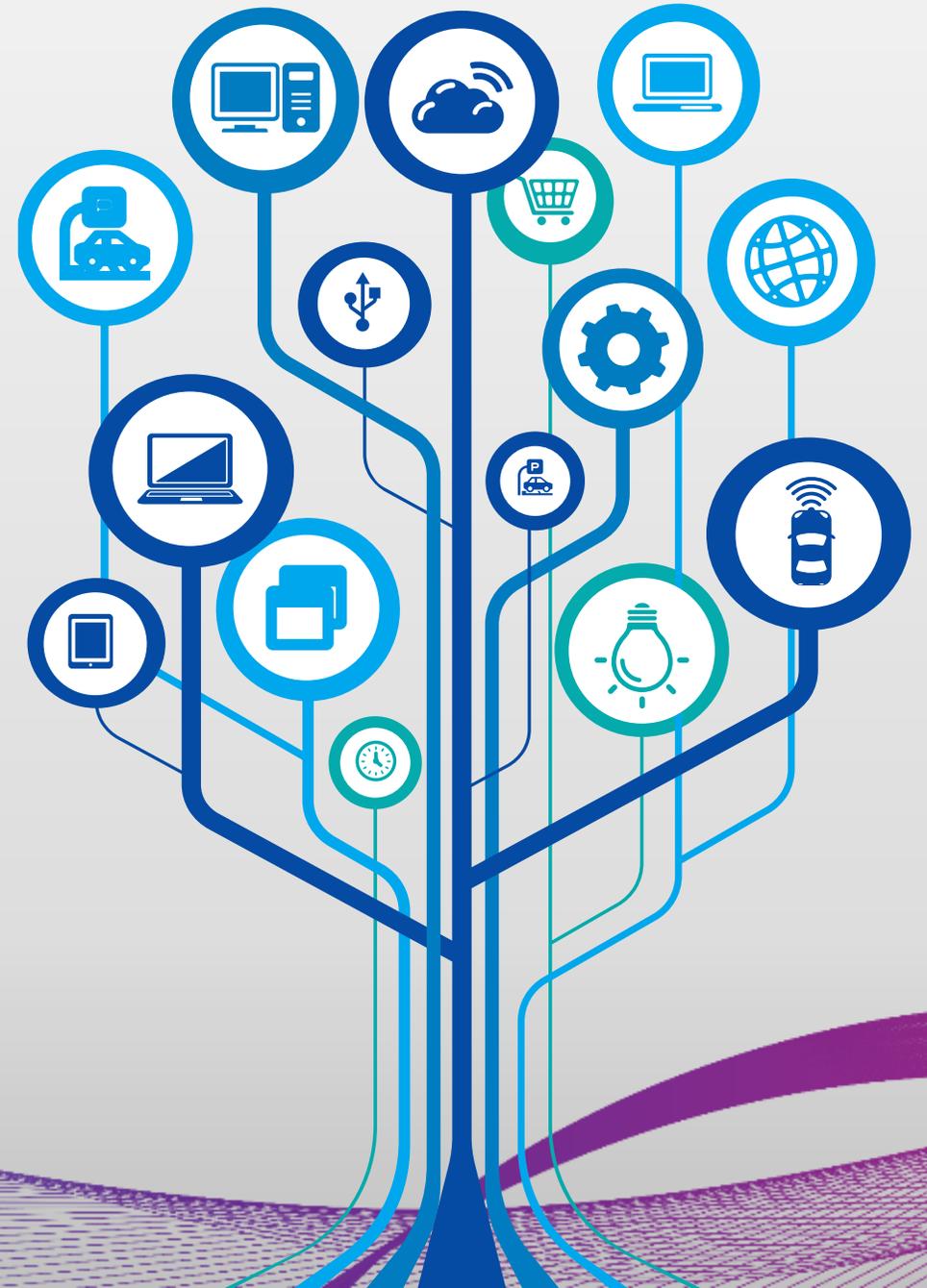




Igniting connected digitalisation

Powered by Narrow Band Internet of Things (NB-IoT)

April 2022



Foreword – KPMG in India

Telecom has long been synonymous with mobility and connectivity in India, the second most populous country in the world with 1.3 billion people. The telecom industry today is entering an exciting era of innovation. IoT (Internet of Things) as a technology – especially NB-IoT (Narrow Band IoT) promises to create better and secure experiences for all by transforming connectivity.

After almost two years under siege from COVID-19, the business sector has far more confident outlook for 2022 as companies take the initiative to invest in growth. The momentum for digital transformation to set the agenda and drive the recovery has never been stronger. Companies and clients are looking to move quickly on ambitious development projects and digital initiatives that would make their businesses more efficient, more resilient, and more competitive. NB-IoT would help usher this digital transformation by (a) enabling traditional businesses to operate smartly via smart meters, smart trackers and (b) opening up new industry opportunities like eHealth and smart city.

As per IEEE (The Institute of Electrical and Electronics Engineers) – “Narrowband Internet of Things (NB-IoT) is an emerging cellular technology that will provide improved coverage for massive number of low-throughput low-cost devices with low device power consumption in delay-tolerant applications”¹.

Around the world more than 150 operators are actively investing in NB-IoT technology of which more than 100 have commercially deployed NB-IoT network². Owing to this boom in technology usage – NB-IoT infrastructure – from chipsets to modules to devices, are now available from a range of companies – start-up or well established, small or big.

In the Indian Union Budget 2022, production linked incentive (PLI) payouts for electronics/technology products, which includes IoT devices as well, is budgeted at INR 53 billion in FY 23 with a 5-year fiscal outlay of INR 459 billion³. This budgetary push by Indian Government is expected to aid the local sourcing of NB IoT infrastructure - thus aiding in NB IoT adoption by different sectors in India. The union budget also has focused on digital and connectivity, 5G, access and customer premise equipment which would also boost NB-IoT. As the economic barriers recede along with a clear regulatory framework on the working of NB-IoT devices, increase in adoption is expected to happen. With more industries coming forward for different use cases for NB-IoT, this technology is likely to be viewed as having a positive impact on the growth trajectory of the people, business and India.

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Sources: [1]: IEEE wireless communication letters, Volume 5, Issue 6, Dec 2016
[2]: NB-IoT and LTE-M: April 2021 – Member Report, GSA (Global Mobile Suppliers Association)
[3]: FY23 union budget documents, KPMG analysis

Foreword – Jio Things

‘IoT has potentially impact the economy by several trillion dollars’. ‘IoT is the foundation of digital transformation’. ‘IoT is the key to disrupt consumer experiences’.

Everything that we heard about IoT was just an ‘expert opinion’. Facts have been far from reality! Technocrats, business leaders and operational managers all have agreed that IoT is the way forward, unfortunately, no one talks about how to scale it! ! Getting a positive return on IoT investments is a question executives look forward to crack. A number of challenges like lack of reliable technologies, constrained device management, security concerns, analytical capabilities, and uncertainty about IoT standards and protocols have limited organisations to realise potential value from their IoT investments.

Bottom line is, that the way to unleash the power of IoT was just not available. The IoT market by theory is huge and can grow at an almost unthinkable clip, but the practical barriers on IoT adoption have ensured that revenues and paybacks do not become a reality but are always a part of boardroom cerebral hypothesis!

This whitepaper has come up with all the answers that the fragmented world was looking for! As businesses become more demanding in terms quality of output, uptimes and cost competitiveness, it is imperative for any IoT Service Provider (IoTSP) to put all the pieces together and become a one-stop-shop to unlock the true value that IoT can generate! Enterprises and consumers today demand superior technology, reliable results and most importantly managed services which is nothing but reliable aftermarket

support! So how do IoTSPs deliver a 10X experience with cost constraints especially in developing market like India? How can IoTSPs unlock IoT data, bring scale and build a sustainable IoT factory that would last for decades to come?

The whitepaper helps you with a “**6C Mantra**” that would help stitch all the pieces together for a successful IoT implementation. These include **Coverage of network, Cost of ownership, Connecting at scale, Cyber security, Constrained device support and Customer experience.**

With the advent of NB-IoT the wait for a technology that covers all the 6C aspects is over! NB-IoT not only has the potential to connect billions of sensors but also is secure, extremely cost effective, easy to deploy and maintain and of course is a global standard. ‘Internet of Behavior’ will soon be reality with help of NB-IoT!

In order to achieve this reality, a strong and committed leadership and a clear and compelling vision to address business problems is needed. Unlocking value from any technology requires more than blind investments and needs to have a clear definition on end-to-end thinking, as IoT doesn’t only consist of multiple technology layers like hardware, network, platform, portals, dashboards, but also field services like installation and aftermarket support! All of this is incomplete without domain knowledge!

We hope you find this whitepaper insightful and enlightening. Let the democratisation of technology begin... Happy reading!

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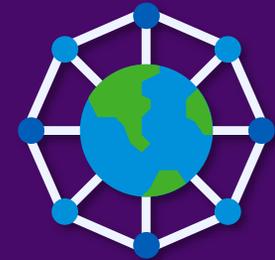
Executive summary

Digital transformation is a significant priority for companies worldwide, more so after COVID 19. CEO surveys and industry reports point to a **significant wave of investment** aligned to rebound in customer sentiment/demand



Backbone for enterprise digital transformation

is the **IoT ecosystem**. Lots of advances made in IoT building blocks – **sensors/devices** (smart/connected), **connectivity** (cellular, LPWAN, 5G), **platform/analytics** (cloud, edge)



Consumer tech has really advanced,

- **Front office/Customer experience (CX)** transformation has delivered significant value to businesses worldwide. Technology companies are using **cloud/SaaS** (Software as a Service) transformation to disrupt industries across sectors.



IoT is being leveraged in some use cases in **urban logistics, manufacturing**, etc. However, it has not lived up to potential for multiple reasons, mostly centered around economics/payback – devices (hard to maintain/service in hostile environments), cellular/4G (expensive for rural applications), cloud/edge (significant upfront investment)

But **enterprise technology** has lagged behind

- **Mid office and back office transformation has not been on par**, after the big shift due to ERP. Tremendous value remains to be unlocked



What is **NB-IOT**: It is a form of **LP-WAN, 4G/5G 'lite' standard, backwards compatible**, being launched globally. It is compatible with existing mobile technologies.



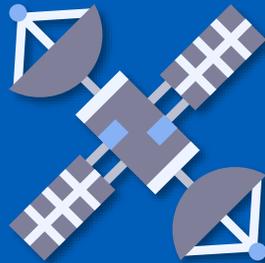
Executive summary (continued)

Why NB-IoT –

It presents a **compelling proposition** due to its **6Cs** (**coverage, cost, connectivity, constraints, cybersecurity and customer experience**).



The **NB-IoT market** in India is **already present and growing since 2018** and has the potential to enhance adoption of IoT owing to its **low cost, low power and massive device supporting capabilities**.



NB-IoT can **power a wide variety of use cases** across sectors



However, there are **potential challenges and constraints to reaching full potential** (regulations, alternative technologies like **Satellite broadband**). These require interventions such as **policy and industry support**

NB-IoT is **witnessing growing investment globally** – **telco OpCos, device OEMs, platform companies, system integrators**



Conclusion – NB-IoT is an exciting **‘Made for India’ and ‘Made in India’** technology. As the dream of **Digital India** takes shape, this technology would play a key role across **B2B and B2C sectors and Government/public services**



Table of contents

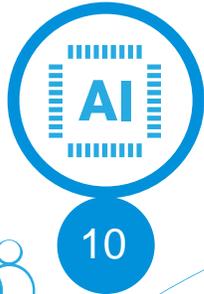
01

The digital transformation opportunity



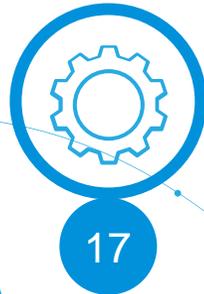
02

The Digital Enterprise – Powered by IoT



03

NB-IoT: A Capability 'Edge'



04

NB-IoT in India: Outlook and Road Ahead



05

Conclusion: An Opportune Moment



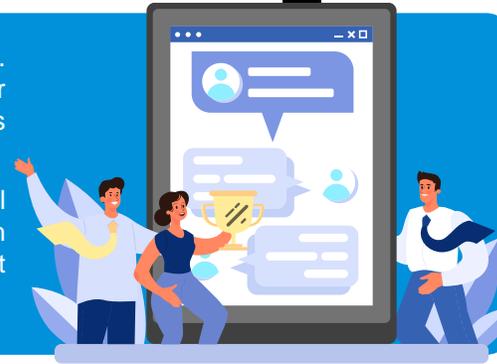
The digital transformation opportunity



Digital transformation has become a significant priority for businesses worldwide

Customer centricity amid social distancing became a challenge during the COVID-19 led pandemic. This was true especially for businesses which were dependent on face-to-face interactions with their customers to drive business. With restrictions such as quarantine and remote working, businesses faced an unimaginable dilemma – How to stay closer to the customer while staying away from them?

