Your response

Question	Your response
Question 1: Have we correctly identified the key changes in the utilities sector that could lead to additional spectrum requirements?	Confidential? – N Your descriptions are in line with the international trends we see in Europe and in other regions as well. In several sectors, the need is identified to have control over the connectivity on power outage resilience, technology life cycle management, priority management and cyber security and keep these at a level that cannot, and will not, be provided by commercial network operators. In the direct vicinity of the United Kingdom, this was recognized by the regulators in Ireland, Germany and, most recently, The Netherlands as well. In each of these countries, spectrum is or will be assigned to operators of critical infrastructures to fulfil their specific connectivity needs with a private network. The frequency bands assigned are (parts of) Band 87 (410-415 MHz paired with 420-425 MHz FDD) in Ireland and Band 72 (451-456 MHz paired with 461-466 MHz FDD) in Germany and The Netherlands. Among the sectors that more and more recognize the need for private spectrum, we find health, industry, transport (including rail) and utilities, with the utilities currently the most outspoken and within the utility sector, as also mentioned in your document in paragraph 2.21, the electricity grid operators in the first place.

Question 2: What alternative communication solutions might play a role in meeting the future operational communication needs of the utilities sector, alongside or instead of additional spectrum for a private network?	Confidential? – N Most of the connectivity needs of the utilities sector can be fulfilled by the incumbent mobile operators as well. However, these operators cannot fulfil specific requirements as mentioned under A1 (such as power outage resilience, technology life cycle management, priority management and cyber security) to sufficient levels, because they • need to optimize their cost levels; • cannot guarantee the long term availability of communication technologies used (which is important given the long lifecycles of many user assets in the field); • always have to find compromises between the interests of multiple customers. For this reason, private networks are a necessity and once a private network exists, the private network operator will also support less critical traffic in order to be more cost effective, with the notion that this less critical traffic will be switched off or at least be suppressed in times of crisis, to give full priority to the critical use cases (such as emergency voice and grid control during major power outages).
Question 3: Are there any other spectrum bands we should consider for use by utilities?	Confidential? – N Among members of the 450 MHz Alliance there is a growing interest in defining new 4G/5G bands in the 380 – 400 MHz spectrum. Though this is primarily seen as an opportunity for the ITU Regions 2 and 3, we believe Ofcom should be aware of these developments and of course we would be happy to discuss this project if Ofcom is interested. Another point to mention is Agenda Item 1.5 at the WRC23 later this year, which is to review the spectrum use and spectrum needs of existing services in the frequency band 470-960 MHz and consider possible regulatory actions in the frequency band 470-694 MHz, both in Region 1. The outcome of this Agenda Item may be that in (a part of) this frequency range a primary status will be allocated to IMT. In that case, more options at relatively low frequencies (which are most favourable for utilities) may come available for Private Networks within a few years.

Question 4: Do you have any comments on the three bandwidths we have considered that might be necessary to support a private network for utilities? Please reference our capacity analysis in annex 7 where relevant.	Confidential? – N As described in the answer on Question 2, private network operators often support less critical communications alongside the critical traffic that is the primary reason of existence of the private network. The driver is that the less critical traffic is needed to generate additional revenues without which the private network may become too expensive. To provide sufficient coverage in a region, a certain minimum amount of radio sites is required, each with power backup capabilities and physical protection measures, so
	there is a minimum cost level that the private network operator cannot avoid. Additional revenues are needed to (at least partly) compensate for these costs. In that light, it is generally seen that 2x 1.4 MHz bandwidth is too small for the fulfilment of the communications needs of Utilities and 2x 3 MHz is the minimum bandwidth needed. From our experience, we recognize the industry suggestion mentioned in paragraph 3.10.

