Annual Global Update

Public version

450 MHz Alliance, December 2024

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1 Introduction

This report provides the global status of the use of spectrum in the 410 MHz and 450 MHz bands. The information is gathered from operators and regulators worldwide by 450 MHz Alliance. The 450 MHz Alliance is an interest group fostering deployments in the 380 to 512 MHz band. Primary activities of the 450 MHz Alliance include advocacy for evolution of standards, technical education, advocacy, regulatory affairs, global cooperation's, system and device availability and cooperation to develop new features and services.

Worldwide, there are currently thirty-two LTE operations with commercial traffic. CDMA networks are still the dominant technology in the 410 MHz and 450 MHz and regulatory work for converting technology specific licenses is an obstacle in the progress of evolving to 4G. Europe is currently leading the conversion from CDMA to LTE with Asia and South America in progress. North America and Australia have been dominated by narrowband systems in the 400 MHz bands, but are currently review the possibility of introducing local permits for industries in the bands. Most licenses today are nationwide, but a trend with local licenses for industry application are growing. The aim of this report is to provide operators with a simple introduction to the 450 MHz ecosystem for their business and to show business opportunities to the suppliers who provide equipment to operators and end-users.

2 Technology Overview

LTE in 450 MHz bands is a part of the 3GPP standard for 4G/LTE. With advanced data and voice capabilities, flexibility and a seamless migration path to next generation technologies (typical 5G), LTE has become a leading wireless technology for delivering voice and broadband data to densely populated urban areas as well as rural and remote regions in developed and developing markets. LTE450 – or LTE in the 450 MHz frequency bands – is a mature and robust technology for cost-effective provisioning of both basic and advanced voice and broadband data services across regions with low population densities or difficult terrain due to the favorable propagation characteristics of the lower frequency band combined with a robust and advanced 4G LTE technology. The unique characteristics due to low spectrum give a superior coverage compared to any other spectrum bands standardized by 3GPP and ITU. The typical coverage area for different spectrums can be seem in the figure 1, below.

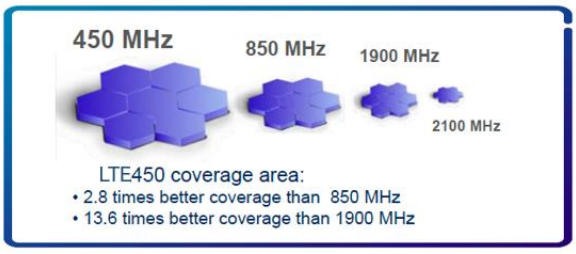


Figure 1. Coverage area for different spectrums

Being part of the 4G/LTE and 3GPP ecosystem brings the advantages of a global technology evolution for connectivity. The fundamental broadband services have evolved to support narrowband and lower power connectivity as well and voice and critical services with access priority and quality of service support. Low power and narrowband support for LTE-M (eMTC) and NB-IoT are available from several suppliers. The path to 5G is in progress, the 450 bands 31 and 72 are completed and will be part of 3GPP release 18, bands 87 and 88 expected to complete the 3GPP RAN process beginning 2025 and will be included in 3GPP release 19. Evolution to 5G follows the general implementation of bandwidth support for 3 MHz and above, since these smaller bandwidths are applicable in the

400 MHz bands. The current view is that both standalone and non-standalone versions are required to be supported and that dynamic spectrum sharing would be essential for some implementations.

3 Market Overview

The major development in the last twelve months has been the network deployment in Germany, Brazil and Poland, start of network deployment in Poland and Ireland, trial in Malaysia, as well as the progress of spectrum allocation in the Kingdom of Saudi Arabia and the consultation in South Africa. Most existing allocations of spectrum in the 400 MHz bands are still not technology neutral and require regulatory updates or changes to the allocation and/or licenses to be able to implement LTE by the local operators. The trend is that the 400 MHz spectrum bands are more and more being allocated to private networks typical Utilities, Public Safety and Transport. The advantage is the predictability of the operation, it will be stable and controlled since the network is deployed with a dedicated business as a base and customized to the requirements of the user. Due to the conversion of the business model, the number of operators is likely to decrease temporarily before new allocations have been awarded. There are more than twenty networks actively investing in LTE globally.

