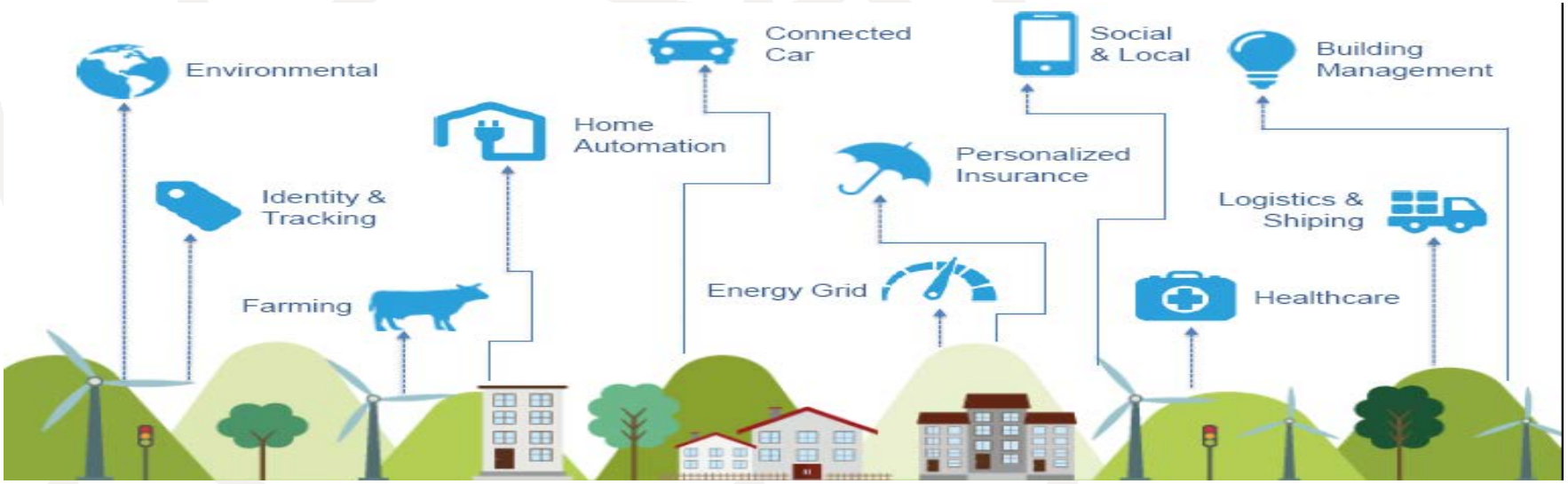
Regional Workshop for Africa on
Developing the ICT ecosystem to harness Internet-of-Things (IoT)
28-30 June 2017, Mauritius

IOT policy and legislation



Imen BEN CHAABANE

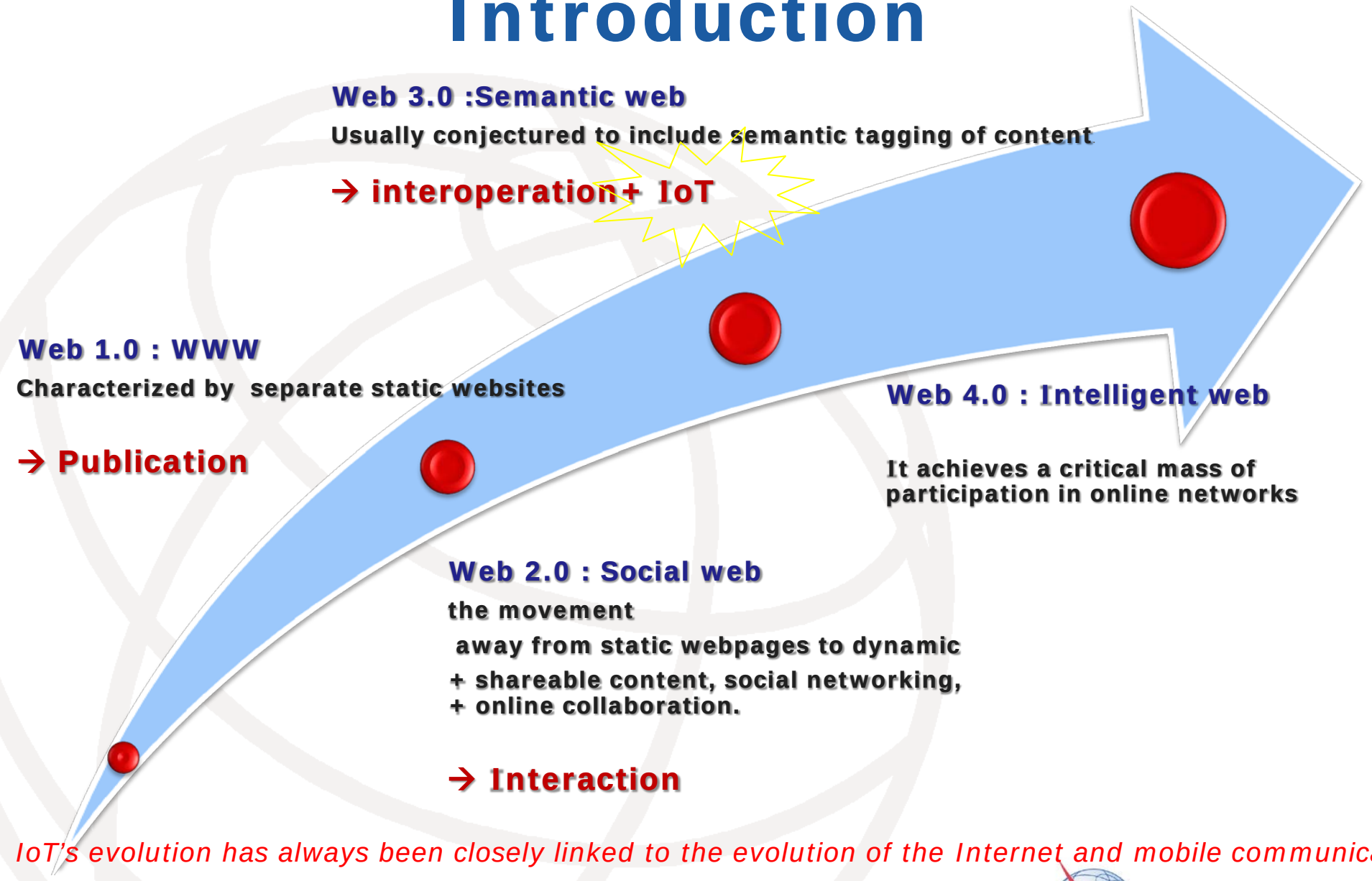
Committed to connecting the world

International Telecommunication Union

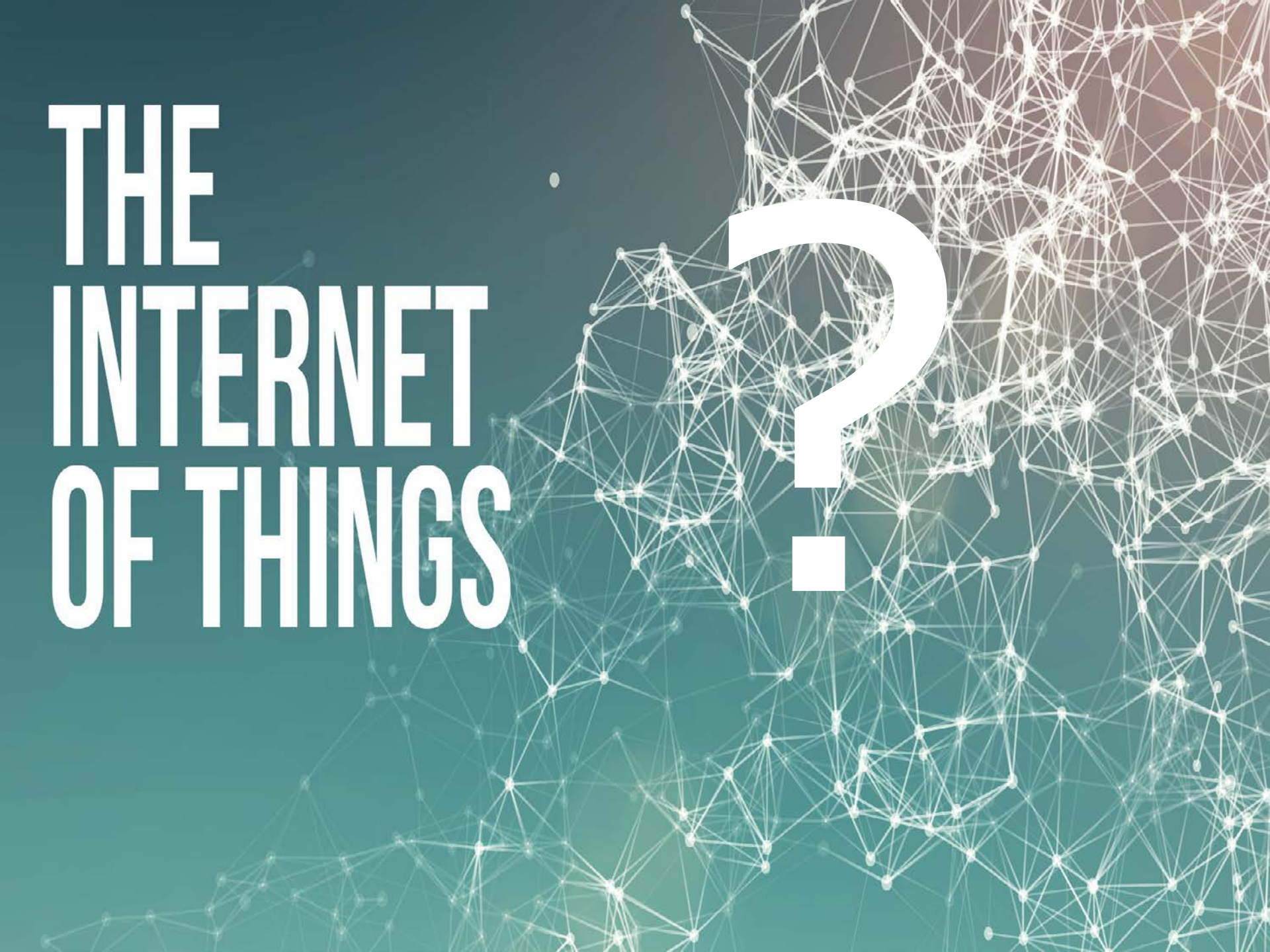
Plan

- Introduction
- Value chain of the internet of objects
- Licensing and spectrum management
- Addressing and numbering
- Security and privacy
- IoT and authorities
- Conclusion

Introduction



IoT's evolution has always been closely linked to the evolution of the Internet and mobile communica


THE
INTERNET
OF THINGS
?

What is IoT ?

1. It refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators -GSMA

2. It is the interconnection of multiple M2M applications often enabling the exchange of data across multiple industry sectors- Ofcom

3. It is the interconnection via the internet of computing devices embedded in everyday objects enabling them to send and receive data – Oxford Dictionary

Summary : What is IoT ?

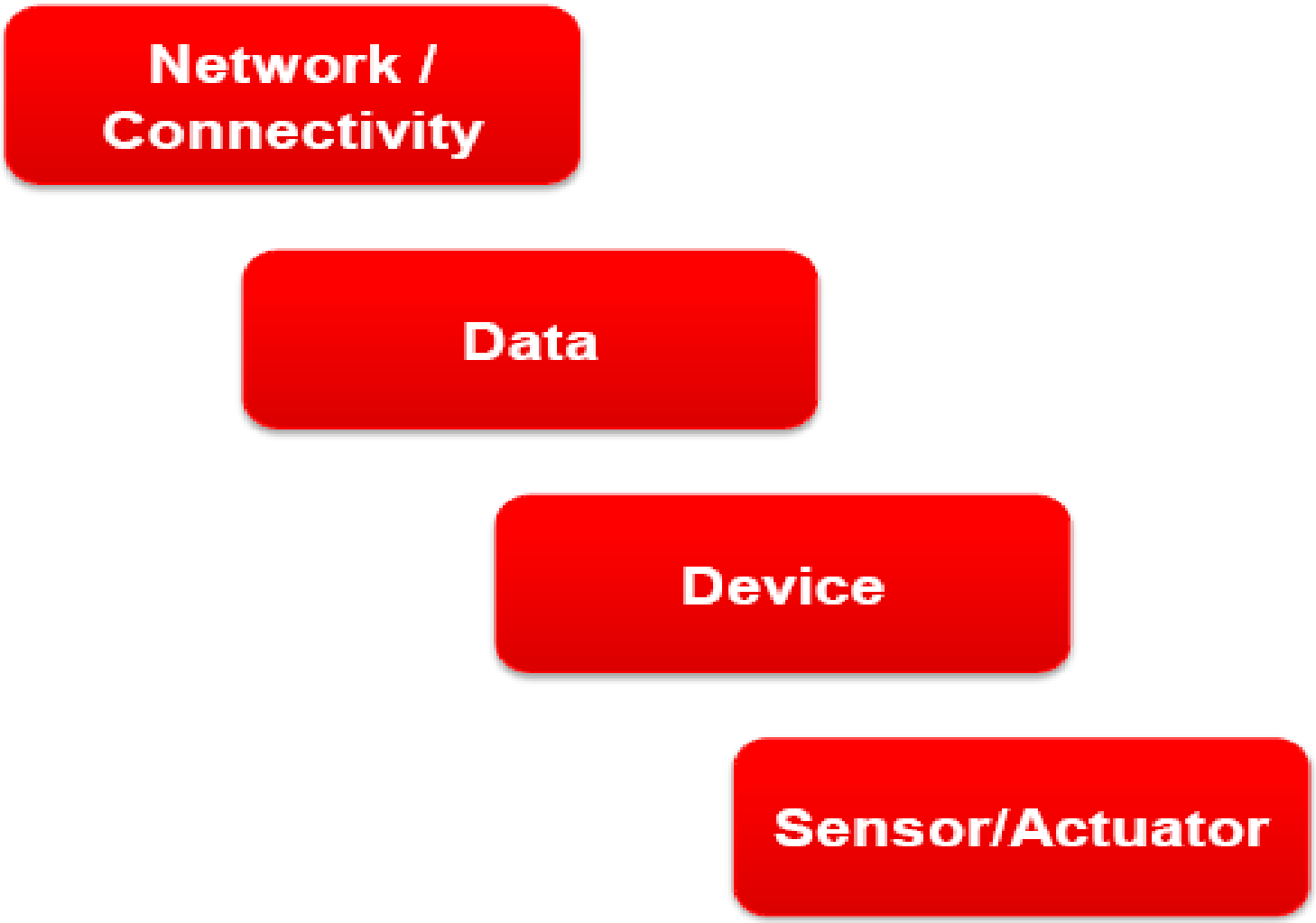
- **There four main elements common to an IoT solution :**
- **A network is used to provide connectivity**
- **Data is transmitted and often received by the end device**
- **The solution is integrated into a new or existing device**
- **Data is captured by sensors and can trigger a reation by actuators**

- **IoT is still evolving and as a result so is its definition**

IoT deployment requirements

- Availability of appropriate spectrum
- communication networks with universal coverage
- confidence in security and privacy of transactions in communication networks
- IoT networks that can connect sensors and devices containing smaller computer chipsts and requiring less power than smartphones
- Affordable terminal equipement
- Addressing requirement for IoT devices : IPv6

Common elements of IoT



Common elements of IoT (con't)

Network / Connectivity

typically

Internet

...but also

Private

Connected car

Smart mining

Common elements of IoT (con't)

Data

typically

Multiple sources

Connected thermostat

...but also

Single source

Smart meters

Common elements of IoT (con't)

Device

typically

Existing

Smart farm

Remote health monitoring

…but also

New

Common elements of IoT (con't)

Sensor / Actuator

typically

Sensor and actuator

Smart solar power plant

Remote health monitoring

...but also

Sensor only

How does IoT differ from traditional services ?