Question 5: Do you have any comments on our approach to examining each potential candidate spectrum band, including the factors relevant to assessing suitability, and the capacity and coverage analysis provided in annexes 7 and 8?	Confidential? – N In general, the examination of the candidate spectrum bands is clear and valid. An exception may be the coverage analysis between the 450 MHz band and the 700 MHz band. Given the available details of the calculations shown, the 450 MHz Alliance can only make a high level assessment of these calculations and the conclusions that are drawn from them. Some of our observations are: • The assumption that the environmental noise level at 450 MHz is 4 dB higher than the noise level at 700 MHz, has much impact on the outcome of the calculations. It is unclear to what extent this assumption is evidence based. • For indoor coverage, taking into account the lower indoor penetration loss at 450 MHz, the advantage of 450 MHz compared to 700 MHz will be significantly higher. • Of course the calculations for the 700 MHz case improve when the transmit power at 700 MHz is increased by 3 dB (which is mentioned to be a small increase, but we find that a considerable step). However, the same would happen if also the transmit power at 450 MHz would increase, so the relevance of this statement is unclear. • In addition to this point: please keep in mind that usually a network planning is uplink limited, and doubling the UE output power is not easy. As a matter of fact, at 450 MHz there is more room for increased UE transmit power since the power limit defined for 450 MHz (Power class 2) is 3 dB higher than at 700 MHz (Power class 3).

	Not surprisingly, simulations by members of the Alliance making similar comparisons, show significantly better coverage at 410 MHz compared to 700 MHz and 800 MHz. The conclusion that coverage at 450 MHz is marginally better than at 700 MHz is therefore in our eyes not generally true. Not only is a 10% difference more than marginal and would result in a significant higher amount of sites needed at 700 MHz to achieve comparable coverage, we also believe that the difference in general will be larger than 10%, especially when indoor coverage and Power Class 2 UE's (possible at 450 MHz, not at 700 MHz) are taken into account.
Question 6: Do you have any comments on our overview of the 400 MHz band in NI? Please consider the specific factors we have discussed in your response.	Confidential? – N As for the ecosystem (paragraph 4.6), the 450 MHz Alliance can confirm that the ecosystem for Band 87 exists and is growing. Because the chip-sets most used for the 450 MHz band also sup-port Bands 87 and 88, the availability of more equipment will come along with a growing de-mand in a relatively short timeframe. The co-channel usage with the RAF Fylingdales radar is a point of attention indeed (paragraph 4.7). Where an exclusion zone of 400 km as rec-ommended in ECC Report 240 (ref your footnote 45) was based on worst case assumptions and according to our experts not needed in practice, good and precise coordination will be required. We recommend performing a field trial together with stakeholders to confirm the assumption that coexistence is possible with good coordina-tion.
Question 7: Do you have any comments on our overview of the 450 MHz band in GB and NI? Please consider the specific factors we have discussed (including the coexistence analysis in annex 9) in your response.	Confidential? – N The 450 MHz Alliance would like to comment on several of the topics raised in your document. In order of their appearance these are: UK's band plan: the reversed band plan in which the transmit and receive bands are opposite from the so-called harmo-nized band plan, may be problematic and become more and more so when offshore networks emerge. In The Neth-erlands, the Ministry of Transport and Water Management seems to aim for an offshore network at the North Sea, using

	a licence in Band 72 to be assigned later this year. Mutual interference issues are to be expected and given the high amount of users in the band, these aren't easily coordinated. On the other hand, since also in Ireland the reversed band plan is applied, converting this in the UK may introduce new interference issues across the Irish Sea and on the border with Northern Ireland. We understand this to be a dilemma. Clearly, many if the issues would be solved if both the UK and Ireland would be able to convert the band usage to the harmonised band plan, at the same time this would be a complex and far-reaching operation. But on the long term a re-farming of the 450 MHz band seems to be the only way to overcome these issues as well as many of the other complexities mentioned in your description of the band plan (paragraphs 5.4 – 5.13 and further). • Equipment Ecosystem (paragraphs 5.14 and 5.15): the 450 MHz Alliance can confirm that the ecosystem for bands 72 and 31 is widely adopted nowadays. This is true at least for the harmonised band plan. For the reversed band plan, systems must be developed. Like for the bands 87 and 88, it may be assumed that development for the reversed band plan will take place once there is sufficient and specific demand for such equipment. Hence, we believe that this issue should not be blocking for the assignment of broadband spectrum in a reversed band plan, although the harmonised band plan remains the preferred option, of course. • Coexistence co-channel (paragraphs 5.16 and 5.17): we agree that co-existence with most other systems would be problematic. Only if the co-existence is limited to a few locations only, it may be locally coordinated. • Coexistence adjacent channel (paragraphs 5.18 – 5.20): we agree to the assessment that in general this should not be a problem, especially if ECC Decision (19)02 is followed. It should also be

