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Low Power Networking Solutions for Second Gen Smart Metering

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New Options Available for Greenfield or Upgrade Advanced Metering Infrastructure

Ten years ago, the American Reinvestment and Recovery Act of 2009 spurred widespread investment in advanced metering infrastructure (AMI, a.k.a. smart meters) across the US. Since then, many electric utilities have realized those early investments no longer economically support the full breadth of applications and data traffic they currently need or desire.

New networking protocols have emerged over the past decade. As a result, utilities should not simply refresh aging infrastructure with legacy protocols. Rather, they must take a fresh look at the long-term operating benefits they can derive from their grid-edge field area networks (FANs) and consider the costs and characteristics of several new AMI networking options.

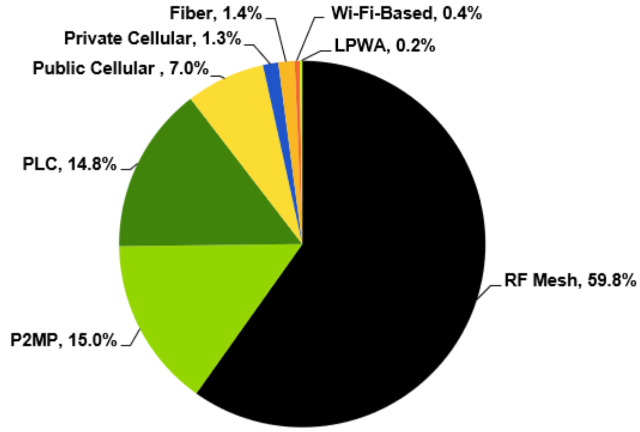
This Guidehouse Insights white paper provides a high-level technical evaluation of several low power wide area (LPWA) networking protocols increasingly considered for AMI systems. It also compares these newer options with the most commonly deployed legacy wireless protocols: unlicensed radio frequency (RF) mesh systems and proprietary broadband point-to-multipoint (P2MP) systems relying on licensed spectrum. (Note that many of the newer LPWA protocols also operate in P2MP configurations, but in the context of this paper, P2MP refers to legacy broadband solutions that utilities have historically deployed for AMI.)

This paper also presents a heat map comparing the suitability of each technology based on characteristics of the AMI deployment. These include once/day meter reads versus 15-minute reads; urban, suburban, and rural environments; grid-edge applications such as transformer and voltage monitoring; and support for water and gas systems or smart city applications.

Overview of Legacy and Emerging AMI Network Protocols

Cooperative utilities across the US were some of the earliest to adopt smart metering, relying heavily on power line communication (PLC) systems to cover their typically rural, low density markets. PLC is advantageous, as it uses power lines already in place to send communications signals but lacks other desirable features, such as last gasp notification during an outage and the ability to perform grid-edge functions such as transformer monitoring. Power lines are also often prone to signal interference, and PLC lacks redundancy due to its reliance on a single path to the operations center. An estimated 15% of smart meters in the US rely on PLC technologies.

Figure 1 Installed Base Electric AMI Network Protocols, US: 2020



(Source: Guidehouse Insights)

Legacy P2MP systems account for another 15% of the estimated 92 million smart meters deployed across the country. Legacy P2MP systems can be relatively expensive, particularly if the terrain is hilly, as multiple base stations may be required to prevent signal fading. These systems also often rely on licensed spectrum, further adding to costs. However, licensed systems are less subject to signal interference and allow for higher transmission power.

