



# GLOBAL NB-IOT ECOSYSTEM: TRENDS, ADOPTION AND OUTLOOK

March 2021

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## Executive Summary

Wireless IoT (internet of things), specifically LPWA (low-power wide-area) technology, continues to drive digital transformation and enhance real-world experiences, addressing consumer comfort and convenience while leading to energy and operating efficiency improvements across a host of industry segments.

NB-IoT (Narrow-Band IoT) is staking its claim as the LPWA technology of choice, with certain characteristics making it preferable to other technologies.

As a licensed technology, NB-IoT utilises existing cellular infrastructure, offering instant standards-driven deployment, security, integration synergies and scale for mobile operators – benefits yet to be proven in unlicensed technologies such as Sigfox and LoRaWAN. NB-IoT also enjoys lower module costs, improved coverage, greater energy efficiency and wider spectrum support compared to fellow licensed LPWA technology LTE-M.

The number of NB-IoT connections has grown rapidly over the past few years, reaching 186 million by the end of 2020: a more than four-fold increase on 2018. Key drivers include:

- **Widespread mobile operator support.** There are currently 106 live NB-IoT networks globally, and with over 100 mobile operators planning to shut down 2G and 3G networks over the next few years, 2G M2M migration will be a major catalyst in driving NB-IoT uptake. Looking further ahead, NB-IoT is a key part of 5G specifications in

upcoming 3GPP releases, making it a future-proof investment.

- **Strong industry support.** NB-IoT has a thriving ecosystem of major chipset vendors, hardware manufacturers and equipment providers. Hundreds of companies are increasingly active across all aspects of the NB-IoT value chain – from components and devices through to platforms and analytics.
- **More use cases.** NB-IoT technology is proving its value in a growing number of sectors, from Smart City and Consumer applications, through to Industry and Agriculture. And with improvements added by 3GPP Release 14, NB-IoT is increasingly supporting mobile applications.

Mobile operators are now well positioned to capitalise on this demand, and Counterpoint Research expects there to be over 1.2 billion NB-IoT connections globally by 2025. This will account for just over a third of total cellular IoT connections, up from 10% in 2020.

Furthermore, NB-IoT represents a significant opportunity for mobile operators to create new revenue streams beyond the exceedingly competitive consumer segment. By moving further up the value chain beyond connectivity into areas such as IoT software/platforms and analytics, operators stand to capture a larger share of the IoT market and diversify across more industries

# 1. LPWA IoT: Key Drivers for Uptake

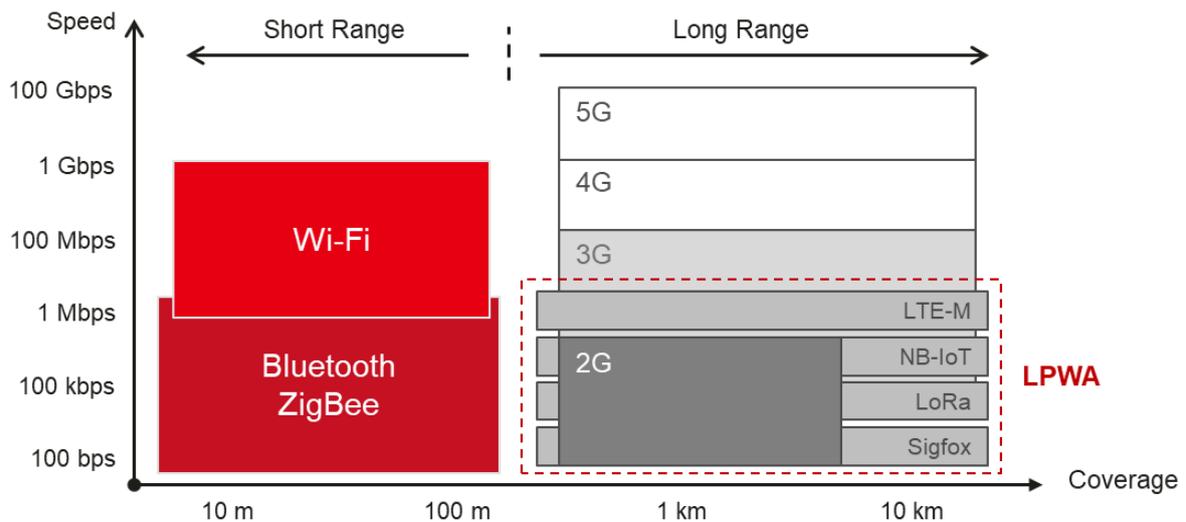


# 1. LPWA IoT: Key Drivers for Uptake

Internet-of-things (IoT) technology continues to power capabilities to sense and control physical devices. Major industries are being disrupted, with organisations tapping into the growing amount of data produced from IoT endpoints to drive digital transformation and enhance real-world experiences. IoT solutions that address customer comfort and convenience, and lead to energy and operating efficiency improvements with scale, are making inroads into a host of industry segments.

Wireless IoT networks have progressed to address a range of device applications in automobiles, wearables, connected homes, parking trackers and industrial automation, amongst others. With a growing array of use cases and many more potential ones to follow, choosing the appropriate connectivity standard becomes vital.

**Exhibit 1: IoT Connection Standards**



A major LPWA category is the mobile operator managed network based on 3GPP standards for IoT and includes two widely recognized technologies – LTE-M (LTE Cat-M1) and NB-IoT

(Narrow-Band IoT). There are other proprietary LPWA technologies that operate across unlicensed bands such as Sigfox and LoRaWAN.

The application prospects with LPWA are endless as the constituent technologies unravel the many possibilities of IoT by addressing three

key aspects for successful deployments: **Price** (data and devices), **Power** (battery life) and **Propagation** (coverage).

### Exhibit 2: Drivers of LPWA Deployment

 <b>Longer Battery</b>	LPWA-enabled devices boast great power efficiency and can operate for more than 10 years on a single, small form-factor battery (e.g., smart metering).
 <b>Low Bandwidth</b>	The majority of LPWA applications are not bandwidth hungry and require only a few bytes of data to be transferred per device daily
 <b>Extensive Coverage</b>	LPWA facilitates country-wide and global coverage with extensive support for in-building and subterranean urban deployments
 <b>Low-cost Hardware</b>	LPWA chipsets and modules cost around \$2 (China) to \$4 (global) for NB-IoT and around \$8-9 for LTE-M (North America, South-East Asia and Middle East and Africa)
 <b>Service Cost</b>	Owing to wider coverage and high endpoint capacity per cell, connectivity costs can be significantly lower than cellular services

## 2. NB-IoT Comparison with other LPWA Technologies

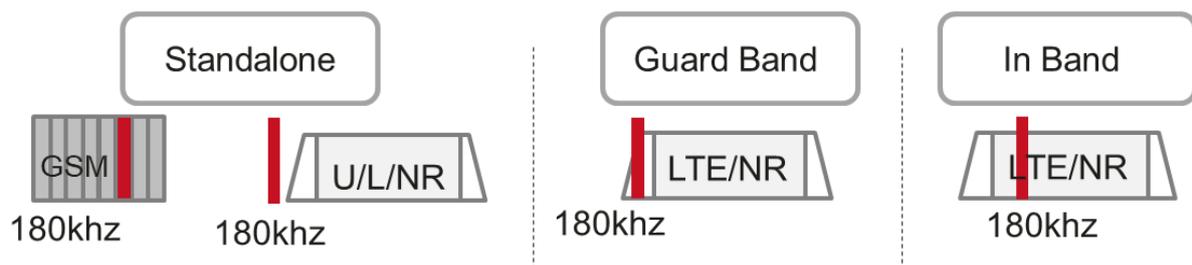


## 2. NB-IoT Comparison with Other LPWA Technologies

NB-IoT was conceived particularly for cellular M2M communications and allows seamless deployment of devices within an operated network. NB-IoT can coexist in the licensed LTE or GSM

bands, and occupies a frequency bandwidth of 200 KHz, corresponding to one resource block in GSM and LTE transmission. NB-IoT can operate via the modes as illustrated in Exhibit 3.

Exhibit 3: NB-IoT Operation Modes



Operators globally are adopting hybrid strategies with cellular and unlicensed non-cellular LPWA applications due to factors such as cost, coverage, battery life, latency, scalability, etc. Until the advent of NB-IoT, LoRaWAN and Sigfox had a head start in forging strong partnerships across the IoT ecosystem. However, the scale, interoperability, security, and co-existence of these proprietary technologies with cellular network deployments for service providers are still not entirely proven.

Licensed technologies such as LTE Cat-1, LTE-M or NB-IoT, however, utilise existing cellular infrastructure,

offering instant standards-driven deployment, security, platform integration synergies and scale for mobile operators. The 3GPP based cellular technologies inherently enjoy ecosystem-level benefits thanks to tighter partnerships between components, devices, infrastructure, operators and cloud vendors.