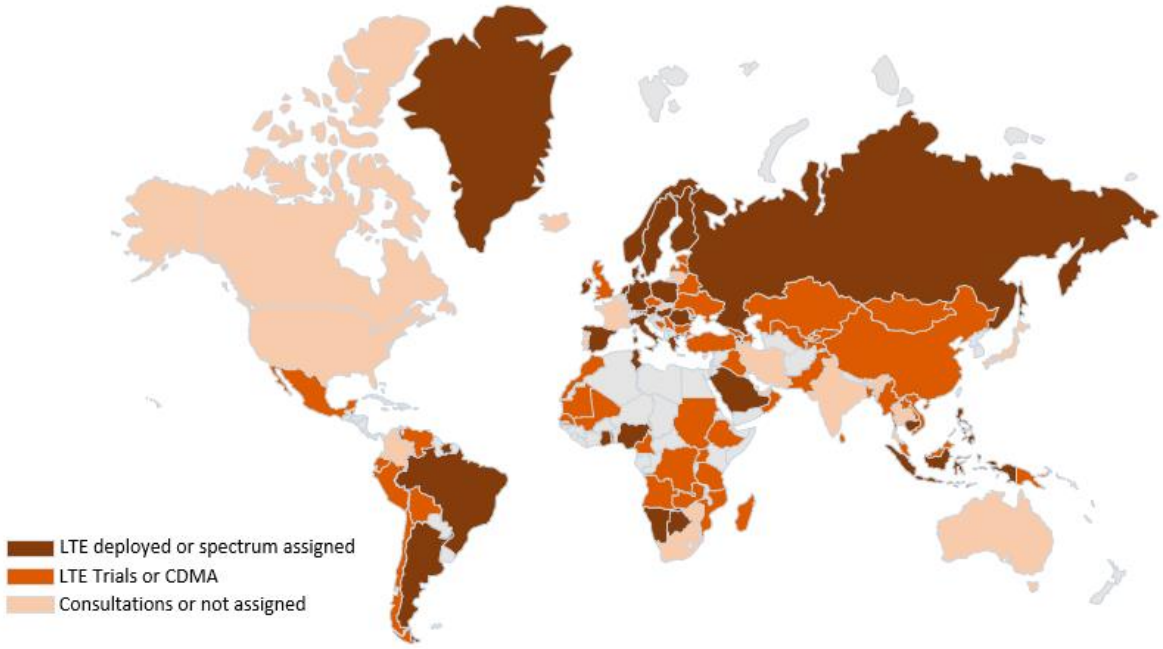


Figure 2. The world map of 380 MHz, 410 MHz and 450 MHz deployment.

Spectrum in the 400 MHz bands is today already allocated or in consultation in countries representing more than 6.8 billion people or 86 percent of the world population, which is a small increase since last year. Networks are being or are already deployed or in trial in countries representing more than 4.0 billion people or 51 percent of the world population, which is a small decrease since last year mainly due to shift in license ownership and changes of technology from CDMA to LTE. 2025 is expected to be the year when there are more LTE spectrum allocations in relation to CDMA.

3.1 Applications

Network deployments in the 400 MHz bands are suitable for many applications both as the primary carrier as well as backup service. The main applications implementing 400 MHz bands can be divided into four main segment Utility, Transport, Public Safety networks and Rural connectivity.

Connectivity to support applications and services for **utility** distribution network evolves to require private and dedicated connectivity network due to them supplying critical function in society. This includes connectivity to support smart grid, smart meters, smart city, local production, electrical vehicle charging stations and devices for the staff. Security of the utilities production, distribution, and delivery of services to their customers is the reason to build dedicated networks. The 400 MHz bands fit for providing the coverage required for these applications and can also cater for the capacity need. The organizations UTC (North America), EUTC (Europe), UTCAL (Latin America), UBBA (USA and Canada) have extensive information regarding Utility application.

