Regional Seminar for Europe and CIS

Spectrum Management and Broadcasting

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Spectrum Management Aspects Enabling IoT Implementation

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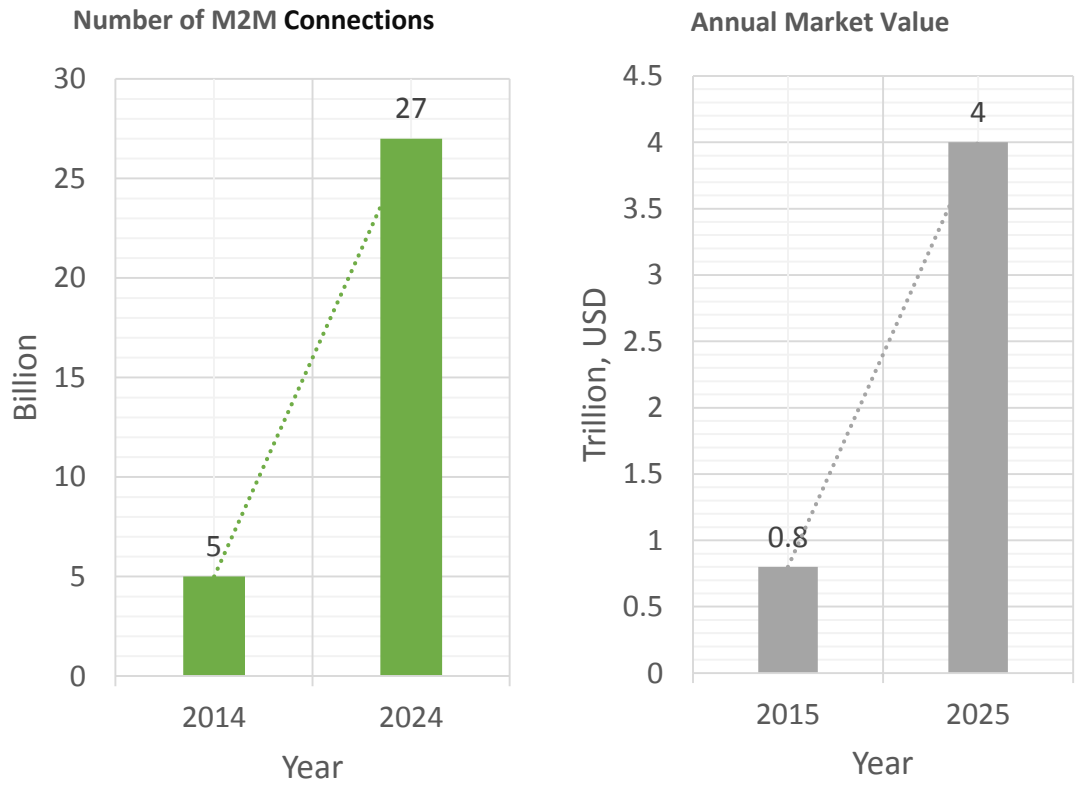
Rapidly Growing Industry

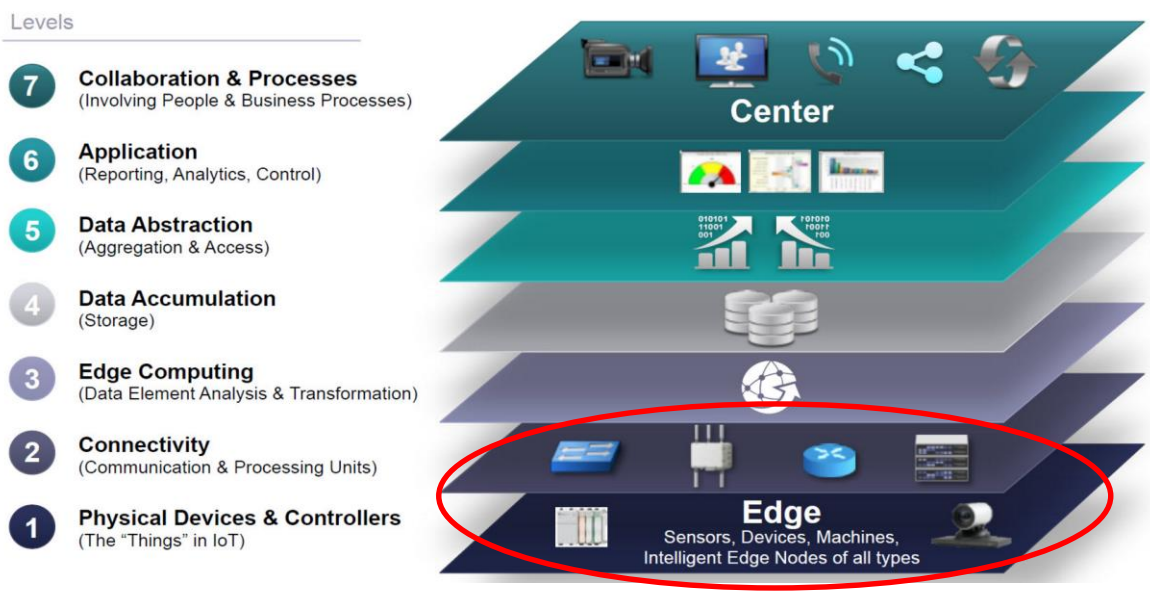
IoT is a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT)*