While some organisations found new ways to connect with their customers through digital interventions using chatbots, social media, online collaboration platforms, others struggled. With customers going increasingly digital, businesses realised the need for a larger digital engagement across functions to enhance their competitiveness.



COVID-19 has made organisations relook at their business models

Pre-COVID 19, private and public organisations were on a journey towards a digital business model, traveling at various speeds. But the scale of the current pandemic has forced a dramatic acceleration, both in the required investment in digital transformation and the speed of change.

To better understand how COVID-19 has impacted companies' digital transformation strategies, in mid-late summer 2020, KPMG conducted various surveys to understand how organisations are reviewing their digital strategy in the wake of COVID-19. The crisis has seen the emergence of 4 models:

A

Hard reset mode

To be adopted by organisations that struggle to recover due to 'permanently' lowered demand for their offerings, insufficient capital to ride out extended recession, and/or poor digital transformation execution resulting in delayed recovery. Example: Hospitality, Aviation

B

Transform to re-emerge

Organisations whose business model has changed along with how their customers want to interact with them. Their recovery could be along a protracted path, requiring capital reserves to transform operating models to keep up with new consumer expectations. Example: Retail

C

Surge mode

Organisations that scale rapidly because consumer behaviour changed permanently during the COVID-19 era. These organisations would need to protect the gains that they have made during the pandemic. Those that can keep the momentum gained from COVID-19 would prove to be opportunistic and agile. Example: Online collaboration software

D

Modified business as usual

Organisations seen as daily essentials that could suffer during the consumer slowdown but recover more quickly as consumer demand rebounds. Example: Utilities

According to a study commissioned by Forrester Consulting on behalf of KPMG in July 2020,

69%

Of the respondents say their digital transformation strategy was a "high" or "top" priority prior to the pandemic

67%

Of the respondents say they've accelerated their digital transformation strategy as a result of COVID-19

63%

Of the respondents said they've increased their digital transformation budget as a result of COVID-19

Organisations view aligning their front, middle and back-office functions as critical to drive an enterprise-wide digital transformation

Back office: The next “frontier” of technology

The COVID 19 pandemic drove explosive changes to customer experience expectations and demands across the world. And this change wasn't only limited to the customers; businesses also expected intuitive, easy and seamless experiences from their suppliers.

While business organisations responded to this sudden shift by adopting digital solutions focused on front office, they soon realised that their back-office processes and structures were not developed to support this transformation over the long term.

To enable a consistent customer experience (further enabled by an enhanced employee experience), it is essential for organisations to embrace the 'One Office' concept.

'One Office' is realised when the customer needs and experiences are the front and centre of the entire business. The old barriers between corporate functions (often referred to as 'front office', 'middle office' and "back office") are dissolved and constraints of legacy ERP systems are minimised. This allows the businesses to invest in digital technologies and capabilities that enable it to cater proactively to its customers' needs at the forefront of the market.



79 per cent
of C-suite respondents view aligning middle- and back-office operations to support customer experiences as “mission critical” or “increasingly important.”

Source: State of Operations and Outsourcing 2017 survey, KPMG US

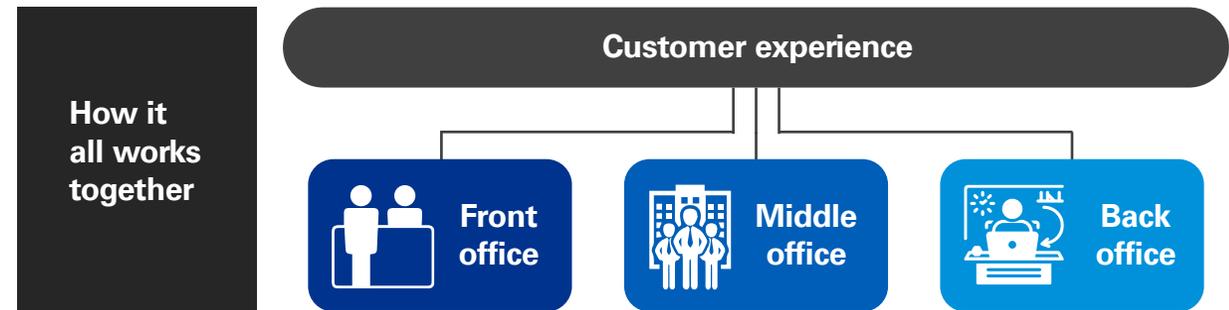
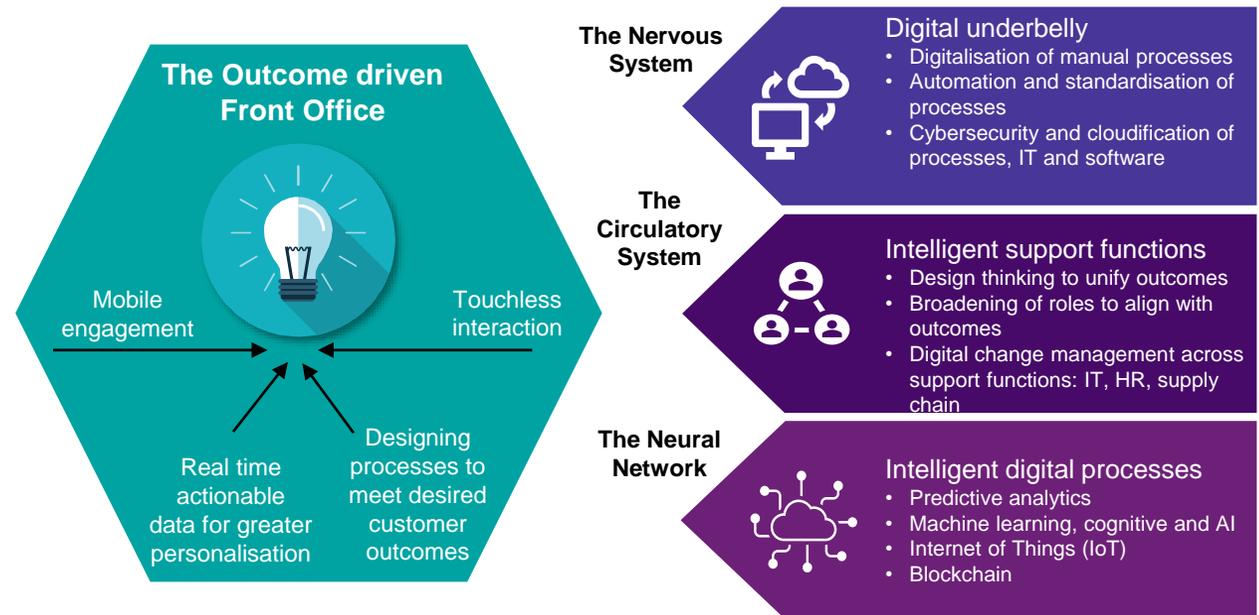
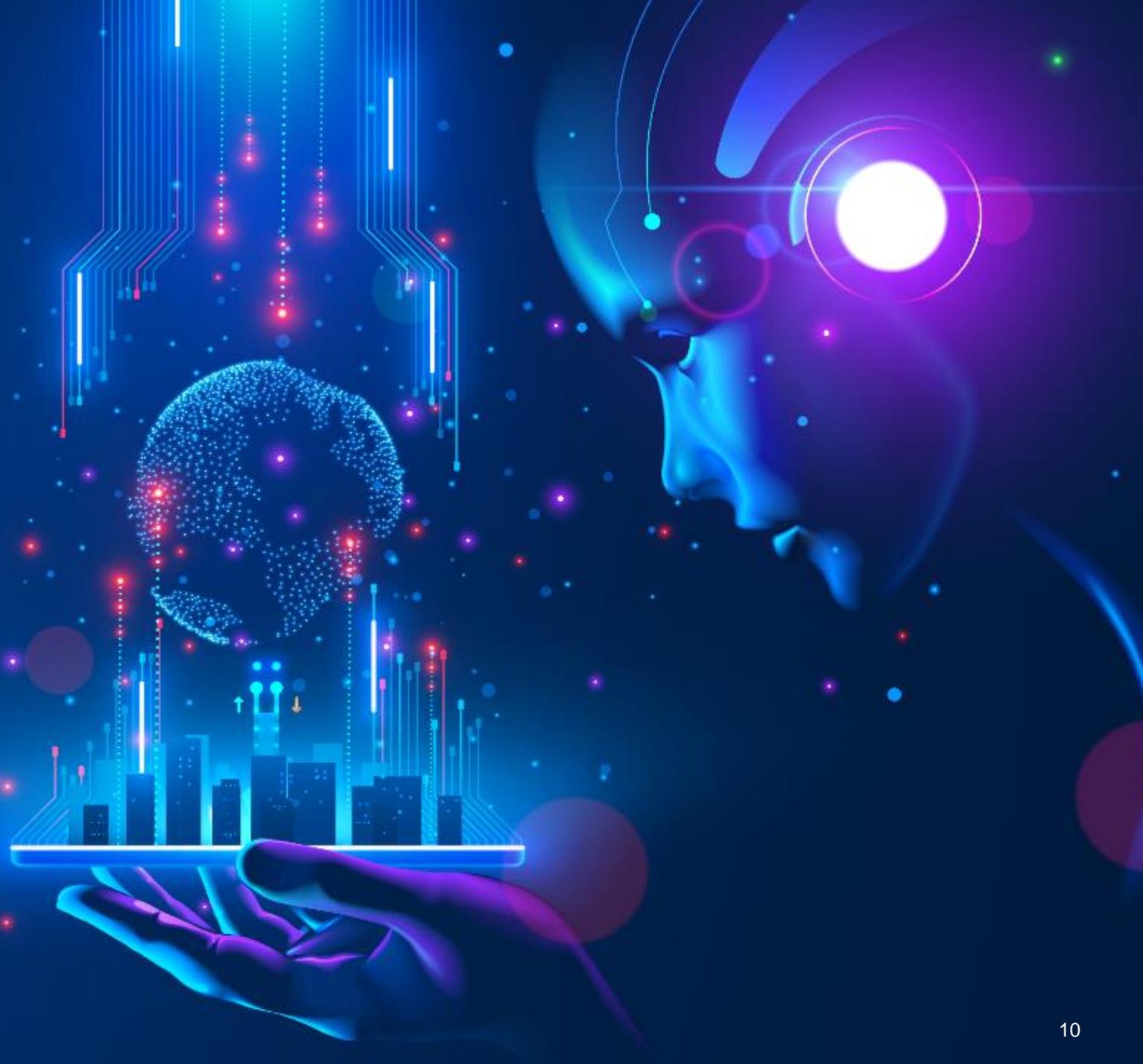


Figure 1: the Digital One Office Framework

Integrating the Front Office and Back Office into One Office



The 'Digital Enterprise' – Powered by IoT



IoT is the foundation for digital transformation driven by a collaborative ecosystem for bringing data - driven insights for enhanced performance

IoT is a network of devices that collect and share data for analysis. IoT has evolved from standalone industry to a mainstream set of tools that can be used, often paired with another technology, to solve challenging business issues

