Spectrum Policies to Enable Mobile Broadband Goals in Malaysia

Review of MCMC's refarming proposals for the 700 MHz, 2300 MHz, and 2600 MHz bands based on international spectrum management practice

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Executive Summary

This report has been prepared by Telecommunications Management Group, Inc. (TMG) on behalf of YTL Communications Sdn Bhd (YTLC). It focuses on the Malaysian Communications and Multimedia Commission (MCMC) public inquiry (PI), "Allocation of spectrum bands for mobile broadband service in Malaysia," which sets out proposals regarding the timeframe, implementation, technical matters, and spectrum fees related to revised allocation and assignment of the 700 MHz, 2300 MHz, and 2600 MHz bands in Malaysia. The report considers MCMC proposals in light of how pro-competitive international spectrum policy approaches and experiences relate to Malaysia's market conditions and the connectivity goals included in the National Fiberization and Connectivity Plan (NFCP).

Appropriate spectrum mix for all operators will facilitate fulfilling NFCP targets

Malaysia's "mobile first" market status (termed as such by the World Bank) makes spectrum a particularly critical input for Malaysia to meet its NFCP targets. Effective spectrum management policies will allow the country to leverage market forces to achieve these targets, including ensuring that 98% of populated areas have access to an average connection speed of 30 Mbps.

The proposals to refarm the 700 MHz band provide MCMC an opportunity to ensure that its spectrum policies are designed and implemented to best achieve these connectivity targets by creating a competitive environment in which all mobile providers possess the necessary spectrum assets to achieve them. To take advantage of this opportunity, MCMC's refarming policies should consider the following key issues:

1. **Make available sub-1 GHz spectrum to late entrants to foster viable competitors**

   Spectrum bands below 1 GHz provide wider coverage per base station than mid-band spectrum, resulting in broader coverage with a smaller number of base stations. Regulators in markets worldwide have recognized the value of balanced spectrum portfolios for mobile providers and taken proactive measures to ensure that late entrants in the mobile market, have access to low-band spectrum when it becomes available.

2. **Ensure balanced spectrum portfolios**

   An analysis of the mobile market's spectrum holdings clearly shows Malaysia as a global outlier in terms of access to balanced spectrum portfolios including bands below and above 1 GHz when the six facilities-based providers' holdings are taken into account. While established providers, namely Celcom, Digi, Maxis, and Umobile, all have relatively similar sub-1 GHz holdings, late entrants, such as YTLC, have yet to be assigned such low-band spectrum. MCMC should look to its successful past experience in rebalancing spectrum portfolios as it advances its refarming plans, particularly in the 700 MHz band.

3. **Continue pro-competitive approach to spectrum allocation policy**

   Malaysia's mobile broadband successes to date are rooted in MCMC's promotion of competition. Disrupting the spectrum bands currently delivering late entrants' 4G services would likely harm competition in Malaysia's mobile sector, especially considering ongoing market consolidation, and may discourage future investment.

4. **Maintain support for light-touch mechanisms to foster efficient spectrum use**

   MCMC's successful policy on spectrum trading and sharing is consistent with international preference for voluntary refarming and allows spectrum use to evolve with a changing market. Such approaches should continue to be the main tool to ensure efficient use of Malaysian spectrum, notably in the 2300 MHz band.

5. **Foster competitive measures for late entrants, particularly with potential mobile market consolidation**

   International experience shows that increased concentration of spectrum could lessen competition in the market. Spectrum concentration in the wake of the Celcom-Digi merger could be further compounded by MCMC's proposed approach to vacate and reassign the 2300 MHz and refarm the 2600 MHz bands. This combination of factors may potentially result in late entrants, namely YTLC and Webe, exiting the market due to disruptions in their ability to provide services to their customers, and leaving behind significant stranded investments. Such a result would further hamper competition and investment, making it potentially more difficult for Malaysia to meet NFCP targets.

Refarming the 700 MHz band should be aimed at fostering competition and meeting NFCP targets

Refarming is one spectrum management tool that may be used to ensure spectrum is put to its highest-value use. The triggers for refarming include meeting new demand, promoting increased spectrum efficiency, and international harmonization. MCMC's proposal to assign the 700 MHz band via nationwide spectrum assignments (SAs) is rooted in the recognition that allocation of the band for mobile broadband service satisfies growing demand and is important to enhance coverage and capacity. However, the proposal specified in the PI likely would hamper the ability of late entrants, such as YTLC, to contribute to NFCP targets.

In considering the 700 MHz band award approach, MCMC should analyze the sub-1 GHz frequency range as a whole, including existing assignments and possible future spectrum assignments. MCMC's spectrum policy should continue to promote balanced spectrum portfolios, as was the case with the refarming of the 900 MHz and 1800 MHz bands in 2016. In order to balance the mix of spectrum bands among Malaysia's operators, MCMC should consider assigning a 2x20 MHz block in the 700 MHz band to providers that do not currently hold sub-1 GHz spectrum, such as YTLC. The remaining spectrum in the 700 MHz band could then be assigned to other providers already holding sub-1 GHz spectrum. Such an approach is common internationally. Spectrum regulators in Germany, Ireland, the Netherlands, Singapore, and the United Kingdom have all adopted digital dividend assignment policies to ensure balanced holdings below 1 GHz for mobile broadband. Moreover, the above-mentioned approach allows operators to aggregate carriers within their sub-1 GHz holdings, ensuring efficient spectrum use due to larger blocks of combined frequencies.

To promote continued investment and innovation in the mobile market, MCMC should also consider forward-looking policies to avoid inflating spectrum prices. By implementing alternative mechanisms, such as coverage and network roll out requirements, MCMC could allow operators to invest to achieve national goals of providing expanded, affordable coverage and meeting NFCP targets.

Conversion is a more appropriate path for the 2300 MHz band than vacating and reassigning it

MCMC's proposal to vacate the current 2300 MHz band apparatus assignments (AAs) and reassign new, nationwide SAs will likely disrupt services delivered to end users and impose significant migration costs on existing licensees. In addition, the proposal does not appear consistent with generally accepted regulatory objectives justifying spectrum refarming. Instead, it may undermine MCMC's stated goals of attracting investment, fostering competition, and improving connectivity and affordability.

Malaysia's current 2300 MHz band plan ensures efficient spectrum use, both for LTE and future 5G services. By contrast, the vacating and reassigning proposal for the 2300 MHz band does not appear to provide any improvement in spectrum efficiency. Malaysian operators, and in particular YTLC, have already voluntarily redeployed their spectrum in order to provide more efficient, best-in-class technologies—namely migrating from WiMAX to LTE. Instead of fostering a vibrant mobile market, the proposed mandatory refarming plan would divert critical resources better utilized to complete YTLC'S migration process and engage in meaningful network deployment and upgrades. In addition, it would impede late entrants from achieving the NFCP's targets, as well as prevent them from obtaining access to the balanced mix of spectrum assets necessary to be viable long-term competitors.

A direct conversion of AAs to SAs would be more appropriate, and in line with 2300 MHz refarming efforts in countries such as Australia, as well as MCMC's proposal for the 2600 MHz band. This conversion would increase flexibility for operators to deploy the most up-to-date technologies and introduce a more cohesive, technology-neutral framework. Perhaps more importantly, would provide legal certainty to underpin investment while saving the significant resources needed to vacate the band.

1. Achieving NFCP targets requires the right spectrum mix

1.1. Spectrum is a key enabler to meet NFCP targets

Globally, spectrum is recognized as a key enabler for the effective roll-out of digital connectivity services, particularly in emerging countries. In Malaysia, close to 80% of the population is online, primarily via mobile networks. As described by the World Bank, Malaysia is a "mobile-first country."[1] As such, it is no surprise that MCMC's PI links spectrum policies to achieving the goal of offering broadband connections with an average speed of 30 Mbps in 98% of populated areas by 2023 (NFCP targets).[2] But to achieve NFCP targets, MCMC's policies in relation to the proposed spectrum refarming of the 700 MHz, 2300 MHz, and 2600 MHz bands will require implementation of a process that ensures an appropriate balance of spectrum below and above 1 GHz for all operators.

1.1.1. Balanced spectrum portfolios are critical to achieving NFCP targets

Sub-1 GHz spectrum (i.e., low-band spectrum) is essential for late entrants[3] to effectively compete against established providers[4] in the market. The larger coverage areas provided by lower bands are especially important for such players as well as for achieving coverage target of NFCP (98% of populated areas), as these bands provide more coverage for the initial investment compared to mid-band spectrum, which would require many more base stations and therefore higher investment for the same coverage.

> "The ACM [of the Netherlands] is of the opinion that the distribution of spectrum must be sufficiently balanced to guarantee effective competition after the auction. An optimal distribution of scarce frequency space must meet this requirement. In view of this, it is undesirable that as a result of the auction outcomes too high a concentration of spectrum is created for one MNO. It is also undesirable that one of the MNOs has too little spectrum as a result of the auction results."[5]

Internationally, regulators and policymakers recognize the value of mobile providers having relatively balanced spectrum portfolios. Because low bands (i.e., sub-1 GHz bands) were the first to be assigned for commercial service, governments have taken proactive measures to ensure that late entrants, generally serving fewer subscribers, have access to low-band spectrum when it becomes available. For example, when assigning sub-1 GHz bands recovered from the digital television transition, countries such as Germany, Ireland, the Netherlands, Portugal, Spain, and the United Kingdom have acknowledged: (i) the value of ensuring access to low-band spectrum; (ii) the need to have an equitable balance and access to spectrum; and (iii) the critical need to avoid giving operators with sub-1 GHz spectrum an unmatchable advantage (in terms of propagation over higher bands, costs, and efficiency) over those competitors without sub-1 GHz spectrum (i.e., late entrants).

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[1] World Bank, Malaysia's Digital Economy, A New Driver of Development, (Sept. 2018), p.50, available at http://documents.worldbank.org/curated/en/435571536244480293/pdf/129777-WP-PUBLIC-sept-11-1pm-World-Bank-2018-Malaysia-Digital-Economy-report.pdf.

[2] See MCMC, PI, para. 1.1.

[3] In the context of the Malaysian mobile market, the term "late entrants" is used to reference YTLC and Webe throughout this report.

[4] The term "established providers" is used to refer to Celcom, Digi, Maxis, and Umobile throughout this report.

[5] ACM, Recommendations on possible measures for frequency auction, (Apr. 9, 2019), para. 186 available at https://www.acm.nl/sites/default/files/documents/frequentieveiling-advies-2019.pdf (in Dutch).