	noted that spectrum masks of LTE systems appear to be significantly better than those mentioned in that ECC Decision, so we wouldn't expect major problems at all. • Enabling the use of the 450 MHz Band for a private network (paragraphs 5.21 – 5.32): we agree that the reasons mentioned in paragraph 5.22 would be sufficient to reconsider the band plan. Certainly, the impact on current users will be significant, as clearly illustrated in the example on page 27, although in reality, the impact may be lower if the actual usage of the spectrum were considered, rather than the number of licences. Since this may be difficult to assess, spectrum measurements on different locations may give some insight into this. Considering the full replan considerations (paragraphs 5.30 to 5.32): this should be Ofcom's ambition for the long term, since it is in line with the harmonized band plan and the only way to cope with cross border interference issues. However, we believe that a full band replan cannot be realized in one major step. All current users should change their uplink and downlink in a very short timeframe because during this migration, the entire spectrum is more or less useless because major interference issues will arise. Given the number of users, the base stations and UE's involved, this seems impossible. Hence, a partial replan is, to our opinion, an inevitable intermediate step. Frequency separation seems to make sense, although measurements should show to what extent adjacent channels cam be used, especially at a local level. • Cost considerations (paragraph 5.33): we agree to the distinguishing cost factors mentioned. A minor addition would be that in general Private Networks are built to obtain a higher level of resilience than public networks can offer. This increases the cost per site.

Question 8: Do you consider that changes in the spectrum environment for the 450 MHz band mean that there is a case for re-examining whether this band should be reconfigured in the UK to align with the harmonised band plan?	Confidential? – N As described above, this is definitely the case.
Question 9: Do you have any comments on our overview of the 700 MHz band in GB and NI? Please consider the specific factors we have discussed in your response.	Confidential? – N We have no detailed comments. A general remark is that this band would be quite suitable for private networks as well. Of course the primary use cases determine the suitability of the band. In case of utilities, we observe that for most use cases coverage and high resilience are more relevant than capacity. For that reason, the 400 MHz range seems to guarantee efficient spectrum use better than the 700 MHz band.
Question 10: Do you have any comments on our overview of the 800/900 MHz band in NI? Please consider the specific factors we have discussed in your response.	Confidential? – N Please refer to our answer to Question 9. In comparison to the 800/900 MHz band, the 400 MHz band seems to be even more beneficial in terms of costs and spectrum efficiency.
Question 11: Do you have any comments on our overview of the 1900 MHz band in GB and NI? Please consider the specific factors we have discussed in your response.	Confidential? – N Please refer to our answers to Questions 9 and 10. The 1900 MHz band is most suitable for use cases requiring good coverage combined with relatively high bandwidth requirements. For utilities, using the 1900 MHz band seems to be inefficient when compared to the 400 MHz band.
Question 12: Which band(s) do you consider we should examine further with a view to developing consultation proposals to enable their use in a private network, if this were needed? Please reference the factors we have considered where appropriate and provide separate answers for GB and NI if relevant.	Confidential? – N We believe that further examination of the bands 410–430 MHz and 450–470 MHz is re-quired. These bands fit best to the needs of Utili-ties. A plan for changing the reverse band plan into the harmonized band plan is needed. For this a stepwise approach seems most feasible, probably in combination with migrating narrow band systems to other bands (such as 700 MHz).

