An Coimisiún um
Rialáil Cumarsáide
Commission for
Communications Regulation

Permitting the General Use of Mobile Phone Repeaters

Response to ComReg Consultation Document 17/103 and Final Decision

Response to Consultation and Final Decision

Reference: ComReg 18/58

Date: 27/06/2018

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Additional Information

Consultation document	17/103
Submissions to Consultation document	18/58s

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1 Introduction and Background

1 The Commission for Communications Regulation ("ComReg") is the statutory body responsible for the regulation of electronic communications, radio communication and broadcasting networks, postal, and premium rate sectors in Ireland in accordance with European Union (EU) and Irish law and manages the national numbering resource, among other responsibilities.

2 One of ComReg's key statutory functions is to manage the radio frequency spectrum ("radio spectrum" or "spectrum"). Radio spectrum is a valuable, finite national resource underpinning many important economic and social activities.

3 In its Radio Spectrum Management Strategy Statement 2016 to 2018 (Document 16/50[1]), ComReg observed that the use of mobile phone repeaters is one potential solution to the issue of indoor coverage[2] and in a more general sense, a way of improving mobile user experience.

4 Furthermore, the Report[3] of the Government Mobile Phone and Broadband Taskforce ("the Taskforce") recommended putting in place a scheme which allows the use of mobile phone repeaters as one of its "key messages". The Taskforce identified this as an important issue to address and recommended that ComReg explore introducing a regime that would permit the *"orderly installation of mobile phone repeaters which would go some way to addressing the problem of indoor coverage"*. It was noted that such devices would be of particular use to households and businesses in rural areas.

5 In December 2017, ComReg published a public consultation on permitting the general use of mobile phone repeaters (Document 17/103)[4] through an exemption order. In this consultation ComReg sets out strict technical conditions that a repeater must adhere to in order to meet the exemption order. The technical conditions were derived from existing ETSI standards to minimise the risk of interference to MNO base stations.

6 This document considers the responses received and sets out ComReg's Final Decision in respect of permitting the general use of mobile phone repeaters.

[1] https://www.comreg.ie/media/2016/03/Radio-Spectrum-Management-Strategy-2016-2018.pdf
[2] Another solution identified is Native Wi-Fi calling. Native Wi-Fi calling is a service for Android and iOS smartphones providing the ability to make and receive phone calls over a Wi-Fi connection. This however is entirely at the discretion of the Mobile Network Operators to introduce. Currently eir are the only network that offers such a facility to its customers. See Chapter 2 – RIA
[3] http://www.chg.gov.ie/app/uploads/2016/12/taskforce-report.pdf
[4] Consultation on Permitting the General Use of Mobile Phone Repeaters (08/12/17)

7 ComReg received six responses to its consultation Document 17/103:

- eir group Limited (eir)
- Multicom Technologies Limited (Multicom)
- Stella Doradus
- Three Ireland Hutchinson Limited (Three)
- Vodafone Ireland Limited (Vodafone)
- Vilicom Engineering Limited (Vilicom)

8 This document is structured as follows:

- **Chapter 2** – sets out ComReg's response to issues raised by the Regulatory Impact assessment in Document 17/103 and final Regulatory Impact Assessment;
- **Chapter 3** – sets out ComReg's response to issues raised by respondents to the proposed technical conditions set in Document 17/103 and ComReg's decision;
- **Chapter 4** – other issues raised by respondents to Document 17/103 and ComReg's response.
- **Chapter 5** – Final Decision

9 ComReg considers that the Final Decision set out in Chapter 5 of this response to consultation and the accompanying Exemption Order (Annex 4) will provide those consumers experiencing poor indoor coverage a prudent solution to the matter.

2 Response to Draft RIA and Final RIA

2.1 Background – Draft RIA in Document 17/103

10 In Chapter 3 of Document 17/103, ComReg outlined its draft Regulatory Impact Assessment ("RIA") having regard to, among other things:

- ComReg's statutory objectives;
- the perception of some consumers of deteriorating indoor signal as outlined in its Electronic Communications Strategy Statement (Document 17/31)[5];
- the issues highlighted by consumers regarding indoor mobile reception in the Mobile Consumer Experience Survey commissioned by ComReg (Document 17/100a); and
- the recommendation of the Government Mobile Phone and Broadband Taskforce that ComReg should explore introducing a regime that would permit the *"orderly installation of mobile phone repeaters which would go some way to addressing the problem of indoor coverage".*[6]

11 ComReg then identified the following regulatory options for consideration:

- Option 1: Maintain the Status Quo i.e. the use of mobile repeaters remains unlawful to consumers.
- Option 2: Permit the licence exempt use of repeaters for consumers on a single Mobile Operator network only ('Single-operator repeaters').
- Option 3: Permit the licence exempt use of repeaters for consumers on all Mobile Operators' networks ('Multi-operator repeaters').

12 ComReg's preferred option in the draft RIA was Option 3 because amongst other things, Option 3:

- provides households/premises with a mobile connectivity solution that benefits the greatest number of consumers by authorising repeaters across all networks,
- is more efficient for consumers as there is no need to buy more than one device per household;

[5] Document 17/31 - Electronic Communications Strategy Statement, Paragraph 7.26
[6] http://www.chg.gov.ie/app/uploads/2016/12/taskforce-report.pdf

- protects Mobile Network Operators ("MNO's")' existing and future efficient investments by mitigating the risks of interference associated with the use of unauthorised repeaters/boosters and also positively impacts on user perceptions of the MNO networks by eliminating issues that had been previously and erroneously associated with them;
- would accord with ComReg's statutory objective of ensuring the efficient management and use of the radio frequency spectrum by allowing the radio spectrum to be used in a manner that provides connectivity solutions to consumers;
- would protect all operators from network interference and provides equal benefits in terms of improved reception for consumers;
- would accord with the principle of safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition; and
- would appear to be the least onerous means by which the policy issues and objectives as stated could be achieved.

2.2 Views of respondents

13 ComReg received five responses in relation to the draft RIA on 'Permitting the General use of Mobile Phone Repeaters' from eir, Vodafone, Three, Vilicom; and Multicom.

14 Respondents' views in relation to the preferred option are primarily formed on the basis of an assessment of whether certain options are more or less likely to result in interference. ComReg assesses such matters in Section 3.2 below and are not discussed further in this Chapter. The remainder of this Chapter focuses on matters of a non-technical nature under the following headings.

- Alternative measures (Section 2.2.1);
- Cost of mobile repeaters (Section 2.2.2);
- Quality assurance of repeaters (Section 2.2.3);
- Illegal Boosters (Section 2.2.4); and
- Competition effects (Section 2.2.5).

15 The issues raised by the respondents in relation to the draft RIA are discussed below.

2.2.1 Alternative measures

16 eir, Multicom and Vilicom submits that other solutions that could improve the connectivity experience of consumers are currently available.

Wi-Fi Calling (eir)

17 eir submits that its Wi-Fi calling service already aims to ensure that their customers are getting better mobile reception. eir also notes that it is adding to the list of supported devices which will extend the reach of the service.

3G Femtocells (Multicom)

18 Multicom suggests that 3G femtocells could combat the problem of poor indoor reception. However, it noted that these units have interoperability issues with the 4G network. Multicom also claims that operators are exploring the possibility of new, smaller femtocells.

LTE Relays (Vilicom)

19 Vilicom proposes that more advanced equipment such as LTE relays could be a potential fourth option.

ComReg's Assessment

20 In Document 17/103, ComReg acknowledged that Native Wi-Fi calling *"…is likely to be the most effective mechanism to improve indoor reception issues, in most instances, in the long run."* [7]Users who have both an internet connection and a Wi-Fi calling enabled phone would be able to avail of Wi-Fi calling. eir is currently the only Irish MNO to have rolled out Wi-Fi calling on its network[8] and is currently adding additional supported devices to extend the reach of the service. In such cases, there may be no need for such users to acquire a Mobile Signal Repeater, particularly where all mobile users in a household have a reliable internet connection and have a phone and operator capable of Wi-Fi calling[9]. However, 11% of households do not have internet access[10] and not all consumers currently have a Wi-Fi enabled phone (i.e. 22% of all mobile phones are 3 years old or more, rising to 34% in more rural areas) Therefore, there are still many users who do not have access to such a service and continue to have poor indoor reception.

21 3G Femtocells require the user to have a broadband connection and would not be appropriate where a broadband internet connection was unavailable. Wi-Fi Calling would appear to be more effective for consumers (does not require the installation

[7] Mobile Phone Repeaters – Consultation, paragraph 49.
[8] https://www.eir.ie/wificalling/
[9] ComReg notes that Vodafone also plan to launch "VoWifi" in 2018 which will offer a similar service to Vodafone customers https://www.siliconrepublic.com/comms/vodafone-voice-lte-wifi
[10] CSO Information Society Statistics – Households 2017 https://www.cso.ie/en/releasesandpublications/er/isshh/informationsocietystatistics-households2017/

of a femtocell at a users' residence) and a more efficient investment given the rollout of fixed networks. In that regard, ComReg notes that MNOs appear to be moving away from offering this option[11].

22 The widespread deployment of LTE Relays to provide ubiquitous mobile connectivity would be at a high cost and unlikely to be practical given the low population density in Ireland[12], particularly in more rural areas where connectivity issues are more likely to arise.

23 ComReg notes that the alternatives outlined above may have a role in improving the connectivity experience of consumers. However, such alternatives are only complementary to the use of mobile phone repeaters and operators or other stakeholders retain their discretion to use the most effective solution depending on the circumstances pertaining to an individual customer or geographic area. However, mobile phone repeaters allow consumers to make decisions to improve connectivity independent of other stakeholder actions which may include some or all of the above.

2.2.2 Cost

24 eir submits that ComReg's upfront cost estimate of €200-€500 is extremely optimistic and would not cover the costs of a system (antennas, repeater unit, cabling, install) which meets the specifications proposed by ComReg.

25 Vilicom submits that there is a large gap in price between cheap boosters online and mobile phone repeaters. Vilicom claims that an exemption order would only marginally effect the demand for boosters as such devices would be cheaper than a compliant repeater.

ComReg's Assessment

26 ComReg notes that the price range referenced in the consultation was to provide a realistic estimate of the cost of a mobile phone repeater. Naturally, the pricing would reflect the increased quality and performance of such devices compared to illegal boosters. Manufacturers are likely to respond to consumer demand by introducing compliant mobile phone repeaters and competition should ensure that the price of a device reflects the increased functionality and interference protection. This has been the experience of other jurisdictions as described in Section 2.2.4 below.

[11] Vodafone no longer sells new Sure Signal devices. https://n.vodafone.ie/support/mobile/sure-signal.html

[12] The average population density in urban areas was 2,008 persons per km2 compared to 27 persons per km^2 in rural areas http://www.cso.ie/en/releasesandpublications/ep/p-cp2tc/cp2pdm/pd/

2.2.3 Quality

27 Vodafone submits that the CE mark is primarily a safety check and having a CE mark alone is no guarantee of radio quality. It is likely many devices with very poor radio characteristics carry the CE mark.

28 eir and Vilicom notes that the CE mark may be fabricated and Vilicom suggests that it may be necessary to have another mark to help consumers identify any equipment that is compliant with the terms of any exemption set out by ComReg. eir also suggests that consumers may not be aware of CE approval.

ComReg's Assessment

29 In relation to Vodafone's claim that the CE mark is primarily a safety check, ComReg notes that Article 3 of the Radio Equipment Directive (RED) states amongst other things, that radio equipment shall be constructed so as to ensure *"…that it both effectively uses and supports the efficient use of radio spectrum to avoid harmful interference"*[13]. The CE marking in compliance with the measures outlined in the RED is not just a *"safety check".*

30 ComReg notes that the RED sets out obligations for manufacturers and importers of radio equipment. However, arising from its surveillance work, ComReg acknowledges that the CE mark can sometimes be falsely applied to non-compliant devices. Therefore, ComReg believes that introducing another marking procedure, which would also be susceptible to fabrication, would not achieve the desired impact and indeed would only likely serve to undermine the European Conformity regime which the CE mark represents[14] and create consumer confusion.

