GSMA Capacity Building

Internet of Things (IoT)

Introductions

Your objectives

- What do you expect to learn from this course?
- How is it relevant to you?

Aims of this course

- Define IoT
- Understand the technology behind IoT
- Analyse operational aspects of IoT
- Understand IoT business models
- Explore the policy and regulatory implications of IoT
- Examine a number of examples of IoT

Outline of the sessions

- Day 1:
- Introduction
- Overview of IoT
  - What is IoT?
  - Differences between IoT and traditional services
  - Drivers and inhibitors of IoT
  - Forecasts
- Technology
  - Value chain and technology of IoT networks
  - Spectrum for IoT
- Business models
- Guided case study
- Wrap-up day 1

- Day 2:
- Introduction
- Case studies
  - Elderly care monitoring
  - Smart public garbage bin
  - Security alarms
  - Industrial IoT
- Policy Summary
- Wrap-up

Overview of IoT

- An introductory video
- What is IoT?
- Exercise: How does IoT differ from traditional services?
- Drivers and inhibitors of IoT
- Connections and revenue forecasts

Overview of IoT: what is IoT?

Key messages

1. Many vertical markets will adopt IoT solutions
2. IoT is still at a very early stage of development, so definitions are still evolving

What is IoT?

Smart meters

Smart cities

Smart mining

Connected car

Connected thermostat

Remote health monitoring

Smart solar power plant

Smart farm

Connected thermostat

Connected car

Remote health monitoring

Smart solar power plant

Smart meters

Smart mining

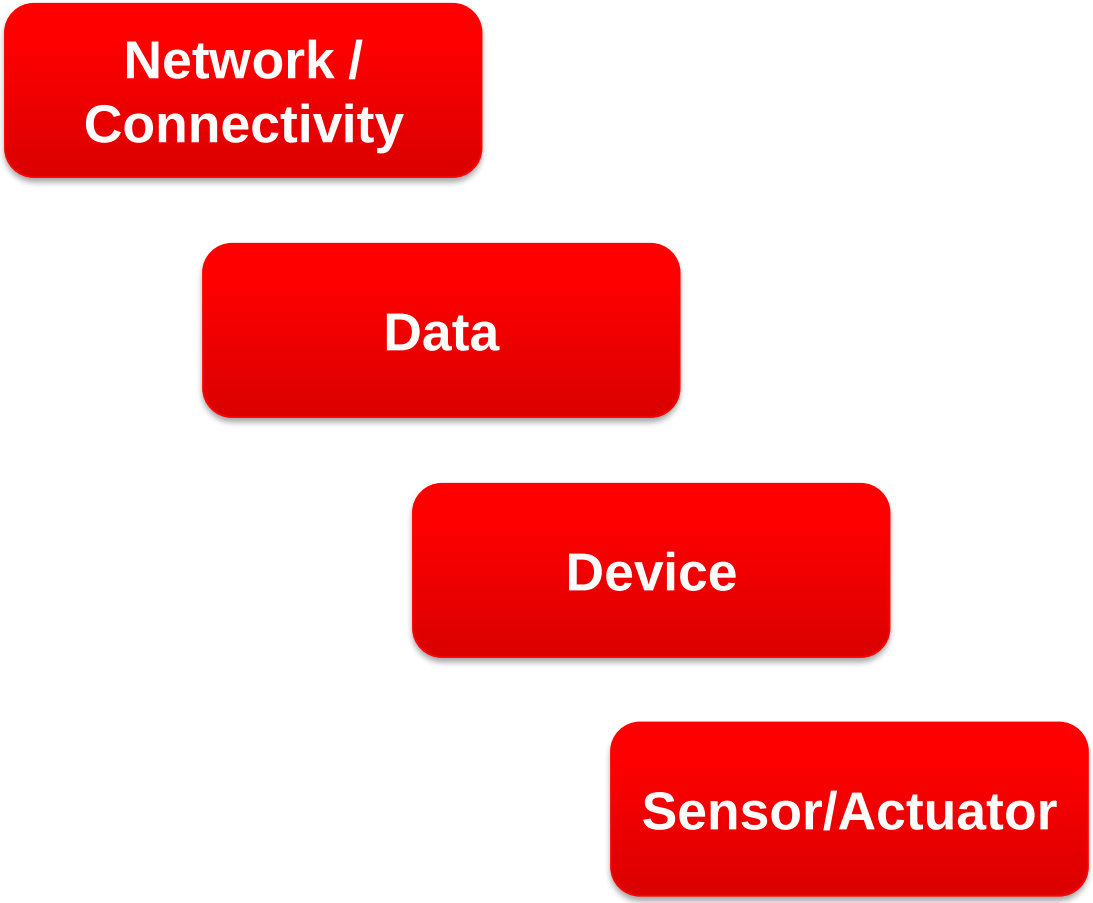
Smart city

Smart farm

Exercise: Identify common IoT elements

- Thinking about the eight examples just presented, what common patterns/elements can you identify across the solutions?
- What would be your definition of IoT?

Common elements of IoT



Common elements of IoT

Network / Connectivity

typically

Internet

…but also

Private

Common elements of IoT

Data

typically

Multiple sources

…but also

Single source

Common elements of IoT

Device

typically

Existing

…but also

New

Common elements of IoT

Sensor / Actuator

typically

Sensor and actuator

…but also

Sensor only

Common elements of IoT

Connectivity / Network	typically	Internet	…but also	Private
Data	typically	Multiple sources	…but also	Single source
Device	typically	Existing	…but also	New
Sensor / Actuator	typically	Sensor and actuator	…but also	Sensor only

Definitions of Internet of Things:

The Internet of Things (IoT) refers to the use of intelligently ***connected devices*** and systems to leverage ***data*** gathered by embedded ***sensors*** and ***actuators*** in machines and other physical objects. – *GSMA*

The IoT is […] the ***interconnection*** of multiple M2M applications, often enabling the exchange of ***data*** across multiple industry sectors. An example is the ability to manage traffic flow, reduce pollution and improve health by combining data from a range of transport, healthcare and environmental ***sensors***. – *Ofcom*

Noun - The ***interconnection*** via the Internet of computing ***devices*** embedded in everyday objects, enabling them to send and receive ***data*** – *Oxford Dictionary*

Definitions of Internet of Things:

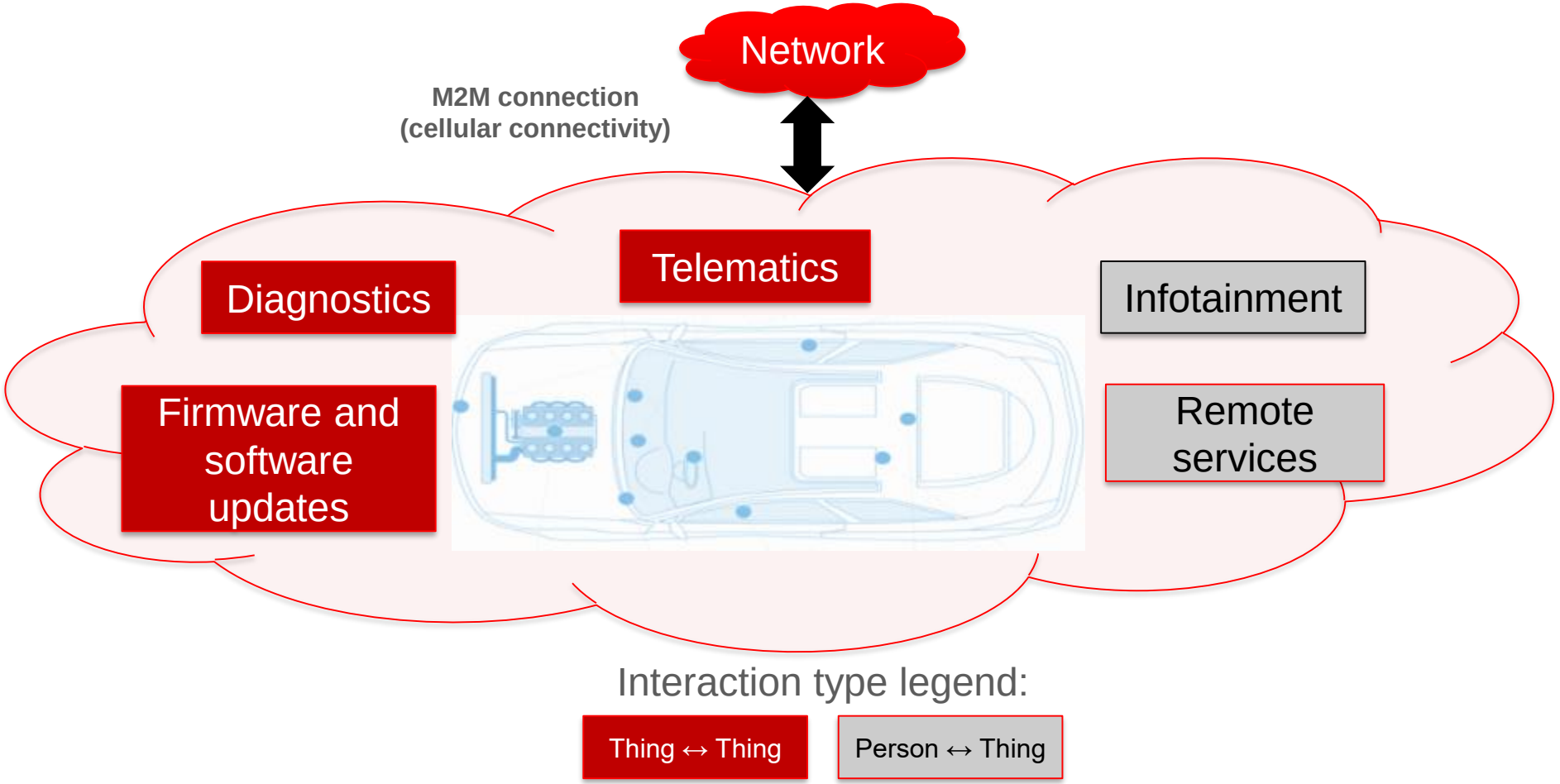
The Internet of Things (IoT) refers to the use of intelligently ***connected devices*** and systems to leverage ***data*** gathered by embedded ***sensors*** and ***actuators*** in machines and other physical objects – GSMA

"what all definitions of IoT have in common is that they focus on how computers, sensors, and objects interact with one another and process data." - FTC

and improve health by combining data from a range of transport, healthcare and environmental ***sensors*** – Ofcom

Noun - The ***interconnection*** via the Internet of computing ***devices*** embedded in everyday objects, enabling them to send and receive ***data*** – *Oxford Dictionary*

Internet of Things (IoT) vs Machine-to-Machine (M2M)



Summary: what is IoT

1

There are four key 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 reaction by actuators

2

IoT is still evolving and, as a result, so is its definition

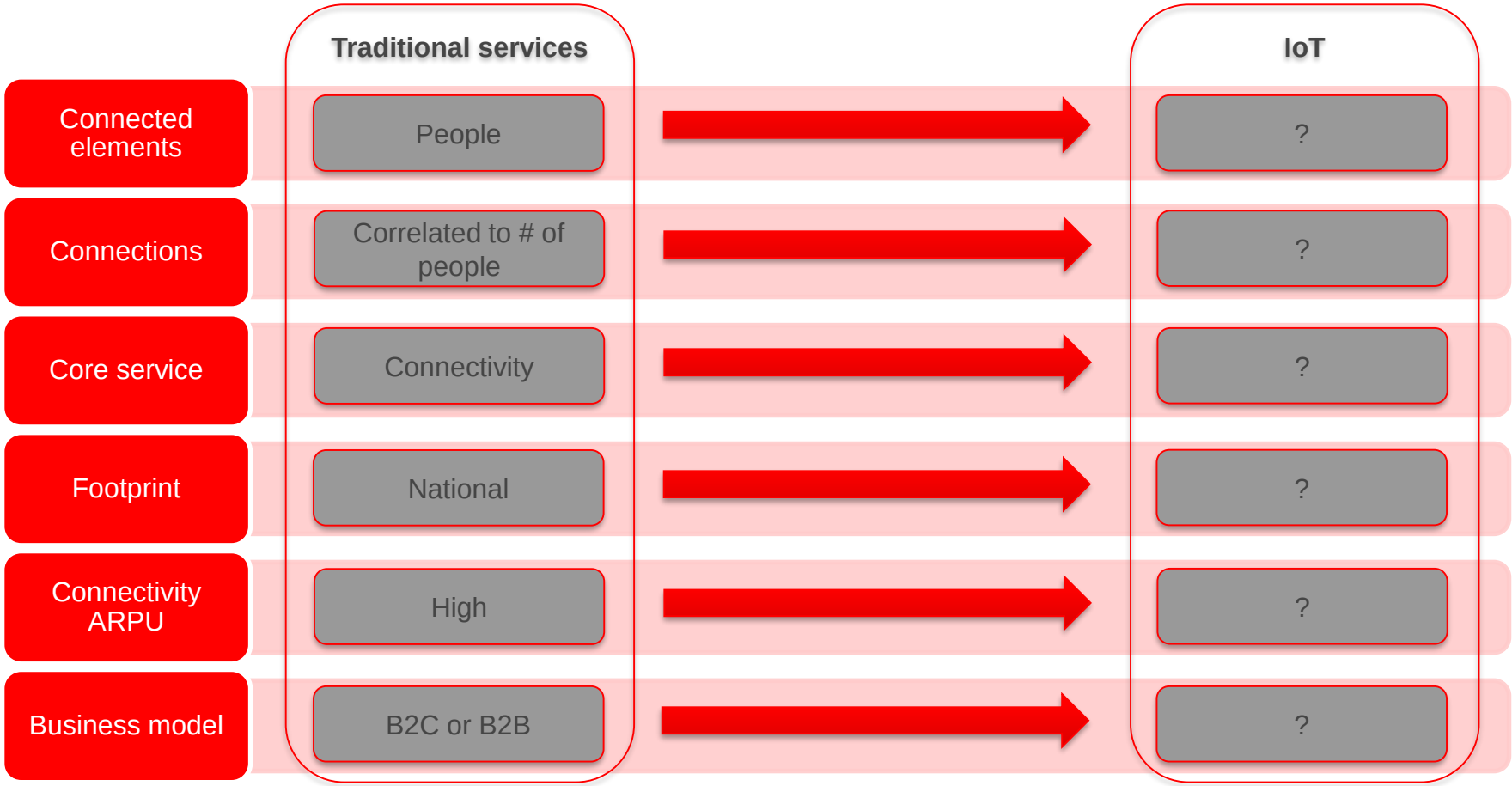
Overview of IoT: How does IoT differ from traditional services?

Key messages

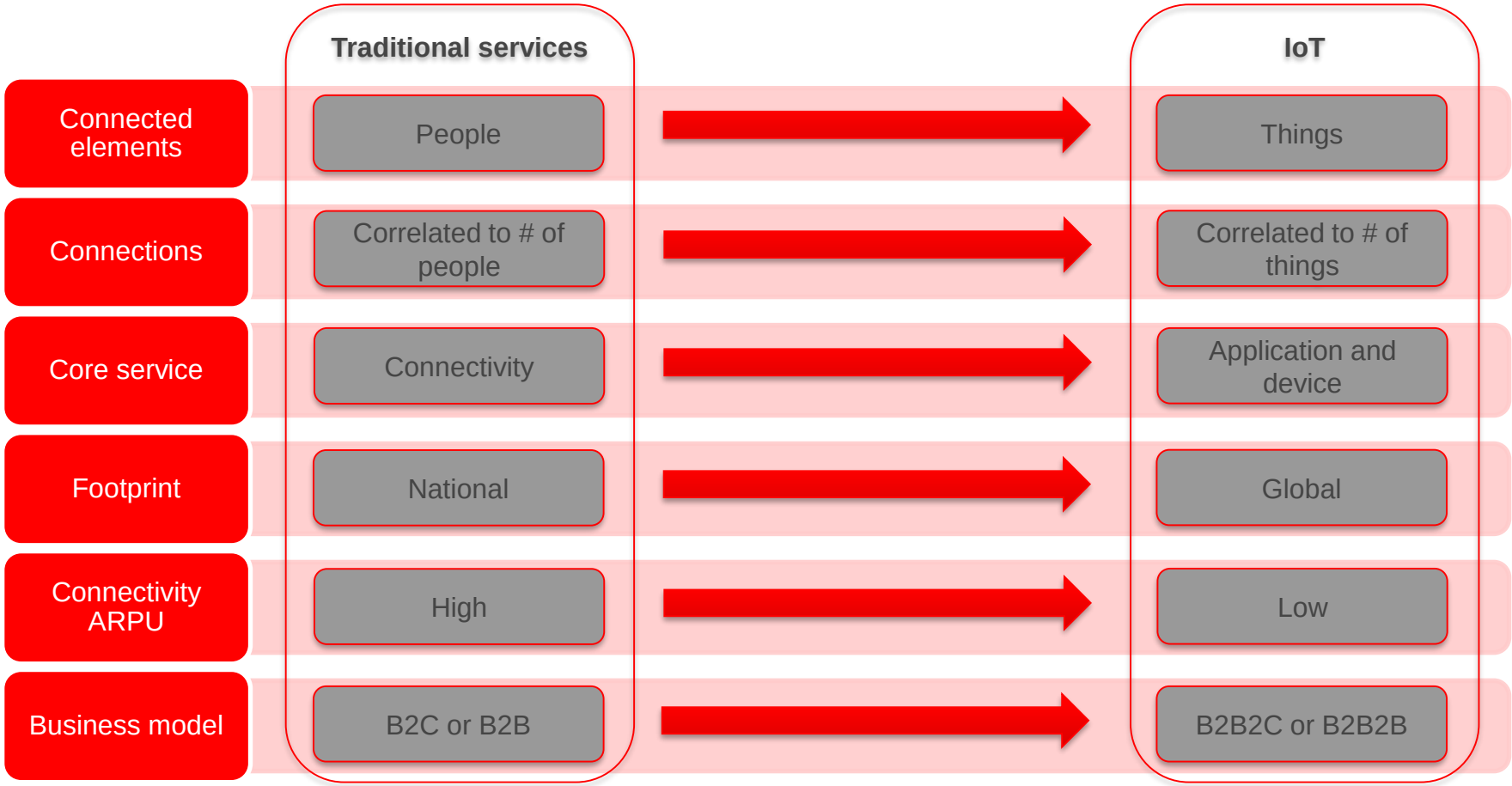
1. IoT services are fundamentally different from traditional telecoms services, such as voice and messaging
2. Regulators should recognise these differences when considering policy and regulatory frameworks

How does IoT differ from traditional services?

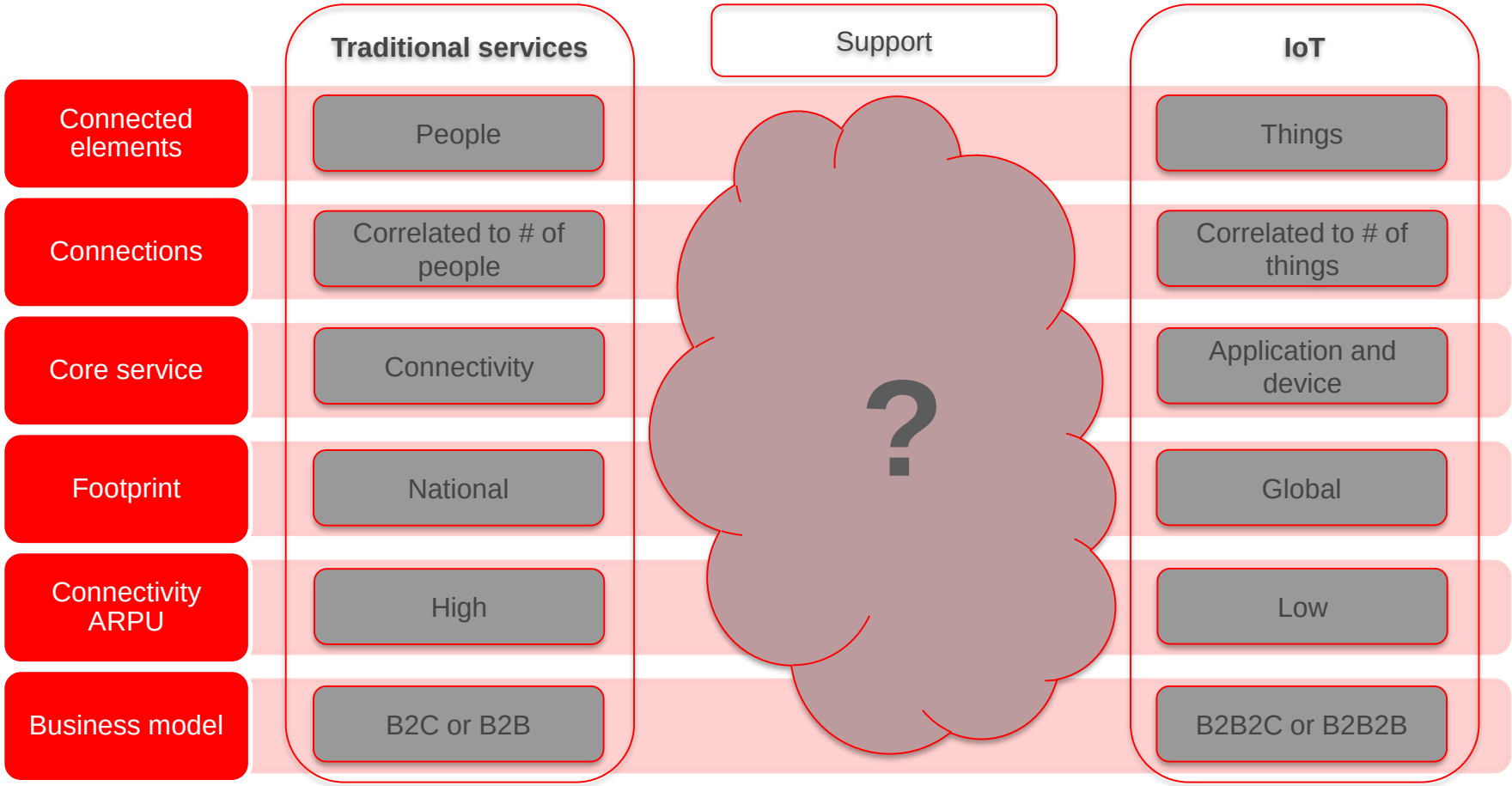
How does IoT differ from traditional services?