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promoting the advancement of 450MHz worldwide.

September 2023

European harmonization of 400 MHz Spectrum for Critical Communications

The fast and full introduction of secure and resilient digital applications, amongst others needed for the deployment of smart energy grids and smart traffic systems, could be much accelerated if European countries would harmonize their national spectrum policies for broadband systems in the 400 MHz band. European countries should therefore commit themselves to more ambitious harmonisation targets than only applying CEPT Recommendations to the extent that they meet their short term national interests. A political agreement on this topic should therefore be pursued. Amongst others, that would directly benefit the energy transition, one if the major pillars of the European Green Deal.

Summary

The Internet of Things (IoT) and the availability of mobile broadband services are major drivers for the digitalisation of many different industry sectors, such as the development of smart energy grids. As its usage expands and importance increases, requirements for security and resilience of the connectivity become more and more stringent and place higher demands on the overall system solutions. Networks applying 3GPP based technologies (i.e. 4G or 5G) in the 400 MHz band turn out to be the most suitable for meeting these requirements.

The CEPT (Conférence Européenne des administrations des Postes et Télécommunications) recognized this opportunity and called in a 2019 Report for careful reflection of these trends in spectrum management activities and national frequency policies. But four years later, there is still a lack of harmonisation among European countries, hampering the fast and full deployment of IoT solutions in the 400 MHz band. This delays the introduction of IoT based secure and resilient applications. More coordination is needed to speed up the spectrum harmonisation efforts.

Introduction

In 2019, the Electronic Communications Committee (CEPT-ECC) published a report[1] on the current and future use of the 400 MHz PMR/PAMR[2] frequencies. The Report states that „the evolution of market demands, the availability of cellular mobile technologies in 400 MHz bands as well as evolving requirements for mission-critical M2M applications should be carefully reflected in spectrum management activities and in national frequency policies.“

This whitepaper investigates the market demands and shows that a further harmonisation of national spectrum policies is needed to meet the requirements of the mission critical applications, such as smart energy grid control or public safety communications.

Several European countries complied with that ECC statement by assigning spectrum licenses for critical industrial use or for public safety (Germany, Ireland, Poland, The Netherlands, Spain, Czech Republic, Austria, Latvia, Hungary, Denmark, Sweden, Finland). These assignments, together with developments in other continents, gave a boost to the development of the ecosystem for the 400 MHz band.

Still, assignments across Europe tend to be fragmented in scope, frequencies, bandwidth and license requirements. This limits the opportunities for efficient deployment, because:

- alignment across national borders appears to be complicated
- future market developments remain unclear, leading to hesitation on the side of equipment vendors to invest heavily in the development of devices and equipment
- potential users (operators) are reluctant to invest in expensive infrastructures.

Concerning the alignment at 400 MHz across national borders it can be noted that this topic was already successfully addressed by CEPT Recommendation T/R25-08[3], defining signal thresholds for technologies using different channel bandwidths, to allow for co-existence in border areas. The applicability of such technical conditions for co-existence are already proven in practice in agreements between several European countries. Nevertheless, many national administrations appear to remain hesitant in implementing the CEPT Recommendation or the best practices in cross border agreements for fair and balanced conditions for all technologies in use.

As a result, the full potential of the 400 MHz spectrum for mission critical applications remains underused across the continent. This is a miss for the energy transition, the deployment of mission critical networks for public safety (PPDR) and other essential developments. A further and fast harmonisation of spectrum assignments as well as a much faster development of cross border agreements among European countries is therefore needed.

Market trends: strong and growing demand for IoT, Security and Resilience

Already for years now, digitalisation emerges in every sector, be it Energy, Transport, Health, Agriculture or any other, with large impact on their business and operations. Together with underlying trends like Big Data, Data Science and Artificial Intelligence, the Internet of Things (IoT) is an important link in the digital chain, with the following characteristics:

- Data exchange takes place between digital devices without human interaction (machine-to-machine communications);
- The devices ‚in the field‘ can come in large amounts, with hundreds or even thousands per km^2, either moving or stationary;
- Per interaction, data volumes tend to be low;
- The data transported is bi-directional: both upward data collection and downward control commands are important.