31 Physical retailers, where most transactions are likely to occur, are likely to stock compliant equipment meeting the technical requirements of the licence exemption, including the use of a compliant CE mark. Such retailers are unlikely to damage their reputation or expose other product ranges to enforcement proceedings. Further, a consumer would likely become aware it was sold a non-compliant product, given the poor performance likely to arise, and recourse against a physical retailer is far more effective than an online retailer based in a different jurisdiction. ComReg's market surveillance team will also continue to monitor for devices that do not comply with the RED.

[13] Directive 2014/53/EU of the European Parliament and of the Council https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0053&from=EN

[14] For example, see Safety of Products for Sale – Citizens Information http://www.citizensinformation.ie/en/consumer_affairs/consumer_protection/product_safety_and_labelling/safety_of_products_for_sale.html#la82be

2.2.4 Illegal boosters

32 Vodafone submits that there is nothing in Option 2 or 3 that would prevent the continued installation of illegal boosters and that the *"the approval by ComReg of some repeaters is likely to encourage the proliferation of these devices."*

ComReg's Assessment

33 In the draft RIA, ComReg was of the preliminary view that Mobile Operators were unlikely to prefer Option 1 because there would likely continue to be some degree of interference caused by unlawful boosters. Vodafone has provided no evidence in support of its claim that the approval of some repeaters would encourage the *"proliferation"* of illegal boosters. While ComReg does not expect that the use of illegal boosters would dissipate overnight, it is not unreasonable to assume that under Options 2 and 3, such illegal devices would be displaced due to a legal alternative. Continued enforcement and confiscation of illegal devices by ComReg would assist in this process.

34 ComReg retains its view that the introduction of compliant mobile phone repeaters would reduce the presence of illegal boosters. In particular, the introduction of mobile phone repeaters has important demand and supply side effects.

- On the supply side:
    - Compliant mobile phone repeaters are likely to become available from reputable physical outlets – a supply option not available for illegal boosters.
    - In that regard, ComReg notes that physical outlets are likely to be the main outlets that satisfy demand for these devices. For example, nearly 70 % of consumers never purchase DIY, household appliances online, only 1 - 4% using online only.[15]
    - Online searches can currently only reveal illegal booster given the absence of a legal alternative. Such illegal devices should be gradually[16] be displaced in the search results by legal repeaters which are likely to become more popular.
- On the demand side:
    - Consumers now have an option to purchase legal devices which was

[15] PWC Retail & Consumer Report 2018.
[16] ComReg accepts that certain consumers may continue to retain or purchase certain devices illegally, however, other consumers will now take up the option of purchasing an approved device.

previously unavailable.

- The establishment of a market for compliant repeaters should assist consumers in distinguishing between lawful and unlawful devices as vendors are likely to highlight the benefits of compliant devices meeting the technical requirements of the licence exemption
- These devices do not require registration which would have acted as a deterrent to consumers purchasing compliant mobile phone repeaters.
- Consumers have option of recourse if a purchased device does not work as advertised or according to specification. This is unlikely to be effective for purchases made online and in an outside jurisdiction.

35 In that regard, ComReg notes the experience of mobile operators and equipment manufacturers in the United States following the introduction of the regulatory framework for Consumer Signal Boosters by the FCC (Federal Communications Commission) in 2013. The FCC are of the view that the availability of legal alternatives has largely eliminated illegal boosters.[17]

36 In April 2018, the FCC noted that experience from relevant stakeholders indicates that compliant devices have functioned as required[18]. In particular:

- T-Mobile noted "[t]*he lack of any known serious widespread incidents demonstrates that the process has worked well and generally prevented poorly designed consumer devices from entering the market, while making signal boosters widely available and easily usable by consumers*"[19]
- Verizon noted that the new rules "*have all but eliminated the interference problems caused by signal boosters manufactured prior to the rules taking effect*"[20]
- Equipment manufacturers (Wilson Electronics and Surecall) also reported strong interest from consumers and no complaints of harmful interference resulting from its signal boosters.[21]

37 Therefore, given the likely demand and supply effect and the experience of same in other jurisdictions, ComReg is of the view that the introduction of compliant

[17] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/107254/Repeaters-Statement-2017.pdf
[18] https://www.fcc.gov/document/fcc-improves-rules-consumer-signal-boosters-0
[19] Ibid, para 8.
[20] Ibid.
[21] Ibid.

mobile phone repeaters would likely lead to the competitive displacement of illegal booster over a period of time.

2.2.5 Competition effects

38 Three disagrees that only permitting single-operator repeaters could corrupt the competitive process (paragraph 74) and submits that the use of single-operator repeaters would not in any way hamper competition in the retail mobile services market. In that regard, Three notes that "*all operators will have equal freedom to provide, supply or sell repeaters that operate on their own network, as will other independent vendors. The conditions under which they can be provided are equal for all, and there is no particular barrier or obstacle to any operator."*

39 Three also notes that under Option 3, single-operator repeaters would also be permitted in some instances where it might be preferable to use single-operator repeaters.

ComReg's Assessment

40 Three misunderstands ComReg's view as stated under paragraph 74 of the draft RIA. ComReg acknowledges that the conditions under which repeaters can be provided are equal for all operators and all operators would have the authority to provide repeaters under the general exemption. However, the issue discussed in paragraph 74 addresses a scenario specific to Option 2 where there may be more than one person per premises and these persons may be on different networks. A single-operator repeater would not be able to cater for all users in such instances.

41 Consequently, those members of a household that do not benefit from the improved reception provided by the single operator repeater would likely have incentives to switch to the network served by the repeater[22]. This could reduce competition because absent the repeater, another operator may have been preferred on the basis of product and service differentiation.

42 Option 3 does not preclude the use of a single operator repeater but rather gives consumers the choice of repeater depending on the circumstances pertaining in a household. Option 2, however, would limit repeaters to serving a single network and consumers referred to by way of example in paragraph 74 would not be able to satisfy their reception requirements. In this way, under Option 3, a household with more than one person and network would have a choice of a multi-operator repeater. Alternatively, where a household contains one or more persons all on the same network, a single operator repeater may be preferable.

[22] Particularly when the barriers to switching networks are low and switching networks is at a lower cost to the consumer than purchasing another single-operator repeater

43 Option 3 allows each individual household to consider their reception requirements and the cost of providing for same before making a decision on which type of repeater is suited to their need. Any exemption order in accordance with Option 3 would stipulate the permitted technical specifications of repeaters and would not specify that they must only accommodate all networks. Consumers would be free to choose whether it required a repeater operating on a single network or operating on multiple networks.

Summary

44 ComReg did not receive any other submissions from respondents on the above proposals, nor is ComReg aware of any other information which would warrant an amendment to these proposals. Taking on board the submissions received from respondents and discussed above, ComReg is pleased to set out its final 'RIA on Permitting the General Use of Mobile Phone Repeaters' below.

2.3 Final RIA

2.3.1 RIA Framework

45 In general terms, a RIA is an analysis of the likely effect of a proposed new regulation or regulatory change, and, indeed, of whether regulation is necessary at all. A RIA should help identify the most effective and least burdensome regulatory option and should seek to establish whether a proposed regulation or regulatory change is likely to achieve the desired objectives, having considered relevant alternatives and the impacts on stakeholders. In conducting a RIA, the aim is to ensure that all proposed measures are appropriate, effective, proportionate and justified.

2.3.2 Structure of a RIA

46 As set out in ComReg's RIA Guidelines,[23] there are five steps in a RIA. These are:

- Step 1: Identify the policy issues and identify the objectives.
- Step 2: Identify and describe the regulatory options.
- Step 3: Determine the impacts on stakeholders.
- Step 4: Determine the impact on competition.

[23] See Document 07/56a - Guidelines on ComReg's approach to Regulatory Impact Assessment - August 2007.

- Step 5: Assess the impacts and choose the best option.

47 In the following sections ComReg identifies the relevant stakeholder groups, specific policy issues to be addressed and relevant objectives (i.e. Step 1 of the RIA process). This is followed by the identification of fundamental policy issues.

48 ComReg then considers these policy issues in accordance with the four remaining steps of ComReg's RIA process.

2.3.3 Identification of stakeholders

49 The focus of Step 3 is to assess the impact of the proposed regulatory options available to ComReg on stakeholders. A precursor to the subsequent steps in the RIA, therefore, is to identify the relevant stakeholders. Stakeholders consist of two main groups:

- consumers; and
- Industry stakeholders.

50 The main industry stakeholders in relation to the matters considered in this chapter are Mobile Operators, which consist of:

- Mobile Network Operators (MNOs); and
- Mobile Virtual Network Operators (MVNOs).

51 Separately, repeater manufacturers/suppliers/installers may also have views on the preferred option.

52 The focus of Step 4 is to assess the impact on competition of the proposed regulatory options available to ComReg. In that regard, ComReg notes that it has various statutory objectives, regulatory principles and duties which are relevant to the issue of competition.

53 Of themselves, the various RIA guidelines provide little guidance on how much weight should be given to the positions and views of each stakeholder group (Step 3), or the impact on competition (Step 4). Accordingly, ComReg has been guided by its statutory objectives, which it is obliged to pursue when exercising its functions. ComReg has the statutory objective of ensuring the efficient management and use of the radio frequency spectrum[24]. ComReg's statutory

[24] It is noted that, for the purposes of ComReg's activities in relation to electronic communications networks and services, Article 8 of the Framework Directive identifies "*encouraging efficient use and ensuring the effective management of radio frequencies (and numbering resources*)" as a sub-objective of the broader objective of the promotion of competition. Furthermore, Regulation 9(11) of the

objectives in relation to the provision of electronic communications networks and services, include:

- the promotion of competition;
- contributing to the development of the internal market; and
- to promote the interest of users within the Community.

54 In this document, ComReg has adopted the following structure in relation to Step 3 and Step 4 – the impact on industry stakeholders is considered first, followed by the impact on competition, followed by the impact on consumers. The order of this assessment does not reflect any assessment of the relative importance of these issues but rather reflects a logical progression. For example, a measure which safeguards and promotes competition should also, in turn, impact positively on consumers. In that regard, the assessment of the impact on consumers draws substantially upon the assessment carried out in respect of the impact on competition.

2.3.4 Identify the policy issues and identify the objectives (Step 1)

Policy Issues

55 In its Electronic Communications Strategy Statement (Document 17/31), ComReg noted that despite the improvements in mobile networks and consumer satisfaction there is a public perception that the mobile retail consumer experience has deteriorated. ComReg recognised that there may be various factors contributing to this perception, including:

- the signal may deteriorate indoors (compared to outdoors) depending on the technology (2G or 3G) and the network operator; and
- the use of better building insulation materials (e.g. foil backed insulation, windows with metallic components and coatings, etc.) and the consequent reduction in indoor signal penetration.

56 In that regard, in order to increase its understanding of the issues experienced by consumers, ComReg commissioned Behaviour and Attitudes to survey residential consumers in Ireland to provide ComReg with an insight into the usage, perceptions and experiences of mobile phones users[25].

Authorisation Regulations also provides that ComReg must ensure that radio frequencies are efficiently and effectively used having regard to Section 12(2)(a) of the 2002 Act and Regulations 16(1) and 17(1) of the Framework Regulations.