IoT is Significantly Growing Market



Source: GSMA. Spectrum for the Internet of Things

IoT Layers as defined by IoT World Forum



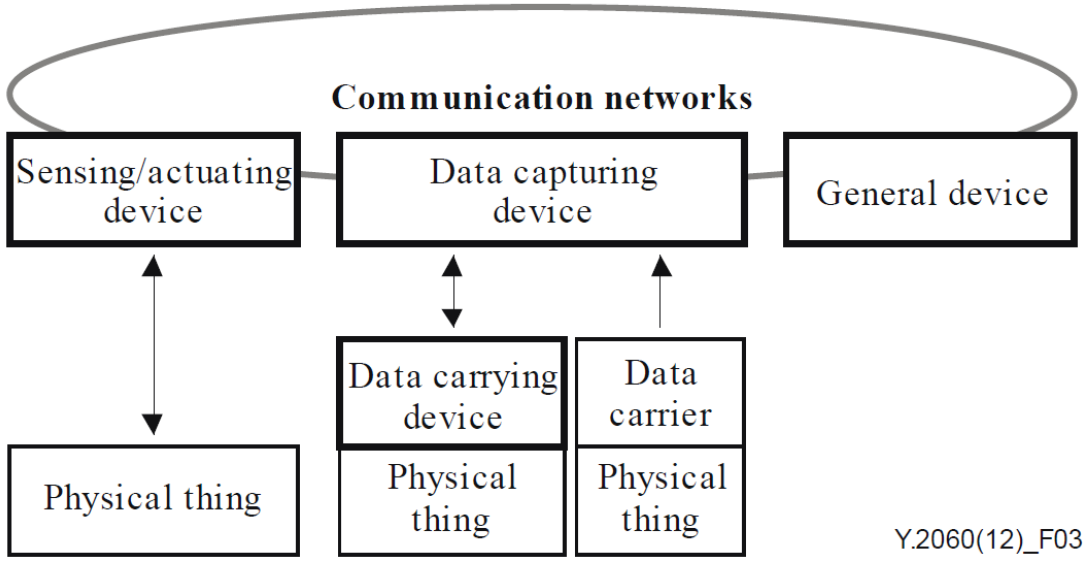
Source: IoT World Forum

Spectrum related issues are attributed to Physical Devices and Connectivity layers.