For these reasons, when auctioning sub-1 GHz spectrum, regulators and policymakers in Ireland, Germany, Portugal, Singapore, and the United Kingdom, among others, have introduced set asides or spectrum caps to allow new entrants access to such spectrum. The Netherlands and Singapore (Box 1), for example, have gone further and specifically reserved low-band spectrum for newcomers, recognizing that without such measures many newcomers would effectively be excluded.[6]

As noted by the Irish regulator, "highly asymmetric distributions of sub-1 GHz spectrum could be detrimental to competition downstream and for this reason, various jurisdictions have imposed sub-1 GHz caps within their auctions."[7]

Similarly, in the United Kingdom, Ofcom justified its spectrum caps decision for the 800 MHz auction as a way to provide "**equality of opportunity for competitors to be able to compete in future mobile markets**"[8] and to "**ensure that the Auction should not result in overall spectrum holdings which distort competition**."[9]

Box 1: Singapore's balanced new entrant spectrum auction

In 2016, Singapore began a multi-band spectrum auction covering the 700 MHz, 900 MHz, 2300 MHz, and 2600 MHz bands.[10] The auction process was designed to include a New Entrant Spectrum Auction (NESA) followed by a General Spectrum Auction. The NESA included potential assignments of up to 2x10 MHz in the 900 MHz band and up to 40 MHz in the 2300 MHz band, allowing the potential new entrant to obtain spectrum both above and below 1 GHz. This arrangement positioned the new entrant with a mix of bands that was intended to allow it to compete effectively against three established providers, all of whom already held spectrum both above and below 1 GHz.

The NESA concluded with Australian operator TPG securing 2x10 MHz in the 900 MHz band and 40 MHz in the NESA.[11] TPG subsequently participated in the General Spectrum Auction, obtaining a further 10 MHz in the 2600 MHz band.

Access to sub-1 GHz spectrum will also be critical as countries begin deploying 5G networks, which will rely upon a mix of not only low- and mid-band spectrum, but also high-band frequencies (e.g., millimeter wave bands).[12] Spectrum in the sub-1 GHz range provides wide coverage and superior in-building

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[6] See Dutch Ministry of Economic Affairs, Agriculture, and Innovation, Regulation of the Dutch Ministry of Economic Affairs, Agriculture, and Innovation to establish the application and auction procedure for licenses for the frequency spectrum in the 800, 900 and 1800 MHz bands for mobile communication applications, 36-37 (Jan. 6, 2012), p. 36-37.

[7] See ComReg, Response to Consultation and Draft Decision: Multi-band spectrum release, Document No. 11/60a (Aug. 24, 2011), para. A 6.127, available at https://www.comreg.ie/csv/downloads/ComReg1160a.pdf

[8] Ofcom, "Assessment of future mobile competition and award of 800 MHz and 2.6 GHz", (July 24, 2012), para. 86 available at http://stakeholders.ofcom.org.uk/spectrum/spectrum-awards/awards-archive/completed-awards/800mhz-2.6ghz/keydocuments/

[9] Id.

[10] Info-Communications Development Authority, "Auction of 700 MHz Spectrum rights (2016), 900 MHz spectrum rights (2016), 2.3 GHz spectrum rights (2016) and 2.5 GHz spectrum rights (2016): Information Memorandum," (April 29, 2016), https://www2.imda.gov.sg/-/media/Imda/Files/Regulation-Licensing-and-Consultations/Frameworks-and-Policies/Spectrum-Management-and-Coordination/Spectrum-Rights-Auctions-Assigment/Final-Information-Memorandum.pdf?la=en.

[11] IMDA, "700 MHz Spectrum Rights (2016), 900 MHz Spectrum Rights (2016), 2.3 GHz Spectrum Rights (2016) and 2.5 GHz Spectrum Rights (2016) Auction ("2016 Spectrum Auction")," https://www2.imda.gov.sg/regulations-and-licensing-listing/spectrum-management-and-coordination/spectrum-rights-auctions-and-assignment/700-mhz-spectrum-rights-900-mhz-spectrum-rights-2-3-ghz-spectrum-rights.

[12] See, for example, Ericsson, "5G spectrum: strategies to maximize all bands," https://www.ericsson.com/en/networks/trending/hot-topics/5g-spectrum-strategies-to-maximize-all-bands.

penetration, which will be particularly useful for massive IoT deployments and connections that do not require higher speeds. Mid-band spectrum, between 1 GHz and 6 GHz, will be key capacity bands, enabling greater throughput and low latencies for both enhanced mobile broadband (eMBB) and ultra-reliable low-latency communications (URLLC) for mission-critical IoT applications. High-band spectrum, in ranges above 6 GHz, is expected to be deployed in bandwidths of more than 100 MHz and will enable very high throughput for eMBB.

1.1.2. International comparison supports need to balance spectrum holdings in Malaysia

The case for the balanced spectrum holdings described in section 1.1.1 is supported by analysis of the competitive impact of balanced spectrum holdings in Malaysia and other markets. To analyze the distribution of spectrum and assess whether it contributes to a competitive market, TMG considered the key point of whether a player will be able to effectively provide service with its given spectrum holdings. As noted above, the propagation characteristics of the sub-1 GHz bands, as compared to the mid-band spectrum, stand out as particularly important due to their wide coverage area and consequent reduction of deployment costs to achieve large coverage areas.

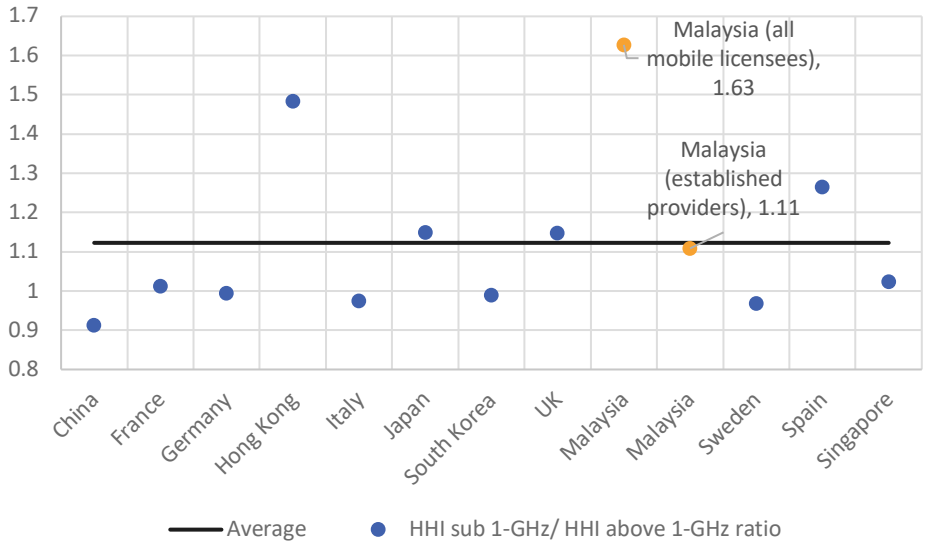
One way to assess concentration of spectrum bands and a mobile operator's future ability to compete is by looking at the Herfindahl Hirschman Index (HHI) of the concentration of sub-1 GHz band spectrum compared to active commercial bands between 1-3 GHz.[13] This comparison provides insight into the market circumstances for spectrum in both frequency ranges, as opposed to looking at simply the sum total of overall spectrum holdings, which would fail to consider the actual spectrum needs required to provide service and more effectively compete with established providers. Therefore, TMG looked at the HHI of sub-1 GHz band compared to bands above 1 GHz.[14]

This exercise did not test the competitiveness of the number of players in the market, but rather how an exogeneous factor, such as spectrum holdings below 1 GHz, may impact those players' ability to compete in the market (i.e., by having both types of spectrum). While we recognize that mobile providers do not need symmetric spectrum holdings to effectively compete, an ideal ratio would be around one, signifying a relatively balanced distribution of sub-1 GHz spectrum and higher-band spectrum among all competitors in the market.

[13] The sub 1-GHz bands included were: 450 MHz, 700 MHz, 800 MHz, 900 MHz bands, and the 1-3 GHz bands were: 1400 MHz, 1800 MHz, 1900 MHz, 2100 MHz, 2300 MHz, 2500 MHz, and 2600 MHz bands. The analysis included 12 countries across Europe and Asia.

[14] The ratio was calculated as follows: $Abilty\ to\ compete = \frac{HHI_{sub\ 1-GHz}}{HHI_{above\ 1-GHz}}$

Figure 1: Ratio of HHI index of sub-1 GHz bands to above 1-GHz bands in selected countries



Source: TMG analysis

As seen in Figure 1, the average of $\frac{HHI_{sub\ 1-GHz}}{HHI_{above\ 1-GHz}}$ in the sample is just above 1.1, meaning that in the majority of the markets analyzed, there are relatively similar HHIs for both types of spectrum. Since HHI is highly influenced by the number of players in the market, this is also a good measure of the number of players holding spectrum in both types of bands. Malaysia's HHI ratio, however, stands out as a clear outlier.[15] This reflects the state of play in the market where many more players hold spectrum above 1 GHz than below 1 GHz, resulting in a ratio of 1.63.[16] However, when considering the spectrum holdings of only the four established providers in the market that ratio drops to the average across the other countries. This suggests that while a number of players hold spectrum above 1 GHz, only a few of them hold the mix of spectrum that will enable them to effectively compete in the market in the long term. This scenario provides further support for MCMC to ensure that the new sub-1 GHz spectrum coming into the market (i.e., the 700 MHz band) is used to secure a more balanced spectrum portfolio for mobile operators currently without it.

1.2. Established providers' existing spectrum assets are sufficient to meet NFCP targets

Existing spectrum holdings of Malaysia's established providers suggest that these providers have sufficient capacity to fulfill the NFCP targets. As discussed in sections 2 and 3, this further limits the justification for assigning 700 MHz blocks exclusively among these four operators or for vacating and reassigning the 2300 MHz band as currently proposed by MCMC. Instead, considering average throughput levels and population coverage achieved by year-end 2018, other measures such as migrating from 2G/3G to 4G

[15] Hong Kong, with a ratio of 1.48, is another outlier. Similar to Malaysia's case, this is due to two additional players holding spectrum in the above 1-GHz spectrum; however, one of them (21 Vianet) offers fixed wireless access via LTE.

