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Response to IDA Public Consultation Paper:

Deployment of Wireless Broadband Technologies in Singapore

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Wireless Broadband: Potential and Benefits

IDA: *View and comments on the potential of and benefits arising from the deployment of wireless broadband technologies, the likely services/applications to be deployed and the potential demand from businesses and consumers.*

SOMA/CADMUS: DSL and cable broadband providers enjoy de facto monopolistic situations through ownership and control of the access to the customer. Wireless broadband technologies represent both a viable alternative to these wireline technologies as well as a platform towards new services such as mobile/nomadic data applications. Over the past 10 years, wireless technologies have demonstrated their reliability to address and support the communication needs of the mass market (e.g. GSM or CDMA PCS deployments). The multiplication of hot spots showed the increasing interest of consumers to get data access "anywhere, anytime", despite the challenges of wi-fi in terms of security, coverage and business model. New wireless broadband technologies shall enable future convergence of fixed and mobile services while guaranteeing quality of service to users.

Channel Planning and Coexistence

IDA: *Views and comments on the allocation of the 2.3 GHz and 2.5 GHz bands for wireless broadband technologies and the harmonization of spectrum at the border areas.*

- *What are the coexistence issues that need to be considered with regards to the deployment of systems (FDD & TDD) in the same geographical area in adjacent frequency blocks, and the deployment of systems across geographic boundaries in the same frequency blocks?*
- *What are the technical assessment and methodology to be used for the deployment and coordination of systems, including separation distances, power spectral flux density limits, out-of-band-emission limits, frequency guard bands etc, to ensure coexistence of system operations?*
- *What are the mitigation techniques that could be employed in case of co-channel interference between systems operating in adjacent geographical areas?*
- *Does the 5 MHz, 5.5 MHz or 6 MHz channeling plan for the 2.3 GHz band and the 2.5 GHz band meet industry requirements?*
- *What is the appropriate duplex separation (Transmit/Receive) for the FDD wireless broadband technologies in the 2.3 GHz and 2.5 GHz bands respectively?*
- *What is the minimum, as well as optimal amount of spectrum required by an operator for specific geographical deployment or nationwide deployment?*

Please provide supporting reasons for each comment and proposal made.

IDA: Coexistence - Co-channel and Adjacent Channel Interference

***SOMA/CADMUS*:** SOMA is a member of the Wireless Communications Association - International (WCA), an international industry consortium whose goal is to accelerate the adoption of Wireless Broadband Access. The WCA has technical groups that have completed technical studies in the areas of coexistence and SOMA supports the WCA's recommendations, either as guidelines or as rules. Some of these recommendations can be seen in a public filing to the FCC made by the WCA to propose a change to the rules governing the MDS/ITFS spectrum (2500-2690 MHz) in the USA. The WCA's proposal would allow the use of the MDS/ITFS spectrum for Wireless Broadband Access but also allow existing incumbents (who use the band for analog TV channel distribution) and new WBA operators to co-exist.

The filing to the FCC can be found online at: RM-10586 Part 1, RM-10586 Part 2, RM-10586 Part 3, RM-10586 Part 4. This document shall be referred to as RM-10586 below.

Adjacent channel interference is comparatively easier to address than co-channel interference. Adjacent channel interference can be addressed by out-of-band emission masks and power limits on the transmitting side and adjacent channel rejection filtering on the receiving side. A single set of 'technology-agnostic' regulations - as proposed in RM-10586 - can be applied to both FDD and TDD technologies. These rules should ensure interoperability between adjacent channel systems, whether the two systems use similar or dissimilar technologies.

Co-channel interference is more difficult, and while there are some established rules and guidelines, ultimately it will be up to the two interfering operators to work together (i.e. coordinate their actions) to solve issues on a case-by-case basis. Despite many decades of experience in the wireless industry both for regulators and operators, no simple and enforceable set of rules has been found to address co-channel interference that also guarantees a solution. If the rules are too detailed and complex, they may 'guarantee' a solution, but they become unimplementable, inflexible and unenforceable. The solution has been to provide basic rules with additional guidelines and encourage operators to coordinate.