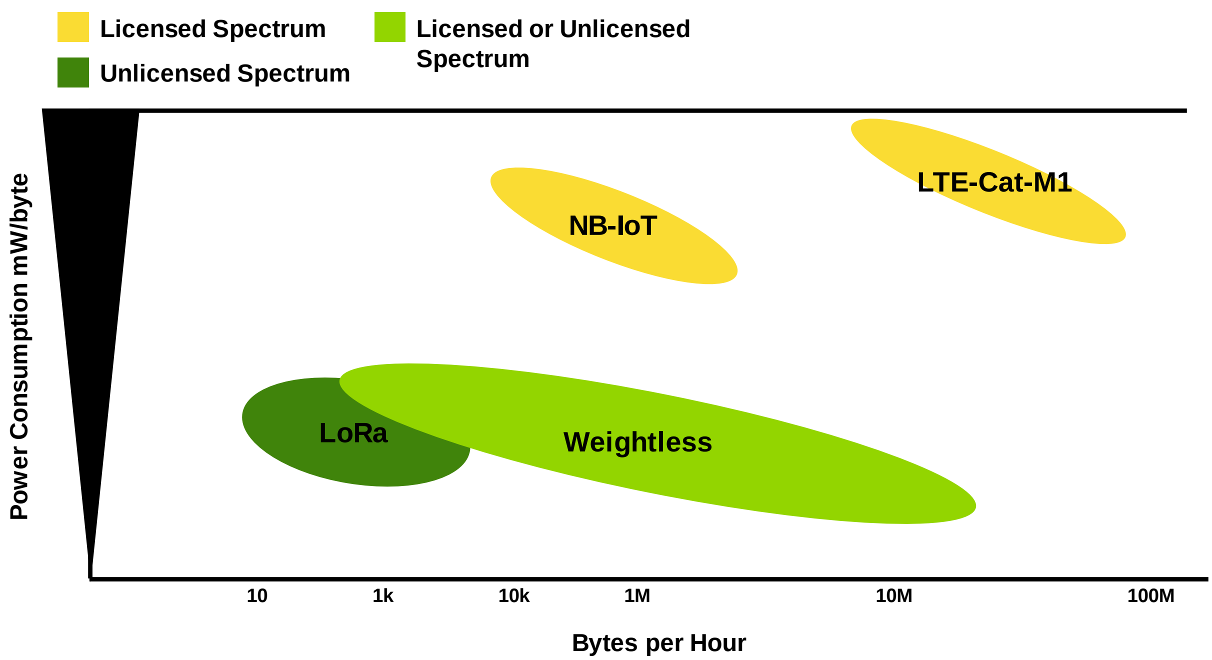
Large investor-owned utilities (IOUs), and increasingly municipals, have widely adopted unlicensed 900 MHz RF mesh systems. Guidehouse Insights estimates nearly 60% of the installed base of smart meters in the US relies on these technologies. Mesh networks have the advantage of being self-healing—if one node in the mesh fails, the signal is automatically rerouted along a different path, improving success rates. Additionally, the network requires less transmission power per device, as the distances between the nodes are shorter. Mesh networks allow end devices to act as repeaters, making it possible to deploy more nodes around a collector and reducing the number of back haul paths.

Mesh networks, however, are less able to handle rapidly increasing data traffic without new infrastructure. Over time, the total cost of ownership might rise markedly—particularly if new distribution automation (DA) functionality is integrated. Additionally, with Internet of Things (IoT) applications using more and more unlicensed frequencies, interference may become a growing problem. Although latency between any two nodes may be quite low, the need for the data to make multiple hops through the mesh reduces the effective throughput and increases latency.

LPWA Technologies Are Changing the Game

Several LPWA technologies may be considered low cost options for smart metering networks. In this analysis, Guidehouse Insights provides an overview of four standards in use for AMI: Weightless, LoRaWAN, Narrowband IoT (NB-IoT), and LTE Cat-M1. These LPWA technologies can be considered next-generation P2MP technologies that have benefited from the innovation around networking technology during the past decade.

Figure 2 LPWA Power Consumption vs. Data Capacity



(Source: Guidehouse Insights)

Broadly, LPWA technologies are less expensive than the legacy AMI networking options. These LPWA protocols have demonstrated higher quality of service, lower latency, and lower power consumption, paving the way for new DA applications and smart city functions such as air quality monitoring and smart parking.

These LPWA protocols are generally narrowband solutions, as opposed to the medium or broadband characteristics of legacy RF mesh or P2MP solutions. However, other characteristics of each technology can have a significant effect on their ability to scale for AMI-based applications and data traffic. The following sections discuss the important technical specifications to evaluate for any given AMI deployment. Table 1 summarizes these specifications for each LPWA standard.