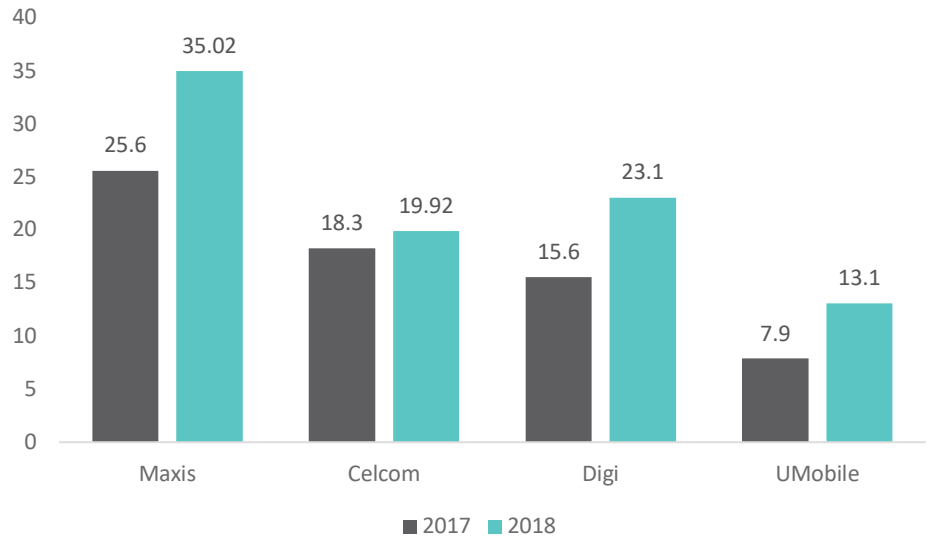
[16] This ratio includes *all* spectrum licensees, including spectrum holdings from Altel, AsiaSpace, and REDtone that are leased to third parties. For the regional holdings of AsiaSpace and REDtone in the 2300 MHz band, the spectrum was weighted based on the population coverage of the area of the regional license in question. Please note that Altel, AsiaSpace, and REDtone have not yet deployed their own networks.

networks and leveraging LTE-Advanced upgrades such as carrier aggregation (CA) will likely allow these providers to meet, and even exceed, the NFCP targets with their current spectrum holdings.

1.2.1. Established providers are able to meet the NFCP targets with their current spectrum holdings

MCMC figures show that the established providers are able to meet the NFCP throughput and coverage targets with their current spectrum assignments via 4G deployments. As indicated in the 2018 MCMC Industry Performance Report, one of the established providers (Maxis) already fulfills the NFCP throughput target, with average downlink speeds for all established providers ranging from 13 to 35 Mbps (Figure 2).[17] Considering that these four operators have very similar spectrum assets (see Figure 11), the difference in the throughput is mainly due to their network topology. Thus, as shown by Maxis's performance, it is still possible to improve performance by using network densification and other techniques, as more capacity could be provided with an increased number of base stations and the use of CA.

Figure 2: Average download throughput for wireless broadband in Malaysia (Mbps)

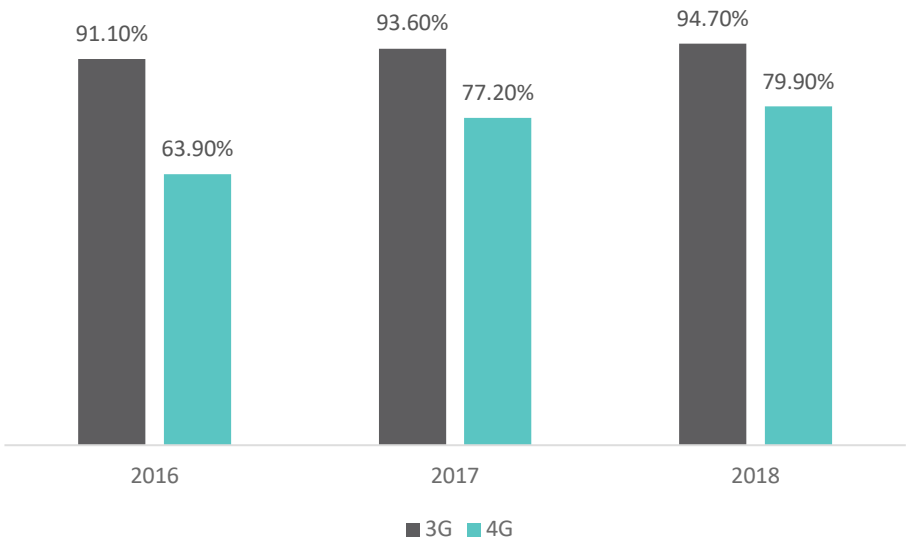


Source: MCMC

When looking at coverage, the 2018 Industry Performance Report states that 79.7% of Malaysia's population is covered by 4G services, while 94.7% is covered by 3G (Figure 3). By migrating the existing sites from 2G/3G to 4G technologies as further discussed in section 1.2.4, established providers in Malaysia would be able to increase coverage of 4G services to almost 95%, nearly achieving the 98% NFCP target. Spectrum constraints do not appear to be the limit to bridging the remaining population coverage gap, as these four operators already hold low-band spectrum with propagation characteristics similar to those found in the 700 MHz band. Rather, other potential incentives, such as policies to promote network deployment (e.g., incentives or subsidies), would likely be the right tools to support the expansion and densification of the networks in order to support expanded coverage and capacity.

[17] MCMC, "Industry Performance Report 2018," (2019), https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Industry-Performance-Report_2018.pdf.

Figure 3: Mobile broadband population coverage



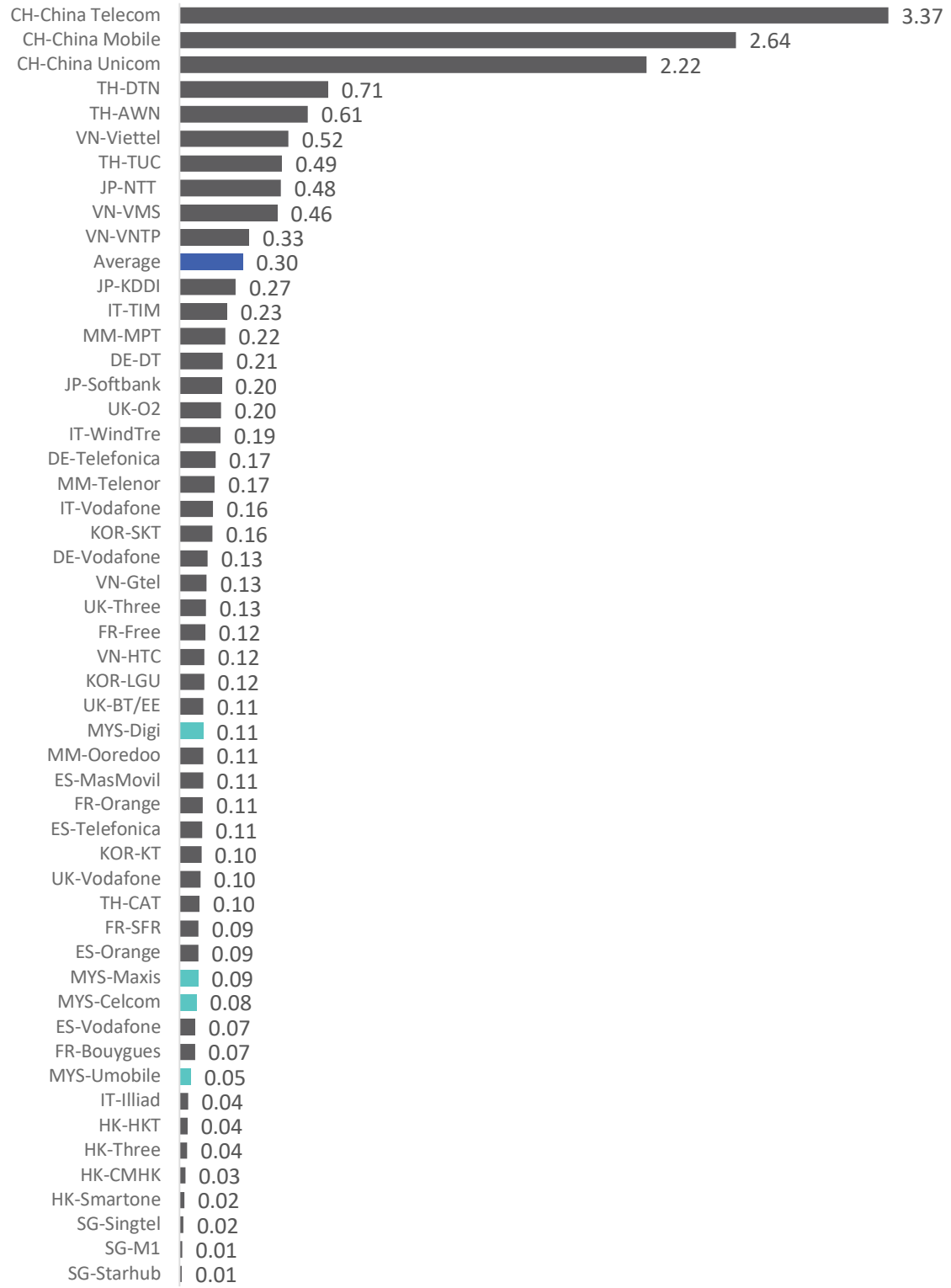
Source: MCMC

1.2.2. Established providers appear to be using their spectrum less intensively than their international peers

A review of spectrum holdings and subscribers of 51 mobile providers in 14 countries in Asia and Europe shows that established providers in Malaysia have among the lowest number of subscribers per MHz assigned of the sample (Figure 4).[18] For example, the average number of subscribers per MHz of the sample is 300,933 subs/MHz. By comparison, established providers in Malaysia are currently serving between 53,841 and 94,839 subscribers per MHz with the spectrum available to them through their own assignments or via leasing arrangements, well below the sample average. This suggests that established providers in Malaysia are using their spectrum less intensively than their international peers and can likely increase capacity to achieve the NFCP targets.

[18] IMT bands reviewed include: 450 MHz, 700 MHz, 800 MHz, 850 MHz, 900 MHz, 1400 MHz, 1800 MHz, 1900 MHz, 2100 MHz, 2300 MHz and 2600 MHz.

Figure 4: Subscribers per MHz by selected mobile providers in Europe and Asia, 2018 (Million subs/MHz)

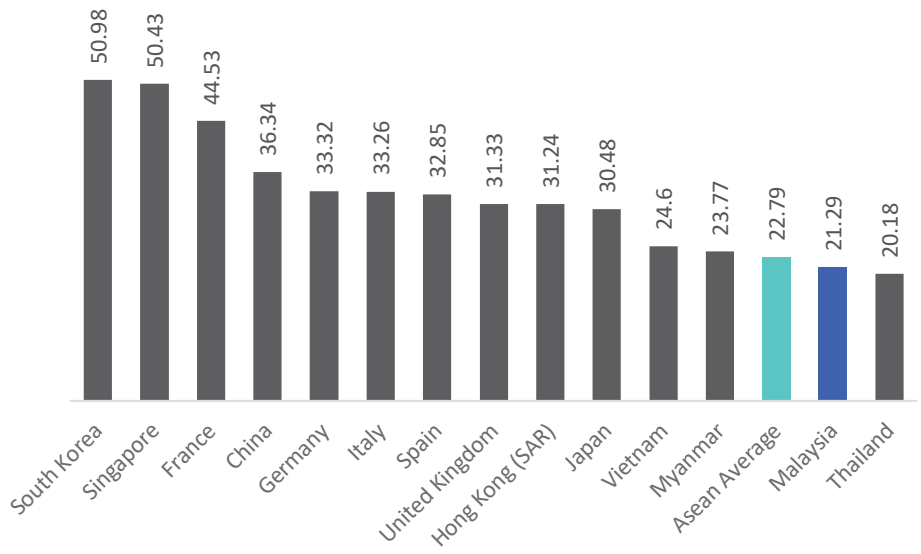


Note: CH=China, DE=Germany, ES=Spain, FR=France, HK=Hong Kong (SAR), IT=Italy, JP=Japan, KOR=South Korea, MYS=Malaysia, MM=Myanmar, SN=Singapore, TH=Thailand, UK=United Kingdom, VN=Vietnam. Vietnam figures estimated based on MIC data.

