Your response

Question	Your response
Question 1: Do you agree with our provisional view that the current non-use of the unpaired 2100 MHz spectrum for high power mobile services and potential future use of the 1900 - 1910 MHz spectrum for the ESN Gateway, may not be optimal given the possible alternative uses of the spectrum?	**Current non-use for high power mobile services and potential future use for the ESN Gateway are not optimal for the 2100 MHz unpaired band, as there is presently no clear demand associated with these. Clear demand exists, however, with the band for support of RMR services.** Despite the ongoing success of GSM-R technology within the rail industry, a new successor technology, FRMCS (Future Railway Mobile Communication System), is in development supported by both the UIC[1] and 3GPP[2], to meet the increasing demands of the industry, inclusive of packet switching, increased traffic demands, greater interoperability, and improved resilience and security. One of the fundamental drivers for change is the impending obsolescence of GSM-R equipment: manufacturing is now halting, spares and repairs are becoming limited, and last buy announcements are in issue[3]. The FRMCS system is being designed to support both critical and non-critical operational services in the rail sector. In support of FRMCS deployment and because of growing industry demand, the rail industry now has a clear and pressing need for radio spectrum. CEPT ECC Decision (20)02[4] has affirmed allocation of the 1900 – 1910 MHz band for Railway Mobile Radio (RMR) use since 2020. RMR encompasses GSM-R and its successor(s), including FRMCS. For reference, in the EU the Commission Implementing Decision (EU) 2021/1730[5] released on 28 September 2021 has specified that the FDD[6] 874.4 – 880.0 MHz (for uplink transmission from the terminal to base station) / 919.4 – 925.0 MHz (for downlink transmission from the base station to terminal) and TDD[7] 1900 – 1910 MHz bands will be used to support FRMCS in Europe, rendering the CEPT Decision legally binding in EU member states. ECC decisions themselves are non-binding but are generally widely supported and adopted by individual CEPT countries, including the UK, on grounds of

[1] See: https://uic.org/rail-system/frmcs/

[2] See: https://www.3gpp.org/

[3] Note: vendor support on GSM-R equipment is expected to run until circa 2035, but supply chains are becoming progressively restricted.

[4] See: https://docdb.cept.org/download/4039

[5] See: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021D1730

[6] FDD: Frequency Division Duplex.

[7] TDD: Time Division Duplex.

international coordination on supply chains, radio interference mitigation, and operational efficiencies.

International alignment (harmonisation) on radio spectrum regulations and international industry standards are fundamental enablers to economies of scale in equipment supply chains, and hence cost efficiencies. Without access to scaled solutions, both costs and risks can rise to unreasonable levels.

Since the Decision, numerous states have completed regulatory implementations (including Belgium, Bulgaria, Denmark, Italy, Spain, Switzerland)[8], with others in planning. To date, the UK has partly implemented the Decision, pending this Consultation on the 2100 MHz unpaired band.

Regulatory allocations of the band for RMR use, taken together with industry alignment on use of FRMCS as a standards-based successor to GSM-R technology, mean that cost efficiencies and risk aversions will accrue to the rail industry in Great Britain (GB) since access to mainstream solutions will be possible.

Network Rail cannot comment on the Home Office's Emergency Services Network (ESN). Neither can it comment specifically on commercial mobile network operators' (MNOs') plans. However, it is generally evident that the ESN venture continues to suffer significant delays and challenges, and that MNOs have not seen any commercial application for the 1900 – 1920 MHz band to date, nor is any expected.

For clarity, Network Rail is not concerned here with the issue of broadband services for passengers and other users on trains, which calls for additional/separate spectrum and commercial solutions.

Our comments relate to the requirements of Network Rail and its partners, taking into account the criticality of our current and future applications with GSM-R and FRMCS systems, especially with operational safety issues.

