and to leverage the streetlight pole's infrastructure to create new connectivity infrastructure to enable other new smart city applications. There is a noticeable trend in the deployment of multiple IoT connectivity technologies leveraging streetlight poles to address broadband and massive IoT use cases, as well to backhaul data from smart city applications. This has been further demonstrated through the Charter Communications Proof of Concept (POC) implementation trialed in the United States *(LoRaWAN® and WiFi trial - An overview of use cases across regions combining two powerful technologies white paper).*

Smart Bins: As regional municipalities, cities, and private refuse collection companies optimize their business operations, such as collection route optimization, more are also deploying sensorized, connected containers. The use of smart waste services in large cities or areas with a high density of activity, such as tourist locations, impact the sensor data transmission frequency that can vary from every 15 minutes to one or two reports per day to collect data, such as container fill level, tilt, and movement, thereby optimizing bin collection and management.

Smart Parking: In smart parking services, sensors are installed in outdoor and multi-level indoor parking spaces to monitor space occupancy. Data transmission is triggered by the sensor when a space is either occupied or when the space is empty, along with daily reports on the device health. The data packets transmitted are less than 10 bytes and can remain in sleep mode for long periods of time. Several adaptations of smart parking sensors are also incorporating LPWAN technologies with additional radios, such as Bluetooth and Radio Frequency Identification (RFID) to enable Identification tags to authorize reserved parking spaces, such as the use of the disabled parking spaces.

Asset Tracking: Asset tracking data consumption is based on the weighted average of several different types of asset tracking categories, including intermodal containers, unit load formation equipment, industrial equipment, etc., but limited to tracking unpowered assets, which are primarily addressed by battery-operated tracker devices. Asset tracking sits in a broader category of asset visibility, which can be segmented broadly into three use cases:

- **Asset Identification:** High-volume package-level tracking of assets using either very low-cost re-usable or disposable tags.
- **Asset Track and Trace:** Includes tracking the location of stationary or slow-moving non-powered assets using battery-powered sensor devices. This also covers use cases where an asset's geolocation is traced when triggered by certain events, such as moving beyond the geofence or theft/loss.
- **Asset Condition Monitoring:** This covers IoT applications that allow for remote monitoring of the condition, status, or health of assets in the field.

Given the decreasing cost of hardware and smaller form factors, devices serving the asset tracking market can easily be retrofitted or embedded in assets, such as pallets, packages, containers, and other unit load formation equipment, to provide supply chain visibility. Most asset trackers today accommodate multi-radio architecture that includes short-range wireless protocols like Bluetooth Low Energy (BLE) and Wi-Fi for indoor location tracking and provide an interface with smartphones. GNSS for outdoor tracking, and WAN technologies such as cellular, LoRaWAN®, and Sigfox, are increasingly being used for network-based geolocation. The average data packet size for location tracking can vary from a few bytes to tens of bytes, depending on the connectivity technology.

With additional sensors, the average data transmitted, depending on the location data (Global Navigation Satellite System (GNSS) + network geolocation) and type of sensor data, can be up to 100 bytes. Asset trackers used in track and trace applications can have data transmission frequency that ranges from every hour to less than a few minutes in the case of asset trace applications. Semtech has introduced device-to-cloud geolocation services to further reduce device hardware costs and optimize battery consumption using the LoRa Edge™ solution, which combines Wi-Fi, GNSS, or LoRa® location data and processes data in the cloud to provide meter-level location accuracy.

Connected Agriculture: Includes a broad range of applications, such as condition monitoring and tracking farm assets. Condition monitoring applications use sensors to monitor soil, water consumption, tanks, containers, feed silos, storehouses, greenhouses, and barns. Among tracking applications, tracking the geolocation of livestock is also increasingly gaining traction, along with tracking farm equipment. Data from the condition-monitoring sensors can range from a few bytes in the case of tank fill-level monitoring collected once or twice a day, whereas the data packet size from other sensors that collect multiple environmental conditions or soil conditions can be higher and also done more frequently. Connected agriculture, similar to asset tracking and logistics, will also benefit from satellite-based IoT connectivity. Relying on Long Range-Frequency Hopping Spread Spectrum (LR-FHSS) modulation, standardized in the LoRaWAN® 1.04 specification, LoRaWAN® will be able to provide Low Power Sensors-to-Satellite (LP-S2S) connectivity where 5G coverage will not be easily available, especially in rural areas.

