EBU

OPERATING EUROVISION AND EURORADIO

TR 054

5G FOR THE DISTRIBUTION OF AUDIOVISUAL MEDIA CONTENT AND SERVICES

TECHNICAL REPORT

Geneva – Final

Contents

Spectrum Aspects

For chipset and equipment manufactures to incorporate 5G functionalities in their devices, they would have to be convinced that there was sufficient market demand for such functionality (c.f. § 4.2). A major factor in their assessment of demand would be the availability of suitable spectrum for the potential deployment of services based on 5G Broadcast.

A1. IMT Bands for 5G Mobile Broadband

Europe has several bands harmonised for mobile communication. 2G (GSM/GPRS/EDGE) started with 900 MHz and added 1800 MHz, 3G (UMTS/HSPA) started in the 2100 MHz band, with 4G (LTE) 800 MHz and 2600 MHz have been added. 5G now further adds 700 MHz, 3400-3800 MHz [33] and 26 GHz [34]. Licences in Europe are technology neutral, i.e. licenses can freely choose the technology to best match their strategy, their terminal population and their deployed network infrastructure. Increasingly, technology allows to define the used technology in software. The table below lists the harmonised European bands, % pop use are guestimates to give a rough indication of usage.

Table A1: Harmonized European bands

Band	Hz]		Technology	available	
700 MHz	2x 30	FDD	4G 5G	~2020	European-wide
700 MHz	15-20	SDL	4G 5G	?	?
800 MHz	2x 30	FDD	4G 5G	~2010	European-wide, >90% pop use
900 MHz	2x 35	FDD	2G 3G 4G 5G	~1990	European-wide, >95% pop use
1400 MHz	40 (90)	SDL	4G 5G	~2015	few countries
1800 MHz	2x75	FDD	2G 3G 4G 5G	~1995	European-wide, >80% pop use
2100 MHz	20	TDD	(3G) 4G	~2000	unused, new uses discussed in CEPT
2100 MHz	2x 60	FDD	3G 4G 5G	~2000	European-wide, >80% pop use
2100 MHz	15	TDD	(3G) 4G	~2000	unused, new uses discussed in CEPT
2600 MHz	2x 70	FDD	4G 5G	~2010	European-wide, >60% pop use
2600 MHz	50	TDD	4G 5G	~2010	European-wide, some use
3.6 GHz	390	TDD	(4G) 5G	~2020	European-wide
26 GHz	3125	TDD	5G	~2020	European-wide

Bands below 1 GHz are ideal for covering large areas with limited amounts of sites. The 800 MHz band is considered “the workhorse” for wide area MBB coverage with 4G. Bands below 6 GHz are less useful for covering wide areas as the number of sites required increases rapidly with the carrier frequency. The 3400 - 3800 MHz range is the European mid pioneer band and allows for substantially wider carrier bandwidths for 5G New Radio in combination with adaptive antennas. 26 GHz is the EU high pioneer band for 5G and will allow for double digit Gbit/s peak data rates but with limited cell ranges, not expected to be deployed nation-wide any time soon.

MNOs increasingly face substantial coverage obligations with spectrum licenses like the recent 100 Mbit/s per antenna sector target in Germany to 98% pop. Most of the available RF bandwidth is in higher bands well suited for densely populated areas. In rural areas, primarily bands below 1 GHz are used. With network load primarily driven by AV content, networks would soon typically exceed a ratio of 10:1 between downlink (DL) and uplink (UL).

A2. IMT Bands for 5G Broadcast

As described above, in Europe the bands in 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2600 MHz, 3400 - 3800 MHz, and 26 GHz are identified for IMT systems. Some frequency bands are used by legacy mobile systems (2G, 3G and 4G) while others will be used for 5G. Being licensed on a technologically neutral basis, all of these frequency bands may, over time, be repurposed for 5G. All these bands are regionally or globally harmonised.

5G Broadcast technology relies on the LTE frequency bands as defined in [35], which provides many options for the deployment of such technology. MNOs are likely to prefer a mixed mode where broadcast is used in addition to unicast for local bandwidth optimisation and this is in principle possible in any of the above-mentioned frequency bands.