Below, we set out our comments relating to non-optimal use of the band:

- Unpaired (TDD, time division duplex) spectrum of limited bandwidth is of little use to commercial mobile operators, given the increasing mobile market demand for broadband-style capacity connections. This is evidenced by the sustained lack of use over many years of the unpaired 2100 MHz band, as set out in Ofcom's Consultation document[9]. We also note that:

[8] See: https://docdb.cept.org/implementation/16736

[9] See: https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-of-the-unpaired-2100-MHz-spectrum

- Mobile traffic continues to grow within the consumer-focused mobile industry (CAGR circa 30%[10]), driven by the popularity of smart devices and bandwidth intensive applications. This is driving ever-higher demands for access to spectrum of commercially usable bandwidth. 5G technology requires a minimum 5 MHz carrier bandwidth, though consumer mobile and fixed wireless market deployments typically use contiguous blocks of 20 MHz or higher, per link direction. Spectrum holdings in the 1900 – 1920 MHz band remain unused by commercial mobile network operators and usefulness of the band to them continues to reduce.
- As BT notes[11], deployment of high power transmissions with certain types of technologies within the unpaired band could give rise to relatively high levels of out of band interference. Mitigation would require complex band edge filters or implementation of a guard band which would reduce the amount of usable spectrum within the band. This further reduces the usefulness of the band for consumer mobile services, though not for RMR services (with still operationally useful data rates expected at around 10 Mbps per train in the longer term).
- As Ofcom has noted in the Consultation document (para. 2.13), there is currently no equipment ecosystem in place, at scale, supporting deployment of high power mobile services in the band.

- Insofar as the unpaired 2100 MHz spectrum resource remains unused, and a singular niche use case (the ESN Gateway) remains undeployed, use of this spectrum is not optimal.
  - We understand that the UK ESN programme remains significantly delayed. It is presently unclear when the system will be launched into operational service. There is thus presently no clear need for access to the 1900 MHz band to support the ESN.
  - The CEPT Decision affirms RMR allocation on a non-exclusive basis. Spectrum sharing could therefore be applied, in principle, and this could support ESN deployments. With primary allocation of the band for RMR services, taking into account the criticality of these supporting safety requirements, any such application would require measures to prevent excessive levels of radio interference in-band. In any case with physical

[10] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0034/249289/connected-nations-uk-report.pdf

[11] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0023/226085/bt.pdf

	spectrum sharing, detailed planning would be required, and we would expect a need for clearly defined radio power levels and geographic zones of separation. Thus, physical spectrum sharing would not support co-located alternative uses[12]. ◦ Modern 4G and 5G technologies can support 'slicing' of distinct operator services over actively shared network estate (in combination with either MOCN[13] or MORAN[14] technologies). Thus, if ESN service implementation were to be required, slicing technologies could be used, with flexible allocations of bandwidth. • Optimal uses of spectrum are typically those with broader rather than niche application. On the basis that the CEPT Decision has affirmed allocation of the 1900 – 1910 MHz band for RMR use[15], and that internationally standards-based FRMCS technology is being widely supported by the rail industry and international equipment suppliers, a credible and substantial case exists for UK RMR allocation. Current use of the band is therefore not optimal.
Question 2: Do you agree with our provisional view that of the alternative high power uses of the unpaired 2100 MHz spectrum, national infrastructure uses such as rail and utilities are likely to be the most optimal?	**With clear decisions and actions from CEPT, industry, 3GPP, and the European Commission, to harmonise the 2100 MHz unpaired (1900 – 1910 MHz) band for RMR use, most optimal use with the band will be with RMR allocation and usage.** FRMCS technology is being designed under the UIC[16], with related technical standards development under 3GPP[17]. Key design elements of the new system include: leverage of 5G technology – to support fully digital radio bearers and software-defined flexible implementations; harmonised use of the 900 MHz and 1900 MHz radio bands per the CEPT Decision; support for a range of new use cases; cost efficiency and high resilience; and leveraged coordination of industry-wide activities. The UIC has defined a framework of use case categories which include: onboard

[12] Note: co-located sharing is possible with MOCN and MORAN technologies (i.e. with active network sharing), providing that – in the latter case – frequency band separation is used.

[13] MOCN: Multi-Operator Core Network technology facilitates 'slicing' of services using spectrum pooling.