[25] Document 17/100a – Mobile Consumer Experience Survey

57 This survey highlighted a number of key issues and concerns with regard to mobile connectivity. In particular:

- consumer satisfaction with respondent's mobile phone networks coverage at the home is relatively high with only 11% of users dissatisfied [26], rising to 19% in more rural areas.[27]
- inside the home is the location most used by consumers to use their mobile phone for voice and data. For example:
  - nearly 70% use their mobile phone for voice or text in the house every day, falling to 60% in more rural areas[28].
  - 74% (45% every day) use their mobile phone for data usage at some point inside the home, rising to 82% (48% every day) for more rural areas.[29]
- Nearly 30% of all respondents experienced various service issues for call/text and data usage during the past month in the home, the highest of all locations assessed[30].
- Incidence of experiencing service issues in the house or part thereof for calls/text and data (c. 30%) is higher than the same service issues that occur outside the home (c.18%)[31].
- Rural consumers have higher rates of experiencing services issues regardless of location with higher levels of service issues arising in the home or part thereof (i.e. indoor). [32]

58 In light of the above, ComReg is of the view that while consumers can experience connectivity issues regardless of their location, those issues occur more frequently at indoor locations and in more rural parts of the country.

59 ComReg's Spectrum Strategy Statement also noted that there may be various ways of addressing indoor reception issues affecting the mobile retail consumer experience. In particular:

[26] Respondents were asked to rate their mobile phone network coverage at the home out of ten. Respondents that rated 4 or lower are classified as dissatisfied.
[27] Slide 62, Document 17/100a – Mobile Consumer Experience Survey
[28] Slide 43, Document 17/100a – Mobile Consumer Experience Survey
[29] Slide 46, Document 17/100a – Mobile Consumer Experience Survey
[30] Slide 51, Document 17/100a –Mobile Consumer Experience Survey
[31] Slide 51, Document 17/100a – Mobile Consumer Experience Survey
[32] Slides 54 and 56, Document 17/100a – Mobile Consumer Experience Survey

- the ability to use fixed broadband connections (e.g. Native Wi-Fi calling) for the provision of mobile services (both voice and data) to address indoor reception issues; and
- the use of mobile repeaters to address indoor reception issues, noting that such repeaters would have to be CE-certified and be authorised (via a licence or a licence-emption) to use the radio frequencies.

60 Further, in response to the draft RIA, respondents suggest that 3G Femtocells and LTE relays would be useful in improving the connectivity experience for consumers indoors.

61 ComReg assesses the various alternative measures below.

Alternative Measures

Wi-Fi calling ("Native Wi-Fi")

62 Native Wi-Fi is not the focus of this response to consultation and Decision. However, ComReg observes that the ability to use Native Wi-Fi is likely to be the most effective mechanism to improve indoor reception issues, in most instances, in the long run. Native Wi-Fi is a service that can be provided by operators that makes it possible for consumers to make/receive phone calls and text messages from their Native Wi-Fi enabled mobile phone, where mobile coverage is not sufficient, by using an existing Wi-Fi network. Native Wi-Fi consumers can use their enabled phones and existing mobile phone number to connect via the Wi-Fi in their users homes to the operator provided voice service to provide voice with data for a higher-quality calling.

63 In that regard, ComReg notes that eir[33] is the first and currently the only operator offering Native Wi-Fi calling and all eir Mobile plans currently being sold can avail of Wi-Fi calling.[34] Vodafone has indicated that it plans to launch a voice over Wi-Fi (VoWiFi) service sometime this year[35]. Notwithstanding, there are likely to be consumers that are currently unable to benefit from Native Wi-Fi for a number of reasons including:

- Not all Mobile Operators currently offer Native Wi-Fi as part of their mobile service offering;

[33] https://www.eir.ie/wificalling
[34] https://www.eir.ie/wificalling "*All eir Mobile plans currently being sold can avail of WiFi Calling*"
[35] https://www.siliconrepublic.com/comms/vodafone-voice-lte-wifi

- Certain consumers, regardless of mobile operator, do not have a Native Wi-Fi enabled phone. For example, 22% of all mobile phones are 3 years old or more, rising to 34% in more rural areas.[36] Such phones are unlikely to be Native Wi-Fi enabled. In addition, certain models on the Apple or Android platforms are not Wi-Fi calling enabled. For example, to use Wi-Fi calling using the Apple platform, an iPhone 5c or later is required on a supported mobile network.[37]

- Certain consumers, particularly rural consumers, may not have an internet connection sufficient to benefit from Wi-Fi calling regardless of operator or handset availability; and

- Certain consumers may not have access to the internet at all. For example, 11% of households do not have internet access[38]

64 These reasons seem likely to become less relevant over time although certain households may never choose to have internet access[39]. In particular, the National Broadband Plan ("NBP") is a Government wide initiative to deliver high speed broadband services to all businesses and households in Ireland at a minimum speed of 30Mbps download and 6Mbps upload by 2020.[40] Further, other Mobile Operators are likely to offer Native Wi-Fi services in the period up to 2020 which would allow consumers to take advantage of improved broadband connectivity indoors. Over the same period, the natural replacement cycle of phones should allow most consumers to be able to benefit from Native Wi-Fi. However, in the meantime the use of repeaters is likely to be of benefit to those consumers who face mobile reception issues indoors.

3G Femtocells

65 3G Femtocells are devices that use an internet connection to connect mobile devices in a household to a mobile operator's network. In certain circumstances, Femtocells can be an important complementary solution to improving mobile coverage. However, a stable internet connection is required to use the service. As discussed above, not all households have access to the internet and so 3G Femtocells are not an option available to all users experiencing poor indoor mobile reception. Irish MNOs appear to be moving away from this option as Wi-Fi calling has emerged as a more effective alternative. Investment in 3G femtocells where

[36] Slide 34, Document 17/100a – Mobile Consumer Experience Survey
[37] https://support.apple.com/en-ie/HT203032
[38] CSO Information Society Statistics – Households 2017 https://www.cso.ie/en/releasesandpublications/er/isshh/informationsocietystatistics-households2017/
[39] CSO Information Society Statistics – Households 2017. For example, 45% of those without access claim "*not to need internet*".
[40] National Broadband Plan https://www.dccae.gov.ie/en-ie/communications/topics/Broadband/national-broadband-plan/Pages/National-Broadband-Plan.aspx

an internet connection can provide for Wi-Fi services would likely be inefficient and technically insufficient given the alternatives.

LTE Relays

66 LTE Relays can be used to extend the coverage area beyond the area covered by a base station. Such relays are less costly to deploy than constructing additional base stations and can also be used to facilitate rapid network roll-out. However, such an intervention would still likely require significant investment to ensure that every household could receive adequate mobile signal, which is not practical given the low population density of Ireland.

67 Additionally, LTE relays may not be an appropriate solution for providing indoor reception as any signal received from the relay remains susceptible to indoor penetration losses with the magnitude varying depending on the household[41]. Therefore investment in LTE Relay technology for the purpose of improving indoor reception would be inefficient given the use of Wi-Fi calling as a more effective option.

Conclusion on alternative measures

68 In certain circumstances, the alternatives above would not be appropriate as a replacement for mobile phone repeaters. In particular, all options require an internet connection and/or compatible handsets neither of which are necessarily available in certain households. While such requirements should improve in the future, certain household's connectivity requirements may always be reliant on a mobile phone repeater. Further, such alternative measures are dependent on the action of MNO's and there will always remain a cohort of consumers who do not have internet access but require indoor reception. Mobile repeaters are the only measure that can be taken by consumers themselves independent of operators.

69 Therefore, ComReg is of the view that the primary policy issue to be considered in this final RIA is whether to make the use of certain mobile phone repeaters that comply with the technical standards set out in Chapter 3 available on a licence exempt basis.

Objectives

70 The focus of this final RIA is to assess the impact of the proposed measure(s) (see regulatory options below) on industry stakeholders, competition and consumers. ComReg can then identify and take the most appropriate and effective course of action that considers the interests of all sets of stakeholders, while also protecting and promoting competition.

[41] Radio signal propagation can be affected by, amongst other things, the geographic characteristics of the environment and the limiting potential of building materials.

71 In this regard, ComReg would highlight:

- its objectives as set out in section 12 of the 2002 Act and Regulation 16(1) of the of the European Communities (Electronic Communications Networks and Services) (Framework) Regulations 2011 ("Framework Regulations") including:
  - to promote competition; and
  - to ensure the efficient management and use of the radio frequency spectrum in accordance with Ministerial Policy Directions issued under section 13 of the 2002 Act;
- the regulatory principles which it is obliged to apply in pursuit of the objectives set out in Regulation 16(2) of the Framework Regulations, including:
  - safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition; and
  - promoting efficient investment and innovation in new and enhanced infrastructures;
- its obligation to ensure that radio frequencies are efficiently and effectively used having regard to Section 12(2)(a) of the 2002 Act and Regulations 16(1) and 17(1) of the Framework Regulations (Regulation 9(1) of the European Communities (Electronic Communications Networks and Services) (Authorisation) Regulations 2011 ("Authorisation Regulations").

2.3.5 Identify and describe the regulatory options (Step 2)

72 ComReg considers that the three regulatory options now available to it are:

Option 1: Status Quo – the use of mobile repeaters remains unlawful for consumers.

73 Option 1 is to leave the current licensing regime unchanged and for ComReg to take no regulatory action i.e. Mobile phone repeaters that are not directly controlled by MNO's would continue to be classed as unlicensed apparatus for wireless telegraphy as defined in the Wireless Telegraphy Acts 1926 to 2009, and remain illegal to possess.

Option 2 – Permit the licence exempt use of repeaters for consumers on a single Mobile Operator network only ('Single-operator Repeaters')

74 Option 2 considers making specific mobile phone repeaters licence exempt on a single mobile network operator only. Mobile phone repeaters would be required to

meet the technical standards and specifications as set out by ComReg in Chapter 3 in order to warrant exemption from the Wireless Telegraphy Acts 1926 to 2009. Repeaters that meet these requirements would be available for consumers to purchase and install.

75 This option would include a requirement that the repeaters operate only over the frequency bands of any single Mobile Operator at a given time. The repeater would only improve the reception of one operator designated for the relevant premises.

Option 3 – Permit the licence exempt use of repeaters for consumers on all Mobile Operators' networks ('Multi-operator Repeaters')

76 Option 3 is the same as Option 2 except this option would allow the repeater used on a premises to improve the reception from all mobile phones regardless of the mobile network operator. Option 3 would also permit the use of single-operator repeaters.

2.3.5 Impact on industry stakeholders (Step 3)

Option 1

77 Connectivity can sometimes be difficult for consumers when trying to access services (voice, text, data) over their mobile phone using their mobile network (as opposed to a Wi-Fi connection). Currently, under Option 1, repeaters can be deployed by MNOs as part of managing ongoing network performance. This is similar to Option 2 except, the cost is typically borne by the Mobile Operator. However, under Option 1, consumers purchase boosters[42] without authorisation in order to improve indoor mobile reception. This typically occurs in rural or remote locations, or to address in-building penetration where outdoor reception is satisfactory. While the consumer-purchased booster may benefit the end-user's reception at the point of its deployment, it is illegal as it can, amongst other things, disrupt or interfere with other consumers' reception in the general area.

78 In that regard, ComReg notes that there are typically around 60 complaints from MNOs each year on issues related to interference with many associated with the use of boosters. Such unauthorised apparatus are primarily, poorly designed, mass market equipment and more often than not are likely to increase the risk of harmful interference, especially due to malfunctions of the booster device and inadequate technical standards.

[42] See Chapter 2 on the difference between repeaters and boosters.

79 eir notes that Option 1 leaves the deployment of repeaters with MNO's thereby allowing an approved repeater to be used in a controlled way that is tested and monitored for performance. However, ComReg notes (under Option 1), consumers are often not deploying repeaters authorised by MNOs but are instead purchasing illegal boosters which have serious quality limitations and are used in an uncontrolled way. Under Options 2 and 3 MNOs would still be authorised to provide approved repeaters to consumers.