* Definition from Recommendation ITU-T Y.2060

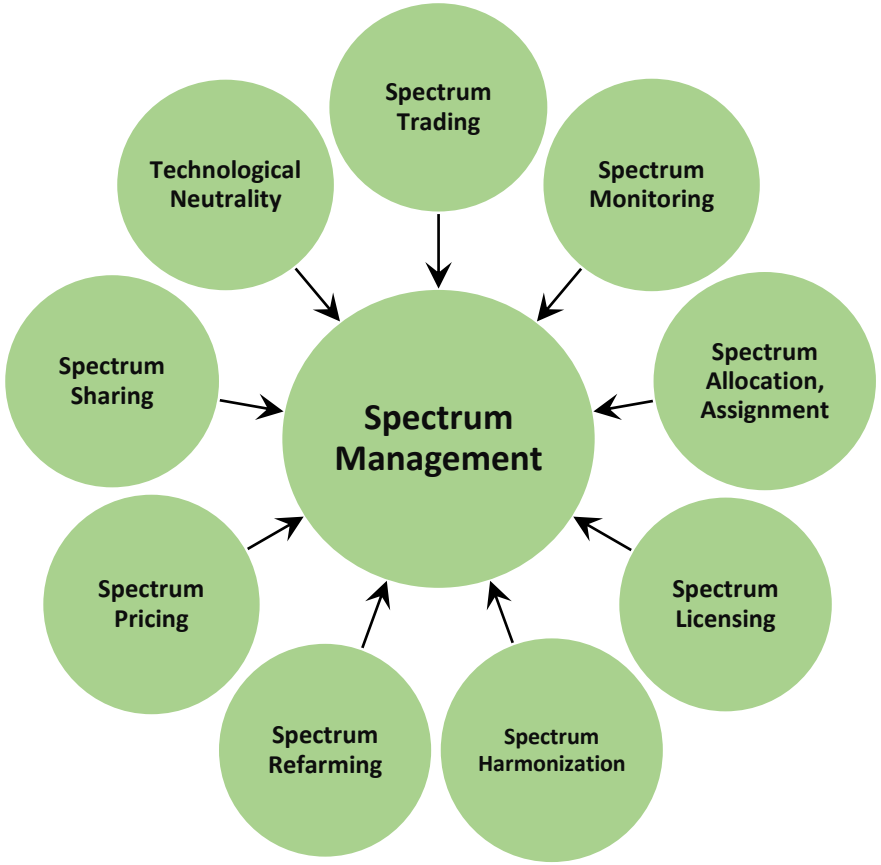
Spectrum Management Issues with IoT Devices

Network and Devices Connections



* Source: Recommendation ITU-T Y.2060

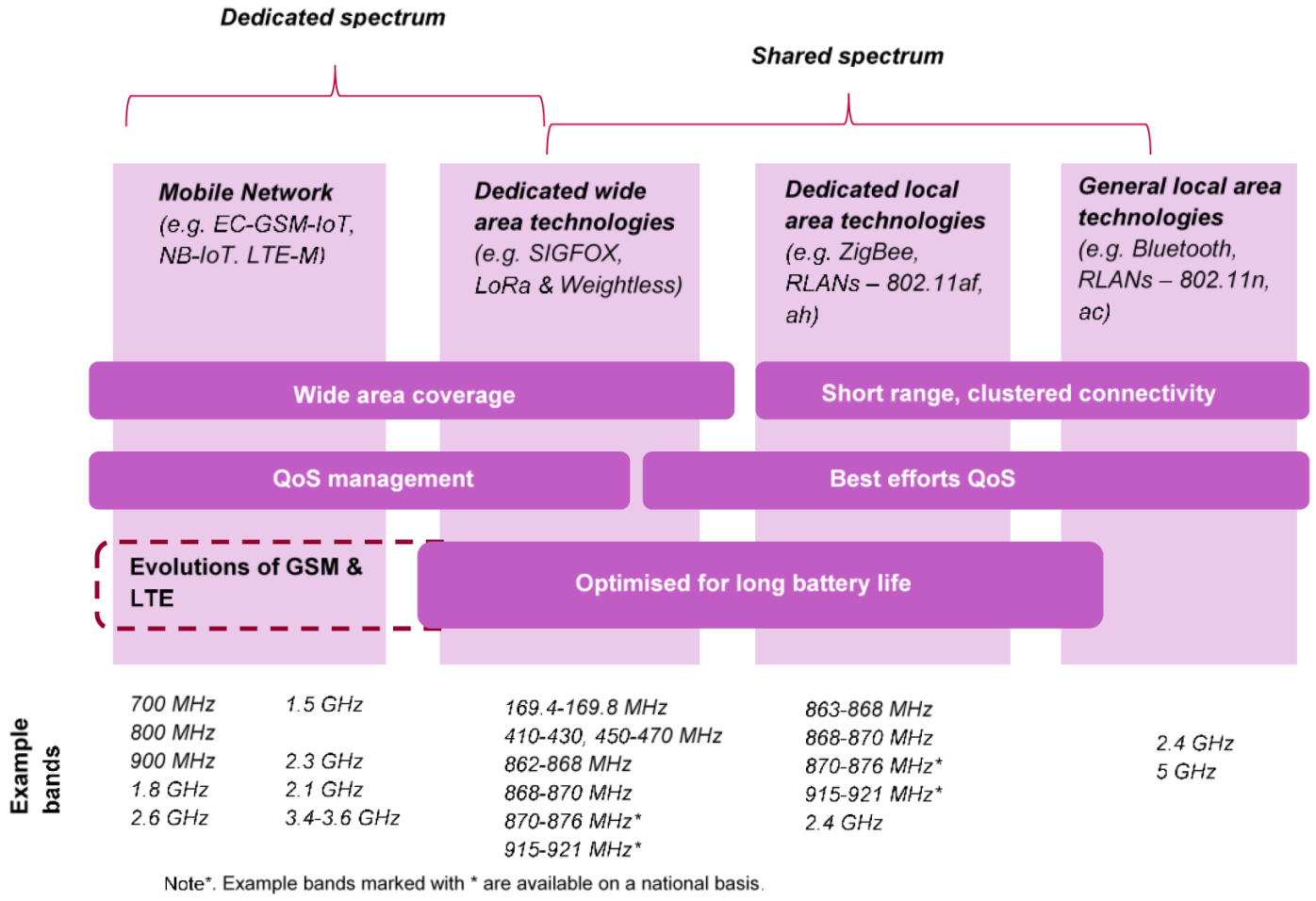
Parts and Parcels of Spectrum Management