Source: TMG analysis

In addition to serving relatively fewer subscribers per MHz than their peers, established providers in Malaysia are achieving average lower mobile broadband speeds than those of peer countries. While mobile broadband speeds have improved with the 4G network roll-outs, average download speeds in Malaysia remain below both NFCP targets and average speeds in the countries reviewed (Figure 5). Importantly, however, as discussed in section 1.2.1, established providers' networks are capable of reaching average speeds consistent with NFCP targets suggesting that network topologies can be further optimized to increase performance.

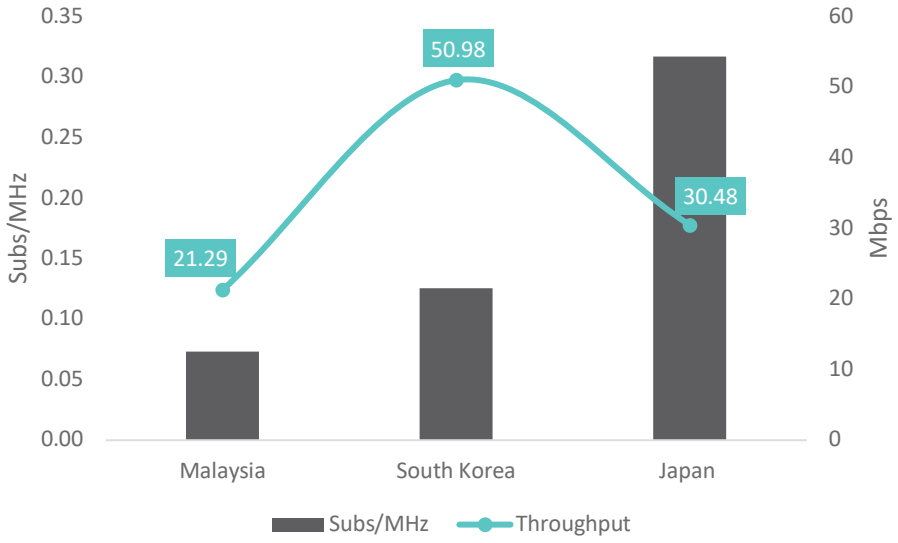
Figure 5: Average mobile broadband download speeds in selected countries, July 2019 (Mbps)



Note: South Korea at December 2018, prior to the commercial launch of 5G networks
Source: Ookla speedtest

Further contrasting performance in key Asian markets, Figure 6 shows that established providers in Malaysia, on average, offer lower speeds despite serving fewer subscribers per MHz. For example, South Korean mobile operators serve on average almost twice as many subscribers per MHz as established providers in Malaysia. Nevertheless, they are able to support average throughputs that are more than double those in Malaysia. Similarly, Japanese providers serve on average over four times as many subscribers per MHz as the established providers in Malaysia, yet are able to offer average download speeds over 40% faster than those in Malaysia. This further suggests that established providers in Malaysia have significant space to increase performance to fulfill NFCP target.

Figure 6: Average subscribers per MHz and average mobile download speeds in leading Asian markets



Source: TMG analysis

It should be noted that, in addition to spectrum in the 1800 MHz, 2100 MHz, and 2600 MHz bands, established providers hold spectrum in low bands to support their coverage requirements. While slight variations in total spectrum holdings exist among these providers, all established providers have access to the 900 MHz band, although some are still using older mobile technologies such as 2G/3G in this band. Even when considering the future growth driven by 5G networks, these mainly would be addressed through the use of other frequency bands, such as the 3.3-3.7 GHz range, and bands above 24 GHz (mmWave). In addition, when deploying future 5G networks, established providers could benefit from the dynamic spectrum sharing (DSS) technology, which permits that they serve both 4G and 5G customers with the same spectrum band, with the division of how much is used by each technology done on a dynamic basis. These options further corroborate that established providers currently have sufficient and balanced spectrum in the bands already available in Malaysia to achieve NFCP targets.

1.2.3. Carrier aggregation will allow established providers to increase mobile broadband speeds

Part of the evolution to higher download speeds comes from the use of CA among different spectrum bands, and other functionalities defined for the LTE-Advanced standard. This is a trend worldwide, and according to the Global mobile Suppliers Association (GSA), there are currently 304 commercially launched LTE-Advanced networks in 134 countries.[19]

The use of CA and other LTE-Advanced techniques could lead to increased efficiency in the use of the same blocks of spectrum. Table 1 shows the maximum theoretical peak throughput that can be achieved by a network using the spectrum bands available in Malaysia, which could be aggregated. Based on this information, depending on which stage of technology each network has deployed, it is possible for the four established providers to improve their efficiency and increase the capacity provided in some bands. Based on current throughput measurements, this would support fulfilling NFCP targets with their existing spectrum holdings.

[19] GSA, LTE-Advanced Status Worldwide, August 2019, https://gsacom.com/download.php?id=7146.

Table 1: LTE theoretical peak data rates

Spectrum (MHz)	LTE Band	Bandwidth (MHz)	Theoretical Peak DL Throughput (Mbps)	Antenna MIMO
2600	7	2x20	300	4x4
2100	1	2x15	225	4x4
1800	3	2x20	300	4x4
900	8	2x10	75	2x2

Source: Based on 3GPP TS 36.101 Table 5.6A.1-2b.

1.2.4. Established providers can upgrade their 2G/3G networks to 4G in order to increase capacity and coverage to achieve NFCP targets

Established operators in Malaysia can take advantage of spectrum efficiency improvements when shifting their existing networks from 2G/3G to 4G. This is especially true for the 900 MHz and 2100 MHz bands, and to a lesser extent in the 1800 MHz band.

In calculating the benefits of migrating 2G networks to use 3G for voice and 4G for data, studies have shown that a typical operator in Europe could serve up to 45 million subscribers with total spectrum assets of 140 MHz and a similar distribution as that of the four established providers, in the 900 MHz, 1800 MHz, 2100 MHz, and 2600 MHz bands, as well as the 800 MHz band.[20] Considering this results in more than three times the current number of subscribers of each of the established providers in Malaysia, it is likely that operators will be able to fulfil NFCP targets with their current spectrum holdings.

1.3. Continue policies to support late entrant's ability to compete

While established providers' spectrum holdings would allow them to meet the NFCP's targets, late entrants like YTLC are disadvantaged in their same efforts due to their lack of low-band spectrum. MCMC previously recognized the value of diversified spectrum portfolios and proactively engaged in efforts to balance spectrum holdings. Similarly, the regulator saw the value of introducing new competitors into the market in 2007 with the assignment of the 2300 MHz band. The valuable disruptive efforts of late entrants, like YTLC, incentivize the market and provide competitive pressure. Their participation has contributed to the inroads made by the sector - in terms of roll-out, price, and quality. As in the past, the proposed refarming process provides the MCMC a similar opportunity to provide late entrants with access to low-band spectrum and allow them to compete on a more even footing.

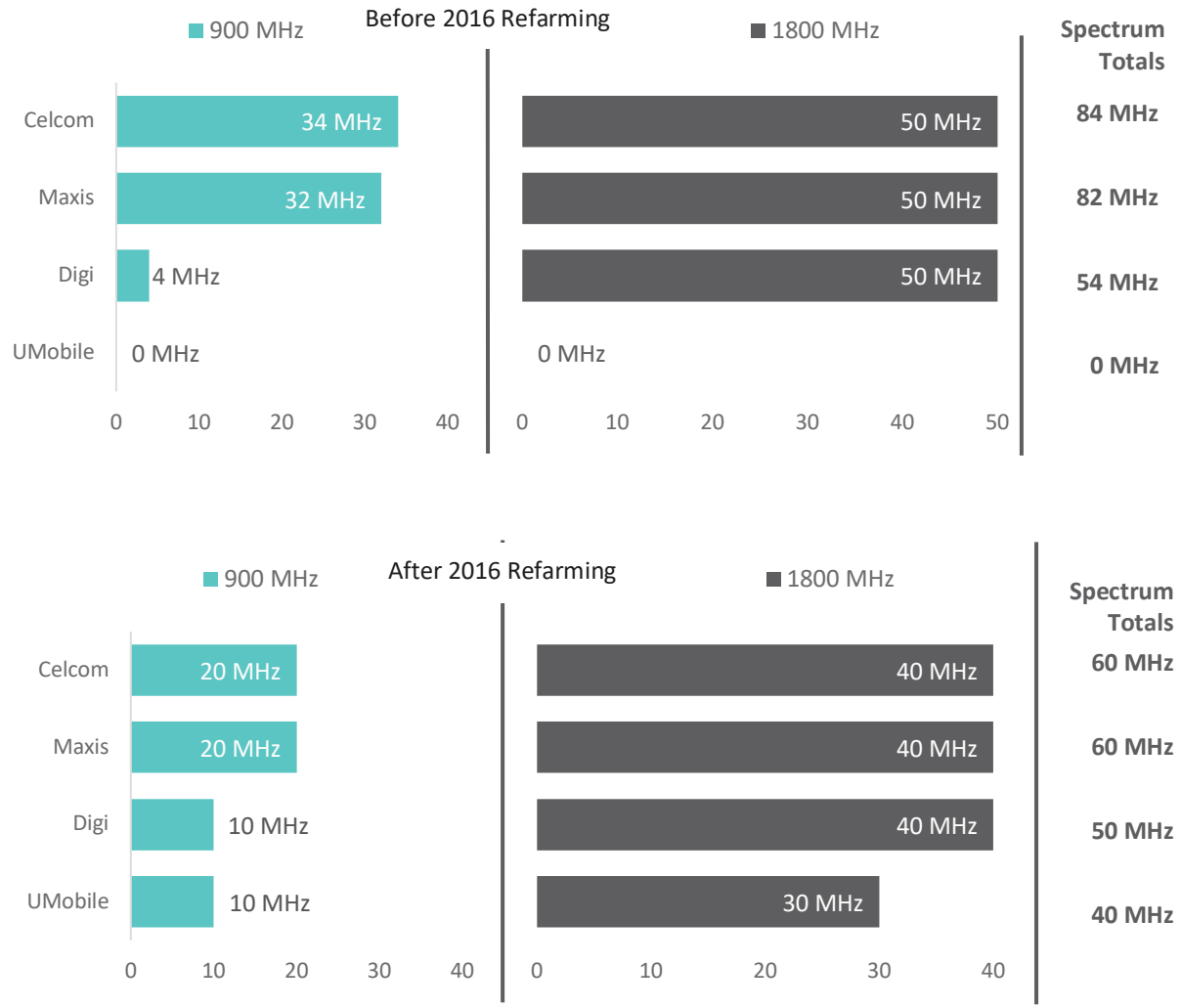
1.3.1. MCMC has engaged in spectrum rebalancing before to promote competition and should consider doing so again