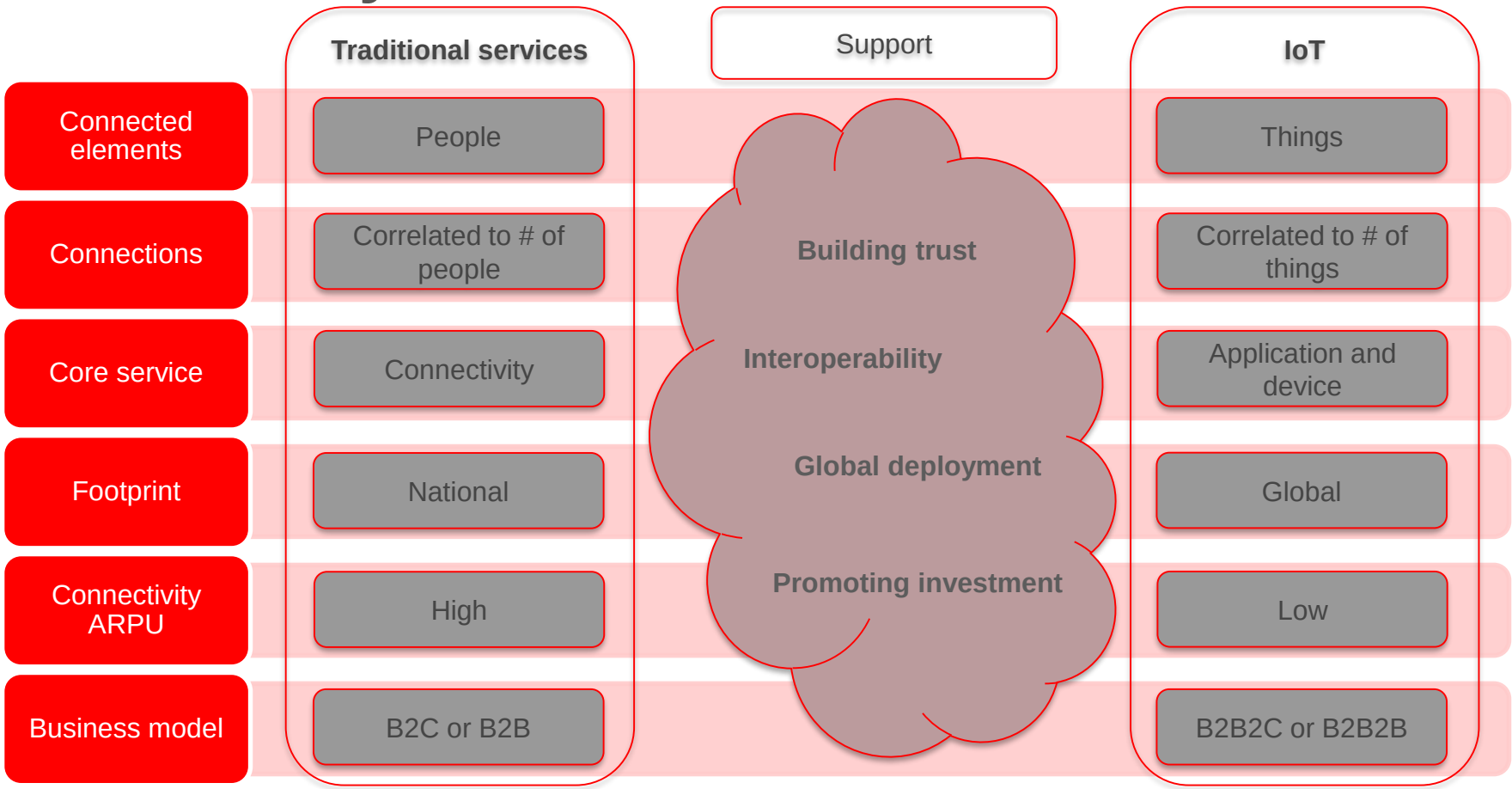
There are many differences…



…and governments can help IoT grow…



…by applying existing laws transparently and consistently



Summary: How does IoT differ from traditional services?

1

IoT services differ from traditional service on dimensions such as:

- What is being connected (things vs people)
- The core element of the service (application vs connectivity)
- The volume of connections
- 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

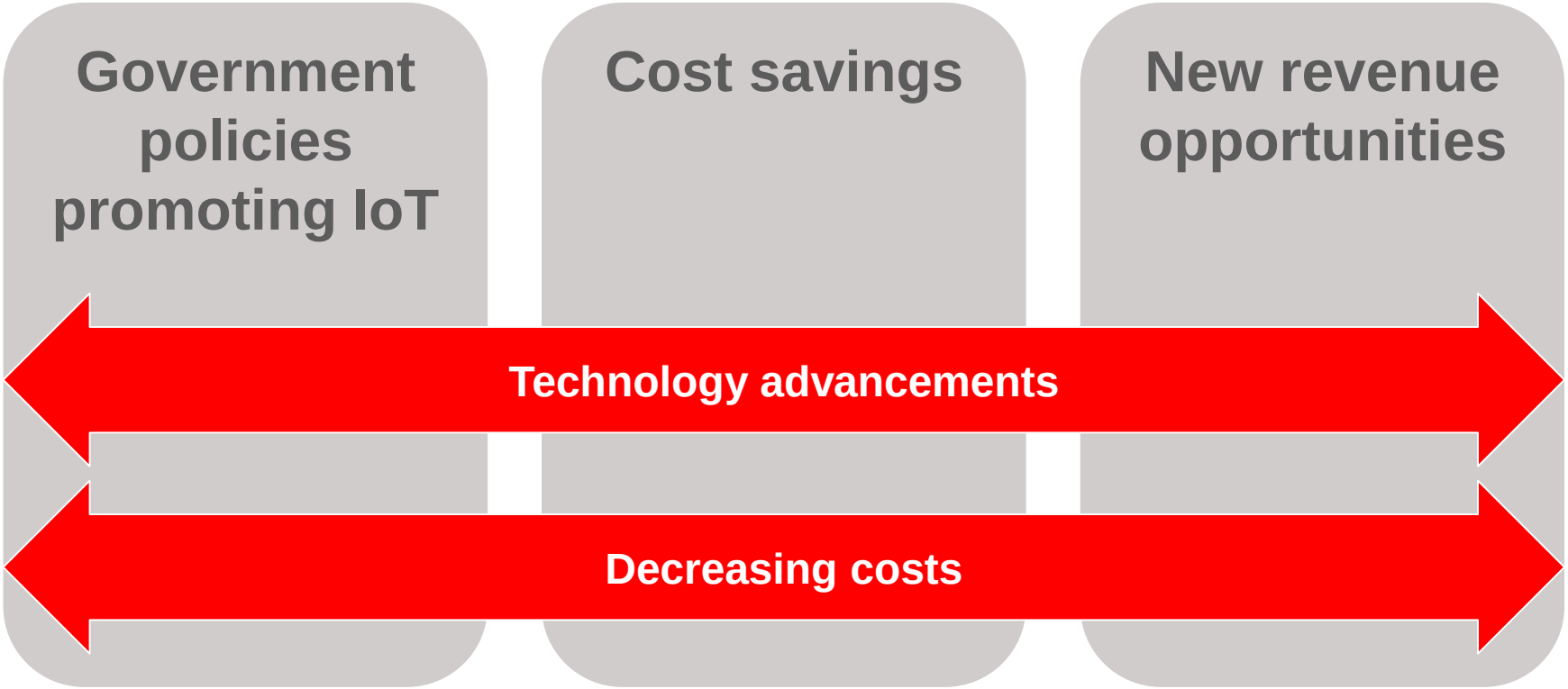
Overview of IoT: drivers and inhibitors of IoT

Key messages

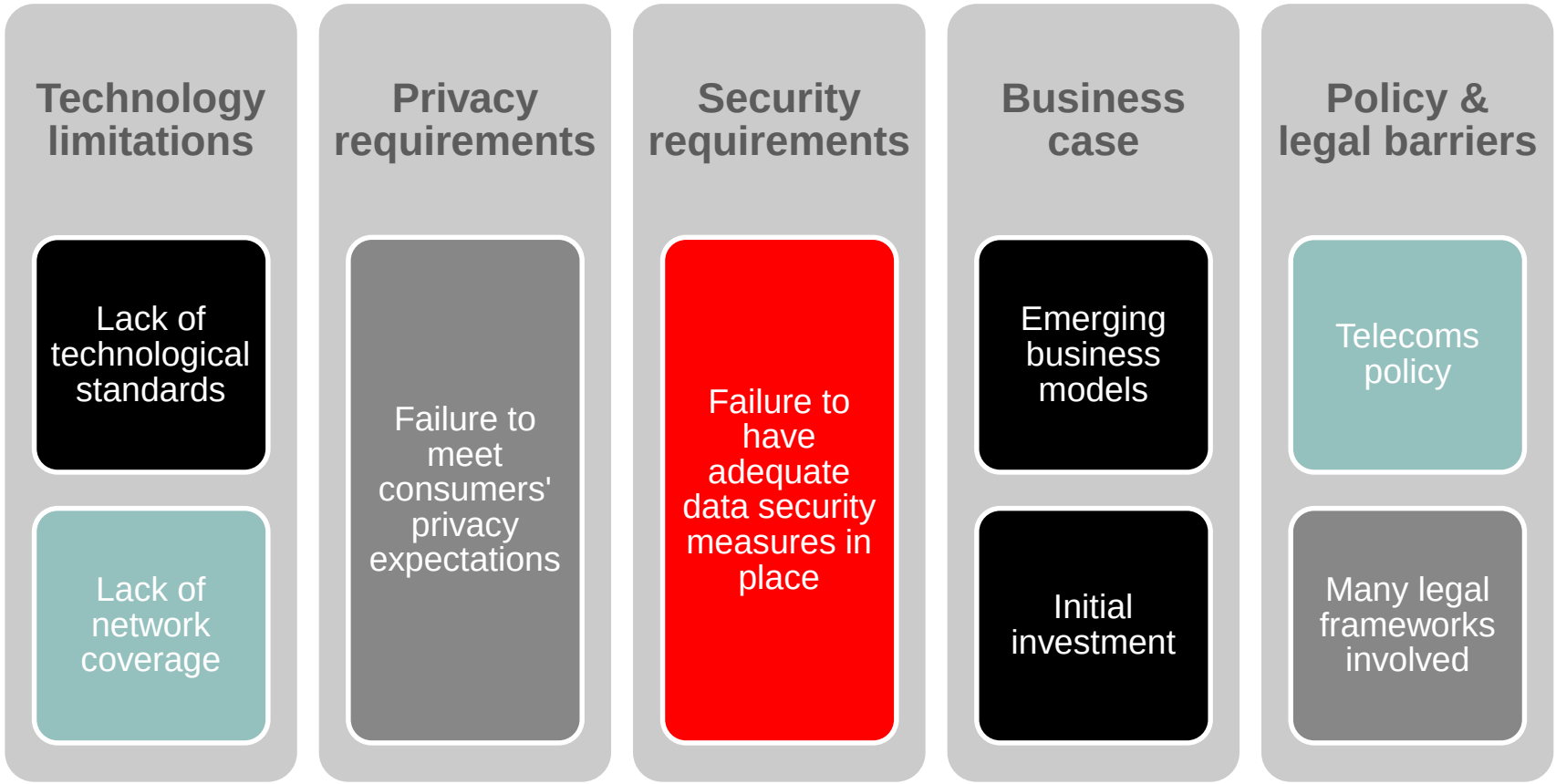
1. IoT is being driven by technology advancements, decreasing costs and demands for efficiency

2. Clarity on how data privacy laws are applied to IoT can help this nascent market develop

Some drivers of IoT…



…and some inhibitors of IoT



Summary: drivers and inhibitors of IoT

1

IoT is driven by:

- Government policies promoting IoT growth
- Cost savings
- New revenue opportunities

2

IoT's growths can be hindered by:

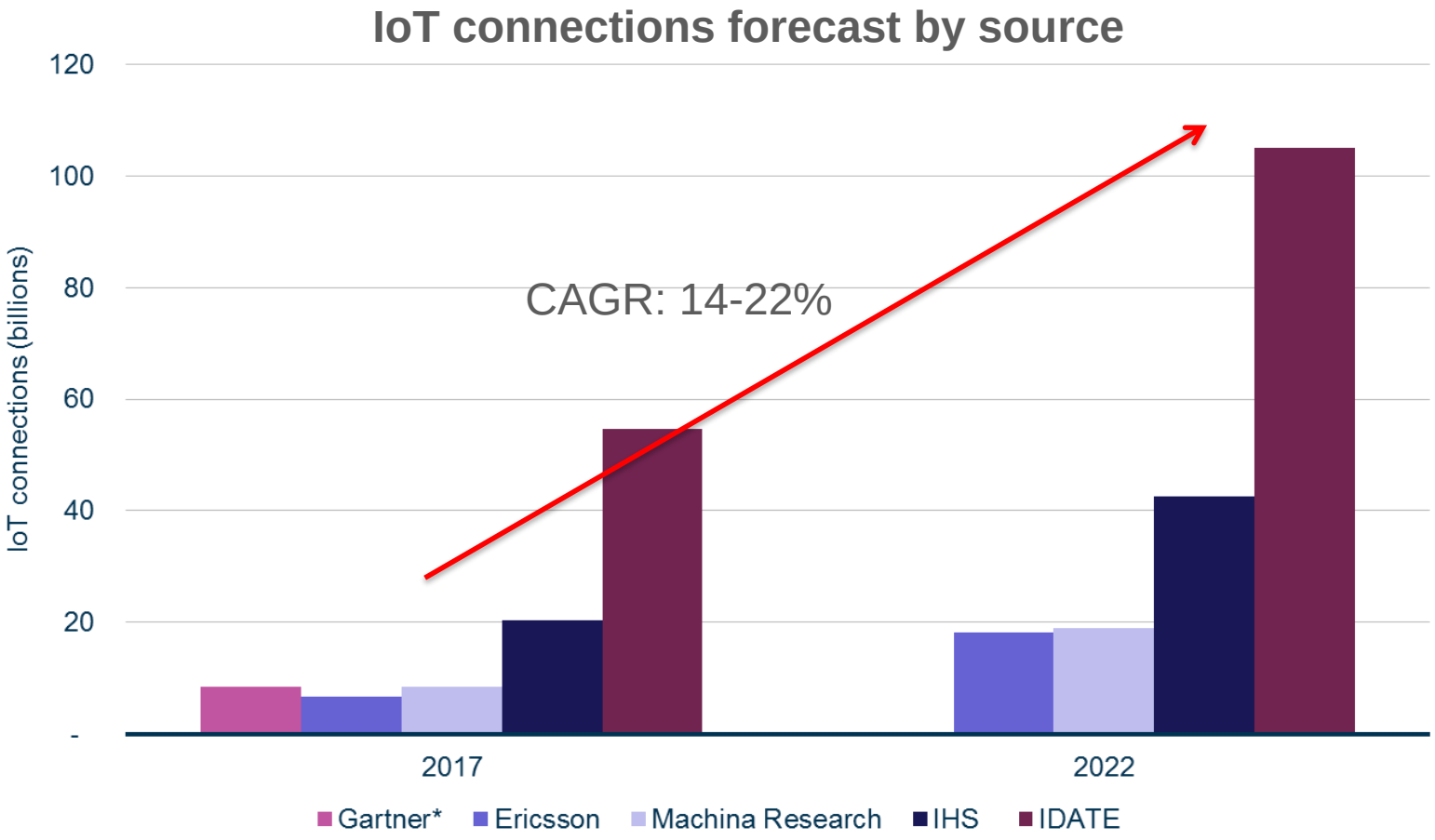
- Technology limitations
- Privacy requirements
- Security requirements
- The business case
- Policy and legal barriers

Overview of IoT: connections and revenue forecasts

Key messages

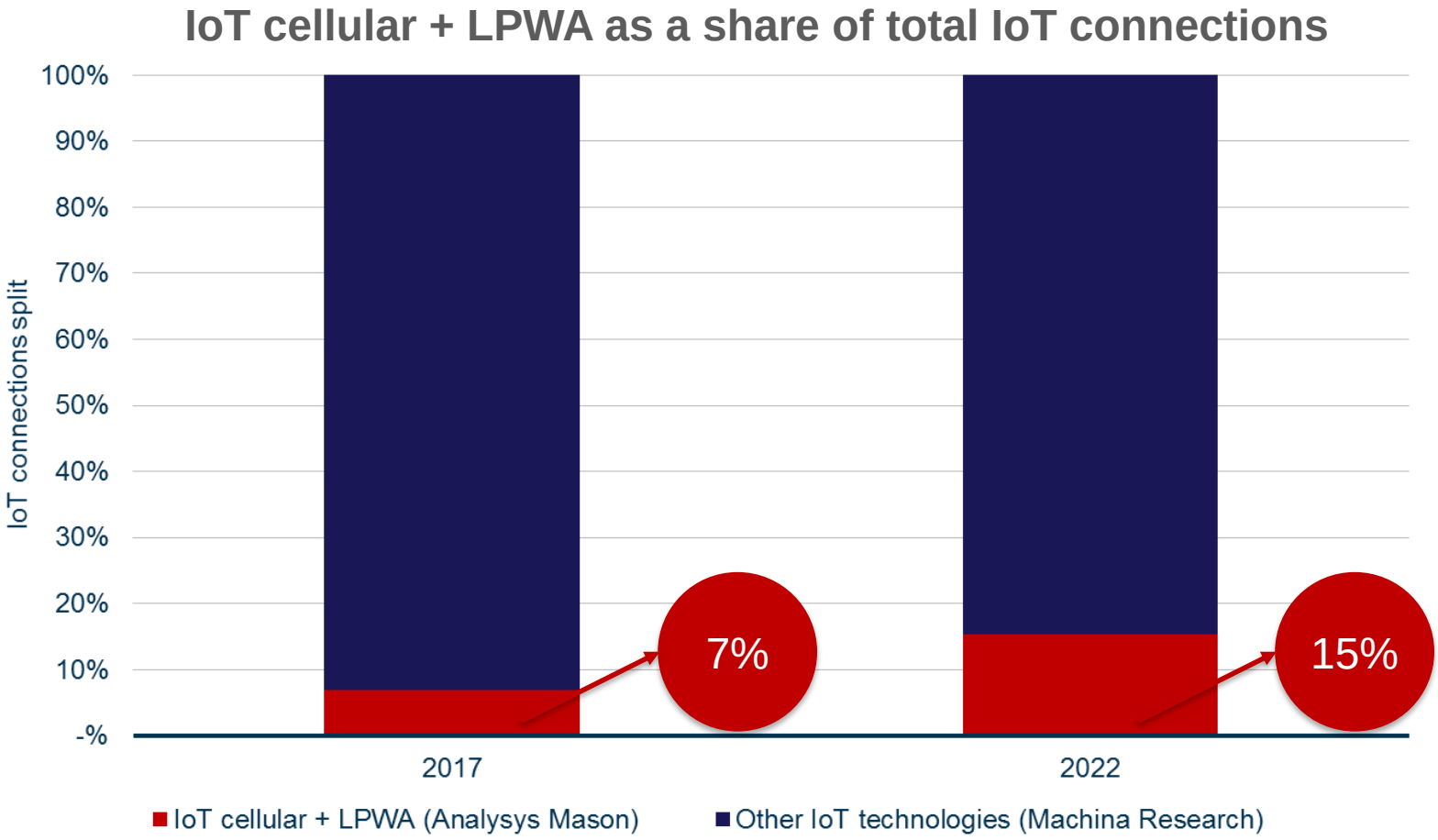
1. IoT is still a nascent industry and is expected to grow at a fast pace
2. Cellular-connect IoT accounts for a very small share of the total IoT market
3. There are many socio-economic benefits that IoT solutions can deliver