80 In that regard, under Option 1, the unauthorised use of boosters, has a number of negative impacts on Mobile Operators, because such devices:

- are likely to cause network interference and damage subscribers' mobile consumer experience.
- are likely to damage the reputation of Mobile Operators where that reputation does not relate to underlying performance of their network but rather the unauthorised use of boosters.
- disproportionality affect Mobile Operators that have:
    - more subscribers in the particular area where the illegal booster is causing interference; and
    - better underlying coverage in those areas, as the connectivity problems experienced by a consumer in the first instance may be related to networks with poorer connectivity;
- they reduce the return earned on efficient investments made by MNOs to improve quality of service and extend coverage in specific areas; and
- they create additional operational costs for MNOs in order to manage related customer complaints, identify interference and report, where relevant, to ComReg.

81 Vodafone submits that there is nothing in Option 2 or 3 that would prevent illegal boosters from continuing to be installed. ComReg notes that the apparatus authorised under Options 2 and 3 includes filtering and interference mitigation mechanisms that substantially reduces the risk of disruption to other spectrum users. While certain consumers may continue to purchase unauthorised apparatus, the availability of authorised licence-exempt apparatus should, over time, reduce the extent to which network interference issues occur due to the use of unauthorised equipment. Currently, where a consumer wishes to acquire equipment to improve coverage, it only has one option, to purchase illegal mobile boosters. While some consumers may continue to pursue this approach, the availability of approved mobile repeaters would allow consumers to adopt this option at the expense of the

illegal alternative. (See Section 2.2.4 above).

82 For example, Options 2 and 3 would encourage the development of a retail market for authorised mobile phone repeaters. Therefore, suppliers of mobile phone repeaters are likely to prefer Options 2 or 3. This would reduce the likelihood that consumers continue to purchase unauthorised apparatus. Continued enforcement and confiscation of existing devices by ComReg would assist in this process. MNOs would likely see a fall in the level of interference on their networks as users adopt the use of legal mobile phone repeaters as envisaged under Options 2 and 3.

Option 2 v Option 3

83 MNOs are likely to assess the costs and benefits of improving coverage in a particular area. In particular, to improve coverage affecting only a small area within a cell, an operator might have to enhance the network's coverage and/or capacity over the entire cell, including places where outdoor coverage may already be satisfactory. Therefore, to the extent that coverage is a particular problem for certain households MNOs may not have the investment incentives to extend coverage in certain areas, particularly where the investment that would arise may be more efficiently allocated in more populated areas where a return can be better generated. Options 2 or 3 are investment neutral options for MNOs that provide the greatest overall benefit to consumers (i.e. devices are purchased by consumers).

84 In relation to Options 2 and 3, ComReg previously set out that Mobile Operators are likely to prefer the Option that provides the greatest potential benefit to their subscribers as it would reduce the level of complaints associated with coverage for that particular premises thereby enhancing consumer satisfaction. This is particularly the case in this matter where the cost associated with improving coverage is borne by consumers and the operator does not need to consider the usual trade-off between any efficient investment it would have to make, and the returns it might earn.

85 In the event that ComReg proceeds with a licence exemption for mobile phone repeaters, Option 2 is seen as the preferred option by eir as it limits the potential for interference. Vodafone also prefers Option 2 due to the claims that a multi-operator repeater under Option 3 is much more likely to cause network problems as optimum gain setting for different operators would not be aligned in its view. Three also notes that a multi operator repeater would, in its view, be more likely to cause interference. ComReg acknowledges the potential for interference through the use of repeaters, however, relative to Option 1, the extent of this interference is likely to be decidedly less. If a premises were to install multiple devices to cover bands used by different operators (i.e. oscillation increases significantly), adopting Option 3 and permitting the general usage of wideband repeaters offers better protection to MNOs and existing spectrum users. This matter is discussed further in Chapter 3.

86 Notwithstanding, Three submits Option 3 as its preferred option because any potential for interference appears to be outweighed by the benefit of being able to improve coverage for customers of all operators. ComReg also notes that single operator repeaters may be more appropriate for a household depending on the circumstances pertaining, (i.e. all members of household are on same network) and Option 3 does not rule out the use of single operator repeaters, but, rather it provides consumers with the full range of options.

2.3.6 Impact on competition (Step 4)

Option 1

87 Under Option 1 the use of boosters remains unlawful for consumers and would likely result in continuing interference to MNOs' networks. This can harm competition as boosters amplify the signal across multiple frequencies assigned to different Mobile Operators. Furthermore, illegal boosters can cause interference across multiple operators, including the Mobile Operator targeted by the booster. In this way, the booster can eliminate any differentiation on outdoor coverage that existed between operators prior to installation of the repeater. For example, an operator that could have competed on coverage (outdoor) as a result of investments made in a particular area may be unable to do so after the unlawful installation of the booster.

88 Further, interference caused by boosters may affect some networks to a greater extent than others reducing the competitive offering associated with those networks. For example, the premises using an illegal booster under Option 1, would disproportionately affect the network whose base stations are situated closer to the premises with the installed booster. Such issues could be ongoing for a significant period of time as other users may not raise concerns until connectivity falls below a certain threshold of acceptability. As such, the affected Mobile Operator may not be aware that their network is not performing efficiently and delivering full benefit to consumers in line with efficient investments already made. This results in consumers forming views on coverage that may not be related to the underlying performance of the networks but rather the interference issues caused by the illegal booster.

89 Therefore, ComReg is of the view that Option 1 is likely to have a negative impact on competition.

Option 2 v Option 3

90 Options 2 and 3 and the use of technically compliant repeaters would not create undue interference on mobile networks allowing Mobile Operators to continue to differentiate on coverage. Under Option 2, the repeater could likely be

reconfigured to a different operator at any given time. Therefore, such consumers would not be locked in and would be free to switch to an alternative operator in response to a price rise or deterioration in service. However, under Option 2, only one network could be served by a single repeater per premises at any given time; this is true even if there are multiple devices operating on multiple networks.

91 As noted below (Impact on Consumers) there is likely to be more than one person per premises and these persons may be on different networks. Those members that do not benefit from the increased reception provided by the repeater would likely have incentives to switch to the network served by the repeater. However, these incentives are not related to the factors which other operators could reasonably compete with and would normally do so in the absence of the repeater. Such consumers might switch to an alternative provider when, absent the repeater, another operator may have been preferred on the basis of product and service differentiation. In this way, the restriction of the repeater to one Mobile Operator reduces competition and does not deliver the best available option to consumers.

92 Therefore, ComReg is of the view that Option 3 is the most beneficial in terms of the impact on competition.

2.3.7 Impact on Consumers

Option 1

93 As outlined earlier, indoor reception can be a particular problem for consumers. Currently, under Option 1 consumers may be unaware of the restrictions on the operation and possession of boosters, and unwittingly be committing an offence under the Wireless Telegraphy Act–1926, as amended.

94 Such unauthorised apparatus can cause undue interference and, in some instances, block certain sectors of the mobile base station creating adverse effects to mobile services for other consumers. Therefore, every consumer served by the associated base station(s), could experience negative mobile connectivity issues, including:

- lower quality voice calls;
- an increase in the number of dropped calls;
- lower mobile data speeds; or
- disconnection from the network entirely.

95 The average mobile base station serves[43] over 2,000 persons[44] therefore depending on a user's position relative to the base station, the number of impacted consumers has the potential to be considerable. Further, the multiple use of such unauthorised boosters in an area increases the extent to which negative connectivity issues might arise for other users.

96 Even for the user that installed the booster it may not remedy the mobile reception to any significant degree. Boosters, being inherently 'noisy' devices are likely to raise the apparent noise floor which typically results in a degraded experience for other users in its vicinity, and in some cases even disabling the sector of the base station. In such cases this degradation is not typically represented by a reduction in the signal displayed on the handset; the user may have a stable downlink and an unstable uplink but still experience poor mobile reception.[45]

97 There is obvious demand for mobile repeaters, as illustrated by the existing market for illegal booster/repeaters and indoor service issues identified by ComReg's Mobile Consumer Experience Survey[46]. Options 2 and 3 would allow for the use of apparatus that is not likely to cause harmful interference or have adverse effects on the quality of service for voice and data. Options 2 and 3 would also provide for the users of repeaters with better connectivity than under Option 1 as the noise level is significantly reduced and the user's phone can connect to the network without unduly reducing the quality of the call.

98 Therefore, ComReg is of the view that consumers are unlikely to prefer Option 1 and thus are likely to have a preference for Options 2 or 3.

Option 2 v Option 3

99 Firstly, it can be assumed that what is good for competition, and what promotes investment in infrastructure, is, in general, good for consumers. This is because increased competition between Mobile Operators brings benefits to their customers in terms of price, choice, and quality of services. As such, consumers are likely to prefer Option 3 because of the positive impacts on competition associated with this Option as described above.

[43] This typically depends on the location of the base station. See section 3.2.4 (Distribution of Traffic in the network - Document 15/62a
[44] Population 4.757,976 (Census 2016) and assuming national network of 2000 – 2,200 base stations.
[45] (2014) Report of the 6th Joint Cross-Border R&TTE Market Surveillance Campaign. Group of Administrative Co-operation under the R&TTE Directive.
[46] Document 17/100a – Mobile Consumer Experience Survey

100 Further, under Option 2 a repeater can only serve one network per premises. Repeaters are likely to be primarily used in the household. In that regard, ComReg observes that a household may contain:

a) more than one person.

b) more than one person with a phone; and

c) more than one operator serving those phones.

101 In relation to (a) ComReg notes that over 75% of all private households contain more than one person. For example, nearly 50% of all private households consist of 3 persons or more and 30% consist of 4 persons or more.[47]

102 In relation to (b) 98% of the population aged 15+ now own a mobile phone.[48] As such, almost all persons (excluding aged <15) in a household will own a phone.

103 In relation to (c) members of the same household could historically have been part of the same network as the selection of that network could have reduced calling costs.[49] However, the advent of bundling in mobile phone plans and the availability of alternative voice and text communications through increased data usage means the incentives to be on the same network as other household members has largely fallen away. For example, ComReg notes that in 2011 being on the same network as family and friends was the main reason (40% of all users) for switching to a network[50].In 2017, this had fallen to just 10%[51]. Therefore, certain households with multiple members are likely to have different networks serving those members.

104 Under Option 2, the main decision maker would configure the repeater so as to only use the channels assigned to the Mobile Operator providing its service. While any other members of the same household using that same Mobile Operator would benefit, those that are using a different Mobile Operator, and have similar mobile connectivity issues would not. These consumers must either (a) purchase their own repeater in which case a household would have multiple repeaters[52] or (b) switch to the operator associated with the repeater (which as noted above distorts competition). Alternatively, under Option 3 the main decision maker is no

[47] Census 2016, Households and Families.
[48] See Slide 15, Document 17/100a – Mobile Consumer Experience Survey.
[49] See Section 5.1.4 of Hutchison 3G UK/Telefonica Ireland (Case No COMP/M.6992) and in particular "*In the past, and prior to reductions enforced by regulation, high termination rates and associated off-network call charges provided strong incentives for subscribers to join and remain on the same network as their friends and family and discouraged switching between networks.*"
[50] Slide 56, Document 12/46a – Market Review: Voice Call Termination on Individual Mobile Networks.
[51] Slide 47, Document 18/23a – Ireland Communicates Survey 2017: Consumer
[52] To cover multiple bands in a premises, consumers would have to purchase multiple devices which would be a significant cost.

worse off and more members of the household would be facilitated by better reception at less cost.

105 Furthermore, a household is far more likely to justify the upfront cost (€200 - €500)[53] for a repeater if the resulting benefit is spread across multiple members of that household. Depending on the household, the upfront cost of a repeater may be a more efficient allocation of resources if the alternative was to upgrade to a number of Wi-Fi calling enabled phones. Finally, Option 3 does not preclude a customer using a single operator repeater, rather, Option 3 provides consumers with the option of either a single operator repeater or a multi operator repeater. Option 2 only allows a consumer to purchase a single operator repeater.