Uplink Data Rate

The faster the uplink data rate of the protocol, the better it can perform more frequent meter reads and the more power efficient and spectrally efficient the communication. In the past, once-daily or 4-hour transmissions were common; however, utilities have implemented 15-minute transmissions—achieving more real-time monitoring of the grid. This increased frequency of transmissions is especially important as distributed energy resources such as EVs and distributed solar continue to grow. If data takes too long to transmit, the interval for uplinks must be lengthened or the number of meters a single base station can support must be reduced for all the data to be sent within the desired time window. A faster uplink rate accompanied by a reliable channel access method can translate into lower cost of

> *The faster the uplink data rate of the protocol, the better it can perform more frequent meter reads.*

deployment by allowing fewer base stations to support the same number of meters without compromising reliability.

Channel Access Method

The RF protocol's channel access layer performs an important role in determining the quality of service of a large network. Several channel access method techniques allow multiple data streams or signals to share the same communication channel or transmission medium. The major LPWA technologies use schemes including random access or asynchronous network (e.g., ALOHA) and scheduled access or synchronous network (e.g., TDMA). Random access methods such as ALOHA entail end devices sending data whenever there is a frame to send. A drawback of this approach is that large networks with more frequent uplinks result in packet collisions and wasted energy due to retransmission. Scheduled access methods such as TDMA divide the signal into time slots. A large network of end devices can reliably send in rapid succession, one after the other, mitigating any chance of inter-network collisions.

Uplink Payload Allowance

The uplink payload allowance affects the system's ability to perform more frequent meter reads containing more data. The larger the payload, the more data that can be transmitted at once (i.e., packet size). A low payload allowance means that packets may have to be split for transmission—increasing network traffic and limiting the number of meters supported per base station. The higher the payload allowance, the greater the scalability of the AMI network.

Furthermore, adequate payload allowance can support transmission of low resolution image data and sound bites, opening doors to new applications. Modern AMI systems provide data on voltage, frequency, kilovolt-ampere, bidirectional readings for solar installations, and more. A higher uplink payload allowance can enable analytics and other grid operations applications beyond consumption metering.

Meters/Base Station

The number of meters each base station can serve is directly correlated with the amount of uplink and downlink traffic, data rate, and payload allowance. The total cost of the AMI network is reduced when these characteristics are higher not only because the network requires fewer base stations but also because there is less need for real estate or leased tower space for those base stations, lower installation costs, and lower ongoing maintenance expenses.

Downlink Data Rate

A higher downlink data rate is beneficial in an AMI network for over the air (OTA) upgrades to the system software, as well as for acknowledging receipt of meter data. An OTA upgrade can paralyze older AMI systems, preventing meter data from being sent for hours or even days. With regard to message acknowledgements, a meter might continue transmitting until it is told that the data has been received; during this time, the meter will resend the packets, using valuable network capacity. A faster downlink rate means that the OTA system upgrade is

> *A higher downlink data rate is beneficial in an AMI network for over the air upgrades … as well as for acknowledging receipt of meter data.*

completed more rapidly, and that meters receive message acknowledgement quickly.

Downlink Payload Allowance

The downlink payload allowance affects the speed at which system upgrades can be sent throughout the AMI network. It also ensures that message acknowledgement is received throughout the network.

100% Acknowledged Messages

Some networks ensure that data is resent until the central system acknowledges receipt—but not all. As previously noted, a meter that does not receive acknowledgement will continue trying to send the packets—reducing the overall network efficiency. One-hundred percent acknowledged messages ensures no gaps in the utility's meter data. Accurate, granular meter data is critical for accurate time-of-use (TOU) billing, load forecasting, demand response (DR), energy theft detection, and more.

OTA Firmware

With adequate downlink data rates and payload, as previously described, system firmware can be efficiently upgraded or repaired OTA, eliminating costly and time-consuming truck rolls. Synchronous protocols such as Weightless, NB-IoT, and LTE-Cat-M1 can support new OTA firmware updates. Weightless can support unicast, multicast, and broadcast of firmware updates.

Supported Frequencies

All the LPWA standards included in this analysis have been designed to use unlicensed spectrum bands, in the 900 MHz or 2.4 GHz range in the US. LPWA network (LPWAN) standards can, however, be designed to work in licensed spectrum as well. LTE-based standards—NB-IoT and LTE Cat-M1—are offered by public cellular carriers over licensed spectrum. Unlicensed bands may be used free of charge, while using a carrier-based licensed solution entails ongoing monthly service costs.