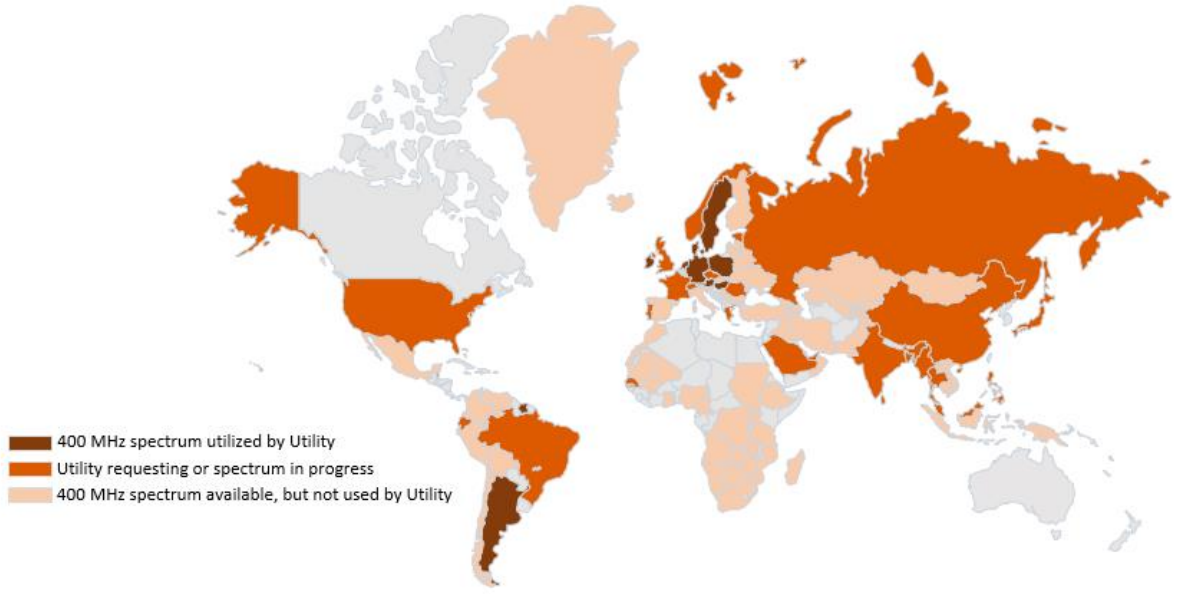


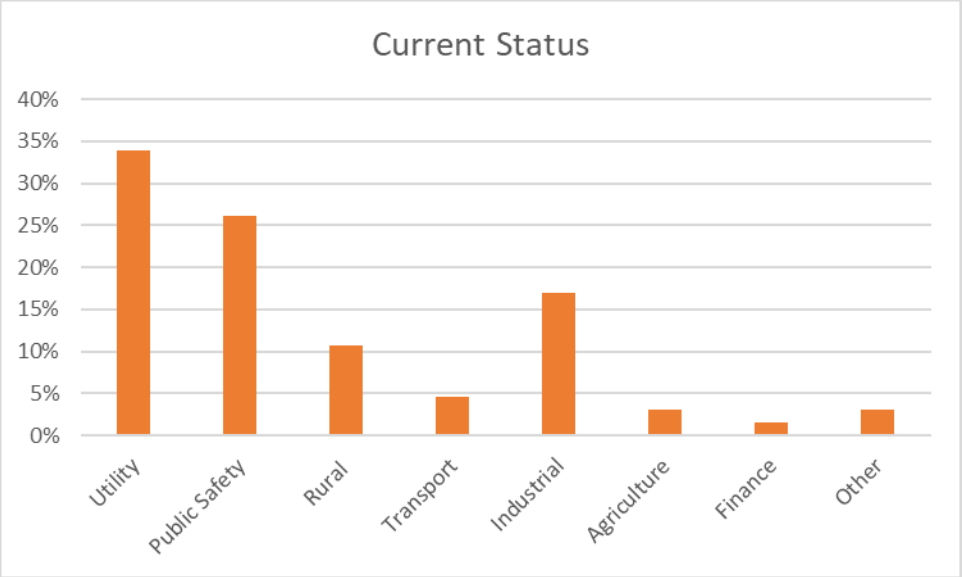
Figure 2. The world map of Utilities interest in the 400 MHz bands.