106 Therefore, ComReg is of the view that consumers would likely prefer Option 3.[54].

2.3.8 ComReg's Preferred Option (step 5)

107 The above assessment has considered the impact of the various options from the perspective of industry stakeholders, as well as the impact on competition and consumers. For the reasons identified above, ComReg considers that, on balance, Option 3 is the more appropriate regulatory option to adopt in the context of the RIA analytical framework.

108 In particular, ComReg is of the view that Option 3 is justified, reasonable and proportionate, because, amongst other things Option 3:

- provides households/premises with a mobile connectivity solution that benefits the greatest number of consumers by authorising repeaters across all networks, and is more efficient for consumers as there is no need to buy more than one device per household;
- protects Mobile Operators existing and future efficient investments by mitigating the risks of interference associated with the use of unauthorised boosters and also positively impacts on user perceptions of the MNO networks by eliminating issues that had been previously and erroneously associated with them;
- accords with ComReg's statutory objective of encouraging the efficient use and ensuring the effective management of spectrum by allowing the radio spectrum to be used in a manner that provides connectivity solutions to

[53] https://www.mobilerepeater.co.uk/

[54] Business customers may also use repeaters to address connectivity issues associated with their premises. In that regard, such users are likely to prefer Option 3 as it would cater for users across all networks.

consumers while protecting against undue interference;

- protects all operators from network interference and provides equal benefits in terms of improved connectivity for consumers;
- accords with the principle of safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure based competition; and
- appears to be least onerous means by which the policy issues and objectives as stated could be achieved.

3 Technical and Operational Conditions

3.1 Summary of ComReg's position in Document 17/103

109 In Chapter 4 of Document 17/103, ComReg set out its proposed technical conditions[55] on mobile phone repeaters to meet licence exemption. The conditions covered the following areas:

- Automatic Standby/Shutoff
- Anti-Oscillation
- Frequency Band
- Power
- Gain
- Gain Control
- Intermodulation Attenuation and
- Radiated Spurious Emissions & Out of Band Gain Limits

110 These technical conditions were based on the RED[56] and existing ETSI[57] standards for GSM (2G), UMTS (3G) and LTE (4G) with the aim of ensuring that a repeater would provide indoor coverage to consumers, while also providing a sufficient level of interference protection to MNOs.

111 ComReg asked the following questions on the technical conditions and licence exemption of these devices.

Q. 1 Do you agree with ComReg's proposal for the licence exemption of mobile phone repeaters?

Q. 2 Do you agree with ComReg's proposed technical conditions set out in Table 1? If not please provide reasons and supporting evidence for your answer.

[55] Chapter 4 Table 1
[56] Radio Equipment Directive
[57] European Telecommunications Standards Institute

3.2 Views of Respondents

112 ComReg received 3 responses in relation to question 1. These responses were from Three, Vodafone and eir. Each operator held a different opinion:

- Three cautiously supports the proposal to permit licence exempt repeaters provided ComReg took into account some of its comments on the consultation;
- eir did not agree with the proposal in its current form stating that Option 3 is the "*least attractive option*". However, it states that Option 2 – single operator repeater would be an acceptable option;
- Vodafone did not indicate whether or not it agreed or disagreed with the licence exemption proposal for mobile phone repeaters, although it did state that it is strongly in favour of developing Option 2 – single operator repeater. On advice from Vilicom, Vodafone adds that "*Option 3, a multi-operator repeater, is much more likely to cause network problems as optimum gain setting for different donor operators will not be aligned*". In addition to submitting its technical report, Vilicom in response to consultation 17/103 states that "*the third option outlined by ComReg will create significant problems for the mobile operators and their customers by creating harmful interference*".

113 On the technical conditions proposed by ComReg in Document 17/103 i.e. question 2, all 6 respondents provided their views. The issues relevant to the Proposed Technical Conditions raised by the respondents are broken down into the following categories and discussed below under the following headings;

- Interference from Multiband/Multi Operator Repeaters
- Power Limits
- Noise & Gain
- In-vehicle Repeaters
- Intermodulation requirements
- Other Issues Raised

Interference from Multiband/Multi-Operator Repeaters

Views of Respondents

114 Vodafone, eir and Vilicom all express the opinion that multi-operator repeaters would cause significant interference to MNO base stations. However, Three was of the view that some interference is inevitable and that on balance the benefit to consumers can outweigh the detriment to network performance overall, provided certain safeguard measures are in place;

- Vodafone claims that illegal repeaters often transmit towards the base-station at powers appropriate for a mobile far from the base station. Therefore, they may block the uplink signal from other mobile users who are further from the site. Vodafone provides an example of how the higher mobile signal from a recently added new site close to a repeater floods the input stage of the repeater causing it to transmit continually back to the original donor site. Vodafone further states that it was only able to detect this interference as the location of the repeater was known.

- eir claims that multi-operator repeaters amplify all signals and although may improve service for one operator, such repeaters may cause interference to another operator. In Annex 1 of eir's response, eir provides an example of a repeater install it conducted in the "*vicinity*" of a donor site. eir claims that if the repeater used in its example were to use similar maximum power and gain as proposed in Document 17/103, the system would have been feeding in noise thereby suggesting that design and deployment process needs to be managed extremely carefully in order to protect the network.

- Vilicom claims that multi-operator repeaters (Option 3) would cause more interference to MNO's than single-operator repeaters (Option 2). Vilicom states that *"Multiple Option 2 repeaters, each for a different MNO would work more independently than a single Option 3 multi-operator (full band) repeater".*

115 Vilicom further queries whether ComReg found any such proposed repeaters causing interference to base stations i.e. *"ComReg notes that no repeaters as defined in its document were encountered during the course of its interference investigations. Perhaps there may be an absence of such repeaters installed, due to general unavailability or relatively high costs?"*

ComReg's Assessment

116 In response to Vodafone and eir's concerns about an Option 3 repeater amplifying all signals and causing interference to sites that are at different distances to each other, ComReg notes that this scenario is not feasible as the repeaters gain control would be dictated by the strongest signal received i.e. the nearest base station. This means that the strongest signal received at the base station would reduce the gain of the repeater to a level that it would not interfere with it. The repeater of itself would not increase its gain to reach the farther base station.

117 In relation to the repeater system claimed to have been installed by eir, ComReg notes that eir did not provide the distance between the repeater and the donor site. eir also failed to provide detailed technical specifications including whether there was gain control on the repeater system. For a device to meet the requirements of the exemption order it **must** have automatic gain control feature that adjusts the gain and uplink power of the repeater relative to the power of the strongest downlink signal present in band of operation. Therefore, if the donor site was installed in the vicinity of the repeater, under the proposed conditions the repeater would have to automatically reduce its gain down to a level that would not cause interference back to the donor site. If the repeater is unable to adjust its gain to a suitable level so that no noise reaches the base station then it **must** power off. This means that the second phone user may not be able to reach the farther base station but this is the trade off to ensure that there is no base station interference from the repeater. ComReg has clarified this further in its proposed technical conditions and has updated the Gain Control section in the Exemption Order to reflect this (see Table 1).

118 In response to Vilicom's claim that an Option 3 (Multi-operator) repeater would create harmful levels of interference compared to Option 2 (single-operator repeaters), the technical conditions are designed with interference protection to MNO's as a priority. Under the proposed technical conditions in Document 17/103, ComReg has not placed any restrictions on the number of MNO services a repeater may service, meaning that both single-operator and multi-operator repeaters are allowed under the licence exemption. The maximum output power is controlled by the gain control of the repeater, which reduces the output power relative to the strongest downlink signal per band. Therefore, there is no greater risk of interference to a base station from a multi-operator repeater than a single-operator repeater. On balance, ComReg agrees with Three's view that some minimal level of interference is inevitable however the benefit to consumers outweighs this risk provided the technical conditions proposed by ComReg are adhered to.

119 With regard to Vilicom's question on whether the lack of repeaters found to be causing interference may in the main be due to unavailability or high costs, ComReg has never found a *"repeater"* to be causing interference to a MNO's base station during an investigation. However, such devices have inevitably entered the country and ComReg has itself witnessed a number of these devices in its market surveillance work and in concert with Irish customs and online retailers.

Power

Views of respondents

120 Vilicom, eir and Multicom query whether the power limits proposed by ComReg included antenna gain, cable loss etc. or if it was just the gain of the repeater, expressing that a high gain antenna could lead to base station interference.

121 Multicom enquires whether there are any guidelines on other passive equipment that is required for the operation of a repeater system such as antennas, cables, connectors etc.

122 Vilicom agrees with ComReg's proposed output downlink power limit of 17 dBm but claims that the uplink power of the mobile handset varies by technology for example in the case of GSM 900, the uplink power is 33 dBm while in the case of UMTS 900 the uplink power is 21 dBm. Further, Vilicom claims that the repeater units for sale also includes antennas, cables etc separately and therefore requests that ComReg specify uplink transmit power in absolute terms per band. All respondents suggests that the uplink power is expressed in EIRP per band and per technology.

ComReg's Assessment

123 As EIRP is related to the power transmitted from the radio taking into account all losses including cables and connectors and the antenna gain, ComReg therefore agrees with respondents above that the maximum uplink and downlink powers need to be expressed in EIRP per band to take into consideration variability of power limits by technology, antenna gain and cable loss for example. In light of this, ComReg has therefore updated the technical conditions i.e. maximum transmitted power expressed in EIRP per band and per technology.

Gain

Views of respondents

124 Both Vilicom and Three express the opinion that the gain limit of 70 dB may not be sufficient:

- Vilicom submits that 70 dB gain is not sufficient and that some installations will not work at this maximum gain, stating that; *"the repeater input power would have to be -53 dBm to get the full output power of 17 dBm"* adding that if a consumer had this level of coverage they would be unlikely to need a repeater in the first place. Three states that, in its view, the proposed gain of 70 dB is unnecessarily restrictive and may rule out many cases where repeaters would be able to solve consumer reception problems. Three further states that it is aware anecdotally of some instances of repeaters with gains above 70 dB that were deployed and operated interference free. Both Three and Vilicom believe that the gain should be increased to 100 dB in line with Ofcom's technical conditions[58].

- Both Vilicom and eir contend that a potential problem may occur when a consumer with a multi-operator repeater receives different power levels from different operators i.e. if one operator's RSSI levels is significantly higher than the other then the gain control feature may reduce the gain of the repeater down to a level that would be inadequate for the consumer trying to use the network of those operators with lower power values.

ComReg's Assessment

125 ComReg firstly notes that the proposed technical conditions in Document 17/103 were derived with interference protection to MNO's as a priority and as such ComReg proposed that a gain of 70 dB would be sufficient for the consumer without causing interference back to a donor site. ComReg acknowledges Vilicom's and Three's concerns that 70dB gain might not be sufficient in some instances for consumers and notes Three's submission that it has experienced repeaters with 100 dB gain in the past without issues of interference. ComReg agrees with Vilicom that a consumer with -53 dBm RSSI would most likely not need a repeater unless such a consumer was experiencing high building entry loss.

[58] Under Ofcom's technical conditions the uplink and downlink system gain in dB of a repeater, referenced to its input and output ports, shall not exceed BSCL-30, where BSCL (base station coupling loss) is the path loss between the base station and the repeater. Where BSCL cannot be determined, the repeater must not transmit. The system gain of the repeater shall not exceed 100 dB.

126 On assessment of the effects of repeaters on mobile networks conducted by PA Consulting[59] on behalf of Ofcom[60], ComReg notes that typical indoor mobile phone repeaters may have a gain of around 55 – 75 dB, however newer smarter repeaters with advanced gain control algorithms may achieve system gains of up to 100 dB without causing harmful interference to an MNO base station. In order to facilitate newer repeaters with advanced gain control features and to prevent any repeaters with gain values of more than 100 dB causing any interference, ComReg agrees that increasing the gain to 100 dB would be beneficial to consumers without risk of interference to an MNO base station.