Downlink and Uplink Channel Bandwidth

As these networks typically rely on unlicensed spectrum bands, the downlink and uplink channel bandwidth become important in order to use the available spectrum in the most efficient manner possible. A narrower channel bandwidth is more advantageous, as it is easier to find a clean block of spectrum to operate in. In addition, narrowband technologies effectually allow more technologies to coexist in the limited unlicensed frequencies. The ideal system operating in unlicensed frequencies uses the least spectrum resources to send the most data.

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Purchasing Model

Historically, the regulated rate of return model under which most American IOUs operate means utilities have historically preferred to build, own, and maintain their own communications networks (CAPEX model), including for AMI. Utilities were not incented to purchase service from a public carrier because that was an operational expense (OPEX model), which can have a negative effect on earnings. Carrier pricing was also notoriously high in the past for machine to machine (M2M) applications such as smart metering.

More recently, carriers have lowered pricing and are working to attract more utility use of their LTE Cat-M1 and NB-IoT networks. These carriers are seeing some success, particularly with cooperatives and municipal utilities. Although regulatory restrictions are changing in some states, most IOUs still prefer to build and own their own networks.

All the LPWA networking protocols included in this analysis can theoretically be built and sold in either a carrier model or an own and operate (O&O) model. In the US, for utility purposes, most of these technologies are still deployed in an O&O model.

Table 1 Select LPWAN Specifications

Specification	Weightless	LoRaWAN (a)	NB-IoT	LTE Cat-M1
Uplink Data Rate	0.625 kbps-100 kbps	0.3 kbps-27 kbps	<66 kbps	<400 kbps
Channel Access Method	TDMA/FDMA	ALOHA	TDMA/FDMA	TDMA/FDMA
Uplink Payload Allowance (Bytes)	65,530	100	>10,000	No Limit
Downlink Data Rate	6.25 kbps-100 kbps	0.3 kbps-27 kbps	<26 kbps	<400 kbps
Downlink Payload Allowance (Bytes)	65,530	<1.000	>10,000	No Limit
100% Acknowledged Messages	Yes	No	No	Yes
Synchronous Network	Yes	No	Yes	Yes
Firmware OTA	Yes	No	Yes (Unicast)	Yes
Supported Frequencies	Unlicensed/Licensed 169 MHz-960 MHz	Unlicensed 868 MHz/915 MHz, 2.4 GHz	Licensed 700 MHz/800 MHz, 1.9 GHz	Licensed 700 MHz/800 MHz, 1.9 GHz
Downlink Channel Bandwidth	12.5 kHz or 100 kHz	125 kHz/500 kHz	180 kHz	1.4 MHz
Uplink Channel Bandwidth	100 kHz/8*12.5 kHz	125 kHz	180 kHz	1.4 MHz
Purchasing Model	Private: Higher CAPEX/ Lower OPEX	Carrier: Lower CAPEX/ Higher OPEX Private: Higher CAPEX/ Lower OPEX	Carrier: Lower CAPEX/ Higher OPEX Private: Higher CAPEX/ Lower OPEX	Carrier: Lower CAPEX/ Higher OPEX Private: Higher CAPEX/ Lower OPEX

(Source: Guidehouse Insights)

LPWA Utility Deployment: Case Studies

The following sections describe in more detail each of the four LPWA protocols under consideration for AMI networks. Electric utility case studies are also presented.

Weightless – Ubiik: Taiwan AMI

Weightless is a bidirectional, synchronous LPWAN technology for use in dense urban networks with a high volume of end devices that require frequent uplinks/downlinks. Weightless supports all types of large-scale IoT applications and achieves low power operation, supporting both battery-powered devices and powered devices on the same network (meaning electricity meters, water meters, gas meters, and lighting can all exist together). A single Weightless data collection unit (DCU) can provide optimized urban coverage and is able to support a large network of meters.