Public safety would use the 400 MHz bands as part of their connectivity solution either as primary or secondary carriers. Typical service would be broadband and machine to machine, but not limited to these. Networks are likely to have a nationwide coverage but could also be suitable for mobile unit with instant wide range coverage. TCCA provides additional information regarding the requirements for public safety application and services.

Applications for **transport** requires coverage over large range of areas, this includes railways, road service, logistics, mining, shipping, timber industry and agriculture. The solutions can vary from simple monitoring to remote control and assisted automation. The 400 MHz spectrum can provide a secure and continues connectivity for many of the applications and with complementary higher spectrum, today supported by most chipsets, be a seamless part of the overall solution. Like the utility network security of the information and the control of the network drives the requirements for a dedicate and private network.

Industrial use has expanded with Mining and Oil and Gas as the main segments.

Rural connectivity includes connectivity for rural schools, health care centers, rural ATMs and bank offices broadband also including services for unconnected or poorly connected consumers. This segment enables services that are critical for a modern society.



Graph 1. The global implementation per application.

The 400 MHz bands provide a service for these applications with an attractive business model. This is due to the capacity and coverage possibilities, which enable the desired traffic pattern with an affordable investment.

3.2 Africa

Listed below is a short status update per country for the most active countries in the last twelve to eighteen months.

- South Africa regulator have an ongoing consultation in the 450-470 MHz band.
- The regulator in Tunisia have initiated a consultation including 410-430 MHz and 450-470 MHz.
- There has been a general spectrum consultation Morocco including the 400 MHz bands.
- In Kenya spectrum in the 400 MHz have been reserved for LTE.
- Open Sky Services (MPS) holds the band 31 in Nigeria and have an ongoing procurement of system.
- The regulator in Uganda is looking at awarding the 380 MHz band for PPDR services.
- The band 31 license in Senegal is being evaluated for different industrial verticals.
- Telecom Namibia holds the band 31 license.
- The 450 MHz spectrum in Angola is in progress to evolve from CDMA to LTE by Angola Telecom.
- Botswana regulator BORCA has announced auction of the 450 – 470 MHz band for broadband use.
- Several countries have test or tactical systems deployed.

3.3 Americas

Listed below is a short status update per country for the most active countries in the last twelve to eighteen months.

- The utilities in the USA are seeking opportunities to obtain their own spectrum, mainly to be independent from third parties and to be in control of the connectivity. Both spectrum in the 410 MHz and in 380 MHz is being evaluated.
- Band 31 in Brazil has been taken back to the regulator for the two small licenses holders of the totally four spectrum owners due to lack of deployment. A number of Utilities in Brazil are conducting trials in the 410 MHz band with the goal of being awarded dedicated licenses for the industry.
- Colombia allocated 380 MHz band for PPDR and have had a consultation regarding the spectrum in the 450 MHz band.
- Alvis is the first former CDMA operator in Argentina evolving to LTE. The deployment includes both band 31 and band 87 with focus on, but not limited to, rural areas and agriculture.
- Suriname has a deployed network in the 450 MHz band for IoT services.
- Telmex holds a 450 MHz license in Mexico currently operational on CDMA and are evaluating to convert to LTE. Consultation of the 450 MHz band has been held during 2024.
- In Bolivia the utility evaluates the possibility of using the 450 MHz spectrum.
- Utilities in Canada are evaluating test allocation in rural areas in the 450 MHz spectrum.

3.4 Asia and Oceania

Listed below is a short status update per country for the most active countries in the last twelve to eighteen months.

- India has had several ongoing investigations for dedicated spectrum for different segments and verticals. 450 MHz has been included in proposals for railway and critical communication.
- China Unicom holds the band 31 license in China. No official statement has been made with regard to services to be delivered using the spectrum at this time. It has been evaluated for power grid and meters as well as railway communication.
- The license holder of band 31 in the Philippines has changed ownership. The new owner has not officially stated the plans for the operation.
- The band 31 and 72 license in Indonesia were taken back by the regulator and have been awarded to the government owned Bakrie Telecom (Btel). The expectation is that the operation will a dedicated network for governmental systems.
- Band 31 is available in Vietnam. Previous license holder was EVN Telecom.
- TNB in Malaysia have done a procurement of system for Band 31 for initial deployments in four areas.
- The Telecom Regulator in Pakistan have had consulted to evaluate the interest in evolving the current CDMA license to a technology neutral or LTE license.
- EWA have deployed a network for water meters in band 87.