Commercial Building Automation: The adoption of smart building technologies in commercial buildings has been predominantly in buildings with an area of over 100,000 Square Feet (sq ft). Field equipment devices that consist of sensors and actuators are used to enable automation of building applications, such as Heating, Ventilation, and Air Conditioning (HVAC), lighting, access control, and fire and life safety systems. In 2019, wired connectivity accounted for nearly 91% of all field equipment devices shipped; however, wireless connectivity is increasingly gaining traction in key building market verticals, such as retail, hospitality, and offices where people occupancy monitoring is critical to optimizing building operations and improving the occupant experience. The need for dense indoor coverage requires wireless technology to be deployed cost efficiently on-demand to support dense sensor networks with tens of thousands of end nodes.

Furthermore, new applications, such as space management, environmental sensing, asset management, cleanliness, and hygiene management, are becoming essential both to enable new services for occupants and complement existing building systems. These new services will be enabled by simple and cost-effective wireless sensors and actuators enabled by multiple radio technologies, such as Wi-Fi, Bluetooth, LoRaWAN®, 4G, and 5G connectivity technologies, to provide a seamless sensor to cloud connectivity and interface for occupant control. The network of wireless sensor devices monitoring environmental conditions of commercial spaces has low data bandwidth requirements not exceeding a few tens of bytes transmitted every hour; for comparison, the average data packet size and frequency of data transmissions of existing field equipment devices can be in the few Kilobytes (KBs), depending on the application.

HOME AUTOMATION AND SECURITY

Smart home devices include various end devices with diverse connectivity requirements that have been addressed in the past by hybrid network architectures using various connectivity technologies depending on the device type (powered versus battery operated), application (single sensor versus multi-sensor), or bandwidth-heavy applications, such as video streaming. PANs using short-range wireless technologies have witnessed exponential growth in the last decade with growing penetration in smart home gateways and voice control devices embedded with connectivity technologies like Wi-Fi, Bluetooth, Zigbee, fixed-line, cellular, and proprietary sub-1 Gigahertz (GHz) connectivity technologies. The key challenge in this vertical is the lack of interoperability, as well as PANs' range limitations.

WAN connectivity technologies, such as 3G and 4G cellular and fixed-line connectivity, have been primarily used for data backhaul from smart home systems, whereby sensor node data is aggregated at a gateway or control panel and then sent to the cloud. However, this traditional architecture is witnessing competition from LPWAN technologies, providing direct device-to-cloud connectivity for a growing number of smart home devices. Amazon, which has pushed into the smart home market with the Echo and Ring ranges of products, made a recent announcement of the Sidewalk connectivity platform that supports BLE, Frequency Shift Keying (FSK), and Chirp Spread Spectrum (LoRa®) in the 900 Megahertz (MHz) band. Sidewalk-enabled devices, such as the Echo Show, Ring Floodlight, and Spotlight camera will double up as Sidewalk gateways capable of supporting a range of Sidewalk devices. The end devices will pair Sidewalk connectivity with BLE support for additional connectivity, and Sidewalk gateways will automatically connect Sidewalk endpoint devices to allow the network to track and locate enabled devices. Smart home sensor devices to gateway communications of a few bytes tend to occur multiple times per day, typically equaling only tens of KBs per month. However, data transmissions from multi-sensor devices, such as thermostats, cameras, and voice control devices, transmit up to a few hundred MBs of data per month.