Taiwan Power Company (Taipower) announced Ubiik's Weightless AMI solution as one of the 5 qualified vendors in May 2018, and a winner among 4 vendors of a nationwide tender in July 2018. Taipower, the state-owned company providing electricity to the entire nation of Taiwan, intends to deploy more than 3 million smart meters by 2024. In 2016, a newly elected government moved aggressively to adopt policies to increase efficiency in the grid, including deployment of AMI. The utility's goals included a bidirectional smart meter data management network, collection of household usage data, enablement of demand-side management and DR programs, and improved efficiency, data transparency, and system reliability.

Taipower asked wireless solution vendors to utilize either NCC (Taiwan's Federal Communications Commission) licensed bands for public utilities (839 MHz-851 MHz initially, and later changed to 839 MHz-847 MHz) or unlicensed frequencies (920 MHz-925 MHz). The tender attracted major wireless tech companies from all around the country. Other participants entered with a variety of technologies, including PLC, Wi-SUN, LTE, and several proprietary sub-gigahertz solutions. Notably, despite the presence of global LoRa hardware vendors in Taiwan, no vendors applied using LoRaWAN, which was reported to fall short in terms of capacity and quality of service for 15-minute data uplink/downlink transmissions from a large-scale network.

Rigorous trials spanned more than 13 months, including hardware lab trials and a field trial of more than 900 meters in the nation's capital city. Ubiik's Weightless solution passed the lab test with a nearly 100% success rate. The field trial environment consisted of tightly packed multi-story residential and commercial buildings. Meters were in difficult RF conditions: basements, stairwells, and inside metal enclosures. Among the competitors, Ubiik used Weightless technology to deploy the least amount of data collection infrastructure to connect all of the meters and achieve a higher than 99% transmission success rate and was awarded as a qualified vendor.

Meter readings are provided every 15 minutes with accumulated kilowatt-hour, kilovolt-ampere reactive hour, and kilovolt-ampere hour (typical payload 30 bytes). Additional readings of instantaneous voltage, current, frequency, and active/reactive power are provided hourly (typical payload 75 bytes). A daily summary is also sent daily at midnight, including accumulated energy with TOU information (typical payload 45 bytes). Also, the payloads are fully DLMS/COSEM compliant, so the content of OTA meter readings can be reconfigured dynamically. [1]

Ubiik was awarded a bid for $8.5 million for the first tender batch. The company's solution included Weightless DCUs, meter FAN modules, and headend system software to manage data collection and

[1] DLMS/COSEM (IEC 62056, EN13757-1) is the global standard for smart energy metering, control and management. It specifies an object-oriented data model, an application layer protocol, and media-specific communication profiles.

transmission. Ubiik's Weightless AMI solution was found to be cost competitive, spectrally efficient, high capacity, and high reliability, and achieve truly bidirectional wireless networking. The initial deployment of 70,000 meters took place in New Taipei City and Kaohsiung and was completed in spring 2019. The performance and cost-effectiveness of the solution allowed Ubiik to earn a second tender victory in December 2019 for an additional 265,000 smart meters, a contract worth $16 million.

The Weightless standard was created by a special interest group in UK and is open, available royalty free, and uses no proprietary hardware. Since the initial hardware release in 2017, more than 100 companies in more than 40 countries have purchased Weightless hardware for evaluation and development of IoT solutions.

Ubiik, a technology agnostic IoT solutions company based in Taiwan, provides complete conceptualization, industrial design, hardware manufacturing, and customized software solutions. Ubiik's AMI connectivity solution uses multiple types of meters and meter data management systems.

LoRaWAN – Semtech: Gehrden, Germany, AMI

LoRaWAN uses unlicensed sub-gigahertz radio spectrum in the industrial, scientific, and medical bands (frequencies vary globally). LoRaWAN defines the communications protocol and system architecture for the network, while LoRa describes the radio layer. LoRa uses Semtech's proprietary chirp spread spectrum (CSS) modulation, which is power efficient and offers long range. CSS has been used in military and space communications for decades due to its range and immunity to interference.

LoRaWAN network architecture is laid out in a star-of-stars topology in which the gateway is a transparent bridge relaying messages between end devices and a central network server in the backend. Gateways are connected to the network server via standard internet protocol connections while end devices use single-hop wireless communication to one or several gateways. All endpoint communications are generally bidirectional but also support operations such as multicast, enabling OTA software upgrades or other mass distribution messages to reduce the on-air communication time.

