



Approaches to 5G Spectrum for Industry 4.0

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Introduction

Advanced mobile networks, most notably 5G, are set to drive major advances in manufacturing and production in order to be a significant contributor to the realisation of Industry 4.0¹. 5G can help significantly improve productivity, reliability and efficiency through advanced monitoring, control and augmentation of the manufacturing and production processes, and the wider supply chain. This is possible through higher bandwidths, lower latencies, ultra-reliable communications, better support for machine to machine communications as well as features like network slicing and edge computing.

Policymakers play a vital role by managing the spectrum which underpins 5G access and investment. This paper lists the different approaches regulators have taken to making 5G spectrum available for mobile networks that can be used for Industry 4.0 (see table 1) in key markets worldwide. The aim is to help the manufacturing and telecommunications ecosystems understand what 5G spectrum they can benefit from in different countries and under which licensing approach. The GSMA's views on the different approaches available to regulators is summarised in a separate public policy position paper, entitled: 'Mobile Networks for Industry Verticals: Spectrum Best Practice'².

Context

Mobile services for Industry 4.0 can be deployed in several different ways. At the highest level there are two broad network categories – 'private' and 'public' networks. Private networks are designed, installed and run exclusively to the manufacturer so these are normally closed networks. Contrastingly, public networks are built for, and made available to, many different organisations and individuals. Public networks can use features like network slicing to create a form of 'dedicated network' for enterprise, providing tailored network characteristics and support for quality of service guarantees. A hybrid of both private and public network approaches can be used and is attractive given the unique benefits of both approaches³.

¹ For more information on the manufacturing use cases and technological solutions please see the GSMA's web site: <https://www.gsma.com/iot/manufacturing/>

² The paper is available here: <https://www.gsma.com/spectrum/resources/mobile-networks-for-verticals/>

³ For more information on 5G private and dedicated networks for manufacturing, please see the GSMA's paper entitled '5G IoT Private & Dedicated Networks for Industry 4.0'

Private and public 5G networks can be deployed in all countries today under traditional commercial mobile spectrum management approaches⁴ where exclusive licences are awarded, typically by auction, to mobile operators⁵ who then can, and do, use their licensed spectrum to deploy private and public networks, for example to manufacturing and production companies. To ensure industrial companies' needs are being met, some regulators have put in place licence obligations to ensure third parties, such as manufacturers, can sublease spectrum from operators.

Some regulators have chosen alternative approaches to making mobile spectrum available to industry verticals, with approaches such as local spectrum set-asides and shared spectrum. This allows a wider variety of players to access mobile spectrum – rather than just those willing, financed and able to participate in spectrum auctions (i.e. mobile operators and Internet Service Providers). Such approaches are not the norm and views vary as to their appropriateness, as a reduction in the amount of spectrum available for public 5G networks has the potential to impact network quality, capacity and coverage across the wider customer base, and affect the speed of rollouts. Furthermore, the greater amount and variation of mobile operators' spectrum assets means they can support a more diverse set of vertical requirements than are possible in set-asides to date.⁶

Spectrum approaches that support 5G networks for Industry 4.0

In most cases, regulators have either entrusted mobile operators to support the industry or have yet to make a decision. The following table provides an overview of 5G licensed spectrum made available⁷ to mobile operators as well as through approaches like set-asides or sharing. This table focuses on leading countries in both the manufacturing and IoT domains as well as other markets which have made notable spectrum decisions.

⁴ It should be noted that spectrum has long been made available for private mobile networks outside of the commonly used 3GPP mobile bands used by commercial cellular operators. These bands are not considered in this paper as the focus is on 5G network technology

⁵ Auctions are open award mechanisms therefore any company can typically participate, not just existing mobile operators

⁶ These issues are discussed in more detail in the afore mentioned public policy position paper (see footnote 2)

⁷ The table includes currently assigned spectrum under the various mechanisms. It does not include future plans which may be subject to delays or change