Rapidly growing IoT industry is entirely in the scope of the traditional spectrum management environment

Technological and Spectrum Landscape of IoT

IoT Connectivity Options



Note*. Example bands marked with * are available on a national basis.

Source: Radio Spectrum Policy Group. A Spectrum Roadmap for IoT

From Spectrum Viewpoint

Dedicated spectrum: there is a regulation of which devices and device types can access and use the spectrum. It is well suited to wide area IoT applications with a required high quality of service.

Shared spectrum: no regulation related to which devices and device types are sharing access to the same spectrum band based on approved access protocols from industry. It is well suited to low power, short range IoT uses with a required local clustered connectivity around an individual, office, premises, vehicles, vessels etc.

IoT is heterogeneous in terms of radio technologies, applications and business cases, spectrum requirements and spectrum access methods. It creates an obvious demand for sustainable regulation for successful implementation.

IoT and Spectrum Harmonization

Current ECC view on IoT spectrum harmonization: "*There does not seem to be a strong case for the specific designation of specific frequency bands for M2M, … no single frequency band defines M2M (i.e. no single frequency band should be viewed in isolation) per se…*"

Public Mobile Networks Bands

(LPWA Licensed Bands)

allocated or identified for the implementation of 2G, 3G, 4G and 5G

EC-GSM-IoT, NB IoT, LTE-eMTC

Largely harmonized

Satellite Bands

Variety of MSS and FSS Bands

PPDR and Fixed Service Bands

Industrial IoT and Critical Infrastructure in PMR bands 80 MHz, 150 MHz, 400 MHz and FS bands 5725 – 5875 MHz

ITS-G5, LTE-V2X

Largely harmonized

Starting from a Scratch?

Partly harmonized

LPWA Non-cellular Bands

169 MHz, 433 MHz, 863-870 MHz, 870-876 MHz and 915-921 MHz, 2400 to 2483.5 MHz, 5150-5350 MHz and 5470-5725 MHz

Sigfox, Weightless, Ingenu, LoRaWAN

Partly harmonized

LPLA Bands

169 MHz, 433 MHz, 863-870 MHz, 915-921 MHz, 2400-2483.5 MHz, 5150-5350 MHz and 5470-5725 MHz

Bluetooth smart, IEEE 802.11ah, IEEE 802.15.4, ZigBee, Z-Wave

IoT Spectrum Harmonization Pros	IoT Spectrum Harmonization Cons
Global harmonization increase economy of scale. Globally harmonized spectrum simplifies regulation.	There is presently a wide variety of spectrum solutions available for diverse use cases, making harmonization partly achievable. May result in implementation delay and restriction of technological neutrality

Spectrum Authorization and Spectrum Pricing with IoT

IoT is the notable example of Spectrum Rights and Spectrum Commons dilemma

Spectrum exclusivity: Shared Spectrum	**Operational requirements**: Used on a non-interference and un-protected basis Applications having no high requirements for low latency. Applications having no requirement for ultra-reliable connections. Operating over a short range (low power devices).	**Technology**: LPWA Sigfox, Weightless, Ingenu, LoRaWAN LPLA Bluetooth smart; IEEE 802.11ah; IEEE 802.15.4; ZigBee; Z-Wave	**Regulatory regime**: General Authorization Model	**Spectrum pricing**: No spectrum related fees
Spectrum exclusivity: Dedicated Spectrum	**Operational requirements**: Applications requiring ultra-reliable connections. Uses real-time communications. Applications with high requirements for low latency. High availability, guaranteed in-time delivery.	**Technology**: Public Mobile Networks EC-GSM-IoT, NB IoT, LTE-eMTC Satellite Applications Industrial IoT and Critical Infrastructure **ITS-G5, LTE-V2X**	**Regulatory regime**: Individual Authorization Model	**Spectrum pricing**: Spectrum entry and annual usage fees

The RSPG of European Commission – "Taking into account the multiple applications, use cases and operational requirements, there is no "one size fits all" in terms of spectrum management for IoT".