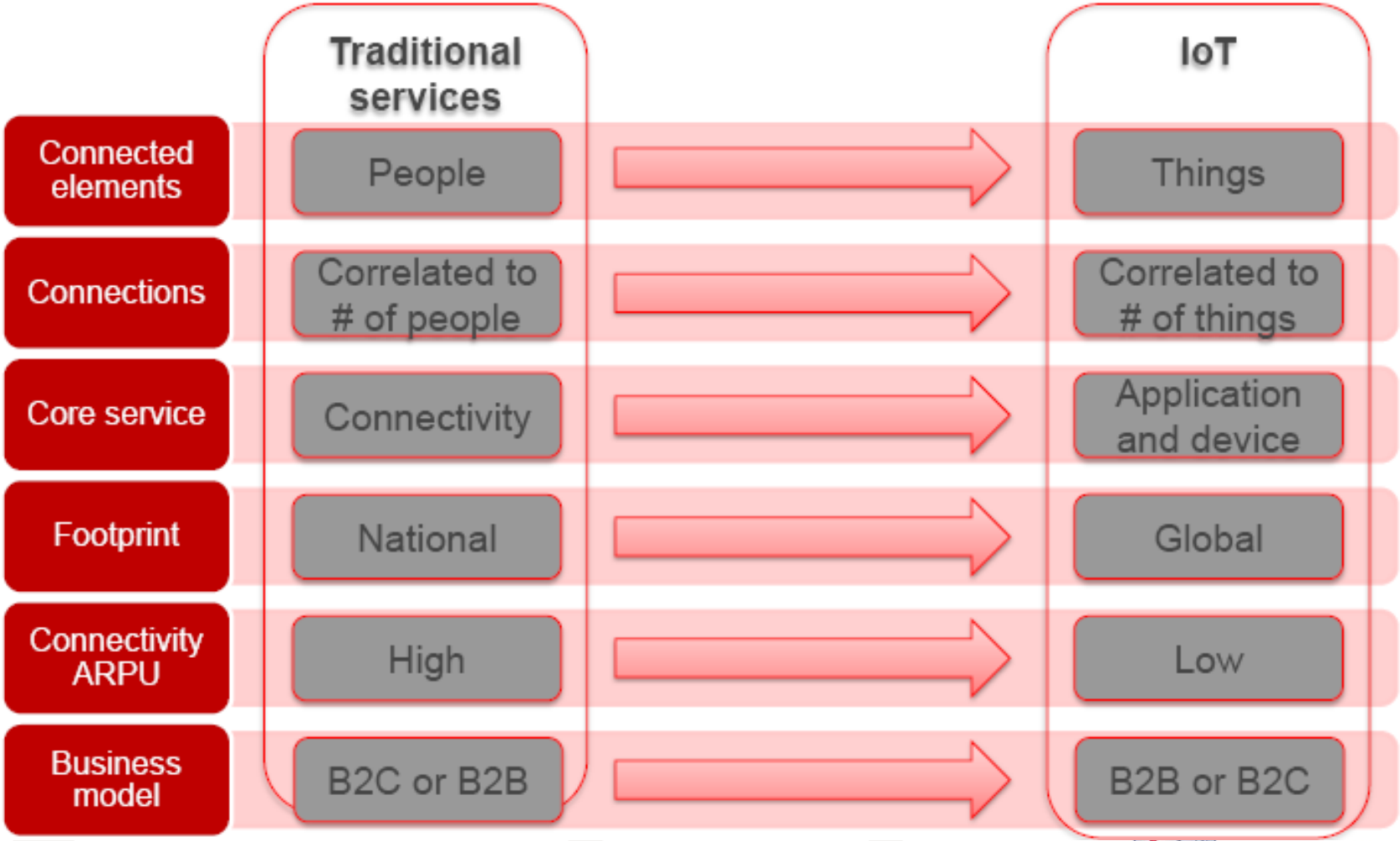
1

- IoT services are fundamentally different from traditional telecoms services such as voice and messaging

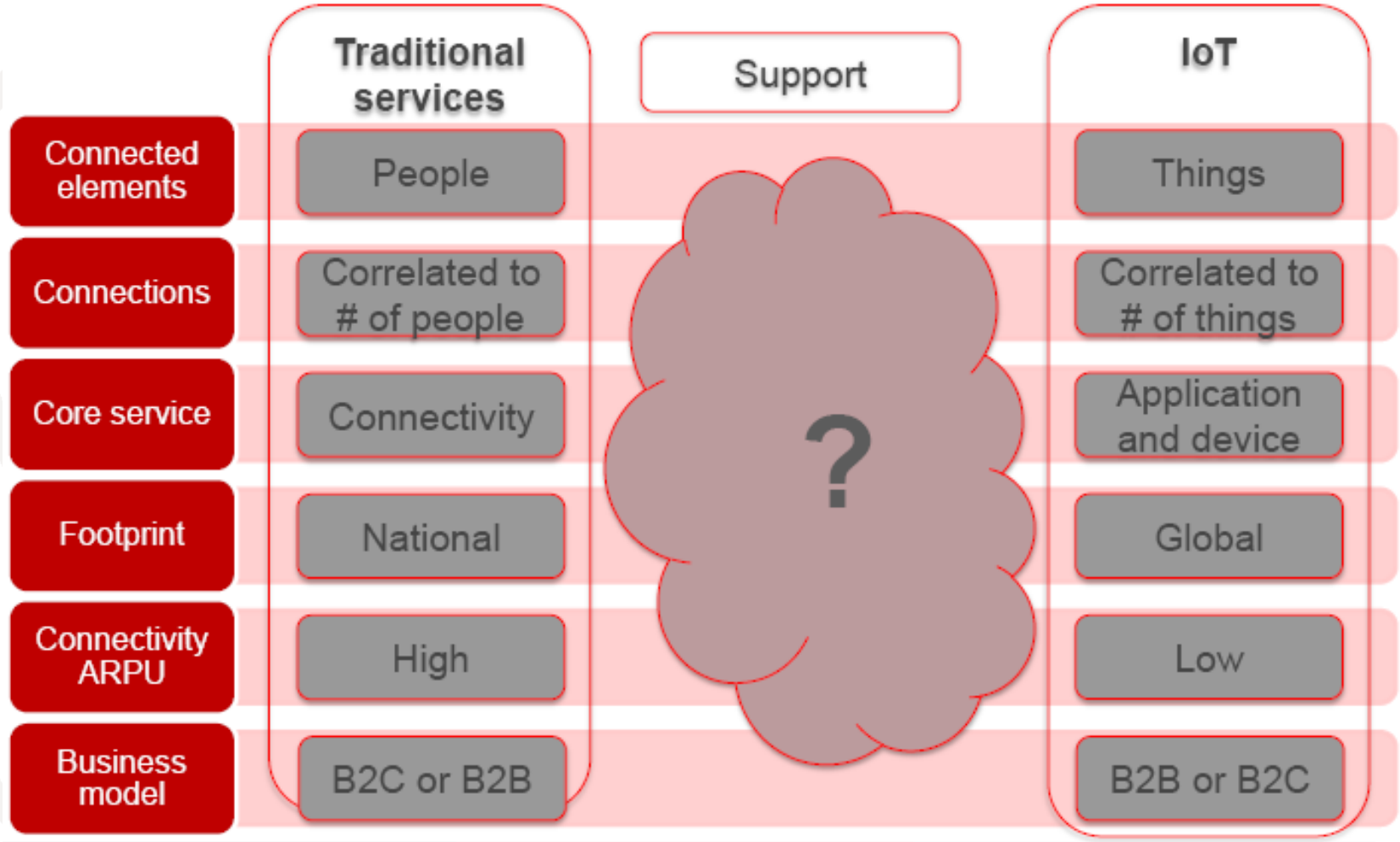
2

- Regulators should recognise these differences when policy and regulatory frameworks

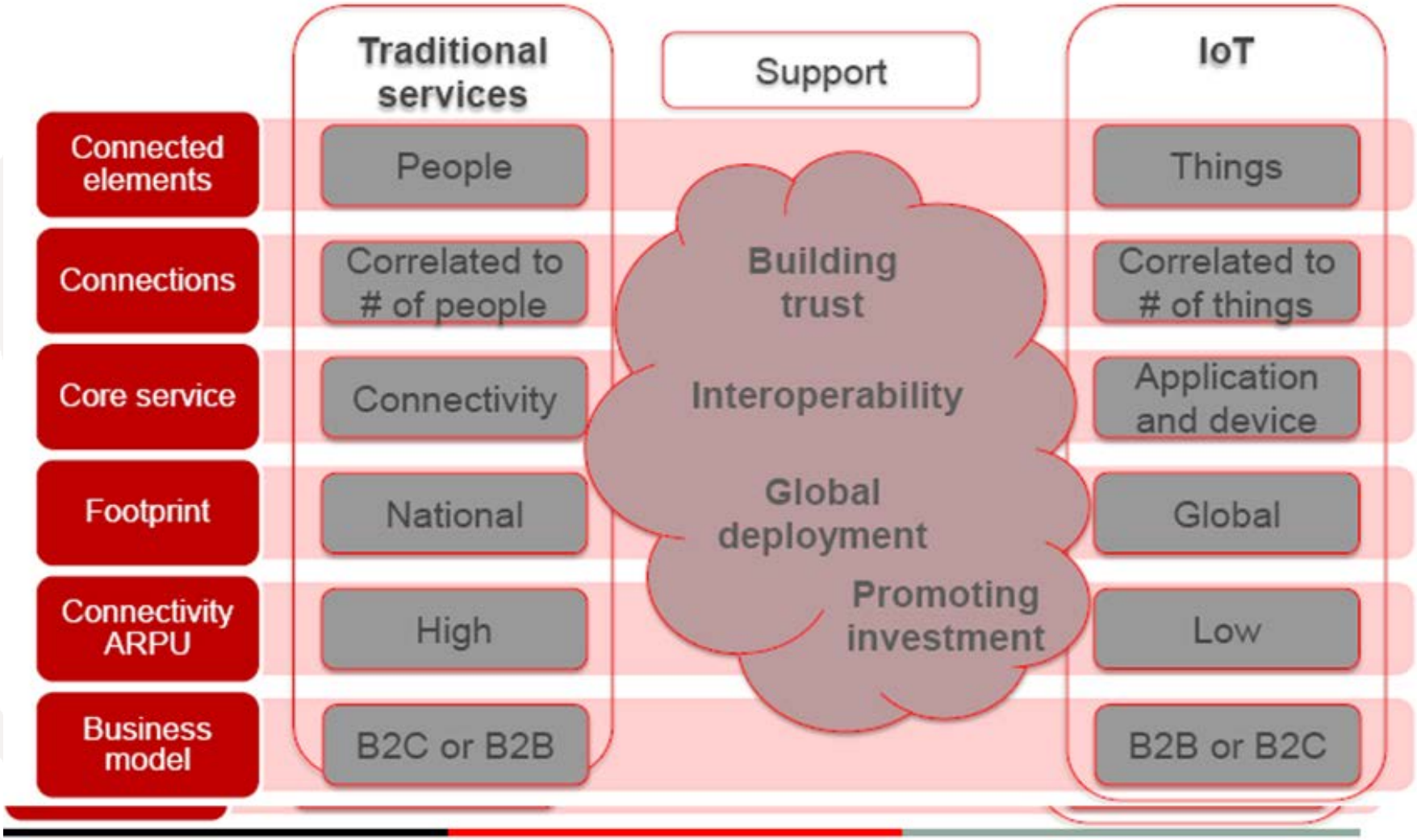
How does IoT differ from traditional services ?



..and governments can help IoT grow



…by applying existing laws transparently and consistently



How does IoT differ from traditionnal services ?