However, for standalone 5G Broadcast networks the number of spectrum options is rather limited, especially if near-universal coverage is required. Such coverage may be best provided by lower frequency bands as opposed to high frequencies such as 26 GHz. Standalone, wide area 5G Broadcast networks may not be commercially viable in the bands owned by MNOs as they would likely derive higher revenues from mobile unicast services.

A3. Supplemental Downlink (SDL) bands for 5G Broadcast

Possible alternatives for stand-alone 5G Broadcast services could be SDL bands that are currently underused (the central gap in the 700 MHz band and the L-band) and, under certain conditions, the sub-700 MHz band. SDL is a form of carrier aggregation. It is not possible to aggregate all combinations of carriers together – only the combinations set out in [35] are permitted.

There are several challenges associated with a possible deployment of 5G Broadcast networks in these SDL bands, including standardisation, device support, regulatory conditions, and ensuring commercial viability.

Table A2 contains an example of potential FDD allocations in the 700 and 800 MHz bands as well as the allocation intended to be used to realize SDL.

It should be noted that potential allocations to downlink-only transmission with unpaired uplink, Standalone Downlink Only (SDO) are not defined in 3GPP. Further consideration is therefore required of which bands may be suitable for 5G Broadcast deployment, including the technical/regulatory considerations associated with them.

A3.1 UHF SDL Band 67 (738 - 758 Mhz)

TR 36.101 only permits the aggregation of the 700 MHz duplex gap (LTE SDL band 67) with the 800 MHz FDD band 20. In other words, SDL in band 67 is not permitted to operate while band 700MHz (LTE FDD band 28) is in use. This is presumably because the uplink in band 28 from a UE would interfere with an SDL downlink signal in band 67.

Should an SDO service be deployed in band 67, it would also suffer interference (within UEs) that were simultaneously using the uplink in band 28. The SDO service would therefore be impaired by the UE’s own uplink when band 28 were in use. The effect would be a smaller coverage area for the SDO service than otherwise expected.

The use of band 67 for an SDO service would therefore require careful thought, should it be practical at all.

Table A2: Examples of FDD bands

Band	Uplink (UL)			Downlink (DL)			Duplex Mode
	F_{UL_low}		F_{UL_high}	F_{DL_low}		F_{DL_high}	
20	832 MHz	—	862 MHz	791 MHz	—	821 MHz	FDD
28	703 MHz	—	748 MHz	758 MHz	—	803 MHz	FDD
32		N/A		1452 MHz	—	1496 MHz	FDD*
67		N/A		738 MHz	—	758 MHz	FDD*

*Restricted to Carrier Aggregation, where the downlink band is paired with the uplink of another carrier.