Hardware and Software Platforms Integrating Multi-RAN Architectures

In analyzing the above IoT applications, it is clear that more and more network connectivity technologies will continue to operate within the device or in gateways. In the past, device OEMs had to decide on a single radio technology to work across various device types; however, as seen in the smart home ecosystem, multi-protocol, multi-radio chipsets, and System on Chip (SOC) designs are simplifying ease of IoT solution design and implementation. The broader IoT market faces similar challenges, and as the market grows, various semiconductor vendors are integrating multi-radio SOCs that support multi-protocol co-existence on a single hardware platform to further simplify IoT implementations and bring economies of scale.

Chipset vendors like TI, Silicon Labs, and Microchip offer SOC solutions that already integrate various connectivity technologies, including, short-range wireless, cellular, and wired connectivity. With the increasing demand for LPWA network technologies across industries and application verticals, there is a growing trend of multi-radio integration on single hardware that enables the co-existence of multi-protocol LPWA networks and short-range wireless radios, such as Bluetooth, Wi-Fi, and/or RFID. For example, STMicroelectronics with its STM-32WL multi-protocol SOC supports a range of sub-GHz radio technologies, including LoRa®, Sigfox, (G)FSK), G(MSK), Binary Phase Shift Keying (BPSK), Wireless M-Bus, and others. The LR-1110 LoRa Edge™ SOC from Semtech integrates LoRa®, GNSS, and Wi-Fi, primarily targeting geolocation for asset tracking applications.

Amazon in its recent announcement about the Sidewalk platform has re-affirmed this trend toward multi-radio integration. Amazon is partnering with Nordic Semiconductor, Semtech, Silicon Labs, and TI to create chipsets that integrate BLE, FSK, and LoRa® in the 900 MHz band to enable hosting new low-bandwidth applications that are not limited to a smart home. Responding to the prevalence of growing demand for multi-radio, multi-protocol environments in vertical IoT markets, network communication hardware vendors have developed intelligent gateways that support multiple wired and wireless technologies to support a wide range of devices and vertical IoT applications. The intelligent gateways also mitigate several challenges regarding wireless radio co-existence and interference.

The increasing demands from IoT vertical applications require more flexibility in network connectivity without compromising on the quality of service, cost, complexity, and coverage. Furthermore, upon analyzing the data transmission requirements of 32 application verticals, at least 11 IoT application verticals will account for nearly a three-quarters share of all IoT WAN connections in 2026, when end-device data transmission does not exceed more than 100 KB per month. This further reinforces the need for LPWA network technologies in enabling various massive IoT vertical applications and connecting battery-powered sensor networks.

Enterprise LoRaWAN® Implementations Based on Multi-RAN Architectures

ORANGE

Orange SA, one of the largest mobile network operators in Europe and Middle East - Africa, has also been an early proponent of LoRaWAN® connectivity for IoT, and in May 2016, it joined the board of the LoRa Alliance®. Orange has been developing a broad portfolio of network offerings, including 2G, 3G, 4G, 5G, and LoRaWAN® serving both Business-to-Business (B2B) and Business-to-Consumer (B2C) IoT application requirements. The installed base of devices on Orange networks reached more than 21 million IoT devices at the end of June 2020.

Orange's first LPWA network used LoRaWAN® deployed in 2016. Since 2017, it deployed LTE-M in its European Footprint (NB-IoT only in Begium and Luxembourg) networks. These networks extend across its European footprint, offering Orange's customers a wide variety of connectivity technology options that best address the market demand. Its multi-radio access network strategy is complemented by its Live Objects platform. Orange Live Objects enables device and data management for cellular and non-cellular LPWA network technologies, and any other Internet Protocol (IP)-based networks. Some examples of Orange enabling multi-RAN IoT architectures through its partners for enterprise customers are as follows:

COLD-CHAIN MONITORING USE CASE: JRI MYSIRIUS

JRI designs and manufactures cold chain monitoring and control solutions for various industries, including healthcare, food retail, and the energy sector. In 2018, JRI launched the JRI-MySirius solution that uses LoRaWAN®-enabled sensors and a cloud-based application platform to provide a turnkey temperature monitoring solution for both fixed and mobile assets. The JRI-MySirius solution provides enterprises the flexibility to implement the solution using either an existing public LoRaWAN® infrastructure or a private network.