As a result, the adoption of any of these cellular LPWA technologies can scale much faster than siloed proprietary LPWA offerings. The key differences between the cellular vs proprietary LPWA technologies are described in Exhibit 4.

Exhibit 4: Licensed vs Unlicensed LPWA Specifications<sup>1</sup>

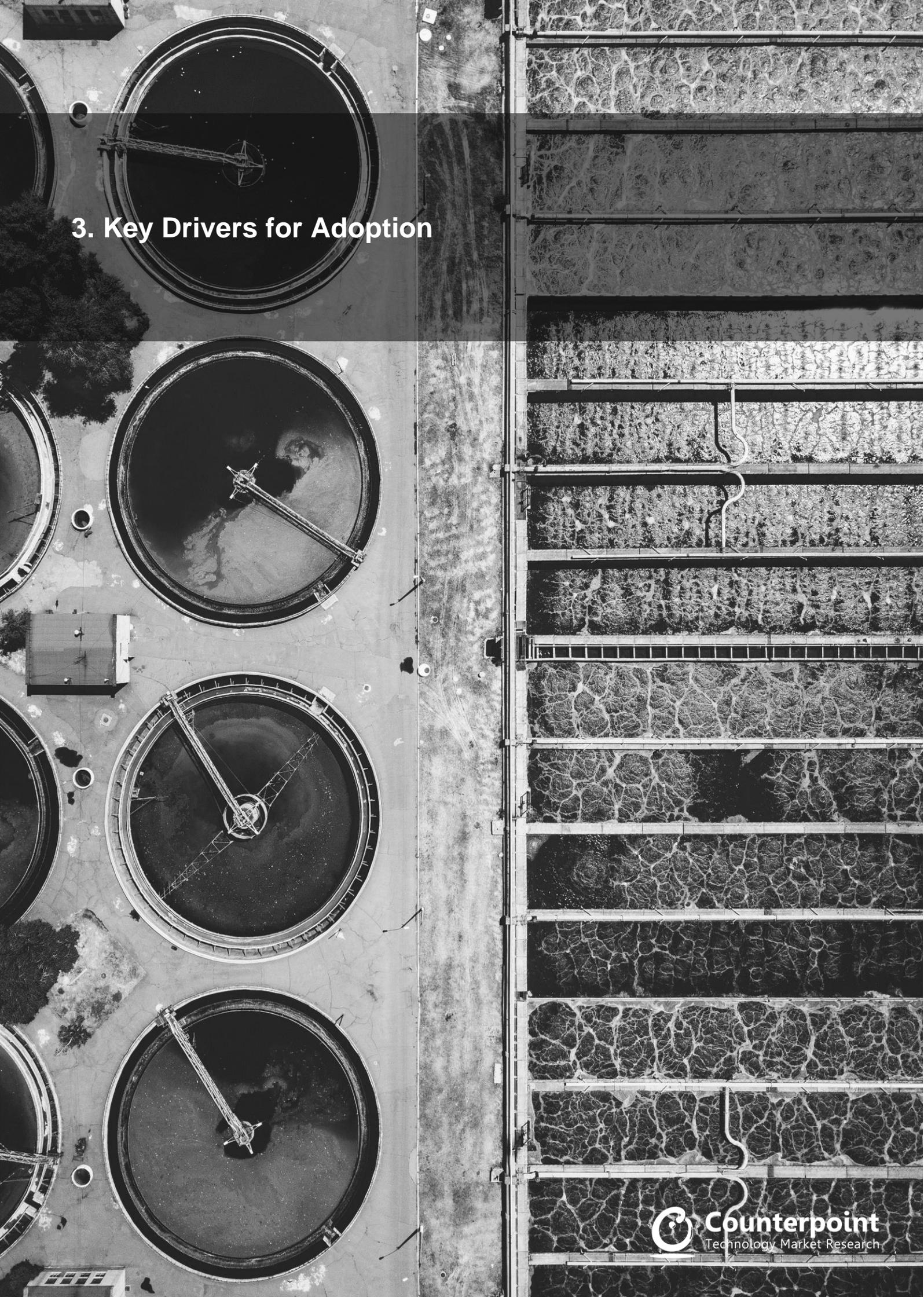


Category	Cellular		Proprietary	
	LTE / 5G	LTE / 5G	Ultra-narrow band	Chirp Spread Spectrum
Technology	LTE / 5G	LTE / 5G	Ultra-narrow band	Chirp Spread Spectrum
Standardization	3GPP	3GPP	Private	Open
Spectrum	Cellular bands	Cellular bands	Sub-GHz ISM	Sub-GHz ISM
Bandwidth	1.08MHz	200KHz	100Hz	125KHz
Throughput	1Mbps	200Kbps	600bps	50kbps
Message Capacity / Day	Unlimited	Unlimited	140 (device) 50,000 (BTS)	50,000 (BTS)
Security	3GPP (128-256 bit) + eSIM	3GPP (128-256 bit) + eSIM	AES (128 bit)	AES (128 bit)
Range / Coverage	■■■■■	■■■■■	■■■■	■■■
Node Firmware Upgradeability	■■■■■	■■■■■	■	■■
Service Cost	■■■	■■■	■■■■■	■■■■■
Module Cost	■■■	■■■	■■■	■■■
Roll-out responsibility	Mobile Operator	Mobile Operator	Mobile Operator/Sigfox	Customer

Source: Counterpoint IoT Tracker & Analysis

■■■■■ High  
 ■■■■ Medium  
 ■■■ Low  
 ■ Very Low

<sup>1</sup> Based on 3GPP Release 14



### 3. Key Drivers for Adoption

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NB-IoT (as first standardised in 3GPP Release 13) was initially developed for simple, fixed, passive, sensor-based applications with low levels of data transmitted at intervals. However, 3GPP Release 14 adds enhanced NB-IoT features such as improved mobility and positional accuracy, increased

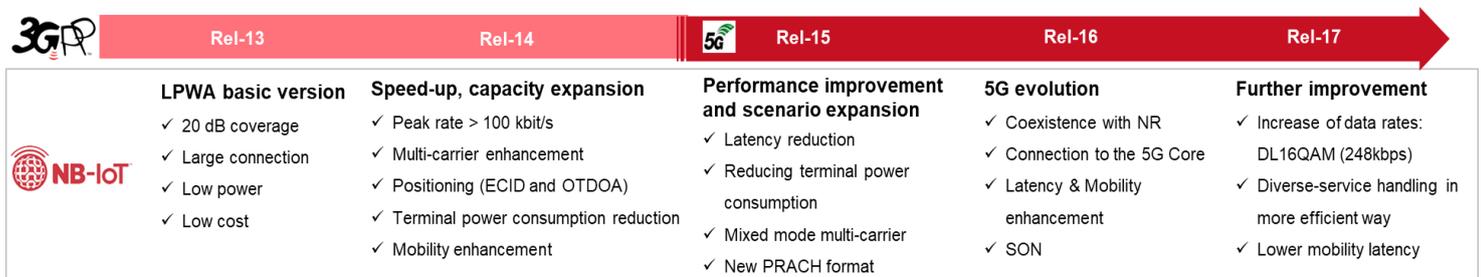
peak data rates, enhanced coverage, and the introduction of a lower-power device class. This greatly improves NB-IoT capabilities compared to other technologies, and features are constantly evolving with subsequent 3GPP standards.

#### NB-IoT to Be a Critical Part of the 5G Ecosystem

While IoT applications are currently supported by the existing 4G networks, including those employing NB-IoT technologies, 5G will bring further improvements. IoT connectivity based on LPWAs will become less expensive and less complicated with the evolution of technology, offering a solid foundation for energy-efficient smart deployments. 3GPP has included NB-IoT into 5G specifications, cementing its

importance as part of future 5G standards. Furthermore, in July 2020, the International Telecommunication Union (ITU) announced that 3GPP technology, including NB-IoT, is officially recognized as an ITU IMT-2020 5G standard. Widescale 5G rollouts will also expedite NB-IoT as it gets embedded within consumer and enterprise applications.

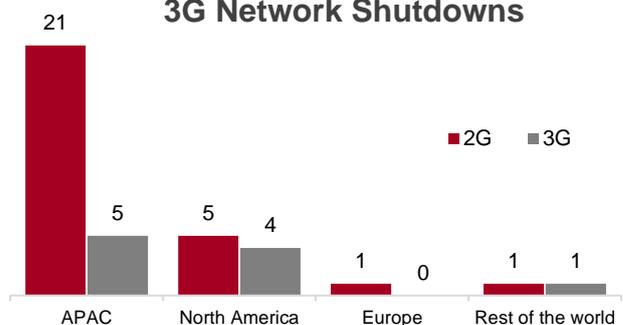
Exhibit 5: The Roadmap of 3GPP Standards



#### 2G M2M Migration to Drive NB-IoT Adoption

2G M2M migration will be a major catalyst in driving NB-IoT uptake. Around 100 mobile operators globally have already announced the shutdown of 2G and 3G networks. By freeing-up the spectrum resources from 2G and migrating to NB-IoT, carriers can markedly reduce OPEX and improve spectrum efficiency by up to six times, consequently increasing the number of M2M connections.