Like other telecommunications regulators globally, Malaysia's regulator encountered a market that required realignment of spectrum portfolios. Thus, in 2016, the government announced plans to reorganize the 900 MHz and 1800 MHz spectrum holdings of Celcom, Digi, and Maxis, and to assign spectrum in both bands to UMobile, which previously only had access to spectrum above 2 GHz. As part of this realignment exercise, Celcom and Maxis saw their 900 MHz holdings (2x17 MHz and 2x16 MHz, respectively) reduced to 2x10 MHz, while Digi's holdings were increased from 2x2 MHz to 2x5 MHz and U Mobile was awarded 2x5 MHz. In the 1800 MHz band, Celcom, Digi, and Maxis each had their 2x25 MHz

[20] Nokia, Mobile Broadband with HSPA and LTE – capacity and cost aspects, pp. 5, 2010, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4555.

holdings reduced to 2x20 MHz, making 2x15 MHz available for award to U Mobile (Figure 7. This spectrum realignment ultimately positioned these four operators to achieve the NFCP targets.

Figure 7: Established operator's mobile spectrum holdings in the 900 MHz and 1800 MHz bands before and after the 2016 refarming process



Source: TMG

In both bands, spectrum holdings were realigned to ensure a more level playing field regarding to key mobile spectrum bands. In particular, the changes enabled UMobile to develop a multi-band spectrum portfolio in line with its competitors, which allowed it to offer a comparable mix of coverage and capacity. Malaysia's reorganization took place shortly after Singapore's new entrant spectrum auction (see Box 1).

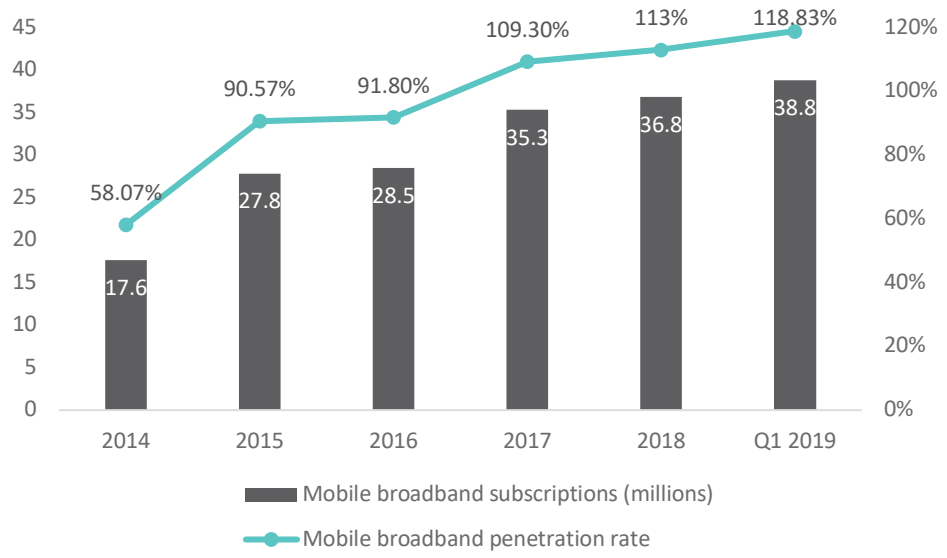
Today, Malaysia finds itself at a similar inflection point, with operators such as YTLC holding more restricted spectrum portfolios than the other operators, and thus with fewer resources to meet NFCP targets. MCMC is positioned to draw upon its successful past rebalancing experience in order to ensure that upcoming spectrum awards—notably the 700 MHz band—are structured to create more equitable distributions of spectrum resources, and thereby foster the potential to strengthen competition and

innovation in Malaysia's mobile sector. In section 2, we discuss in further detail policy approaches to the assignment of the 700 MHz band.

1.3.2. MCMC's policies have generated a more competitive mobile broadband market

Pro-competitive MCMC policies and actions, such as those described in section 1.3.1, generated significant progress in Malaysia's mobile broadband market. In only five years—between 2014 and the first quarter of 2019—mobile broadband subscriptions in Malaysia doubled to reach 38.8 million, with mobile broadband penetration growing to 118% (Figure 8). 4G technology, a key enabler for mobile broadband and efficient spectrum use, covered around 80% of the Malaysian population at year end 2018 and accounted for about 60% of all mobile subscriptions in Q1 2019, while 2G networks were still serving approximately 15% of subscribers at that time.[21]

Figure 8: Mobile broadband subscriptions and penetration



Source: Based on MCMC, Facts and Figures.

While gaps remain to achieve the NFCP coverage and average broadband speed objectives as shown above, Malaysia's mobile broadband successes are due, in large part, to MCMC's commitment to promote competition, including assigning spectrum to new entrants in the initial awards of the 2300 MHz and 2600 MHz bands. Such policies are consistent with international practice aimed at introducing disruptive players, or "mavericks," into mobile markets. These players do not follow the crowd and actively shake up existing market dynamics. As such, they are viewed by government authorities as positive disruptors due to their ability to increase competition.[22]

YTLC is arguably a Malaysian maverick. In 2014, YTLC pivoted from WiMAX to roll out its LTE network in the 2300 MHz and 2600 MHz bands. In 2016, YTLC became Malaysia's first operator to deploy a nationwide LTE network and offer voice-over-LTE (VoLTE), which enables customers to make high-quality voice calls, as well as video calls, seamless voice/video call swapping during mobile calls, and the ability

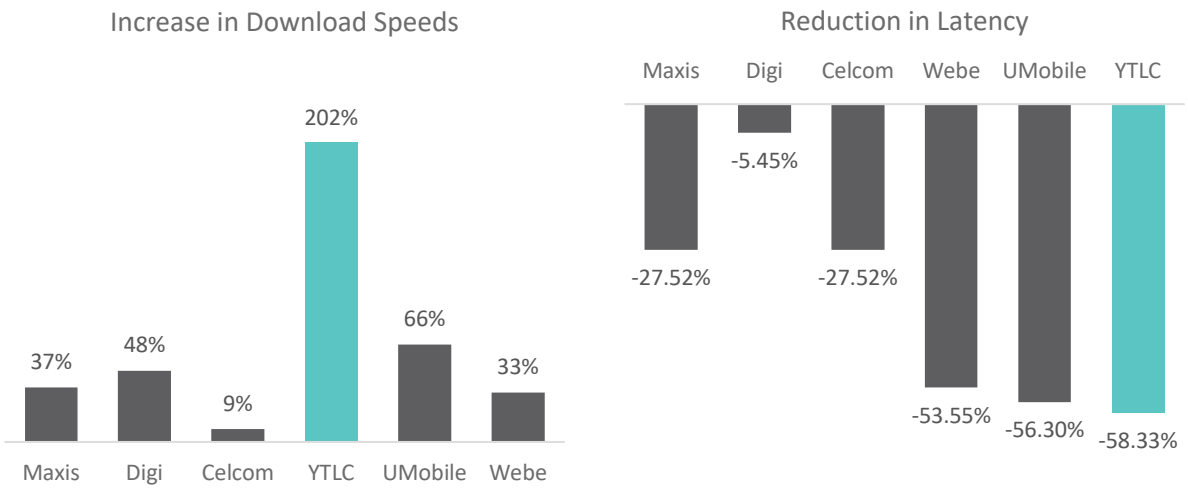
[21] See MCMC, 1Q 2019 Facts and Figures, p. 2, available at https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Q1-2019.pdf.

[22] Ofcom, A cross-country econometric analysis of the effect of disruptive firms on mobile pricing, p.1, 15 March 2016, https://www.ofcom.org.uk/__data/assets/pdf_file/0019/74107/research_document.pdf.

to share multimedia like images or website links during calls. Realizing these milestones required substantial investments. By 2016, YTLC had invested MYR 4 billion—nearly USD 1 billion. But the scale of investments required to build out network infrastructure requires time to recoup costs, as well as regulatory certainty that operators will be able to rely on the use of their existing spectrum holdings in order to continue offering services.

Late entrants, such as YTLC, are making significant strides to increase competitive pressure in the market and drive higher quality mobile broadband services. For example, between 2017 and 2018, YTLC saw the largest year-over-year improvement in average download speeds for mobile broadband services, with speeds increasing by over 200%, or triple the market average. Similarly, over the same period YTLC showed the steepest drop in latency in Malaysia, reducing this indicator by over 58%. (Figure 9).

Figure 9: Mobile broadband QoS performance changes, 2017-2018



Source: Based on MCMC, Industry Performance Report 2018

1.3.3. Vacating the 2300 MHz band would likely harm competition

To vacate and reassign the 2300 MHz band –currently being used for 4G services by providers like YTLC – would likely harm the competitive field MCMC nurtured and will create uncertainty that may potentially discourage future investment. Considered together with the proposed merger between Celcom and Digi, the potential exit or, at a minimum, significant disruption to two additional providers (YTLC and Webe) that heavily depend on the use of the 2300 MHz band, may see the number of viable competitors reduced to only three service providers in the Malaysian market. As further discussed in section 1.4, such an outcome is likely to harm existing competition and consumer choice and hamper achievement of NFCP targets.

The latest technologies are already being deployed in the 2300 MHz and 2600 MHz bands, leading to efficient use of the spectrum and increased competitive pressure in the market. As such, MCMC should further its long-standing pro-competitive policies, and allow players like YTLC that have made significant investments and rolled out networks centered in both of these bands to not only retain their spectrum assignments following the refarming process, but to obtain further legal certainty and stability in their spectrum holdings to leverage further network investments. Section 3 addresses the reasons supporting this policy choice in further detail.

1.4. Potential market consolidation may impact competition

Mergers between mobile operators may result in a concentration of spectrum resources, which, in turn, may lead to competition concerns. With the potential merger of Celcom and Digi, the number of providers actively serving the mobile broadband market would decrease from six to five.[23] Moreover, the proposed refarming of the 2300 MHz and 2600 MHz bands may inadvertently result in the exit of two additional operators, namely YTLC and Webe, both of which have deployed mobile broadband networks in Malaysia. This potential combined outcome would likely limit competition in the provision of mobile broadband services and the achievement of NFCP targets, as well as significantly reduce consumer choice.