127 On Vilicom's and eir's point on different power levels, ComReg acknowledges that if one operator's RSSI level is significantly higher than the other then the consumer may still experience reception issues. ComReg is of the view that in order to optimise reception the consumer and or installer should establish the optimum location and type of repeater to install. In situations, such as that described by Vilicom, the consumer has a number of options to improve their reception including moving the external antenna pointing away from the strongest base station, using the building to attenuate the stronger base station, using a more directional antenna or using a single operator repeater.

Noise & Gain Control

Views of respondents

128 ComReg received four responses from Vilicom, Vodafone, eir and Three. Both Vodafone and Vilicom claim that a large number of repeaters in a given area would most likely increase noise power causing cell shrinkage and reduce coverage of the sites. Vilicom further states that in most repeaters with Gain Control the amplifier is kept at maximum gain while attenuators at the ports adjust the output power, thus the Automatic Gain Control (AGC) does not provide maximum control over the noise output.

129 Three claims that repeaters can and will increase the noise floor within the serving cell. eir contends that an unregulated and unmonitored repeater system could cause noise levels to rise in the MNO's licensed frequency bands.

130 On Shutdown limits and uplink noise protection:

- Vilicom queries whether the shutdown limit should be defined as -40 dBm for the band of operation.

[59] https://www.ofcom.org.uk/__data/assets/pdf_file/0017/85004/eeffects_of_repeaters_on_mobile_networks.pdf
[60] https://www.ofcom.org.uk/__data/assets/pdf_file/0019/107254/Repeaters-Statement-2017.pdf

- eir asks if the gain control is based on aggregated power or the power from each separate base station.

- Stella Doradus observes that the ETSI limit for uplink noise is less than -53 dBm/100 kHz. At this level, Stella Doradus believes that the "*noise from a repeater would be detected by a 900 MHz base station almost 1.5 km away*". Furthermore, Stella Doradus recommends that instead of the proposed shutdown level of RSSI >= -40 dBm that ComReg set the max uplink noise limit as *"-103dBm/MHz –RSSI"*. This in Stella Doradus's view would offer better protection to MNO's by not allowing any noise from the repeater to reach the base station. Stella Doradus provides several examples illustrating that when using the above equation the uplink noise falls short of the base station's ability to detect it by 22 dB. Stella Doradus further claims that by using this method of gain control that more than 100 repeaters would need to be installed on a cell before the combined noise could be detected.

ComReg's Assessment

131 ComReg notes that while all electronic or radio devices generate noise, the technical conditions proposed are designed such that no noise from a repeater should reach the base station. This along with the Automatic Standby/Shutoff mode of the repeater would ensure that there is no constant transmission of noise back to the base station. After 1 minute of the device being idle it would reduce its output power significantly or power off the uplink completely. This means that any potential noise from the repeater would only occur when the device is transmitting. However, the call or data signal power transmitted back to the base station would be much greater than the noise level from the repeater.

132 Vilicom's arguments appear contradictory given it is in favour of installing multiple single-operator repeaters to reduce risk of interference, yet installing multiple repeaters in a cell would increase the noise level greater than a single multi-operator repeater, assuming gain is equal.

133 In response to eir's query, ComReg confirms that the shutdown limit is based on aggregated power. The Automatic Gain Control (AGC) is to be adjusted from the strongest signal present in the downlink per band of operation. The AGC is to adjust such that no noise from the repeater can reach the base station.

134 ComReg carefully considered the material provided by Stella Doradus in relation to using proximity control instead of the proposed shutdown limit of -40 dBm. ComReg views that this method offers a better alternative to the proposed shut down limit of RSSI > -40 dBm for the following reasons:

- provides better control over the noise level transmitted in the uplink band;

- offers better protection to mobile network operator sites;

- gain is adjusted relative to both RSSI and noise of the repeater amplifier (see examples in Annex 4)

135 ComReg, therefore considers to adopt the proposed proximity control equation for the gain control condition i.e. max uplink noise limit of *"-103dBm/MHz –RSSI"*.

In-vehicle repeaters

Views of respondents

136 The Draft Exemption Order of Document 17/103 defined a mobile phone repeater as "*apparatus for wireless telegraphy, which is used specifically to amplify signals between a mobile phone and a network operator's base station, either indoors or in-vehicle*". ComReg received two responses in relation to the use for in-vehicle repeaters:

- Three contends that ComReg should also consider in-vehicle repeaters similar to Ofcom's proposal stating that; "*If properly specified, this could significantly improve the quality of in-car calls without causing interference. Failure to include such systems now would be a missed opportunity, as we do not believe this matter will be reviewed in the short to medium term*".

- eir queries whether in-vehicle repeaters are also permitted under the proposed exemption scheme, noting that the Taskforce only recommended developing a scheme for in-door coverage only and that if ComReg intends to also exempt in-vehicle repeaters then further consultation would be required.

137 In addition to the above, Vilicom states that "*should any exemption be put in place, it would be good to carry out an impact assessment at some fixed period after the license exemption comes into force, for example after 12 or 18 months*".

ComReg's Assessment

138 ComReg's proposal deliberately did not specify how the repeater was to be installed once the device met the proposed technical conditions; it would be considered licenced exempt under the proposed exemption order. Under action 37[61] of the Taskforce report it was recommended that ComReg develop a licensing scheme to allow the use of mobile phone repeaters. While the recommendation from the Taskforce did not explicitly mention in-vehicle repeaters and the main focus of consultation Document 17/103 was on in-door repeaters, ComReg considers that there is no reason to exclude in-vehicle coverage and that its inclusion would be a benefit to consumers.

139 ComReg agrees with Three's views that the right specifications can lead to good in-vehicle reception without causing interference to a base station. ComReg also agrees that the proposed gain limit for the repeater would need to be less for an in-vehicle repeater compared to an indoor building repeater because a vehicle has less frequency attenuation than that of a building. Furthermore, the internal antenna and external antenna are much closer together in a vehicle. Considering these factors ComReg, has updated the technical conditions to limit the gain levels for in-vehicle repeaters.

140 In response to Vilicom's proposal on impact assessment to be carried after the licence exemption comes into force, ComReg does not consider it necessary to carry out a specific impact assessment after the licence exemption comes into force as proposed by Vilicom. ComReg is of the view that the effectiveness of the exemption order will become apparent over time and will be evidenced by such things as reports of interference from MNOs and the number of boosters coming onto the market. Such indicators will enable ComReg to assess the impact of the exemption order and make any changes that may be considered appropriate.

Intermodulation requirements

Views of respondents

141 Stella Doradus contends that that there is no need to include intermodulation requirements in the technical conditions as it is encompassed by the RED Directive. In relation to Radiated Emissions Stella Doradus states that the harmonised standards only cover GSM and not UMTS or LTE.

142 For band edge roll off requirements it suggest that *"the roll off requirements for GSM only apply to the 900 and 1800 bands, and the UMTS/LTE requirements (see above) apply to 800, 2100, 2600 bands. (2600 not applicable in Ireland yet)".*

[61] ComReg will develop a licensing scheme allowing the use of mobile phone repeaters to help address the issue of indoor coverage, particularly in rural areas.

ComReg's Assessment

143 ComReg notes that the technical parameters including intermodulation requirements and out of band gain values as proposed in Table 1 of Document 17/103 may change as revisions to the current ETSI standard are made. To that effect, ComReg has removed the limit values from the technical conditions and directly provided a reference to the ETSI standards in order to avoid any potential issues with possible future amendments to these standards.

3.3 ComReg's final position on proposed conditions of use

144 In Summary, ComReg will proceed with the licence exemption of the general usage of mobile phone repeaters as set out in Chapter 5 of this document. These repeaters will have no restrictions on the number of operators or technologies it may service, be it single/multi-operator or single/multi-band.

145 ComReg acknowledges the concerns from all respondents in relation to interference from repeaters to MNO base stations. These concerns in ComReg's view have been dealt with above and ComReg is satisfied that on balance the benefit to consumers outweighs minimal risk of interference overall provided the technical conditions proposed by ComReg are adhered to.

146 ComReg is appreciative of the various response received with regard to Document 17/103 and has made a number of amendments to the required technical conditions as a result. These changes include:

- Changing the maximum gain to 100 dB for in-door use and 20 dB for in-vehicle;
- Changing the maximum transmitted power to be in terms of EIRP per band of operation;
- Rewording the gain conditions as overall system gain rather than just gain of the repeater;
- Changing the gain control from shutting off the repeater in the presence of -40 dBm RSSI to the gain adjusting to limit the uplink noise using the formula -103dBm/MHz – RSSI. This is to offer better gain control and protection to MNO's from high noise levels; and
- Removal of out of band emissions and intermodulation requirements from the technical conditions as these are adequately covered by the Radio Equipment Directive (RED).

4 Other Issues Raised

147 A number of additional issues were raised by respondents. These issues are discussed below.

Definition of repeaters

Views of respondents

148 Both Vilicom and Multicom contend that distinction between boosters and repeaters can be somewhat ambiguous and that some devices that are currently advertised as a repeater would, under the technical conditions for licence exemption, be now considered as a booster.

ComReg's Assessment

149 ComReg understands that the words booster and repeater are generally used interchangeably by manufacturers and consumers. However ComReg would like to emphasise that any device that meets the proposed technical conditions would be considered a repeater and thus would be licence exempt. Any device that does not meet the proposed technical conditions would be considered as booster and would thus be illegal.

Guidance on installation

Views of respondents

150 In relation to the installation of licence exempt repeaters:

- Vodafone states that "*It would be useful for ComReg to produce a guideline document on installation*".
- Multicom asks "*Who will undertake the installation of repeater systems? Will there be a list of operator approved installers that a customer can use?*"

ComReg's Assessment

151 In common with most manufactured devices, ComReg believes that an installer guidelines document should be up to the manufacturers of these devices. In ComReg's view any device that operates within the technical conditions set by the exemption order is licence-exempt. The manufacturer or installer can best provide guidelines or tips to consumers on how to make best use of their device.

152 It is neither ComReg's practice nor remit to maintain lists of approved installers for the likes of Satellite, Digital TV or broadband installers. ComReg views the installation of repeater devices in a similar fashion. ComReg believes that most of these systems will be installed by professional installers to ensure best optimisation.

Interference Investigations

Views of respondents

153 A number of respondents raised concerns regarding the potential for the increased interference to MNO base stations::

- Vodafone requests that further safeguards should be put in place to prevent degrading of service for customers before the exemption order is put in place.
- Three states that; *"ComReg has traditionally suffered from a lack of resources available to track down and eliminate interference"* and asked for reassurances that ComReg would be able to quickly identify and eliminate any properly reported cases of interference to mobile or other networks prior to introducing licence exempt repeaters.
- In relation to the expense of interference investigations, eir queries who will bear the cost of investigations. eir also states that *"ComReg's procedures and processes need to be enhanced to address this ensuring that sources of interference to mobile networks, including accredited repeaters, can be rapidly eliminated. eir's support for Option 2 is therefore contingent on ComReg committing that it will increase resources in the interference investigation and enforcement teams to deal with the widespread use of repeaters".* eir further states that it would also like to see a service level agreement in place between ComReg and MNO's for investigating network interference.

ComReg's Assessment

154 The decision to exempt certain wireless telegraphy apparatus from licensing requires ComReg to carry out a rigorous assessment of the technical conditions that would relate to such an exemption. This is to ensure that, to the extent possible, such an exemption would not give to rise to any increased potential for interference to existing licensed apparatus. ComReg is satisfied that the technical conditions for the licence exemption of repeaters will not cause harmful interference to MNO base stations. The proposed technical conditions are designed with MNO protection in mind and have been further updated in light of response to consultation to provide better protection to base stations. In response to submissions from eir, Vodafone, Three and Vilicom on concerns around interference investigations ComReg firstly notes that:

- ComReg's Spectrum Intelligence & Investigations (SII) team, previously Spectrum Compliance[62] handles all cases of external interference to licenced operators in the State.