[14] MORAN: Multi-Operator Radio Access Network technology facilitates active network sharing, with physically separate radio bands.

[15] Whereas the CEPT Decision is concerned with allocation of the 1900 – 1910 MHz band for RMR usage, no firm decisions on RMR allocation exist in relation to the 1910 – 1920 MHz band, though various studies have been carried out; see: https://docdb.cept.org/download/1425. This is partly driven by historical factors: the 1900 – 1920 MHz band was originally introduced to support 3G UMTS TDD operation; it was then subsequently included in 4G LTE specifications as band 33, again for TDD. As it was never used by any European operator, it does not appear explicitly in 5G New Radio specifications (excepting the wider band 39 reference).

[16] See: https://uic.org/rail-system/frmcs/

[17] See: https://www.3gpp.org/

	users, depot and trackside, station and platform, railway offices, and data centres[18]. Specific use cases defined include CCTV, infrastructure monitoring, and ATC/ATO[19]. The criticality of current GSM-R and future FRMCS RMR systems, as operated by Network Rail, cannot be overstated. These systems support essential railway signalling and communications throughout Great Britain, in use to control the safe motion and routing of trains and to provide essential communication for railway workers. FRMCS goes further, introducing new capability to support a wide variety of fully digital RMR-focused services. Without reliable and resilient operation of these systems, there is potential for significant harm to the nation's railway workers, passengers, and high value assets. In short, failure (of RMR systems) is not an option. Ofcom has defined 'optimal use' of spectrum as meaning '*spectrum is used in a way that maximises the benefits that people, businesses and other organisations derive from its use, including the wider social value of spectrum use*'[20]. Essentially, optimal use accrues with both economic and social benefits, and allocation of radio spectrum is informed with consideration of relative levels of optimal use. A number of studies have examined socio-economic factors associated with spectrum allocation. Social value is associated with various dimensions including access to employment and education, protection of the environment, well-being, and health, all of which scale up with volumes of people impacted. With around 1 billion passenger rail journeys made in Great Britain per year alone[21] (*excepting* freight), the social value of Great Britain's rail networks and associated spectrum usage is clear. This will be impaired if access to required levels of radio spectrum is limited or impeded. The CEPT ECC Decision on harmonisation and allocation of the 1900 – 1910 MHz band for RMR is a point of fact, with a number of countries now moving to full regulatory implementation, as noted above. The Decision is specifically for RMR services, meaning that commercial mobile and utilities services are excluded. With this, and with the equipment industry now firmly aligned on development of FRMCS as the internationally standardised successor technology to GSM-R, European harmonisation of this portion of the 2100 MHz band for Railway Mobile Radio (RMR) is well underway.

[18] See: https://uic.org/IMG/pdf/brochure_frmcs_v2_web.pdf

[19] ATC: Automatic Train Control; ATO: Automatic Train Operation.

[20] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0017/222173/spectrum-strategy-statement.pdf

[21] See: https://www.gov.uk/government/statistics/rail-factsheet-2022/rail-factsheet-2022

The UK is thus presented with a clear choice; to align with international industry and regulatory decisions on use of the band for RMR applications, or to diverge. Such divergence has no apparent benefits and the strong potential for bringing significant challenge or even harm to the GB rail industry as it continues to evolve. Such harm comprises loss of scale economies and service capacity and presentation of an unnecessarily complex and costly technology evolution path, with no clear guarantee of success.

With the recently published Wireless Infrastructure Strategy[22], UK Government has now clearly defined policy associated with digital infrastructure, telecoms, and data systems, with focus on three key dimensions: *prosperity* – to drive economic growth and support cost efficiencies; *resilience* – to ensure digital security and prevention of harm; and *influence* – to position UK industry in alignment with and supporting development of global standards and industry opportunities. Key elements within the Strategy include: '*maximising the UK's influence at international spectrum negotiations, with alignment of international and domestic spectrum frameworks where possible*' and '*International engagement and alignment is also essential to deliver access to future technologies and ensure that the UK's interests are reflected in global standards and decisions*'.