SRD Ranges Harmonization = LPLA and LPWA Ranges Harmonization

Global and Regional SRD Harmonized Bands as Defined in ITU-R SM.1896

Frequency Ranges for Global Harmonization

Frequency range
9-148.5 kHz
3 155-3 400 kHz
6 765-6 795 kHz
13.553-13.567 MHz
26.957-27.283 MHz
40.66-40.7 MHz
2 400-2 500 MHz
5 725-5 875 MHz
24.00-24.25 GHz
61.0-61.5 GHz
122-123 GHz
244-246 GHz

Frequency Ranges for Regional Harmonization

Frequency range	Region 1	Region 2	Region 3
7 400-8 800 kHz	Available	Available	Available in some countries
312-315 MHz	Available in some countries	Available	Available in some countries
433.05-434.79 MHz	Available	Available in some countries	Available in some countries
862-875 MHz	Available	Not available	Available in some countries
875-960 MHz	Available in some countries	Available	Available in some countries

Resolution ITU-R 54-2 Prescribes Further Studies to Achieve Harmonization for SRD:

- to continue studies on the regional and/or global harmonization of technical and operating parameters, including frequency ranges and interference mitigation techniques for SRDs;
- to study spectrum utilization and technical requirements of SRDs to promote the efficient use of spectrum;
- to conduct technical studies to evaluate the feasibility of deploying SRDs in specific frequency bands that could be harmonized globally or regionally;
- to continue studies to enable implementation of advanced technologies for SRDs, thereby in particular focusing on a strategy for the future.

The benefits of SRD harmonization include increased interoperability, globalization of markets resulting in economies of scale and expanded equipment availability, improved spectrum management and enhanced circulation of equipment.

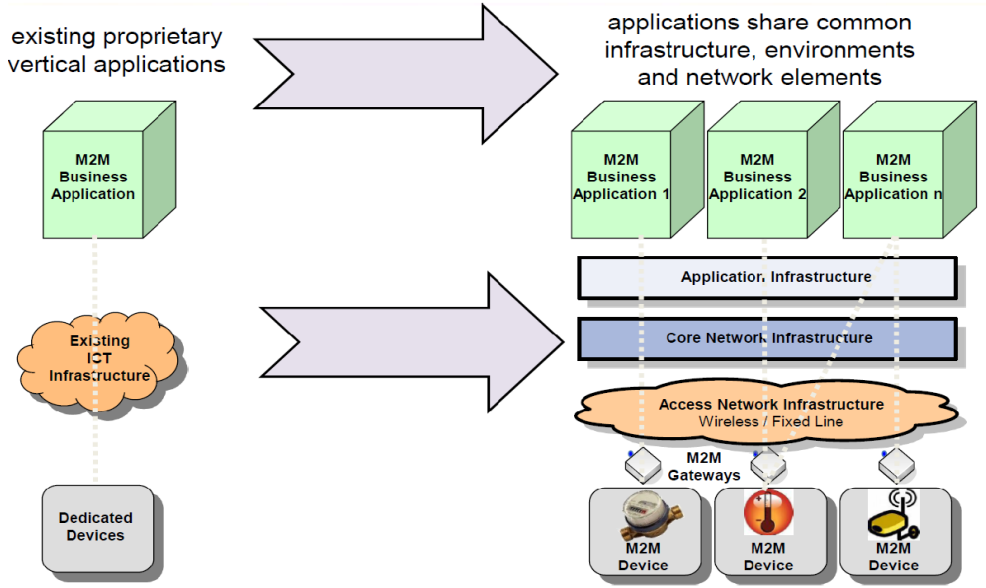
IoT and Technological Neutrality

Technologies Ecosystem Underpins Regulatory Neutrality

SIGFOX One network A billion dreams
nwave
LoRa
LTE-M
NB-LTE
INGENU
WEIGHTLESS
IEEE 802.11ah
DASH7 ALLIANCE
EC-GSM
ZigBee3.0
Bluetooth 4.0

1. The wide range of IoT applications will need to be powered by a host of different technology capabilities targeted on specific functionalities.
2. To promote the full scope of IoT offerings, it is imperative that regulators employ an approach that adheres to principles of technological neutrality.
3. With regard to spectrum, flexible policy should be consistent with baseline technical rules that are technically neutral and allowing for both licensed and unlicensed uses.