IoT connections



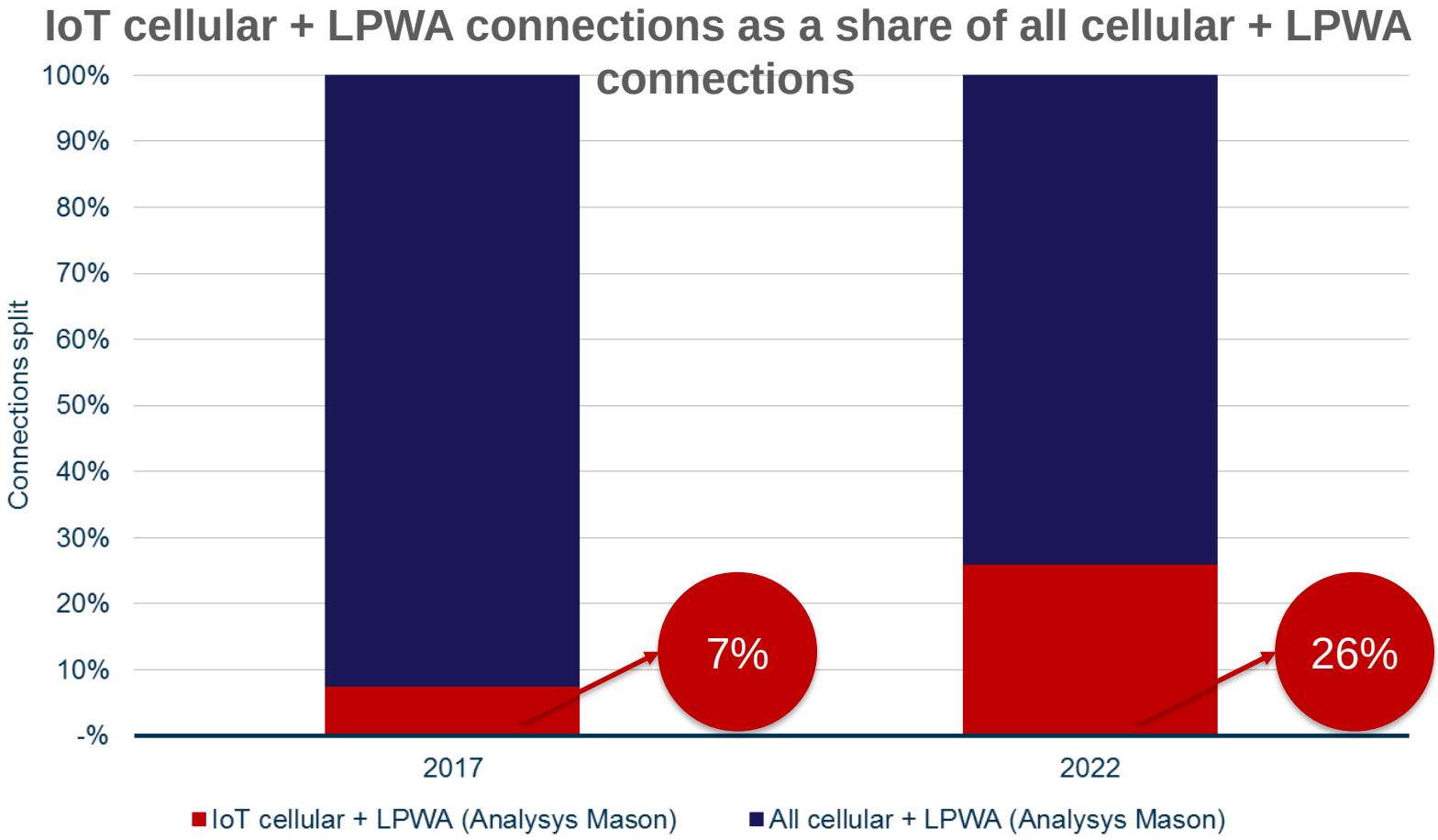
** Gartner did not report forecasts for 2022*

IoT cellular and LPWA connections



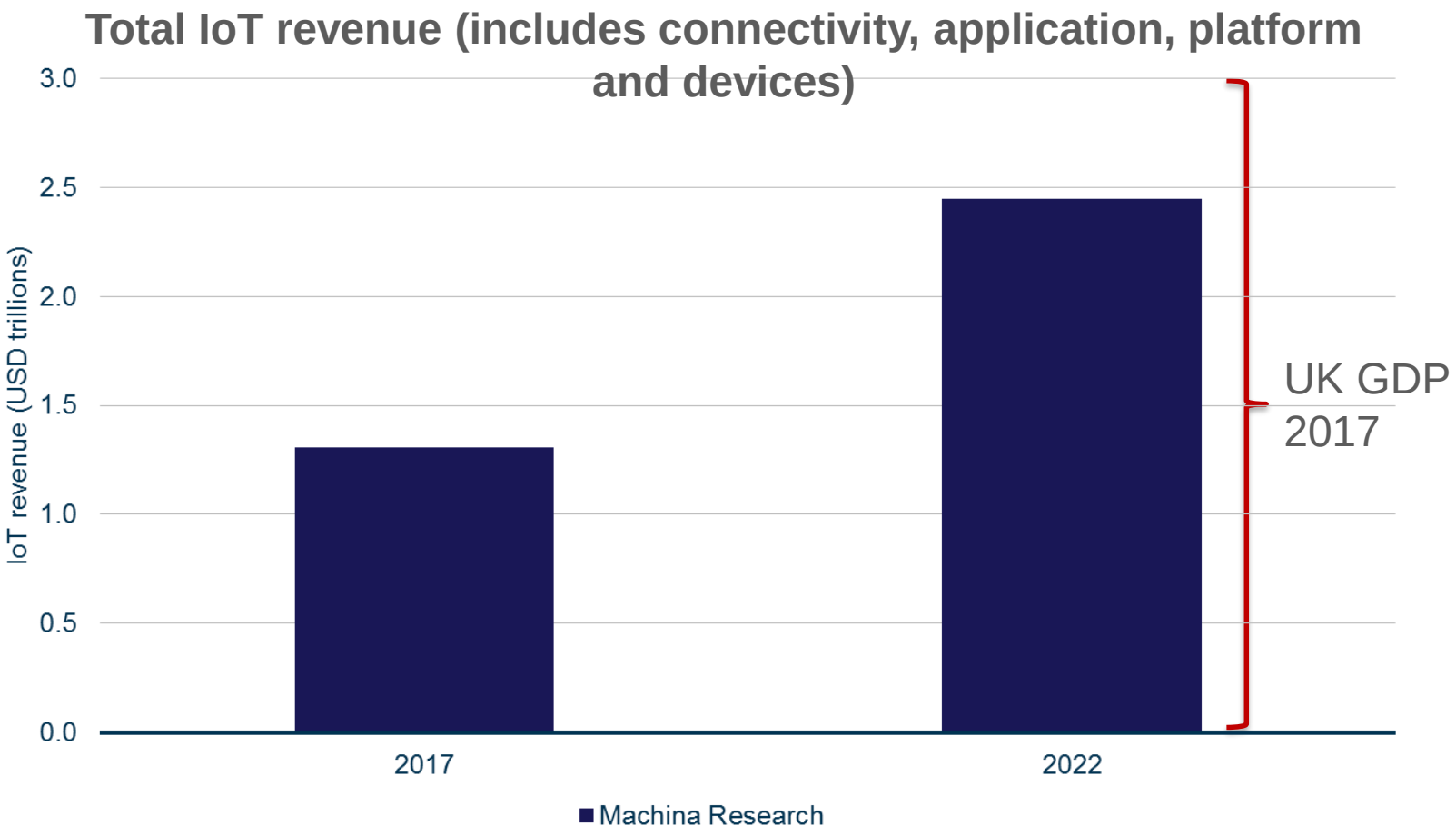
Source: Analysys Mason

IoT cellular and LPWA connections

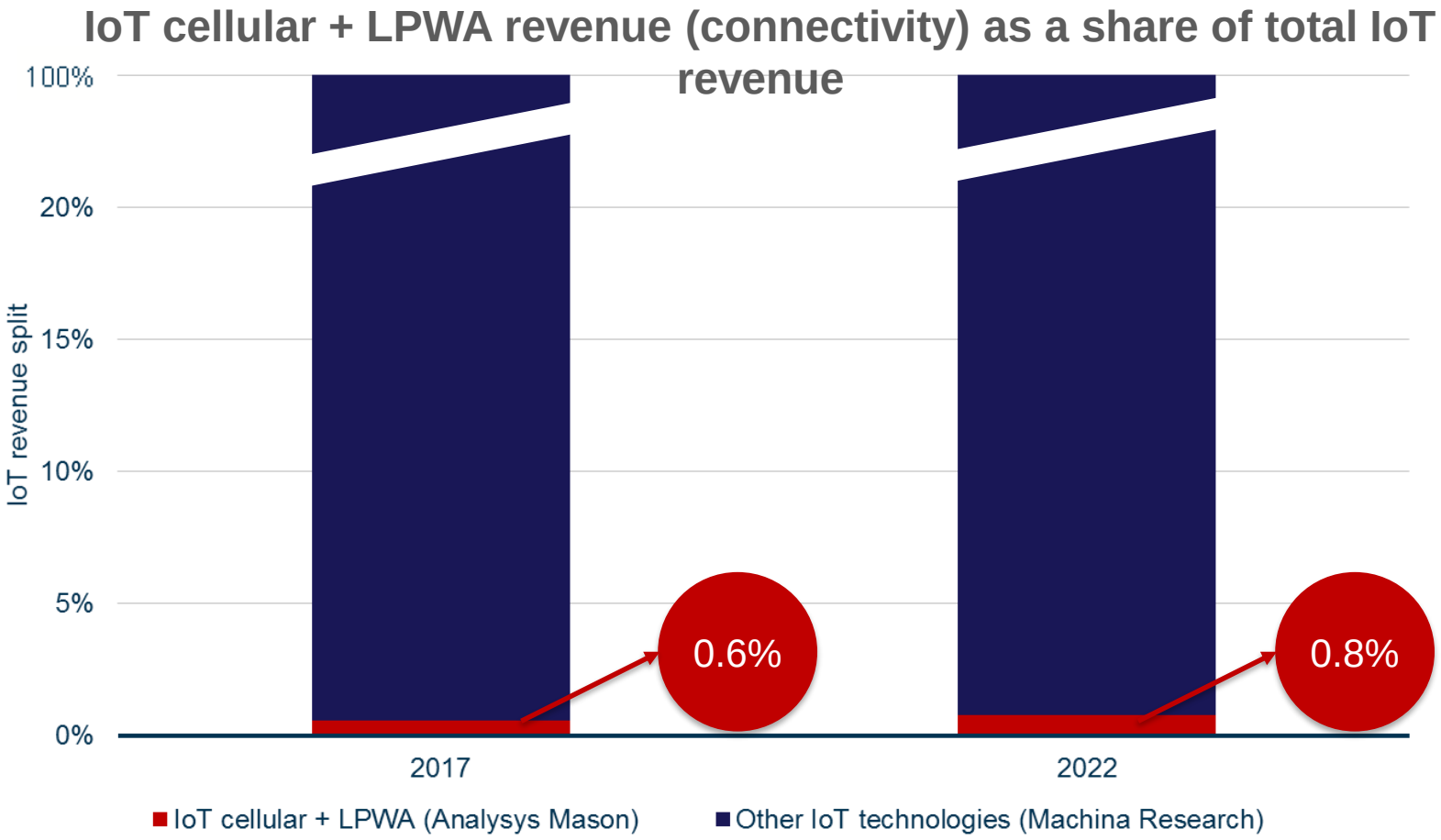


Source: Analysys Mason

IoT revenues

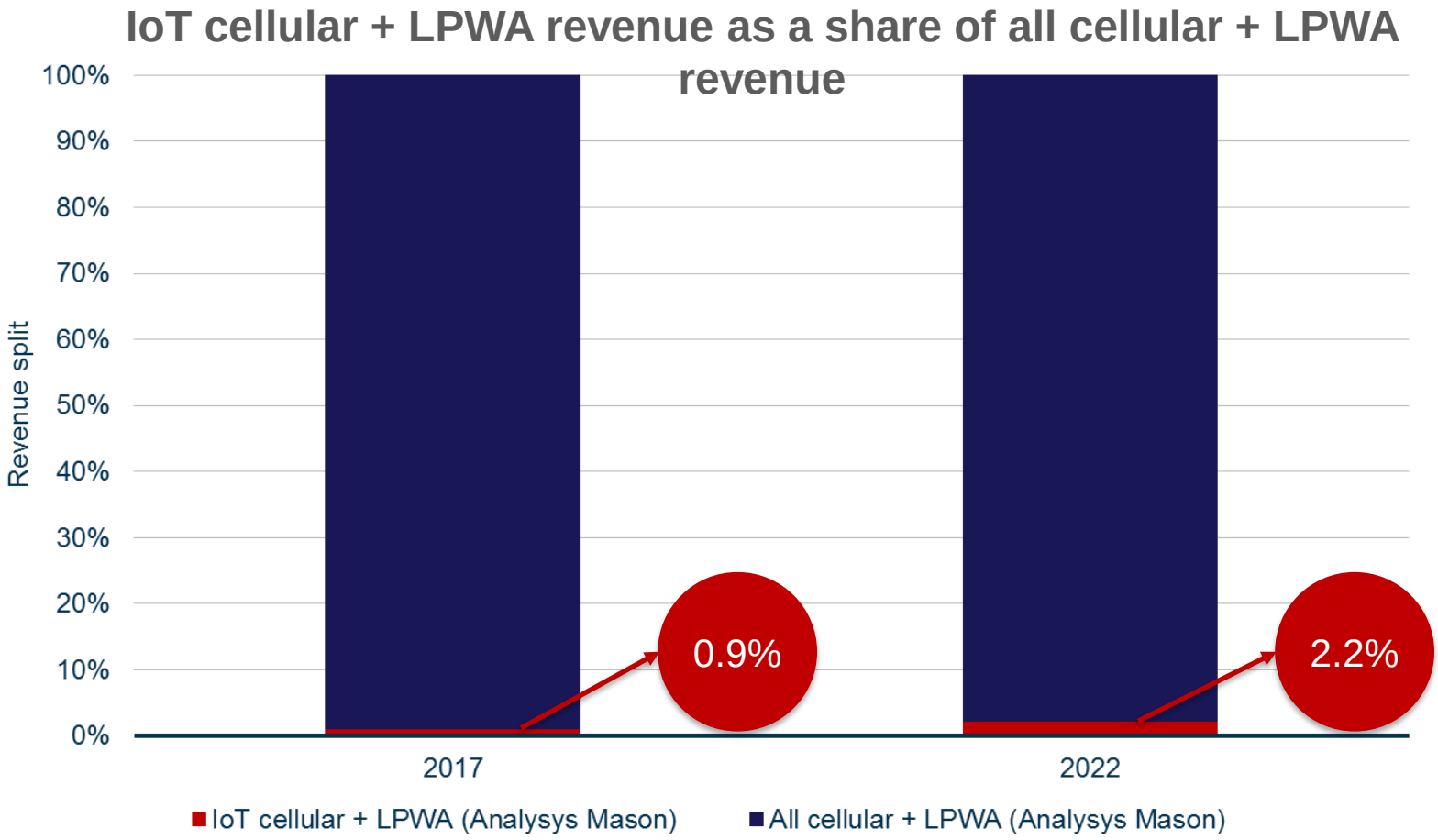


IoT cellular and LPWA revenues



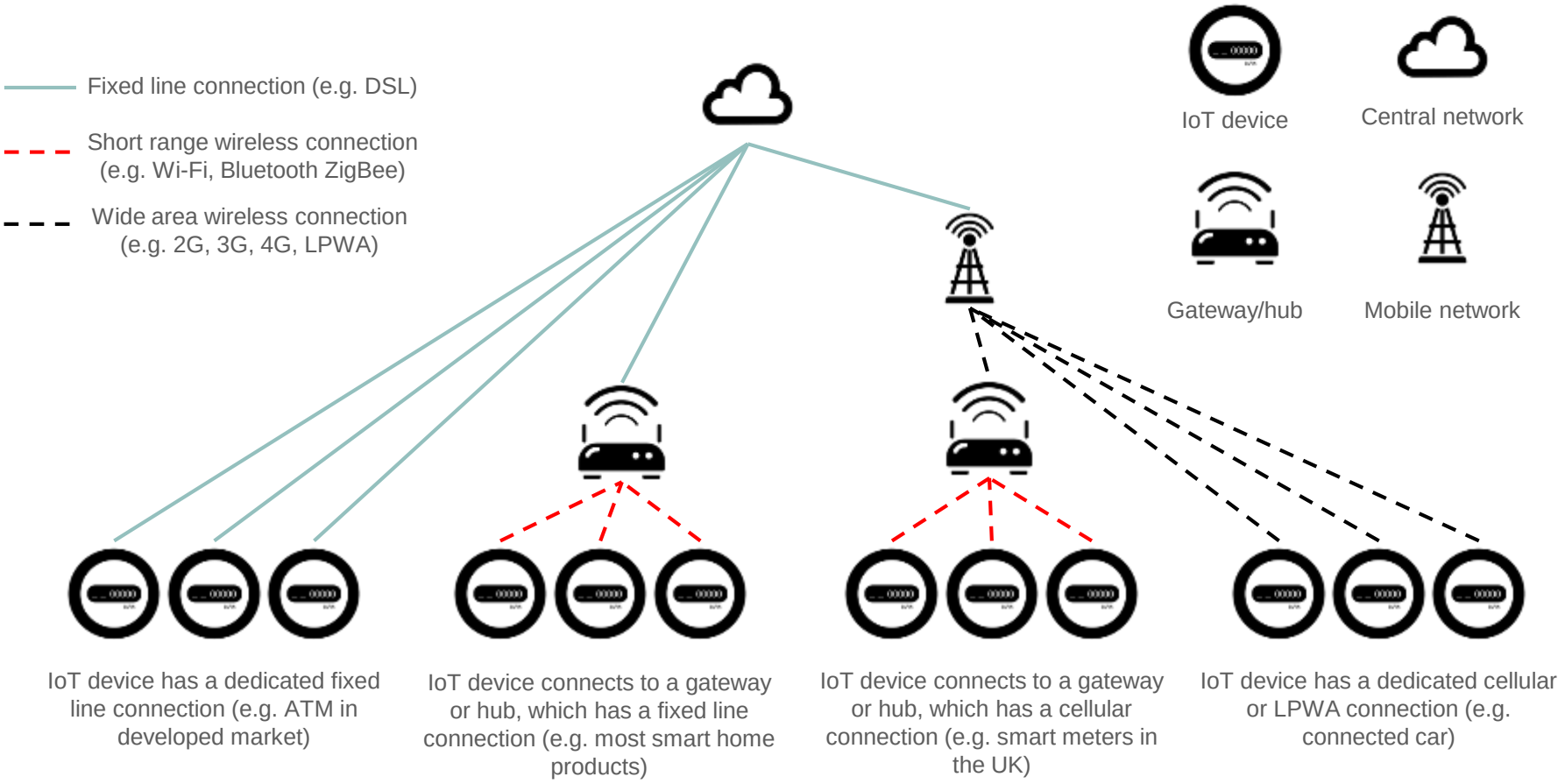
Source: Analysys Mason

IoT cellular and LPWA revenues



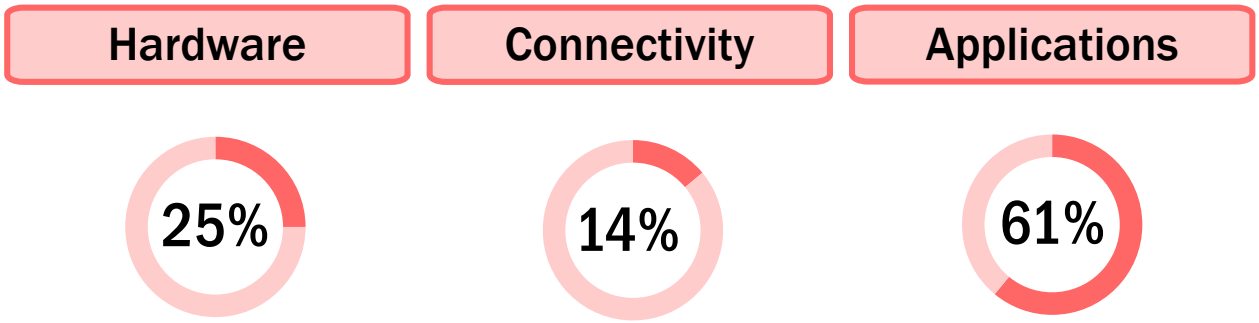
Source: Analysys Mason

There are many configurations for IoT solutions



Even for solutions using mobile networks, connectivity is only a small share of revenue

Revenue for IoT services using cellular and LPWA connectivity, by value chain element



Source: Analysys Mason

Socio-economic benefits of IoT

Social benefits

- 1 in 9 lives saved in road accidents - GSMA
- $400 billion savings in healthcare in 2017 - GSMA
- 400 million extra people fed by avoiding food wastage - GSMA
- $20 billion from traffic optimisation - PWC

Economic benefits

- Between $3.9tn and $11.1tn of economic impact by 2025 - Mckinsey
- $14.4 trillion in higher revenue and lower cost - Cisco
- Annual global savings of over $5.6tn with semi-autonomous and autonomous cars – Morgan Stanley