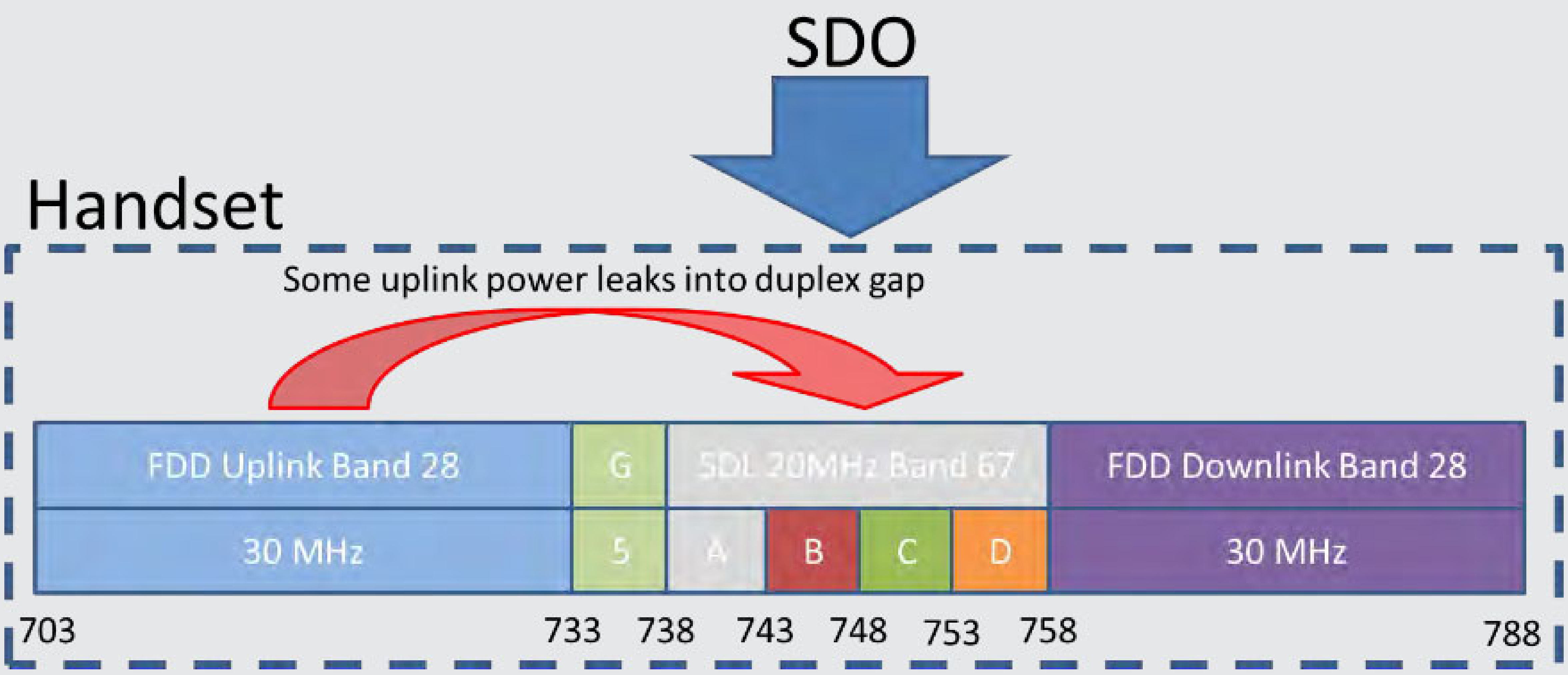

Figure A1: Potential self-interference from handset uplink to SDO service

A3.2 L-band SDL Band 32 (1452 – 1496MHz)

TR 36.101 permits the aggregation of the LTE SDL Band 32 with the 700 MHz FDD Band 28 and with the 800 MHz FDD Band 20.

The L-band is not currently intended for use by SDO. In Europe it has been set aside for SDL. In principle the L-Band could be used for SDO in Europe, but a request for such use would likely require wide support from many countries.

A4. Broadcast bands for 5G Broadcast

The main terrestrial broadcasting bands in Europe include VHF Band II 87.5 - 108 MHz (FM radio) and Band III 174 - 230 MHz (T-DAB) and part of UHF Bands IV/V, 470 - 694 MHz (DVB-T/2); the UHF Bands predominately targeting fixed rooftop reception from HPHT networks.

HPHT transmissions require careful coordination between countries, particularly in the border areas between one country and another. The use of broadcasting Bands V/V, in ITU Region 1, are subject to the Geneva 06 (GE06) Agreement [36]. This agreement provides a framework to manage the rights to use the UHF Bands, which are subdivided into 8 MHz UHF channels, in associated countries. All transmissions in the 470 - 694 MHz band must conform to the framework of GE06 which ensures compatibility between services.

Two options have been considered for the operation of 5G Broadcast in the 470-694 MHz range. The first of these is co-existence whereby 5G Broadcast would operate within the band at the same time as HPHT DTT broadcasting. The second is a clean sheet in which 5G Broadcast would not have to consider compatibility with DTT.

A4.1 Coexistence

The first option, co-existence, would require that the 5G Broadcast transmissions were compatible with the existing DTT transmissions, and vice versa. Two further sub-options for co-existence are:

a) using the interleaved spectrum that is locally unused by DTT, the so-called 'white spaces'.
b) Using existing planned DTT assignments for 5G Broadcast. In ITU/Region 1 this corresponds to using the envelope concept of the GE06 Agreement which allows plan entries to be used for other purposes if they conform with the GE06 envelope concept. In other Regions, this corresponds to bilaterally or multilaterally coordinated DTT assignments.