Exhibit 6: Global 2G and 3G Network Shutdowns

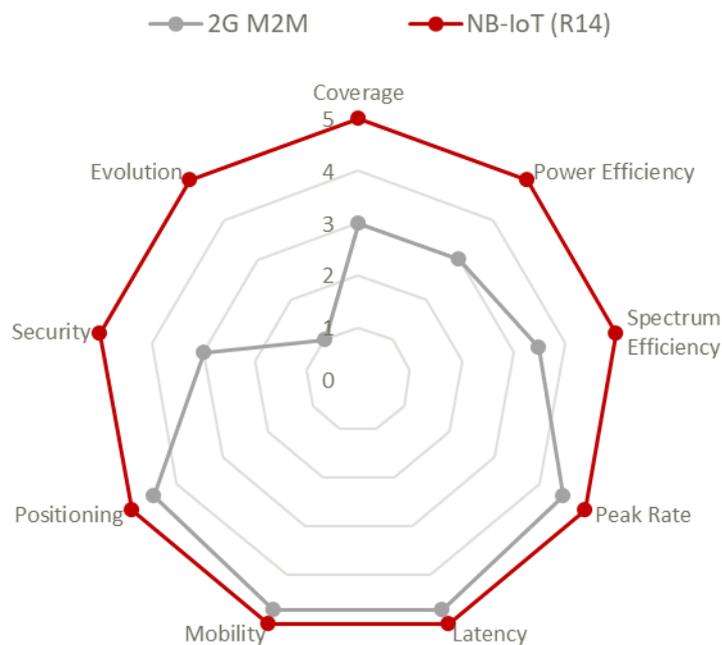


Source: GSMA (May 2020)

Furthermore, for applications that require transmission of small amounts of data, NB-IoT outperforms 2G. NB-IoT provides superior power consumption characteristics while also offering the choice to make use of three

coverage forms, which surpasses 2G with regards to penetration. Moreover, NB-IoT allows the transmission of non-IP messages, which further increases the efficiency.

**Exhibit 7: NB-IoT vs 2G Benefits**



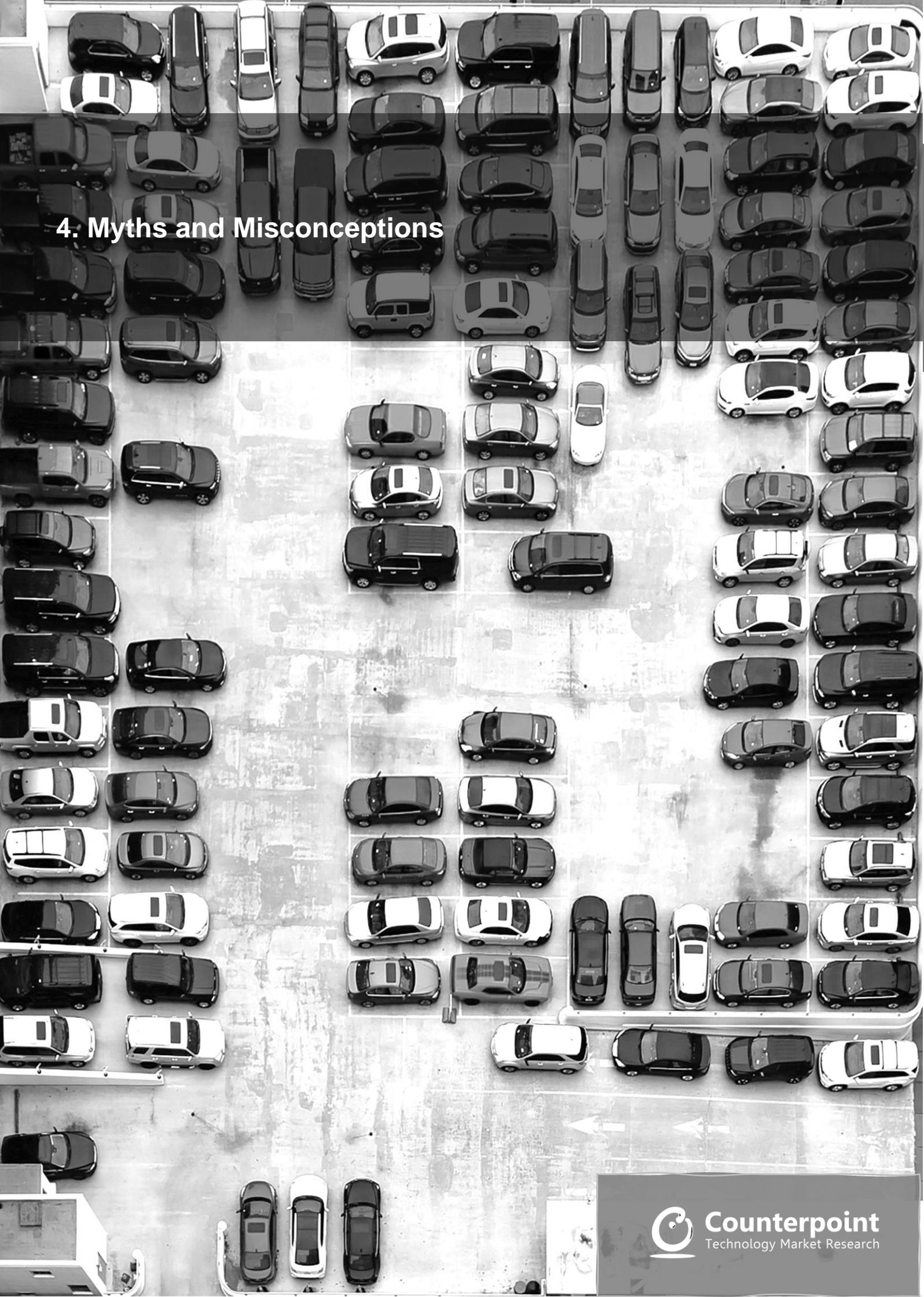
### Roaming Likely to Expedite NB-IoT Adoption

The lack of roaming agreements between mobile operators has been one of the major hurdles for NB-IoT adoption outside China. Roaming is essential to simplify IoT device deployments across borders and plays a critical role in mobility applications where assets such as trailers and containers are required to be tracked across countries. In Europe, some operators have already taken strides towards ubiquitous NB-IoT coverage. Deutsche Telekom and Vodafone are among the first adopters of NB-IoT that have announced official roaming agreements with partner operators.

Vodafone entered into a roaming agreement with AT&T in 2019 to enable cross-border IoT deployments in the US and parts of Europe. Deutsche Telekom signed NB-IoT roaming agreements in April 2020 with Vodafone, Swisscom, and Telia Company to make mobile IoT roaming available across 18 European countries. Deutsche Telekom plans to complete its EU roaming footprint over the coming months. With an increasing number of roaming agreements, NB-IoT adoption is expected to grow as the technology finds its way into major product segments such as sensors, trackers, and consumer electronics.

## Other Major Drivers of NB-IoT Adoption

<p><b>Rapid and Flexible Deployment</b></p> 	<ul style="list-style-type: none"> <li>▪ NB-IoT can be rapidly and flexibly deployed on active 2G, 3G, 4G and 5G networks. It can utilise both the network in-band and operate alongside other network technologies in standalone mode.</li> <li>▪ The facility to leverage existing network infrastructure is a massive benefit over proprietary technologies such as Sigfox and LoRa, where new network assets need to be deployed and managed by operators or enterprises.</li> <li>▪ Not only are such deployments expensive and tedious, but they also entail challenges around planning permission, backhaul provisioning and other complex operational considerations.</li> </ul>
<p><b>Robust Security</b></p> 	<ul style="list-style-type: none"> <li>▪ NB-IoT boasts robust security for IoT connectivity as it operates within the licensed spectrum, leveraging LTE networks' distinctive capabilities to authenticate and encrypt data in transit.</li> <li>▪ NB-IoT SIM cards come with embedded keys used to mutually authenticate networks and devices, and to generate session keys for encrypting data traffic between the device and core network.</li> </ul>
<p><b>Declining Hardware Costs</b></p> 	<ul style="list-style-type: none"> <li>▪ NB-IoT features simple designs and requires minimal hardware costs for chipset fabrication, antennas, and modules, helping accelerate the technology's adoption.</li> <li>▪ Driven by increasing demand and volume deployments across different regions, the average price of NB-IoT modules has decreased markedly.</li> </ul> <p>The global average selling price (ASP) of NB-IoT modules has declined from \$7.00 to \$4.20 in 2020, almost to 2G module levels. We expect ASPs to reach sub-\$2 over the next three to five years.</p>
<p><b>Strong Market Support</b></p> 	<ul style="list-style-type: none"> <li>▪ NB-IoT is backed by major chipset vendors (e.g., Qualcomm, MediaTek, Unisoc, Huawei, Altair Semi, Sequans, ASR, Nordic Semi etc) and hardware manufacturers from modules to connected devices (e.g., Quectel, Sunsea, Thales, u-blox, Sierra Wireless, Fibocom and Cheerzing).</li> <li>▪ Equipment vendors such (e.g., Ericsson, Nokia and Huawei) are helping leading mobile operators (e.g., Vodafone, Deutsche Telekom, Telefonica, China Unicom, China Mobile, Verizon, and AT&amp;T deploy NB-IoT networks).</li> <li>▪ This long-term commitment and rising deployments in China and other parts of the world is well-positioned to drive economies of scale in near future.</li> </ul>

An aerial, top-down view of a large parking lot. The lot is filled with cars of various colors, including black, white, and grey. The cars are parked in neat, parallel rows, with some spaces between them. The ground is a light-colored, possibly concrete or asphalt, with some darker patches and markings. The overall scene is organized and orderly.