Summary: 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

Technologies related to IoT networks

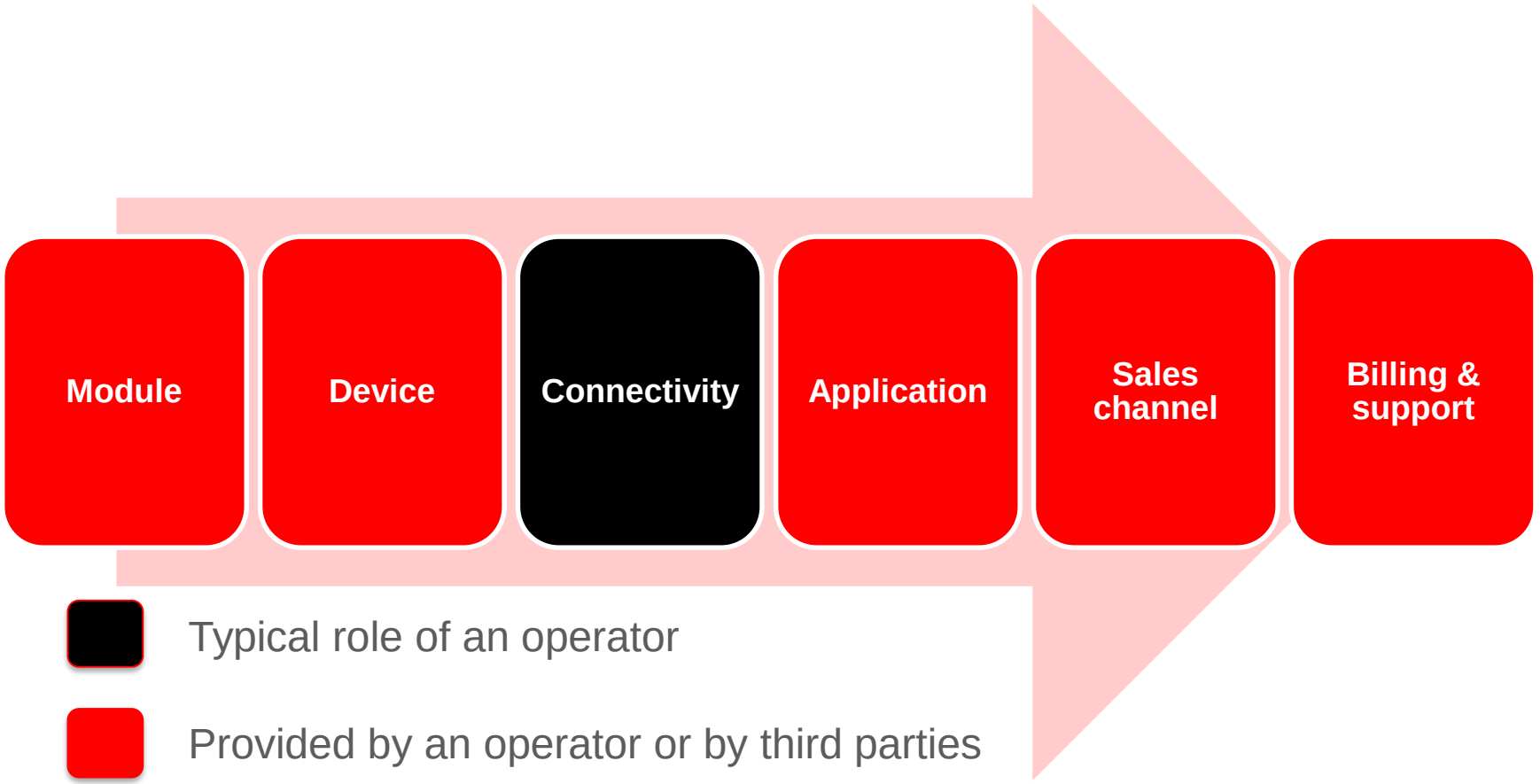
- Value chain and connectivity technologies
- Exercise: Which technology for which IoT solution?
- Spectrum and policy implications

Technology: value chain and connectivity technologies

Key messages

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

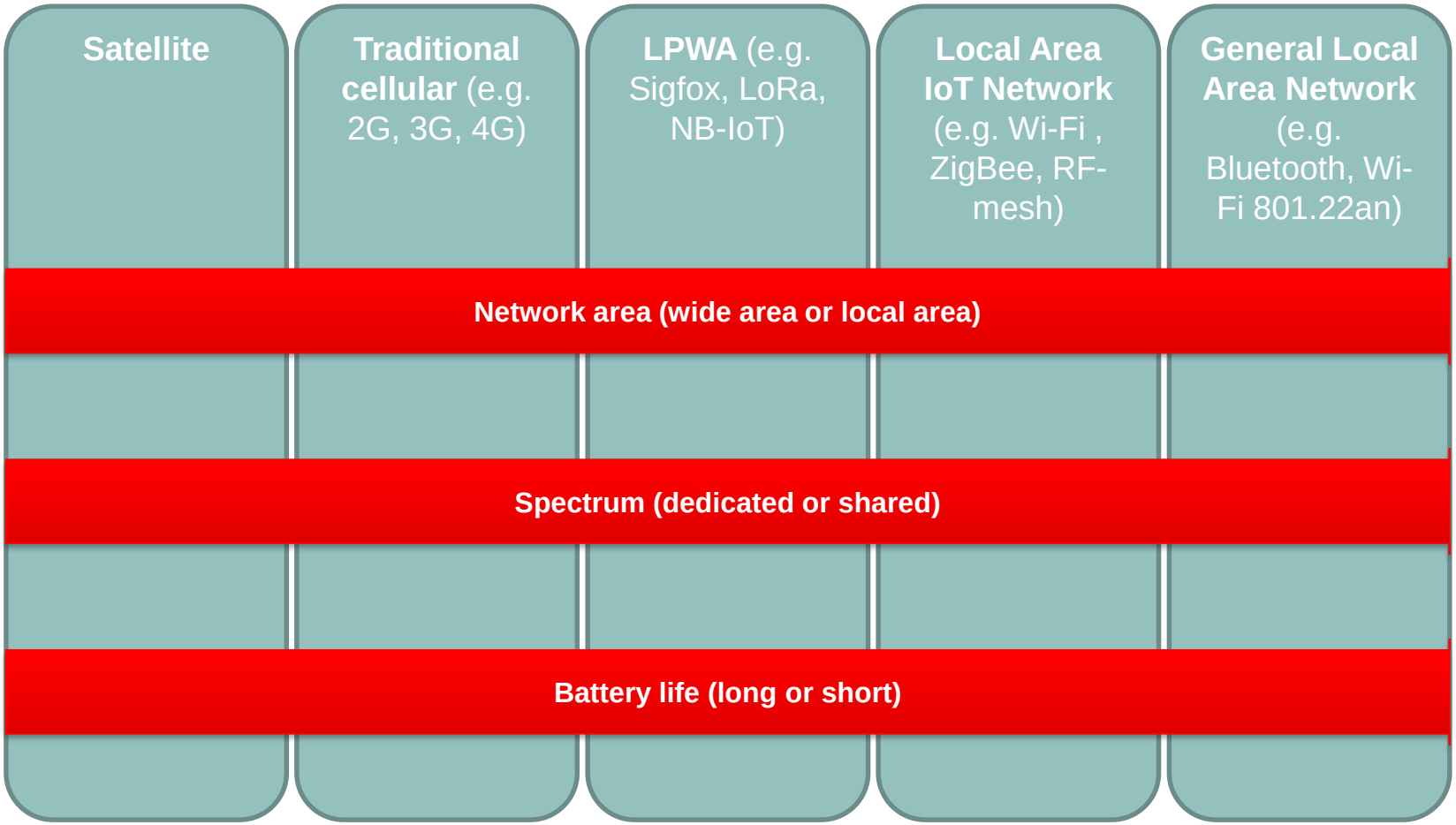
The basic IoT value chain



Key characteristics of IoT networks

Satellite	**Traditional cellular** (e.g. 2G, 3G, 4G)	**LPWA** (e.g. Sigfox, LoRa, NB-IoT)	**Local Area IoT Network** (e.g. Wi-Fi , ZigBee, RF-mesh)	**General Local Area Network** (e.g. Bluetooth, Wi-Fi 801.22an)

Technology group dimensions



Technology group dimensions

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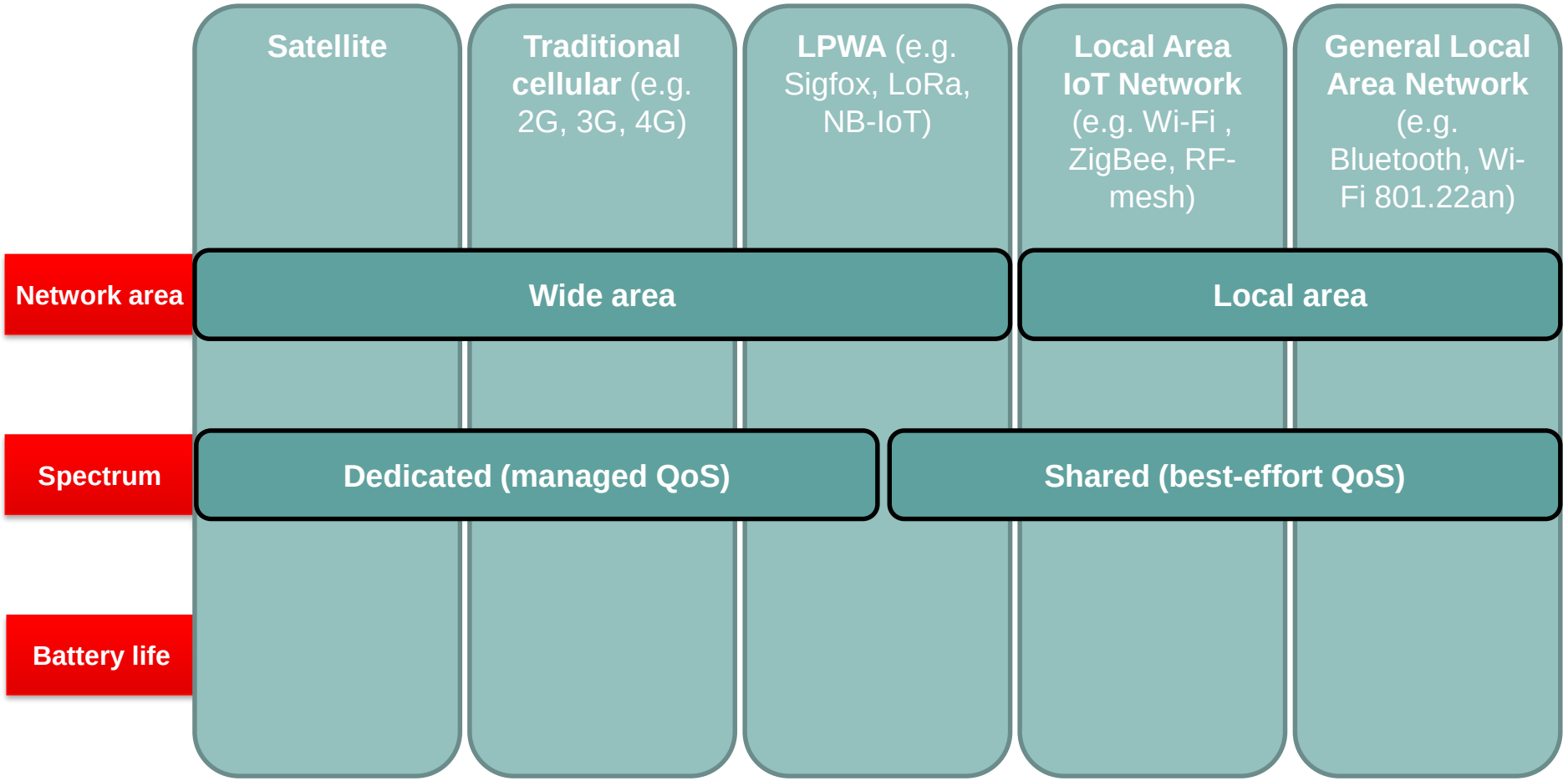
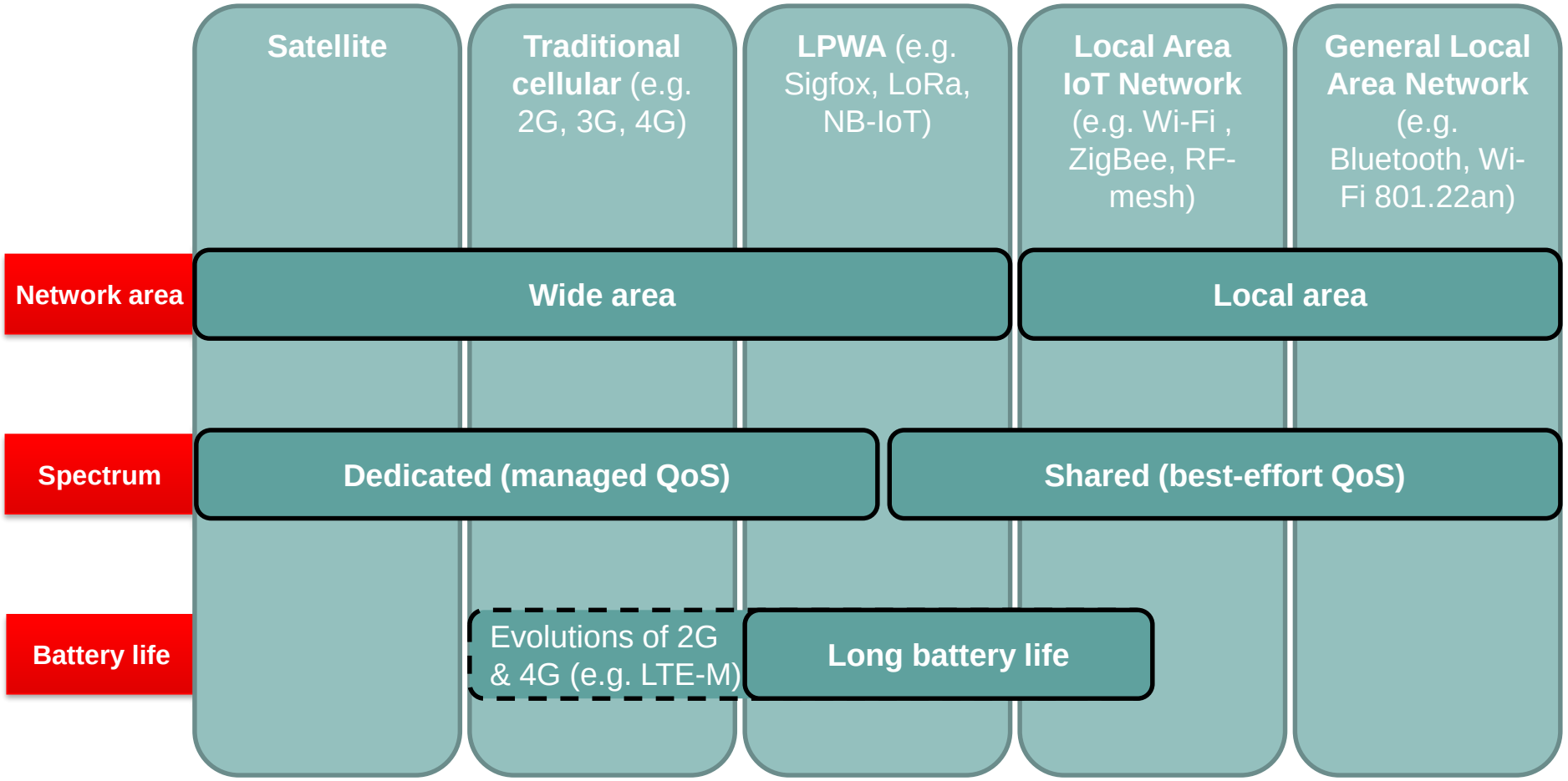
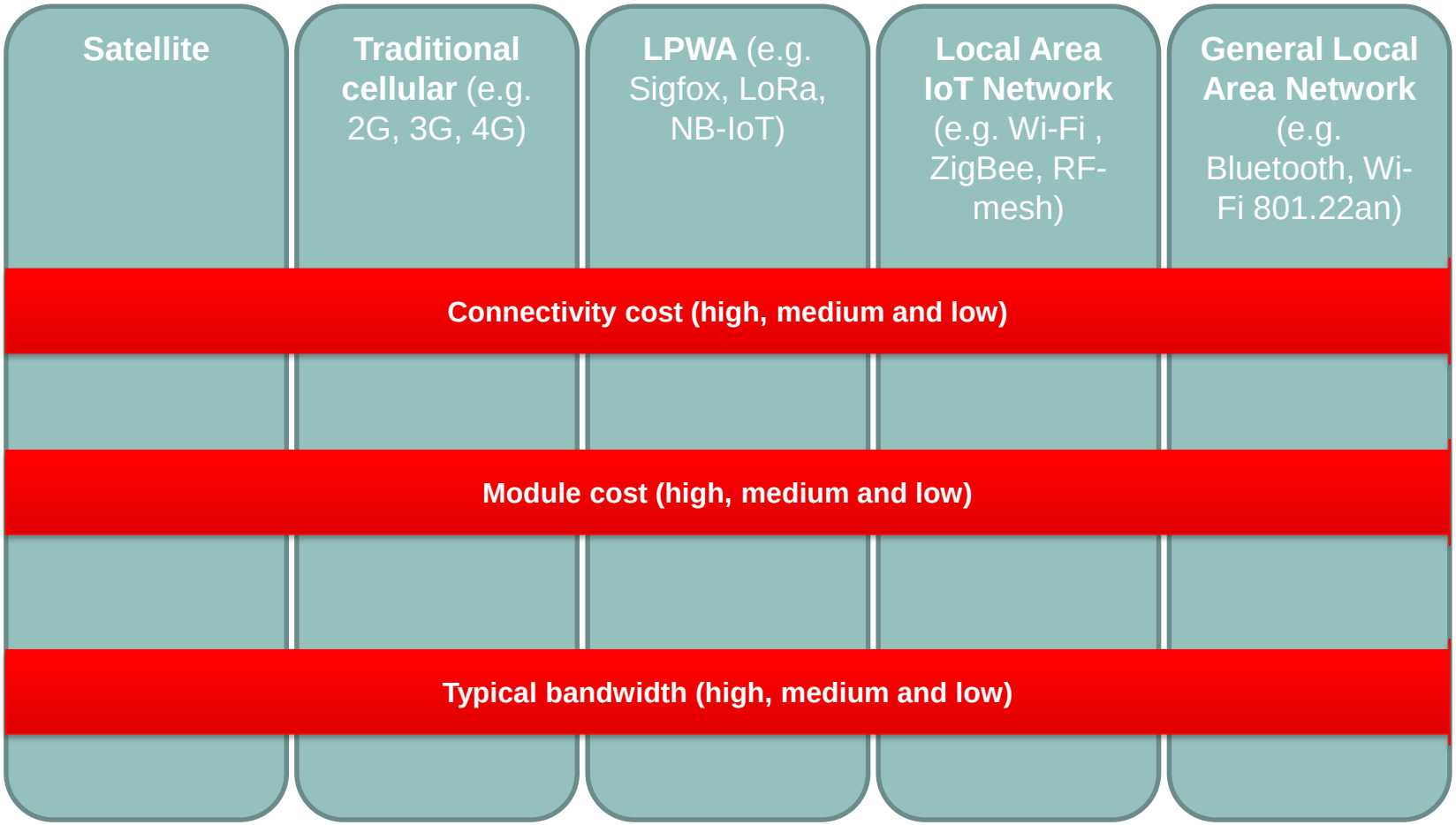


Technology group dimensions

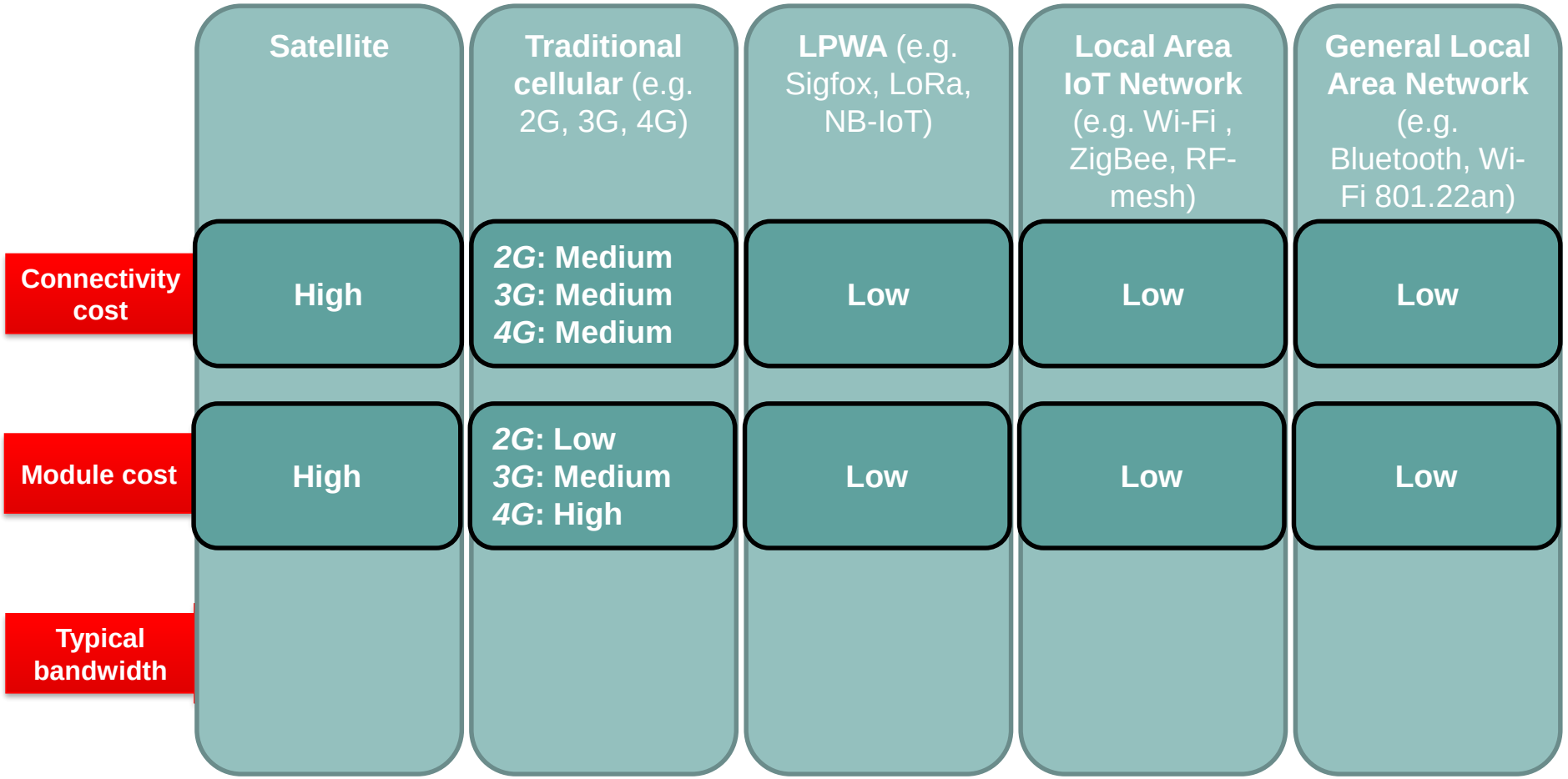


Technology specific dimensions



Technology specific dimensions

Technology specific dimensions



Technology specific dimensions

	Satellite	Traditional cellular (e.g. 2G, 3G, 4G)	LPWA (e.g. Sigfox, LoRa, NB-IoT)	Local Area IoT Network (e.g. Wi-Fi , ZigBee, RF-mesh)	General Local Area Network (e.g. Bluetooth, Wi-Fi 801.22an)
Connectivity cost	High	*2G*: Medium *3G*: Medium *4G*: Medium	Low	Low	Low
Module cost	High	*2G*: Low *3G*: Medium *4G*: High	Low	Low	Low
Typical bandwidth	Low to high	*2G*: Low *3G*: Medium *4G*: High	Low	*ZigBee*: Low RF-mesh: Low *Wi-Fi*: High	*Bluetooth*: Low *Wi-Fi 801.22an* : High

