Power to low-power

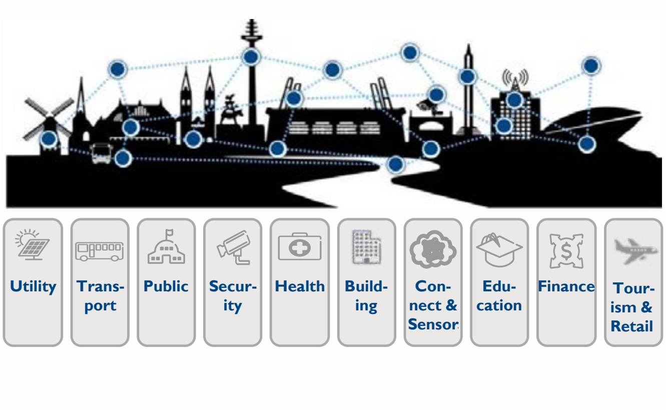
Low-power wide-area networks as enabler for smart ecosystems

As of today, smart ecosystems are limited to reaching their full potential based on the underlying connectivity technologies, such as fiber, cellular and wi-fi. Due to their insufficient capabilities with respect to high energy consumption, cost of network roll-out and (hardware) investments, many important use cases (such as tracking, parking and lighting) are economically difficult to realize. Recently, a new alternative has seen the light of day, namely low-power, wide-area (LPWAN) technologies. In this viewpoint, we will present some of the emerging standards and examples in which LPWAN as the connectivity enabler can create significant benefits.

Smart ecosystems demand an underlying connectivity technology that precisely fits their needs

Smart ecosystems such as smart cities are developing into an important cornerstone in the "digital society" and have become a global phenomenon. It is estimated that the number of connected devices related to smart cities will represent approximately 20 to 30 percent of total Internet of Things (IoT) connections (Gartner, 2016). Typical use cases include garbage containers, parking spaces and light posts, and will reach across multiple "verticals" in a smart ecosystem. These particular IoT applications contributing to make an ecosystem "smart" do not consume a lot of data per transmission – usually only a couple of bytes – and only require near real-time communication.

Smart ecosystems



Additional requirements for such use cases usually include a long battery life to minimize maintenance cost. This is because sensors might be placed in remote or hostile areas, making replacement challenging – for example, sensors embedded into the tarmac of roads. Moreover, a low-cost infrastructure is paramount to make these smart ecosystem use cases economically viable. Furthermore, secure communication must be guaranteed in order to meet the highest security standards. Lastly, the sheer number of connections sending only small amounts of data requires a scalable and efficient network technology that does not compromise or overload the existing public infrastructure (e.g. mobile networks).

The available technology solutions are diverse and target different use cases

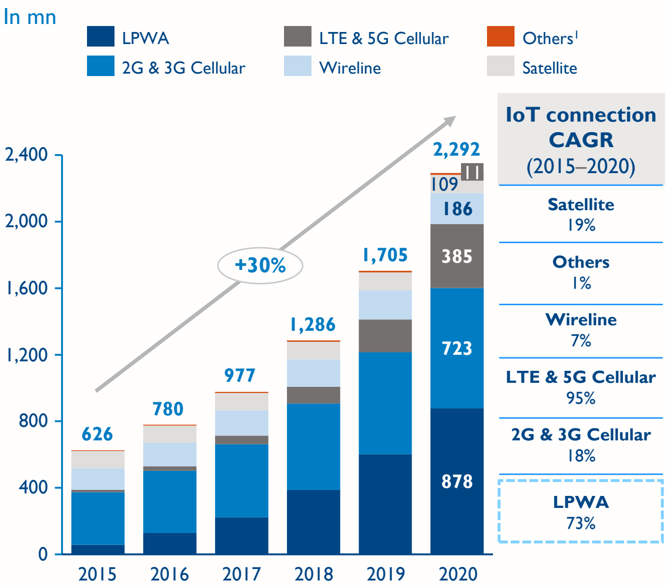
Over the last decades, a variety of alternative network technologies have emerged. These are mostly deployed by the classical telecom-operator community, but have also partly allowed institutions, infrastructure companies, utilities and other private companies to deploy their own (private) networks.