The demand for IoT grows rapidly, and more and more organisations start to discover the almost limitless possibilities that come with it, so this growth will further accelerate and continue for years[4].

Since digitalisation is the basis for many new business models and for critical applications, the relevance of IoT increases. The IoT must therefore be highly reliable and, in many cases, even becomes business or mission critical and must be extremely resilient and secure.

A clear illustration of this trend can be found in the Energy Sector. Here we see that IoT is used for the data collection from Smart Meter data and for downloading Firmware updates towards Smart Meters. For this purpose, the IoT must be secure and reliable, but the applications are not critical as such. In recent years however the energy distribution networks became digital Smart Grids, to dynamically monitor and control power demand and power delivery in lower levels of the grid, to cope with the increasing dynamics in local production (solar panels, windmills) and consumption (eg Electric Vehicles). These Smart Grids become crucial for the functioning of the power distribution systems and at the same time make the functioning of the grid more vulnerable for cyber-attacks. Hence it is no longer enough for the IoT to be ‚just' reliable and secure, it must be extremely resilient and also shielded off from public communication platforms as much as possible to keep intruders at a distance.

Security and resilience are also requirements for public safety networks (PPDR), either stand alone or as a backup facility for other networks.

International standardisation supporting critical communications

3GPP, the standards organisation that amongst others developed the 3G, 4G and 5G standards, recognized the need for radio technologies supporting IoT, resilience and security already a long time ago. This resulted in many enhancements and extensions of the 3GPP standards. In the scope of this paper, the following are worth to be highlighted:

- LTE-M: optimized for Machine-to-Machine communications with bandwidths of 1.4, 3 or 5 MHz. LTE-M foresees in better coverage, low power consumption of End User Equipment and efficient handling of many communication sessions per cell, at the cost of lower maximum bitrates.
- NB-IoT: a Narrow Band (200 kHz) channel to be used either stand alone or in combination with „standard" LTE communication systems and also optimised for low power consumption and high coverage.
- HPUE: High Power User Equipment, allowing higher power in the Uplink, thus effectively increasing network coverage.
- Carrier Aggregation: to allow for the seamless combination of different frequency bands into a single connectivity service.
- Various features to provide optimal privacy and security.

Networks at 400 MHz can be built based on these standards. In Europe, the following bands are available:

Band	Uplink [MHz]	Downlink [MHz]	Bandwidths [MHz]
Band 31	452.5 – 457.5	462.5 – 467.5	1.4, 3 and 5
Band 72	451 – 456	461 – 466	1.4, 3 and 5
Band 87	410 – 415	420 – 425	1.4, 3 and 5
Band 88	412 – 417	422 – 427	1.4, 3 and 5

The definition of 5G for these bands has started as well and will be implemented in some of the future 3GPP releases.

Critical Communications at 400 MHz

Secure and resilient networks require, amongst others, high investments in power backup and (physical) security measures on every radio site. This leads to a considerable cost increase of secure and resilient wireless networks, and is the reason why commercial mobile networks in general have a relatively low level of protection.

However, thanks to the physical properties of radio wave propagation at lower frequencies, the number of sites can be kept lower at 400 MHz than at the bands normally used for cellular mobile networks. At 400 MHz, the area covered with a single base station is much larger than at higher frequencies. Moreover, the signal also better penetrates walls and other barriers. As a result, in a given region or country, the number of sites needed to provide good coverage is significantly lower than is seen in cellular networks at 800 MHz or higher, thus allowing for efficient investment in high black-out resiliency and other protection measures..

These propagation benefits in combination with the existing 3GPP standards make the 400 MHz band very useful for critical communication networks. The possibilities and the growing application of 400 MHz networks are also recognized by renowned institutes like the TCCA[5], the EUTC[6] and the GSA[7].