Option a) does not seem to be viable as in most cases within Europe the UHF spectrum is heavily used for both DTT and PMSE. The available white spaces are therefore considered to be insufficient for the deployment of 5G Broadcast at a scale sufficiently large for content distribution. Therefore, option b) is the remaining opportunity.

Under option b), some countries may be able to use their planned, yet unused, DTT assignments, for 5G Broadcast. Others may need to replace some of their existing DTT transmissions with 5G Broadcast.

In any event, for option b), the frequency raster (i.e. channel bandwidths and centre frequencies) of 5G Broadcast would have to be considered alongside the 8 MHz frequency raster of DTT. 5G Broadcast – as used in this context – is based on LTE carriers. LTE defines carrier bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz i.e. 5G Broadcast does not currently have an 8 MHz bandwidth.

Unless the specifications are further modified, any deployment of 5G Broadcast would therefore need to use one of these non-8 MHz bandwidths. Option b) therefore involves the use of mismatching DTT and 5G Broadcast frequency channel rasters. Should this be done, several compatibility issues would arise. The most obvious of these issues are outlined below for 5 MHz, 10 MHz, and 15 MHz LTE carriers.

Figure A2 illustrates two possibilities for the 5 MHz carrier whereas Figure A3 illustrates two possibilities for the 10 MHz carrier.

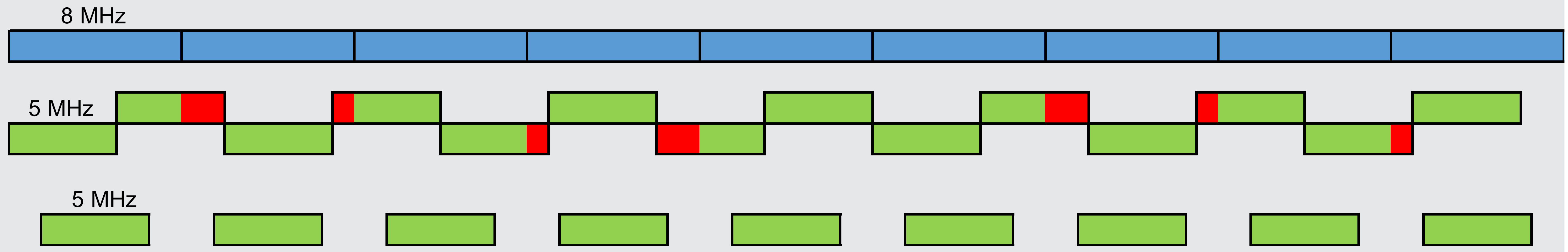

Figure A2: Position of a 5 MHz channel bandwidth in an 8 MHz raster with off-centred (middle) and centred allocations (bottom).

A 5 MHz carrier, effectively occupying 4.5 MHz, could be aligned relative to an 8 MHz DTT channel as shown in Figure A2. Should the 5 MHz channels be centred on the 8 MHz channels (lower line in Figure A2), they can be directly used under 8 MHz GE06 plan entries.

In case they are not centred (middle line of Figure A2) several of them would overlap with adjacent DTT channels and mutual interference would occur.