The most prominent wireless technology in this context is probably classical cellular, including 2G, 3G and 4G, which is widely deployed and reliable. Typical smart ecosystem use cases suited for cellular include smart-grid management, medical wearables and video surveillance applications.

However, operating and maintenance costs are considerable. In addition, complex protocols have a negative impact on energy consumption, resulting in low battery life – hence low autonomy.

Short-range wireless technologies, such as wi-fi, Bluetooth and near-field communication (NFC), are great for small distances. In the smart-ecosystem context, the latter fits contactless payment, for example, purchasing and validating tickets for public transport services using NFC-equipped mobile phones, and Bluetooth beacons monitoring traffic and road construction projects. However, those technologies are only capable of communicating for a couple of meters at maximum without being amplified. Therefore, deploying a large-scale network would be too expensive and difficult to manage because of the numerous required gateways. These shortcomings, along with constraints on battery life, will limit the usability of such technologies in the smart-ecosystem context.

Global wide area IoT connections by technology



Note: The chart refers only to a subset of all IOT connections, namely wide area technologies. It does not include other widely used IOT connectivity technologies, such as wi-fi, Bluetooth or NFC.

1 Others include WiMAX, Powerline Communication and a range of niche standards

Source: SNS Research, Arthur D. Little

In the other extreme, satellites offer ubiquitous coverage but are usually not suited to serve smart ecosystem use cases as the connectivity is comparably expensive, requires line-of-sight and has limitations in handling the vast amount of possible connections in the IoT ecosystem.

LPWA technologies, such as LoRaWAN, ultra-narrow band (UNB) and narrow-band IoT (NB-IoT) can provide a remedy and precisely address the needs of low-power, low-cost smart ecosystem applications. As a result, LPWA is expected to grow by an annual average of more than 70 percent through 2020, as Figure above shows, which puts the different IoT technologies in perspective.

Low-power wide-area networks address most of the connectivity requirements of smart ecosystems

Low-power wide-area networks provide broad coverage while reducing power consumption to a minimum. Due to the low data rates transmitted by LPWA devices, battery life is extended immensely, permitting unattended operation for long periods. This has a direct positive impact on the total cost of ownership since a low volume of data is consumed, reducing recurring fees (if any), and replacement of batteries is less frequent. The effect is tangible when multiplying these numbers by the millions of devices that can potentially be deployed. In addition, LPWA module and hardware costs are already about 60 to 70 percent less expensive than LTE modules, according to Link Labs. As LPWA networks mature, this cost is expected to decrease further.

Three underlying LPWA technologies are at the forefront of discussion. First is the LoRaWAN protocol, backed by renowned multinationals such as Cisco and IBM through the LoRa Alliance. LoRa is an attempt to define a universal standard for LPWA networks. The collaboration serves to guarantee interoperability between operators on a global scale. As another prominent player, Sigfox has established significant coverage with its own proprietary UNB technology. This French start-up was able to raise EUR 100 million through the largest round of venture-capital funding in its country's history, backed by companies such as Samsung and Telefonica.

These technologies are operating in the so-called unlicensed spectrum, hence allowing private networks without a classical telecommunication company. Many operators are pushing the third relevant technology, operating in the licensed spectrum, and hence operator controlled. 3GPP, the influential cellular standards group – which, for instance, defined 4G and LTE and is comprised of numerous telecommunication firms including AT&T, Orange, Vodafone and other companies such as Intel and Ericsson – has agreed to a common standard in order to play a more significant role in the IoT market. Pilots with respective cellular technologies, such as NB-IoT and LTE machine-type communication (LTE-M), have recently been rolled out, with commercialization expected to be established by the end of 2016 and beginning of 2017, respectively.

Today, industry pioneers such as Sigfox are shaping the ecosystem and currently have a head-start over many traditional telecommunication operators. For example, Digimondo, a 100 percent subsidiary of E.ON and a member of the LoRa Alliance, is gradually rolling out LPWA networks on the unlicensed spectrum, empowering German smart ecosystems.

However, the operator-backed licensed spectrum has some significant advantages – namely higher transmitting power and constant quality of service – allowing stricter security and more reliable device management (e.g. critical application monitoring, firmware upgrades, etc.). This capability is crucial, as the increasing amount of use cases will result in a growing number of devices connected to an LPWA cell and, hence, likely lead to network interferences that need to be managed efficiently.