## 4. Myths and Misconceptions



## 4. Myths and Misconceptions

### Not fit for Mobile Applications

NB-IoT supports mobility use cases. 3GPP R14 has brought RRC Connection re-establishment to NB-IoT, enabling modems to switch cells without renegotiating a new connection. R14 and future releases not only mean that NB-IoT will be suited for seamless mobile communication use cases such as asset tracking, logistics, and pet tracking, but will also cut overhead data and ensuing power consumption.

### Data rates inadequate for IoT deployments

NB-IoT is purposely designed for smaller data packet transmission. This limitation in functionality allows NB-IoT modules to be more energy efficient and cheaper to make and provides for better building penetration via frequent transmission of the small data packets.

### Does not use a SIM card

SIM functionality is a must since NB-IoT works inside licensed cellular bands. Some NB-IoT devices use classic plastic SIMs and in others, the SIM is permanently integrated into the device board in the form of an eSIM or integrated directly into the modem chip without separate SIM hardware – termed as integrated SIM or iSIM.



### Does not support OTA updates

Firmware over-the-air updates are possible since NB-IoT has a reliable downlink channel. Vendors are making devices capable of FOTA to support security updates. However, like all the LPWA technologies, the related energy consumption must also be considered, especially for battery-powered applications.

### Default battery life is ten years

NB-IoT modules could run up to 10 years. However, this is not the default life and devices could perform differently based on several parameters such as battery capacity, the frequency of data transmission / reception, and the Coverage Enhancement (CE) level. on one battery charge.

### NB-IoT is TCP/IP-based

NB-IoT supports transfer protocols such as TCP/IP, UDP/IP, or Non-IP. Users can choose any of these based on applications and module capabilities. However, TCP/IP is not primarily endorsed owing to higher data volume. UDP/IP is the ideal and recommended transfer protocol for NB-IoT.

## 5. Ecosystem Momentum



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### NB-IoT Value Chain

The NB-IoT ecosystem is thriving and recently there has been rapid growth in industry activity and interest. Hundreds of companies are increasingly active across all aspects of the NB-IoT value chain – from components and devices through to platforms and analytics (see Exhibit 8).

Focus varies across the ecosystem. Some companies prefer to focus on one segment. Most operators, for example, concentrate (at least for now) on their core capability which is connectivity. Other companies – such as Cisco, Huawei, Telit and Thales – are active in multiple segments.

Exhibit 8: NB-IoT Ecosystem

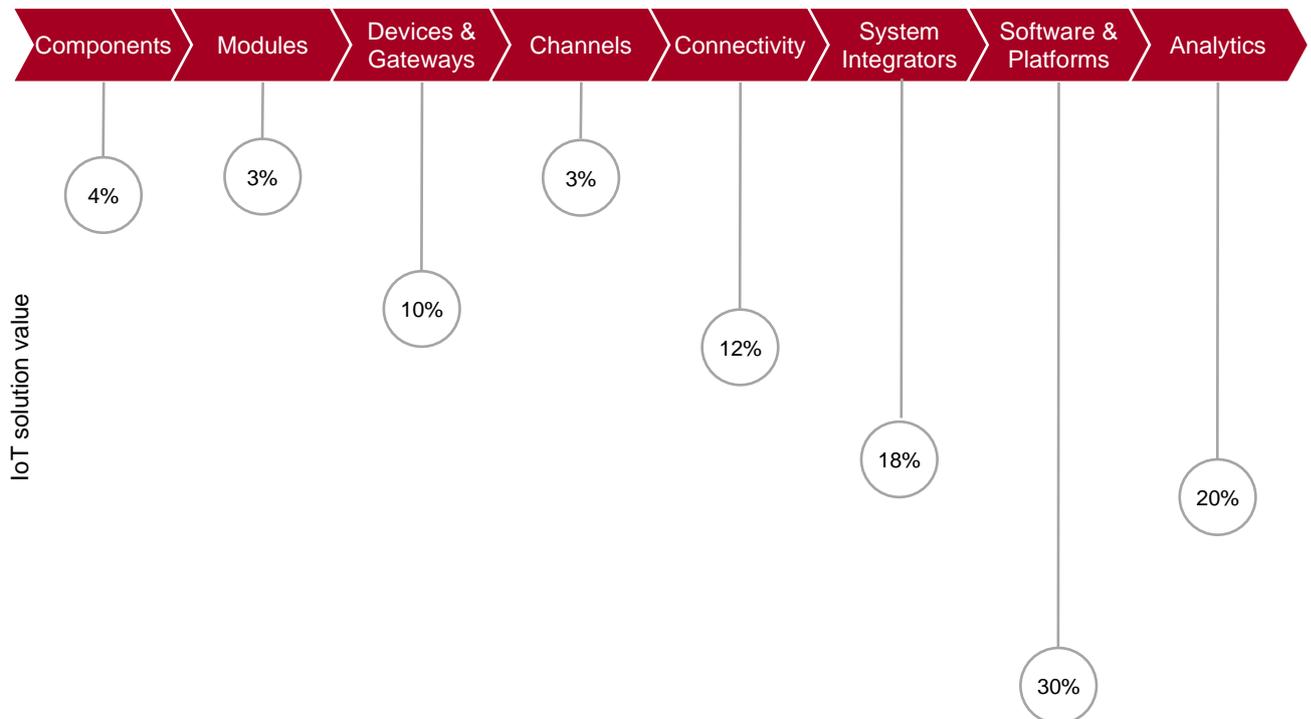


## NB-IoT Value Proposition

The NB-IoT value proposition is divided across several parts of an NB-IoT solution, and every stakeholder is bound to create and capture value. Service providers looking to generate the next wave of ARPU have a particularly strong opportunity to bundle an end-to-end solution – from device to connectivity through to integration – leveraging a platform approach to create significant value for customers.

The highest value segments of the NB-IoT ecosystem, and the most likely sources of future revenue growth, are Platforms, and Analytics. Platforms will be essential in enabling the integration of devices, networks, and applications across all NB-IoT segments and verticals, while analytics services will be critical in generating meaningful insights from the ever-increasing amount of data generated by the connection of more and more NB-IoT devices.

**Exhibit 9: Value Capture for an NB-IoT Solution Across NB-IoT Value Chain**

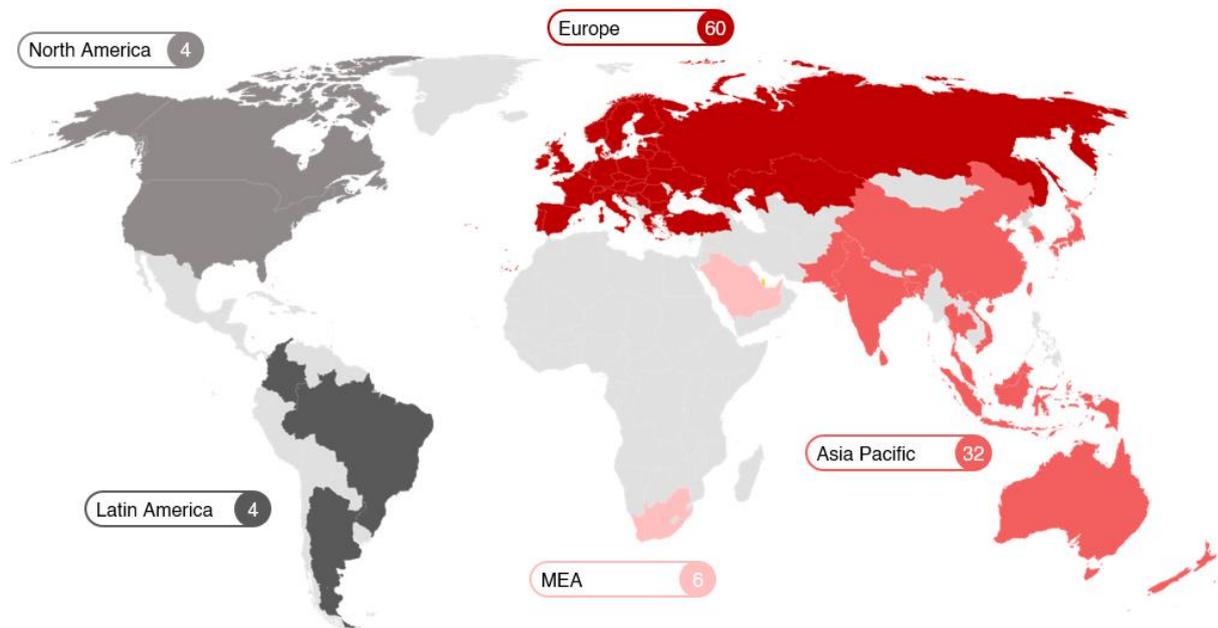


## NB-IoT Connectivity Landscape

The Connectivity segment is the crux of the NB-IoT value chain, and there is a growing number of NB-IoT service providers. There are currently over 100 live NB-IoT networks around the world – mostly in Europe and Asia Pacific, but also quickly expanding into the