LoRaWAN defines three types of edge devices depending on downloading needs:

- **Class A:** The majority of LoRaWAN devices are Class A, which is suitable for battery-powered devices as it only wakes to send and can only be reached for a short window following data transmission. Otherwise, the Class A LoRaWAN end devices cannot be reached and thus cannot support applications requiring on-demand downlink (i.e., system control or OTA system upgrades).
- **Class B:** Class B end devices are scheduled to listen every 15 minutes. Latency is higher and availability of Class B end device modules is also limited (coordinated sampled listening strategy, medium power consumption).
- **Class C:** Class C LoRaWAN end devices are always listening, so they cannot support battery-powered devices but can provide a 1-2 second latency (continuous listening strategy, large power consumption).

All three LoRaWAN classes have uncoordinated transmissions, meaning frequent transmissions in a large network may result in inter-network packet collisions and greater risk of interference.

In 2017, in the Calenberg Land region near Hanover, Germany, a network of 10,000 electricity meters equipped with Semtech's LoRa devices was deployed, including in the city of Gehrden (population 15,000). Installation of a meter featuring Semtech's LoRa technology was offered to 7,000 households.

LoRa uses Semtech's proprietary chirp spread spectrum (CSS) modulation, which is power efficient and offers long range.

Gehrden is a typical smaller German city where buildings rarely exceed three stories and most families live in single-family detached houses. Eleven gateways equipped with LoRa were installed to operate on an eight-channel plan. Each gateway had a 30 cm or 70 cm half-wave dipole antenna. The gateways were mounted on rooftops or 5-meter-high towers. A modem chip and antenna equipped with LoRa were added to existing meters.

The protocol was defined for simple metering applications that required only the register reading on the seven-digit display. The goal was to make the protocol as easy as possible and the payload no bigger than necessary. As a result, the application payload for uplinks consists of only one header byte with status information and 3 bytes for every register (only one register in the case of the actual meter). The downlink messages have a fixed size (10 bytes) to configure reading intervals for confirmed and unconfirmed uplinks as well as retries in case of unacknowledged confirmed uplinks. The meters operate as Class C devices.

Each electrical meter was configured to send a 4-byte payload every 15 minutes as an unconfirmed uplink and as a confirmed uplink once per day. Semtech reported the system was architected for a 10% collision rate (or packet loss rate) and that each base station could support about 5,000 meters.

On the gas utility side, in 2016, Semtech worked with Korean gas supplier SK E&S and telecom operator SK Telecom to deploy automated gas meters and detectors in Busan, Seoul, and Gangwon Province for AMI system testing. The company planned to deploy in eight cities across Korea in 2017.

NB-IoT – Landis+Gyr: NB-IoT AMI as a Service

NB-IoT operates at sub-gigahertz frequencies within the 3G Partnership Project (3GPP) standards, with the goal of provisioning low data devices and sensors with low power requirements. As of May 2020, it can operate at full effectiveness, depending on configuration, at 450 MHz, 850 MHz, and 900 MHz frequencies. NB-IoT is considered to have the lowest cost and throughput of the cellular-based LPWA standards. Commercial launch of NB-IoT by cellular operators began in 2018; in the US, NB-IoT is available from Verizon, AT&T, and T-Mobile. NB-IoT networks are also deploying in a private model using unlicensed spectrum bands.

NB-IoT is considered to have the lowest cost and throughput of the cellular-based LPWA standards.

Carrier-based NB-IoT follows the traditional cellular company subscription business model of monthly payments per device based on usage. For a larger network of devices, there could be substantial monthly charges involved with maintaining an NB-IoT network. In addition, if there are any coverage issues, users would need to consult their local carrier for support or troubleshooting. NB-IoT modules also have higher power consumption than other LPWAN modules.

In April 2020, Japanese carrier NTT DOCOMO announced it was suspending provision of NB-IoT service, after less than one year of being active. The company expects to continue offering LTE Cat-M1 service, suggesting it may be more advantageous than NB-IoT for applications such as AMI.