1

IoT services differ from traditional service on dimension such as :

1. What is being connected (things vs people)
2. The core element of the service (Application vs connectivity)
3. The volume of connections
4. The ARPU (low vs high)

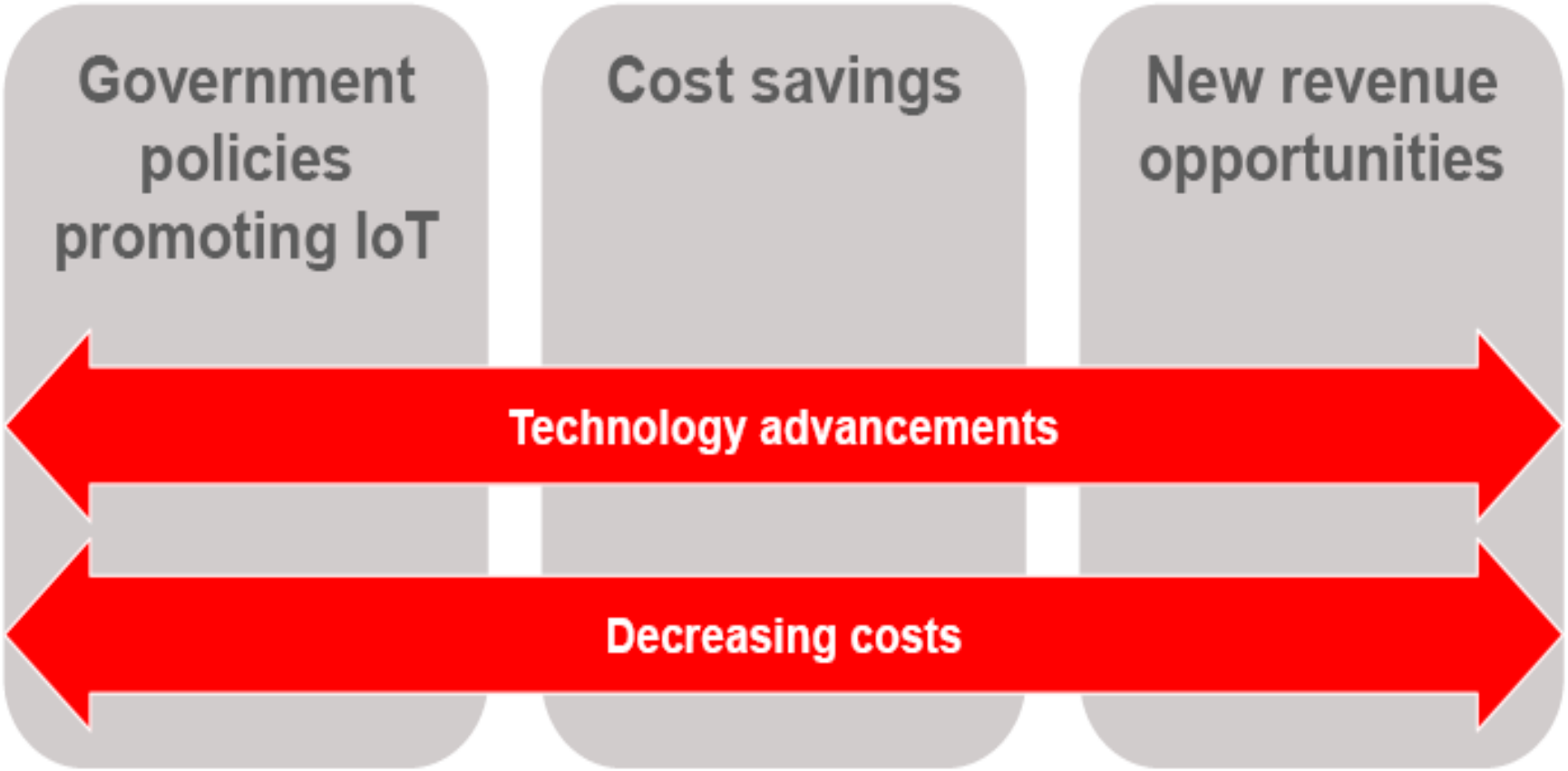
2

- Governments can help drive IoT adoption in their country by focusing on four areas :
- Enabling global deployment, promoting investment, building trust, promoting interoperability

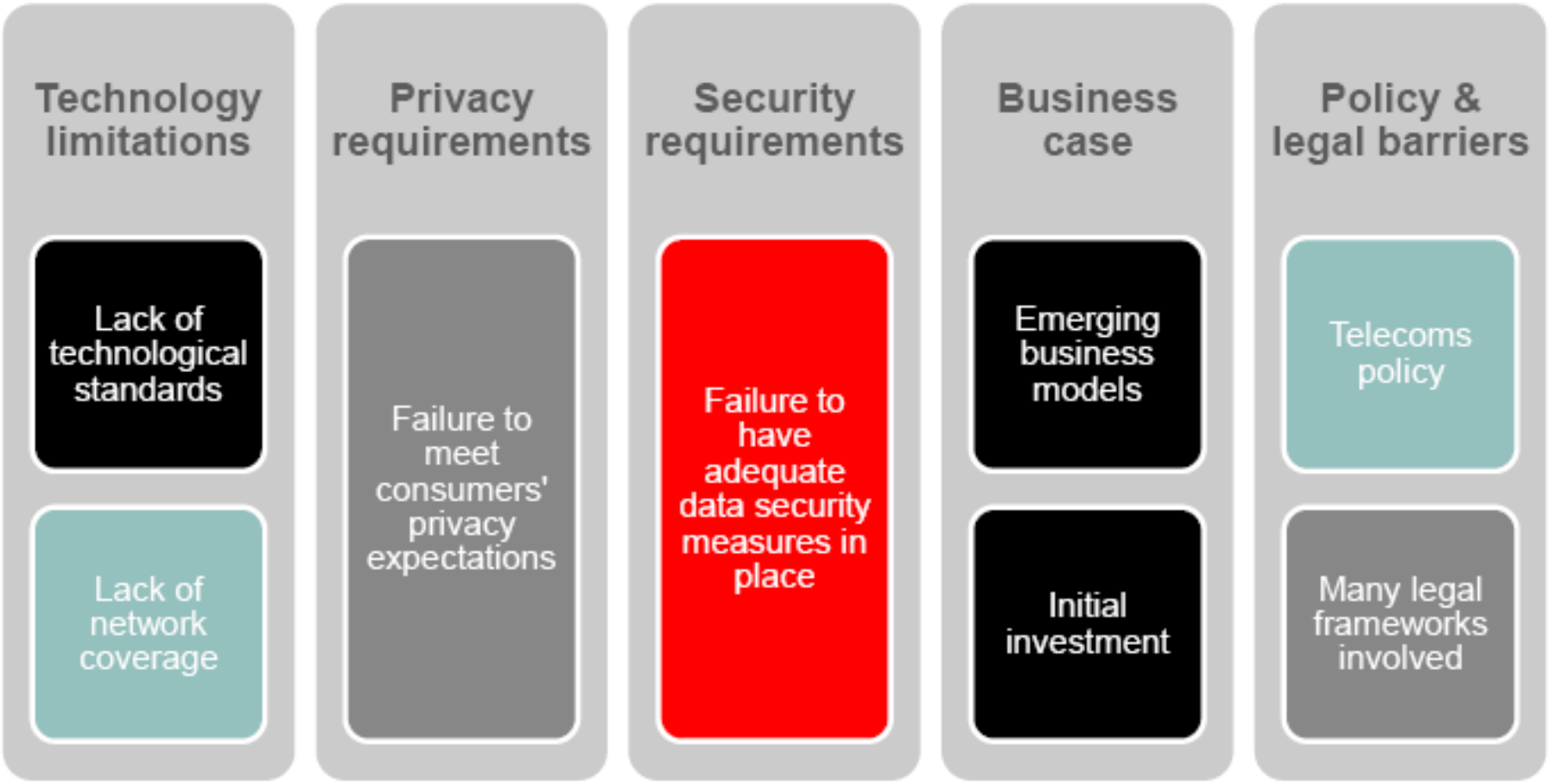
Overview of IoT : drivers and inhibitors of IoT

- IoT is being driven by technology advancements, decreasing costs and demand for efficiency
- Clarity on how data privacy laws are applied to IoT can help develop this market

Some drivers of IoT



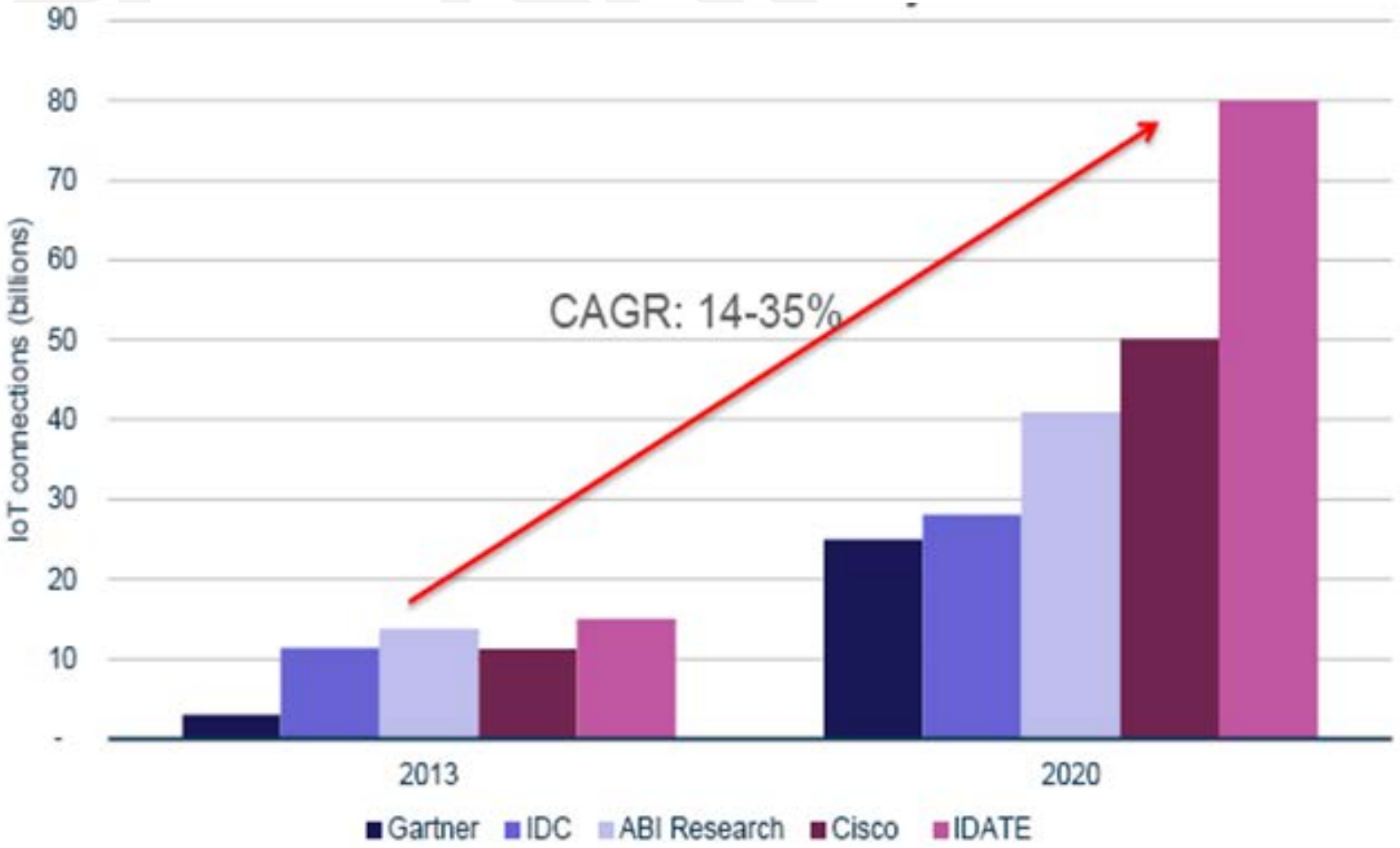
…and some inhibitors of IoT



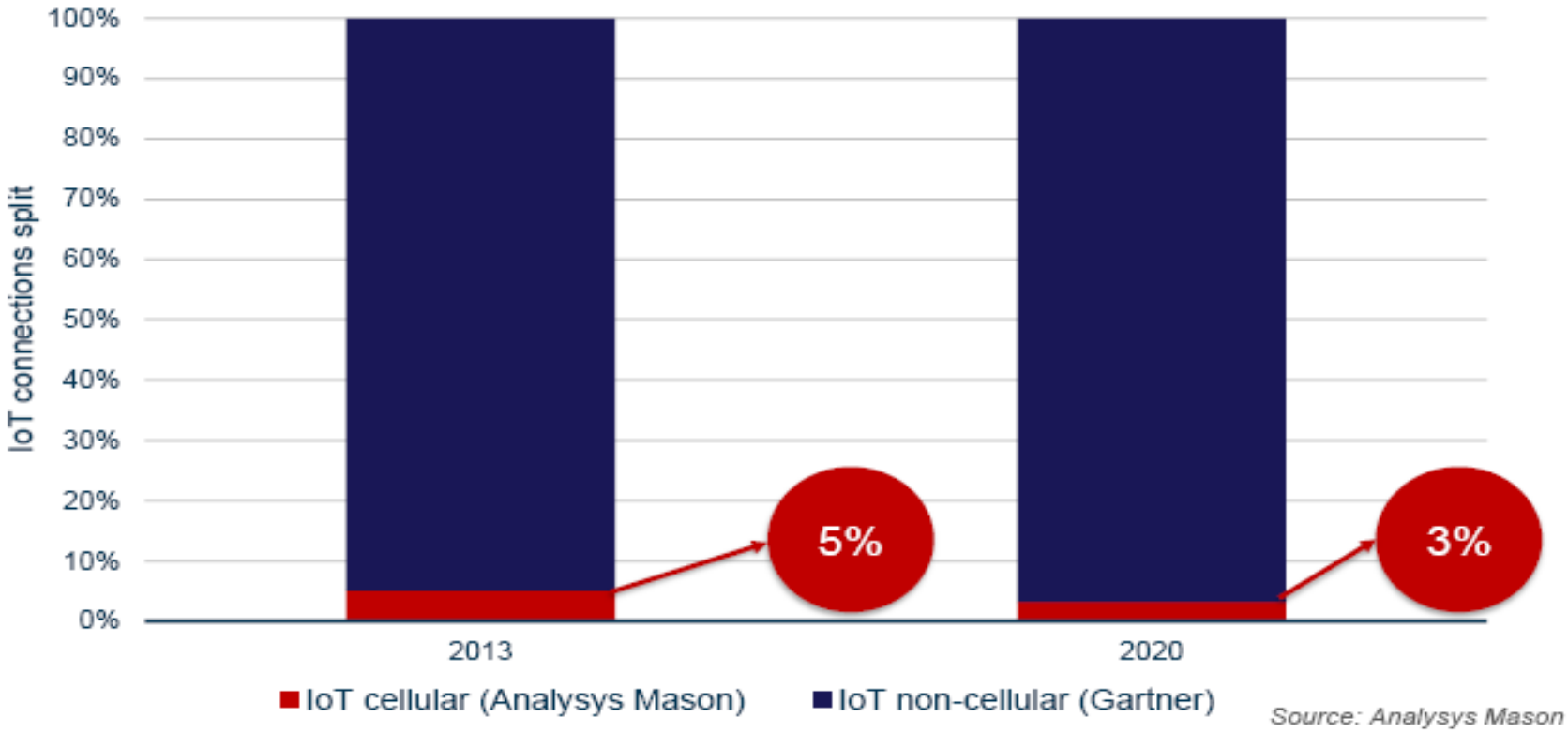
Overview of IoT : connections and revenue forecasts