Americas, Middle East, and Africa. Some operators have launched both LTE-M and NB-IoT networks, although the latter is still the most common worldwide (51 versus 106, respectively) and bound to grow further.

**Exhibit 10: 106 live NB-IoT networks globally**



Source: GSMA

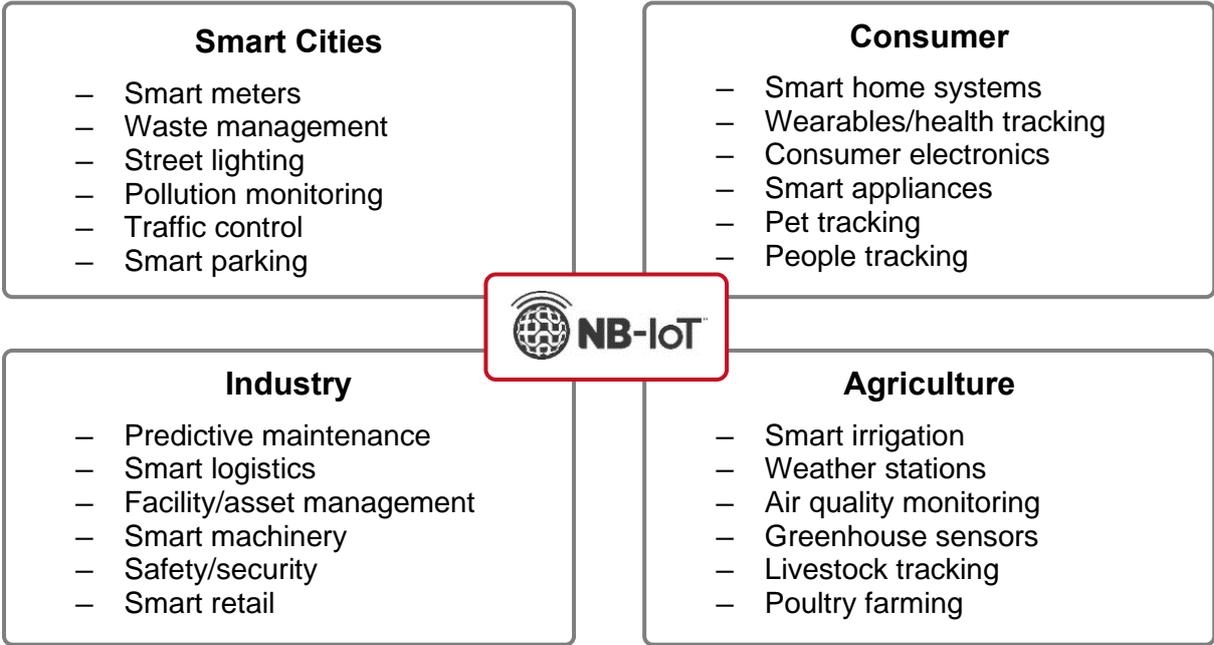
## 6. Applications and Use Cases



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NB-IoT is suited to a wide range of applications based on its favourable characteristics around coverage, longevity, and scalability.

**Exhibit 11: Wide Array of NB-IoT Applications**



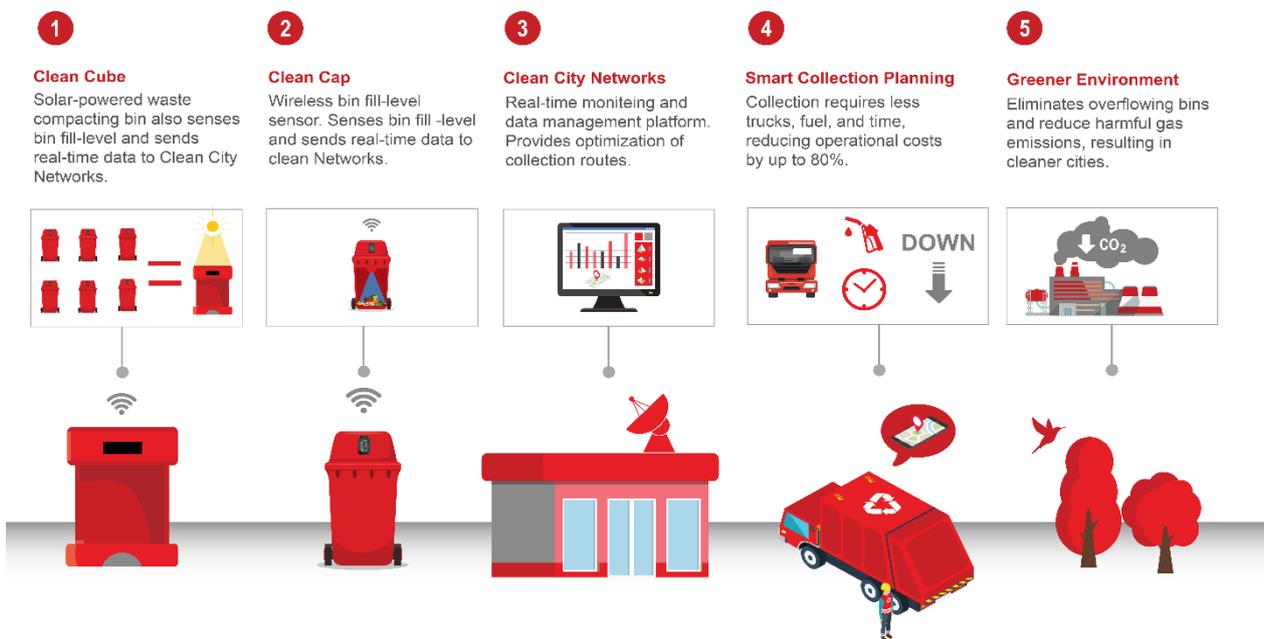
## Application Examples

### Smart Cities



**Waste management:** Sensors placed in rubbish bins that monitor the level of waste which, when combined with location data, can help optimise waste collection services and improve the urban environment.

In Singapore, mobile operator M1, OTTO Waste Systems and the National Environment Agency have deployed smart rubbish bins across the city. NB-IoT-connected sensors inside the bins detect when they are full, enabling cleaning service providers to remove the waste at the right time, increasing efficiency. Data is aggregated and analysed by M1's data analytics platform, helping further streamline operations.



Source: OTTO ECubeLabs Brochure



**Smart meters:** Connected smart meters that, together with a cloud-based management system, simplify and optimise the meter reading process, enabling accurate billing for utilities consumption.

The Saudi Electricity Company (SEC) began the rollout of approximately 10 million NB-IoT-powered smart meters across Saudi Arabia in January 2020, with the aim of 100% coverage by the end of March 2021.<sup>2</sup> The system will help in the efficient usage of energy, as well as improve demand management and overall access to electricity.

<sup>2</sup> Saudi Electricity Co raises funding for smart meters, renewables, Smart Energy International, September 2020

Similarly, Vodafone UK has partnered with SES Water to develop a NB-IoT based system to save water lost to leaks.<sup>3</sup> About 23% of water that runs through underground pipes is lost to leakage, and the project's short-term aim is to reduce this by 15% in five years, and more than halving it by 2045.