The interworking between different communication systems applied in the 400 MHz range is to be taken into account. The radio spectrum at 400 MHz is intensively used for many purposes: narrow band PMR, radio astronomy, digital broadcasting, paging, fixed links, PMSE (audio/video production), location services and others. Though a point of attention, extensive compatibility studies show that coexistence is possible, both for PAMR[8] and for PPDR[9], which in the meantime also has proven in actual deployments.

European spectrum policy

Finding suitable space (ideally 2x 5 MHz) in the highly occupied 400 MHz band is a regulatory puzzle in many countries, especially taking into account the compatibility and sharing requirements between the different services mentioned. It cannot be a surprise that every regulator comes with their own solution, choosing for different frequencies, bandwidths, channels and license conditions. A lack of a clear and aligned vision seems to play a role here in some cases as well.

For the short term, these variations seem hard to avoid and it is already a great step beyond that so many countries in Europe have chosen for 3GPP-compatible licenses in the 400 MHz Band in recent years. However, a clear vision on spectrum harmonisation is necessary to reduce (and in the end completely abandon) fragmentation. By refarming current licenses and working towards internationally agreed band plans, the 400 MHz band can become as much harmonised as the bands for land mobile systems at the higher frequencies (700 MHz, 800 MHz and so on). This would be beneficial for the development of business and mission critical IoT applications and hence for all industries that must rely on this specific type of connectivity. Given the speed of developments, with the energy transition as one of the front runners, this has become more urgent than ever and action is needed now.

Conclusion

Further harmonisation of the 400 MHz bands in Europe is required to move away from the current fragmentation. Only then the potential of this frequency band in Europe will be exploited to its full extent. The objective should be to allocate broadband spectrum in one or more LTE-bands in the 400 MHz range to critical communications, be it PPDR, Utility driven or otherwise, in every country, where the bands and other spectrum arrangements are aligned among neighbouring countries as much as possible.
To achieve this, European countries should commit themselves to more ambitious harmonisation targets than only applying CEPT Recommendations to the extent that they meet their short term national interests. A political agreement on this topic should therefore be pursued. As a starting point, national governments shall prioritize international cross border agreements in the 400 MHz band to make sure that wherever spectrum assignments are not completely aligned, systems can still be properly used in the border regions.

Amongst others, that would directly benefit the energy transition, one if the major pillars of the European Green Deal.

Closing Remarks

This paper was released by the 450 MHz Alliance to emphasize the importance of accelerated and coordinated spectrum harmonisation within Europe of broadband cellular networks in the 400 MHz band.

The 450 MHz Alliance is an industry association that represents the interests of stakeholders in 3GPP compliant technologies in the frequency range of 380 – 470 MHz to address use cases critical to society. Our members include wireless industry companies such as spectrum license holders, carriers and leading equipment manufacturers, as well as companies representing various vertical markets for business critical and mission critical communications. The Alliance aims at spectrum harmonisation within each of the three ITU regions, the further development of standards in the 400 MHz band and the creation of a mature ecosystem for all standardized frequency bands.

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[1] ECC Report 292: Current Use, Future Opportunities and Guidance to Administrations for the 400 MHz PMR/PAMR frequencies (February 2019).
[2] PMR = Private Mobile Radio; PAMR = Public Access Mobile Radio. Both types of networks are for use by a limited group of users, where PMR is deployed for a single user and PAMR serves multiple users.
[3] ECC T/R 25-08: Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7-470 MHz (Amended 28 September 2018)
[4] See for example https://iot-analytics.com/iot-market-size/
[5] https://tcca.info/documents/january-2019-tcca-spectrum-position.pdf/

[6] https://eutc.org/media/2022/05/EUTC-response-to-NL-consultation-on-450-MHz-2022.pdf
[7] https://gsacom.com/paper/low-band-update-january-2022-executive-summary/
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