1. IoT is still a nascent industry and is expected to grow at a fast pace
2. Cellular accounts for a small share of the total IoT market
3. There are many socio economic benefits that IoT can deliver

IoT connections forecast by source

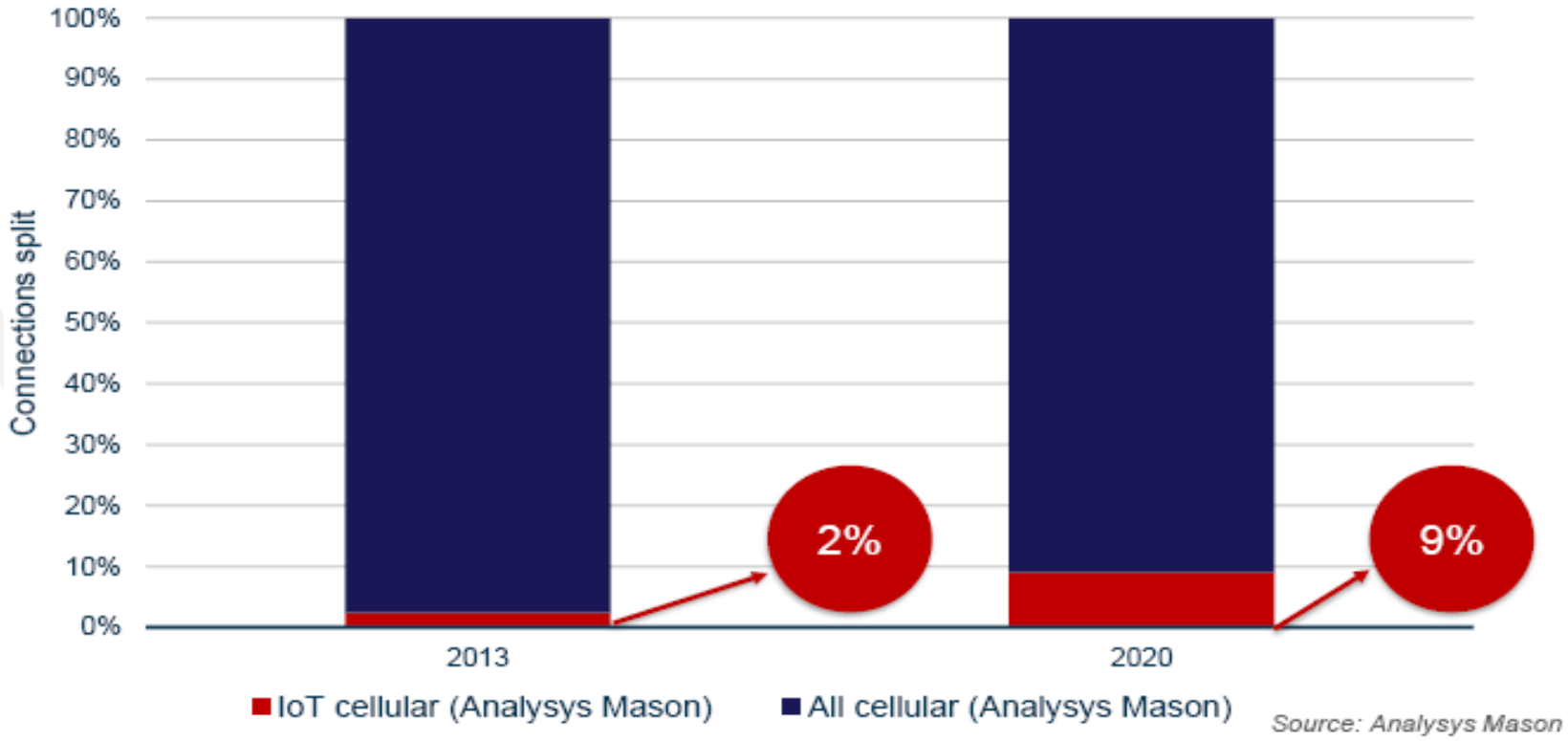


IoT connections split between cellular and non-cellular connectivity

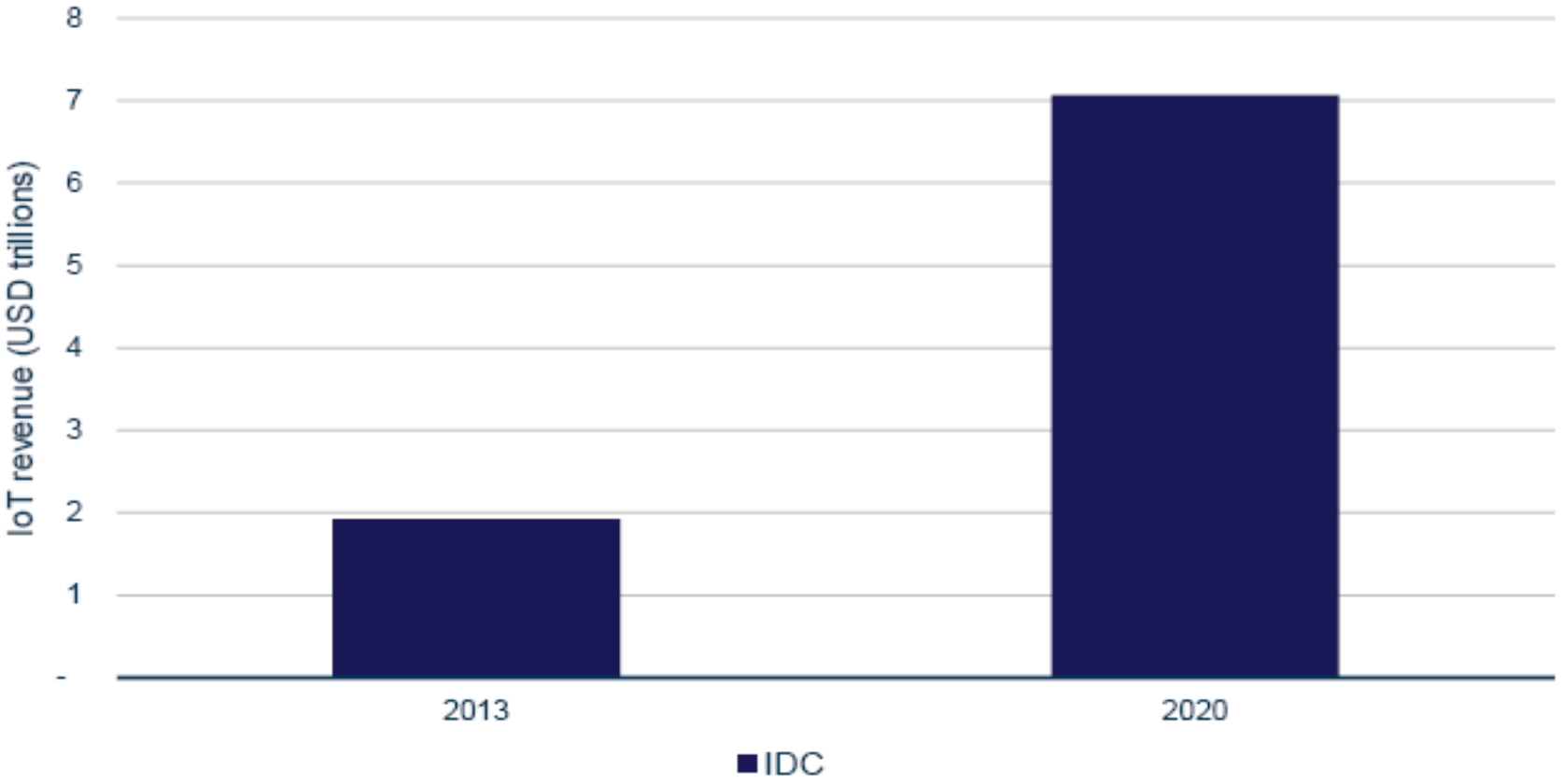


Source: Analysys Mason

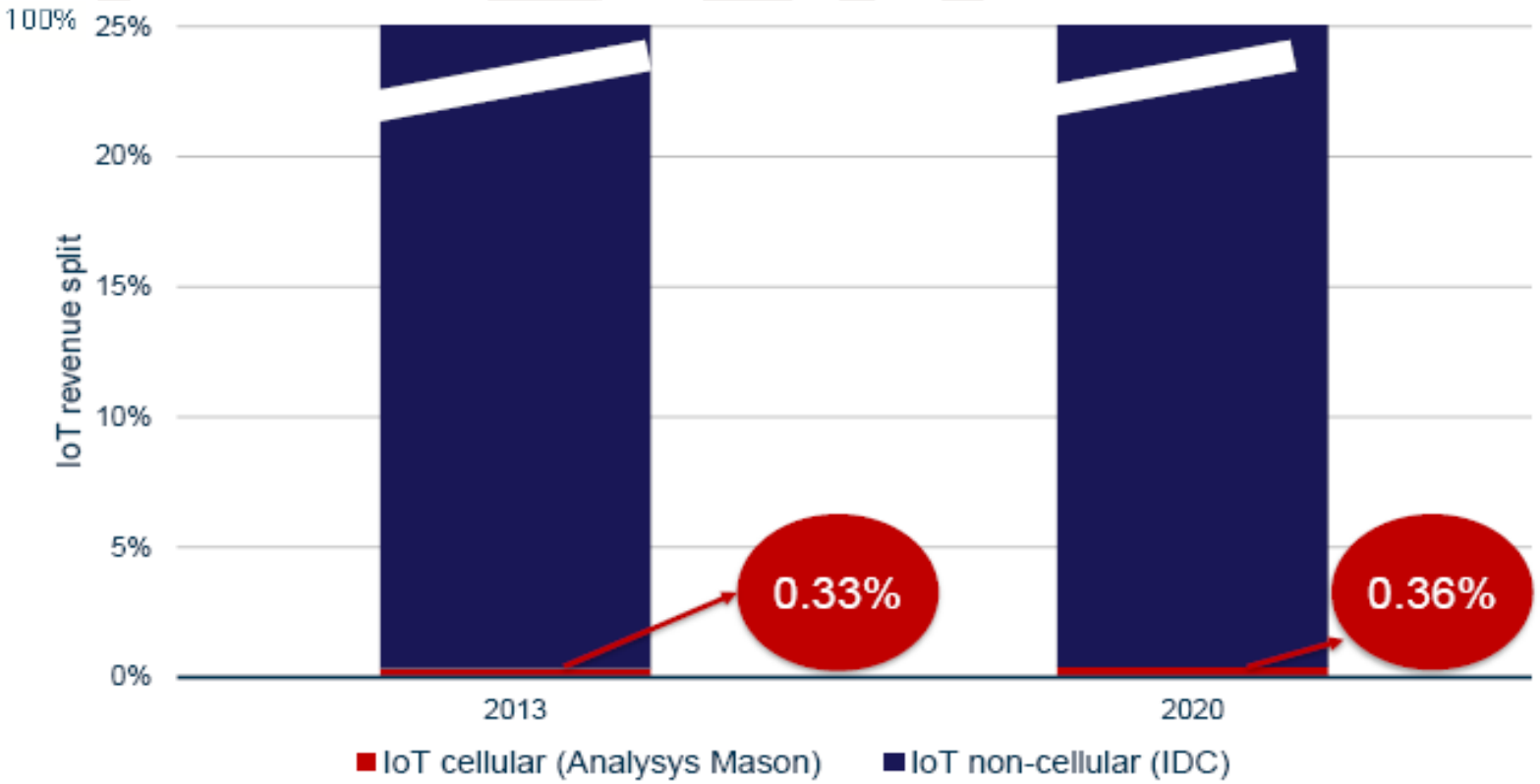
IoT cellular connections as share of all cellular connections



Total IoT revenue (includes connectivity, application, plateform and devices)