From Vertical to Horizontal Standardization

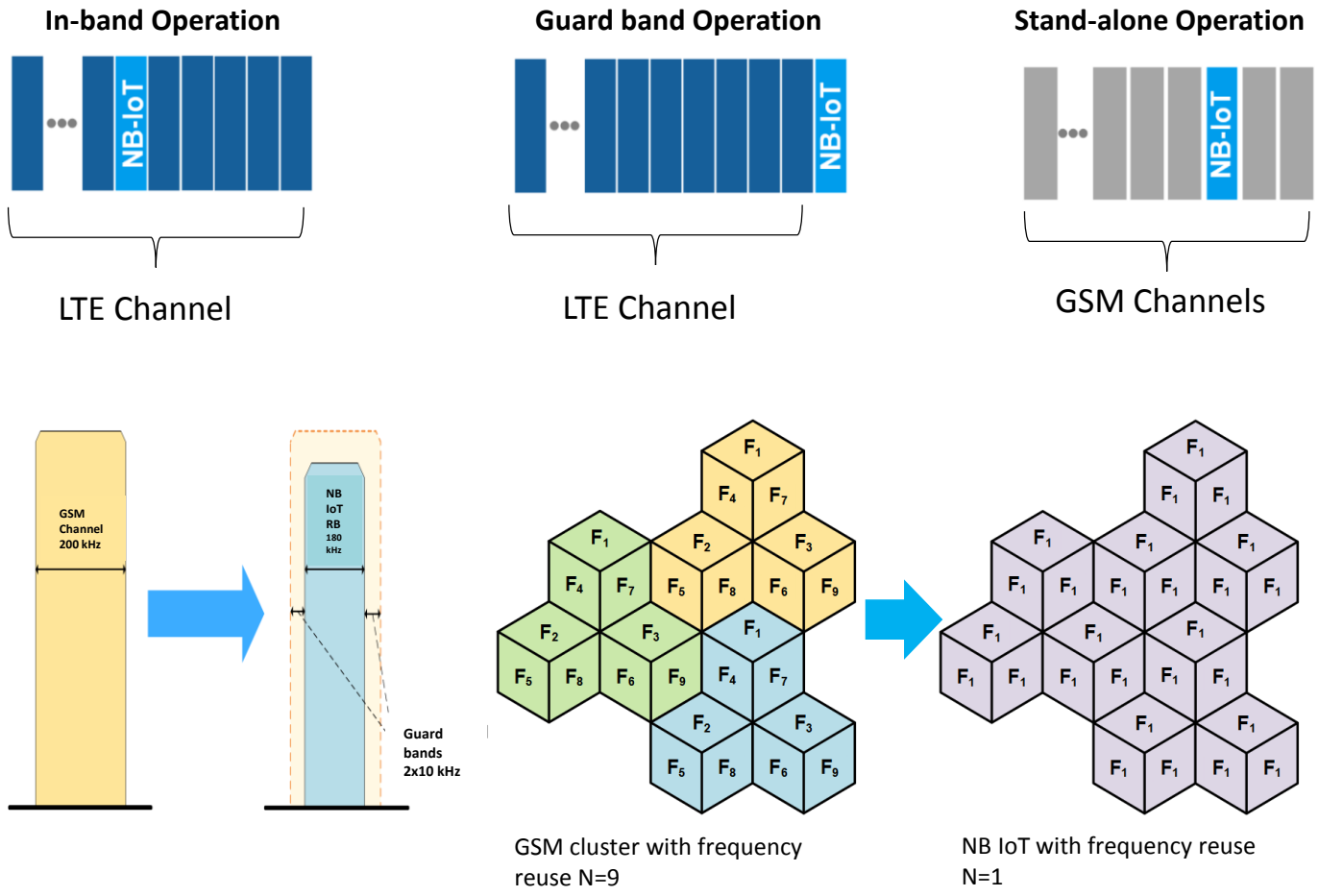


1. Currently, a number of the standards apply across verticals, dealing with specific vertical domains.
2. There are numerous connectivity and interoperability standards and specifications that are not IoT-specific.
3. In order to achieve success in global IoT ecosystem there is the task to make the choice for one solution (notably architecture) across verticals that allows for cross domain interoperability.