With respect to the co-channel interference of FDD and TDD systems, the following text from RM-10586 is pertinent (see section IV, subsection 2, part b, on page 28):

> "That is not to say that co-channel interference between FDD and TDD is inevitable, merely that it can occur if system operators do not cooperate with one another. Indeed, WCA's Technical Task Group believes that there are a wide variety of techniques that can be utilized to mitigate co-channel

interference between even the least compatible technologies, including adding beam tilts, modifying antenna orientation, coordinating frequency reuse patterns and even limiting the usage of certain frequencies in border areas. However, there is considerable tension between the desires to minimize additional regulation above and beyond the 47 dBμV/m benchmark and the recognition that one licensee can do considerable damage to another's system if it does not cooperate. Due to the unique features of the MDS/ITFS band, and the need to accommodate multiple technologies in the band, WCA, NIA and CTN are exploring possible regulatory approaches that will focus on cooperative efforts by affected licensees, but at the same time provide some regulatory "teeth" that offer licensees a modicum of certainty that systems will not he devastated by interference. They will keep the Commission apprised of those efforts."

IDA: Coexistence - Technical Assessment and Methodologies

***SOMA/CADMUS*:** Please see RM-10586 section IV, sub-section 2, "The Non-MBS Technical and Operation Rules" for a discussion of the technical and assessment procedures and methodologies.

For adjacent channel interference, the spectral mask limits are as proposed in RM-10586, which are essentially the same as those used in the cellular industry, namely 43+10log(P) dB for both the subscriber station and the base station (where P is the transmitter power in Watts). For the subscriber station, the WCA technical group submitted a follow-on recommendation to make the spectral mask limits slightly more stringent. The more stringent subscriber station mask is 43+10log(P) dB in the first adjacent channel, but then goes down to 55+10log(P) dB thereafter. For the base station, the WCA proposal also includes a 'special exception' mask of 67+10log(P) dB in cases where an adjacent channel operator submits a written request (including analysis and evidence) indicating that the default levels of 43+10log(P) dB would cause undue interference to their system. This special exception mask is intended to be invoked only on a case-by-case basis for specific base stations, and is not intended as a general requirement.

For co-channel interference, the basic approach is the measurement of field strength at 1.5m height at the border region between two systems using the same channels (i.e. co-channel systems) to achieve field strength maximum limits of 47 dBμV/m.

IDA: Co-channel Interference Mitigation Techniques

***SOMA/CADMUS*:** These are discussed in RM-10586 and some methods are listed above. This list includes:

- Cell-site selection coordination between operators at border areas
- Cell-site (base station) antenna deployment (down-tilt, antenna pointing, antenna type and radiation pattern/directivity) coordination between operators
- Reduced Base station and/or CPE radiated power limits
- Directive CPE antennas
- Coordination of frequency and frequency reuse patterns

IDA: Channel Plan - 5 MHz, 5.5 MHz or 6 MHz?

***SOMA/CADMUS*:** SOMA recommends a channel plan using 5 MHz channels, for reasons outlined below. If this is deemed infeasible for other reasons, then SOMA's second recommendation would be 5.5 MHz and its third recommendation would be 6 MHz.

From a regulator's standpoint, efficiency of spectrum usage and flexibility of spectrum allocation are key. For a regulator, spectrum is viewed as a scarce resource, and must be used as efficiently as possible for provision of services to the populace. Flexibility means that the regulator would like to be able to match supply and demand for the spectrum resource as effectively as possible. Flexibility tends to argue for smaller channels, so that for a given amount of spectrum more channels are available. Making channels too small becomes a management nightmare for the regulator, though. (Imagine a market with 100 MHz of spectrum and the regulator allowing licensing of 100 kHz channels which can be grouped together. The regulator would have to file and maintain paperwork on 1000 separate channels.)

From an operator's standpoint, spectrum is equal to dollars and so efficiency (in this case economic) is key. The operator would like just enough spectrum to provide their service and no more, since extra spectrum (such as a guard band) that is not used for revenue generation is essentially overhead as far as the operator is concerned.