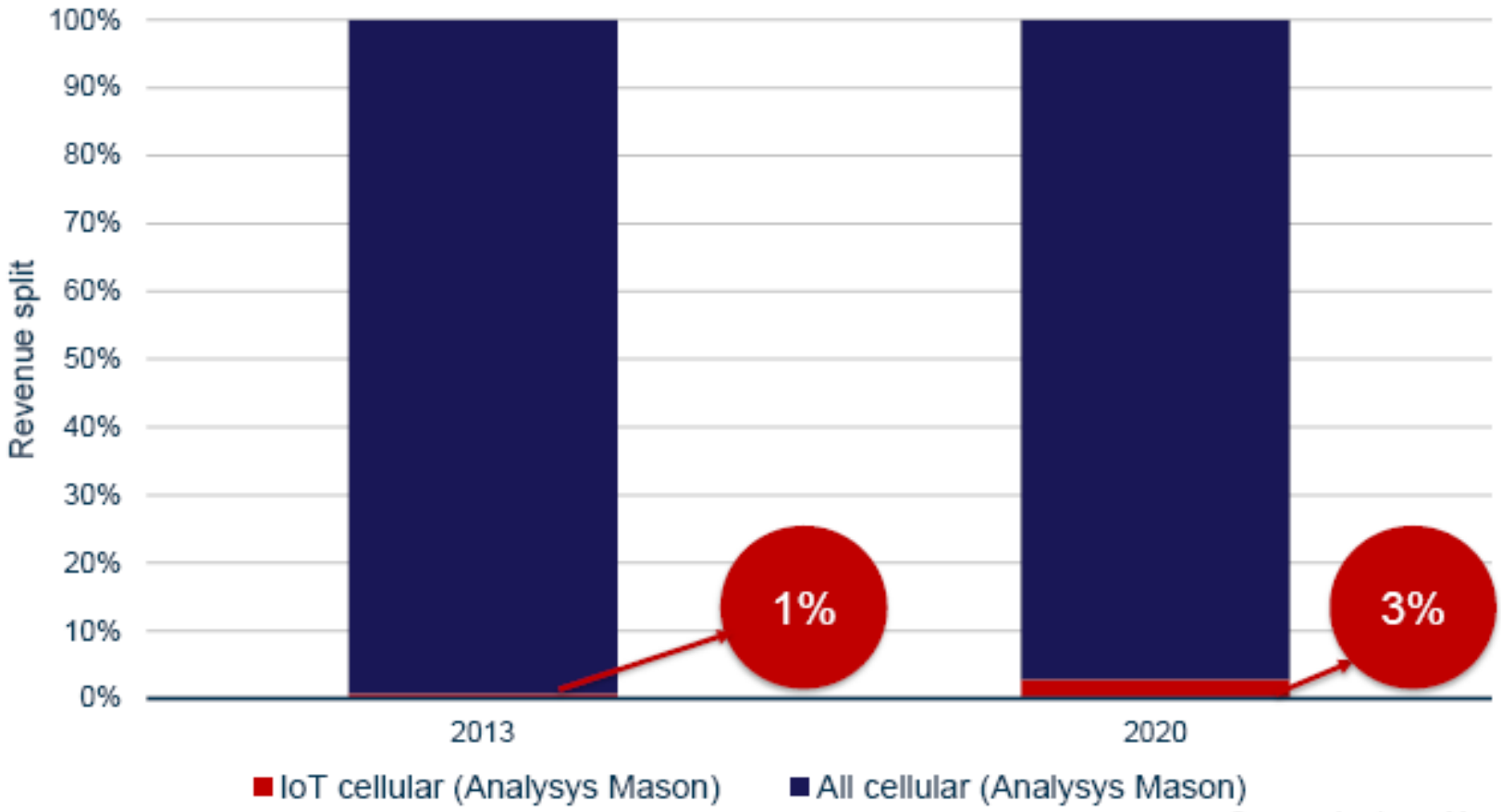


IoT cellular revenue (connectivity) as a share of total IoT revenue



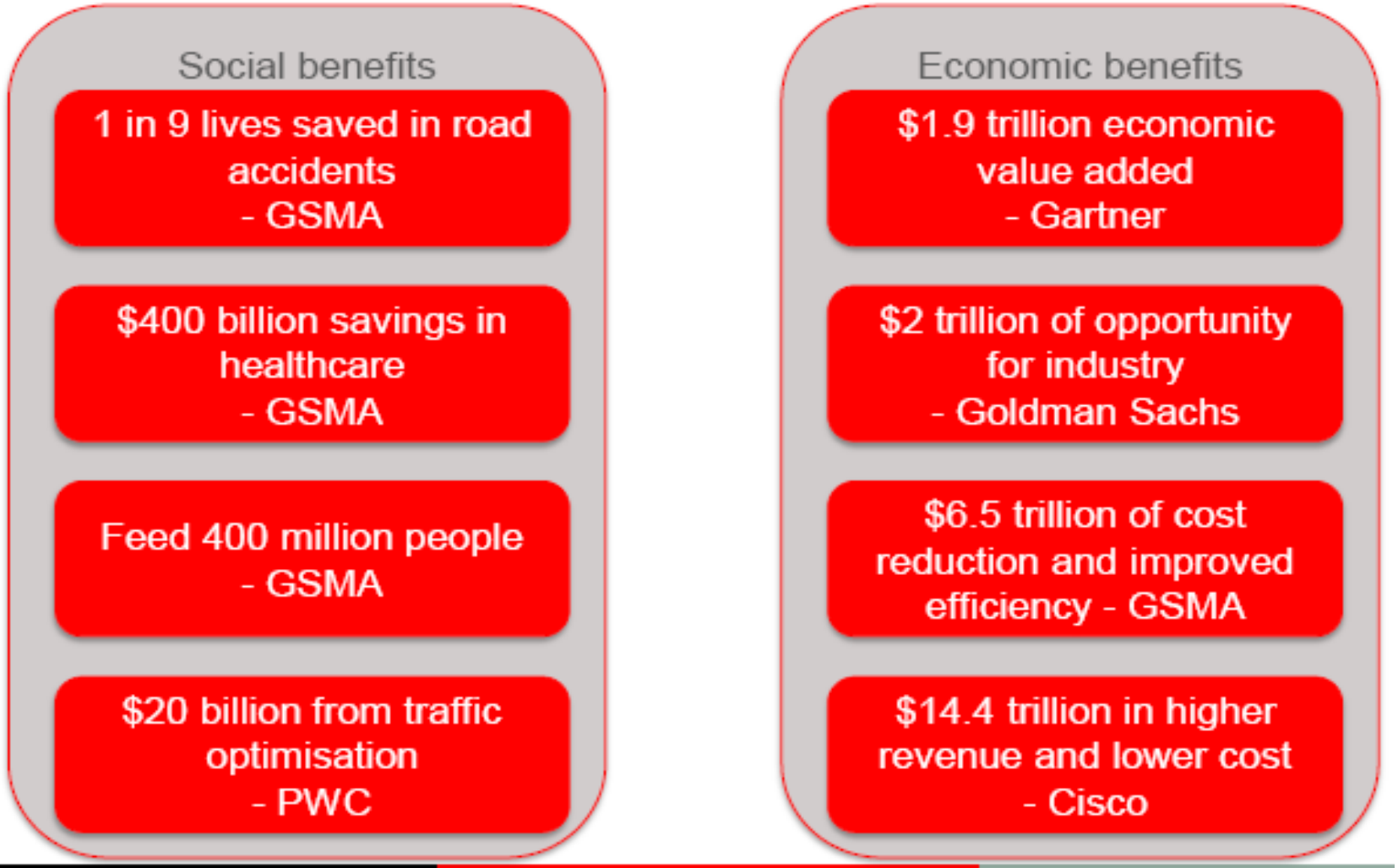
Source: Analysys Mason

IoT cellular revenue as a share of all cellular revenue



Source: Analysys Mason

Socio-economic benefits of IoT



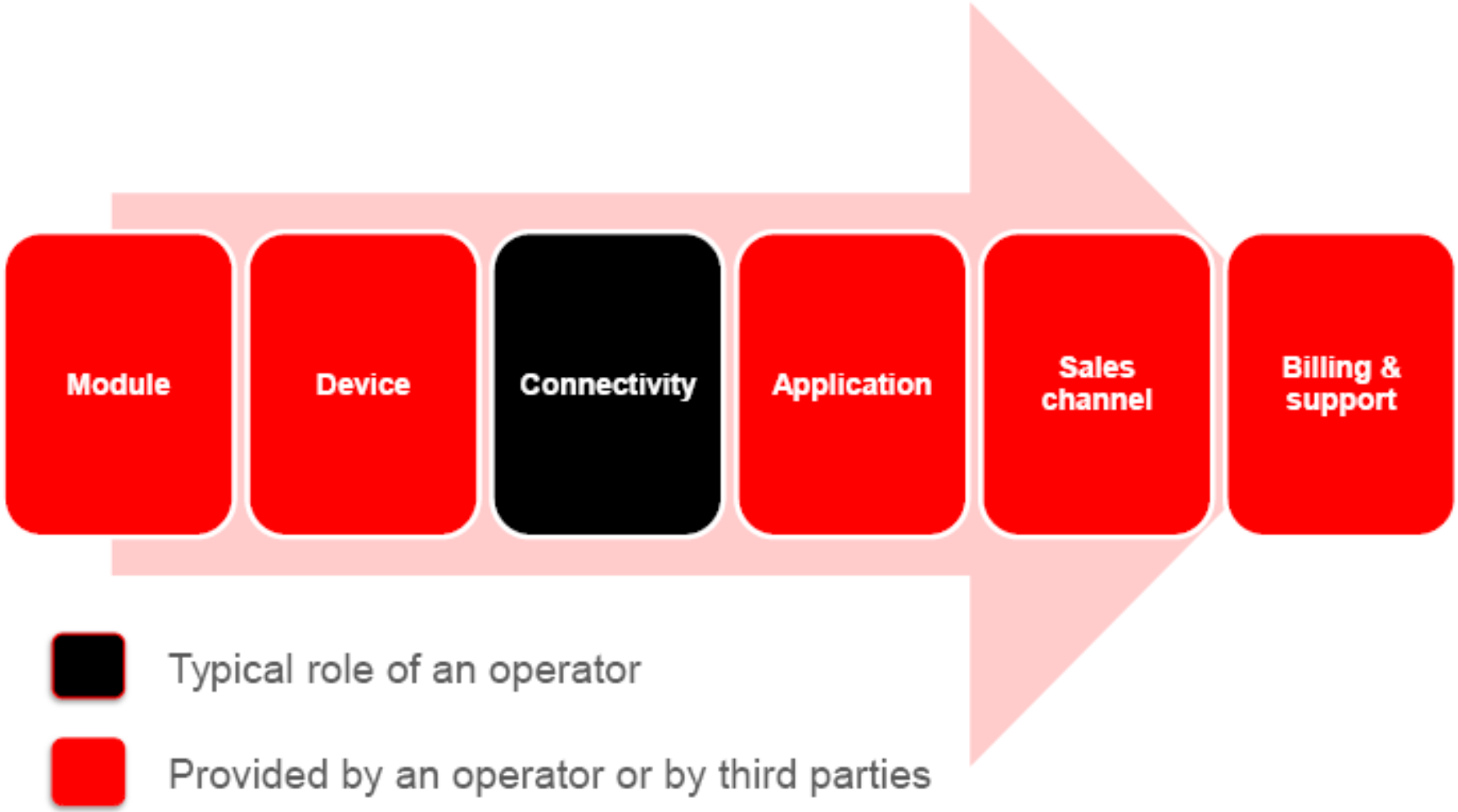
Connections and revenue forecasts

1	IoT is still a nascent industry and is expected to grow at a fast pace
2	IoT cellular accounts for a very small share of the total IoT
3	There are a wide range of socio-economic benefits that IoT can deliver

Technology : value chain and connectivity technologies

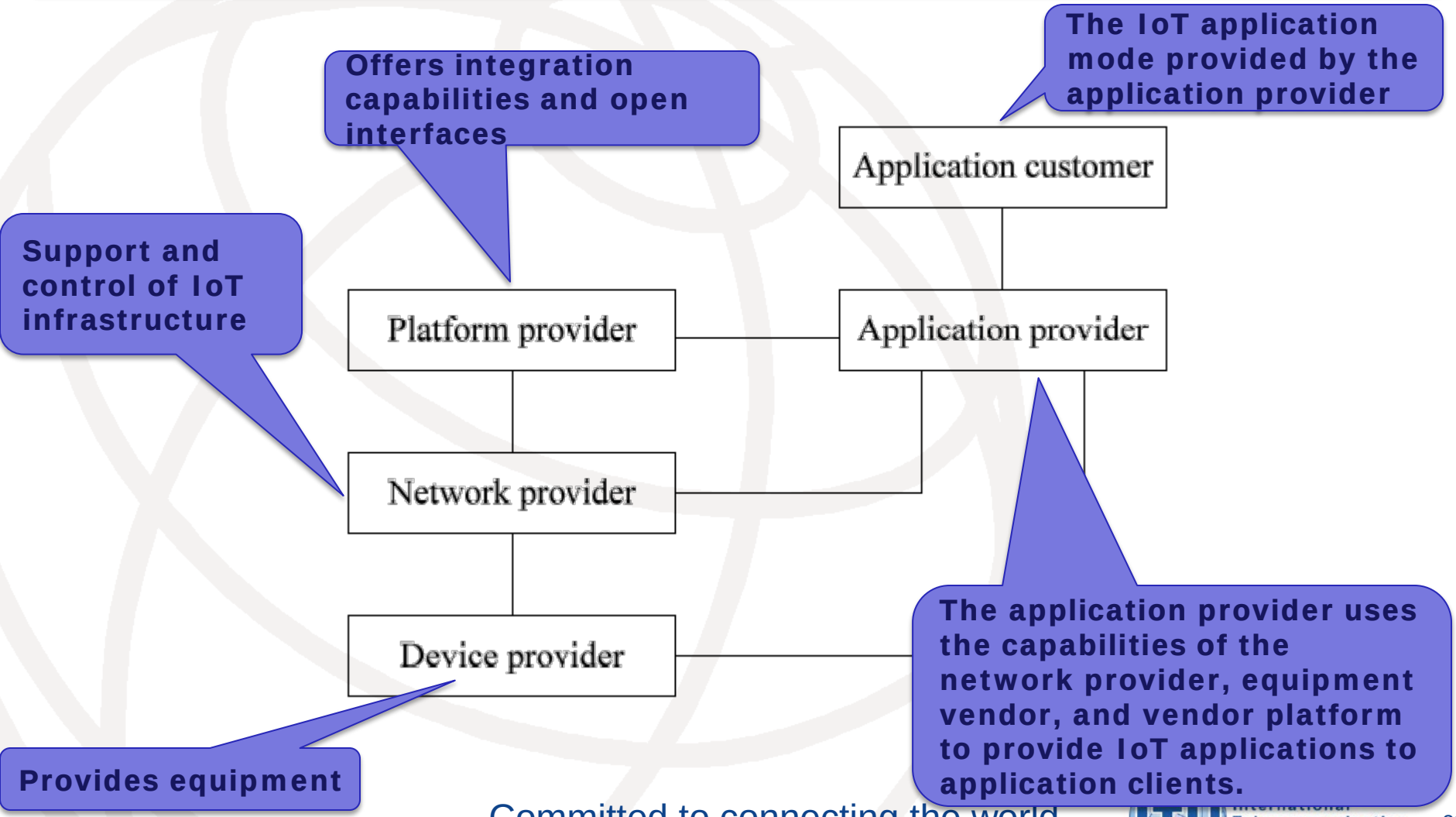
1. Connectivity is only one part of the IoT value chain
2. Many different connectivity technologies support IoT solutions
3. The characteristics of each technology define its suitability for a given IoT solution