Summary: value chain and connectivity technologies

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

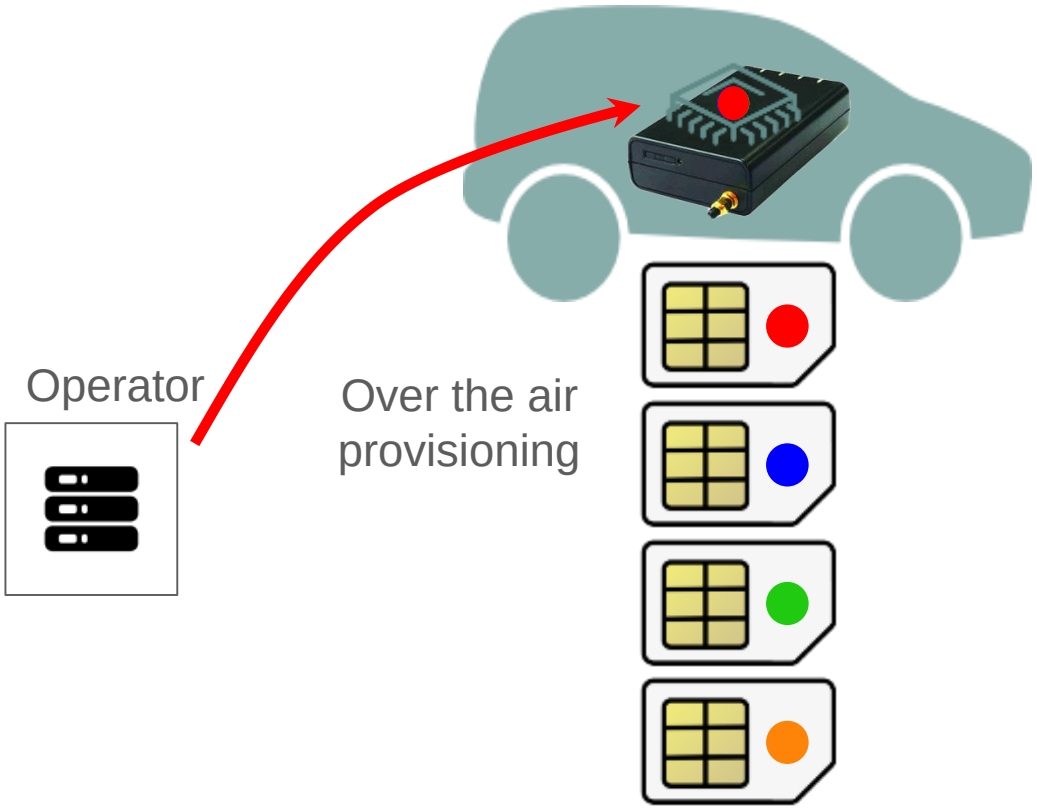
Technology: Remote SIM provisioning for Machine-to-Machine devices

Key messages

1. Remote ‘over the air’ provisioning of M2M devices
2. Promotes a common, global and interoperable remote provisioning architecture

The GSMA remote SIM provisioning for Machine-to-Machine (M2M) specification

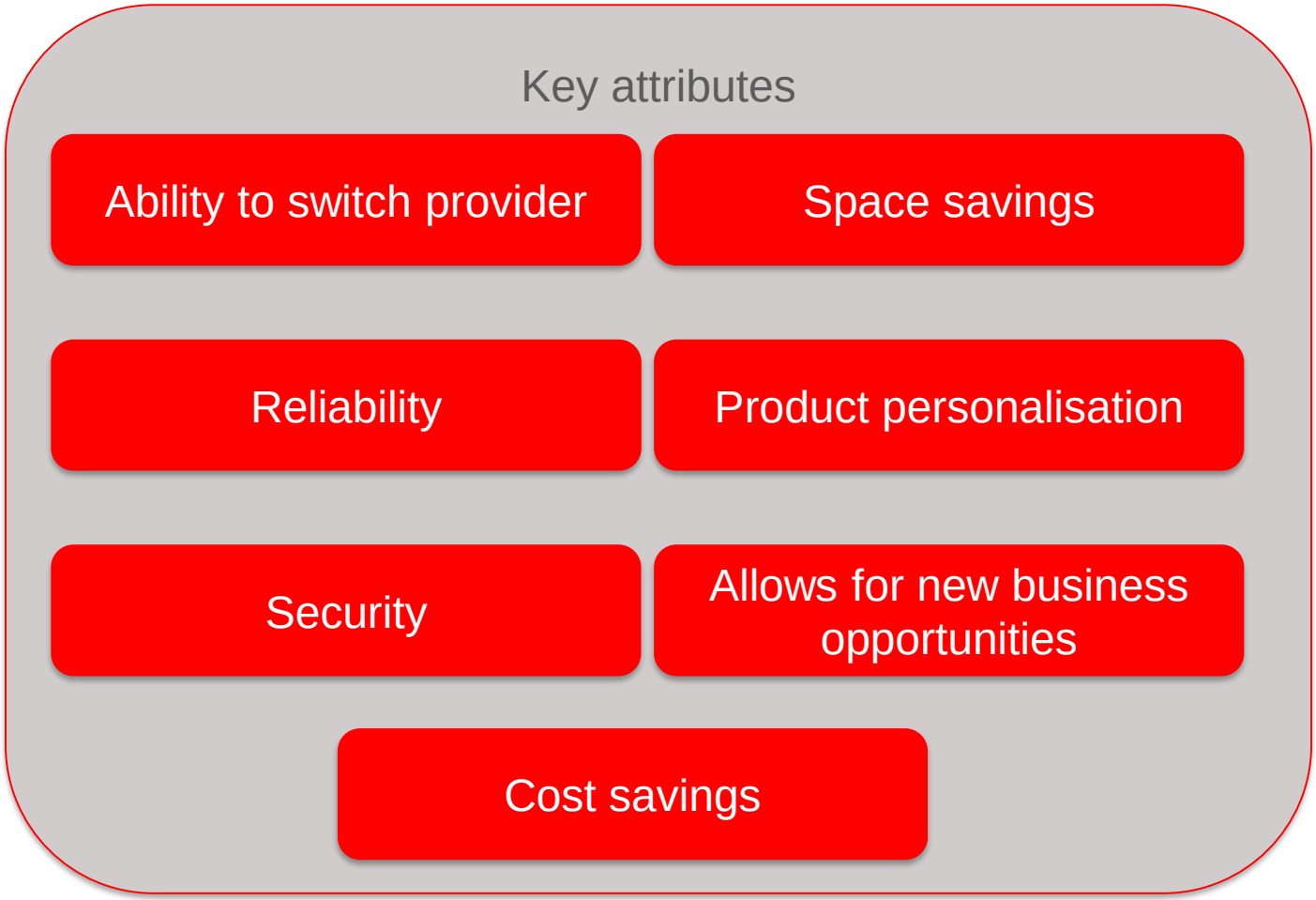
Specification for remote provisioning of SIM cards



Advantages

- Provides a global product for a global manufacturing process.
- Local provisioning when the product is deployed in the field.
- Solves the challenge of managing remotely located devices in the field
- Many of the interfaces and processes for SIM personalisation are virtually identical to current processes

Remote SIM Provisioning for M2M



Broad industry support

- 22 operators have launched remote SIM provisioning for M2M and 5 major automotive manufacturers endorse the technology

AUTOMOTIVE INDUSTRY ADOPTS GSMA EMBEDDED SIM SPECIFICATION TO ACCELERATE CONNECTED CAR MARKET

February 10, 2016 | Press Release

General Motors, Jaguar Land Rover, Renault Nissan, Scania and Volvo Cars Support Specification for Delivery of Range of Connected Vehicle Services; 22 Live Operator Solutions Now Commercially Available

Summary: Remote SIM provisioning for M2M

1	Remote ‘over the air’ provisioning of M2M devices
2	Promotes a common, global and interoperable remote provisioning architecture to reduce costs, boost security and accelerate the rapidly growing M2M market

Technology: spectrum

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

Spectrum harmonisation can help the IoT market grow faster

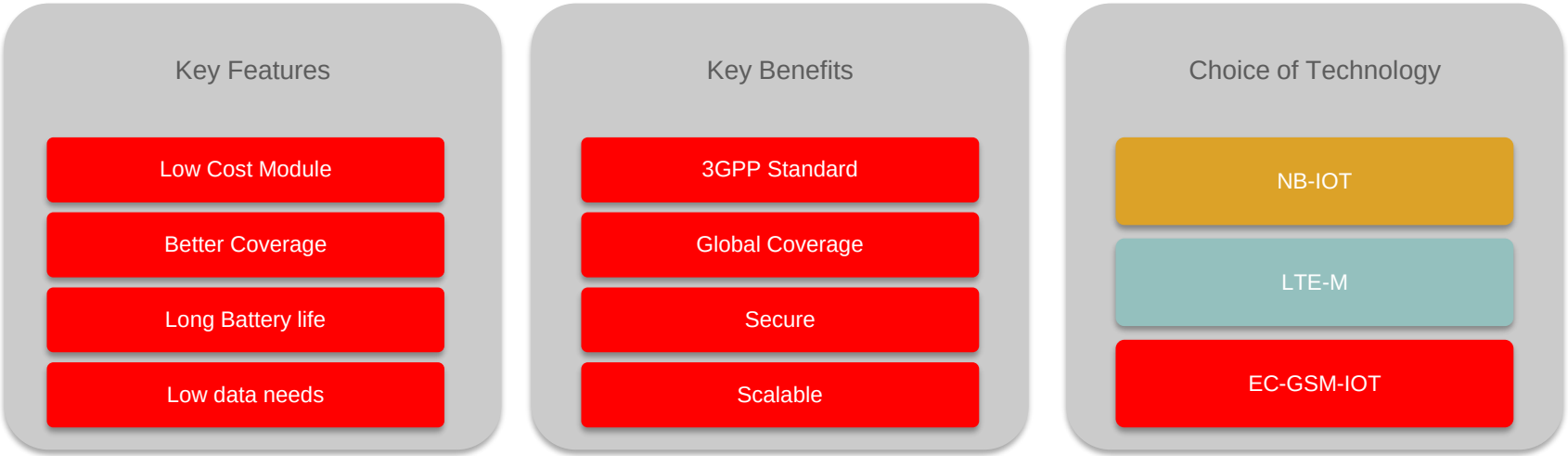
Benefit of harmonisation	Acts as a driver for IoT market growth through lower cost of modules
Industry players' role	Identify which bands are to be harmonised
Holistic approach	Harmonisation needs to consider the spectrum requirement of different IoT applications

Comparison of licensed and unlicensed IoT technologies

Name	LoRa	Sigfox	LTE-M	LTE NB-IoT	EC-GSM-IoT
Description	Uses spread-spectrum technology and is optimised for long battery life.	Uses Ultra Narrow Band technology to deliver long battery life and low data-transfer speeds	Offers the broadest range of cellular IoT capabilities	Scalable, ultra low-end cellular IoT with deep indoor coverage	Builds on legacy GPRS, offering improved battery life, wider coverage
Spectrum	Unlicensed	Unlicensed	Licensed	Licensed	Licensed
Deployment	ISM bands	ISM bands	In-band LTE	In-band & Guard-band LTE, standalone	In-band GSM
Bands	868/ 902-928Mhz	868/915 MHz	LTE bands 1, 2, 3, 5, 7, 8, 11,12, 13, 17, 18, 19, 20, 21,	LTE bands 1, 2, 3, 5, 8, 12, 13, 17, 18, 19, 20, 26, 28, 66	Available for all GSM bands
Standard Org.	LoRa Alliance	ETSI*	3GPP	3GPP	3GPP
Coverage	153-161 dB	149-161 dB	155.7 dB (23 dBm power class) **	164 dB for standalone (23 dBm power class) *	164 dB with 33dBm power class, 154 dB with 23dBm power class
Max. Data Rate	50 kbps	100 bps	1 Mbps	~240kbps	~250 kbps

* Currently seeking standardisation via the ETSI Low Throughput Networks group

Mobile IoT: 3GPP standardised technologies for licensed mobile spectrum

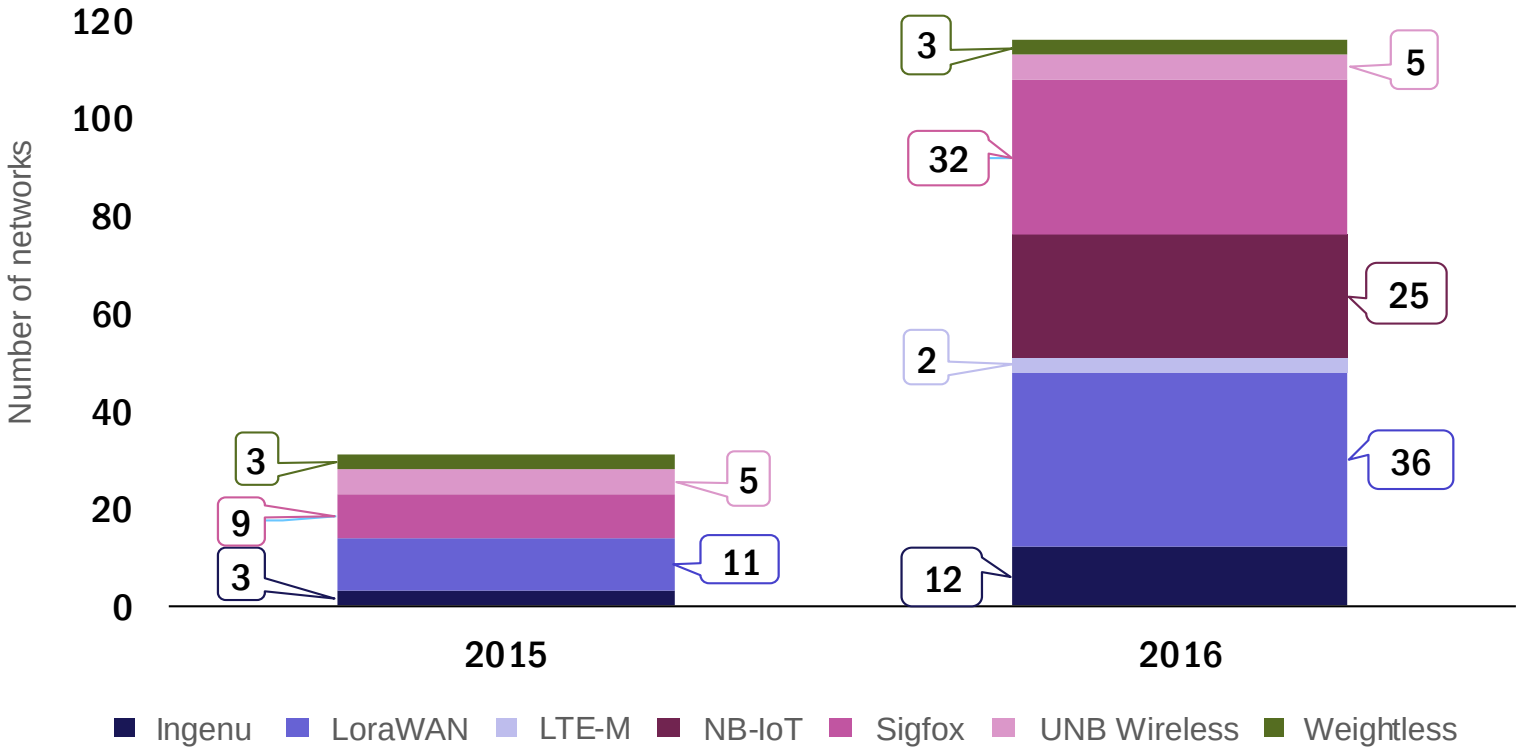


Part of 3GPP Release 13 (June'2016)

NB-IoT	• Narrow Band – IoT (LTE NB 1)
LTE-M	• Long Term Evolution for Machines (also known as Cat M1)
EC-GSM-IoT	• Extended Coverage GSM IoT

LPWA announcements increased significantly in 2016

Active (deployed) or planned LPWA networks, 2015 and 2016



Source: Analsys Mason

Matching applications to technologies

- Split into groups
- In the next slides you will be presented with eight applications
- Describe the applications in terms of the six dimensions previously presented and then identify the connectivity solutions that you think could best suit the needs of the application

Activity

Smart washing machine

Smart t-shirt

Smart oil field

Smart water pump

eHealth

HD surveillance camera

Smart parking sensors

Fleet tracking system

Activity

Sensors monitor operating parameters, such as temperature and pressure

Smart oil field

Informs if pump is damaged

Smart water pump

Can record heart rate, GPS location, route, speed and altitude; data is sent to mobile phone

Smart t-shirt

Smart washing machine

Washing machine that can be controlled via a mobile app

Drivers can see where spaces are available

Smart parking sensor

eHealth

Sends patient data

HD surveillance camera

Sends out video accessible via a mobile app

Monitors fleet location and driving habits

Fleet tracking system

Exercise template [1/2]

Application requirement	Smart washing machine	Smart t-shirt	eHealth	Smart oil field
Network Area	▪ Wide ▪ **Local**	▪ Wide ▪ Local	▪ Wide ▪ Local	▪ Wide ▪ Local
Spectrum	▪ Dedicated ▪ **Shared**	▪ Dedicated ▪ Shared	▪ Dedicated ▪ Shared	▪ Dedicated ▪ Shared
Battery life	▪ Long ▪ Short ▪ **N/A**	▪ Long ▪ Short ▪ N/A	▪ Long ▪ Short ▪ N/A	▪ Long ▪ Short ▪ N/A
Connectivity cost	▪ High ▪ Medium ▪ **Low**	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Module cost	▪ High ▪ Medium ▪ **Low**	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Bandwidth	▪ High ▪ **Medium** ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Connectivity technology?	**Wi-Fi**			

Exercise template [2/2]

Application requirement	Smart water pump	Surveillance camera	Smart parking sensors	Fleet tracking
Network Area	▪ Wide ▪ Local	▪ Wide ▪ Local	▪ Wide ▪ Local	▪ Wide ▪ Local
Spectrum	▪ Dedicated ▪ Shared	▪ Dedicated ▪ Shared	▪ Dedicated ▪ Shared	▪ Dedicated ▪ Shared
Battery life	▪ Long ▪ Short ▪ N/A	▪ Long ▪ Short ▪ N/A	▪ Long ▪ Short ▪ N/A	▪ Long ▪ Short ▪ N/A
Connectivity cost	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Module cost	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Bandwidth	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low	▪ High ▪ Medium ▪ Low
Connectivity technology?				