Efficiency for both the regulator and operator lead to a desire for channels that are as small as possible, but still allowing for the operator's technology to work. Channels that are too small make it impossible to use the channel for a given technology. For example, GSM has a basic requirement of 0.2 MHz of spectrum per carrier, whereas CDMA2000's 1xRTT requires 1.25 MHz and 3GPP systems require a minimum channel size of 5 MHz. Choosing a channel size of 2.5 MHz, for example, would be fine for GSM and 1xRTT systems (allowing them to fit one or more of their own channels into the granted channel), but would make it impossible to deploy a 3GPP-based system (unless the operator owned multiple contiguous channels and could join them together to act as a single channel).

Making the channel width too large has the disadvantage of making spectrum allocation inefficient, so an optimum point must be found.

However, the optimum point also tends to increase over time as the market requires ever higher bandwidth. The net bandwidth available to an operator of any given system is a product of the amount of spectrum (in MHz) times the spectral efficiency (in bits/second/Hz) of the particular system being deployed by the operator. The spectral efficiency is very much technology dependent and grows slowly over time. The market pressure for higher bandwith grows more quickly than the spectral efficiency, thus the amount of spectrum required increases. Due to the underlying technologies and the use of wireless standards, the spectrum requirements tend to go up in discrete 'steps'. GSM required 0.2 MHz, 2.5G CDMA requires around 1.25 MHz and 3G W-CDMA requires 5 MHz. It is SOMA's opinion that 5 MHz-wide channels represent the 'sweet spot' for the current generation of technology. SOMA is aware of some other vendors' products that can optionally make use of channels wider than 5 MHz (e.g. 6 MHz). However, these systems usually achieve this by ganging together multiple smaller sub-carriers, so they can also operate in 5 MHz channels. W-CDMA systems such as 3GPP and SOMA's system, however, do not have this flexibility and need 5 MHz and no less.

Thus 5 MHz would be the optimal choice from a basic technology standpoint. The main reason for choosing channels larger than 5 MHz is to provide extra guard bands between channels. For example, a 5 MHz radio channel centered within a 5.5 MHz spectrum channel will provide 0.25 MHz of guard band either side. This guard band is typically used to provide extra protection against adjacent-channel interference. It is SOMA's feeling that these guard bands are not necessary. The main approach to dealing with adjacent-channel interference is to use out-of-band emissions masks and radiated power limits on the transmitter side, and Adjacent Channel Rejection filtering on the receiver side. SOMA believes that with industry-standard mask requirements it is possible to adequately control adjacent-channel interference between systems. SOMA has also found that current technology allows these standard masks to be met without unduly increasing the cost of implementation. Also, filter technology has advanced to the point where high-performance filters do not add excessive cost or size to subscriber stations. It should also be pointed out that by making use of guard bands, spectrum is essentially 'wasted' (i.e. the spectrum is not directly used for generating revenue) and spectrum is an extremely expensive and precious resource. From a regulator's standpoint, it is better to increase the cost of the product slightly but be able to provide more channels (and hence more competition in the market and more bandwidth to consumers). Also note that from the regulator's standpoint, the slight increase in the product cost is born by all equipment manufacturers and so the cost

is fair, in the sense that the requirement for aggressive spectral masks applies equally to all those who compete in the market.

Appendix A: Channel Plans contains some existing and proposed channels plans for the 2.6 GHz spectrum around the world. As mentioned above, SOMA's recommendation is for the "Proposed Southeast Asia Channel Plan – 5 MHz Option".

IDA: FDD Tx/Rx Separation

***SOMA/CADMUS*:** The WCA has also considered this question in its proposal, RM-10586. Its general recommendation is to provide a channel plan which has a 'natural' separation in terms of spectrum efficiency (which is 120 MHz in the case of WCA's proposal), but to avoid enforcing any particular separation as part of the rules. Thus in the proposed channel plan presented by SOMA in Appendix A, the natural Tx/Rx separation is 94 MHz for efficient usage of the spectrum, but an equipment manufacturer is free to use any separation they want, as long as all the other legal requirements on power and spectral masks are met.

The other recommendation made by the WCA is that if a system uses FDD, then it should adhere to the convention that the higher frequency band should be used for the downlink (i.e. the link from base station to subscriber station) and the lower frequency band should be used for the uplink (i.e. the link from the subscriber station to the base station). This is in line with other licensed spectrum assignments such as UMTS and PCS.