In September 2019, Landis+Gyr announced it would deliver an NB-IoT-based smart metering solution to Olofströms Kraft in Sweden. The project is anticipated to be delivered in a software as a service (SaaS) model. Olofströms Kraft is a midsize energy utility serving 13,500 household customers in the south of Sweden. The project began in fall 2019. Landis+Gyr is handling system integrations and SaaS setup. The migration from the existing system PLC AMI system to the new SaaS environment is also expected to be delivered as a service.

LTE Cat-M1 – Verizon: Peninsula Light

LTE Cat-M1 is also a 3GPP, LTE-based standard. It was launched commercially in the US by Verizon and AT&T in 2017. LTE Cat-M1 consumes more power and modules are anticipated to be slightly more expensive than NB-IoT, but the protocol is expected to offer higher data rates, better downlink performance, and interference immunity at the expense of power consumption.

Verizon's Grid Wide platform as a service model for utilities uses its Cat-M1 network. The company promotes Grid Wide for AMI, meter data management, DR, and distribution monitoring and control. It also offers the service to water and gas utilities.

In mid-2019, Verizon announced that Peninsula Light in Washington State would use its Grid Wide platform for Peninsula Light's 33,000 cooperative customers. In addition to smart metering, the platform manages billing, remote connect-disconnect applications, outage detection, and grid monitoring. The utility is replacing a legacy PLC AMI system.

Verizon has also announced Dakota Valley Electric Cooperative (North Dakota) as a Grid Wide customer. In addition, Hawaiian Electric said in 2018 that it would use Grid Wide to manage its Customer Grid Supply Plus solar program, which allows the utility to control how much solar power is exported to the grid.

LTE Cat-M1 consumes more power and modules are anticipated to be slightly more expensive than NB-IoT, but the protocol is expected to offer higher data rates, better downlink performance, and interference immunity at the expense of power consumption.

AMI Network Suitability: Technology vs. Application

Each of the LPWA protocols described has its place in the AMI ecosystem, as do legacy protocols such as P2MP and RF mesh-based systems. Utilities must base selection on their application needs and operating environments. In this section, Guidehouse Insights describes several AMI deployment characteristics to consider and presents a heat map of suitability for each networking protocol and application.

Frequency of Meter Reads

Early AMI systems often transmit meter reads once per day or, more recently, every 4 hours. But the latest utility requirements often include 15-minute meter reading and transmission. Depending on data uplink rates and payload, not all protocols can efficiently accommodate 15-minute meter reading transmission at high success rates.

Urban, Suburban, or Rural

The topology of the utility's territory has a substantial effect on which networking protocol should be selected. Carrier LTE-based networks such as NB-IoT and Cat-M1 are seen to be the most cost-effective for rural markets where coverage is present. RF mesh is suitable for the suburban layout that allows the technology to hop between end devices without too many obstructions. The new LPWA technologies make a great case for densely populated urban environments.

DA Applications

Latency and throughput vary widely between various AMI network protocols and even between different deployments of the same protocol. Generally, lower latency and higher throughput (bandwidth) networks are better equipped to handle DA control applications such as fault location, isolation, and service restoration, although some monitoring or asset management functions can be supported.

Water and Gas Networks

Water and gas AMI networks, unlike power utility systems, do not generally have power at the meter and must rely on battery-powered systems. Here, the LPWA solutions are uniquely suitable. For municipal utilities where the AMI system is expected to manage power and water or gas, the LPWA solutions are often most suitable.