1.4.1. Proposed consolidation in the market will increase spectrum concentration in Malaysia

To consider the possible impacts that such a merger may have on the market, TMG evaluated the concentration of spectrum in the six-player market. Without considering whether all players have adequate sub-1 GHz spectrum and looking at overall spectrum holdings, there is a 65 MHz difference in spectrum holdings between Celcom and YTLC (Table 2). While the top four spectrum holders are also the largest players by market share (i.e., Celcom, Maxis, Digi, UMobile), the actions taken by MCMC in 2016 to balance spectrum holdings between them resulted in a low concentration of spectrum holdings, as shown by an HHI of 1385.6, an outcome consistent with the existing market structure.

Table 2: Spectrum holdings of all mobile operators before merger

Operator	Spectrum Assigned (MHz)	Share of total spectrum
Celcom	115	18%
Maxis	115	18%
Digi	105	16.4%
UMobile	95	14.8%
Webe	70	11%
YTLC	50	7.8%
Altel*	40	6.3%
REDtone*	26	4.1%
AsiaSpace*	24	3.7%
HHI (spectrum holdings)	1385.6	

**Note: Altel, REDtone, and AsiaSpace do not provide mobile broadband service to end users. Altel and REDtone spectrum holdings in the 2300 MHz band have been adjusted based on a weighted average of population served to reflect a national spectrum license.*
Source: TMG

If the merger of Celcom and Digi is approved, the spectrum holdings will become much more disparate between the four established providers and the late entrants (Table 3). Since the merged entity brings together two operators with significant spectrum holdings prior to the merger, the resulting combined entity would hold almost double that of the operator with the next highest amount of spectrum (220 MHz compared to Maxis' 115 MHz). The spread between the lowest (YTLC) and highest (Celcom + Digi) spectrum holders among operators that have deployed networks would grow from around 65 MHz to 170 MHz, resulting in increased spectrum concentration, represented by an HHI of 1975.2.

[23] The six main mobile operators referred to here are Celcom, Maxis, Digi, U Mobile, Webe, and YTLC. REDtone, Altel, and AsiaSpace hold spectrum in the 2300 MHz and 2600 MHz bands and were therefore considered in this exercise; however, they lease the majority of their spectrum to other players and have not deployed their own networks.

Table 3: Spectrum holdings of all mobile operators post-merger

Operator	Spectrum Assigned (MHz)	Share of total spectrum
Celcom + Digi	220	34.4%
Maxis	115	18%
UMobile	95	14.8%
Webe	70	11%
YTLC	50	7.8%
Altel*	40	6.3%
REDtone*	26	4.1%
AsiaSpace*	24	3.7%
HHI (spectrum holdings)	1975.2	

**Note: Altel, REDtone, and AsiaSpace do not provide mobile broadband service to end users. Altel and REDtone spectrum holdings in the 2300 MHz band have been adjusted based on a weighted average of population served to reflect a national spectrum license.*
Source: TMG

Increased concentration of spectrum in the merged entity could provide it with an advantage over its competitors, likely resulting in lower costs for network deployment and capacity upgrades, and reducing overall competitive pressure. For these reasons, as discussed in the following subsection mergers and acquisitions are often carefully considered by competition and regulatory authorities to evaluate their impact. And, if where warranted, specific conditions are imposed to mitigate valid competitive concerns.

1.4.2. International approaches to address spectrum concentration resulting from market consolidation

Over the years, international trends have emerged regarding how regulators may address potential competition concerns, especially where newly merged mobile companies would end up holding large swaths of spectrum. In many cases, regulators often make merger approval contingent on spectrum divestiture to ensure that valuable mobile spectrum is placed back into the marketplace, mitigating potential competition concerns stemming from consolidation in the mobile sector. Examples in Germany, Italy, the United Kingdom, and the United States are highlighted in Box 2.

Box 2: Examples of spectrum divestiture conditions in selected mobile operator mergers

United States

In July 2019, the U.S. Department of Justice approved the merger between the third and fourth largest national mobile providers in the United States, Sprint, and T-Mobile, subject to a series of divestiture conditions to enable the post-merger entry of a viable facilities-based competitor. Among other conditions, the merging parties agreed to divest 800 MHz spectrum licenses held by Sprint to DISH Network to enable it to launch a fourth nationwide mobile network.[24]

Italy

In 2016, Hutchison and Vimpelcom in Italy were permitted to create a 50-50 joint venture, conditioned on their divesting certain spectrum holdings in the 900 MHz, 1800 MHz, 2100 MHz, and 2600 MHz bands, along with other requirements. In reviewing the proposed deal, the European Commission

[24] See *United States of America, et al, v Deutsche Telekom AG, T-Mobile U.S., Inc., Softbank Group Corp., Sprint Corporation and Dish Network Corporation*, Proposed Final Judgement, (Jul 26, 2019), p. 11, available at https://www.justice.gov/opa/press-release/file/1187706/download.

raised competition concerns, particularly that new entrant Iliad would be at a competitive disadvantage.[25] As a remedy, the European Commission proposed that Iliad would be the purchaser of the divested assets, which was framed as a "fix-it-first" remedy.

Germany

The European Commission approved the 2014 merger between mobile operators Telefonica and E-Plus in Germany, subject to several conditions to mitigate anticompetitive effects, including divestiture of spectrum in the 2100 MHz and 2600 MHz bands.[26]

United Kingdom

in the 2010 merger between Orange and T-Mobile in the United Kingdom, the European Commission required divestiture of 2x10 MHz and 2x5 MHz in the 1800 MHz band, which equaled one-quarter of the operators' spectrum holdings in the band, among other conditions.[27] Despite the divestiture of certain assets, the merged entity, Everything Everywhere (EE), retained sufficient spectrum to lead 4G network deployments in the country.

United States

In 2004, the U.S. Department of Justice and FCC required Cingular Wireless and AT&T Wireless to divest numerous assets as a merger condition, including the sale of spectrum licenses across the country.[28]

In order to address upcoming potential mergers, the MCMC issued Guidelines on Mergers and Acquisitions (M&A Guidelines).[29] The M&A Guidelines are intended to increase licensees' understanding of the legal bases and processes that MCMC would use to assess mergers and acquisitions. Should MCMC determine that the merging parties must divest spectrum to mitigate competition concerns, such spectrum could be reintroduced into the market to promote more balanced spectrum holdings and long-term competition goals.

1.4.3. MCMC proposal for refarming the 2300 MHz and 2600 MHz bands may lead to further spectrum concentration

MCMC's proposal to vacate and reassign the 2300 MHz band could have a marked impact on the competition of the mobile industry in Malaysia -- leading to further spectrum concentration and potential exit of the late entrants from the market. First, the immediate outcome would be to take away spectrum from two late entrants, YTLC and Webe, that heavily depend on this band. This would create considerable disruption in their ability to offer continuous service to their subscribers at the same service quality and would significantly affect their ability to meet NFCP targets. Moreover, considering their resulting spectrum holdings, if these providers were unable to acquire sufficient spectrum in the re-tendering process of the 2300 MHz, a potential outcome is that their technology and investment paths to achieve viable scale to compete in the mobile broadband market would be impaired, leading to their eventual

[25] European Commission, Mergers: Commission approves Hutchison/VimpelCom joint venture in Italy, subject to conditions, 1 September 2016, https://europa.eu/rapid/press-release_IP-16-2932_en.htm?locale=en.

[26] European Commission, Mergers: Commission clears proposed merger between Telefónica Deutschland (Telefónica) E-Plus subject to conditions-frequently asked questions, 2 July 2014, https://europa.eu/rapid/press-release_MEMO-14-460_en.htm.

[27] European Commission, Case No COMP/M.5650 - T-MOBILE/ ORANGE, 1 March 2010, http://ec.europa.eu/competition/mergers/cases/decisions/m5650_1469_2.pdf.

[28] U.S. Department of Justice, Justice Department Requires Divestitures in Cingular Wireless's Acquisition of AT&T Wireless, 25 October 2004, https://www.justice.gov/archive/opa/pr/2004/October/04_at_718.htm.

[29] MCMC, Guidelines on Mergers and Acquisitions, 17 May 2019, https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/Guidelines-on-Merger-and-Acquisitions.pdf.

exit. Second, the proposed refarming of the 2600 MHz band also would likely result in the exit of operators currently leasing that spectrum, as discussed above.

Such a move would only affect the late entrants, as none of the established providers currently hold spectrum in the 2300 MHz band and their holdings in the 2600 MHz would be converted into spectrum authorizations (SA). Thus, there is the very real possibility that if the Celcom and Digi merger moves forward and the 2300 MHz and 2600 MHz bands are refarmed as proposed, the market would decrease from five players to three players. Under the three-player scenario, but without considering the possible redistribution of the 2300 MHz band, the concentration of spectrum would rise considerably, as demonstrated in Table 4 below. In addition, the joint Celcom + Digi entity would hold over 50% of the mobile broadband spectrum assigned in Malaysia.

Table 4: Possible spectrum holdings in a three-player market (assuming the exit of YTLC, Webe, Altel, Redtone, and AsiaSpace)

Operator	Spectrum Assigned (MHz)	Share of total spectrum
Celcom + Digi	260	53%
Maxis	135	27.6%
UMobile	95	19.4%
HHI (spectrum holdings)	3950.4	

Source: TMG

Such an outcome would further negate MCMC's positive efforts to increase competition in the market. Reduced competitive pressure could, in turn stifle innovation and investment incentives in the mobile broadband market, potentially undermining the ability to achieve NFCP targets.

2. 700 MHz band refarming should be aimed at fostering competition and achieving NFCP targets

2.1. Description of MCMC´s proposal

As indicated in the PI, current terrestrial television services are being migrated from the 700 MHz band, with the analog switch off expected by the end of 2019. With this migration, MCMC is proposing to refarm the 700 MHz band to a different service, making available 2x40 MHz in this band for mobile broadband services.[30]

MCMC recognizes that the allocation of the 700 MHz band for mobile broadband service in Malaysia is important to enhance coverage and capacity, and thus proposes to tender it for use by nationwide SAs. The 700 MHz band is proposed to be divided into four blocks of 2x10 MHz and assigned by the end of 2020.

2.2. Effective spectrum refarming moves spectrum from lower to higher value uses

Refarming is one spectrum management tool available to ensure that higher value spectrum uses and services are introduced into the market. Depending on the regulatory framework and market conditions, refarming can be undertaken directly by the licensees, or at the direction of the regulator. In either case, spectrum refarming is generally implemented in response to one or more triggers, including:

- meeting new market demand for spectrum in response to insufficient spectrum availability or spectrum congestion,
- promoting increased spectrum efficiency by incentivizing technological advances; and
- enabling harmonization of spectrum usage among multiple countries.