Source: Vodafone

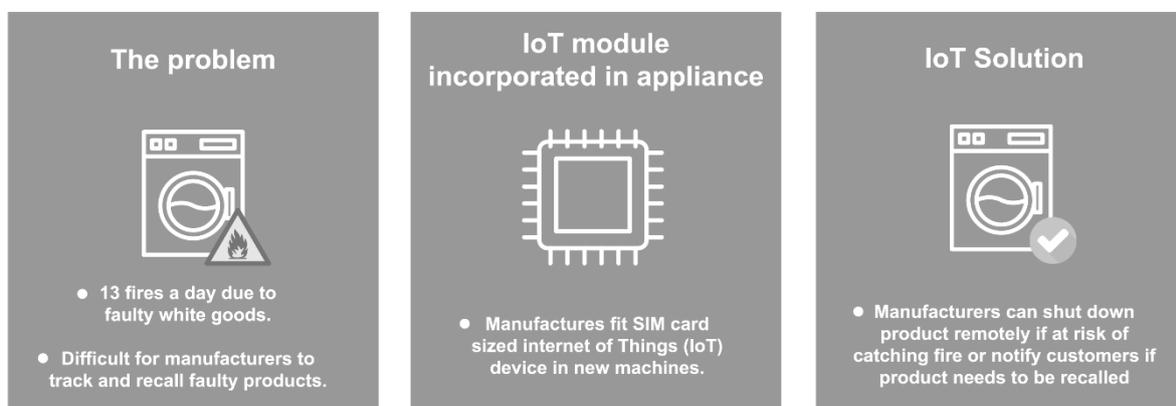
Smart metering is also being used in the care of vulnerable elderly people living on their own in China. For example, if the water consumption drops below a certain level (e.g., 0.01m<sup>3</sup> over 12 hours), an alarm is triggered at the community centre for elderly care.

## Consumer



**Smart appliances:** Connecting and monitoring home appliances (e.g., washing machines, dishwashers, refrigerators, ovens and boilers) to improve the user experience and help with maintenance.

Vodafone has launched an NB-IoT-enabled smart product recall system for home appliances. The Safety Alert Message Indicator (SAMI)<sup>4</sup> allows appliance manufacturers to notify consumers of faults in electrical goods (e.g., tumble dryers, washing machines, refrigerators and freezers), and shut them down remotely if needed.



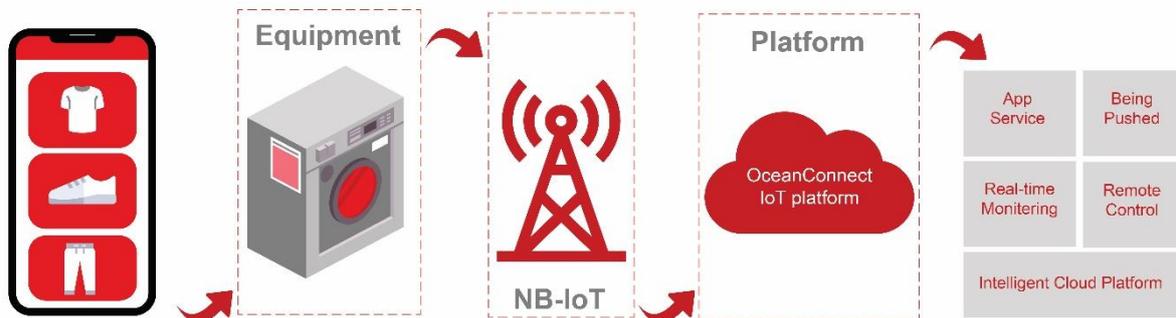
Source: Vodafone 'Smart' product recall system allows manufacturers to warn consumers of faulty goods, Vodafone, Sep 2020

Another example is China Telecom, which plans to connect 1.2 million appliances (e.g., air conditioners, washing machines, and water purifiers) in schools and apartments in Beijing, Shanghai, Guangzhou, Shenzhen, and Chengdu. Its 'Commercial Laundry Room', initially based at the Beijing University of Chemical Technology, comprises NB-IoT-enabled washing machines that can be reserved and paid for via an app, with notifications sent upon wash completion. Appliances

<sup>3</sup> SES Water turns to Vodafone technology to help reduce water leaks, Vodafone, June 2020

<sup>4</sup> Vodafone builds remote monitoring and product recall IoT platform, Vodafone, September 2020

connected via NB-IoT are online over 99% of the time, compared to less than 20% when connected via Wi-Fi.



Source: Huawei

## Industry



**Facility/asset management:** A set of sensors that monitor specific processes and/or assets within a factory that can predict when equipment is likely to fail, allowing maintenance to be scheduled to minimise downtime and disruption.

Haier's COSMOPlat is an industrial IoT platform allowing customers to place customised orders for devices, choosing only the features they require. Customers can follow the process from design to distribution and can manage production lines accordingly. Haier aims to deploy one million NB-IoT connected devices by 2022.



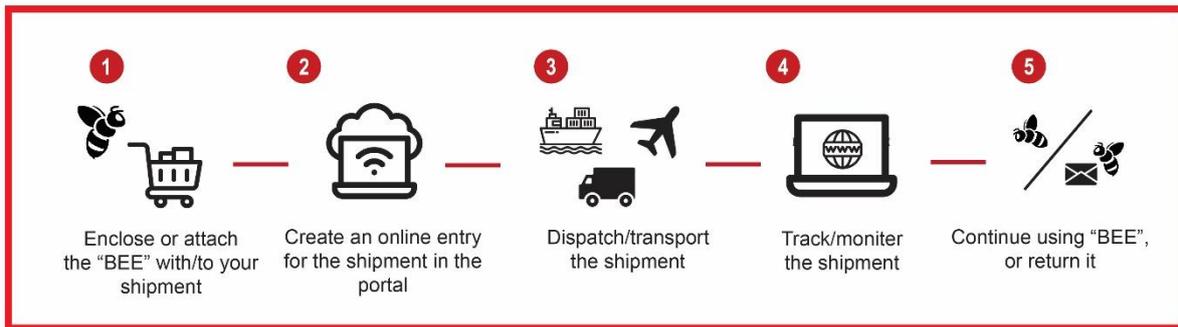
Source: Haier



**Smart logistics:** A system that tracks the location and transport conditions of a product or material, ensuring quality and allowing anticipation of deliveries.

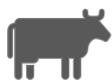
Deutsche Telekom's Roambee is an intelligent transport and monitoring solution.<sup>5</sup> 'Bees' are added to goods or vehicles, and sensors provide exact location as well as comprehensive information on the condition of the goods (e.g., temperature, humidity, light, handling, GPS interference, vibration, pressure, and movement). As a result of this increased engagement with customers, Roambee announced its orders increased by 126% annually in 2019.

<sup>5</sup> <https://iot.telekom.com/en/solutions/shipment-asset-monitoring-powered-by-roambee>



Source: Shipment & Asset Monitoring powered by Roambee, Deutsche Telekom

## Agriculture



**Livestock tracking:** A small device used by a farmer to locate livestock, regularly providing updates on the location of the animals, as well as information on the device’s status (e.g., battery levels).

Connected Animal,<sup>6</sup> launched by MTN and Huawei, aims to solve the widespread problems of stock theft and rhino poaching in South Africa. The system uses NB-IoT sensors to monitor and analyse animal activity and movement, providing farmers with early warning information that help in managing livestock, thereby improving efficiency, and reducing costs.