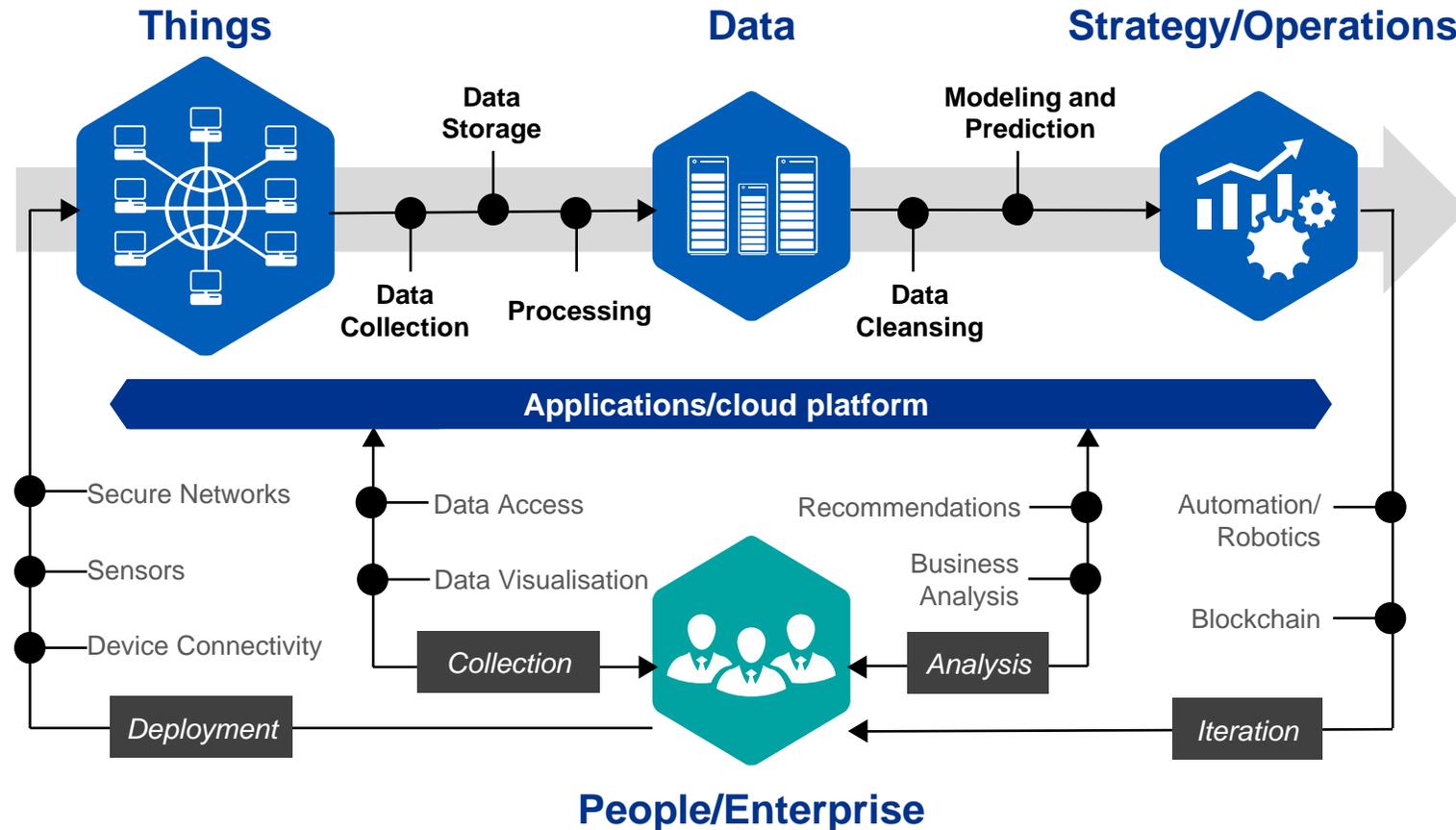


Figure 2: IoT collaborative ecosystem

More than just devices

Deploy: Devices and systems (i.e., things) are connected to the internet through low-cost sensors

Analyse: Humans can monitor and learn from this data, informing more accurate business decisions and improved customer interactions

Collect: Interconnected devices collect behavioral data and environmental data that can be analysed and visualised.

Iterate: In maturity, devices would autonomously act based on this data stream, ultimately making business decisions

Challenges for IoT introduction

- **Interoperability:** Challenges in establishing and maintaining interoperability between different IoT systems
- **Integration:** Integration of various products with the right IoT platforms
- **Unstructured data and processing:** Challenges in managing unstructured data on the parameters of variety, volume and velocity
- **Data security and privacy:** Development and implementation of sound data security and cyber security policies for the purpose of consumer protection
- **Authentication and device management:** Identification and authentication of IoT devices on single platform that requires system architecture and formalisation

Six principles for creating business value with IoT

Define the business problem

- Clearly define why you are looking to utilise IoT
- Define the business problem to be solved and the benefit sought – in terms of cost reduction, customer experience, quality, productivity, growth, improving products or risk reduction?
- Define a clear problem statement, use cases, value statement and success criterion



1

Collaborate to create value

- IoT's power is when talking, sharing and connecting happens. From devices to people, processes and data
- The richer the sharing, the wider the span, and the more benefit that will be achieved
- Open standards and interoperability play a critical role, reducing cost and improving success



2

Re-think skills and culture

- IoT will disrupt the way your business operates
- New experiences, new processes and new products will emerge
- Don't assume your current team has all skills or mind set to work optimally in this new environment without extra training
- A balanced mix of creative, analytic, data, technical and business process skills will be critical – with the ability to span silos and functions



3

Experiment

- Apply the adage 'think big, start small'
- Develop a richer understanding of IoT benefits and risks for your business through testing and learning solutions
- Assess successes and failures
- Measure the value and degree of disruption
- Run gradually bigger experiments as you learn – building stronger capabilities



4

Know the risks and rules

- With value comes risk. IoT will likely take your business places it's never been
- Understand any regulations or risks associated with your initiative
- Security, privacy, safety are important (but are not the only things) to consider
- Ensure you are thinking across customers, employees, assets, partners and all other stakeholders



5

Establish your ecosystem

- IoT requires a connected ecosystem of 'components' to deliver value
- Your solution won't rely on one vendor or product, but many working together
- With your problem in mind, create a clear view of who your partners need to be in each area, and how you want them to work with each other



6

Evolution of IoT

Till 2020

2020-2021

2022 onwards

IoT Evolution over the years

Digital disruption era focused on technology adoption

- During 2010-2020, period known for digital disruption, **focused mainly on technology adoption**
- **It was witnessed that technologies were intertwining** into every industry and industry value chains
- **Industry convergence** was witnessed as firms saw huge competition from outside sectors, such as from eCommerce, automobiles, and manufacturing

Accelerated IoT adoption to focused sectoral implementation

- Trends such as **accelerated IoT adoption to focused sectoral IoT implementation across businesses** was observed during 2020-2021
- **Changing consumer/patient preferences** and work-from-anywhere model drove IoT application across sectors
- **HealthTech, EdTech, and RetailTech** sectors are the top-most sectors showing high adoption for IoT

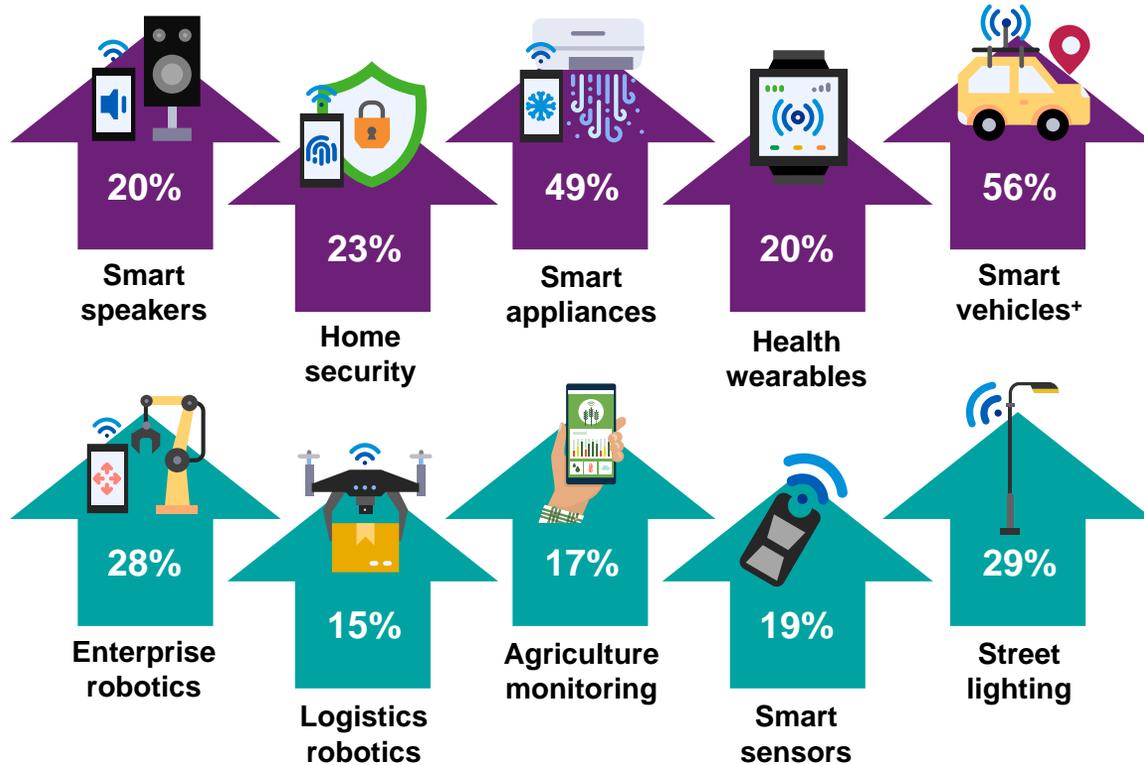
IoT in conjunction with other technologies gaining momentum

- Adoption of IoT/loB (Internet of Behaviour) attaining ground
- **Internet of Behaviour** refers to the data gathering (big data, business intelligence, customer data platforms etc.) that offer important information on consumer interest, preferences and behaviours - a behavioural psychology standpoint. **IoT incorporated with technologies like AI and ML** is essential to achieving this state.
- Spending pattern to shift to **cloud, data and analytics, and software** from devices and sensors, for companies to manage daily tasks and be ahead

The market opportunity for IoT is huge...

From smart devices to smart cities, IoT is growing rapidly, with the pace and scale of enterprise IoT far outweighs consumer IoT. IDC predicts that by 2025 there would be 55.7 billion connected IoT devices worldwide generating almost 80 zettabytes (ZB) of data³.

Installed device CAGR, 2020-2025⁴

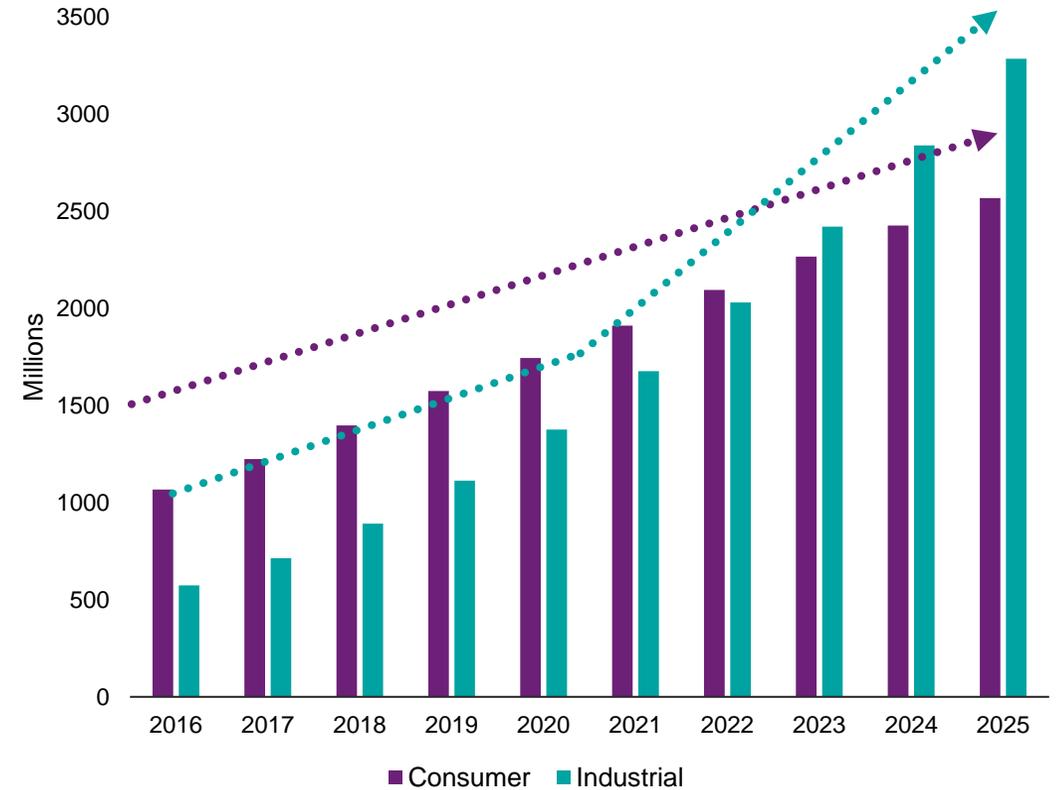


Note +: Represents CAGR for semi and fully autonomous vehicles, which accounts for 13.6% of the total IoT-enabled vehicle shipments in 2023. When including connected vehicles, which accounts for 86.4% of the total IoT-enabled vehicle shipments in 2023, the aggregate CAGR is 7.8%.