A number of significant points can be noted:

- FRMCS technology as defined by the UIC constitutes a systems architecture, with an original premise for radio bearer agnosticism (i.e. a 'network of networks' concept with use of multiple radio technologies within the system). FRMCS has now been developed further, with work ongoing in 3GPP and industry, to include 5G technology. In practice, elements of the design will not be bearer agnostic, and the 1900 – 1910 MHz band allocated for RMR use is not one of the main 5G 'pioneer bands' (i.e. 700 MHz, 3.5 GHz, 26-28 GHz). Therefore, the GB rail industry will benefit from harmonisation with FRMCS technology across 3GPP standards, regulation, and industry developments. Regulatory actions will have direct impact upon rail sector supply chains and equipment costs by virtue of resultant supply chain scales.
- If UK regulation diverges from the CEPT Decision, the UK rail industry will be forced to adopt niche technical solutions, in effect penalising GB rail operations without any countervailing benefits. Actions which increase risk in UK supply chains and reduce international influence

[22] See: https://www.gov.uk/government/publications/uk-wireless-infrastructure-strategy/uk-wireless-infrastructure-strategy

are directly counter to UK Government priorities expressed via the Diversification initiative[23] and recently announced new policies[24].

- Work on FRMCS under 3GPP is likely to lead to global standardisation (including further harmonisation of the 1900 – 1910 MHz band). Authorities and industry across Europe and more widely[25] are variously planning long-term FRMCS strategies involving the 1900 – 1910 MHz range.
- As an internationally approved standard, GSM-R technology has proved to be one of the success stories of the rail industry. With high take-up, the technology has supported an economically efficient supply chain, a focused skill base, safer rail travel, and seamless cross-border transit. The benefits of mass market adoption on an industry standards-based solution are clear.
- With the FRMCS standards still under development, removal of the potential for band allocations is premature. Regulatory misalignment between the UK and other regions will prevent the GB rail industry from effectively accessing key elements of the technology, including novel use cases that will benefit both passengers and freight services.

Network Rail thus intends to continue with its stable course of adoption of volume-based industry standards, because of the benefits that this will bring to the railway and wider public policy objectives.

The GSM-R system will become obsolete in the 2035 – 2040 period since suppliers will cease support. The GB rail industry expects to transition from GSM-R to FRMCS over a time-period that may be more than a decade on inclusion of contingency. Given the long development and change cycles within the rail sector, important planning work on migration and future systems is already underway. National deployment of FRMCS will be a complex and staged undertaking with regional and route-based roll-outs, testing, and transition. During migration, Network Rail must maintain, unaffected, the GSM-R critical communication service operating within the 900 MHz band. FRMCS and GSM-R deployments will therefore co-exist for some 10 years.

Regulatory decisions will affect the complexity of this migration significantly. Without access to the 1900 MHz band, Network Rail will be thrown into unchartered territory and forced to examine niche and unproven future systems, likely to give rise to excessive risk and disproportionately high costs. A further concern is that without band

[23] See: https://www.gov.uk/government/publications/telecoms-diversification-taskforce-findings-and-report

[24] See: https://www.gov.uk/government/publications/uk-international-technology-strategy

[25] For example, see: https://www.icasa.org.za/uploads/files/PRASA-Submission-on-the-Draft-Radio-Frequency-Spectrum-Assignment-Plans.pdf ;and https://www.acma.gov.au/sites/default/files/2023-04/Draft%20FYSO%202023-28_for%20consultation.pdf