Source: Huawei



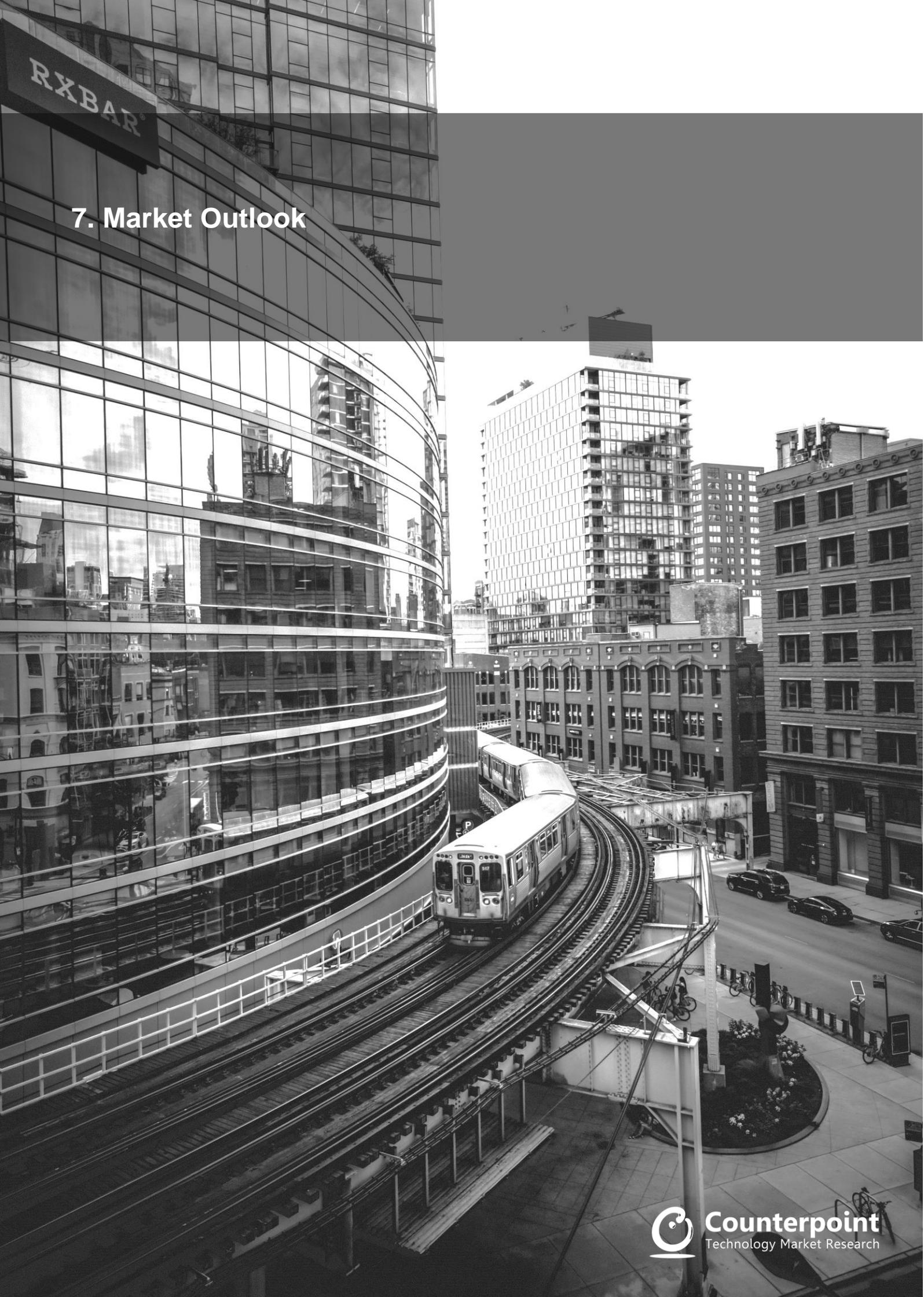
**Poultry farming:** A system of sensors that help poultry farmers monitor produce and the growing environment, maximising yields and increasing feed efficiency

XL Smart Poultry by XL Axiata increases efficiency of poultry farm management.<sup>7</sup> The solution monitors environmental conditions in real-time, tracks feed efficiency, and measures the quantity and weight of the chicken harvest. It also provides notification and alert features, as well as integration into the broader poultry industry ecosystem.



<sup>6</sup> MTN SA and Huawei Launch Connected Animal Solution at AfricaCom 2018, Huawei, November 2018

<sup>7</sup> XL Axiata Successfully Proves The Increase Of Poultry Production – Sierad Produce Expands Application of flexIoT XL Smart Poultry Solutions, XL Axiata, August 2020



# 7. Market Outlook

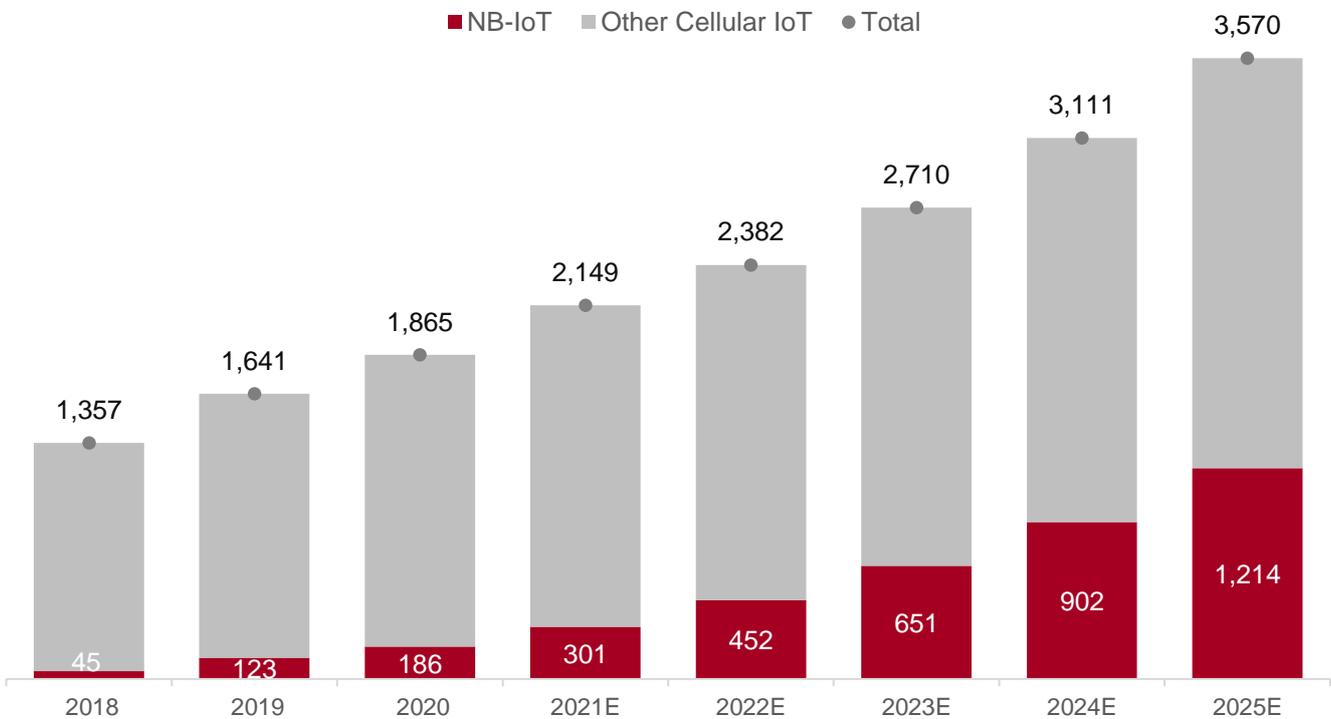
## 7. Market Outlook

The past two years have brought more than a four-fold increase in NB-IoT connections, driven by key applications like utilities metering, but also more diverse implementations for verticals from agriculture to transport.

Mobile operators are now well positioned to capitalise on demand, and

Counterpoint Research expects mid double-digit connections growth to be sustained through the long term. By 2025, we forecast NB-IoT connections to exceed the 1.2 billion mark, accounting for around a third of global cellular IoT connections, up from 10% in 2020 (see Exhibit 12).

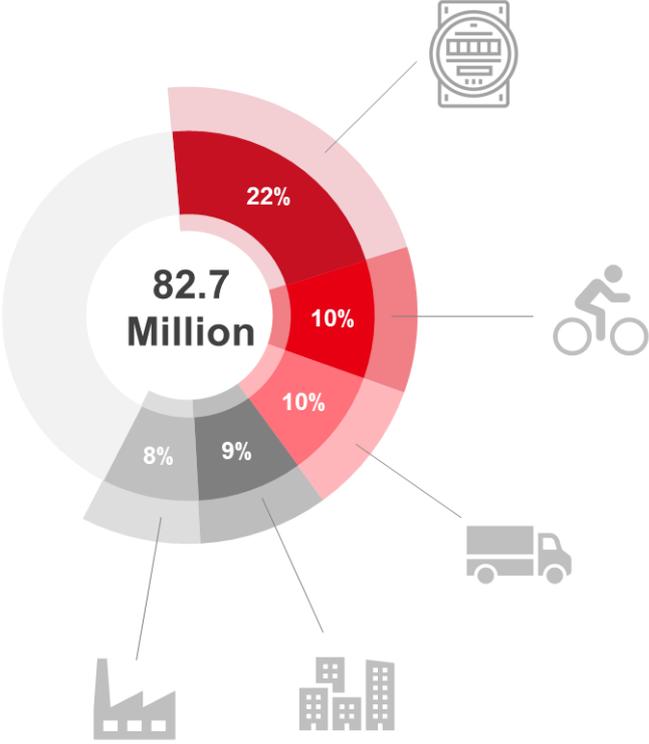
**Exhibit 12: Global Cellular IoT Connections (million)**



Supporting this growth is the proliferation of NB-IoT modules, with shipments reaching 82.7 million units in 2020. Much of the NB-IoT module

growth has been due to steep price drops, particularly in China, where module costs have dipped below those of 2G.

### Exhibit 13: Global NB-IoT Module Shipments by Application



- Installed base of smart power, gas, and water meters is set to exceed one billion over the coming years; NB-IoT is a clear choice for such deployments.
- Use cases in parking will be vast due to NB-IoT's ability to track parking bay status, bill more precisely and enhance utilization.
- NB-IoT will be used for ensuring safety of E-bikes, allowing real-time data transfer on bicycle position, speed, etc.
- NB-IoT will seep into enterprise use cases such as smart buildings including event detection systems, and solutions that offer info on incidents such as temperature changes or the presence of smoke.