Voluntary refarming, in which licensees change the usage of their assigned spectrum with zero or minimal regulator involvement, is generally the preferred approach, due to operators' knowledge of their own resources and priorities, and the lower administrative cost. By comparison, administrative or mandatory refarming is often seen as a tool of last resort for regulators.[31]

Given the change in use of the 700 MHz band from digital television to mobile broadband, voluntary refarming is not a viable option and MCMC must play a central role in the band's refarming process, facilitating band clearing and reassignment. However, it is important that the refarmed spectrum not only become available for mobile broadband, but also be assigned in a manner best benefiting the Malaysian market.

[30] MCMC, PI, para. 3.1.

[31] For example, the Conference of European Postal and Telecommunications Administrations (CEPT) has noted that "[r]efarming often is a 'last-thought' option of spectrum management, because it is likely to cause the most problems to set up and usually is the most lengthy to implement. Therefore the option of spectrum sharing, that is co-location of old and new uses or radiocommunication systems within the same frequency band, is perceived as a natural preference and will always be extensively considered first." See ECC, "Refarming and secondary trading in a changing radiocommunications world," (September 2002), https://www.ecodocdb.dk/download/29a46119-a848/ECCREP016.PDF.

2.3. The 700 MHz band refarming is an opportunity to address late entrants' low-band spectrum deficiency

MCMC's proposed plan for refarming the 700 MHz band will not create the best opportunity for operators currently lacking low-band spectrum to obtain the balanced spectrum portfolio necessary to effectively compete in the market.

Mobile operators will need an appropriate mix of spectrum assets to meet the NFCP target of 98% coverage of populated areas with a 30 Mbps average speed by 2023. This requires low-band spectrum to deploy networks with adequate coverage at a reasonable cost, while mid and high spectrum bands will address capacity requirements for denser areas.

> As noted by the GSMA in a note on the Asia Pacific region in 2014, "the allocation of the 700 MHz band for mobile in APAC will carry substantial socioeconomic benefits while enabling operators to reduce capital and network costs, thereby accelerating rollout and lowering prices for end users. According to the research, the network infrastructure investment required for operating in the 700 MHz band can be up to 70% lower compared to the 2100 MHz band."[32]

In Malaysia, late entrants, such as YTLC, currently lack low-band spectrum. As such, the most prudent way to promote robust competition in the provision of 4G, and later 5G services, is to ensure that the newly available 700 MHz spectrum is released with specific measures that afford such providers an opportunity to access that spectrum.

2.4. Diverse spectrum bands will enable late entrants to meet capacity and coverage needs – and compete effectively

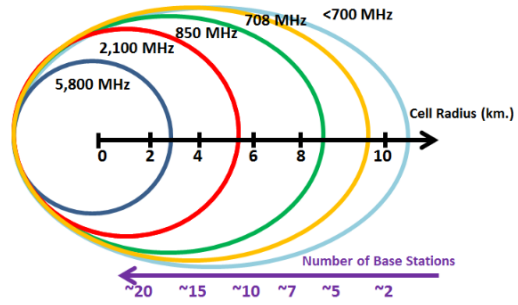
A mobile operator would need to use LTE-Advanced technologies to fulfill the NFCP's target of average 30 Mbps mobile broadband speeds. The current 3GPP standards indicate that it is possible to aggregate up to four carriers in different spectrum bands.[33] All the bands available in Malaysia can be combined among themselves. Malaysia's late entrants, which currently only have access to the 2300 MHz and 2600 MHz bands, could benefit from the use of carrier aggregation to provide 30 Mbps broadband enabled, but the lack of low-band spectrum will likely make fulfilling the NFCP 98% coverage target cost-prohibitive.

In order to meet the coverage target, lower spectrum bands are essential due to their propagation characteristics. As shown in Figure 10, the cell radius of one base station using the 700 MHz band can be more than 10 km, while in bands above 2100 MHz it would be less than 5 km. This implies that having the same coverage area with higher spectrum bands will require a greater number of base stations, consequently resulting in much higher implementation and maintenance costs.

[32] GSMA, "Mixed picture for 4G in Asia Pacific as lack of low-frequency spectrum limits coverage," 5 June 2014, https://www.gsmaintelligence.com/research/2014/06/mixed-picture-for-4g-in-asia-pacific-as-lack-of-low-frequency-spectrum-limits-coverage/431/.

[33] 3GPP TS 36.101, Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception, Table 5.5A-2, June 2019.

Figure 10: Relative cell radius



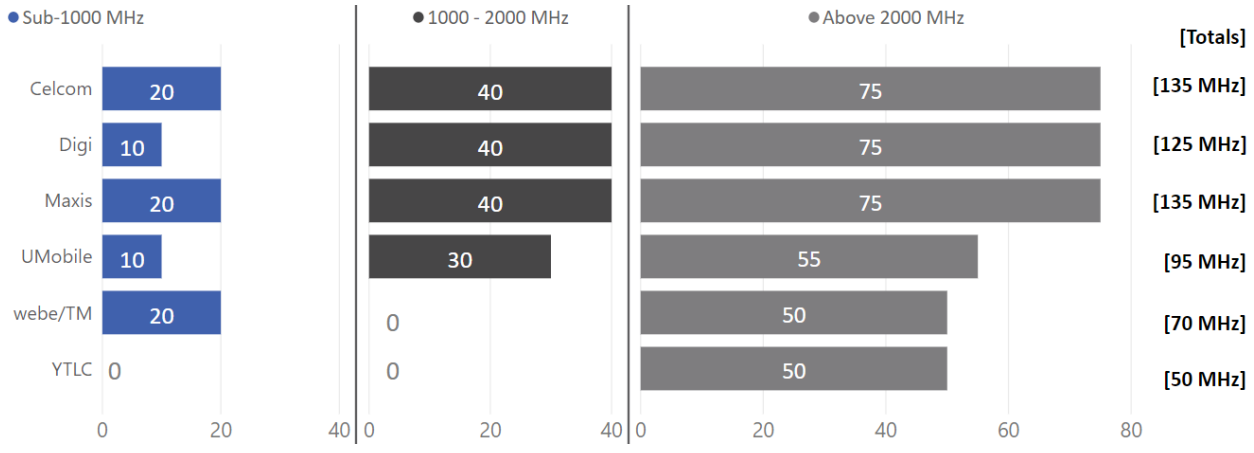
Source: 5G Americas

2.5. Alternative approach to refarming 700 MHz band fosters long-term competition

The assignment of the 700 MHz band in Malaysia should be viewed as a continuation of the process towards a more balanced distribution of spectrum among the existing mobile operators. In order to adequately define how to divide the band, it is important to analyze the sub-1 GHz bands as a whole, including existing assignments in bands such as the 900 MHz band. The ideal situation would be that the combined assets of each operator using these bands would be better balanced than in the existing situation.

As recognized in the PI, the 700 MHz band could be assigned in at least one block of 2x20 MHz, which provides the most efficient use of this spectrum. In order to balance the mix of spectrum bands among the different operators, MCMC should consider assigning a 2x20 MHz block to the late entrants that currently have no sub-1 GHz spectrum such as YTLC (see Figure 11). In this manner, late entrants would be positioned to achieve NFCP targets on a more equal footing with the established providers, similar to the 2016 spectrum refarming process discussed in section 1.3.1. MCMC could also consider the assignment of the remaining 2x20 MHz to other providers currently holding sub-1 GHz spectrum as needed.

Figure 11: Current spectrum utilization in Malaysia



Note: figure only includes spectrum assignments with naitonal coverage
Source: TMG based on MCMC data

While there has been a significant increase in the number of devices that support the 700 MHz band, the ecosystem is still under development if compared to other sub-1 GHz bands. For example, while the 700 MHz band (band 28) is supported by 1,789 devices, the 900 MHz band (band 8) is supported by 5,014 devices.[34] This further corroborates that the 700 MHz licensees will not only need to invest in the network deployment, but also in continuing to drive the development of the device ecosystem.

Finally, although the 700 MHz band would be considered for some of the future 5G applications, especially applications that require lower throughput and large coverage, the ecosystem for this band will take some time to be developed. Current deployment of 5G networks are mainly supported through the use of other frequency bands, such as the 3.3-3.7 GHz range, and bands above 24 GHz (mmWave). Presently, the 700 MHz band is still being used for LTE deployments, which could later be converted to 5G, when the ecosystem and demand are sufficiently mature.

2.6. 700 MHz band requires additional operator investment

Another consideration for MCMC is the relationship between spectrum fees and resources for network deployment. As the GSMA has noted, regulators should avoid inflating spectrum prices, including through excessive reserve prices or annual fees, "as this risks limiting network investment and driving up the cost of services."[35] MCMC's view expressed in the PI is consistent with this approach, as it recognizes that inflated spectrum prices "may restrict operators' ability to invest in network deployment."[36] Accordingly, MCMC should consider whether, to promote network deployments and upgrades, other in-kind contributions may be used, either alone or in conjunction with reduced fees.

Mechanisms that can reflect true spectrum value in conjunction with lower assignment fees include coverage obligations and network investment commitments. Recent international examples of this approach are detailed in Table 5.

Table 5: Examples of policies to promote mobile networks deployment and investment as an alternative to high fees

Country (year)	Policy alternatives to high spectrum fees
Japan (2019)	In April 2019, The Ministry of Internal Affairs and Communications (MIC) assigned spectrum in the 3.7 GHz, 4.5 GHz, and 28 GHz bands through a beauty contest to the four mobile operators in Japan.[37] Rather than focus on generating revenues for the state, the licenses came with a number of conditions, including population coverage obligations and commitments to meet 5G network investments.
United Kingdom (2018)	Ofcom is planning to auction 700 MHz and 3.6-3.8 GHz band spectrum in 2020.[38] In a recent consultation, Ofcom proposed that licensees of certain blocks should comply with coverage obligations within four years of the license award, including delivery of good

[34] GSA, Status of the LTE Ecosystem, June 2019.
[35] GSMA, 5G Spectrum GSMA Public Policy Position, July 2019, https://www.gsma.com/spectrum/wp-content/uploads/2019/07/5G-Spectrum-Positions.pdf.
[36] MCM, PI, para. 3.1.2.2.
[37] TeleGeography, MIC approves allocation of 5G spectrum to Japanese operators, with conditions, 11 April 2019, https://www.telegeography.com/products/commsupdate/articles/2019/04/11/mic-approves-allocation-of-5g-spectrum-to-japanese-operators-with-conditions/.
[38] Ofcom, Award of the 700 MHz and 3.6-3.8 GHz spectrum bands. 18 December 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0019/130726/Award-of-the-700-MHz-and-3.6-3.8-GHz-spectrum-bands.pdf.

	quality mobile coverage outdoors to at least 90% of the UK landmass. In exchange, Ofcom proposes to discount blocks with coverage obligations between GBP 300 million and GBP 400 million. The intention is to enable the industry to provide services with greater capacity and wider coverage, and to pave the way for companies to take advantage of new wireless technologies, including 5G, while also providing strong incentives for the companies which participate in the award to invest in providing better quality services in rural areas.