Samsung WF457 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 Cityzen Sciences Smart D-Shirt

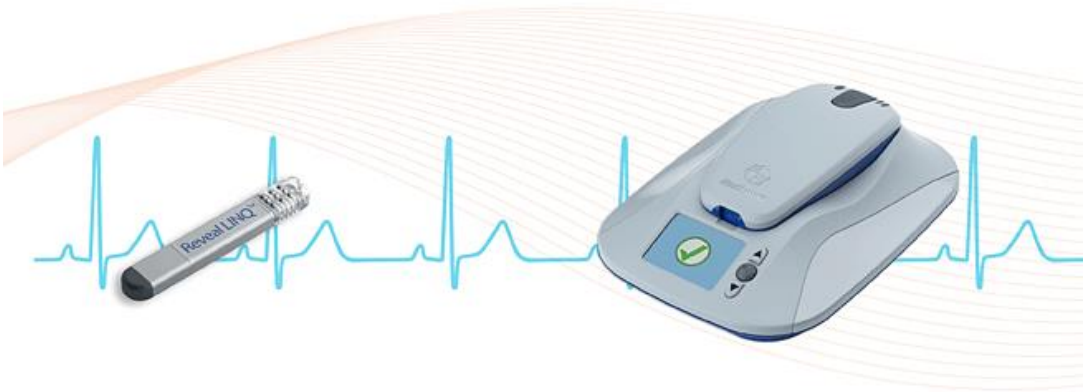
Feature	Requirement
Network Area	▪ Local
Spectrum	▪ Shared
Battery life	▪ Long
Connectivity cost	▪ Low (None)
Module cost	▪ Low
Bandwidth	▪ Low

Bluetooth

Other technologies: LPWA

eHealth Medtronic MyCareLink Monitor

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



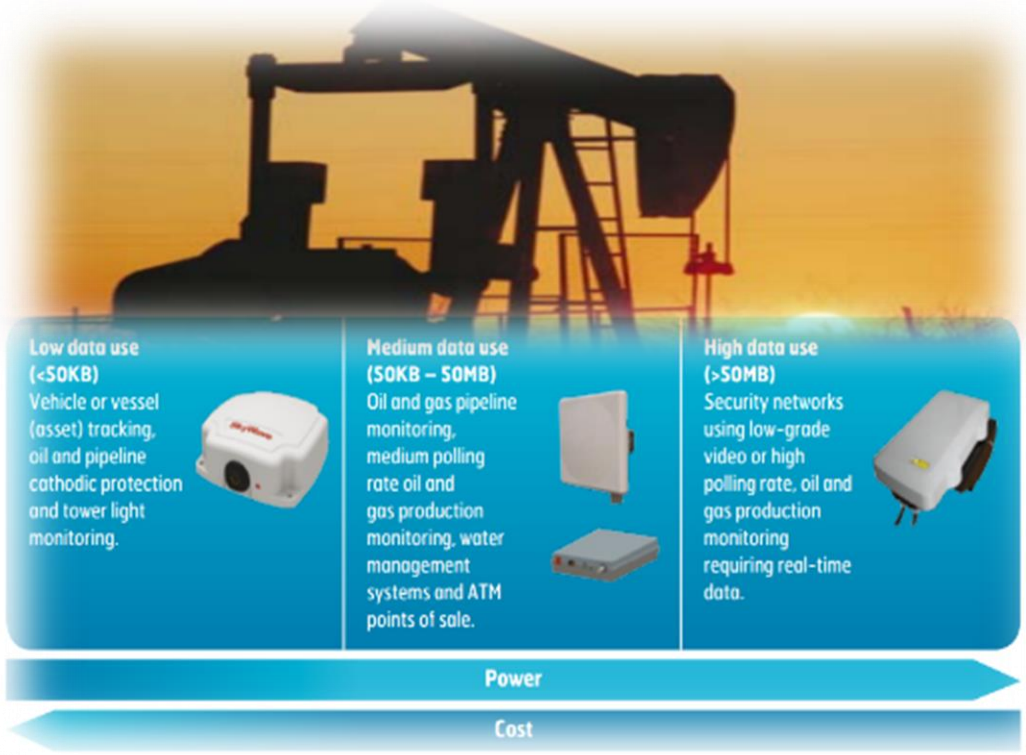
3G

Other technologies: 4G

Smart oil field Inmarsat SCADA network

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

Satellite



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

Smart water pump CellPump

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 Thinx 4G 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

Smart parking sensors from Libelium

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

LPWA

Other technologies: 2G, Wi-Fi

Fleet tracking Cloud Your Car

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

2G

Other technologies: 3G, LPWA

Exercise solution

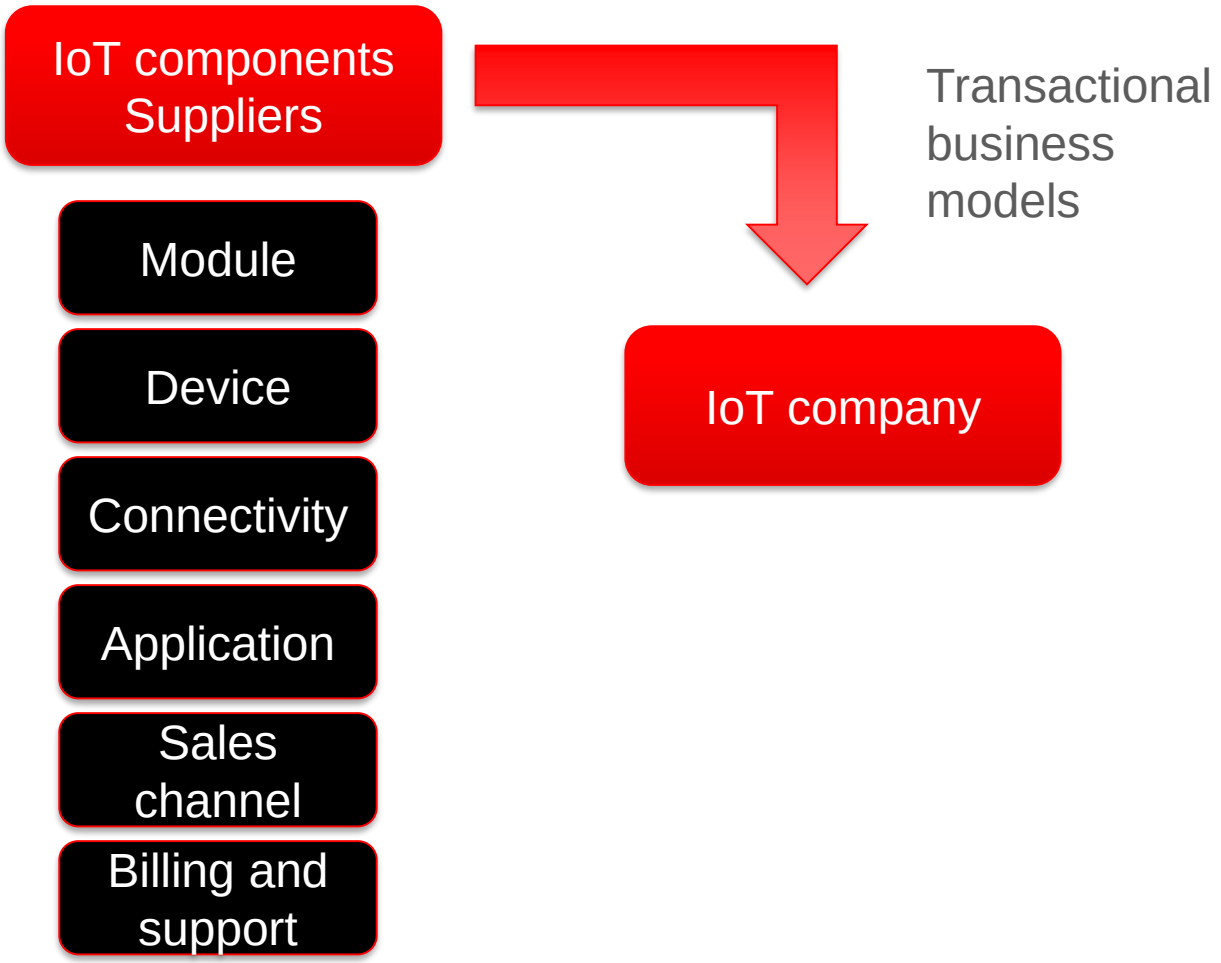
Application	Technology in example	Other possible technologies
Smart washer	Wi-Fi	2G, 3G
Smart t-shirt	Bluetooth	LPWA
eHealth	3G	4G
Smart oil field	Satellite	2G, 3G, 4G, LPWA
Electricity smart meter	RF-mesh	2G, LPWA
Surveillance camera	4G	3G, Wi-Fi
Smart parking sensors	LPWA	2G, Wi-Fi
Fleet tracking	2G	3G, LPWA

Business models of IoT

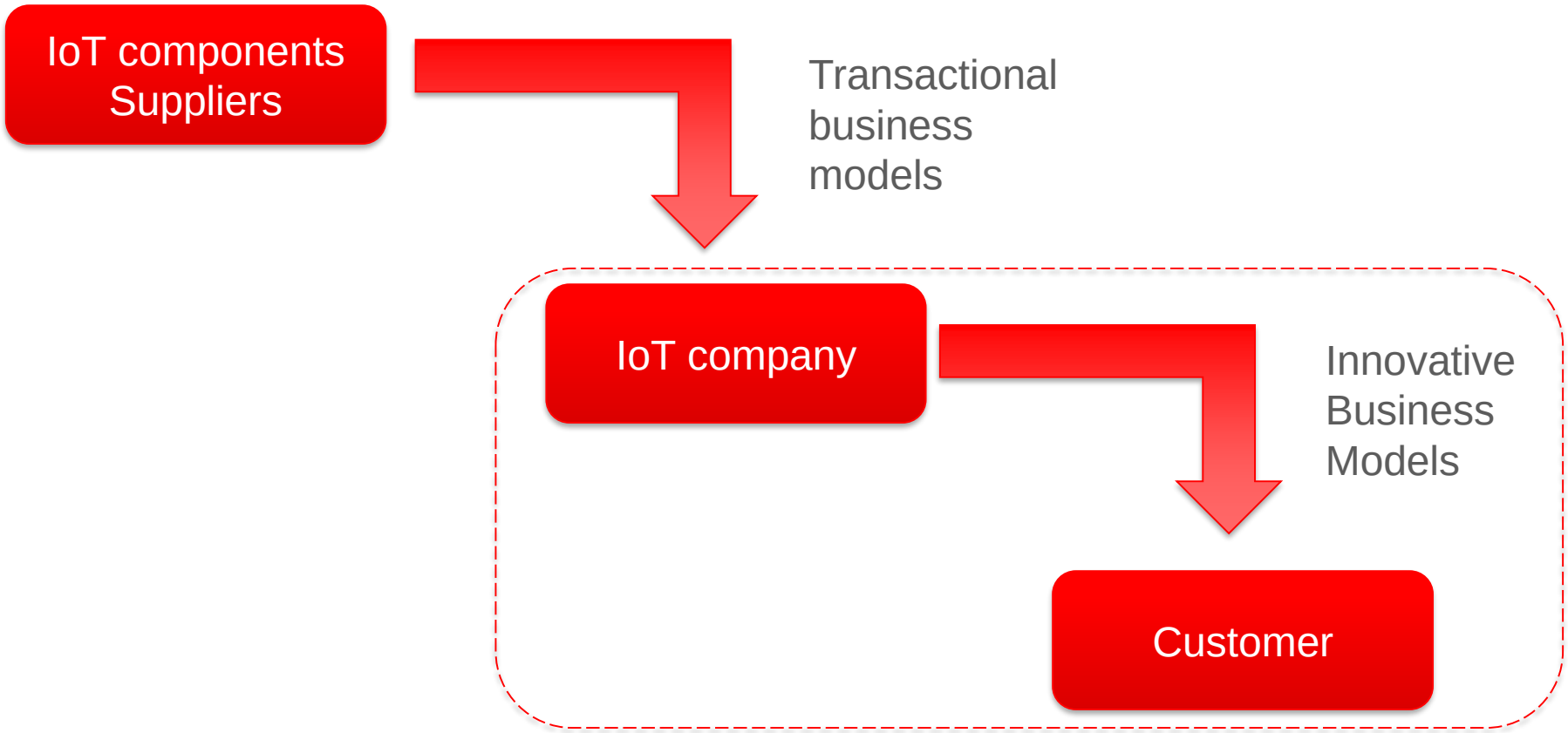
Key messages

1. IoT can provide significant innovation in business models
2. Business model innovation will mostly impact where the IoT company interacts with the customer

Business models of IoT: from suppliers to customer



Business models of IoT: from suppliers to customer



There are 5 main business models enabled by IoT between the IoT company and the customer …

Business models
Revenue-sharing
Cost-savings sharing
Product-sharing
Product-as-a-Service
Performance-as-a-Product
Transactional

Source: Analysys Mason

…and can be compared in terms of revenue structure and device ownership

Business models	Revenue of the IoT company			Device ownership	
	Upfront	Recurring	Usage	User	IoT company
Revenue-sharing		✓			✓
Cost-savings sharing		✓			✓
Product-sharing			✓		✓
Product-as-a-Service		✓			✓
Performance-as-a-Product			✓	✓	
Transactional	✓			✓	

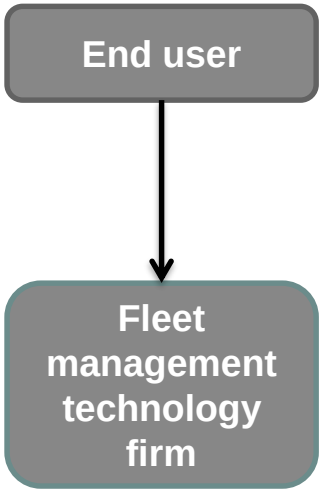
The descriptions above are the most common and variations are possible.
For example, transactional may also include device ownership from the IoT company.

Revenue-sharing

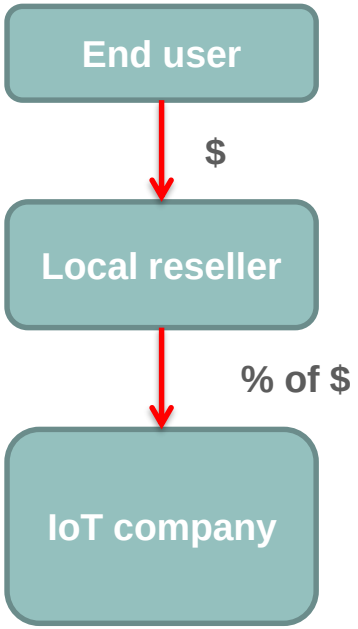
Problem	Tracking location and status of vehicles
Traditional solution	• Traditional fleet management solutions were static software packages that could not provide the fleet manager real time information on a vehicle's location or status
IoT solution	• A tracking device, like an on-board diagnostics (OBD-II) module, can be placed in the vehicle and provide the fleet manager with real time information
IoT business model	• A local reseller, like a mobile operator, sells and supports the solution. It shares revenues with the company providing the technology (hardware and software) for the service.

Revenue-sharing

Traditional business model



IoT business model



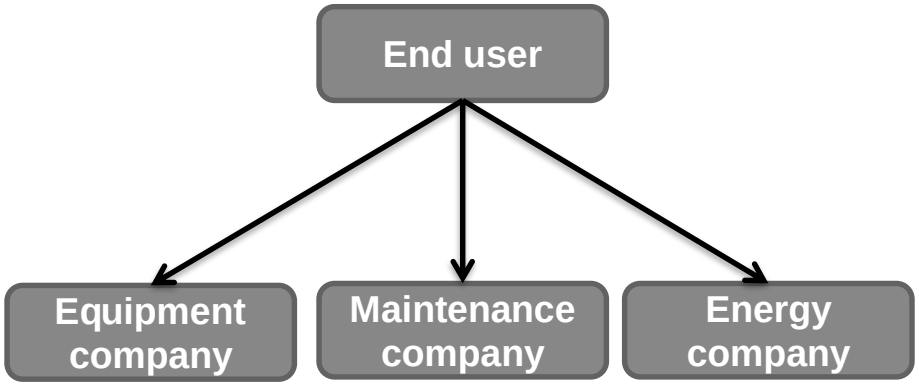
The revenue share model gives the local reseller access to a broader range of technology. For the fleet management firm, the model allows it to enter new countries. For both parties, the revenue share model limits risk.

Costs savings sharing

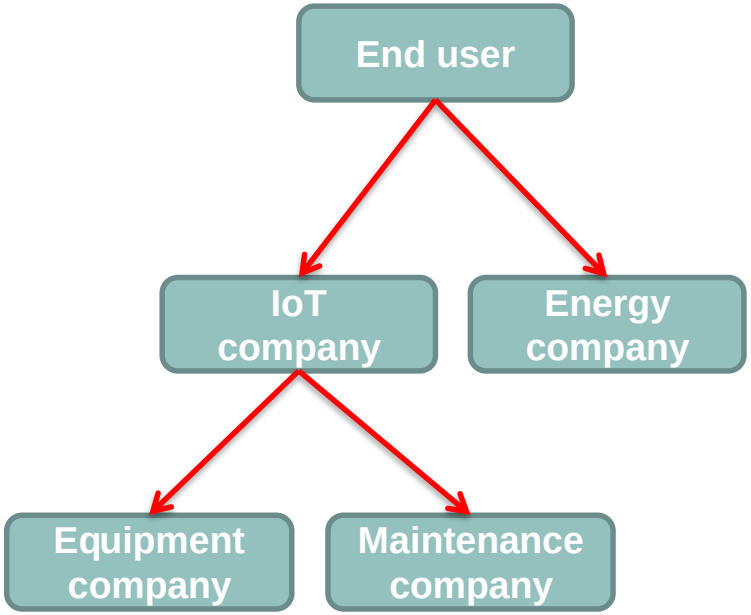
Problem	Home/building energy consumption.
Traditional solution	• The end user pays for the Heating, Ventilating and Air Conditioning (HVAC) system and its maintenance, and also pays the energy company for its power consumption.
IoT solution	• The IoT company installs equipment to monitor and control the HVAC system at the customer's premise. The HVAC system automatically adjusts to the user's requirements and optimises its energy consumption.
IoT business model	• The end user pays no up front fees; equipment costs are covered by the IoT company. • The end user benefits from lower energy costs. A share of the money saved goes to the IoT company to cover the cost of equipment.

Costs savings sharing

Traditional business model



IoT business model



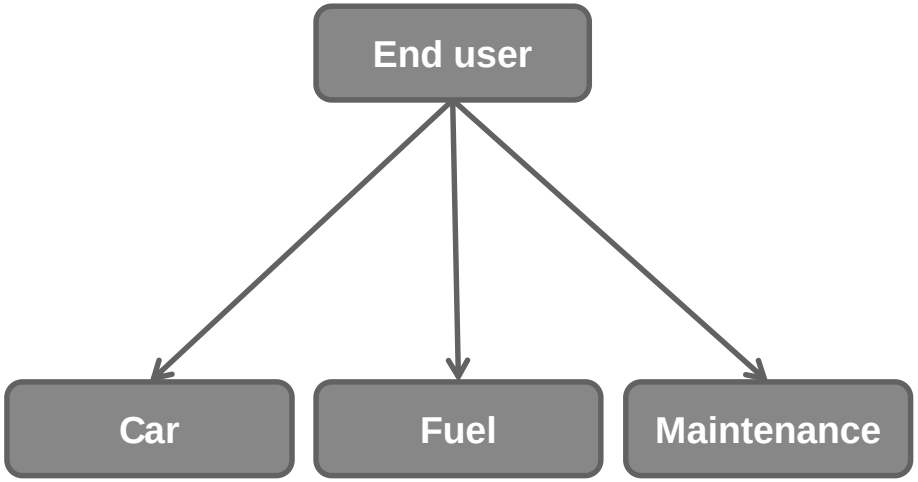
The IoT solution allows end users to save on their energy consumption costs and use part of the savings to pay for the IoT solution

Product-sharing

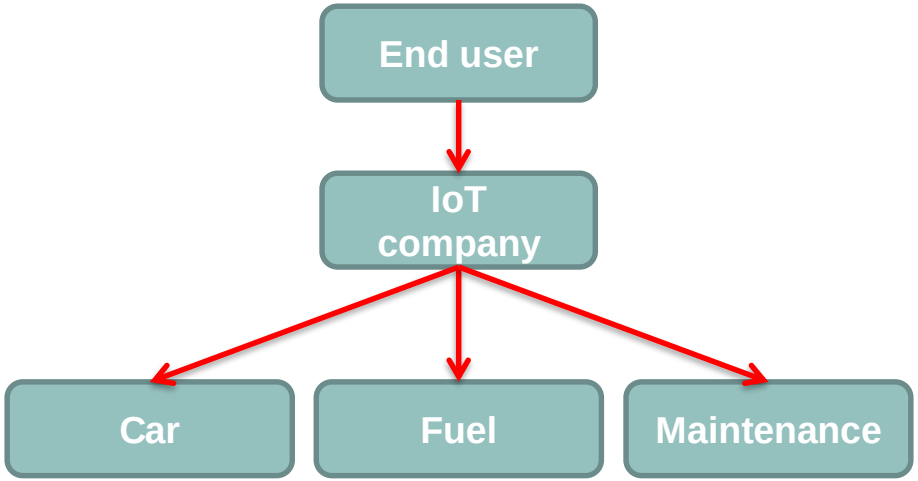
Problem	Relatively high investment and maintenance costs of a car.
Traditional solution	• The end user buys the car upfront and pays for its ongoing maintenance, fuel and insurance.
IoT solution	• The end user can drive a number of cars made available across a city, without needing to own one. • All car related costs are managed by the IoT company, Car2Go. A smartphone app, allows users to reserve the car, locate and unlock it.
IoT business model	• The IoT company charges end users by the minute for using a car. The fees include the cost of the car, its maintenance, fuel and insurance. • From managing a large fleet of vehicles, the IoT company can achieve economies of scale, which can be translated into competitive prices for the end user.

Product-sharing

Traditional business model



IoT business model



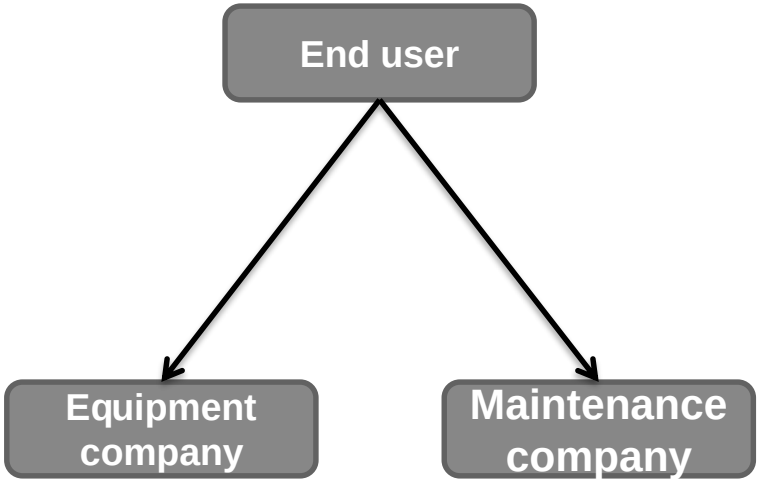
The IoT business model allows the IoT company to transfer savings from economies of scale to the end user

Product-as-a-Service

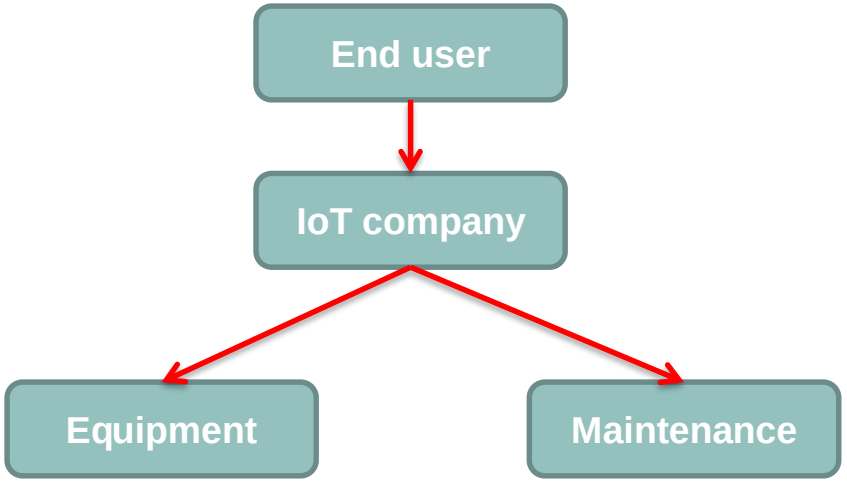
Problem	High investment and maintenance cost of heavy medical equipment.
Traditional solution	• The user (e.g. hospital) buys the equipment upfront and can face high maintenance costs. Different suppliers may be involved in selling and supporting the equipment.
IoT solution	• The hospital pays for the equipment and maintenance to the IoT company. • The equipment is remotely monitored in terms of usage and performance, allowing the IoT company to perform predictive maintenance. As a result, the end user can benefit from reduced or no disruption from equipment downtime.
IoT business model	• The IoT company charges a recurring fee to the hospital. This fee includes the use of the equipment and its maintenance. • The equipment is owned by the IoT company, who by actively monitoring it can pre-empt potentially serious issues that could result in expensive maintenance.