Source: [3]: Future of Industry Ecosystems: Shared Data and Insights, IDC, posted on Jan 2021, accessed on Jan 20, 2022

[4]: Business Insider Intelligence, GSMA Intelligence, IDC, Market Watch, PR Newswire, KPMG analysis

Northern America IoT connections⁴



IoT is expected to impact the majority of traditional industries by 2023 - 2025 depending on data found

Manufacturing



87.6 billion smart sensors in manufacturing by 2025⁵

Infrastructure



24% annual increase in IoT infrastructure spending⁶

Utilities



1.3 billion smart meters deployed by 2025⁷

Defense



USD 26.8 billion military drone market by 2025⁸

Retail



USD 35.5 billion expected market size of IoT in the industry by 2025⁹

USD 18.1 billion value of global agricultural IoT market by 2026¹⁰



Agriculture

74% of insurance executives believe IoT would disrupt the industry¹¹



Banking & finance

USD 8.4 billion expected market valuation of IoT in the industry by 2025¹²



Food services

470 million connected cars by 2025¹³



Transportation

USD 188 billion expected value for IoT devices used in healthcare by 2025¹⁴



Healthcare

Source: [5]: Smart Sensor Market Global Forecast to 2025, MarketsandMarkets, Mar 2020; [6]: Global IoT spending to grow 24% in 2021, IoT Analytics, posted on Jun 2021, accessed on Nov 21, 2021; [7]:AMI global forecast 2020-2025: H1 2020, Wood Mackenzie report, Mar 2020; [8]: Military Drones Market, MarketsandMarkets, Oct 2018; [9]: Internet of Things (IoT) in Retail Market - Global Forecast to 2025, MarketsandMarkets, Mar 2020; [10]: Agriculture IoT Market, Market, Markets and Markets, May 2021, [11]: How IoT will change auto insurance, Global Big Data Conference posted on Mar 2017, accessed on Nov 20, 2021; [12]: Internet of Things and Traceability for Food & Beverage Manufacturing Market, Forecast to 2025, Frost & Sullivan, Sep 2018; [13]: "470 Million Connected Vehicles On the Road by 2025," ITSdigest, February 16, 2018; [14]: IoT in Healthcare Market, Markets and Markets, Jun 2020

IoT usage for hyper focused industries to deliver significant opportunities

Healthcare



Client opportunity:

- Improve patient outcomes
- Streamline operations
- Effective response to pandemics
- Remote patient management

Target submarkets:

- Hospital and other medical facilities
- Hi-Tech pharmaceuticals
- Bio-technology research

Cities/Spaces



Client opportunity:

- City/building operational efficiency
- Enhanced employee, citizen, visitor experience
- Improved safety and security
- Integrated transportation and improved traffic flow

Target submarkets:

- Smart buildings
- Hospitality
- Smart cities
- Integrated transportation
- Sports venues

Industrial manufacturing



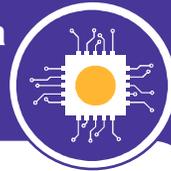
Client opportunity:

- Factory floor automation
- Workforce safety
- Product waste reduction
- Predictive and preventative maintenance
- Logistics and supply chain

Target submarkets:

- Automotive manufacturing
- Chemical manufacturing
- Medical devices manufacturing
- Warehouse and logistics
- Fleet management

Technology, Media and Telecom



Client opportunity:

- Product globalisation
- Network integration
- Market collaboration
- Asset management and tracking
- Operational efficiency

Target submarkets:

- Software and hardware providers
- Semiconductors
- Media production and distribution
- Telecommunications

Secondary Industries

Retail services

Oil and gas

Agriculture

Financial services

Higher education

Energy distribution

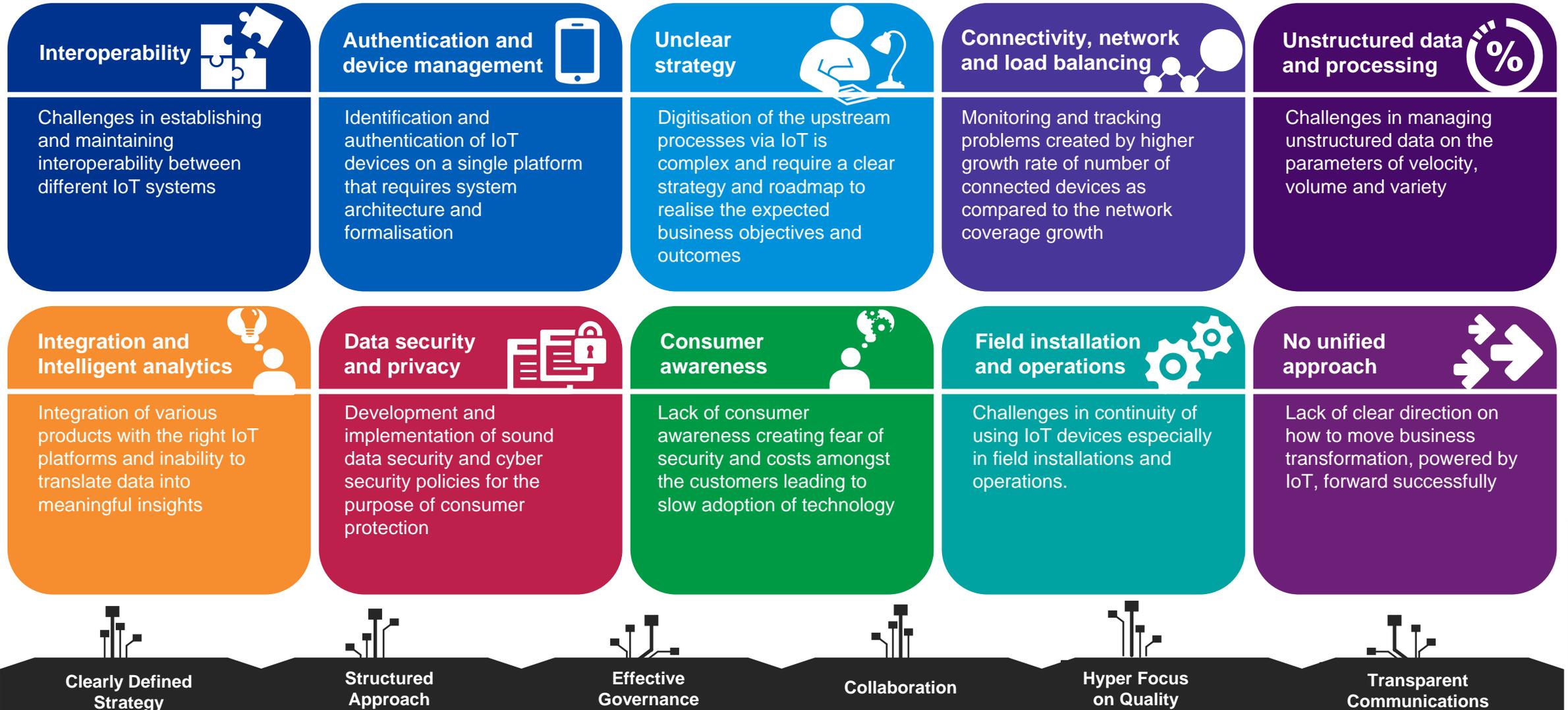
Transportation

Government (Fed/Local)

Consumer products

Asset management

Unlocking the value of the IoT has its challenges and requires a clearly defined strategy



Successful IoT implementations require a structured governance framework

A structured IoT Governance framework helps **identify various components and stakeholders** of a comprehensive IoT program. The IoT **strategy, delivery, and operations models are integrated with risk**, governance, and controls considerations throughout the program lifecycle to help ensure timely and effective risk identification, evaluation, mitigation, and in some cases, acceptance.

This framework also helps in:

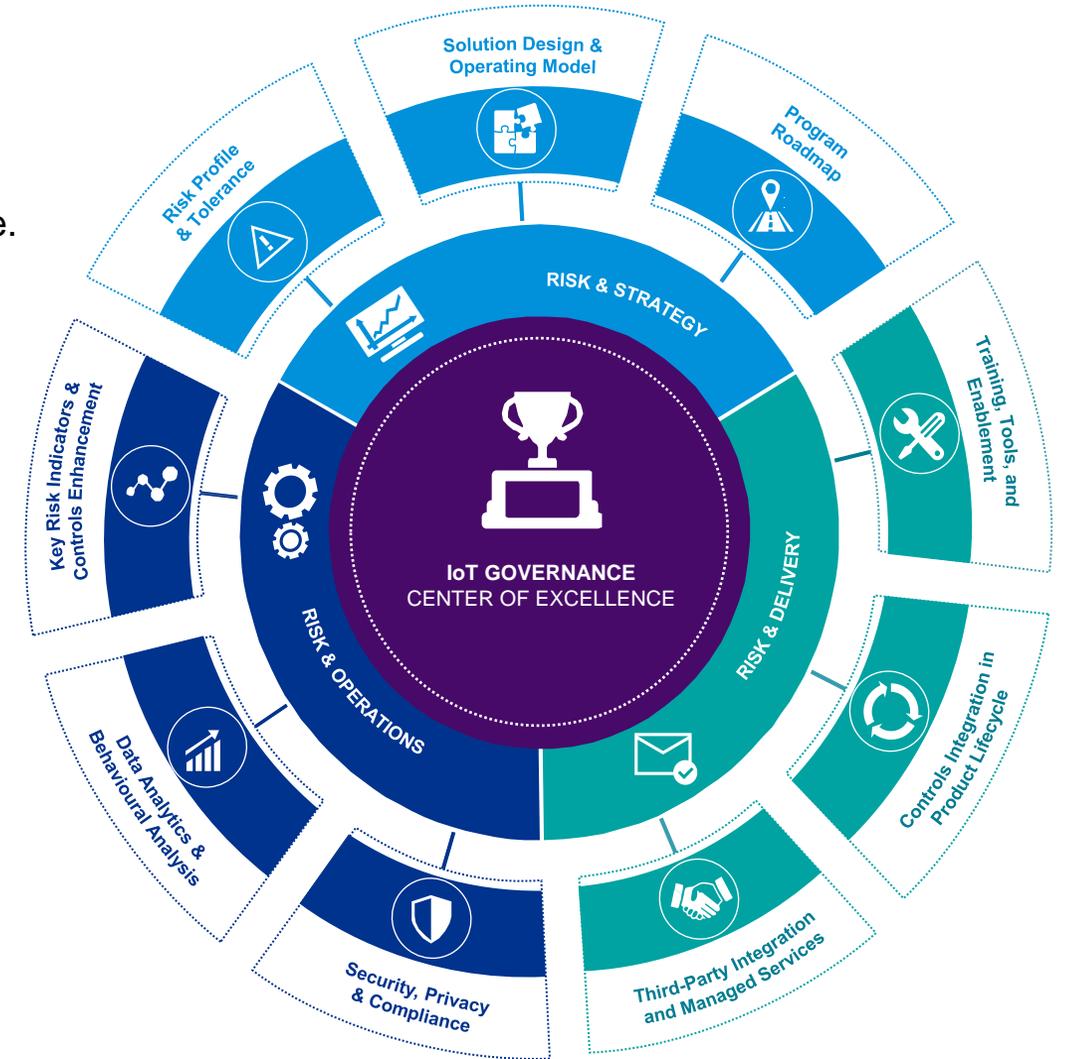
Holistic approach to responsibly **building and managing a connected device program**

Supports a sustainable program for **product design, development, and ongoing support**

Aligns people, process, and technology across different brands with common objectives and policies

Enables **continuous innovation** without compromising security, privacy and trust

Layered approach with **embedded checks and balances**



NB-IoT: A capability 'edge'



Different IoT communication standards especially LPWAN technology options driven by its low costs and operating requirements

IoT communication standards: LPWAN takes the lead

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

Feature	Sigfox	LoRaWAN	NB-IoT
Modulation	BPSK (Binary Phase Shift Keying)	CSS (Chirp Spread Spectrum)	QPSK (Quadrature Phase Shift Keying)
Frequency	Unlicensed ISM band	Unlicensed ISM band	Licensed LTE frequency
Bandwidth	100 Hz	250 kHz and 125 kHz	200 kHz
Maximum data rate	100 bps	50 kbps	200 kbps
Bidirectional	Limited / Half Duplex	Yes / Half Duplex	Yes / Half Duplex
Maximum messages / day	140 (UL), 4 (DL)	Unlimited	Unlimited
Maximum payload length	12 bytes (UL), 8 bytes (DL)	243 bytes	1600 bytes
Range	10km (Urban), 40km (Rural)	5km (Urban), 20km (Rural)	1km (Urban), 10km (Rural)
Interference immunity	Very high	Very high	Low
Authentication & encryption	Not supported	Yes (AES 128b)	Yes (LTE encryption)
Adaptive data rate	No	Yes	No
Handover	End-devices do not join a single base station	End-devices do not join a single base station	End-devices join a single base station
Allow private network	No	Yes	No

Figure 3 Comparison of different technologies ^{15, 16}

Source: [15]: KPMG analysis; [16]: A comparative study of LPWAN technologies for large-scale IoT deployment, Kais Mekki, Eddy Bajica, Frederic Chaxel, Fernand Meyer, Science Direct, Mar 2019

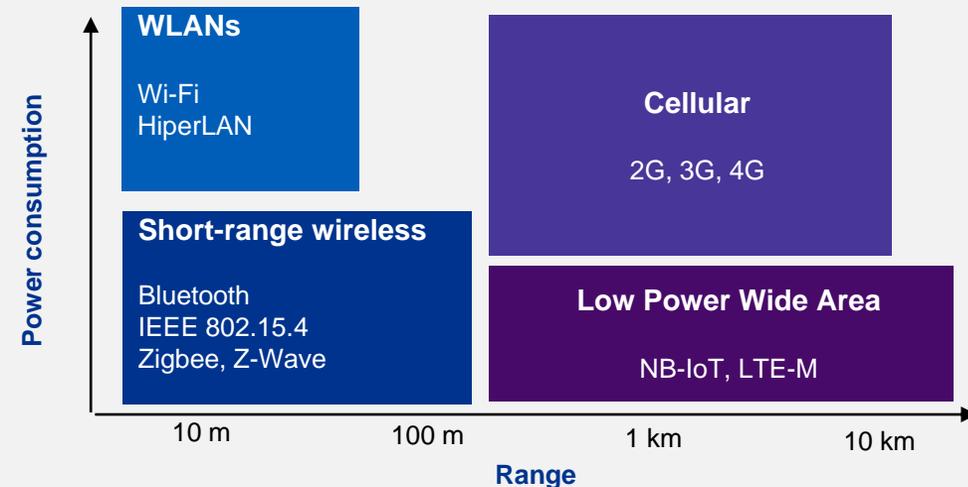


Figure 4: IoT connection standards mapped against power consumption and coverage¹⁵

NB-IoT stands out amongst the IoT standards

NB-IoT was conceived particularly for cellular M2M communications and allows seamless deployment of devices within an operated network. It can coexist in the licensed LTE/GSM bands with a frequency bandwidth of 200 KHz¹⁶.