The basic IoT value chain

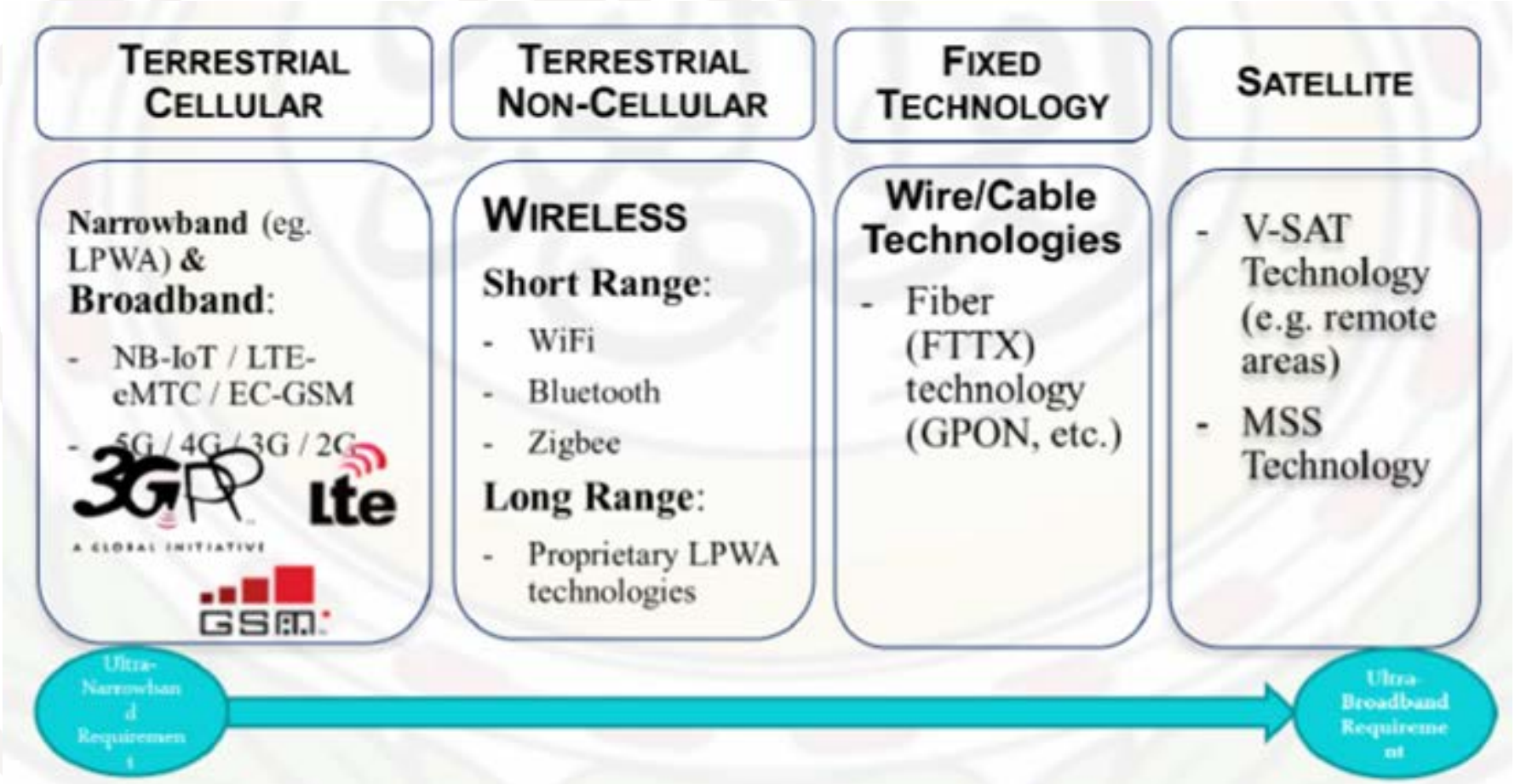


IoT ecosystem

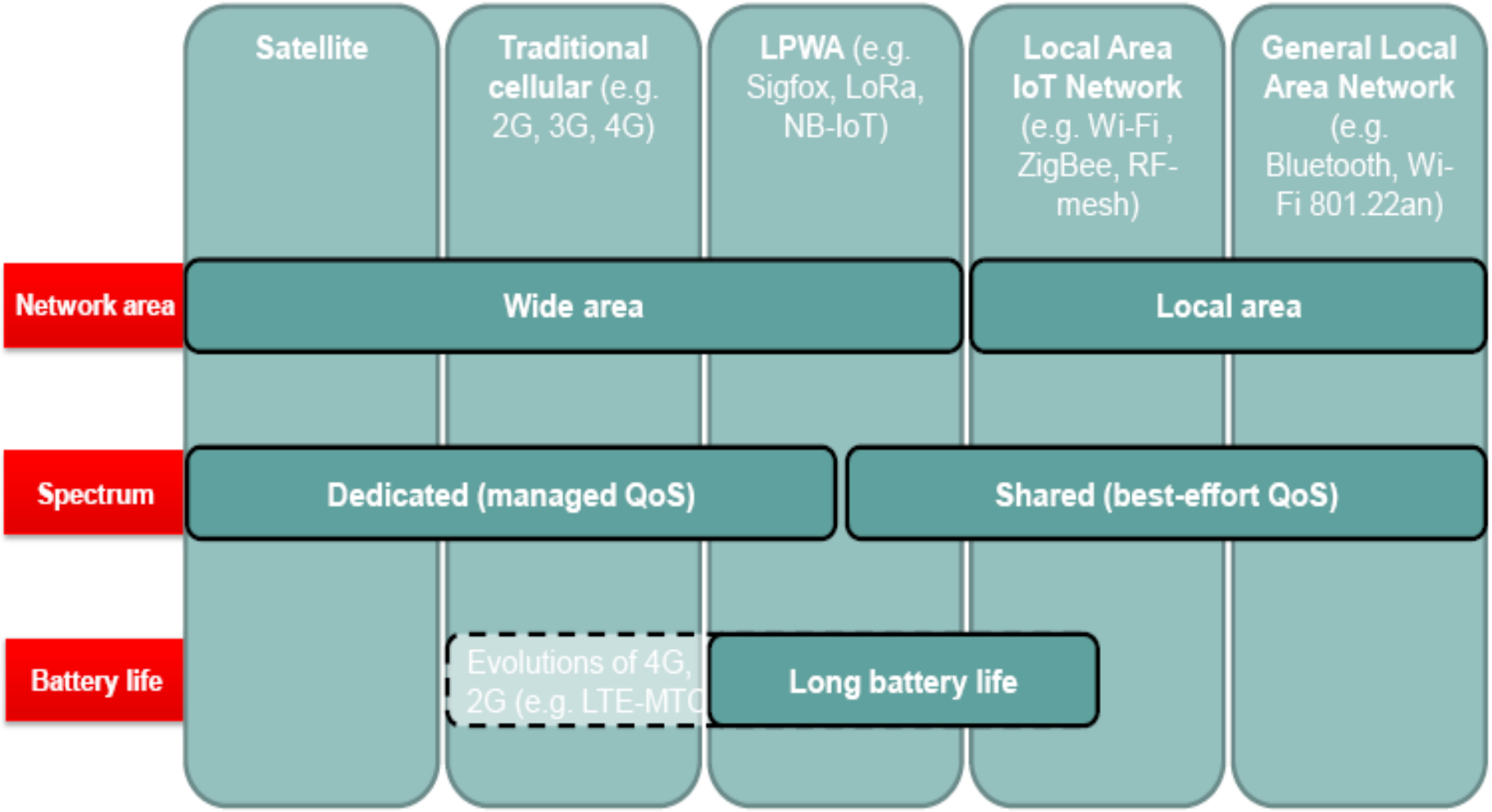
The IoT ecosystem is composed of several commercial actors. Each actor can play one or more roles at a time.



IoT communication technologies



Technology group dimensions



Technology specific dimensions

Spectrum issues

Spectrum used in IoT solutions can be dedicated (licensed) or shared (unlicensed); each option has benefits and disadvantages

Spectrum for IoT		
Characteristic	**Dedicated**	**Shared**
QoS	Supported	Not supported
Cost	Higher	Lower
Time to market	Slower	Faster

What are the spectrum needs of IoT?

- Determined by each application's throughput requirements, but also latency
  - For a given spectral efficiency (b/s/Hz), the lower the latency requirements the larger the bandwidth needed to send a given amount of data
- While many IoT applications might not need high speed connections and/or have very stringent latency requirements, some do (e.g. remote surgery)

In what frequency bands?

- Determined by each IoT application's range and coverage requirements, but also bandwidth needs of the applications
- Range and coverage requirements also depend on deployment scenarios
  - Point-to-point, mesh, broadcast, multi-cast, etc.

Dedicated IoT spectrum ?

Pros

- Global harmonization of spectrum increases economies of scale
- Dedicated spectrum might help lower spectrum management risks

Economies of scale in a variety of existing bands (cellular, unlicensed) could emerge through industry consensus and market development

Cons

- Achieving global harmonization on band(s) for IoT likely very difficult, if not impossible
- Could delay deployments and implementations
- Many gov'ts strongly opposed to dedicated spectrum for IoT
- Less flexibility as proponents could seek dedicated spectrum for various applications

Spectrum for IoT

IOT SPECTRUM		
Dedicated Spectrum		Shared Spectrum
National Mobile Network. (LTE, GSM)	Wide area IOT network (e.g. LoRa, SigFox)	WIFI, Bluetooth, SRDs. Dynamic spectrum access techniques.
Wide Coverage		Short Range
Guaranteed QoS	Long battery life, low cost. propagation	Long battery life; low cost. Best effort QoS
800MHz, 900MHz 1800MHz, 1900MHz 2100MHz, 2600MHz	400MHz , 868MHz	SRD (various), WI-FI (2.4 & 5GHz) WI-GIG (60GHz), Bluetooth (2.4GHz), ZIGBEE, UWB?, TVWS?

Spectrum harmonisation

It can help the IoT market growing faster

Benefit of harmonisation	Acts as a driver for IoT market growth through lower cost of modules
Industry players' role	Identify which bands are to be harmonised
Holistic approach	Harmonisation needs to consider the spectrum requirement of different IoT applications

Frequency bands of SRDs

Global
Only in Europe
Only in Americas

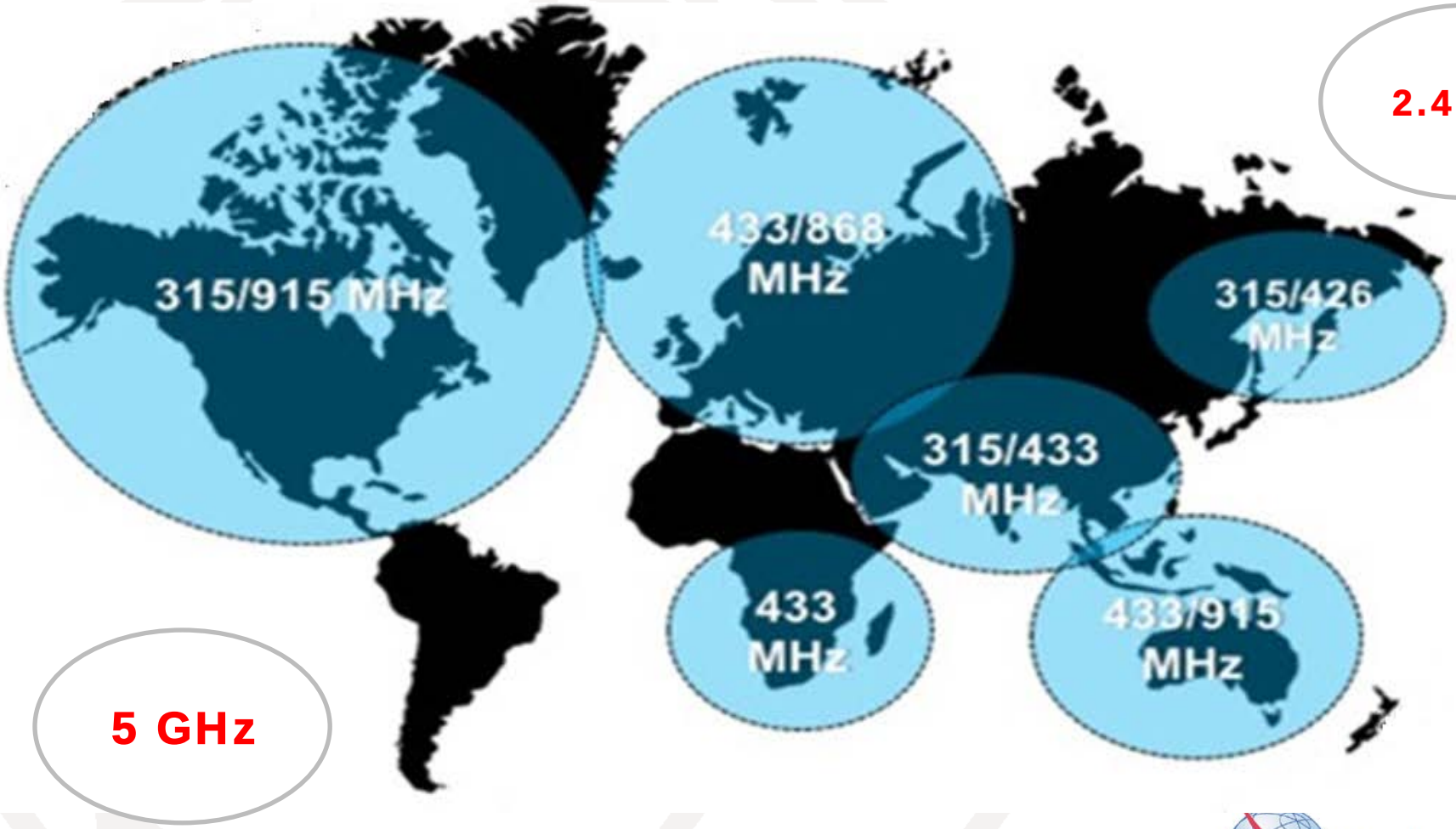
ISM bands

6,780 kHz; 13,560 kHz
27,120 kHz; 40.68 MHz
433.92 MHz
915 MHz
2,450 MHz; 5,800 MHz
24.125 GHz; 61.25 GHz
122.5 GHz; 245 GHz