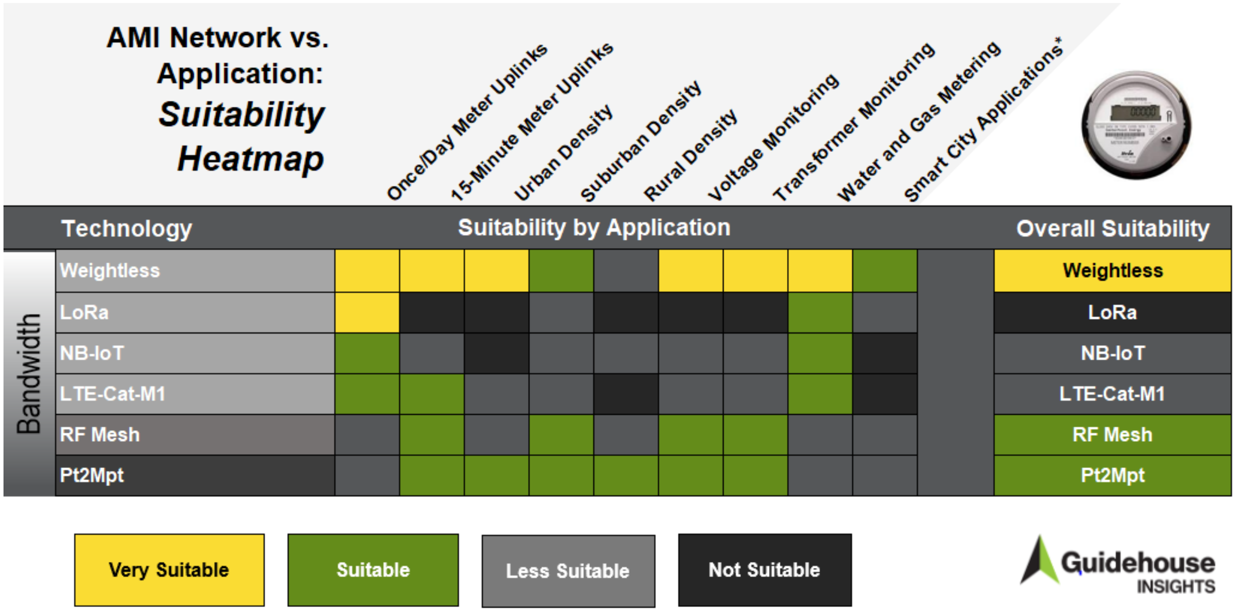
Smart City Applications

Many smart city applications have differing requirements depending on the application. All but the most latency- or capacity-intensive (gun-shot detection, video monitoring) can be well served with most LPWA solutions. Alternatively, these smart city applications—smart parking, smart garbage, smart street lighting control, etc.—can also be served with legacy RF mesh or P2MP solutions, but generally at a higher cost. RF mesh systems in particular can become expensive as the number of endpoints scales to high levels.

Capabilities Heatmap

To map diverse network requirements and applications against protocol capabilities, Guidehouse Insights analyzed the requirements for these applications and compared them with the networking technology characteristics of the LPWA and legacy wireless AMI solutions included in this analysis. A scoring system was devised based on how well each networking solution meets the requirements of each application or situation to generate a heatmap of the most attractive networking solutions for each application—and overall. The heatmap provides a visual representation of the strengths and weaknesses of the networking solutions reviewed.

Figure 3 AMI Network vs. Application: Suitability Heatmap



*Excludes video/traffic management applications requiring broadband capacity

(Source: Guidehouse Insights)

LoRa demonstrates great range but having limited bandwidth and an asynchronous, random channel access method makes scaling the network more difficult without packet collisions. The cellular-based narrowband solutions—NB-IoT and LTE Cat-M1—enjoy the security benefits that major carrier networks (built on privately owned spectrum and carefully safeguarded) offer. But service cost into perpetuity mean the total cost of ownership of these options could be higher than with some other options. Weightless, LoRa, and RF mesh solutions all use unlicensed spectrum, leading to lower cost. There is reasonable concern of increased interference in the unlicensed spectrum. Protocols such as Weightless have implemented noise mitigation techniques like listen-before-talk and frequency hopping.

Legacy RF mesh solutions do not perform well in rural environments and may become costly as applications beyond AMI are layered into the network. Legacy P2MP solutions have greater bandwidth and as such can handle more applications. They are also better suited to rural deployments, thanks to their star topology, but can cost substantially more than the newer LPWA options.

Each of these networking technology choices has its relative pros and cons. As the heatmap demonstrates, the Weightless LPWA option scores best overall in terms of balancing upfront and ongoing expense with flexibility and robustness to support a variety of applications.

Conclusion

Guidehouse Insights expects electric, water, and gas utilities to deploy more than 288 million smart meters during the next decade, as prior AMI deployments reach their end-of-life cycles and new deployments commence. Newer LPWA networking protocols offer utilities the opportunity to not only lower their cost of deployment and ownership but also enable attractive new applications to the AMI network. Final selection depends on each utility's requirements, but these newer LPWA protocols should not be overlooked when evaluating AMI networking options.

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