Operators, until now, opted for hybrid technology as there was no cellular LPWAN technology. In addition, hybrid strategies with cellular and unlicensed non-cellular LPWAN applications were opted for due to factors such as cost, coverage, battery life, latency, and scalability. However, with introduction of LTE-M and NB-IoT, available options have increased and so has the likelihood of using cellular LPWAN.

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. As a result, the adoption of any of these cellular LPWAN technologies can scale much faster in a country like India.

Introducing NB-IoT and its potential benefits

Benefits of NB-IoT – 5 Cs

NB-IoT is staking its claim as the LPWAN technology of choice, with certain characteristics making it preferable to other technologies. Key reasons include utilising existing infrastructure, open standards driven deployment, security, integration synergies and scale for mobile operators.

Key growth drivers include

Widespread mobile networks globally: There are currently more than 100 live NB-IoT networks globally, and with over 100 mobile operators planning to shutdown 2G and 3G networks in the next few years, 2G M2M migration could be a major catalyst in driving NB-IoT uptake²¹.

Strong industry support: NB-IoT has a thriving ecosystem of major chipset vendors, hardware manufacturers and equipment providers.

More use cases: NB-IoT technology is proving its value in a growing number of sectors, from smart city and consumer applications, through to industrial manufacturing and agriculture.

High 2G module chipset costs: Chipset cost of 2G modules increasing as operators are shutting 2G operations globally.

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

As the world is transitioning towards an era of connected devices, one of the important goals of mobile communications is to achieve massive connectivity. The NB-IoT system helps realise this goal using a very narrow bandwidth. From a customer perspective NB-IoT based systems help make IoT deployments possible in situations where it is difficult to deploy a dedicated unlicensed network. Any area with mobile network coverage can be the breeding ground for NB-IoT. NB-IoT is less sophisticated but more secure than traditional cellular modules – thus simplifying design, development and deployment for Original Equipment Manufacturers (OEMs).

Sources: [17], [18]: Cellular networks for Massive IoT, Ericsson, Jan 2020

[19]: What is NB-IoT? Unlock its business potential – Ericsson, accessed on Nov 1, 2021

[20]: A comparative study of LPWAN technologies for large-scale IoT deployment, Kais Mekki, Eddy Bajica, Frederic Chaxel, Fernand Meyer, Science Direct, Mar 2019

[21]: Global NB-IoT Ecosystem: Trends, Adoption and Outlook, Counterpoint Research, March 2021

6Cs of NB-IoT

- **Coverage:** large area of coverage, over 20dB higher than legacy cellular technologies. Extended coverage using repetition of transmissions¹⁷
- **Cost:** low cost, low maintenance due to high battery life, ability to leverage telco towers. 50% economical that Cat1/Cat4 with no upfront infrastructure deployment cost or no network maintenance¹⁸
- **Connections:** up to 50,000 connections cells¹⁹
- **Constrained devices:** well suited for battery operated applications
- **Cybersecurity:** advanced CloT security for IP and Non-IP data delivery
- **Customer experience:** easy and hassle-free onboarding with no aftermarket/maintenance challenges

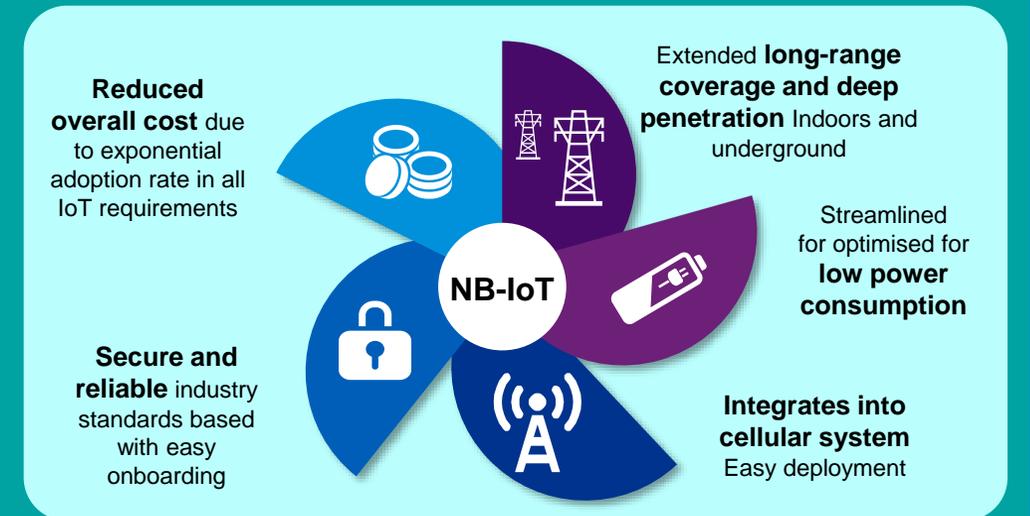


Figure 5: Advantages of Nb-IoT

With a promising value proposition, NB-IoT is witnessing increasing global deployments supported by a growing number of 3GPP compliant devices

NB-IoT: A promising value proposition

The cellular stakeholders require a standardised solutions to go one step further to provide cellular standards for LPWAN networks. It is their pressure that has accelerated the evolution of 3GPP standards relating to IoT. The potential new subscribers originated by the IoT use cases are a reason behind this need for standardisation.

NB-IoT is a 3GPP effort to penetrate the ultra-low cost, throughput and power, expanded coverage, and tolerant to delay IoT marketplace, which, in 5G nomenclature, is the massive Machine Type Communication (mMTC) use case. This use case has one of the highest number of potential IoT subscribers (order of several billion). In addition to extended coverage and massive deployment capabilities listed earlier, NB-IoT offers the following capabilities as well:

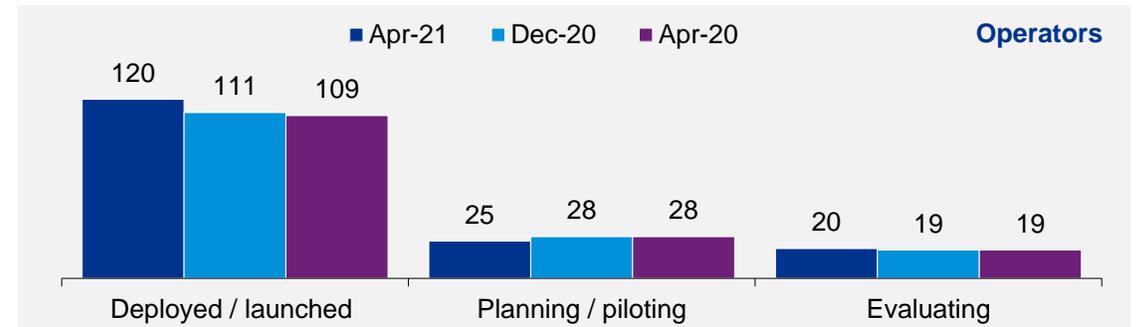
- Extremely low-cost device** → 3GPP NB-IoT standard provides 15% lower modem complexity v/s previous versions as part of MTC standard²¹
- Reduced data rates** → 3GPP offers transfer rates of up to 200 kbps in the downlink and 20 kbps in the uplink²²
- High allowed latency** → Uplink latency can be up to 10 seconds²³
- Low power consumption** → 10-yr battery life, assuming a 5 Wh battery capacity²¹

Figure 6: NB-IoT offers unmatched capabilities

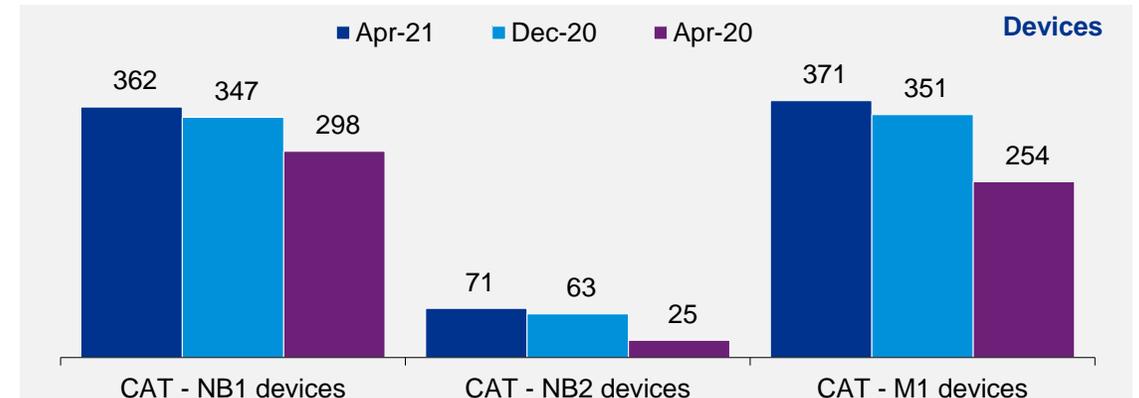
Source: [18]: Cellular networks for Massive IoT, Ericsson, Jan 2020; [19]: What is NB-IoT? Unlock its business potential – Ericsson, accessed on Nov 1, 2021; [21]: NB-IoT Deployment Guide to Basic Feature set Requirements, GSMA, June 2019; [22]: A comparative study of LPWAN technologies for large-scale IoT deployment, Kais Mekki, Eddy Bajic, Frederic Chaxel, Fernand Meyer, Dec 2017; [23]: A Systematic Analysis of Narrowband IoT Quality of Service, Andreas Philipp Matz, Jose-Angel Fernandez-Prieto, Joaquin Cañada-Bago and Ulrich Birkel, Mar 2020; [24]: NB-IoT and LTE-M: April 2021 – Member Report, GSA, Apr 2021; [25]: NB-IoT and LTE-M: Dec 2020 – Member Report, GSA, Dec 2020, [26]: NB-IoT and LTE-M: April 2020 – Member Report, GSA, Apr 2020

NB-IoT: Growing number of operators and devices

According to GSA, as of April 2021, 165 operators are actively investing in NB-IoT technology compared to 158 in December 2020 and 156 in April 2020^{24,25,26}



In terms of IoT equipment, there has been a rise in devices supporting 3GPP IoT standards by 33% compared to June 2020 (518 in Apr 2021 v/s 493 in December 2020 v/s 390 in June 2020)^{24,25,26}.



NB-IoT deployment in India is still at the early stages ...

NB-IoT in India: Early days

NB-IoT has been in India since 2018 and has the potential to enhance adoption of IoT given its value proposition and relevance for the India market because of its low cost, low power and massive device supporting capabilities.

NB-IoT in India is crucial because of the bandwidth limitations in the license-free bands in India. While some other countries have non-cellular LPWAN IoT technologies (E.g., LoRaWAN), the very same non cellular IoT technologies are constrained for bandwidth in India. In a way NB-IoT is one of the first LPWAN technology in India that has the potential to scale to the magnitude of the Indian IoT demands.