9-148.5 kHz; 3,155-3,400 kHz
9 kHz- 47 MHz (specific SRDs)
7,400-8,800 kHz
138.20-138.45 MHz
169.4-216 MHz
312-315MHz (non Europe)
402-405 MHz medical devices
470-489 MHz (normally individually licensed)
823-832 MHz and 1,785-1,805 MHz
862-875 MHz in some Asian counties
862-876MHz Non-Specific SRDs
915-921 MHz (in some countries)
5,150-5,350 & 5,470-5,725 MHz
57-64GHz, 76-77GHz, 77-81GHz

non-ISM candidate bands for SRDs

Band IoT


2.4 GHz
315/915 MHz
433/868 MHz
315/426 MHz
315/433 MHz
433 MHz
433/915 MHz
5 GHz

Frequency band for LPWAN

Networks	Fréquence utilisée bande ISM	Largeur de la bande	Modulation	Débit	Pays couvert ou en déploiement
LoRaWan	868 Mhz et 433 Mhz (EU) 915Mhz (US)	120 khz	DSS CDMA	300 bit/s à 100 kbit/s	USA, France, Belgique, Pays-bas, suisse, Afrique du sud, Corée du sud
Sigfox	868 Mhz (Eu) 915 Mh(USA)	100 Khz	UNB, GFSK	500 bit/s	France, Allemagne, Espagne, USA
Weightless-N	868 Mhz (Eu) 915 Mh(USA	Information non communiquée publiquement	UNB, DBPSK	10 bit/s à 10kbits/s	Londre
Ingenu	2.4Ghz	80 Mhz	RPMA	600kbit/s en downstream, et 100kbit/s en upstream	USA, Italie
QOWISIO	868Mhz (EU)	Information non communiquée publiquement	UNB	Information non communiquée publiquement	Afrique, moyen orient, Russie
LTE-M	Bandes sous licences	200khz	??	200kbps	In progress

To add specific RF to IoT at SRD bands?

1. Resolution 958 (WRC-15), Annex item 3 and WRC-19 Agenda Item 9.1 (issue 9.1.8) 'Studies on the technical and operational aspects of radio networks and systems, as well as **spectrum needed**, including possible harmonized use of spectrum to support the implementation of **narrowband and broadband machine-type communication infrastructures**'

2. In addition to mobile systems (such as GSM), without prejudging WRC-19 results, the **present SRDs RF bands, shown at previous slide, may provide to IoT the necessary coverage and capacity** for narrow and wideband, in narrow and wide area

Challenges for IoT spectrum in developing countries

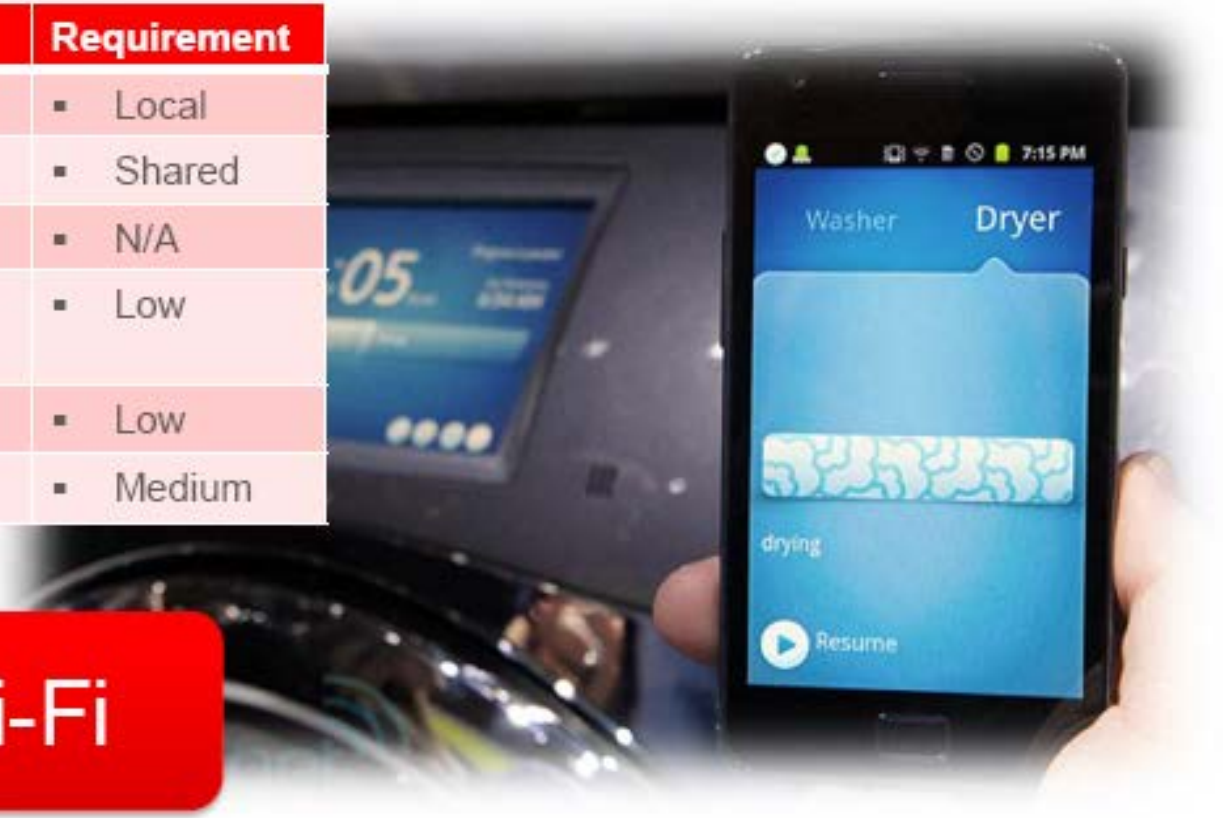
- Spectrum Fragmentation provides real challenges for the introduction of efficient and cost effective IoT ecosystem for enabling development of developing countries on a timely manner
- Various terrestrial Radiocommunication spectrum available for IoT broadband and narrowband communication:
  - IMT Frequency bands
  - ISM band
- Majority of IoT use cases / connections have **Narrowband LPWA IoT requirement** including:
  - Cheap / Low cost devices to provide cost effective solutions for Billions of IoT connections
  - Wide coverage
  - Low power consumption

Opportunities for IoT spectrum
Possible spectrum harmonization

- New IMT based technologies were standardized by June 2016 and being commercialized, (in 3GPP Release 13 Specs) to cater Narrowband IoT requirement, such as:
  - NB-IOT (200KHz): is a new radio added to the LTE platform, optimized for the low end of the market. The 9 months standardization after the study period shows the rapidly growing demands for various IoT capabilities.
  - LTE-eMTC (1.4MHz): is delivering further LTE enhancements for Machine Type Communications, building on Release-12 (new PSM)

Smart washer

Feature	Requirement
Network Area	▪ Local
Spectrum	▪ Shared
Battery life	▪ N/A
Connectivity cost	▪ Low
Module cost	▪ Low
Bandwidth	▪ Medium



Wi-Fi

Other technologies: 2G, 3G

Smart T-shirt

Feature	Requirement
Network Area	▪ Local
Spectrum	▪ Shared
Battery life	▪ Low
Connectivity cost	▪ Low (None)
Module cost	▪ Low
Bandwidth	▪ Low

Bluetooth

Other technologies: LPWA

eHealth

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Dedicated
Battery life	▪ N/A
Connectivity cost	▪ Medium
Module cost	▪ Medium
Bandwidth	▪ Medium

3G

Other technologies: 4G

Smart oil field

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Dedicated
Battery life	▪ Short / N/A
Connectivity cost	▪ High
Module cost	▪ High
Bandwidth	▪ Low to high

Satellite

Other technologies: 2G, 3G, 4G, LPWA

Smart water pump

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Shared
Battery life	▪ Long
Connectivity cost	▪ Low
Module cost	▪ Low
Bandwidth	▪ Low

LPWA

Other technologies: 2G

HD surveillance camera

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Dedicated
Battery life	▪ N/A
Connectivity cost	▪ Medium
Module cost	▪ High
Bandwidth	▪ High

4G

Other technologies: 3G, Wi-Fi

Smoke detector

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Shared
Battery life	▪ Long
Connectivity cost	▪ Low
Module cost	▪ Low
Bandwidth	▪ Low

LPWA

Other technologies: 2G, Wi-Fi, RF-mesh

Other technologies: 3G, Wi-Fi

Fleet tracking

Feature	Requirement
Network Area	▪ Wide
Spectrum	▪ Dedicated
Battery life	▪ N/A
Connectivity cost	▪ Medium
Module cost	▪ Low
Bandwidth	▪ Low

2G

Other technologies: 3G, LPWA

Addressing objects

Insufficiency of numbering resources

- Object addressing is provided in case of 6LoWPAN layer (IPV6 Low Power Wireless Personal Area Network). Its large-scale objective is to be able to address the sensors or the actuators of the 802.15.4 networks which will be seen as "IPV6" objects.
- A 6LowPan network is composed of nodes sharing the same IPV6 prefix, usually with a single gateway router connected to other IP networks.

Security and privacy protection capabilities

The security and privacy protection group includes :

- Communication security capability involves the abilities of supporting secure, trusted and privacy-protected communication
- Data management security capability involves the abilities of providing secure, trusted and privacy-protected data management
- Service provision security capability involves the abilities of providing secure, trusted and privacy-protected service provision
- Security integration capability involves the abilities of integrating different security policies and techniques related to the variety of IoT functional components
- Mutual authentication and authorization capability involves the abilities of authenticating and authorizing each other before a device accesses the IoT based on predefined security policies
- Security audit capability involves the abilities of monitoring any data access or attempt to access IoT applications in a fully transparent, traceable and reproducible way based on appropriate regulation and laws

Security in LoRaWan Networks

LoRaWan networks use two layers of security, one for the network and one for applications :

- ✓ The network part ensures the authenticity of the nodes on the network. It uses AES 128 encryption.
- ✓ The application part ensures that the network provider does not have access to the information transmitted.

Three types of keys are used:

- ✓ A secret primary key per object (objectId / @ MAC-Id)
- ✓ A network key per operator (MIC: integrity code): an integrity code known by the network
- ✓ An encryption key per service provider (encryption key known by the client, not known by the operator): encrypts the flows to the client's application servers.

INTEROPERABILITY AND STANDARDS

- IoTs have both public and proprietary standards currently
- Standardization is important for Interoperability, reducing costs and barriers to entry
- ITU-T SG 20 (IOT and Smart Cities, Smart Communities)
- National Standardization bodies
- International Standardization bodies

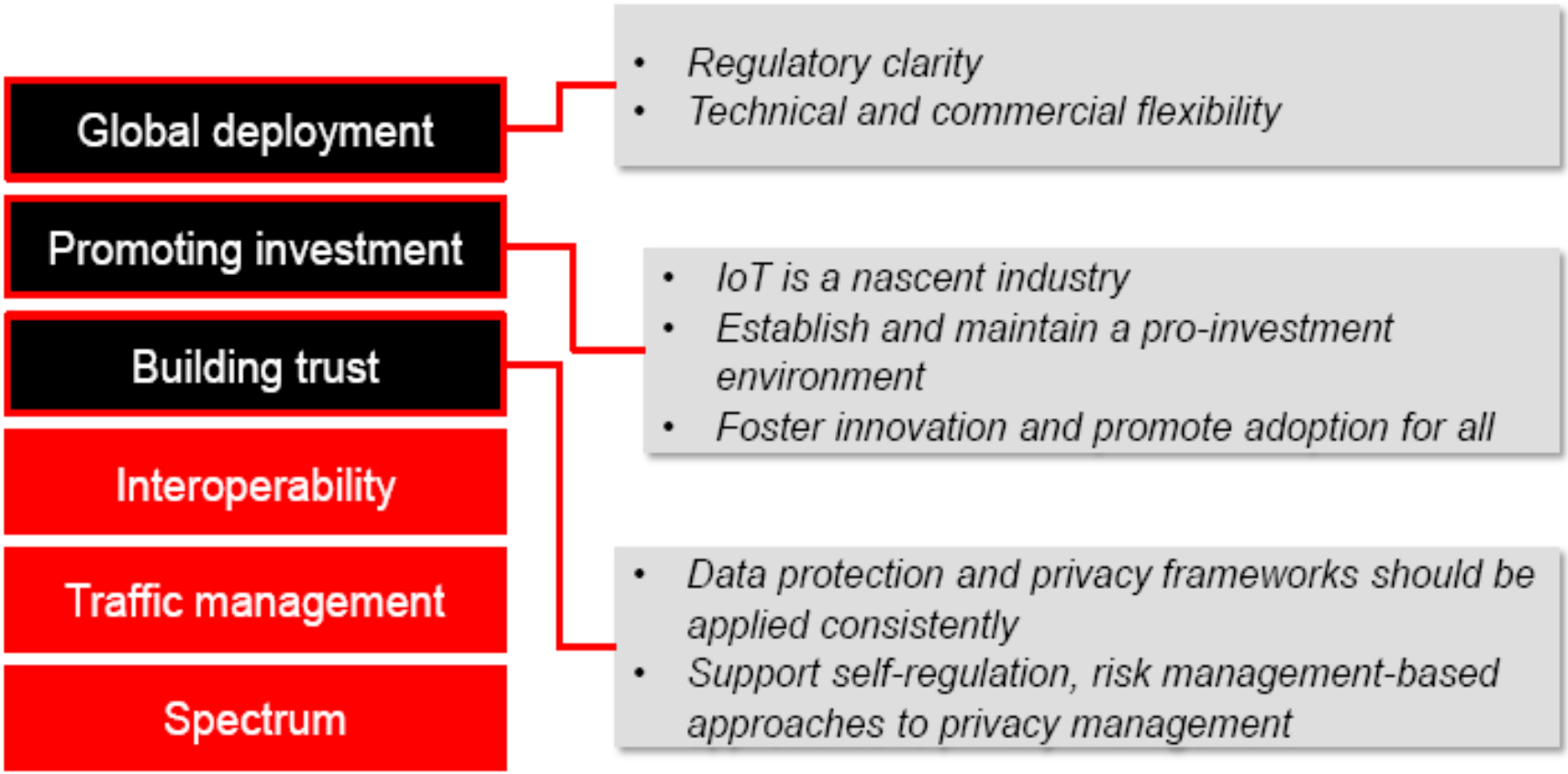
Cross-sectoral collaboration is very important as IoT are deployed in multiple sectors