	access, existing GSM-R deployments and operational systems are likely to need reconfigurations which will result in yet more risk and cost impacts. Impact to live GSM-R operations cannot be readily accommodated. UK regulatory alignment with the CEPT Decision will provide the British rail industry with the stability that it needs to execute on a complex programme of migration, whilst developing firmly defined strategic plans for future operations. FRMCS deployment in the 1900 MHz band with ongoing GSM-R operation in the 900 MHz band in busy areas offers a 'clean' migration path, preventing disruptive deployment of FRMCS technology in the 900 MHz band at too early a stage. Alternative approaches are being explored to support migration within the 900 MHz band, but we see these as presenting increased risk. These would require GSM-R and FRMCS co-existence within a small 5.6 MHz spectrum range comprising Network Rail's existing 4 MHz and an additional, contiguous 1.6 MHz harmonised by CEPT for RMR[26]. Network Rail has reviewed these options in some detail; additional information is provided for information to Ofcom in our response under Question 5 below. Considered use of these options comprises some unknown risk for all European rail infrastructure managers. Risk for the British railways may be more acute since proportionately higher levels of GSM-R have been rolled out. Other European states enjoy more certainty on access to the 1900 MHz band and some, as noted above, are already planning 'clean' migrations on that basis. We recognise that Government, Ofcom, and industry continue to seek efficient allocation of radio spectrum, and that spectrum sharing methods may be one way of supporting this. The CEPT Decision on harmonisation of the 1900 – 1910 MHz band is on a non-exclusive basis, meaning that the band could be made available to other users where not required for RMR operations, subject to national regulatory implementations. As with Ofcom's own implementation of spectrum sharing in the shared access bands[27], spectrum sharing requires careful management of radio power levels; the existing regulations do not provide for band sharing other than at low and medium power levels[28]. Any sharing of spectrum involving higher power systems is likely to present some challenges with radio planning, and risk of interference. Given the criticality of wireless systems to Network Rail operations, we envisage that any such physical

[26] See: https://www.ofcom.org.uk/consultations-and-statements/category-1/future-use-of-the-unpaired-2100-MHz-spectrum

[27] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

[28] For example, with shared access at 1800 MHz, maximum EIRP per sector carrier is currently limited to 42 dBm.

	spectrum sharing will require significant geographical boundaries between Network Rail operational areas and other shared spectrum operators. Network Rail welcomes discussion with Ofcom to explore the potential application of spectrum sharing and alternative related options (such as active network sharing and service slicing).
Question 3: Do you agree with our assessment that liberalising the spectrum and relying on trading is unlikely to be effective in securing optimal use of this spectrum?	**We agree that trading of spectrum licences will not be effective in securing optimal use of the spectrum within the unpaired 2100 MHz TDD band, as the potential for very varied uses would result in high risk and complexity levels.** Whilst the concept of spectrum trading is well-established and generally supported under the terms of radio spectrum licences[29], trading rarely works well in practice, as commercial positioning, administrative delays, and variations in technical consumption can drive complexities. For example, with different technical uses before and after licence trades, variations can occur with interference profiles which can impact neighbouring systems. Where trading can work is with paired spectrum allocations and with trading between entities with similar spectrum usages and applications. The 1900 MHz band is unpaired, which naturally aligns with TDD applications and hence higher complexities with any trading instances. Spectrum trading cannot be applied effectively to the rail sector, where national coverage and system resilience are fundamental requirements, and adherence to international standards is required. With long development cycles in the rail sector, changes to radio spectrum licences and associated systems cannot easily be applied without national impacts. To operate safely, effectively and with due regard to efficient use of public funding, Network Rail must act with risk aversion in mind at all times. This means that stability across the environment and ecosystem is of utmost importance. Trading of spectrum and frequent regulatory changes will not support Network Rail's interests to manage risk optimally.

[29] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0029/88337/Trading-guidance-notes.pdf