Product-as-a-Service

Traditional business model



IoT business model



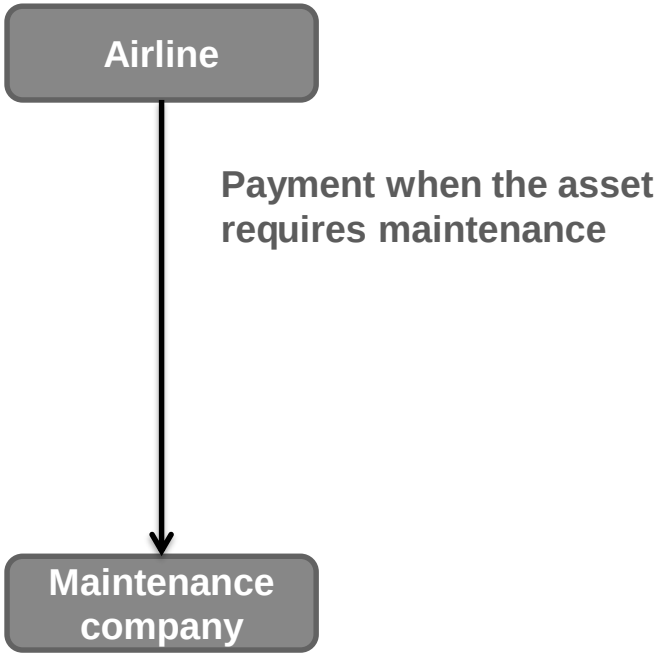
The IoT solution can perform predictive maintenance, allowing the end user to benefit from lower or no disruption and more affordable cost

Performance-as-a-product

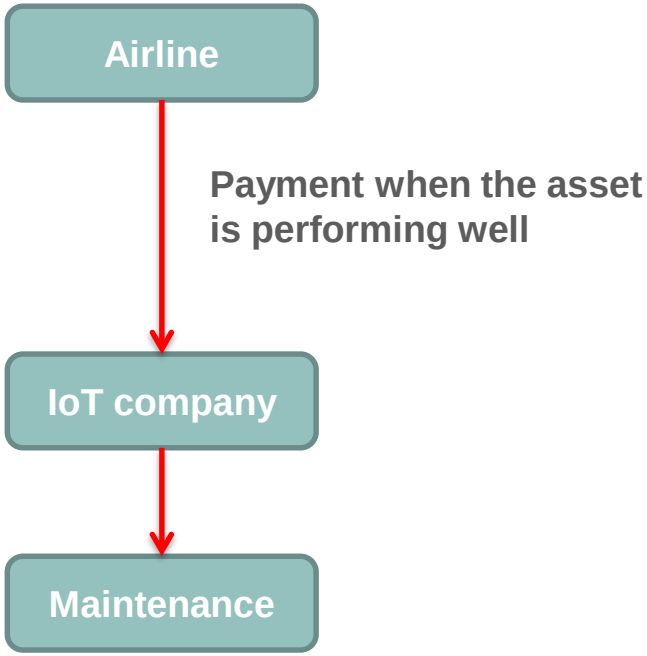
Problem	Uncertain aircraft engine maintenance cost.
Traditional solution	• Airlines would buy the engine from manufacturers such as Rolls-Royce and take on the risk of the engine becoming inoperable and possible high maintenance cost.
IoT solution	• The aircraft engines have embedded sensors that send data back to the engine manufacturer (IoT company). • This information is used by the IoT company to identify and fix problems remotely, minimising the risk of engine downtime.
IoT business model	• Rolls-Royce's TotalCare program is sold to airlines as a solution to make the engine's maintenance costs predictable. • Under this program, Rolls-Royce is responsible for the engine's maintenance and only gets paid if the engine is operational. Its revenues equal a fixed fee per flying hour.

Performance-as-a-product

Traditional business model



IoT business model



The IoT solution aligns the interests of the airline with the maintenance provider

Summary: business models

1	IoT can be a catalyst for significant innovation in business models
2	Business model innovation will have the most impact in the area where the IoT company interacts with the cutomer

Wrap up day 1

- **So far, we have learnt that:**
- IoT is still nascent and there is no single definition
- The transition from traditional services to IoT requires policymakers and regulators to apply existing rules in a transparent and consistent way
- There are several technological, economic and legal drivers and inhibitors of IoT
- IoT can help deliver a wide range of socio-economic benefits
- A variety of connectivity technologies can support IoT solutions
- IoT can enable new business models

Thank you!

GSMA Capacity Building

Internet of Things (IoT)

Day 2

Summary of day 1

- **So far we have learnt that…**
  - IoT is still nascent and there is no single definition
  - The transition from traditional services to IoT requires policymakers and regulators to apply existing rules in a transparent and consistent way
  - There are several technological, economic and legal drivers and inhibitors of IoT
  - IoT can help deliver a wide range of socio-economic benefits
  - A variety of connectivity technologies can support IoT solutions
  - IoT can enable new business models

Guided case study

- Put yourself in the shoes of an IoT company that wants to launch a service
  - What customers are you targeting?
  - Which customer needs are you addressing?
  - Which connectivity technology will you use?
  - Which business models will you adopt?
  - What legal and operational risks will you have to consider?

Exercise instructions

1

IoT solution & benefits

- How are we solving the customer's problem?
- What benefits are we generating?

2

Technologies

- What technologies are we using to solve their problem?

3

Business models

- How do we make money? (Up front? Performance-based? Monthly fee?)
- What are the most important costs?

4

Risks & Policies

- What are the main risks associated with the product/service?
- What regulations and policies may affect the commercialisation of our product/service?

Exercise template [1/4]

IoT solution & benefits

IoT solution	
Benefits	

Exercise template [2/4]

Technologies

Feature	Requirement	Comment
Network Area	▪ Wide ▪ Local	
Spectrum	▪ Dedicated ▪ Shared	
Battery life	▪ Long ▪ Short	
Connectivity cost	▪ High ▪ Medium ▪ Low	
Module cost	▪ High ▪ Medium ▪ Low	
Bandwidth	▪ High ▪ Medium ▪ Low	

Technologies:

Exercise template [3/4]

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Exercise template [4/4]

Operational issues & policy topics

Operational considerations	Policy areas

Guided case: Farm water monitoring

- **Problem that needs to be addressed**:
- How do I know if my water tanks need to be refilled?

Farm water monitoring

Problem: How do I know if my water tanks need to be refilled?

Customers	• Farmers
Needs to address	• Water availability for animals. This is particularly relevant in dry lands (e.g. certain areas of Africa)

Farm water monitoring

IoT solution & benefits

IoT solution

- A sensor is placed in the water tanks and troughs to monitor the water level and send an alert to the controlling station (or via SMS text or email) If water levels, flow or pressures go outside a pre-configured range

Benefits

- The solution makes it much easier for a farmer to check water levels in tanks and troughs and helps keep livestock safe from dehydration, which is especially important in developing countries and dry lands.

Farm water monitoring

Technologies

Feature	Requirement	Comment
Network Area	▪ Wide	Extended fields in remote locations can require significant signal coverage
Spectrum	▪ Shared / Dedicated	Quality of service of transmission is not a crucial factor
Battery life	▪ Long	The sensors may be placed in remote points of the field and need to have long battery life. Solar panels may contribute to extending battery life
Connectivity cost	▪ Low	Associated to the low bandwidth requirement
Module cost	▪ Medium	Price may be an issue in developing countries
Bandwidth	▪ Low	Data needed to monitor water level is limited

Technologies: LPWA 2G ?

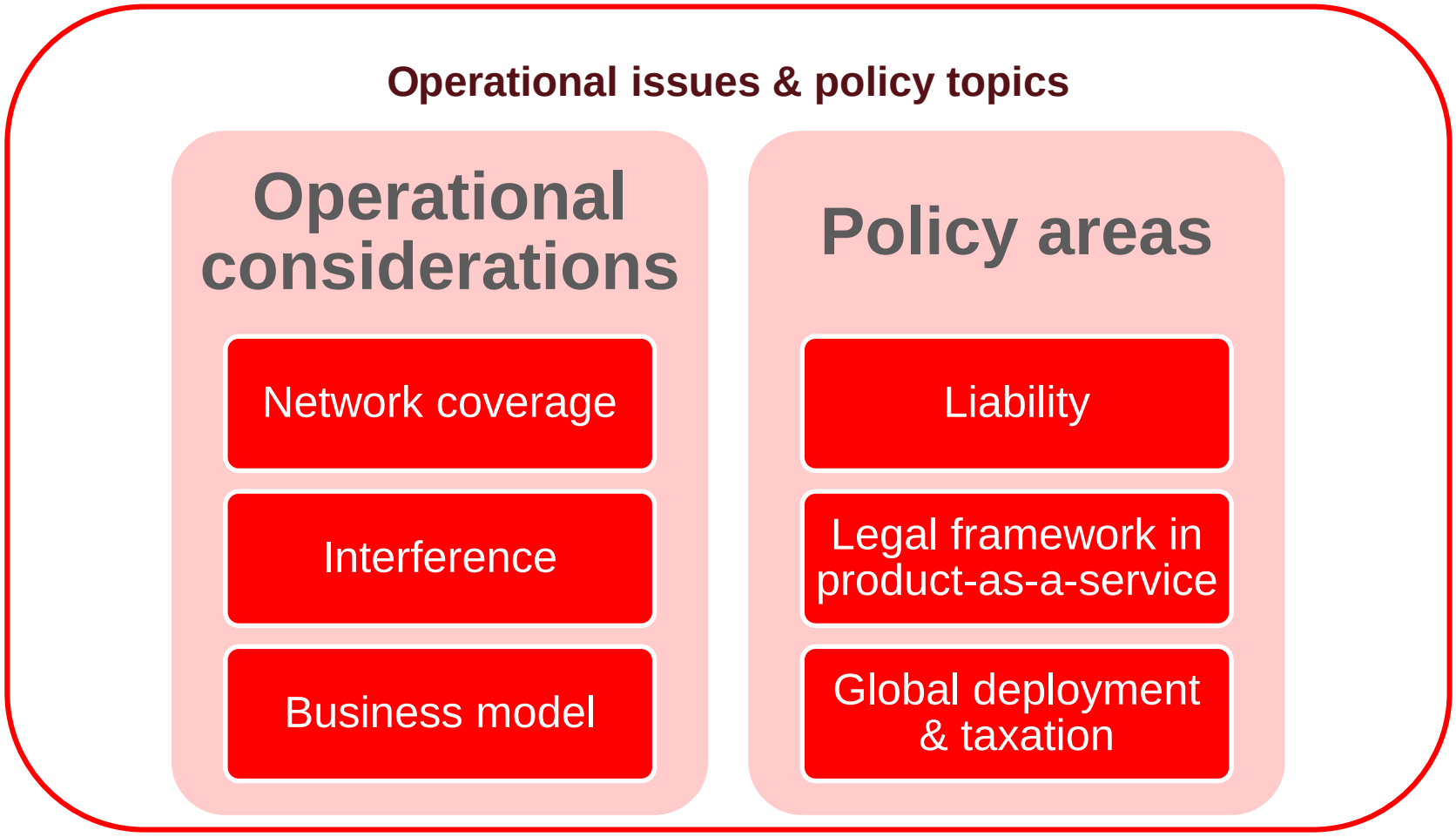
Farm water monitoring – most likely business models

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Most likely business models

Source: Analysys Mason

Farm water monitoring



Liability

Liability

- Establishing responsibility needs to be clear in the event of damages resulting from the IoT solution
- If the solution fails and animals die because of lack of water, who is to blame:
  - The local reseller installer?
  - The IoT technology company?
  - The network operator?
  - The farmer?

Case studies exercises

- Elderly monitoring
- Smart public garbage bin
- Security alarms
- Industrial IoT

Instructions

- Divide into groups
- Build a business case around the example given
- Put yourself in the position of the IoT company
- Follow the topic area structure in the hand-outs
  - IoT solution & benefits
  - Technology
  - Business model
  - Risks and policies
- Compare each group's solution

Problems that you will need to address

- How can I monitor an elderly family member?
- How can you improve the efficiency of waste collection in cities?
- How can I keep my home protected?
- How can I improve manufacturing efficiency?

Case study 1: Elderly care monitoring

Elderly care monitoring

Problem: How can I monitor an elderly family member?

Customers	• People with elderly family members
Needs to address	• Monitoring the activity of the elderly person • Alert if the activity significantly changes from what is expected

Elderly care monitoring

Suggested solution

Elderly care monitoring

IoT solution & benefits

IoT solution

- Movement sensors are placed around the home, transmitting data on activity (e.g. doors, people)
- The sensors are connected to a hub that sends data to an application, using cellular connectivity

Benefits

- The monitoring system can reduce family members' anxiety regarding the well being of their elderly relative
- Elderly can continue living in their homes, avoiding being taken to a care home

Elderly care monitoring

Technologies

Feature	Requirement	Comment
Network Area	▪ Wide	The hub sending data to an application uses cellular connectivity, so requires wide network area
Spectrum	▪ Dedicated	The connectivity service needs to be reliable
Battery life	▪ Low	The hub is plugged in to an electrical outlet
Connectivity cost	▪ Medium	Price sensitivity will vary by person or country. We assume the price will need to be moderate
Module cost	▪ Medium	Again, price sensitivity will vary but we assume it will need to be moderate
Bandwidth	▪ Low	The application requires low bandwidth

Technologies: 2G ? ?

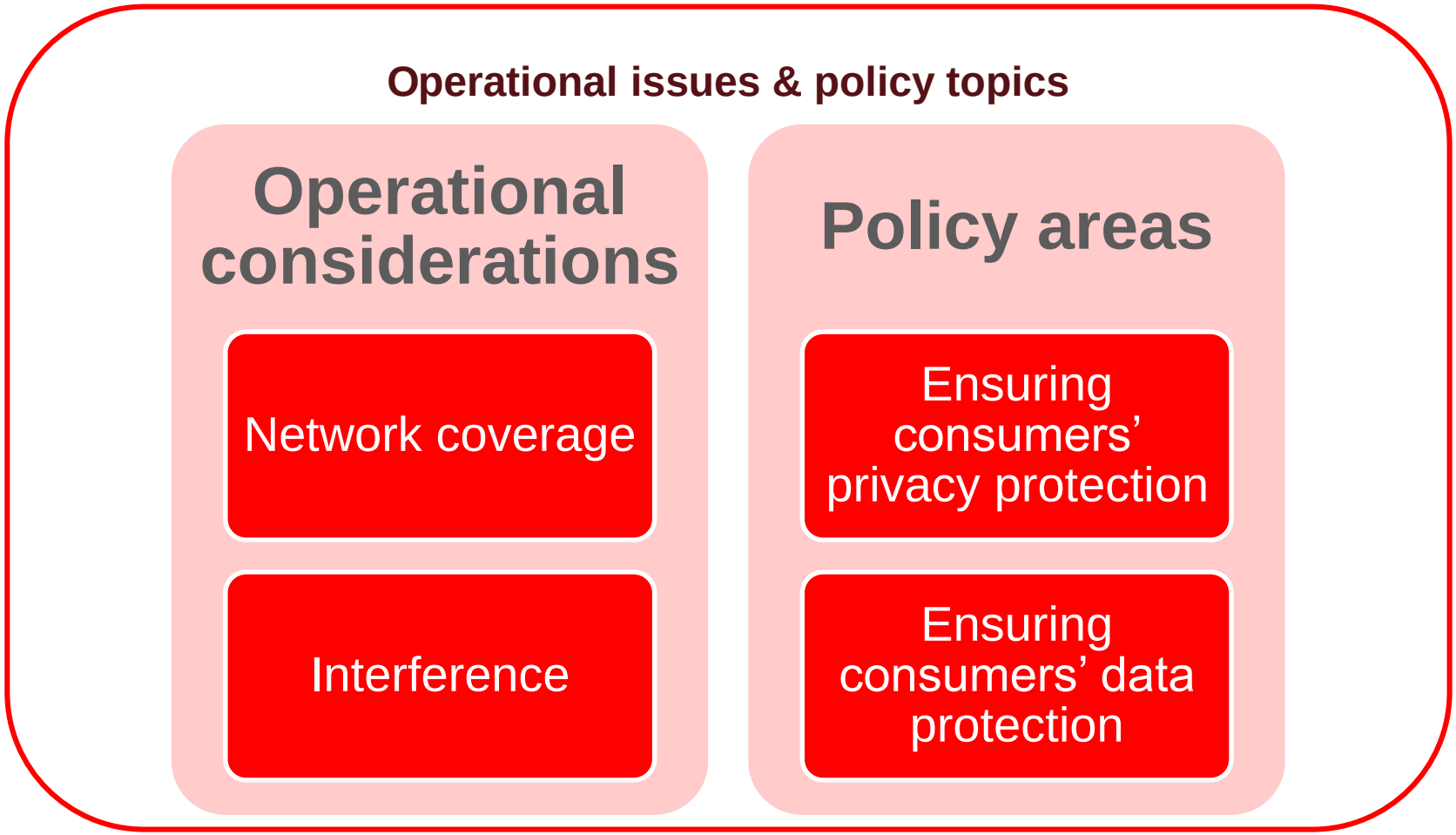
Elderly care monitoring – most likely business models

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Most likely business models

Source: Analysys Mason

Elderly care monitoring



Privacy and data protection

Data collection	• Who collects, shares and uses the individuals' data and why?
Data protection	• How is the security of individuals' data ensured? • How is the privacy of individuals' data ensured?
Data use	• How can individuals exercise choice and control over how their data will be used?

Case study 2: Smart public garbage bin

Smart public garbage bin

Problem: How can you improve the efficiency of waste collection in cities?

Customers	• Cities and towns
Needs to address	• Improve the public waste collection service • Save costs on public waste management by making the service more efficient

Smart public garbage bin

Suggested solution

Smart public garbage bin

IoT solution & benefits

IoT solution

- The smart garbage bin monitors and reports the bins status, alerting when it needs to be emptied
- The solutions helps optimise waste collection (i.e. only emptying bins when necessary)

Benefits

- Pollution is reduced as bins are never full and traffic on the roads is reduced
- Taxes can be spent more efficiently

Smart public garbage bin

Technologies

Feature	Requirement	Comment
Network Area	▪ Wide	The bins are located community-wide or city-wide
Spectrum	▪ Shared / Dedicated	Quality of service (timeliness) of transmission is not a crucial factor
Battery life	▪ Long	Battery life has to be long, but use of solar panels may help widen the battery life
Connectivity cost	▪ Low	Expected to be low and in line with bandwidth requirements
Module cost	▪ Low	The cost per bin needs to be low so it is feasible to deploy across all bins in a given community/city. Bins are exposed and easily subject to theft.
Bandwidth	▪ Low	The application requires low bandwidth

Technologies: LPWA 2G ?

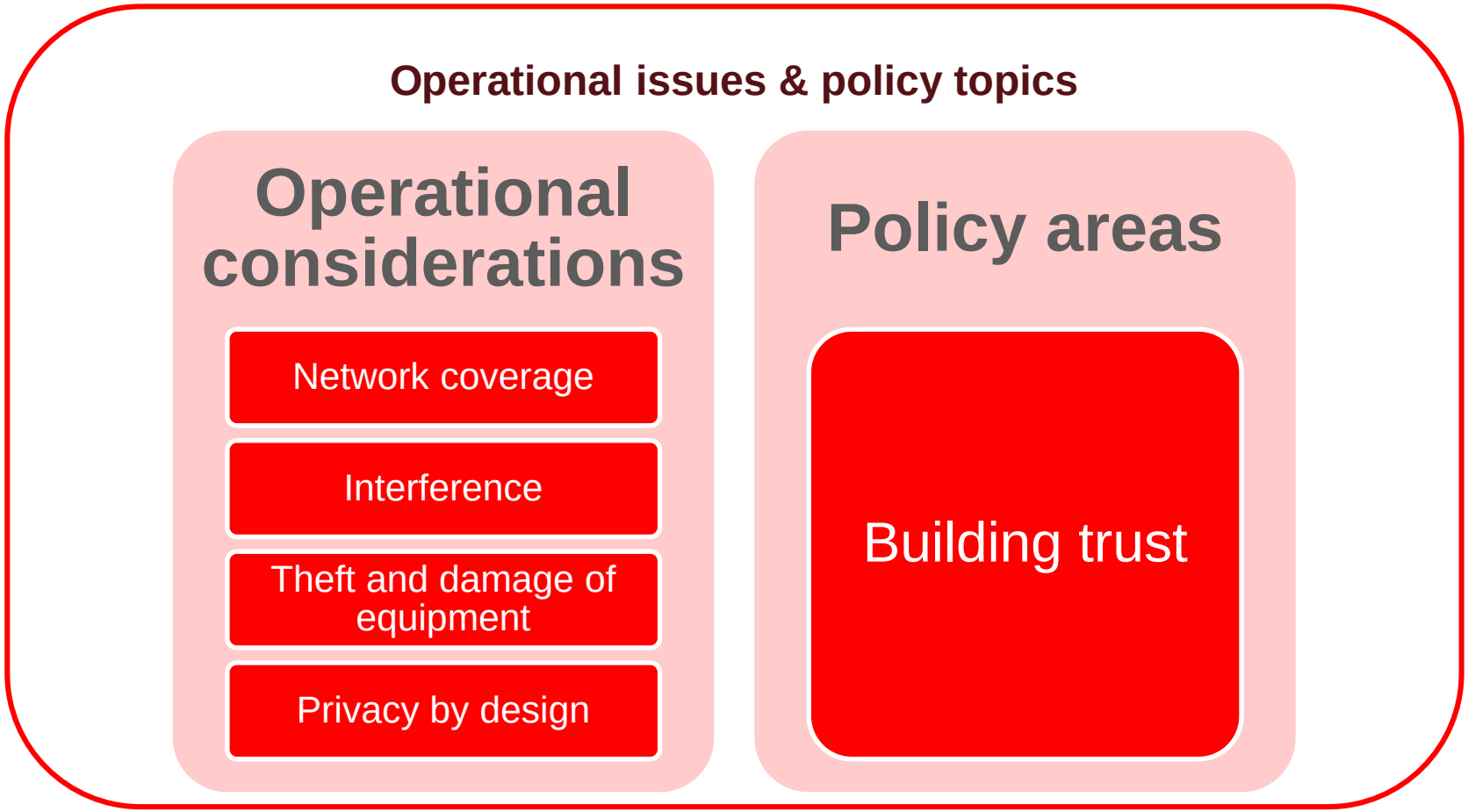
Smart public garbage bin – most likely business models

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Most likely business models

Source: Analysys Mason

Smart public garbage bin



Privacy

Data collection

- Regulators should support and encourage measures by which industry can identify and mitigate risks to privacy, and through which they can demonstrate accountability.
- This objective can be achieved through privacy enhancing technologies and tools that help consumers to manage their privacy and control how their data are used.