The status of NB-IoT readiness in India can be summarised below:

Area	Key developments
NB-IoT ready mobile networks	In 2018, deployments of NB-IoT network started in select cities in India which meant that mobile network operators had planned about rolling out NB-IoT for real. Today NB-IoT solutions have gone live in multiple cities at a considerable scale.
NB-IoT hardware/module vendors	With NB-IoT arriving rather late in India when compared to other countries around the globe, there are dozens of already developed NB-IoT modules available from every major cellular module manufacturer.
Operational cost	The operational/connection cost is a make-or-break factor for NB-IoT in India. However, for a cost conscious market like India, the prices were expected to be among the lowest globally. The possible price band of USD 0.2 to USD 0.5 per device per month which would be a reasonable cost band for most IoT applications.
Network coverage	Network coverage is another major reason for fast scale up of NB-IoT and if most of the cities are covered, NB-IoT product manufacturers could be struggling to meet customer demands



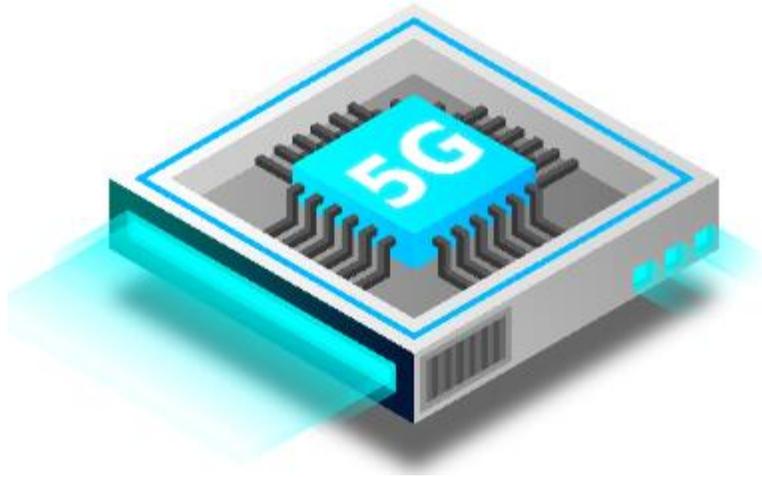
... and is expected to drive the country to become the fastest growing market for IoT module shipments

India projected to be the fastest growing market for Cellular IoT shipments

According to Counterpoint's Global Cellular IoT Module and Chipset Forecast published in February 2021, IoT module shipments would cross 780 mn in 2024. The share of NB-IoT would lead the cellular IoT module shipments followed by cellular technologies of 4G and 5G.

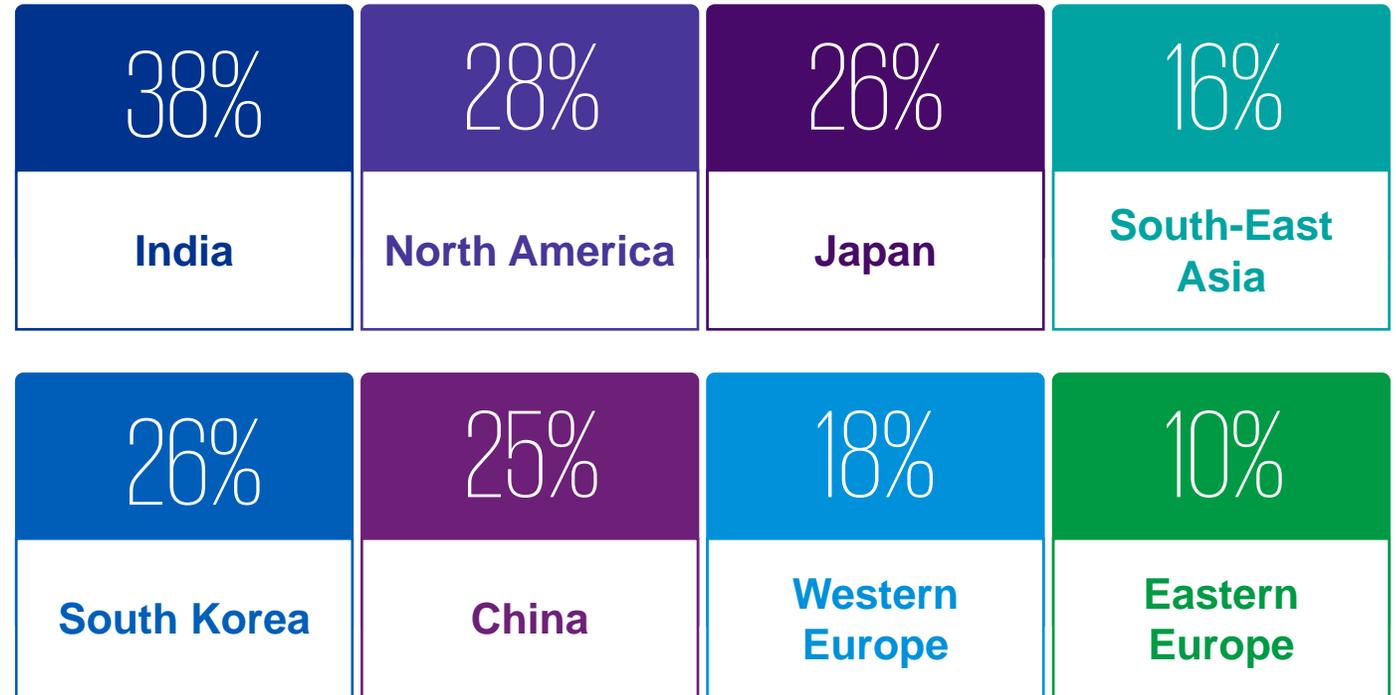
China would continue to dominate globally in terms of volume and value ushering growth from NB-IoT to high throughput 5G IoT networks.

India, the world's second largest mobile economy to register the highest growth in shipments driven by large-scale roll out of NB-IoT and 4G/5G deployments in next four-five years



Sources: [27]: Global Cellular IoT Module and Chipset Forecast, Counterpoint Research, Feb 2021

Figure 7 : Projected CAGR in cellular IoT module shipment growth 2019 - 2024 by key regions²⁷



Organisations in India are experimenting with the use of NB-IoT for specific applications to enhance user experience

Smart Cities - Intelligent Lighting

Vadodara Municipal Corporation (VMC) has deployed 15,000 NB-IoT based Smart Street Lights. The Smart lights can communicate with cloud based IoT platform in real time, enabling the corporation to manage them remotely from central command and control centre and perform operations such as, on-off, dimming, fault detection, schedule-based operation, and energy monitoring. NB-IoT has helped in achieving energy savings and increasing safety. The network installation and maintenance cost have become zero.

EESL

In October 2020, EESL invited bids for procurement of 2.35 mn smart electricity meters based on NB-IoT technology

“NB-IoT has provided us with an end-to-end solution to make coolers intelligent at a market acceptable price-point. We believe that NB-IoT is the technology that will change the course of connected coolers & freezers because of factors such as nationwide coverage, indoor reach, cost and adoption by 5G!”

Harmeet Singh, Western Refrigeration, Chairman & MD

Air pollution monitor

One of the leading Indian engineering institute and Ericsson signed a memorandum of understanding (MoU) in 2019 to deploy an NB-IoT-based sensor network, named Indiagyu76, to monitor air pollution in Delhi. As per the deal, Ericsson will be using locally developed air quality sensors that can share environmental data including PM1, PM2.5, and PM10 levels at specified time intervals. This will help in better monitoring and analysis of data collected from different parts of the capital. Periodically, the findings will be shared with local authorities and other key stakeholders.

Connected Coolers

Western Refrigeration has been working on connected coolers for a while now, however due to lack of a reliable & omnipresent technology & high cost, connected coolers as a concept couldn't be productionised. With the advent of NB-IoT, they were able to deliver the complete solution & help to monitor location, temperature and power cycles . Moreover, the door sensor-based analytics will help their customers to track inventory, sales, monitor usage pattern enabling them to increase sales.

Power utility

Utilities like Tata Power, Meghalaya electricity board and several other states have either adopted or are evaluating NB-IoT for digitising their automated utility bill payment, theft reduction, analytics, etc.

We have evaluated multiple IoT technologies for giving a connected water purifier experience to the consumers. It was difficult since the water purifiers are usually in kitchen where Wi-Fi or any other cellular technology doesn't reach. NB-IoT looks promising because of its reach and payload light architecture, we shall be launching our NB-IoT connected range of water purifiers in the early FY'23.

Shashank Singh, Eureka Forbes, Vice-President, Transformation | Strategy | Marketing

Not only in India, globally there has been a buzz about NB IoT that has translated into many use cases across industries

Operator: African operator

In 2017, the operator launched an NB-IoT-enabled commercial network in South Africa with an average of 55,000 new connections per month to enhance sim security, licensed spectrum usage, and scalability.

Operator: US operator

In 2019, the operator launched its NB-IoT network in USA. The company has collaborated with chipset and module manufacturers to build devices for its NB-IoT-enabled network. This would help its enterprise customers to launch NB-IoT solutions in the market.

Operator: US operator

In July 2018, the operator launched its NB-IoT services and NB-IoT enabled guard bands across USA for increased efficiency, high device connectivity at a low device cost, long battery life, and less power usage.

Operator: Greek operator

In 2018, a telecom OEM completed deploying NB-IoT clusters in the Greek operator's 4G network to support the emerging use cases of massive Machine Type Communications (mMTC). The OEM has also upgraded the operator's LTE network through NB-IoT-enabled technology.

Operator: Singapore operator

In 2018, a telecom OEM and a Singapore telecom operator collaborated to roll out one of the first commercially available CIoT networks which supports both Cat-M1 and NB-IoT devices in Singapore.

Operator: Middle east Asian operator

In 2018, a middle east operator collaborated with a telecom OEM to expand their 4G network in a middle east Asian country nationwide which included LTE Advanced and NB-IoT in its Radio Access Network.

NB-IoT Connectivity over Satellite

In 2020, a NB-IoT network-based satellite communication vendor teamed up with an Asian semiconductor company to bring 5G-ready NB-IoT connectivity through satellite. The firms would work to create and deploy CIoT chipsets that use standardised, 5G-ready, NB-IoT protocol and connected via geo-stationary satellites

Partnership for satellite capacity

A NB-IoT network-based satellite communication vendor and British satellite telecom company partnered in June 2021 to enable a commercial NB-IoT over satellite solution. The telecom company could offer this satellite capacity backbone to deliver its IoT solutions.

NB-IoT enabled Smoke or Gas Detector

An Asian telecom operator planned to deploy 170,000 NB-IoT connected smoke detection and alarm devices in rental homes in their province in 2019 by collaborating with different IoT partners. The units could monitor the smoke levels and send data to a backend platform about smoke levels, power usage, and network signal strength.

Smart Cities

A European operator developed PAC (parking area control), a small NB-IoT parking sensor. The operator used a telecom OEM's platform which simplifies the business and integrates the problems associated with IoT projects. This autonomous PAC might be installed partially or entirely underneath the ground and connects directly to the operator's cloud.

Water Telemetry

An American multinational technology conglomerate signed an MOU with a European multinational telecommunications and mass media company in collaboration with a water management solutions provider where they developed proof of water telemetry concept by exploring the IoT services provided by the conglomerate including NB-IoT.

Smart Farming Service

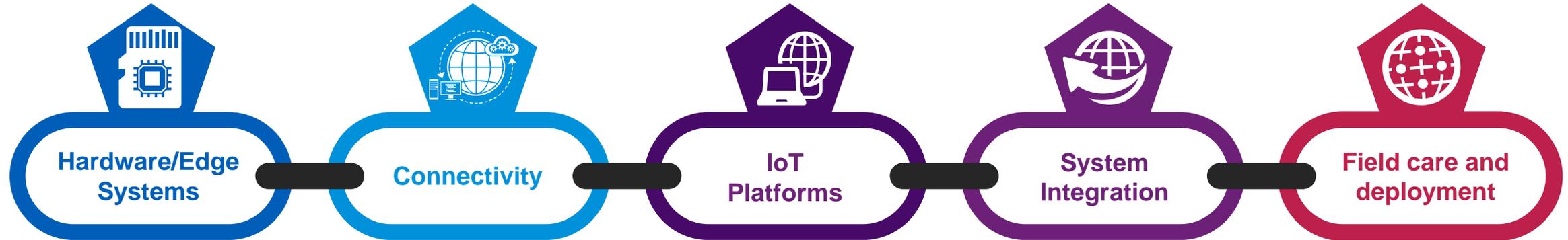
A European communication provider and a European company that develops and delivers rugged condition monitoring systems have collaborated to launch a NB-IoT enabled farming service, which provides farmers with a smart irrigation systems monitoring systems.



Need for end-to-end approach across NB-IoT value chain

IoT strategy

IoT Program Governance



NB-IoT requires simple design and low-cost hardware hence it can be deployed at a rapid pace and at minimal expenses. The three core components of any NB-IoT hardware system are (1) chipsets, (2) modules and (3) devices.

Edge processing and north-bound communication are other critical components that complete the device. Standardised stacks for IPDD and NIDD communication, device management and FOTA make development fast and reliable.

NB-IoT devices require connectivity-as-a-service to function. It enables IoT product to seamlessly establish a connection to the cloud and ensure an uninterrupted flow of data with appropriate actions. IoT connectivity enablement is a multi-stakeholder ecosystem that includes eNodeB equipment, service providers and SCEF gateway providers for NIDD.