The role of a regulator as relates to technology is to proceed with un-biased policy considering the relevant needs, risks, and benefits of various stakeholders entities – consumers and industry, public and private, enterprise and government etc.

Spectrum Re-farming with IoT

Spectrum Re-farming with NB IoT



Practical Implementation Requirements

Re-farming for NB IoT: in-band operation does not assume regulatory intervention as being within the allocated band of an operator.

Implementing NB IoT in GSM spectrum: the technology is highly spectrum efficient as allows frequency reuse factor N=1. At the same time, utilization of selected limited number of 180 kHz channels for NB IoT presumes modification of the remaining GSM frequency channel plans (re-farming).

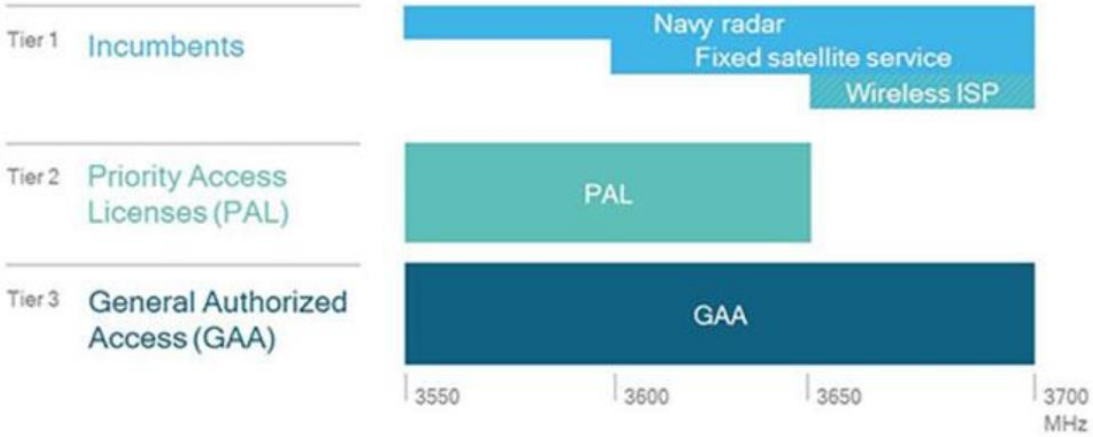
IoT in licensed spectrum may require regulatory intervention for technically binding licences, as well as re-farming associated costs for GSM networks should be noted to ensure successful business cases.

Spectrum Sharing with IoT

New Opportunities for Spectrum Sharing

In 2016 the FCC opened up 150 MHz of spectrum in the U.S. around 3.5 GHz that it named Citizens Broadband Radio Service (CBRS)

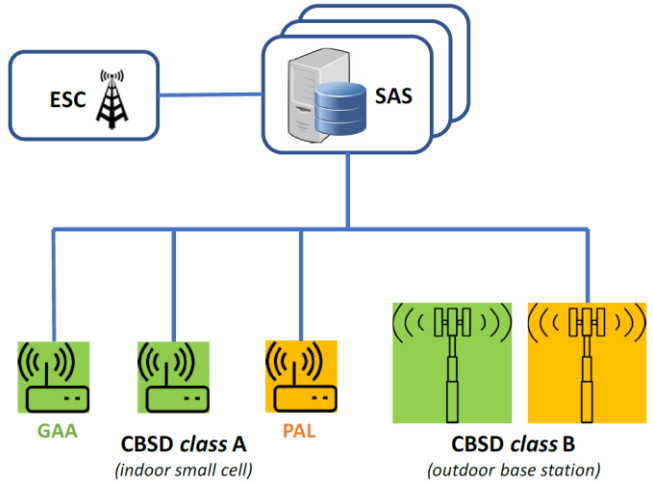
In addition to sharing with incumbents — CBRS adds a 'third-tier' of general usage.



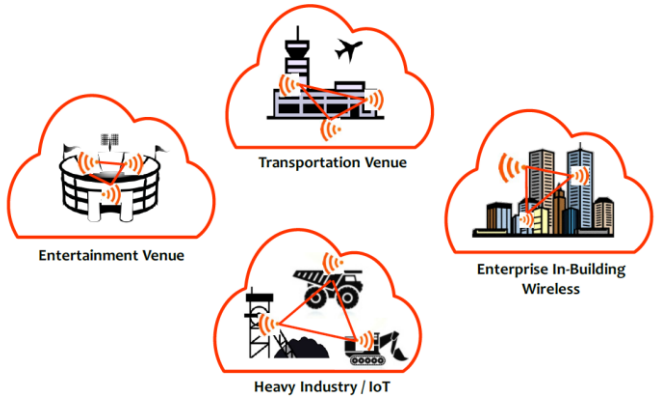
CBRS adds a 'third-tier' of general usage where anyone can use the spectrum when it is not used by the higher tiers (the incumbents or users that paid for a license). GAA will encompass IoT uses.