IDA: Minimal/Optimal Spectrum Requirements

***SOMA/CADMUS*:** SOMA's system is based on FDD W-CDMA. As such the minimum spectrum required to operate the system is a single 5 MHz pair of spectrum (i.e. 5+5 MHz). SOMA's system can use 1:1 reuse. To improve system capacity and decrease the number of base stations required, higher orders of reuse are desirable. The 'optimal' level of reuse (and hence spectrum required) depends on the system technology and is generally specific to particular deployments, however SOMA has found that the knee of the curve for our system occurs at reuse factors of 1:3 or 1:4. Thus SOMA would recommend that the licensing rules make it feasible for operators to obtain paired blocks of contiguous channels consisting of 20+20 MHz or 15+15 MHz.

Spectrum Auction: Key Features and Service Obligations

IDA: *Views and comments on the key features and service obligation to be applied for auctioning the spectrum for the deployment of wireless broadband technologies. If the key features are not appropriate, please provide supporting reasons why they are not.*

***SOMA/CADMUS*:** A spectrum auction needs to take a few parameters into consideration in order to achieve its objective:

1. Be fair: the auction process shall not prevent any interested party from getting a chance to acquire spectrum. As mentioned earlier, while broadband wireless technologies give a chance to new players to start competing against wireline service providers, it is also an opportunity for these wireline providers to offer new services such as nomadic applications.
2. Avoid expanding monopolies: the auction should however make sure that service providers who already own broadband infrastructure do not expand their control over the market through excessive control of the spectrum, preventing new players from deploying their own network.
3. Protect the business case: the risk of auctions is to see the pricing of spectrum going to price levels that challenge the business case and, therefore, creating an important barrier to entry.

We consider that the rules described by IDA (Reserve price, Initial Offer, Duration of Spectrum Rights, Obligation to Deploy) will help achieve the objectives of the spectrum allocation. IDA may want to:

1. Give a minimum deployment requirement (e.g. minimum number of users or minimum coverage) within the two-year period;
2. Specify whether spectrum rights could be renewed;
3. Confirm that there will be no ongoing fee for the spectrum.

Spectrum Auction: Rules

IDA: *Views and comments on whether spectrum should be auctioned in generic lots or in blocks with specified frequencies; the appropriateness of the lot sizes; and the maximum amount of spectrum to be set.*

SOMA/CADMUS: For the 2.6GHz spectrum, we think it should be auctioned in such a way that it leaves to the service provider the option of deploying FDD or TDD technology. Therefore, we would recommend that the spectrum be auctioned in paired blocks with a fixed separation. Service providers can then decide to use a FDD or TDD technology at its own discretion.
We would also recommend that each block of different sizes be offered. Each block will have a different reserve price. In the case of 2.6GHz spectrum, an optimal way to allocate the spectrum would be to offer 3 paired blocks of 5MHz, 3 paired blocks of 10MHz and 3 paired blocks of 15MHz. Existing broadband infrastructure owners should be limited to buy a maximum amount of spectrum (10MHz paired: 1 paired block of 10MHz or 2 paired blocks of 5MHz).

SOMA understands that IDA plans to allocate a sub-segment of 2.3GHz: 2300MHz to 2350MHz. For that band, SOMA recommends that IDA auction the

band in 5MHz pairs from 2300-2315 + 2335-2350 with 35MHz separation for FDD only. 2315-2335MHz shall be auctioned by blocks of 5MHz for exclusive use by TDD technologies.

Deployment of WBA in 3G Bands

IDA: *Views and comments on the deployment of wireless broadband technologies in the 3G spectrum bands. Are there any technical considerations that IDA should consider? Please provide detailed supporting reasons for each comment and proposal made.*

***SOMA/CADMUS*:** All the comments made on co-existence remain valid for operations of wireless broadband technologies in the 3G spectrum bands. Some differences reside in the fact that 3G spectrum was given for exclusive use of FDD or TDD technologies, eliminating the risks related to TDD and FDD co-existence. A recommendation is to ensure that wireless broadband technologies to be deployed in 3G spectrum bands shall respect 3G masks.