Source: TMG analysis

Furthermore, due to the relatively less mature device ecosystem in the 700 MHz, when determining spectrum assignment fees, MCMC should consider operators' needs to both invest in network deployment and continue to drive the development of the device ecosystem. National goals of providing expanded, affordable coverage and meeting NFCP targets will be best served by adopting forward-looking spectrum fee policies that take account of market realities to incentivize investment and innovation.

3. Conversion is a more appropriate path for the 2300 MHz band

3.1. Description of MCMC´s proposal

As indicated in the PI, MCMC is currently proposing to vacate the current mix of national and regional 2300 MHz apparatus assignments (AAs) and to issue new, nationwide SAs. In terminating the existing assignments, MCMC proposes to offer nine blocks of 10 MHz each through a beauty contest process, although noting that 20 MHz bandwidths are ideal for the LTE network deployments.

The proposed refarming would reorganize the band plan in use for the provision of LTE services, potentially creating smaller assignments for each operator for the provision of LTE services. In doing so, as the PI notes, the potential exists for disrupting services delivered to end users and imposing significant migration costs on 2300 MHz band licensees.

3.2. Triggers for mandatory refarming are not present

As discussed in section 2.2, specific circumstances or triggers may necessitate refarming. But even in such cases, international practice suggests that administrative refarming generally should be used only as a last resort mechanism. Given the mobile market situation in Malaysia, the proposal in the PI seems inconsistent with international practices. The proposed refarming process does not satisfy the triggers justifying spectrum refarming, and instead may work against MCMC's goals of attracting more investment to provide connectivity and improve the affordability of devices and services.

3.2.1. Refarming decision process

The first step a spectrum manager must consider when deciding on the implementation of a refarming process is to assess whether refarming in specific spectrum band is justified, by determining whether the key triggers are present. In the absence of such triggers, the spectrum manager should reconsider the factors driving the interest in new spectrum and then there should be no change to current uses.

Conversely, if refarming is justified, then voluntary refarming should be the next consideration, as it is generally less disruptive and costly for operators and users. It is only if voluntary refarming does not meet spectrum demand and requirements within the timeframes needed to achieve the underlying policy justification that administrative refarming should be considered as an option.

3.2.2. Current band plan ensures efficient use

The 2300 MHz band is included in the 3GPP technical standards for 4G technology and defined in those standards as Band 40. According to the standards, this band can be used with block sizes of 5 MHz, 10 MHz, 15 MHz, or 20 MHz.[39] Malaysia's current assignments for this band are based on 30 MHz assignments for each operator, which is in line with international assignments in the band as shown in Table 6.

In Malaysia, combinations through commercial agreements enable effective assignments of up to 60 MHz for a single operator. As such, the deployment of services in the band can leverage combinations of blocks

[39] 3GPP TS 36.101, Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception, Table 5.6.1-1, June 2019.

in accordance with sizes indicated by 3GPP standards (e.g., 20 MHz+10 MHz, or 15 MHz+15 MHz), which ensures efficient use of the spectrum.

Table 6: 2300 MHz block sizes in Hong Kong, Singapore, China, South Korea, and the United Kingdom

Operator	Operator	Block size (MHz)
Hong Kong	Three	30
	CMHK	30
	21 Vianet	30
Singapore	TPG Telecom	40
China	China Unicom	20
	China Mobile	50
South Korea	SKT	27
	KT	30
United Kingdom	O2	40

Source: TMG research

When considering the evolution to newer technologies, such as 5G, the 2300 MHz band can be organized in block sizes of 5 MHz, 10 MHz, 15 MHz, 20 MHz, 25 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, and 80 MHz.[40] When the 5G technology ecosystem is mature, mobile operators in Malaysia using the 2300 MHz band will have the ability to upgrade their networks to take advantage of a single 30 MHz block within their existing assignments, further improving spectrum efficiency in the use of this band.

In this regard, MCMC's proposal to vacate and reassign this band as nine blocks of 10 MHz each does not necessarily provide any improvement in terms of spectrum efficiency, as the current 30 MHz blocks are already efficient for both current usage and when considering the evolution to 5G.

3.2.3. Current users have voluntarily refarmed to more efficient/best-in-class technologies

Presently, the 2300 MHz band in Malaysia includes deployments using LTE and WiMAX technologies. More than 5,000 devices support 3GPP band 40 in 2300 MHz, or 80% of all TD-LTE devices, making the 2300 MHz band home to the largest TD-LTE device ecosystem.[41]

The development of this expansive TD-LTE ecosystem has provided the opportunity for mobile operators in Malaysia to migrate to this technology, allowing for more efficient use of the 2300 MHz band than with the initial deployments using WiMAX technology. This migration also has provided users with a wider range of options for user devices.

Utilization of TDD technology offers significant advantages with respect to spectrum efficiency, network performance and capacity, and suggests a viable evolution path from 4G towards 5G networks and services.

[40] 3GPP TS 38.101, NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone, Table 5.3.5-1, June 2019.

[41] GSA, Status of the LTE Ecosystem, June 2019.

3.2.4. Mandatory refarming diverts critical resources from network improvement

Rather than promoting Malaysia's national connectivity objectives, the proposed refarming plan is likely to hinder the ability of late entrants, such as YTLC, to contribute to the NFCP targets. In particular, refarming will divert resources from network deployment and upgrades and will prevent late entrants from obtaining the mix of low- and mid-band spectrum necessary to provide coverage and capacity.

An administrative refarming plan that is not necessitated by the triggers mentioned in section 2.2 will impose obligations on all providers to draw upon resources—financial, technical, and human—to complete the refarming process. In particular, financial resources that otherwise could have been devoted to network improvements, such as additional site deployments or technology upgrades, will instead be diverted to network reconfiguration that will not increase capacity in the near term. This effectively enables a lateral move, rather than the forward progress necessary to meet NFCP targets.

This mandated diversion of resources has a particularly significant impact on late entrants, which generally have fewer resources to divert away from established business plans. Rather than creating an environment that enables late entrants to compete effectively, the refarming proposals would disincentivize their investment in network upgrades and expansion.

3.3. Preferable route to achieving NFCP goals: conversion of AA to SA

Because an AA authorizes only a specified type of network in a particular band, it is more rigid than a SA, allowing the operator to use one or more specified bands for any purpose consistent with MCMC's conditions. As MCMC suggests in the PI, 2300 MHz AAs should be converted to SAs in a fair, reasonable, and equitable manner.

This conversion would increase flexibility for operators to deploy the most up-to-date technologies and introduce a more cohesive, technology-neutral framework. Transitioning to the SA framework would also provide legal certainty and promote investment as operators would have a longer license duration to recoup costs, as opposed to short-term AA licensing of five years or less.

Importantly, converting from an AA to SA regime in the 2300 MHz band does not require current users to vacate the band, thus avoiding harmful impacts of such market disruption, costs of migration, and stranded investments. Malaysia could follow the approach used by Australia, as outlined in Box 3, where 2300 MHz licensees were allowed to convert their licenses from AA to SA without subjecting such licensees to a spectrum auction.

Box 3. Conversion from apparatus to spectrum licenses in Australia

In 2000, Australia's Minister for Communications, Information Technology and the Arts (now the Department of Communications and the Arts) issued a decision to convert the existing 2300 MHz spectrum use rights from AA to SA licenses.[42]

Licensees in the 2300 MHz band, which were at the time, were given the opportunity to convert their 5-year apparatus licenses to 15-year spectrum licenses. The conversion framework also involved adopting a technology-neutral approach allowing licensees to use their assigned spectrum for any purpose that complied with the technical framework.

The majority of MDS licensees opted to convert in 2000, paying a conversion fee (in the form of a spectrum access charge) totaling AUD 71 million (USD 48 million) for a new 15-year license term. In

[42] Minster for Communications, Information Technology and the Arts, Radiocommunications (Spectrum Designation) Notice No. 1 of 2000 (14/01/2000), 14 January 2000, https://www.legislation.gov.au/Details/F2004B00494/Download.

2012, the Minister for Broadband, Communications and the Digital Economy issued a decision that it would be in the public interest to re-issue the 2300 MHz band licenses who had been providing wireless broadband services, as opposed to holding a new auction for reassignment of the spectrum.

When the spectrum licenses expired in 2015, the Australian Communications and Media Authority (ACMA) re-issued the spectrum licenses to the same licensees, subject to license compliance and payment of the associated spectrum access charge.

The AA-to-SA conversion enabled Australian regulatory authorities to effectively refarm the 2300 MHz band without disrupting the operators already offering mobile broadband. The result of these decisions is that the licensees upgraded their technologies and are now offering 4G services in the band.

4. Conclusions

An effective spectrum assignment strategy is a critical tool at MCMC's disposal for meeting the NFCP targets and ensuring viable mobile sector competition in Malaysia. MCMC can play a key role in achieving these goals by ensuring balanced spectrum holdings, particularly in the sub-1 GHz bands. This will enable all carriers to contribute to meeting NFCP targets.

To this end, it is particularly important that Malaysia's late entrants have an appropriate opportunity to obtain low-band spectrum. MCMC has a proven track record of taking pro-competitive actions to ensure balanced spectrum holdings as it considers refarming the 700 MHz band. However, it is also important that MCMC take into account potential consolidation or market changes in response to spectrum refarming activities to ensure that competition remains strong.

The proposals put forth in the PI address key bands, but international experiences and precedents offer alternative approaches that should be considered to promote efficient spectrum use and competition.

- In the 700 MHz band, and sub-1 GHz bands more broadly, MCMC should ensure that late entrants with a nationwide network have a legitimate opportunity to obtain adequate spectrum to more effectively compete with established providers that already hold low-band spectrum and have the capacity to add subscribers within their current spectrum holdings.

- Considering the 2300 MHz band, the MCMC's proposal to convert AAs to SAs is appropriate, but current conditions offer no need or justification for a mandatory vacating and reassigning process. Administrative refarming, as MCMC proposes, would detrimentally disrupt existing licensees and their customers without necessarily achieving the stated goals of managing spectrum efficiently and maximizing the economic and social benefits of spectrum resources.

As noted by MCMC, inflated spectrum prices may limit mobile operators' ability to invest in network deployment. Therefore, MCMC should consider using alternative in-kind contribution mechanisms, such as coverage and network deployment obligations, as a way for operators to pay for the spectrum.

The bands under consideration in the PI are crucial to advancing broadband services in Malaysia. In order to best position Malaysia for future innovation and meet NFCP targets, MCMC should revise the proposals to focus on equitable access to spectrum and fostering robust competition.

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