The JRI-MySirius solution was chosen and implemented by a leading grocery retailer in France for real-time monitoring of its cold storage supply chain. The JRI system was initially used for monitoring the temperature of fixed installations and fleets of regional vehicles, and was later deployed on a national scale to provide real-time visibility to a 650-vehicle fleet, ranging from 3.5 to 19 ton vehicles, each equipped with two temperature-controlled refrigerated containers. Previously, temperature was monitored using data loggers that required manual collection from each refrigerated container every week. This system was not only labor-intensive, but as the data are processed on a weekly basis, this also severely limited the visibility of the supply chain's flow. After careful analysis of various IoT solutions in the market, the grocery retailer implemented the JRI solution using LoRaWAN®, which enables real-time monitoring of its assets. The LoRa® SPY sensors are attached inside the refrigerated container to measure the temperature at regular intervals and transmit data to JRI's Software-as-a-Service (SaaS)-based JRI-MySirius platform. The temperature sensors are independent of the vehicle's telematics system and communicate directly to the platform using public LoRaWAN®.

The sensors, which cost around €130, can also be remotely configured in case they need to be reused in a different refrigerated container units. Subscription costs start at €80 per year depending on the options of the service and the sensors. LoRaWAN® access can be over public networks, such as from Orange, or via a private LoRaWAN® in instances where a public network's indoor coverage cannot penetrate metallic structures, thick walls, and insulated cold rooms. Typically, a private LoRaWAN® is enabled using gateways with cellular backhaul to complement or augment a public network.

ERCOGENER/SNCF'S IoT USE CASE: ASSET TRACKING

French IoT device marker Ercogener, part of Groupe Zakat, has developed an end-to-end asset visibility solution for industrial assets using its EG-IoT 4E811 device. The device supports LoRaWAN®, LTE-M, NB-IoT, GNSS, and BLE 5.0, and includes temperature, accelerometer, and magnetometer sensors.

The asset tracking solution from Ercogener is implemented by Frances's national state-owned railway company, SNCF, to provide real-time visibility of its valuable assets. LoRaWAN® is the primary bearer in this application, providing long device battery life made possible because location and sensor information is only sent every 10 minutes up to a maximum of 144 messages per day. Longer battery life also limits truck rolls to replace batteries, dramatically improving overall device life cycle management costs.

The LTE-M radio within the 4E811 device is used for real-time tracking if the asset is lost or stolen and needs to be recovered. The LTE-M network is also used for supporting heavier bandwidth applications, such as updating firmware Over-the-Air (OTA).

MULTITECH

MultiTech, a leading supplier of IoT communication equipment and a founding member of the LoRa Alliance®, has been an early proponent of LoRaWAN®. MultiTech offers a wide range of communication equipment from embedded connectivity modems, routers, and intelligent gateways supporting most every cellular wireless technology both public and private for broadband critical communications with, GNSS for tracking, Wi-Fi, to empower worker productivity and Bluetooth simplifying out of band configuration, with LoRaWAN realizing massive IoT.

MultiTech's portfolio of gateway solutions includes the MultiConnect® rCell 100 series, providing ruggedized remote connectivity for a broad class of commercial and industrial assets connected over Ethernet, Serial, USB, Wi-Fi & Bluetooth across all price point supporting a mix of 2G, 3G, 4G-LTE Cat 4, Cat 3, LTE-M and NB-IoT cellular backhaul connectivity, that also includes lifetime fleet management through DeviceHQ a remote management platform.