IoT platforms integrated with SCEF (NIDD) enables organisations to efficiently manage billions of devices by reducing compute cost. Platforms ensure connectivity between endpoints, gateways, apps, and services. It connects device sensors with the data network and enables application development, data collection and secure connectivity

System integration is required to make the different cogs of the IoT ecosystem work together e.g., IoT services, IoT applications, IoT developer services and field installations, commissioning and maintenance

NB-IoT devices when deployed enjoys the benefits of certain factors such as Zero Touch Provisioning, embedded SIMs, FOTA and remote diagnostics that gives this technology an upper hand over the conventional devices.



NB-IoT in India: Outlook and road ahead

Significant opportunity for application of NB-IoT in large scale programs to enhance efficiency and quality of service delivery

NB-IoT: Made for India?

India is on the cusp of a digital revolution given the emerging technology ecosystem and the growing internet penetration which has accelerated the adoption of digital transformation amongst user industries for whom these technologies bring significant value proposition through enhanced customer experience, operational efficiency and/or lower costs.

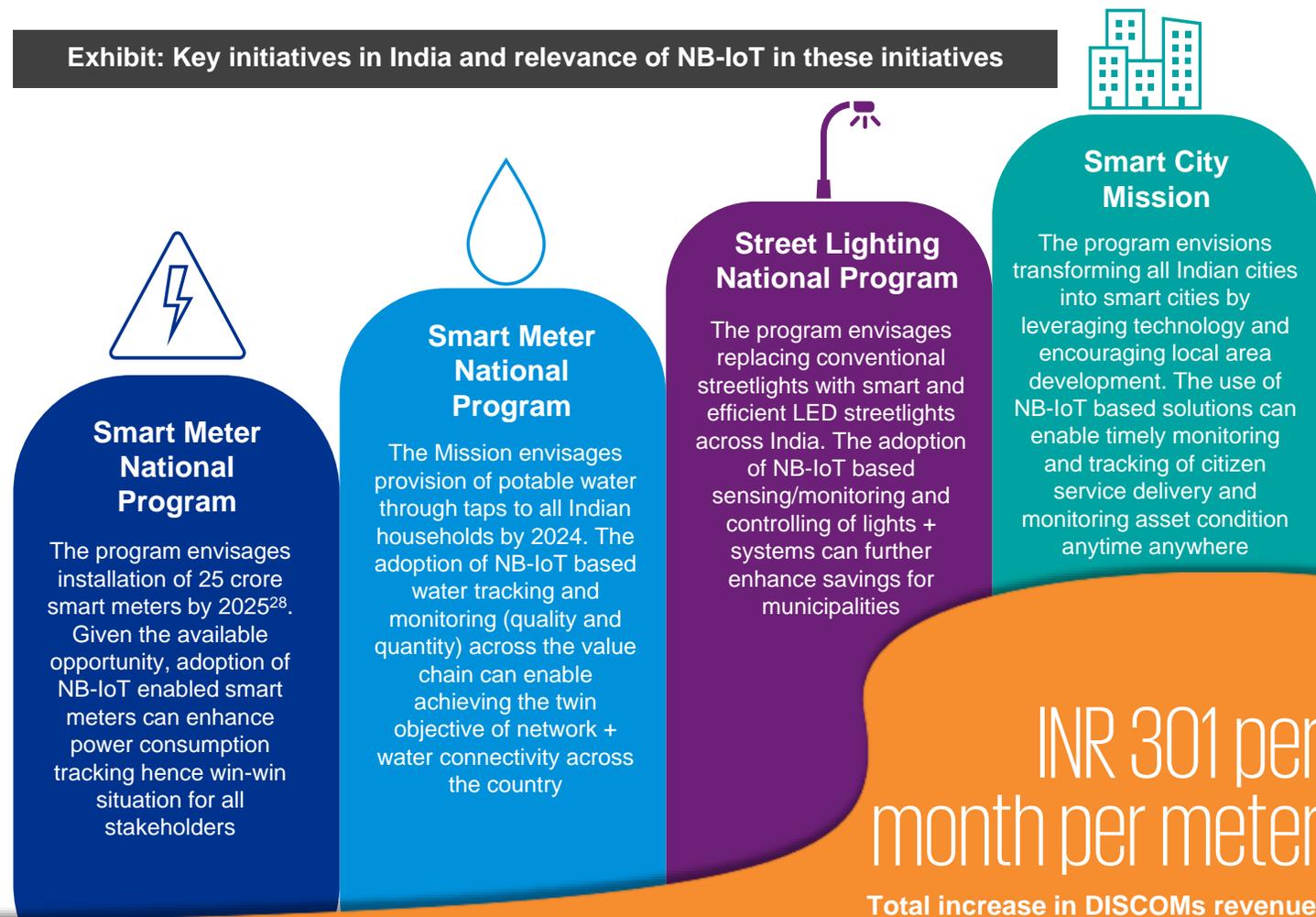
In a post COVID world, to ensure that the digital transformation momentum is maintained, it is imperative for service providers to quickly adapt and scale up their solution offerings relevant for the Indian milieu. This is necessary to ensure that users prioritise the adoption of a tested value promising technology as they begin their capex cycle towards a value – driven investment.

For enterprises, NB-IoT offers a game changing approach in managing their value chain to bring forth an open, transparent and efficiency driven operating environment for many stakeholders including customers, vendors, shareholders and employees besides others.

For the government, the timely conduct and rollout of 5G auctions besides defining the standards for data safety and privacy is imperative to ensure that the benefits offered by NB-IoT is realised to its full potential.

The pace of adoption of NB-IoT can be further accelerated by the key initiatives currently being planned by the government to enhance efficiency and national well being.

Exhibit: Key initiatives in India and relevance of NB-IoT in these initiatives



Source: [28]: EESL annual report 2019-20

[29]: National Smart Meter Dashboard at <https://smnp.eeslindia.org/> accessed on 7 Feb 2022.

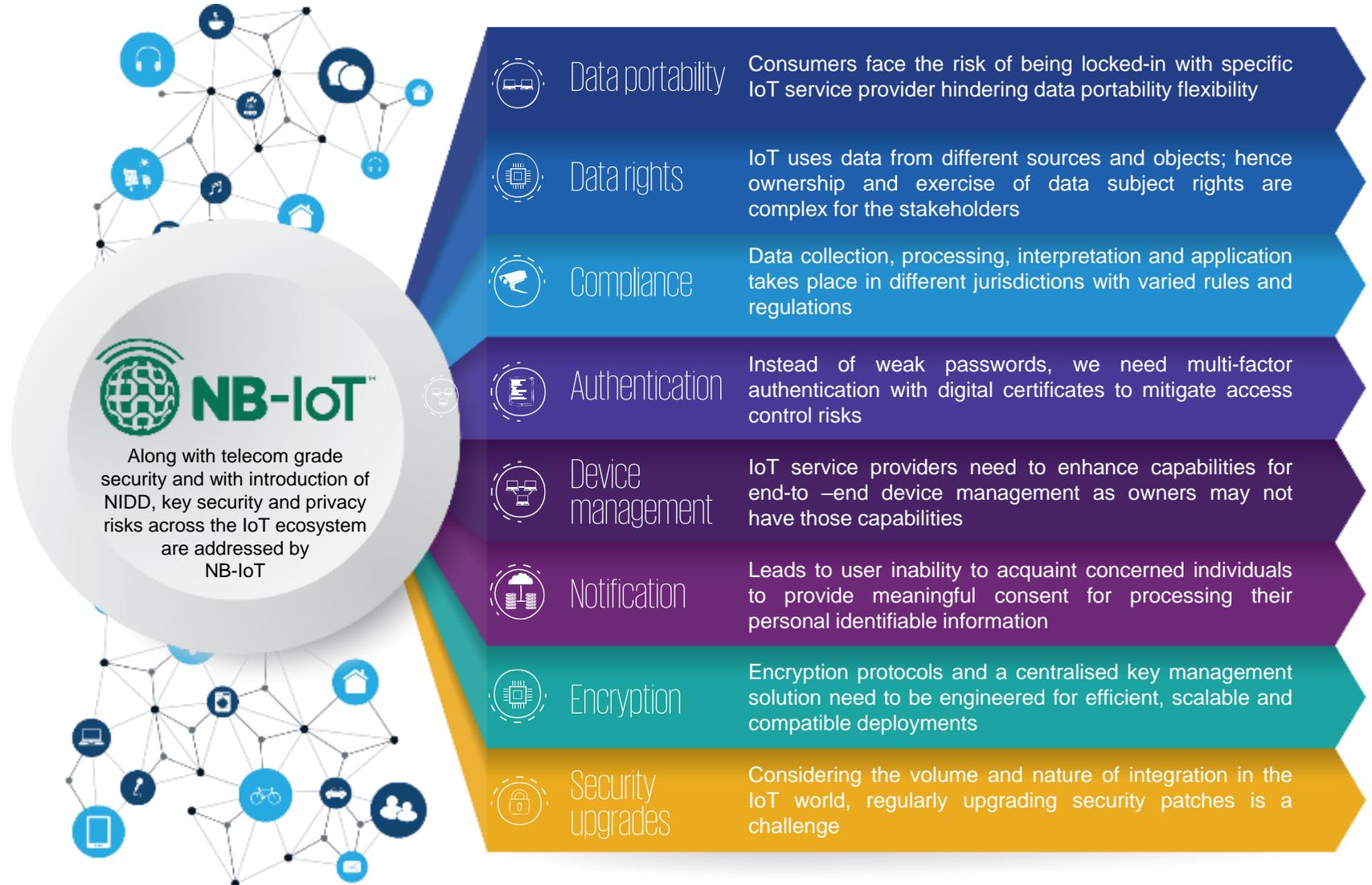
However, concerns pertaining to data security and privacy is a challenge, which the industry needs to address

IoT: Data security and privacy challenges to be addressed

IoT brings in a new dimension to information and data security. As the internet meets the physical world, it also brings challenges in ensuring that the sensors and edge devices do not become the “primary threat tool” or get hijacked; the captured information is used and stored securely, and privacy rights are respected while collecting and using data.

The rapid emergence of diverse technology applications and their vulnerability to external attacks (as they are designed for speed over security with limited filters on data integrity) increases the risk of unwanted data flows into the system. While IoT endpoints and gateways may be dedicated to specific services, IoT systems could frequently share resources with a variety of unrelated systems and applications.

Given the complexity of different networks, protocols, operating systems and different manufacturers with each designed to handle different types of risks, there are a variety of security and privacy challenges associated with implementing any IoT system.



Foundation for Indian NB-IoT regulation has been laid down by the National Telecom M2M roadmap

NB-IoT regulatory outlook in India

M2M is one of the key components of the evolving IoT revolution. M2M connections form part of the IoT, along with cloud computing, big data analytics, and sensors and actuators that in combination can run intelligent systems and autonomous machines. NB IoT has been designed for cellular M2M communications and hence M2M regulations play an important part in NB IoT deployments.

The Department of Telecom (DoT) of India published the “National Telecom M2M Roadmap” in May 2015 post seeking inputs from certain industry stakeholders. The roadmap focuses on M2M communication aspects with the aim to have interoperable standards, policies and regulations suited for Indian conditions across multiple sectors.