- Aramco Digital have been awarded the 450 MHz band and procurement of systems are ongoing.
- The Cambodia regulator has awarded 60 MHz from 390-450 MHz to Titan. The focus is to provide broadband services.
- Singapore have allocated the 450 MHz spectrum DSTA.
- Dialog holds the 450 MHz license in Sri Lanka and are looking to evolve to LTE.
- Thailand is reviewing the use of 450 MHz to 470 MHz-band.
- Telecom Armenia holds the 450 MHz license in Armenia and provides a broadband service.

3.5 Europe

Listed below is a short status update per country for the most active countries in the last twelve to eighteen months.

- Elisa holds the band 31 license in Finland. The license is up for renewal in 2025.
- ice holds the band 31 license in Norway which is mainly used for consumer broadband in rural areas typical second homes, but during 2024 ice have started to convert the customers from the network to change focus to industrial use. ice is own by Lyse and utility in Nowray. A license for band 87 has been out for consultation with limited interest from the main operators, other industries were not included in the consultation.
- Teracom holds the band 31 license in Sweden. Their main use case is utilities in cooperation with Telenor. Teracoms focus on public safety and governmental users.
- Cibicom holds the band 31 license in Denmark with the initial focus for the IoT and are focusing on industrial solution. The Danish police holds the license in band 87 and are evaluating the options to progress.
- ESB holds the band 87 license in Ireland and is currently in the deployment phase for network infrastructure and devices. The main initial use case is to deploy connectivity for smart grid.
- PGE holds the band 31 license in Poland and have deployed some region in Poland for the smart grid, smart meter and field service handhelds. Polkomtel/Puls holds the band 87 license and will launch the MCX service in the beginning of 2025.
- Utility Connect holds the band 31 license in the Netherlands which is mainly used for smart meters and smart grid connectivity.
- 450connect holds the band 72 license in Germany. The operator has deployed and launched the first phases of the network and service. The network will be deployed with a focus on emergency voice communication, smart meters, smart grid and communication of other critical infrastructures.
- ArgoNET is holding the band 72 spectrum licenses in Austria. They have multiple regional CDMA and LTE networks have been deployed to address various utility applications including smart grid and MCX handhelds.
- SIRDEE holds the band 31 license in Spain and have given Telefonica the task to build and operate a public safety network. Network deployment has been on hold during 2024.
- EDP have had trial network in Portugal. However, the commercial terms have not been at a level enabling the benefits of the deployment, so the process to award the license is ongoing.

- Tele2 Russia, part of Rostelecom, holds the band 31 license in Russia. The network provides services for Public safety staff, industries and transport.
- HMEI holds the band 31 license in Hungary with primary service for smart city, smart grid and smart meters. The ownership of HMEI has changed during 2024 and the focus is to provide services for governmental users.
- Greece have allocated a license in band 87.
- Italy have allocated the 450 MHz spectrum for nomadic use as part of a tactical communication system.
- UK have had a consultation regarding 410 and 450 MHz spectrum and have proposed to progress with an allocation for the utilities within medium term time frame.
- France have done a consultation and there is an interest to move forward with an allocation for the band, but the path have not been set. EDF are reviewing a field test during 2025.
- Georgia have started to review the possibility of converting the license to technology neutral.