The Conduit® programmable gateway was the original LoRa® gateway for industrial IoT applications with support for Ethernet, 2G, 3G, 4G-LTE, Wi-Fi/Bluetooth/BLE, and GNSS. Over the years, MultiTech's Conduit family has grown as its IoT strategy has focused on building a portfolio of LoRaWAN® solutions targeting five key vertical industry segments, including energy, smart buildings, transport & logistics, agriculture, and healthcare. In the energy segment, MultiTech is making significant inroads within the oil & gas industry by offering integrated LoRaWAN® network connectivity solutions with MultiTech Conduit gateways and the LENS® platform, a distributed LoRaWAN® embedded network server and key management toolset. Where data processing, decision making from data received from LoRaWAN® assets is securely processed OnPrem within the Conduit Gateway, closer to where the data is being consumed. While integrated directly to often isolated OnPrem SCADA & Process Control Networks as well as cloud based data management platforms. Improving privacy, while greatly reducing on backhaul data, cloud compute, storage and LoRaWAN® centralized operating costs.

CHEVRON'S IoT USE CASE: TANK CONDITION MONITORING

Chevron, one of the world's largest energy companies, has embarked on a multi-year initiative to digitize its operations in oil field production and at retail service stations. Over the next few years, Chevron plans to connect all its high-value critical field assets with wireless IoT sensor devices and remotely monitor their health with the goal of applying advanced analytics to predict when maintenance is required, rather than when a machine breaks or is underperforming. Chevron wants to harness the constant stream of real-time data to generate valuable business insights, to drive the overall performance of business operations, improve reliability, and reduce costs. In the past, oil & gas companies have relied on a combination of wired and wireless connectivity technologies, often proprietary, to monitor its oil field operations. However, the recent developments in open standards wireless connectivity technologies are enabling Chevron to quickly install machines with sensors that, in the past, took weeks to months of wiring and installation to legacy supervisory and control networks.

Chevron's San Joaquin Valley (SJV) business unit in California operates in six oil & gas fields spread over 100 square kilometers. In 2019, Chevrons SJV business unit implemented LoRaWAN® infrastructure to cover the oil fields with a few dozen MultiTech Conduit gateways with 4G cellular backhaul connectivity managed through LENS to process data from the Conduit gateways directly to Chevrons Azure IoT service using MQTT. The LPWA network is used to connect LoRaWAN®-based smart lids to more than 3,500 tanks wells on their way to 10,000 wells and tanks remotely transmitting fluid level readings, an activity done earlier by manually driving between wells using dipsticks and paper records. Following the successful implementation of the smart lids, Chevron's SJV business unit was able to significantly reduce drive time with the data collected from the smart lids, optimizing the supply chain operations and greatly improved well productivity. For Chevron, the Return on Investment (ROI) for the smart lid solution was nearly 10:1. Building on the successful smart lid implementation, Chevron's SVJ business unit plans to implement other remote condition monitoring use cases using its existing LoRaWAN infrastructure.

Conclusion

As IoT connects physical devices to digital assets, LoRa technology will play an integral role as a key LPWA network technology in the future. In 2020, as LoRa® technology completes 10 years since it was invented, the technology continues to evolve and expand its adoption across various IoT markets. As the LoRaWAN® footprint expands globally, IoT application developers benefit from the flexibility in network deployments (public and/or private) and the multi-RAN architecture to address a wide spectrum of massive IoT applications. 5G will initially be used in gateway to aggregate and backhaul sensor data to the cloud.

Furthermore, terrestrial networks that use LoRa® will be complemented by multiple constellations of Low-Earth Orbiting (LEO) satellite-based LoRa® connectivity from service providers such as Swarm Technologies, Fleet Space and Hiber to provide ubiquitous global Low power Sensor to Satellite (LP-S2S) connectivity. Originally conceived as a wireless connectivity technology for industrial sensor networks, LoRa® continues to thrive in the enterprise IoT. However, operating in the unlicensed ISM band, it is also becoming an increasingly popular choice among developers building LoRa®-enabled consumer applications. As enterprises explore ways to simplify IoT deployments at scale and consumer adoption begins to take-off, a multi-RAN architecture that consolidates multiple radio access network technologies into a single platform using LoRa® as a bearer technology is an efficient and cost effective solution to mitigate wireless network complexity at the edge.

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