Limits on Access to WBA Spectrum for Existing Providers

IDA: *Views and comments on the eligibility of existing 3G and broadband infrastructure providers for the 2.3 GHz and 2.5 GHz spectrum, and the limit on the spectrum amount for which they could bid.*

SOMA/CADMUS: We think that 3G and broadband wireless technologies are more complimentary technologies than competing ones. We would therefore not limit access to spectrum for 3G providers. We would however limit spectrum for broadband infrastructure providers who already enjoy dominant positions in the market and could expand their control in the market by limiting the possible entry of new players in the fixed broadband market by control over the spectrum. Suggestions could be a maximum of 10MHz paired in 2.5 GHz and one 5MHz pair or one 5MHz block in 2.3GHz.

Interconnection and Open Access Issues

IDA: *Views and comments on whether there are issues that may pose problems to achieving transparent and seamless interconnection and open access. IDA further seeks comments on the type and level of QoS standards that will be appropriate and whether the existing set of QoS standards for broadband service providers are applicable for service delivery using wireless broadband networks. Please provide supporting reasons for each comment and proposal made.*

***SOMA/CADMUS*:** We have no specific comment but agree that Interconnection and Open Access should be requirements for the deployment. Regarding QoS

requirements, we consider that it is in the interest of the service provider to offer a service that competes with other technologies. We believe that the set of QoS standards should be recommendations rather than requirements. Defining same sets of requirements for wireless and wireline technologies might present a risk. However, it will be in the interest of the wireless broadband service provider to choose a technology that allows him to successfully compete with other broadband infrastructure providers.

Market Trial Licence Framework

IDA: *Views and comments on the Market Trial Licence framework and the specific features set out in Annex 2. Is the market trial licence framework conducive in helping market participants testing the commercial viability of innovative service? Are there additional issues that IDA should consider? Please provide detailed supporting reasons for each comment and proposal made.*

***SOMA/CADMUS*:** We only have one question: how will these trial licenses (who could last up to 12 months) fit within the timing for auction? If these Trial Licenses present a risk of delay for any auction, we would recommend limiting it to 3 months renewable.

Appendix A: Channel Plans

Figure 1 below shows the existing MMDS channel plan for Malaysia, as well as SOMA's proposals for a new, unified, Southeast Asia channel plan using either 5 or 6 MHz channels. Either plan uses a 94 MHz FDD Tx/Rx separation. The 6 MHz option provides for 15 paired channels (6+6 MHz pairs). The 5 MHz option uses exactly the same bands, but fits in 18 paired channels (5+5 MHz pairs). The coloration of channels in groups of three (i.e. three pairs) is meant to indicate the possibility that the regulator might want to grant spectrum in blocks of channels. (This is much like the PCS spectrum in North America, which has a mix of 5 and 15 MHz blocks.)

Figure 2 shows the existing and proposed channel plans for the 2.6 GHz spectrum in Europe. (The term 'MMDS' is not generally used to refer to this spectrum in Europe.) The existing channel plan is already well suited for WBA except for the use of 7 MHz-wide channels. The only proposed change for the new channel plan is to use 5 MHz-wide channels.

Figure 3 shows the existing and proposed new channel plans for the US. The existing channel plan is much like the Malaysian plan: it is 'flat' with no dedicated structure for FDD, which is a legacy of its original use for analog TV channel distribution. Because the MMDS spectrum is very sparsely used for TV distribution nowadays in the US, an industry consortium called the WCA is lobbying the FCC to re-channelize the spectrum as shown in the figure. For political reasons it is not possible to clear all the remaining TV channel operators out of the MMDS spectrum, so the WCA has proposed moving these legacy TV channels into the center of the band and using the upper and lower portions of the band for provision of WBA. The choice of 5.5 MHz channels was primarily to provide some guard bands. However, as SOMA has discussed above, we do not feel that the guard bands are technically necessary.