Question 4: Do you agree that revocation of the licences to enable reallocation may therefore be necessary to secure optimal use of the spectrum and that this is objectively justified and proportionate?	**We agree that revocation of existing 2100 MHz unpaired TDD licences is necessary in order to secure optimal use.** The 2100 MHz TDD spectrum has remained unused by cellular operators given its unpaired format and limited bandwidth – which is not well-suited to current and developing commercial mobile market demand. Current licensing permits use of the band for niche ESN Gateway services – extensions to the planned ESN network where existing cellular coverage levels may be limited. However, the ESN programme remains significantly delayed, and it is unclear when the operational service will be launched. This use case could be fully accommodated using a different radio band, via active network sharing, or via spectrum sharing. There is thus presently no clear demand for use of the spectrum with existing licence holders, and the band remains unused – at odds with Government policy (‘*More efficient use of spectrum and coordination across public and private sector use is a priority to ensure that spectrum is not a limiting factor on the UK’s economic and societal potential*’[30]) and Ofcom’s stated objectives (‘*Ofcom’s principal duty with regards to spectrum management is to ensure that spectrum is being managed in the most efficient way*’[31]). In contrast, clear demand and practical application exists for the spectrum in the railway industry. The CEPT Decision has affirmed international harmonisation of the 1900 – 1910 MHz band for RMR deployments, and this has been further endorsed with an EU Commission Implementing Decision, and global standards development work on FRMCS technology under 3GPP. Whilst the UK is at liberty, of course, to define its own path, it makes no sense to diverge from developing industry standards which will bring clear benefits for British industry in the form of supply chain resilience, significant scale economies, and effective radio interference management. The rail industry requires regulatory certainty and long-term stability and cannot accommodate spectrum trading with this band, which will not work effectively given the criticality of RMR communications. Ofcom identifies a necessary five-year notice period from the point at which it decides upon regulatory intervention in favour of revocation. That timeframe aligns relatively well with the expected timetable for national FRMCS implementation. Ofcom further notes that users might have earlier recourse to the spectrum, where it is not in use. Network Rail is interested in earlier

[30] See: https://www.gov.uk/government/publications/spectrum-statement/spectrum-statement

[31] See: https://www.ofcom.org.uk/__data/assets/pdf_file/0032/255956/discussion-paper-flexible-adaptive-spectrum.pdf

	access to the 1900 – 1910 MHz band to support FRMCS trials in defined areas and would welcome discussion with Ofcom on this in due course. Hence, revocation of the existing licences is required, such that the most optimal use of the spectrum can be secured, in line with bringing widest economic and social benefits for UK industry and citizens. In this instance, alignment of the UK spectrum regulatory position with that of international counterparts and the wider rail industry appears objectively justified and proportionate. The proportionality argument is strengthened with the opportunity for spectrum and network sharing that the rail use case enables.
Question 5: Do you have further views / comments that you wish to make in respect of this consultation?	**We are providing information on two approaches being developed within industry which would allow, in principle, for 900 MHz in-band migration from GSM-R to FRMCS technology. However, neither of these are commercially proven at present.** Details of two niche 900 MHz in-band technologies under development are provided below for information. Each of these is being explored by one vendor to offer a potential solution for migration from GSM-R to FRMCS technology, without requiring access to the 1900 MHz band. Neither of these are commercially proven and both are likely to drive up both risks and costs. In any case, our considered view is that the time taken to trial and commercialise either of these approaches would be significant, with no guarantee of success or efficient use of public funds. **Option #1: 'White space solution' (900 MHz 5G New Radio overlay to GSM-R)** The solution is based on overlaying 5G New Radio transmissions within spectrum used by GSM-R. The approach is with use of novel TDD scheduler techniques to 'interleave' GSM-R and FRMCS radio bursts, giving rise to the solution name (white space) i.e. use of blank timeslots to allow common frequency usage. A working assumption is that, to adopt the approach, Network Rail would need to access the full 5.6 MHz of the 900 MHz band (per link direction), in order to deploy single 5 MHz 5G New Radio carriers. A merit of the solution includes: avoidance of the need to adjust the GSM-R frequency plan. However, we see a number of risks with this approach:

- The solution does not leverage standard 5G equipment. There is thus no direct supply chain benefit in terms of scale.
- The solution remains under development and at the proof of concept (POC) stage, and has not as yet been tested in a live environment. No operational trials have been carried out within the rail industry. Whereas trials are planned (with Deutsche Bahn and SNCF-R), these remain some 18 months away and would take time to complete. Any deployments would require a trial to stress test specific GSM-R implementations, and it would be unusual for a POC to translate directly to a real-world environment without need for further development. It may be that the solution cannot be adequately developed into a deployment-ready product for the live environment in time or at all.
- As the solution has not been tested in a British operational context, there is some risk that it will not function properly in Great Britain. Any resolutions to such a situation would likely involve bespoke workarounds which can become very costly in terms of both finance and project timelines. In short, there is risk that complexity is so high that the solution is not practical.
- Ability with the solution to support a full 5G New Radio 5 MHz carrier is unproven, especially in areas where Network Rail's GSM-R frequency plan is at its busiest, whilst supporting GSM-R traffic unimpeded.
- With any use of spectrum sharing, this would present further problems as sharing would not be available without complex, traffic-based analyses – not practically feasible (at least without dynamic allocation, which is not yet operationally mature or approved).
- Competitive procurement is not supported and supply chain resilience is therefore low. While the overlay solution is 3GPP compliant (advanced scheduling techniques operate in alignment with 3GPP standards, but may be proprietary), there is only one vendor developing this approach. There is thus obvious commercial risk on pricing, vendor dependence, and value for money.

Option #2: '5G narrowband solution' (5G New Radio channel bandwidth smaller than 5 MHz)

The industry is working on this approach as an alternative to the '900 MHz 5G New Radio overlay to GSM-R' solution discussed above.

The approach requires a change in the 3GPP standards to allow a minimum 5G New Radio carrier width of circa 3 MHz instead of 5 MHz as with the standard 5G design. If realised, this would enable the 900 MHz GSM-R FDD band (2 x 5.6 MHz) to be subdivided – with 2 x 3 MHz for

	FRMCS rollout and the remaining 2 x 2.6 MHz for continued parallel GSM-R operation. This approach avoids the complex TDD scheduling of Option #1, but introduces a separate set of risks: • The 3GPP international standards process is notoriously complex, with high levels of competition and high barriers to entry. There is no guarantee that changes in standards will be made – a process which typically involves significant time, scale, cost, and industry consensus building. Industry orchestration of a change to 3GPP Release 18 standards is in train with ETSI, but no resolution has been achieved as yet. There are many historic examples of technologies not being adopted into final 3GPP specifications. • Even if 3GPP standards changes are attained, there is no guarantee that vendors will implement the standards into products, and those for the rail sector. Typically, as new technologies are standardised, equipment vendors develop commercial products based on a subset of standards that they each deem commercially relevant, and according to demand. Standards application usually accrues with commercial product implementations over time. Again, there are numerous examples, with technologies not being implemented. Further, timing of product general availabilities cannot be accurately predicted, and as with Option #1, vendor risk is high and scale economies low. • If adopted, the approach would require replanning of radio designs across the whole of Great Britain, as capacity levels on existing GSM-R networks would be reduced. This would be completely impractical. As noted, GSM-R is a live critical system supporting national rail operations; migration and changes can only be realistically approached with carefully planned and executed staging. No part of the national network would go untouched, given how the transmissions of each cell impact those of all neighbours. Any form of replanning on wireless access networks can incur significant cost, effort, and operational risk, and replanning on a network heading towards retirement raises questions and concerns over efficient use of public funds. • The GSM-R 900 MHz frequency re-use pattern is such that it exhausts the current 2 x 4 MHz holding in busy areas[32]. Such areas comprise urban, urban fringe, and areas where multiple rail lines come into close proximity. Compressing a 4 MHz frequency plan into 2.6 MHz may not prove possible[33]. Our own analysis confirms that Network Rail will be

[32] Within CEPT countries, and with the UK, GSM-R is deployed in the 'standard' GSM-R bands as: 876-880 MHz (uplink) and 921-925 MHz (downlink).

[33] Note: a reduction of the band width to 2.6 MHz (per link direction) would support only 12 of GSM-R's 200 kHz carriers plus its 100 kHz guard band at either end.

	unable to accomplish this in some high traffic areas (e.g. London approaches). • The current British GSM-R system was planned with reasonable system capacity 'headroom'. In some locations, radio link power budgets are weak. With overall GSM-R bandwidth reduced from 4 to 2.6 MHz per link direction, there will be a reduction in viable data rates for wanted signals. In any case, with reduced bandwidth, the proportion of the band useful for wanted traffic will reduce, given the need for bearer error correction and overhead data.

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