Country	3GPP 5G NR bands licensed to MNOs	3GPP 5G NR bands available through sharing or local/vertical set-asides for manufacturing <i>[Frequency band, 3GPP band #, total usable range where known]</i>
Brazil	700 MHz (n28) 80 MHz 850 MHz (n5) 50 MHz 1.8 GHz (n3) 150 MHz 2.1 GHz (n1) 120 MHz 2.6 GHz (n41) 120 MHz	
Canada	600 MHz (n71) 72 MHz 700 MHz (n28) 69 MHz 1.9 GHz (n2/n66) 122 MHz 2.6 GHz (n41) 232 MHz	
China	700 MHz (n28) 80 MHz 850 MHz (n5) 20 MHz 900 MHz (n8) 52 MHz 1.8 GHz (n3) 140 MHz 1.9 GHz (n39) 40 MHz 2.1 GHz (n1) 105 MHz 2.3 GHz (n40) 90 MHz 2.6 GHz (n41) 160 MHz 3.5 GHz (n77) 300 MHz 4.8 GHz (n79) 200 MHz	
Finland	700 MHz (n28) 60 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 69 MHz 1.8 GHz (n39) 149 MHz 2.1 GHz (n1) 119 MHz 2.6 GHz (n41) 190 MHz 3.5 GHz (n78) 390 MHz 26 GHz (n258) 2,400 MHz	Local set-aside: 26 GHz (n258) (24.25 – 25.1 GHz) 2.3 GHz (n40) (2,300-2,320 MHz) NB. MNOs are contractually obligated to sub-lease spectrum in 3.5 GHz (n78) to verticals where they are unable to provide competitive service offerings
France	700 MHz (n28) 60 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 70 MHz 1.8 GHz (n39) 198 MHz 2.1 GHz (n1) 119 MHz 2.6 GHz (n41) 140 MHz	Broadband Private Mobile Radio (BB-PMR), often using LTE technologies: 2.6 GHz (n38) (2,575-2,615 GHz)
Germany	700 MHz (n28) 60 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 70 MHz 1.5 GHz (n50) 40 MHz 1.8 GHz (n39) 120 MHz 2.1 GHz (n1) 128 MHz 2.6 GHz (n41) 190 MHz 3.5 GHz (n78) 300 MHz	Local set-aside: 3.5 GHz (n78) (3.7-3.8 GHz)

India	850 MHz (n5) 40 MHz 900 MHz (n8) 50 MHz 1.8 GHz (n3) 110 MHz 2.1 GHz (n1) 120 MHz 2.3 GHz (n40) 100 MHz 2.6 GHz (n41) 190 MHz	
Italy	700 MHz (n28) 60 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 29 MHz 1.5 GHz (n50) 40 MHz 1.8 GHz (n39) 150 MHz 2.1 GHz (n1) 140 MHz 2.6 GHz (n41) 150 MHz 3.5 GHz (n78) 240 MHz 26 GHz (n258) 800 MHz	
Japan	700 MHz (n28) 60 MHz 850 MHz (n5) 60 MHz 900 MHz (n8) 30 MHz 1.5 GHz (n50) 70 MHz 1.8 GHz (n3) 150 MHz 1.9 GHz (n39) 30 MHz 2.1 GHz (n1) 120 MHz 2.6 GHz (n41) 80 MHz 3.5 GHz (n78) 620 MHz 4.8 GHz (n79) 100 MHz 28 GHz (n257) 900 MHz	Local licences: 2.6 GHz (n41) (2,575-2,595 MHz*) 28 GHz (n257) (28.2 - 28.3 GHz)
Mexico	600 MHz (n71) 70 MHz 700 MHz (n28) 90 MHz 800 MHz (n20) 20 MHz 850 MHz (n5) 40 MHz 1.9 GHz (n2) 120 MHz 2.1 GHz (n66) 140 MHz 2.6 GHz (n41) 140 MHz 3.5 GHz (n78) 50 MHz	
Netherlands	700 MHz (n28) 60 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 70 MHz 1.8 GHz (n39) 140 MHz 2.1 GHz (n1) 120 MHz 2.6 GHz (n41) 190 MHz	
South Korea	850 MHz (n5) 60 MHz 900 MHz (n8) 20 MHz 1.8 GHz (n3) 110 MHz 2.1 GHz (n1) 120 MHz 2.6 GHz (n41) 100 MHz 3.5 GHz (n78) 280 MHz 28 GHz (n257) 2,400 MHz	

Sweden	700 MHz (n28) 40 MHz 800 MHz (n20) 60 MHz 900 MHz (n8) 70 MHz 1.8 GHz (n39) 140 MHz 2.1 GHz (n1) 134 MHz 2.6 GHz (n41) 190 MHz 28 GHz (n257) 1,000 MHz	
UK	800 MHz (n20) 150 MHz 900 MHz (n8) 70 MHz 1.5 GHz (n50) 40 MHz 1.8 GHz (n39) 133 MHz 2.1 GHz (n1) 140 MHz 2.3 GHz (n40) 40 MHz 2.6 GHz (n41) 190 MHz 3.5 GHz (n78) 270 MHz	Local set-aside (for indoor & outdoor licences): 3.7 GHz (n78) (3.8-4.2 GHz)
US	600 MHz (n71) 69 MHz 700 MHz (n28) 94 MHz 850 MHz (n5) 50 MHz 1.9 GHz (n2/n66) 130 MHz 2.3 GHz (n40) 31 MHz 2.6 GHz (n41) 190 MHz CBRS/3.5 GHz (n48) 70 MHz (PAL)** 24 GHz (n258) 638 MHz 28 GHz (n257) 646 MHz 37 GHz (n260) 990 MHz 39 GHz (n260) 1,255 MHz 47 GHz (not NR) 989 MHz	Spectrum sharing: CBRS/3.5 GHz (n48) – (GAA** tier offers 80-150 MHz in 3550 MHz-3700 MHz)



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