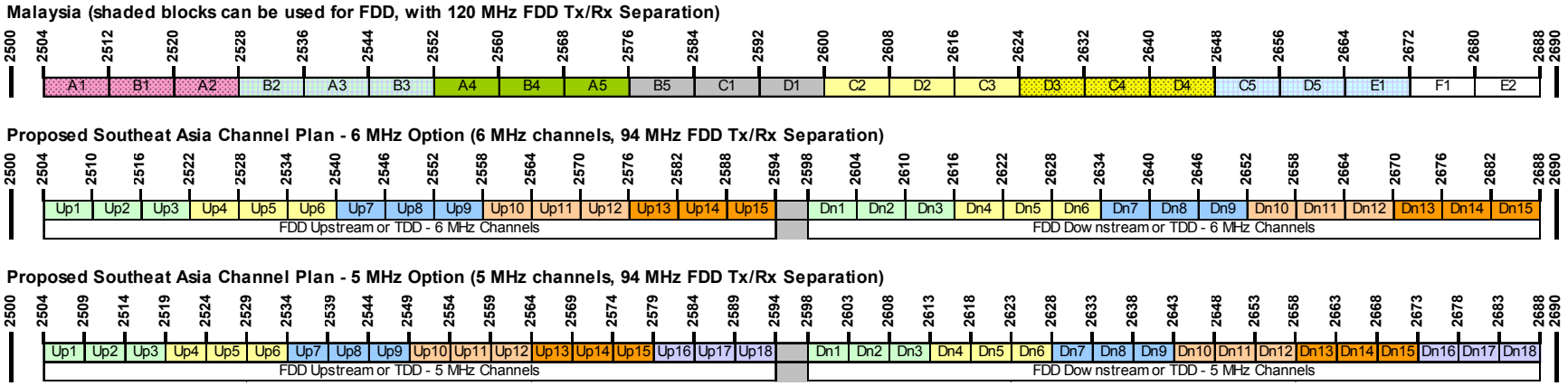

Figure 1: Existing Malaysian channel plan and proposed new channel plans.

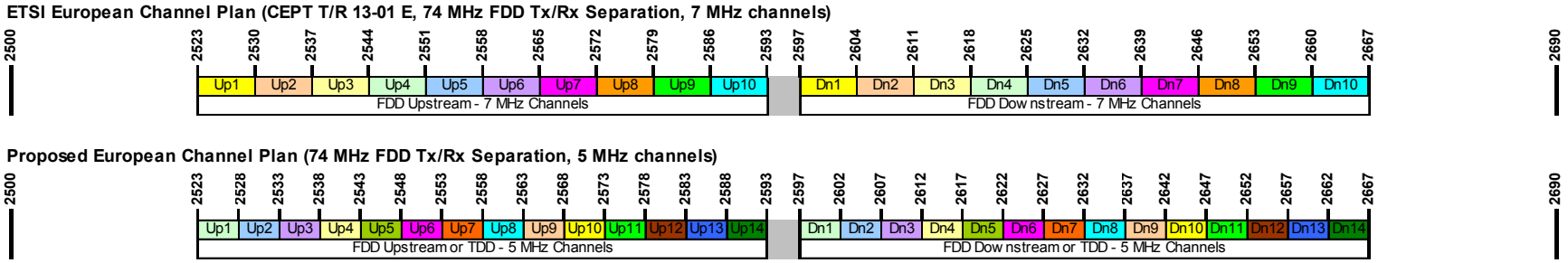

Figure 2: Existing European channel plan and proposed new channel plan.

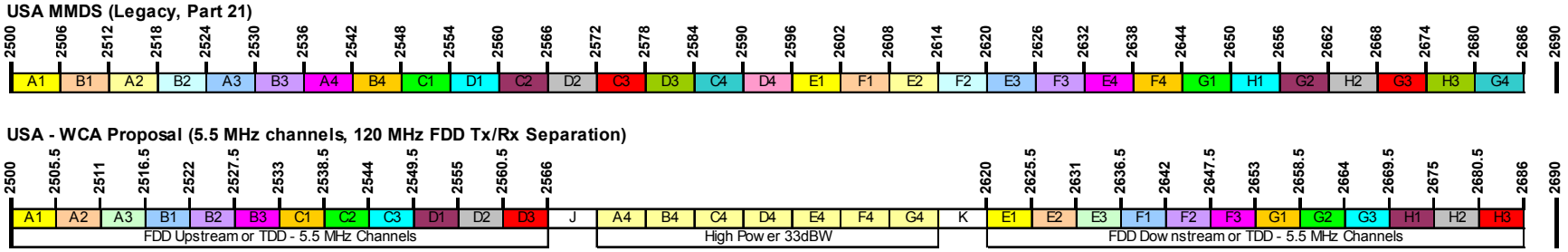

Figure 3: Existing US MMDS channel plan and new channel plan proposed by WCA.