■ Smart Meters ■ Telematics ■ Asset Tracking ■ Enterprise ■ Industrial ■ Others

## 8. Conclusions and Recommendations



## 8. Conclusions and Recommendations

IoT represents a significant opportunity for mobile operators to create new revenue streams beyond the exceedingly competitive consumer segment. Integrating IoT services for business customers can radically enhance revenue by creating more demand for carrier SIMs and more consumption of the mobile data services on offer. Being cognizant of an ever-growing network of internet connected electronic devices in operation globally, several mobile operators are focusing on enhancements to incorporate IoT services to address the current and potential mass market demands from their subscribers and business customers.

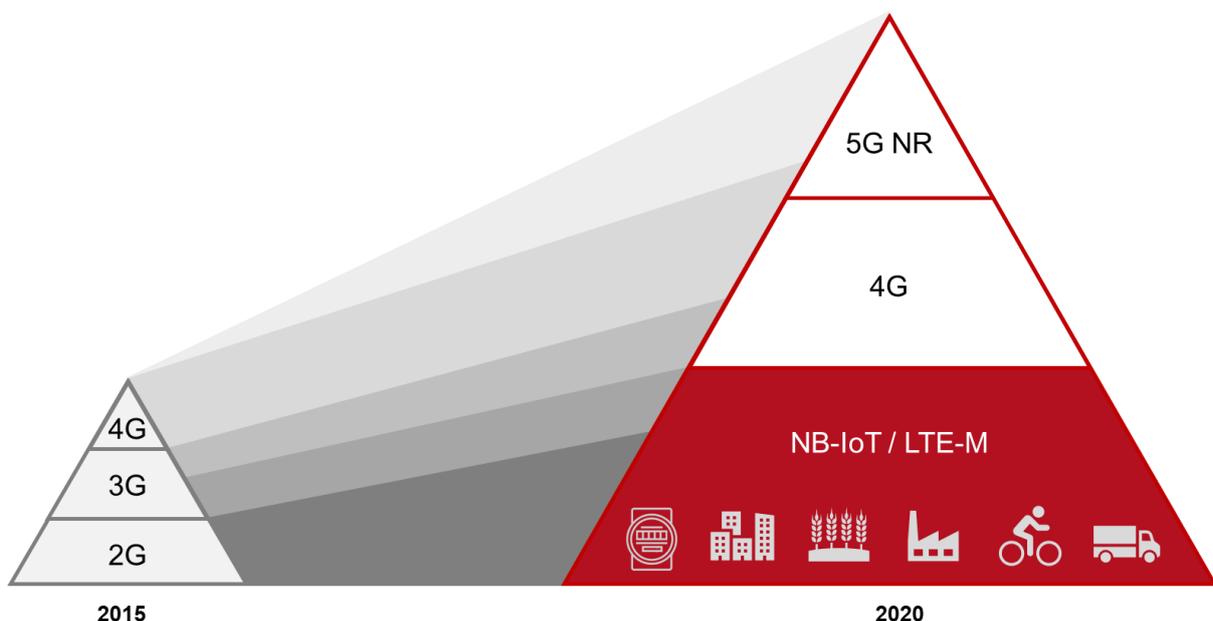
Additionally, while most of the operators are currently focusing on revenue realisation through network and connectivity services, moving further up the value chain can enable them to capture a larger share of the IoT market and diversify across more industries.

This can be done by creating value for their customers by supplementing their portfolios with solutions such as such as IoT software / Platforms, Analytics, etc.

Operator IoT opportunities are set to grow as wireless IoT networks address the ever-expanding range of device applications across a broad range of sectors. But new opportunities bring new uncertainties, especially with respect to choosing the appropriate connectivity standard.

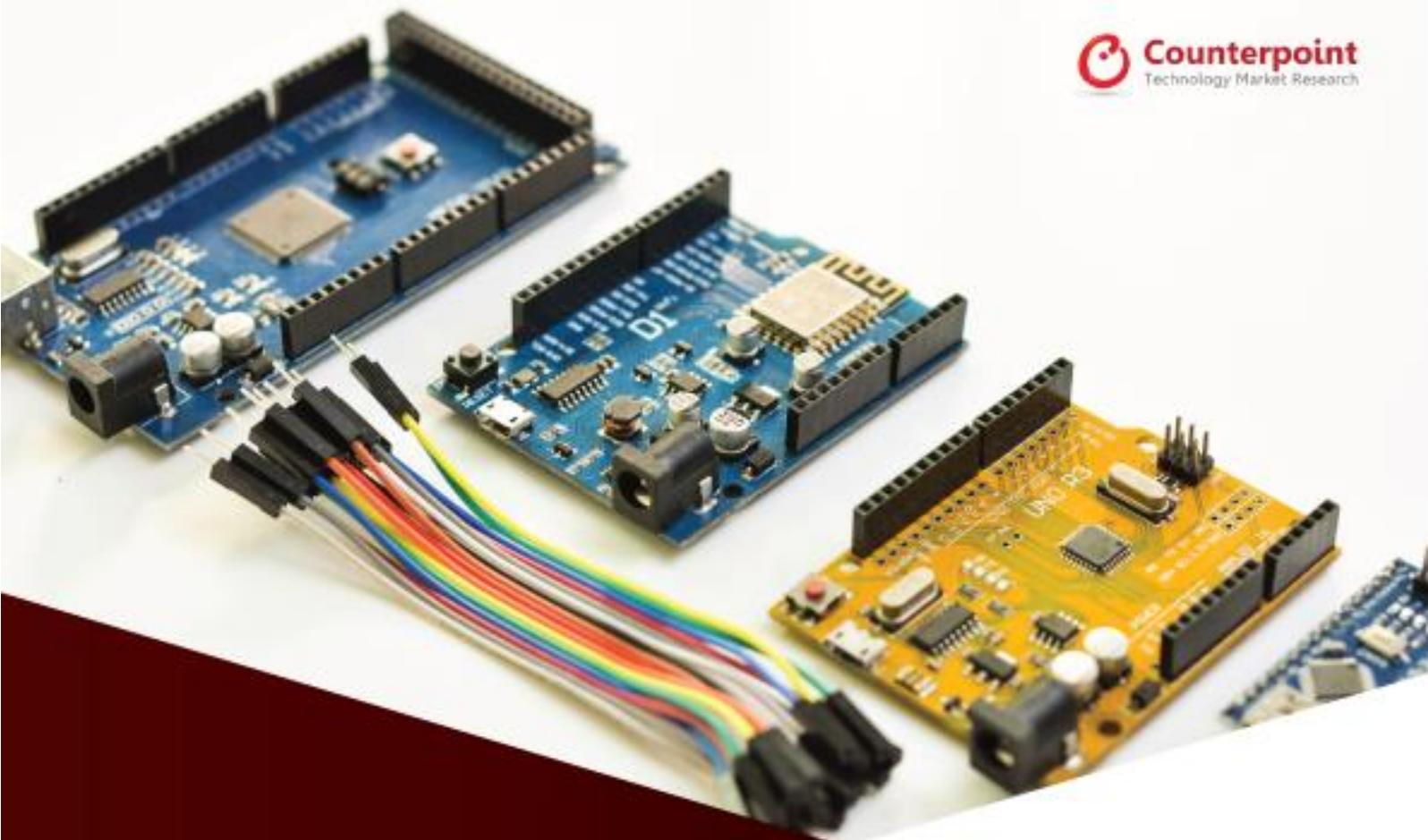
NB-IoT provides a hedge against many of the risks by allowing wireless players to minimize operational costs while extending both longevity and coverage. Other benefits like rapid and flexible deployments, future proofing with 5G, robust security, and, importantly, declining hardware costs make NB-IoT a strong choice for operators contemplating wide-area IoT deployments.

**Exhibit 14: Future Oriented Cellular IoT Architecture**



## Key recommendations for operators considering wireless IoT networks

<b>Prioritize agility</b>	NB-IoT allows rapid rollouts by offering flexible deployments on active 2G through 5G networks by operating in standalone mode or utilising LTE in-bands.
<b>Leverage existing coverage</b>	Avoid complexity, cost, and other challenges inherent in greenfield network rollouts. If possible, piggy-back on existing cellular networks versus deploying proprietary technology.
<b>Future-proof module costs</b>	Scaling IoT services requires device costs to follow steep declines. Choose technologies featuring simple designs requiring minimal hardware costs across chipset, antennas, and modules.
<b>Future-proof technology</b>	5G is the future, and for maximizing return on investment, operators will need evolve their networks to address all 5G-IoT use cases, across different industries.
<b>Ensure security</b>	Beyond assuring proper authentication protocols are followed, more robust measures can be taken if networks are inherently limited in terms of access. Operating on licensed spectrum enables this, along with other benefits such as in-transit authentication and encryption.
<b>Maximise value</b>	Platforms and analytics provide the greatest opportunity for long-term growth; operators are well positioned to capture this.



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