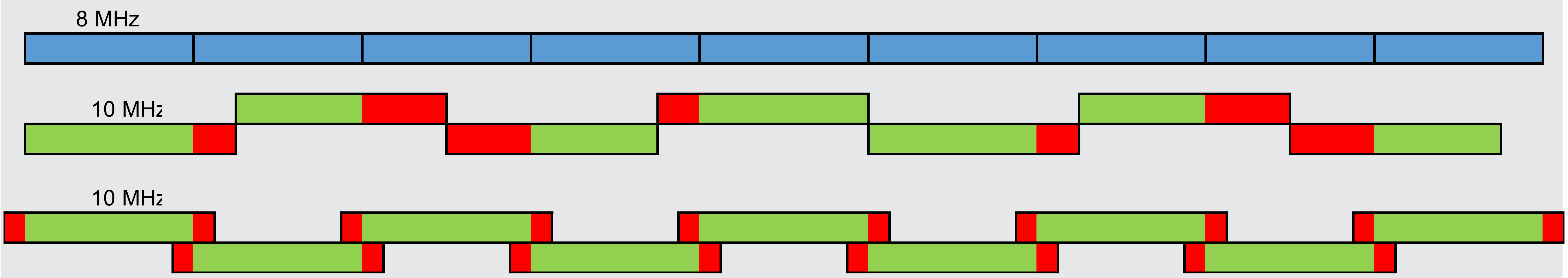

Figure A3: Position of a 10 MHz channel bandwidth in an 8 MHz raster with off-centred (middle) and centred allocations (bottom), in the latter case with overlapping carriers

A 10 MHz carrier, effectively occupying 9 MHz (the active portion of the occupied bandwidth), could be centred on an 8 MHz channel with an (active) overlap of 0.5 MHz into each of the adjacent channels (see the lower illustration in Figure A3).

It can also be off-centred (see middle illustration in Figure A3). However, in both cases the LTE carrier would overlap with adjacent DTT channels and mutual interference would occur.

The only option which could be implemented straightforwardly under the GE06 envelope concept is the centred 5 MHz variant. However, as only 5/8 of the available spectrum would be employed this would not be an efficient use of the spectrum. All other options would have to cope with adjacent channel interference. The question whether this could be mitigated, for example by means of specific network designs, including power reduction, use of lower antenna heights with directive antenna patterns, requires further study.

Another possibility for 5G deployment in the sub-700 MHz band could be to use a 15 MHz LTE block which would be positioned such to occupy two adjacent DTT channels. Figure A4 shows such a layout.

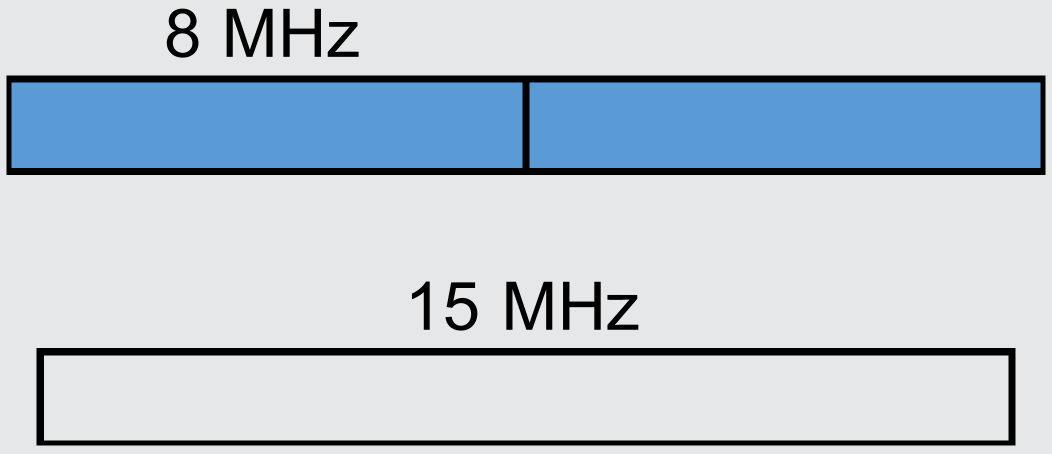

Figure A4: Position of 15 MHz channel bandwidth in an 8 MHz raster placed at the centre of 2 adjacent 8 MHz channels

However, the availability of two adjacent channels in the same geographical area is not prevalent in the GE06 plan in Region 1 or within any bilaterally coordinated plan based on 8 MHz raster elsewhere. While modification of existing plans is always possible, generalising the above-mentioned solution would require substantial re-planning and coordination efforts. It should also be noted that this option would not strictly meet the GE06 requirements in terms of envelope concept and spectrum mask.

A4.1.1 Potential of 8 MHz carrier bandwidth

An LTE 8 MHz carrier bandwidth would fit into the existing 8 MHz raster and co-exist with current deployments in large part of the world. Use of 8 MHz bandwidth maximizes spectrum use and minimise interference. The potential to standardise such an 8 MHz bandwidth should therefore be considered.