Source: CBRS Alliance

How It Works in Practice



SAS – Spectrum Access System
ESC – environmental sensors or Environmental Sensing Capabilities.
CBSD – Citizens Broadband Radio Service Devices



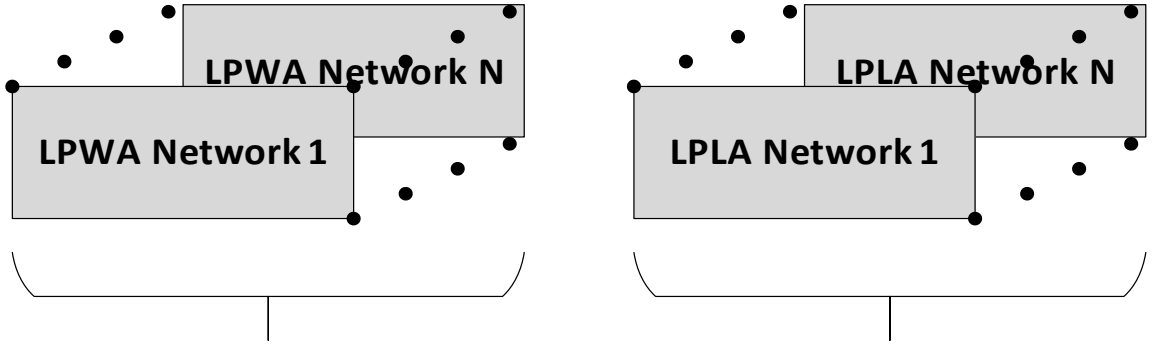
Heavy industry companies can set up an Enterprise Private LTE networks and run industrial IoT applications.

Where spectrum sharing is technically and economically (!) feasible, regulators should apply advanced engineering practices to create environment for heavy "packing" of uses in the same band while protecting superior users.

Proposed IoT Regulatory Landscape and Use Cases

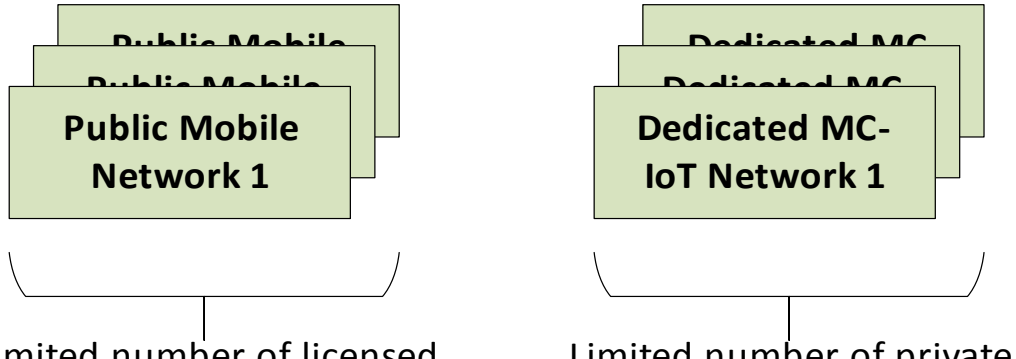
IoT regulatory landscape and use cases should be comprised of licensed and unlicensed networks/spectrum

Unlicensed Spectrum



1. Networks under general authorization regime (commons, class licences etc.) subject to certain regulatory conditions (EIRP limits, duty cycles etc.).
2. Spectrum is used on a non-interference and un-protected basis, as a result, mainly identified for low power devices.
3. Applications have no strict requirements for low latency and ultra-reliable connections.
4. Applications are delay tolerant.
5. Applications with no guarantees for sustainable QoS.

Licensed Spectrum



1. Number of Public Mobile IoT networks is defined by bandwidth of licensed spectrum available for MNOs.
2. Dedicated Mission-Critical IoT networks are likely to utilize newly harmonized spectrum bands, e.g. 870 – 876/915 – 921 MHz, FS bands, such as 5725 – 5875 MHz etc.
3. Applications requiring ultra-reliable connections in real-time communications.
4. Applications with high requirements for low latency.
5. High availability, guaranteed in-time delivery and QoS.

Thank You