Two level committees have been formed by DoT to address policy and regulatory issues towards M2M network communication aspects. First is a high level ‘Policy and Regulatory Committee’ formed with DoT representatives. This committee aims to outline Government side policy and regulatory aspects. Second is an ‘Industry level Consultative Committee’ which has been constituted to outline draft policy taking

industry view into consideration. Following issues and actionable points were identified for consideration towards M2M Policy:

- Adoption of standards, in line with global standards, for M2M networks
- Spectrum allocation for M2M local area network layer
- Accommodation of M2M numbering needs by revisiting National Numbering Plan
- Ensuring “Always on” requirements viz. Inter-Network Mobility and Inter-Operator Roaming
- Addressing data protection and privacy
- Addressing customer traceability issues and KYC (Know Your Customer) norms
- Addressing security and lawful interception for M2M connections
- Having policy around customers’ ethical issues
- Coordination with relevant global organisations



Sector specific use cases and requirements released by Telecom Engineering Centre (TEC) help identify future action points for M2M applications

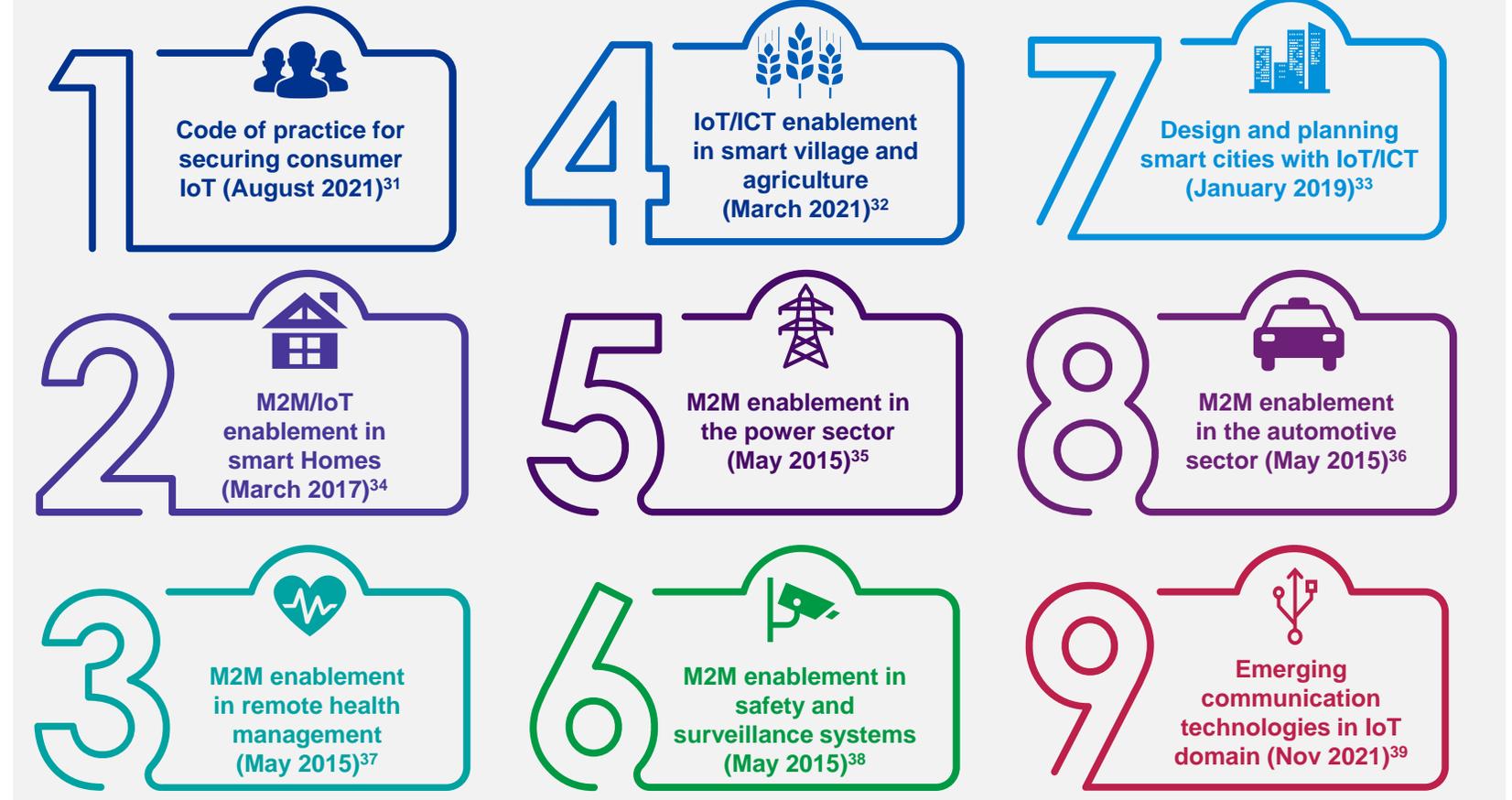
M2M service provider registration with DOT

M2M service providers (MSP) are likely to have different businesses. In open settlement protocol (OSP) services, the end users use their own SIM/telephone connection to use the offered services like telebanking, etc., whereas in most of the M2M services, internet connection or individual SIMs are used exclusively for such services i.e., SIM fitted vehicle. In OSP services, ownership of SIM normally is with the end-user of services, whereas in M2M services, ownership is with MSP (in most cases). Hence, it would be judicious to have a separate category of registration to have oversight over MSP using telecom resources from authorised telecom service providers. All M2M service

providers utilising TSPs' telecom facilities should have MSP registration to address different concerns like interface issues with KYC, security, telecom service provider and encryption (for lawful interception purposes at the telecom service provider level)

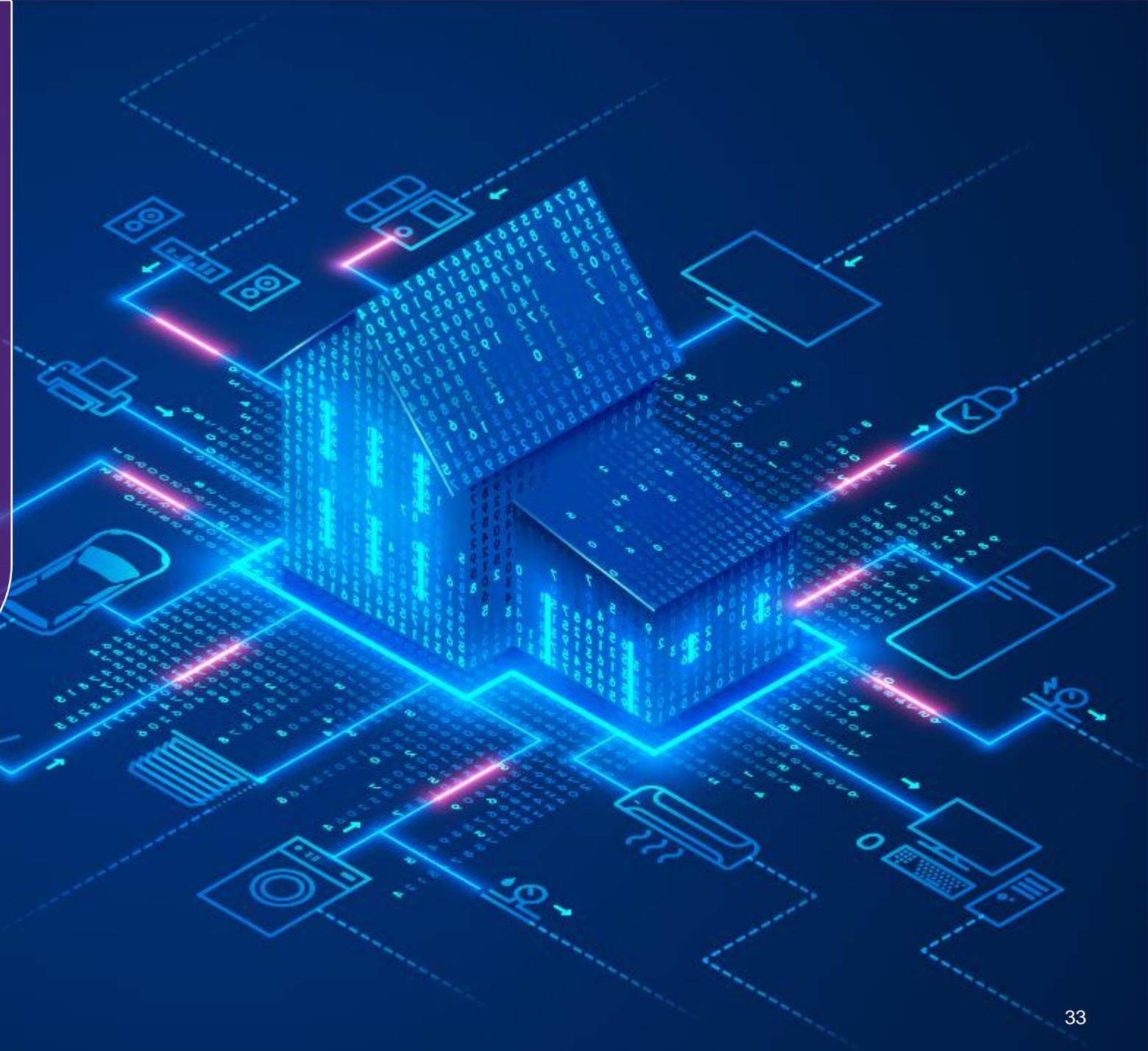
In addition, Telecom Engineering Centre (TEC) of DoT has also come out with nine technical reports³⁰ in 2015 on M2M detailing sector specific requirements/use cases to carry out gap analysis and future action plans with possible models of service delivery with additional technical reports released time to time.

Figure 7: Sector specific use cases defined by TEC



Source: [30]: TEC M2M/IoT technical reports accessed on 7 Feb 2022 [31]: Code of practice for securing consumer IoT, Telecommunication Engineering Center, Aug 2021; [32]: IoT/ICT enablement in Smart village and agriculture, Telecommunication Engineering Center, Mar 2021; [33] Design and planning Smart cities with IoT/ICT, Telecommunication Engineering Center, Jan 2019; [34] M2M/IoT enablement in Smart Homes, Telecommunication Engineering Center, Mar 2017; [35] M2M enablement in the power sector, Telecommunication Engineering Center, May 2015; [36] M2M enablement in the Automotive sector, Telecommunication Engineering Center, May 2015; [37] M2M enablement in remote health management, Telecommunication Engineering Center, May 2015; [38] M2M enablement in safety & surveillance systems, Telecommunication Engineering Center, May 2015; [39] Emerging communication technologies in IoT domain, Telecommunication Engineering Center, Nov 2021;

Conclusion:
An opportune
moment



As India begins a capex cycle, NB-IoT is attractively positioned at the core

NB-IoT is an exciting 'Made for India' technology. As the dream of 'Digital India' takes shape, this technology could play a key role across the spectrum of B2B, B2C and Government/public services



With India beginning its capex cycle, NB-IoT is positioned at its core to address the varied needs of the various user segments

NB-IoT: Addresses the needs across the user spectrum

IoT's diverse applicability along with lowering device costs makes it an attractive technology option for serving the pain points and issues faced by a variety of users across segments.

While users have tested and realised the benefits of using the NB-IoT technology within their respective domain, India is yet to witness widespread applicability and rollout.

While the implementation of 5G is likely to further boost NB-IoT business case, the impact may differ significantly across sectors/user segments given the rollout of competing technologies such as cloud, blockchain etc., which would complement IoT either due to a stronger business case and increased security.

The Digital India initiative coupled with the enhancing technology infrastructure, and adequately supported by forward looking production linked incentives of INR 53 billion in the Indian Union Budget 2022, NB-IoT has the potential to deliver the promised value proposition by addressing all the weaknesses of existing IoT implementations and meeting the unique requirements of the three broad level user segments i.e., B2B, B2C and Government.



- End to end value chain tracking and real-time SLA review and improvements right from procurement to customer delivery
- Enables organisations to enhance their customer interface and experience with limited additional physical contact
- Enables early identification of errors/issues via proactive alerts and hence avoiding any supply/service disruptions
- Provides additional insights on performance across key parameters and ability to identify issues more proactively than other technologies



- Customer touchpoint channel to enhance revenues (point of sale)
- Monitor customer experience/product performance and provide real-time assistance to recommend course of action
- Get real-time customer feedback and identify areas of improvements at the earliest
- Enhances situational awareness and/or choices for the customer for taking necessary decision
- Customer convenience and "intelligence companion"



- Monitor service delivery for citizens/general public
- Track resource movement and leakages if any and recommend/trigger action without waiting for incoming data/reports
- Remote monitoring enables keeping an audit trail of activities/events to enable decision making
- Ability to integrate with existing infrastructure hence avoids need for additional investments

About KPMG in India

KPMG entities in India are professional services firm(s). These Indian member firms are affiliated with KPMG International Limited. KPMG was established in India in August 1993. Our professionals leverage the global network of firms, and are conversant with local laws, regulations, markets and competition. KPMG has offices across India in Ahmedabad, Bengaluru, Chandigarh, Chennai, Gurugram, Hyderabad, Jaipur, Kochi, Kolkata, Mumbai, Noida, Pune, Vadodara and Vijayawada.

KPMG entities in India offer services to national and international clients in India across sectors. We strive to provide rapid, performance-based, industry-focused and technology-enabled services, which reflect a shared knowledge of global and local industries and our experience of the Indian business environment.

About JioThings

Jio Things Limited, a subsidiary of Jio Platform Limited, is an ultimate IoT destination for B2B, B2C and government IoT needs. With digital transformation at heart, JioThings has built a prodigious IoT portfolio using bleeding edge technologies, hyper-scalable IoT platform and distributed computing on edge and cloud.

Why JioThings?

The Internet of Things (IoT) was complex – a lot of suppliers providing different components, inevitably making it difficult to implement, very difficult to manage and extremely difficult to afford! With the advent of JioThings, all these problems have become a matter of past! JioThings delivers market proven C2C (Chipset-2-Cloud) solutions to enable organisations drive digital transformation! JioThings is one of the worlds first organisation that provides, hardware, connectivity, cloud platforms, portals, installation, and aftermarket services – all under single roof!

JioThings brings infinite value at an unbelievably economical cost platform to individuals and organisations to achieve sustainable growth, reduce operational expenditure, increase efficiency, boost safety, and make both living and working easy!

JioThings offers IoT solutions in industries like Utilities, Lighting, Transportation and logistics, Manufacturing, Smart cities, Smart spaces, Health, Agriculture and others.

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