A4.2 Clean Sheet

A clean sheet – in which compatibility with DTT was of no concern – would have significantly more freedom and could potentially use any of the non-8MHz carrier bandwidths defined today.

However, at present, such a clean sheet does not exist and implementing it would require significant national planning and cross-border coordination effort and would require a long transition time. During this transition, co-existence solutions with DTT would still be required to avoid viewer disruption in areas/countries where DTT may remain a primary distribution platform in the future. Such a transition might also be eased by the introduction of an 8 MHz channel for 5G Broadcast as mentioned above.

A4.3 Global Harmonisation of sub-700 MHz Usage for 5G Broadcast

Taking Europe alone, it may be difficult to create sufficient market demand for 5G Broadcast devices, given the wide diversity of member states and their policy objectives. Thus, activities in economies outside Europe deserve some attention.

Notable developments in China include plans for 5G Broadcast with initial demos foreseen in February 2022 to be followed by large scale deployments. The Chinese Academy of Broadcast Science has shown plans to reserve the 700 MHz band for mobile communication with an FDD global Band 28 band plan and consider 5G Broadcast on a HPHT topology below the 700 MHz band. One discussed option is a band split with the range 470 - 606 MHz dedicated to conventional DTMB in an 8 MHz raster and the range 606 - 702 MHz planned for 5G Broadcast deployments based on 3GPP Rel14/Rel16 5/10/15/20 MHz carrier offering. This band segmentation seems to be motivated by the non-availability of an 8 MHz carrier bandwidth solution from 3GPP, which would allow for a degree of sharing of the band between DTT and 5G Broadcast. If China's current plans materialize in a 5G terminal ecosystem, this would be of limited use in Europe where 5G Broadcast would need to fit into the existing 8 MHz raster of GE06 and all current DTT deployments. However, should China choose a 5G Broadcast band plan with an 8 MHz raster, a wider ecosystem could be created with better prospects of device implementation in Europe.

In India, proposals have been discussed to offload eMBMS broadcast traffic from spectrum licensed to MNOs into UHF spectrum below 700 MHz. In the report [37] from the Telecommunications Standards Development Society India (TSDSI), there are competing proposals for ATSC3.0 and for 3GPP 5G Broadcast technology in user terminals. While India is not expected to set the pace for a device ecosystem, it could greatly enlarge a 470 - 694 MHz ecosystem perspective when choosing the 3GPP path.

A4.4 Summary

The most straightforward option for 5G Broadcast to co-exist with DTT, is for 5G Broadcast to use 5 MHz channels with the same channel centres as the 8 MHz DTT raster. However, as this option would use only 5/8 of the available spectrum and it would be spectrally inefficient. A newly defined 8MHz bandwidth would be more efficient while also being compatible with the GE06 framework in ITU Region 1 and with coordinated plans in other Regions that use 8 MHz channel raster for TV broadcasting.

A clean sheet approach – in which compatibility with DTT was of no concern – could potentially use any of the existing 5G Broadcast channel bandwidths. However, transitioning to this situation may still require a solution for co-existence with DTT. An 8 MHz channel bandwidth for 5G Broadcast would also help with this in large parts of the world.

The potential for standardizing an 8 MHz channel bandwidth should be further investigated as it has clear advantages in all the options considered in this document.

It would also be useful to investigate several other areas such as:

- Whether techniques, such as specific network designs, including power reduction and the use of lower antenna heights with directive antenna patterns may help compatibility between DTT and 5G Broadcast using existing LTE channel bandwidths.
- The extent to which contiguous pairs of adjacent 8 MHz channels are available in the existing DTT frequency plans (to allow 15 MHz LTE channels to co-exist with existing DTT)

Whatever paths may be considered potentially successful for the introduction of 5G Broadcast in the band 470 - 694 MHz, it is absolutely crucial that a joint effort is made globally, i.e. all stakeholders around the world need to agree to follow the same direction. Different proposals from different regions of the world will diminish the chances of global 5G Broadcast uptake.