- In 2013, the City of London fitted devices in recycling bins to collect data on footfall.
- The data was collected by logging the media access control (MAC) of passing phones and done without the knowledge of those individuals.

Case study 3: Security alarms

Security alarms

Problem: How can I keep my home protected?

Customers	• Property owners
Needs to address	• Alert the police and the property owner in case of intrusion • The system needs to be able to work without a local power source or fixed line connectivity

Security alarms

Suggested solution

Security alarms

IoT solution & benefits

IoT solution

- Sensors are spread around the property to detect motion and sound.
- When a sensor is activated, it sends an alert to the property owner and/or control centre, who can warn the police
- The security system can be monitored and armed/disarmed using a smartphone app or web-interface

Benefits

- Reduction of crime. The dissuasive effect of the alarm system can help reduce the chances of a break-in
- Reduction of the negative outcome from a break-in, due to the early dispatch of the police and system's ability to operate without fixed line connection and local power source

Security alarms

Technologies

Feature	Requirement	Comment
Network Area	▪ Local	The area to be covered is indoors and needs to operate without fixed line
Spectrum	▪ Dedicated ▪ Shared	Ideally, the service would have some quality guarantee, but it could also work in shared spectrum
Battery life	▪ Short	Battery life can be short as the alarm can be connected to a local power source
Connectivity cost	▪ Low	The cost is expected to account for a relatively low amount of the security alarm system's recurring fee
Module cost	▪ Medium	The cost is expected to account for a relatively low amount of the security alarm system's cost
Bandwidth	▪ Low	The application requires low bandwidth

Technologies: 2G ZigBee RF-Mesh

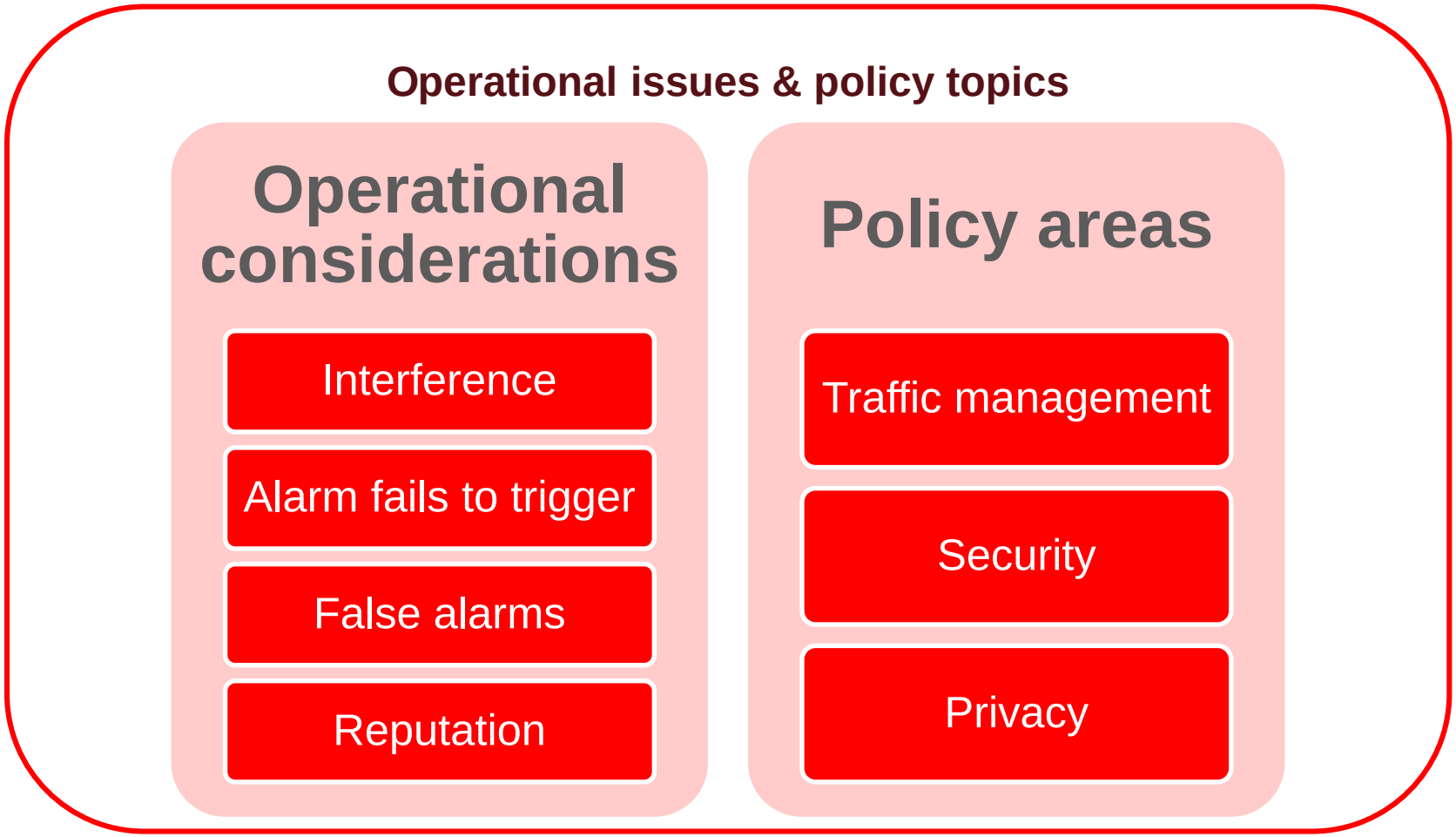
Security alarms – most likely business models

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Most likely business models

Source: Analysys Mason

Security alarm



Traffic management

Traffic prioritisation

- For IoT applications related to mission-critical services, operators may need to prioritise traffic.

QoS classification

- It is important to define IoT applications by QoS class and perform traffic management based on that.

Case study 4: Industrial IoT

Industrial IoT

Problem: How can I improve manufacturing efficiency?

Customers	• Industrial manufacturers
Needs to address	• Minimise machinery maintenance cost • Optimise manufacturing processes

Industrial IoT

Suggested solution

Industrial IoT

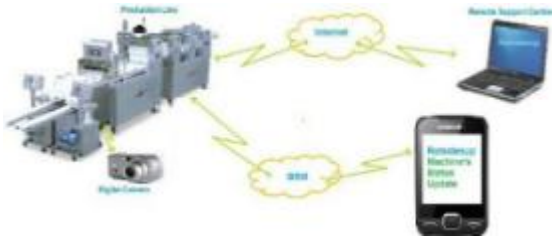
IoT solution & benefits

IoT solution

- Manufacturing machinery is equipped with sensors/actuators that allow the plant operator to remotely monitor and control it
- Machinery performance data is collected and analysed to help optimise the manufacturing processes

Benefits

- Improved manufacturing efficiency, which can lead to lower production cost and more affordable products
- Predictive maintenance leads to better management of replacement parts and increased uptime of manufacturing machinery



Industrial IoT

Technologies

Feature	Requirement	Comment
Network Area	▪ Local	Typically the area to be covered is indoors
Spectrum	▪ Dedicated ▪ Shared	Depends on the application. For most, shared spectrum will be suitable, but some applications may need dedicated spectrum
Battery life	▪ Typically NA	Connections will likely have access to a local power source and so not be dependent on battery power
Connectivity cost	▪ High, Medium, or Low	
Module cost	▪ High	Modules should be of industrial grade, robust enough to operate in an industrial environment
Bandwidth	▪ High, Medium, or Low	Dependent on application

Technologies: 3G ZigBee RF-Mesh

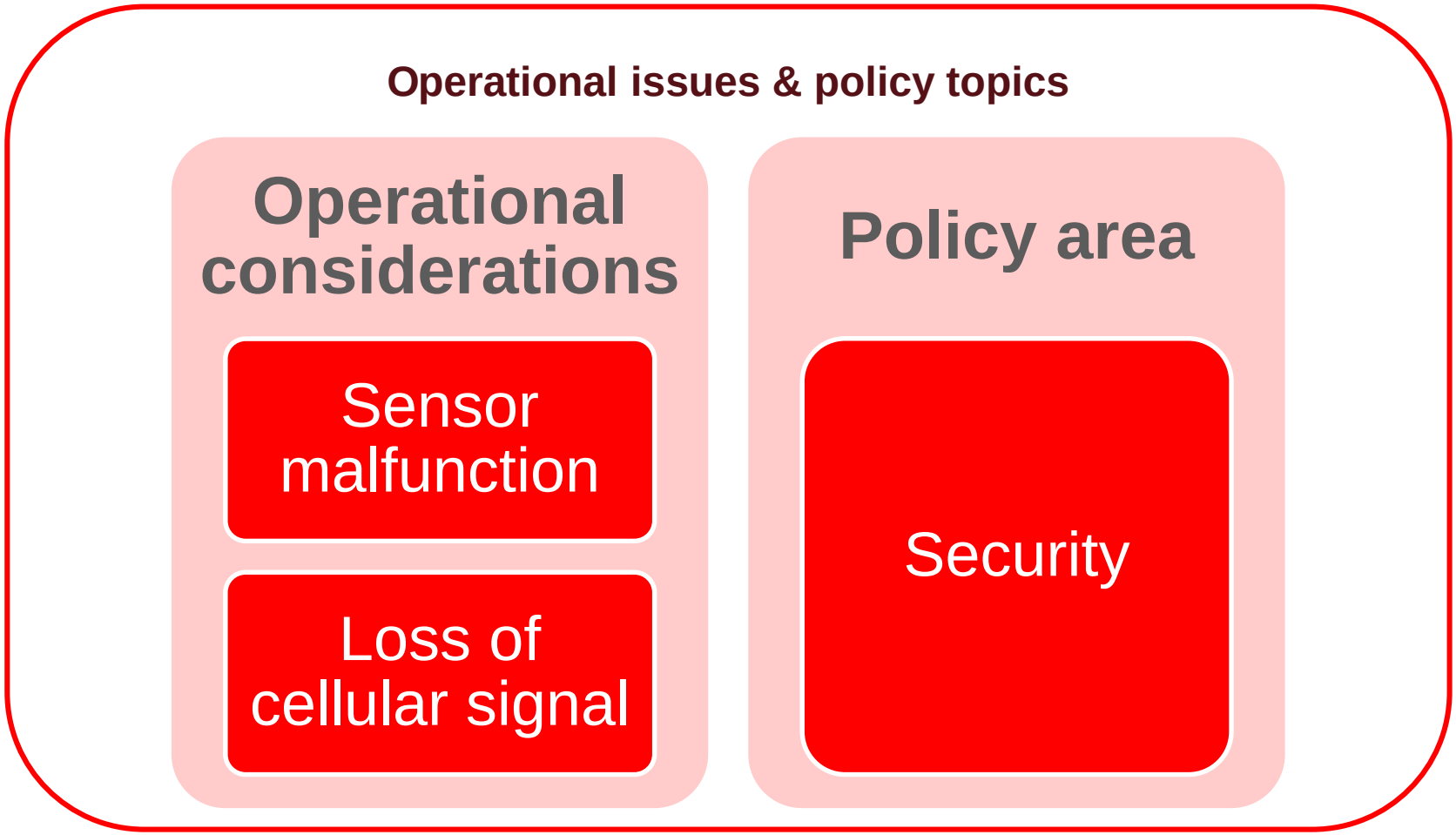
Industrial IoT – most likely business models

Business models	Revenue of the IoT company	Device ownership
Revenue-sharing	Recurring	IoT company
Cost-savings sharing	Recurring	IoT company
Product-sharing	Usage	IoT company
Product-as-a-Service	Recurring	IoT company
Performance-as-a-Product	Usage	User
Transactional	Upfront	User

Most likely business models

Source: Analysys Mason

Industrial IoT



Security

Security

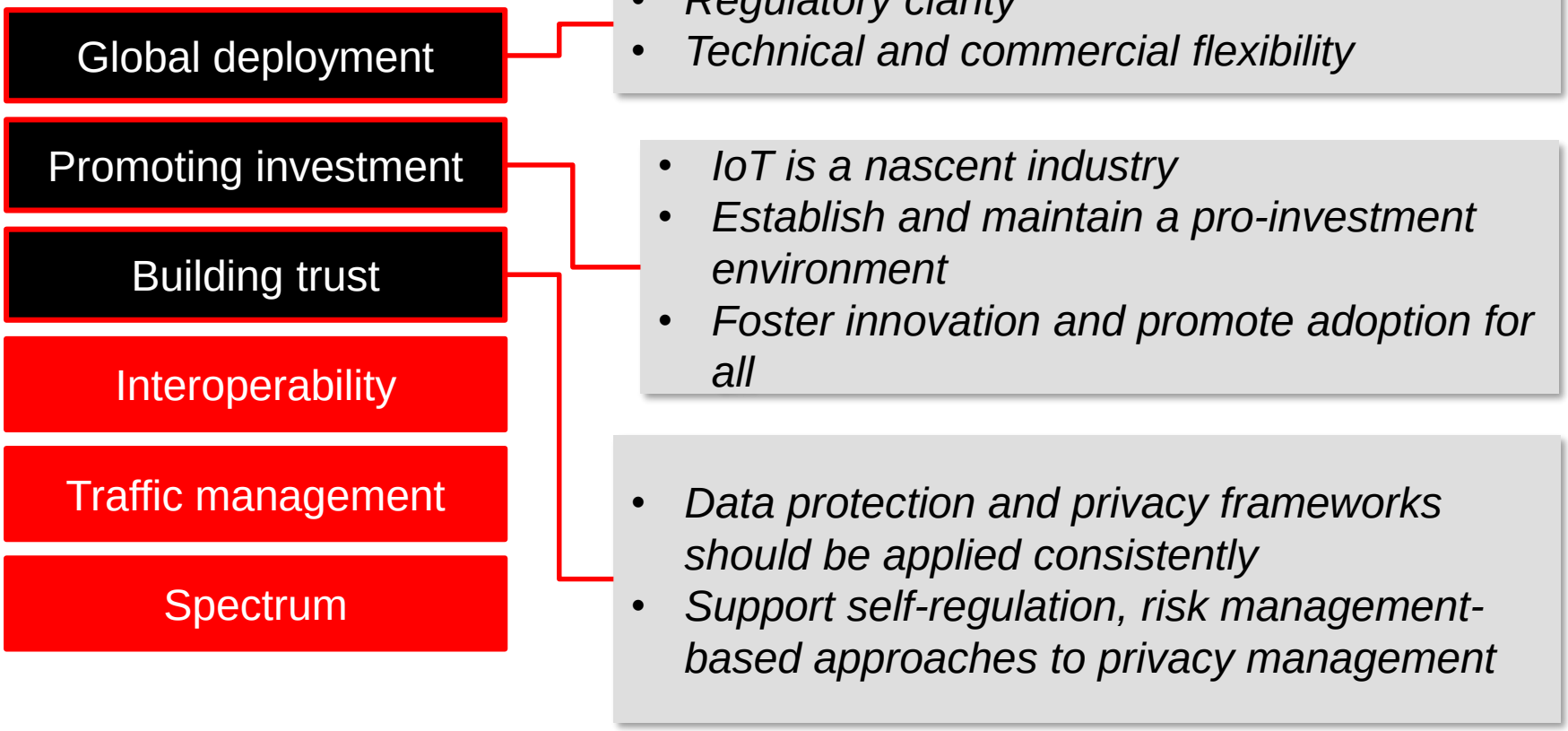
- Reliable, secure networks build trust and confidence, while supporting the growth and development of the IoT.

How governments can help drive IoT adoption in their country

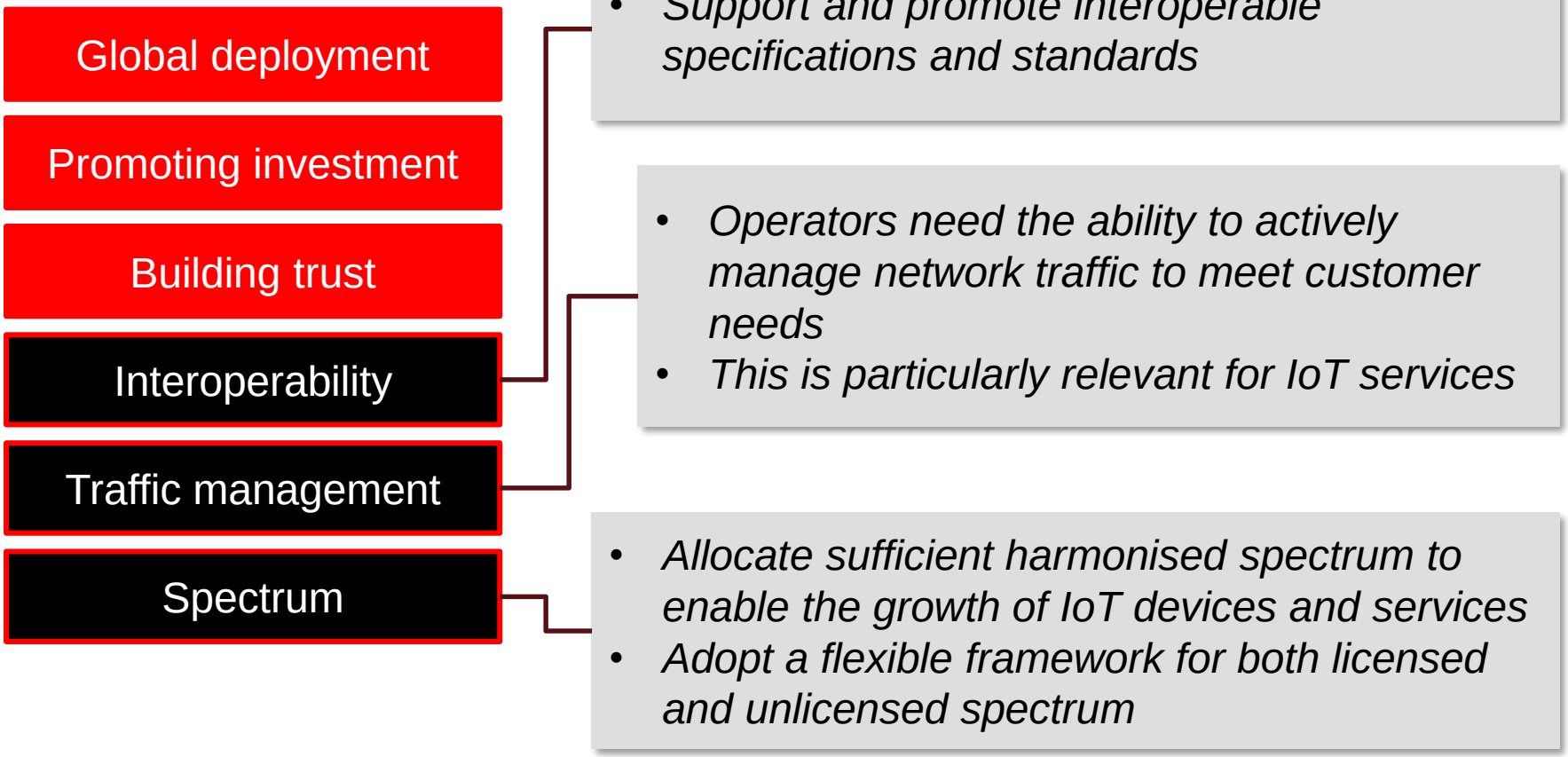
Governments should focus in six main areas to help drive the adoption of IoT products and services

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

Facilitating global deployments, promoting investment, building trust…



…supporting interoperability, traffic management and spectrum harmonisation



Wrap up

- Your objectives?
- Open issues?

Your objectives?

Open issues?

Thank you!

Glossary

- ARPD: average revenue per device
- ARPU: average revenue per user
- BTS: base transceiver station
- eCall: in-vehicle emergency call system triggered in case of an accident
- HVAC: heating, ventilating and air conditioning system
- IPv6: Internet protocol version 6
- LPWA: low power, wide area
- LTE M: LTE Machine-Type Communications
- MAC: media access control
- NB-IoT: narrow band IoT
- OTA: over-the-air
- QoS: quality of service
- SCADA: supervisory control and data acquisition