4 Overview of Spectrum

The LTE bands available in the 380 MHz to 512 MHz are currently:

- Band 31 (450 MHz)
- Band 72 (450 MHz)
- Band 73 (450 MHz), not in use
- Band 87 (410 MHz)
- Band 88 (410 MHz)

The 5G bands in progress for 3GPP release 18 in the 380 MHz to 512 MHz are currently:

- Band n31 (450 MHz)
- Band n72 (450 MHz)

The 5G bands in progress for 3GPP release 19 in the 380 MHz to 512 MHz are currently:

- Band n87 (410 MHz)
- Band n88 (410 MHz)

All bands are standardized to support LTE, LTE-M and LTE-NB (NB-IoT). Ongoing strategic work with TCCA, EUTC, UTCAL, UTC and other parties in the ecosystem are progressing to identify spectrum allocation in the 380 MHz and 470 MHz bands. During the last twelve months several enquiries have been made in regard to the evolution and standardizing bands for 5G, current plan is that band n31 and n72 will be part of 3GPP release 18 and band n87 and n88 will be part of release 19. The 380 MHz Band is currently ongoing with a plan to be part of 3GPP release 20.

The initial discussion regarding 6G has been initiated.

5 Global spectrum allocations

450 MHz provides a more or less global footprint, and the 410 MHz footprint is increasing rapidly. The number of commercial operations is fairly limited in relation to the global mobile industry. This is due to having only one

operator per country. The spectrum attracts interest from many segments and the introduction of LTE has made it easier to deploy networks. CDMA licenses are gradually being converted and narrowband systems that have been widely used in this spectrum are being evolved to commercial mobile networks and to more capable and secure private networks which enable additional bandwidth to be available. The global trend of allocating spectrum for private and dedicated networks drives regulators to find fitting frequency ranges these varies a lot pending on the region.

The global variation of spectrum allocation for dedicated or private network can be seen in the table below.

Spectrum Region	410 MHz 450 MHz	700 MHz	800 MHz 850 MHz 900 MHz	1600 MHz 1800 MHz	2100 MHz 2300 MHz	2500 MHz 2600 MHz	3500 MHz 3700 MHz	4900 MHz	2nd lease
Africa	B31/72/87	B28/68							Yes
Asia	B31/72/87		B26/27			B41		n79	Yes
Europe	B31/72/87	B28/68		B3	B40 n40	B38 n38/n90	B42/43 n77/78		Yes
Middle East	B31/72/87				B1 n65		B43 n77/78		
North America	B31/72/87	B14	B106	B54			B48		Yes
Oceania Pacific	B31/72/87		B26/27					n79	Yes
South America	B31/72/87		B26/27		B40 n40	B38 n38	B42/43 n77/78		Yes

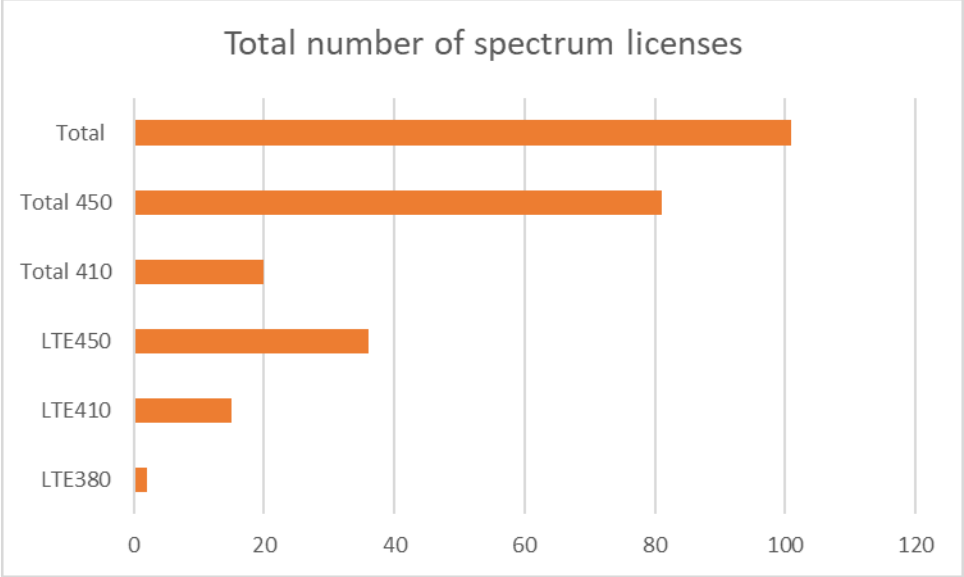
Table 1. Private network spectrum allocations per region

The 450 MHz bands are today the only common band for all regions in the world. The bands that are not used by commercial operators are 410, 450, 700 (B68), 850 (B27), 900 (B106) and 4900 (n79) MHz.