- As set out in ComReg document 17/87[63], all cases of interference are ranked according to severity and impact and assigned a Class from 1 – 5. Class 1 being the most severe. Interference complaints that render a licenced channel unusable or has a detrimental effect on the economic interests of a licensee are designated as Class 2 and are responded to within 3 working days. 80% of complaints received fall into the lower categories which have a 7+ working day response time. ComReg is of the view that this existing system of classification and the associated response times is clear and unambiguous and has proven to be effective in enabling ComReg to meet its obligations in respect of same.

155 ComReg enjoys full independence and discretion as to the manner in which it will conduct all of its investigations. ComReg will not fetter its discretion by agreeing with any third party (including, in particular, any likely or potential complainant) as to the manner in which it will exercise its investigatory function.

156 With regard to eir's query in respect of costs pertaining to any interference investigations, ComReg is charged with maintaining the integrity of the radio spectrum. Accordingly, ComReg bears all costs of any radio interference investigation undertaken.

Device Registration

Views of respondents

157 Vodafone, Three, eir and Multicom raise the issue of having licence exempt repeaters registered. In particular:

- Vodafone contends that a register of repeater devices would help in identifying where repeaters are in the network. This would, in Vodafone's view, help deal with any issues arising in a less labour-intensive way.

[62] https://www.comreg.ie/industry/radio-spectrum/spectrum-compliance/
[63] https://www.comreg.ie/publication/spectrum-intelligence-investigations-annual-report-2016-2017/

- Three suggests that a device registration database should be set up on ComReg's website for all repeaters that meet the licence exemption conditions. The database would record the location of the device. Three believes this would aid ComReg in any interference investigations. Three would also like this data made available to operators to assist with preliminary investigations of interference investigations.

- eir contends that repeaters purchased and deployed by a party other than an MNO must be registered in a central database which records details such as the repeater model, operator band and geo location of the repeater. This information it believes should be captured at the point of sale.

- Multicom enquires as to whether it is the intention to create a database or registration of all licence-exempt installations.

ComReg's Assessment

158 ComReg believes that the creation of a device database would be inimical to the licence exemption scheme. The more barriers placed before consumers, the more likely they are to refrain from using a repeater and the creation of any such register would most likely drive many towards the purchase of a booster that is known to cause interference. Such a development would seriously undermine the repeater initiative. ComReg has set its technical conditions with protection to base stations as priority and any technical faults detected should cause the device to shutdown causing no interference to a base station. Knowing the location of these devices would not materially aid in any interference investigations to a base station that is caused by an unregistered illegal booster. Given that ComReg will not for the reasons stated above be maintaining a register of licence exempt repeaters, the matter of sharing such a register does not arise.

5 Final Decision Instrument

159 This section sets out the technical conditions that ComReg has decided to apply in granting licence exemption for a mobile phone repeater. For a repeater to be considered licence-exempt it must comply with the Radio Equipment Directive (RED). ETSI set the standards[64] for mobile phone repeaters requirements for out of band gain, intermodulation attenuation and radiated spurious emissions. The device must comply with these conditions and meet the restrictions set out in Table 1.

160 The technical requirements set out in Table 1 reflect the following interference protection considerations:

- **Automatic Standby/Shutoff** – to reduce the risk of interference to other spectrum users and use the spectrum efficiently the repeater must have an automatic standby/shutoff mode. This ensures that when not in use the repeater will not contribute any unwanted emissions or electromagnetic noise in the mobile frequency uplink bands.

- **Anti-Oscillation** – to minimise risk of interference to mobile phone base stations and other spectrum users the repeater must have anti-oscillation detection and mitigation features. Interference in the uplink band tends to be more detrimental to the network as a whole and as such has been prioritised. In addition, any interference on the downlink is not likely to impact on users other than those in the building with the repeater. As such the cut off times outlined in Table 1 in ComReg's view are sufficient to protect all users in the bands in question.

  Accordingly, the device must either power off, restart, or reduce its output power until oscillations are no longer detected. If mitigations fail the device must power off completely.

- **Frequency Band** – the repeater must only repeat signals within bands assigned for mobile use (listed in Table 1). ComReg is not imposing any restrictions on the number of operators or bands the device may amplify. Both single band single operator repeaters and multi band multi operator repeaters are considered license-exempt under these specifications.

[64] ETSI EN 303 609 – GSM(2G)
ESTI EN 301 908-11 – UMTS (3G)
ETSI EN 301 908-15 – LTE(4G)

- **Power** – a base station should not be able to see any difference between a repeater or mobile handset transmitting to it. As such ComReg has limited the maximum uplink power to be similar to that of the maximum power of a mobile handset per band of operation.

  Furthermore, ComReg is limiting the maximum downlink power to 17 dBm, similar to the power levels of a typical domestic Wi-Fi router[65]. ComReg believes this should be sufficient to allow coverage within a typical domestic home, while making interference to other users in the locality unlikely. This is due to the fact that the building entrance loss mentioned earlier works in both directions, signals that emanate from within a building are likely to be significantly attenuated as they exit the building.

  All power levels are expressed in EIRP this is to include other factors such as antenna, cable loss and the gain of the repeater itself.

- **Gain** – the repeater must be capable of offering sufficient gain to allow consumers in weak signal areas and at the fringes of coverage areas to benefit as much as possible. Should too high a gain be permitted it is likely that the risk of disruption and interference to existing users, especially the base stations on a mobile network would be unacceptable. ComReg has set the maximum gain in Table 1. The device must operate within this limit to meet the licence exemption order.

- **Gain Control** - the repeater must have automatic gain control to fall within the proposed framework. This is primarily to limit the amplitude of signals received and protect base stations from unnecessary interference and disruption.

  The gain of the repeater per band of operation is limited based on the level of the downlink signal per band of operation detected at the repeater's external antenna. The Repeater should be able to adjust its gain such that noise from the device never reaches the base station. Simply put, the device should effectively work out its relative distance from the base station serving it based on free space loss being constant.

[65] Typical power of a WiFi router is 20 dBm

<table>
<tr><th>Limit Type</th><th>Specification</th></tr>
<tr><td>Automatic Standby/Shutoff</td><td>When not in use for 1 minute the device must reduce its output power to no more than -70 dBm/MHz per band of operation</td></tr>
<tr><td>Protection against Oscillation</td><td>The repeater must be able to detect and mitigate any oscillations in the uplink or downlink bands. Detection and mitigation must occur within 0.3 seconds in the uplink band and 1 second in the downlink.</td></tr>
<tr><td>Frequency Band</td><td>The amplified frequencies are limited to those that are currently used in the Republic of Ireland for mobile phone services:

800 Band: 791-821 MHz DL
832-862 MHz UL
900 Band: 880-915 MHz UL
925-960 MHz DL
1800 Band: 1710-1785 MHz UL
1805-1880 MHz DL
2100 Band: 1920-1980 MHz UL
2110-2170 MHz DL

No restriction on number of MNOs or mobile services the device may amplify</td></tr>
<tr><td>Power</td><td>
<table>
<tr><th>Band</th><th>Technology</th><th>Maximum Uplink *</th><th>Maximum Downlink *</th></tr>
<tr><td>800</td><td>Neutral</td><td>23 dBm</td><td>17 dBm</td></tr>
<tr><td>900</td><td>GSM</td><td>33 dBm</td><td>17 dBm</td></tr>
<tr><td>900</td><td>UMTS</td><td>23 dBm</td><td>17 dBm</td></tr>
<tr><td>1800</td><td>GSM</td><td>24 dBm</td><td>17 dBm</td></tr>
<tr><td>1800</td><td>LTE</td><td>23 dBm</td><td>17 dBm</td></tr>
<tr><td>2100</td><td>UMTS</td><td>24 dBm</td><td>17 dBm</td></tr>
</table>
</td></tr>
</table>

	*** Absolute power expressed in EIRP for in-door use and TRP for in-vehicle use.**
Gain	The maximum system gain of the repeater is limited to: • 100 dB for indoor use and • 20 dB for in vehicular use
Gain Control	The repeater must have automatic gain control to protect against excessive input signals that would produce output power emissions that would cause interference to a mobile base station. The repeater must adjust its gain in accordance to the strongest signal present in the downlink band of operation so that the noise of the repeater cannot reach the base station. The gain of the repeater must be adjusted so that the uplink noise does not exceed the formula: **-103dBm/MHz – RSSI** Where RSSI is the measure of Received Signal Strength (dBm) per band of operation at the port of the device. The repeater must power off if it can no longer meet this specification.

Table 1 - Technical Conditions for Licence Exemption

6 Decision

The Commission for Communications Regulation, in exercise of the powers conferred on it by section 3(6)(a) of the Wireless Telegraphy Act 1926 (No. 45 of 1926), (inserted by section 11(c) of the Wireless Telegraphy Act 1972 (No. 5 of 1972)), transferred to the Commission for Communications Regulation by section 4(2) of the Communications Regulation (Amendment) Act 2007 (No. 22 of 2007), hereby decides to make the order attached in Annex 4 to this Response to Consultation.

Annex: 1 Glossary

A 1.1 The definitions in this glossary shall apply to this document as a whole.

A 1.2 Where a term in this glossary is defined by reference to a definition in a section or paragraph and an explanation of that term is provided in this glossary, the latter explanation is for convenience only and reference should be made to the appropriate part of the document for the definitive meaning of that term in its appropriate context.

A 1.3 Any reference to any provision of any legislation shall include any modification re-enactment or extension thereof.

A 1.4 Terms defined in this consultation paper shall, unless the context otherwise requires or admits, have the meaning set out below:

MNO	Mobile Network Operator
Uplink	Frequency used to talk to a mobile base station from a mobile handset
Downlink	Frequency used to talk to a mobile handset from a base station
800 MHz band	The frequency range 790 - 862 MHz
900 MHz band	The frequency range 880 – 960 MHz
1800 MHz band	The frequency range 1710 - 1880 MHz
2100 MHz band	The frequency range 1920 - 2170 MHz
NRA	National Regulatory Authority
RIA	Regulatory Impact Assessment. An analysis of the likely effect of, and necessity of, a proposed new regulation or regulatory change.
dB	Decibel is a logarithmic expression of the ratio between two signal power
dBm	A unit measure of power in decibels referenced to one miliwatt (mW)

dBi	dB isotropic is the forward gain of an antenna compared with the hypothetical isotropic antenna, which uniformly distributes energy in all directions.
mW	Miliwatt, a unit of power equal to one thousandth of a watt
MHz	megahertz (1 million Hertz)
Intermodulation	Intermodulation is the undesired combining of several signals in a nonlinear device, producing new, unwanted frequencies
Oscillation	An undesirable variation in output voltage or current in an electronic device, usually an amplifier. It is often caused by feedback in the amplifier
Gain	The increase in power from the input to the output of a device, usually an amplifier or antenna
Spurious Emissions	Spurious Emission are emission which are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products
AGC	Automatic Gain Control is the ability to automatic adjust the gain of an amplifier through intelligent software.
Attenuation	The reduction in signal strength
ETSI	European Telecommunications Standards Institute.
BEREC	Body of European Regulators for Electronic Communications
EIRP	Effective Isotropic Radiated Power is the measured radiated power in a single direction
TRP	Total Radiated Power is a measure of how much power is radiated by an antenna when the antenna is connected to an actual radio (or transmitter)

Annex: 2 Gain Control Requirements

In Section 4 of this document, ComReg outlined its intention to adopt the proximity control conditions proposed by Stella Doradus as a form of gain control to prevent noise from the repeater reaching a base station.

Stella Doradus proposed that the uplink noise of the repeater should not be greater than:

-103 dBm/MHz – RSSI

Where RSSI is the strongest received signal strength per band of operation at the input port of the repeater. The -103 dBm/MHz figure is derived from ETSI limits on uplink noise (-53 dBm/100 kHz).

Below are examples of how using this equation leaves a 22 dB safety margin of the noise reaching the base station.