On the other hand, unlicensed-spectrum technologies are already deployed on a large scale, allowing for fast time-to-market of applications. Current networks are deployed by, among others, Sigfox (UNB), Telensa (UNB), Link Labs (LoRa), Qowisio (UNB and LoRa) and M2COMM (Weightless). Due to the unlicensed nature, it is possible to operate private networks independently of the established operators. Though the initial capital investment might be higher, in the long-term the total cost of ownership is likely to be lower as no license fees occur.

Although generally different in nature, all LPWA technologies show significant benefits over alternative wireless solutions for low-cost/low-power use cases and, as a result, are part of the future of urban IoT connectivity. The selected use cases described on the right illustrate specific areas of application within the smart ecosystem environment that highlight the financial benefits that go in hand with deployment and operationalization of LPWA networks.

Insight for executives

Within the smart-ecosystem context, a plethora of use cases today cannot be implemented effectively due to the nature of existing public network technologies such as GSM. This is especially so for the use cases described in this paper, and one of the reasons those smart-ecosystem applications will not become pervasive until a multipurpose wireless connectivity technology solution emerges that

1. can be easily deployed,
2. works reliably at great scale, and
3. delivers an attractive business case.

LPWA technologies can address all these needs and hence serve as a meaningful addition to the overall network infrastructure for sensor networks. However, the LPWA ecosystem is still very fragmented – within both the licensed and unlicensed spectrums – and we see co-existence of different standards as the likely scenario. As we do not predict that over time one global standard will emerge, the choice of the most suitable LPWA technology requires a clear assessment of the respective use cases and economical boundaries within which it must operate.

Use case 1: Waste-container tracking for optimizing garbage-truck utilization

Smart waste management saves ecosystems up to 30 percent of operating and infrastructure costs, in addition to further benefits such as the avoidance of overflowing waste containers and trash accumulating on sidewalks. The example of Urbiotica, a provider of smart waste management solutions, shows this. In contrast to the traditional fixed routes and schedules of garbage trucks, smart waste containers signal in real time when they are full and in need of service. Based on this information and historical collection data, the optimal route is calculated and automatically communicated to the driver of the waste collection vehicle. LPWA technologies are particularly suitable due to their low cost and long battery life, which facilitates the management of a smart waste collection system.

Use case 2: Smart parking to reduce congestion and improve urban air quality

Donald Shoup, Professor of Urban Planning at the University of California, found that today, approximately 30 percent of urban traffic congestion is caused by motorists circling around to find parking spaces. LPWA-backed smart-parking solutions will allow comprehensive parking management, providing drivers with real-time occupancy data, thus significantly reducing congestion and ultimately improving urban air quality and quality of life. Other benefits arise: e.g., controllers are remotely informed when a parking infringement takes place, which reduces the necessity of being in the field; or retailers can offer parking-time extensions when a spending threshold is reached, thus stimulating shopping activity.

Use case 3: Intelligent lighting for significant savings on energy consumption

Wireless remote-lighting switching and dimming control can realize significant savings on energy consumption by managing light usage with an LPWA sensor and allowing only the precise amount of light required. In urban areas, such a cell can communicate up to a range of five kilometers, and a corresponding base station can handle up to 10,000 of such units, according to Telensa. For an ecosystem such as Berlin (~900 km^2), with approximately 18,000 street lamps, an LPWA-operated street-light network can save somewhere between 30 and 40 percent of energy per annum. Given these potentials, the set-up costs are close to negligible: with today's LPWA solutions, the entire area could be covered with less than 50 base stations and the corresponding unit cells per light post.

Viewpoint

Contacts

Ansgar Schlautmann
Central Europe
schlautmann.ansgar@adlittle.com

Shinichi Akayama
Japan
akayama.shinichi@adlittle.com

Guillem Casahuga
LATAM
Casahuga.Guillem@adlittle.com

Morsi Berguiga
Middle East
Berguiga.Morsi@adlittle.com

Martin Glaumann
Nordic
glaumann.martin@adlittle.com

Authors

Ansgar Schlautmann, Max-Christian Rath and Tobias Aebi

Arthur D. Little

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