5.1 410 MHz and 450 MHz spectrum allocations listed by 450 MHz Alliance

The annual global spectrum update by 450 MHz Alliance collects information from regulators, operators and suppliers. The following information has been obtained from the responses of 74 regulators. In addition to the regulators, a number of operators, suppliers and industry organizations have made their contributions, which makes the total number of countries with confirmed status 122.

The total number of licenses globally is 101. The progress varies from consultation to deployed and operational networks. Detailed information can be found in the table below.



Graph 2. Number of licenses globally for 380 MHz, 410 MHz and 450 MHz.

Progress of deployments in these spectrum bands is controlled by the individual country. Currently there is no single stakeholder that drives the global progress of evolving or deploying the bands. Below, are the tables showing the status per region globally.

	Deployments	LTE Deployments	Consultation	Not in use
Africa	22	6	3	2
Americas	9	5	7	2
Asia and Oceania	18	5	7	5
Europe	25	16	6	15
Total	74	32	23	24

Table 1. Number of countries per region and globally with 380 MHz, 410 MHz and 450 MHz.

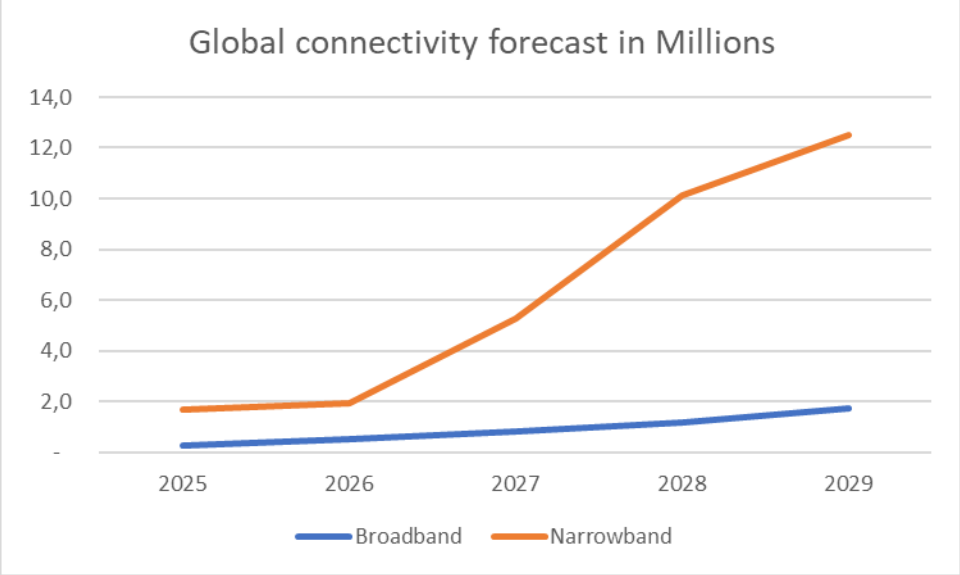
6 General outlook

The evolvement towards LTE of the spectrum in 380 MHz to 512 MHz is expected to increase. Bandwidth and coverage requirements for private and closed networks as well as public networks for rural communication are getting more interest and with this also an increased interest for the lower spectrum bands. With only twenty active operation and spectrum allocated in over seventy countries the expansion can be very fast. The ongoing consultations and the interest from government and companies are likely to drive the ecosystem even faster.

The estimation for connections for the coming years considering the currently know operations in progress are listed in the table below.

	2024	2025	2026	2027	2028
Broadband	263 100	526 000	825 000	1 150 000	1 725 000
Narrowband	1 665 000	1 924 000	5 286 000	10 145 000	12 495 000

Table 6. Global forecast of connections for services in the 380 to 470 MHz.



Graph 3. Global forecast of connections for services in the 380 to 470 MHz in millions of units.

Broadband includes all connections with a higher category than Cat. 1 and Narrowband includes Cat.1, LTE-M and NB-IoT.