Assuming the following;

- 33 dBm base station transmitter,
- 15 dBi base station antenna,
- 10 dB donor antenna at repeater site,
- No cable loss between the repeater and antenna,
- -114 dBm/1 MHz noise floor

Example 1

With an RSSI = -65 dBm at 900 MHz

Then using the above equation the ***maximum permitted uplink noise*** is calculated:

-103 – (-65) = -38 dBm

The ***Gain*** of the repeater must adjust so that the maximum uplink noise is not greater than -38 dBm. The gain of the repeater is calculated as follows:

Gain = - Noise Floor + (-103-RSSI) – NF

Where NF is the noise figure of the repeater.

For the above example the gain of the repeater would be;

Gain = 114 – 38 = 76 dB for an ideal repeater and

Gain = 114 – 38 – 8 = 68 dB for a repeater with a NF of 8 dB (a more realistic figure)

For the uplink noise not to be detected by the base station the ***required path loss*** needs to attenuate the uplink noise by:

Noise Floor + uplink noise + donor antenna gain + base station antenna gain

114 – 38 + 10 + 15 = 101 dB

The calculated ***actual path loss*** from the base station to the repeater is:

Base Transmitter Power + Base Antenna Gain + Repeater Antenna Gain – RSSI =

33 + 15 + 10 - (-65) = 123 dB

Noise Margin = Actual Path Loss – Required Path Loss

= 123 – 101 = 22 dB

Therefore the safety margin of noise reaching the base station is **22 dB**.

Using the Free Space Path Loss formula the minimum distance the repeater can be detected by the base station is:

FSPL (dB) = 20log(d) + 20log(f) + 32.44

Where d is distance in km

F is frequency in MHz

101 = 20log(d) + 20log(900) + 32.44

101 – 59 – 32.44 = 20log(d)

9.56/20 = log(d)

0.478 = log(d)

10^0.478 = d

=> d = 3 km

Example 2

With an RSSI at 900 MHz = -20 dBm

Then using the above equation the ***maximum permitted uplink noise*** is calculated:

-103 – (-20) = -83 dBm

The ***Gain*** of the repeater must adjust so that the maximum uplink noise is not greater than --83 dBm. The gain of the repeater is calculated as follows:

Gain = - Noise Floor + (-103-RSSI) – NF

Where NF is the noise figure of the repeater.

For the above example the gain of the repeater would be;

Gain = 114 – 83 = 31 dB for an ideal repeater and

Gain = 114 – 83 – 8 = 23 dB for a repeater with a NF of 8 dB (a more realistic figure)

For the uplink noise not to be detected by the base station the ***required path loss*** needs to attenuate the uplink noise by:

Noise Floor + uplink noise + donor antenna gain + base station antenna gain

114 – 83 + 10 + 15 = 56 dB

The calculated ***actual path loss*** from the base station to the repeater is:

Base Transmitter Power + Base Antenna Gain + Repeater Antenna Gain – RSSI =

33+15+10+20 = 78 dB

Noise Margin = Actual Path Loss – Required Path Loss

= 78 – 56 = 22 dB

Therefore the safety margin of noise reaching the base station is **22 dB**.

Using the Free Space Path Loss formula the minimum distance the repeater can be detected by the base station is:

FSPL (dB) = 20log(d) + 20log(f) + 32.44

Where d is distance in km

F is frequency in MHz

56 = 20log(d) + 20log(900) + 32.44

56 – 59 – 32.44 = 20log(d)

-35.44/20 = log(d)

-1.772 = log (d)

10^-1.772 = d

=> d = 17 m

ComReg views this method of Gain Control as a better alternative to the proposed shut down limit of RSSI > -40 dBm as it gives better control over the noise level transmitted in the uplink band. This offers better protection to mobile network operator sites. Also rather than limiting what the gain of the repeater should be without taking into account the noise from the amplifier, using this method the gain is adjusted relative to both the RSSI and noise of the repeater amplifier.

Annex: 3 Legal Basis

The Communications Regulation Acts 2002-2011 (the "2002 Act"), the Common Regulatory Framework (including the Framework and Authorisation Directives as transposed into Irish law by the corresponding Framework and Authorisation Regulations), and the Wireless Telegraphy Acts 1926 to 2009 ("the 1926 Act") set out, amongst other things, powers, functions, duties and objectives of ComReg that are relevant to the management of the radio frequency spectrum in Ireland.

Apart from licensing and making regulations in relation to licences, ComReg's functions include the management of Ireland's radio frequency spectrum in accordance with ministerial Policy Directions under section 13 of the 2002 Act, having regard to its objectives under section 12 of the 2002 Act, Regulation 16 of the Framework Regulations and the provisions of Article 8a of the Framework Directive. ComReg is to carry out its functions effectively, and in a manner serving to ensure that the allocation and assignment of radio frequencies is based on objective, transparent, non-discriminatory and proportionate criteria.

Section 3(1) of the 1926 Act sets out the general prohibition on possession of unauthorised wireless telegraphy apparatus, but under section 3(6)(a), ComReg can declare, in an exemption order, that a certain class or description of wireless telegraphy is exempt from section 3.

It is considered that mobile phone repeaters are capable of coming within the definition of "apparatus for wireless telegraphy" for the purposes of the 1926 Act, namely: "apparatus capable of emitting and receiving, or emitting only or receiving only, over paths which are not provided by any material substance constructed or arranged for that purpose, electric, magnetic or electro-magnetic energy, of a frequency not exceeding 3 million megahertz, whether or not such energy serves the conveying (whether they are actually received or not) of communications, sounds, signs, visual images or signals, or the actuation or control of machinery or apparatus, and includes any part of such apparatus, or any article capable of being used as part of such apparatus, and also includes any other apparatus which is associated with, or electrically coupled to, apparatus capable of so emitting such energy.

Annex: 4 Exemption Order

Wireless Telegraphy Act 1926 (section 3) (Exemption of Mobile Phone Repeaters) Order 2018

Notice of the making of this Statutory Instrument was published in

"Iris Oifigiúil" of [-].

The Commission for Communications Regulation, in exercise of the powers conferred on it by section 3(6)(*a*) of the Wireless Telegraphy Act 1926 (No. 45 of 1926), (inserted by section 11(*c*) of the Wireless Telegraphy Act 1972 (No. 5 of 1972)), transferred to the Commission for Communications Regulation by section 4(2) of the Communications Regulation (Amendment) Act 2007 (No. 22 of 2007), hereby makes the following Order:

Citation

1. This Order may be cited as the Wireless Telegraphy Act 1926 (section 3) (Exemption of Mobile Phone Repeaters) Order 2017.

Interpretation

2. In this Order—

"Mobile Phone Repeater" means apparatus for wireless telegraphy, which is used specifically to amplify signals between a mobile phone and a network operator's base station, either indoors or in-vehicle;

"Apparatus for Wireless Telegraphy" has the same definition herein as in the Wireless Telegraphy Act 1926 (No. 45 of 1926);

"dB" means a unit of transmission giving the ratio of two powers: if P1 and P2 represent two values of power and n the number of decibels representing their ratio then n=10 log10 P1/P2. If the two powers are dissipated in equal resistive impedances their ratio in decibels may be expressed by n=20 log10 V1/V2 where V1 and V2 are the voltages across the two resistive impedances;

"dBm" means decibels of power referenced to one milliWatt;

"GHz" means gigahertz (1,000,000,000 Hertz);
"Hertz" means Unit of Frequency;

"kHz" means kilohertz (1,000 Hertz);

"MHz" means megahertz (1,000,000 Hertz);

"Mobile Base Station" means Apparatus for Wireless Telegraphy connected to a backhaul network, which provides a Radiocommunication Service to Terminal Stations;

"Radio Equipment Directive" means Directive 2014/53/EU of the European Parliament and of the Council, of 16 April 2014, on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing

Directive 1999/5/EC on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity;

"Radio Equipment Regulations" means the European Union (Radio Equipment) Regulations 2017 (S.I. No. 248 of 2017).

"ETSI" means the European Telecommunications Standards Institute;

Limitation

3. This Order only applies within the jurisdiction of the State and only applies to Mobile Phone Repeaters which are in conformance with the Radio Equipment Directive and the Radio Equipment Regulations.

Applicability

4. Section 3 of the Wireless Telegraphy Act 1926 (No. 45 of 1926) does not apply to classes of Mobile Phone Repeaters described as, and fulfilling the requirements set out in, this Order.

Conditions

5. Mobile Phone Repeaters to which this Order applies shall comply with the following conditions:

(*a*) The Mobile Phone Repeater shall comply with ETSI standards EN 303 609, EN 301 908-11 and EN 301 908-15, and any revisions to those standards;

(*b*) When the Mobile Phone Repeater is no longer serving an active device connection, it must, after no longer than 1 minute, reduce its power to no more than -70 dBm/MHz;

(*c*) The Mobile Phone Repeater must detect and mitigate (by automatic gain reduction or shutdown) any oscillations in uplink and downlink bands, and such detection and mitigation must occur within 0.3 seconds in the uplink band, and 1 second in the downlink;

(d) ComReg reserves the right to inspect the Mobile Phone Repeater at the licensee's own expense prior to and during operation if necessary;

(e) The amplified frequencies which the Mobile Phone Repeater is capable of using shall be limited to those amplified frequencies that are used in the State for mobile phone services, namely:

800 MHz - 791-821 MHz (Downlink) 832-862 MHz (Uplink);
900 MHz - 880-915 MHz (Uplink) 925-960 MHz (Downlink);
1800 MHz - 1710-1785 MHz (Uplink) 1805-1880 MHz (Downlink); and
2100 MHz - 1920-1980 MHz (Uplink) 2110-2170 MHz (Downlink);

(f) no restrictions on number of mobile services or operators the Mobile Phone Repeater may amplify;

(g) The transmit power of the Mobile Phone Repeater for in-door use is limited to the following:

Band	**Technology**	**Maximum Uplink**	**Maximum Downlink**
800	Neutral	23 dBm EIRP	17 dBm EIRP
900	GSM	33 dBm EIRP	17 dBm EIRP
900	UMTS	23 dBm EIRP	17 dBm EIRP
1800	GSM	24 dBm EIRP	17 dBm EIRP
1800	LTE	23 dBm EIRP	17 dBm EIRP
2100	UMTS	24 dBm EIRP	17 dBm EIRP

(h) The transmit power of the Mobile Phone Repeater for in-vehicle use is limited to the following:

Band	**Technology**	**Maximum Uplink**	**Maximum Downlink**
800	Neutral	23 dBm TRP	17 dBm TRP
900	GSM	33 dBm TRP	17 dBm TRP
900	UMTS	23 dBm TRP	17 dBm TRP
1800	GSM	24 dBm TRP	17 dBm TRP
1800	LTE	23 dBm TRP	17 dBm TRP
2100	UMTS	24 dBm TRP	17 dBm TRP

(i) The maximum gain of the Mobile Phone Repeater is limited to 100 dB for in-door use and 20 dB for in-vehicle use;

(j) The Mobile Phone Repeater must have automatic gain control to protect against excessive input signals that would produce output power emissions that would cause interference to a Mobile Base Station;

(k) The Mobile Phone Repeater must adjust its gain in accordance to the strongest signal present in the downlink per band of operation;

(l) The Mobile Phone Repeater must adjust its gain so that the maximum uplink noise is less than:

-103 dBm/MHz – RSSI

where RSSI is the measure of Received Signal Strength (dBm) per band of operation at the input ports of the Mobile Phone Repeater; and

(m) The Mobile Phone Repeater must cease transmitting and shut off automatically if it cannot meet this specification.

GIVEN under the official seal of the Commission for Communications Regulation,

[-] 2018.

GERRY FAHY,

For and on Behalf of the Commission for Communications Regulation.

EXPLANATORY NOTE

(This note is not part of the Instrument and does not purport to be a legal interpretation.)

This Order provides for the exemption of certain wireless telegraphy apparatus, namely mobile phone repeaters, which meet certain conditions stated in the face of the order, from the requirement to be licensed under the Wireless Telegraphy Act 1926.