Role of governments to drive IoT adoption

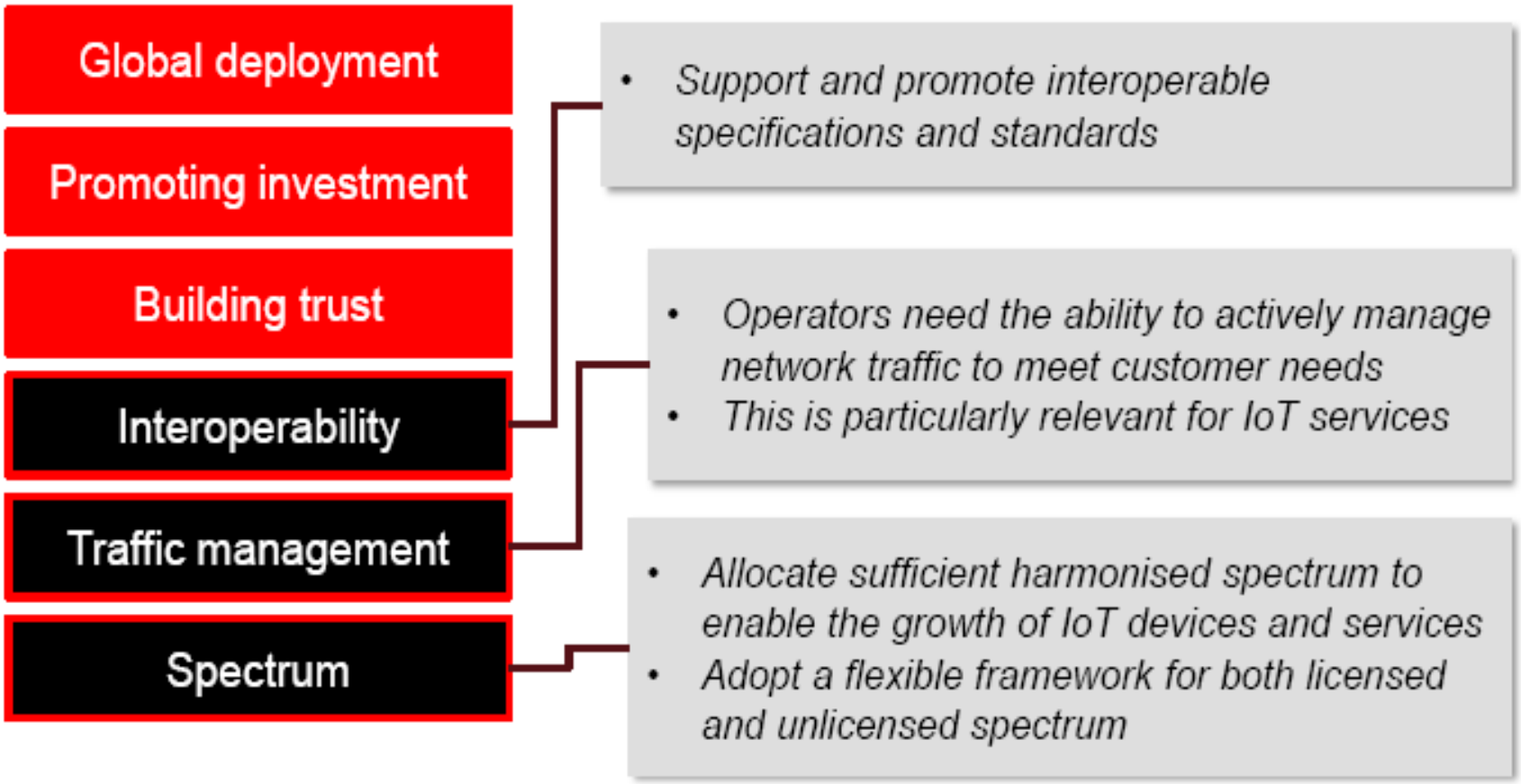
Governments should focus in six main areas to help drive the adoption of IoT products and services

- Global deployment
- Promoting investment
- Building trust
- Interoperability
- Traffic management
- Spectrum

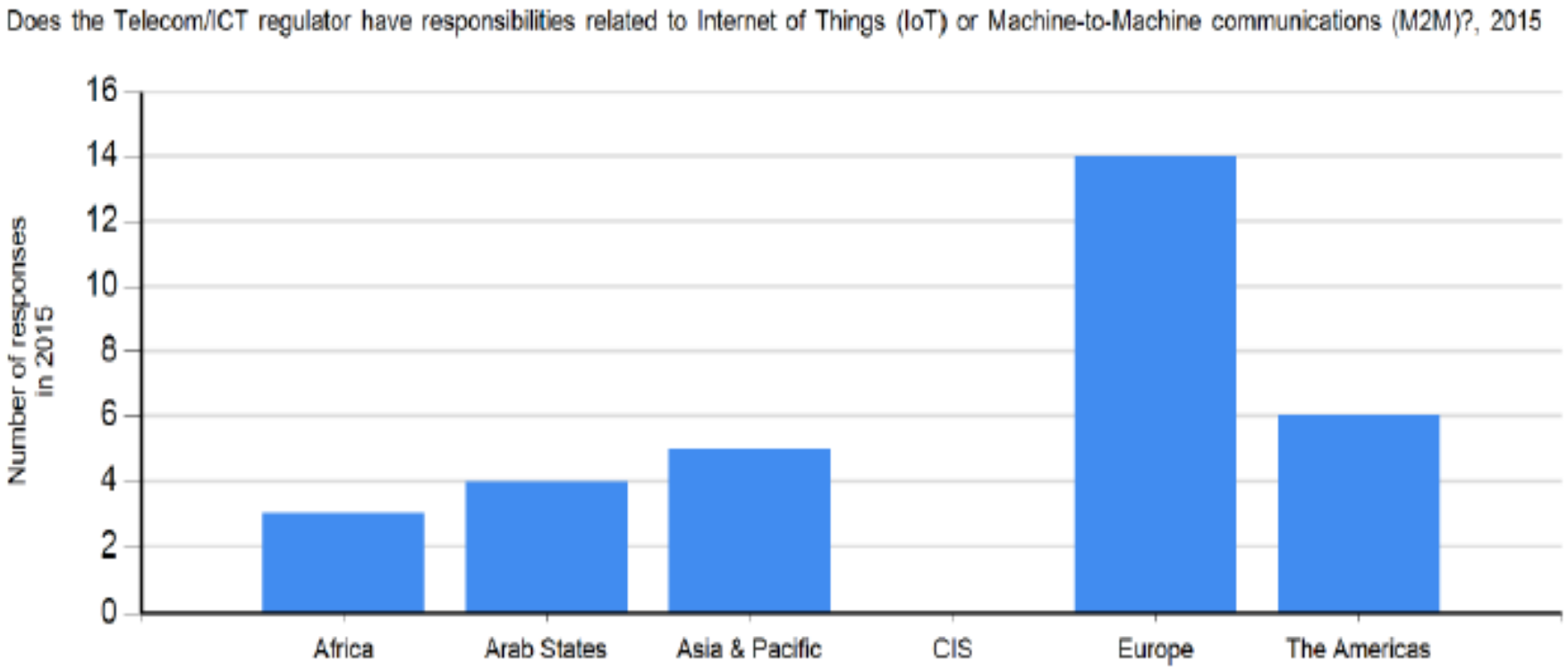
Facilitating global deployments, promoting investments, building trust…



...Supporting interoperability, traffic management and spectrum harmonisation

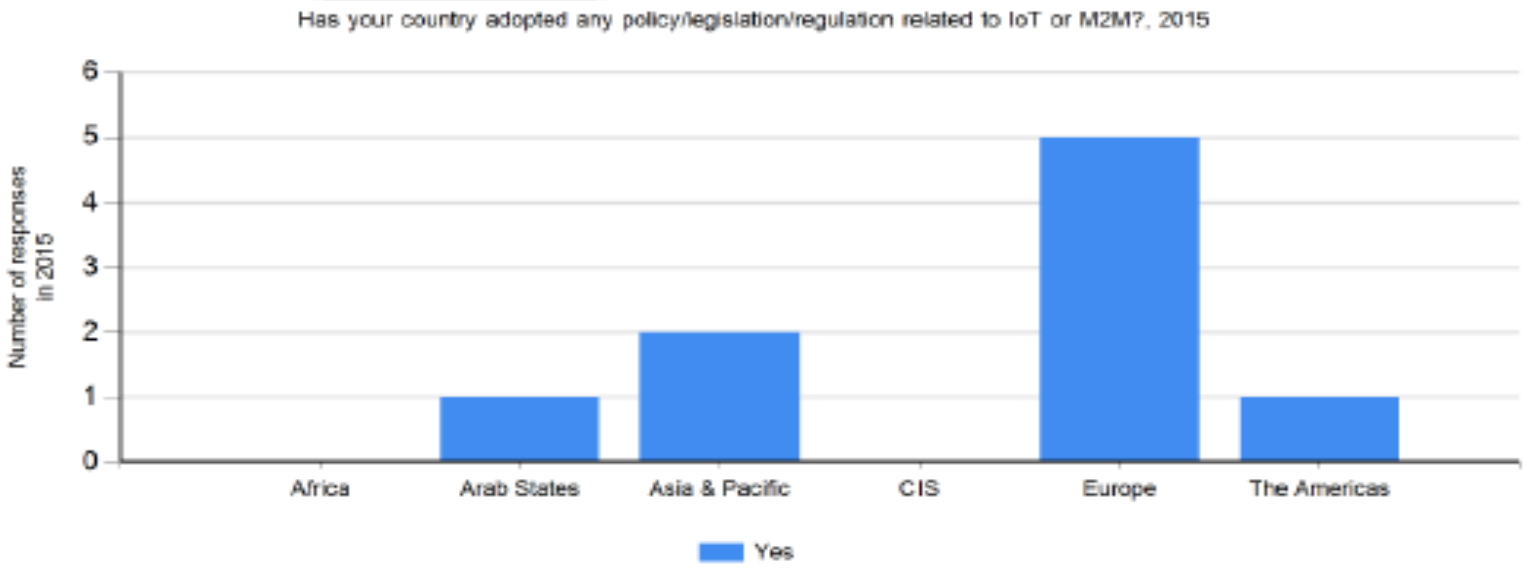


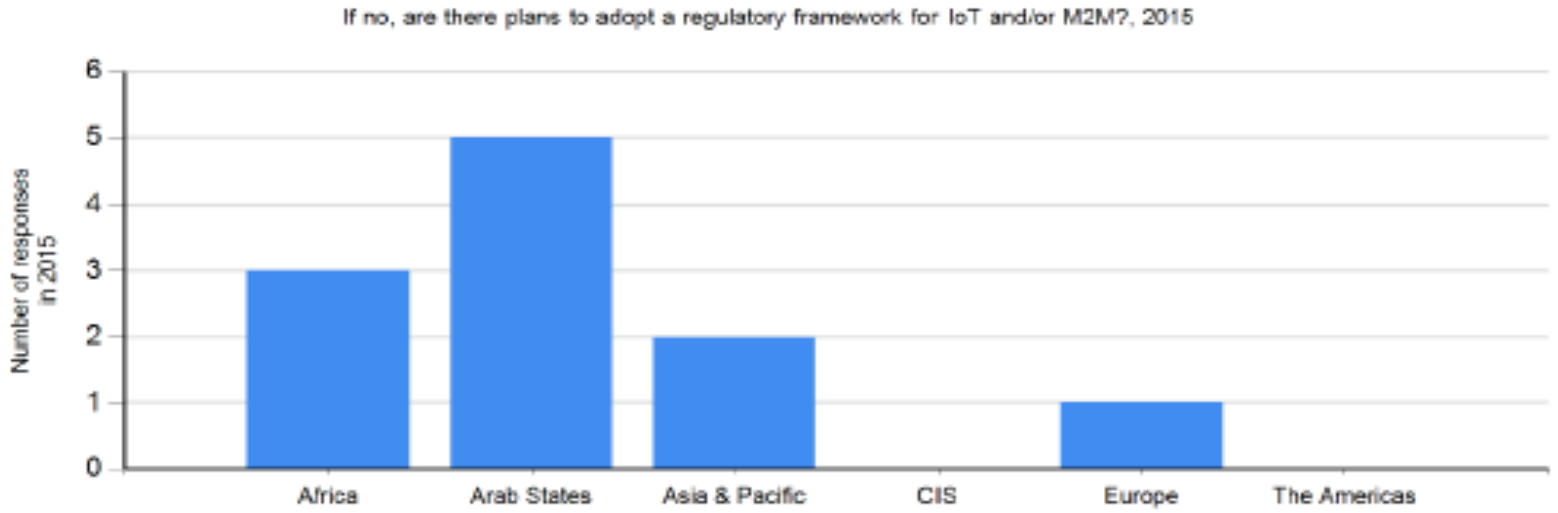
IoT and regulatory authority



Source: ITU World Telecommunication Regulatory Database

IoT policy and legislation





Conclusion

- IoT market is growing fast and will play significant role in digital transformation and economic development of the world in particular developing countries.
- Harmonization of spectrum is a key factor for developing countries to enable cost effective IoT solutions
- LP-WAN is a IoT enabler
- Internet is a service enabler

→ Ongoing standardization effort to merge these two technologies

Thanks for your attention

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Question?