



Response to Ofcom's Consultation Document on:

Mobile Phone Repeaters

(Issued by Ofcom on 5 April 2017)

Executive summary

1. In EE's response to Ofcom's previous CFI (in 2014) we provided evidence of the harmful effects of illegal repeaters. We explained why there would be no technical criteria that would apply to illegal repeaters whereby EE and Ofcom could be confident that the illegal repeaters could be deployed without causing undue interference and/or the likelihood of an adverse impact on the technical quality of EE's services.
2. Ofcom's proposals fail to demonstrate that it has taken this evidence into account or how it intends to address these risks. In the consultation Ofcom makes no reference to the advice and evidence put forward by EE and other stakeholders or explanation of how they shaped their proposal to legalise repeaters. In doing so Ofcom has failed to follow its own key regulatory principles.
3. It is unclear how the single-operator repeaters Ofcom proposes to legalise could bring any incremental benefit to consumers over and above the repeaters and other coverage enhancing solutions already offered by EE and other Mobile Network Operators ("MNOs"). Ofcom has failed to provide any evidence to substantiate this.
4. In contrast, the potential for such repeaters to cause consumer harm is clear and likely to be substantial. All repeaters have the potential to cause interference when placed incorrectly in the network and when not properly designed with the appropriate specification. As a result, even if Ofcom's specified requirements for repeaters were equivalent to those of a MNO repeater, under its proposals, MNOs and Ofcom have no way of verifying that a repeater meets these requirements before they are distributed, nor can they monitor their location, which is critical to managing harmful interference, or shut them down where they cause interference. Furthermore, without any monitoring or quality assurance measures in place Ofcom's proposals provide significant scope for illegal repeaters to hide behind apparently legitimate devices, and lead to a proliferation of poor quality illegal repeaters.
5. The upshot of this is that Ofcom's proposals are likely to lead to an increase in repeater related network interference which results in a degradation or even loss of mobile services. Given the increasing value consumers place on mobile services, particularly mobile broadband services, the consumer harm resulting from this could be significant.
6. Ofcom's proposed technical requirements lack sufficient clarity in parts and fall short of the standards required to mitigate interference in others.
7. A move to licence exemption would clearly not promote any of Ofcom's statutory duties given the risks outlined above. If Ofcom nonetheless decides to take its proposals forward then, to reduce the harmful and costly effects of illegal repeaters, Ofcom must as a minimum include the following features to its proposal:
 - Amend the technical requirements to reflect the standards employed by MNOs that manage the network including specifying the antenna characteristics and the maximum noise of the repeater.
 - An active register of the repeaters in operation and their location must be maintained, through a form of light licensing, in order to allow them to be identified in the event of any interference problems.
 - Mandatory labelling on repeaters specifying the contact details of the manufacturer and that they are not affiliated with MNOs.
 - Given that there is already a proliferation of illegal repeaters, enabling their introduction through a VNS would not provide sufficient clarity on the status of devices. If repeaters are to be permitted, then this should be done through conformance to an appropriate European Harmonised Standard for consumer repeaters.

1. Introduction

- 1.1. BT and EE responded to the previous Ofcom Call for Inputs on “Mobile Coverage Enhancers” (issued 7 May 2014), and we recall that there was a robust and harmonised view from the mobile industry that the risk of interference from authorised mobile repeaters far outweighed any possible benefits. It was our understanding that Ofcom had accepted this view and would continue to treat such devices as operating illegally (infringing the WT Act). Consequently we are very surprised to see that Ofcom is now making these proposals to permit such devices, albeit subject to certain limitations.
- 1.2. Our view is unchanged, and we continue to believe that unauthorised mobile repeaters should not be permitted, even subject to the constraints proposed by Ofcom, and we elaborate on those reasons in the following sections.
- 1.3. In general, unless noted otherwise, the comments in our response apply to the “static mobile phone repeaters for indoor use”, although some of our comments could be applied equally to the “in-car mobile repeaters”.

2. Ofcom do not take proper account of the evidence already provided by mobile operators

- 2.1. In our response to Ofcom’s May 2014 call for inputs (“CFI”) we explained why the harmful effects of illegal repeater deployment (e.g. undue interference) cannot be mitigated by setting certain requirements for repeaters, in order for them to be licence exempt, and why Ofcom had failed to establish that the benefits of licence exemption outweighed the costs and thus the need for intervention. In summary:
 - All repeaters have the potential to cause interference when placed incorrectly in the network and when not properly designed with the appropriate specification. In real terms this degradation will have the effect of either causing customers, near the edge of coverage on a cell, to drop their call involuntarily, or poor call quality resulting in broken speech. The worse the degradation, the larger the area affected. We provided detailed case studies showing the real impact of illegal repeaters on the performance of a cell.
 - EE already deploys repeaters itself in the network at a small scale, alongside other bespoke coverage solutions. We have a rigorous new product introduction process which ensures any product offered by a vendor for use on our network is fit for purpose. The repeaters are only deployed if we are satisfied that the risk of interference is minimal and there are no planned network changes that will have an impact in the near future.
 - In contrast illegal repeaters are deployed without the knowledge of MNOs or Ofcom and without meeting network specific safeguards and guidelines. As Ofcom is fully aware from its existing enforcement work on illegal repeaters, in order to be offered cheaply in the consumer market, illegal repeaters are often poorly manufactured. As a result there would be no technical criteria that would apply to illegal repeaters, whereby EE and Ofcom could be confident that the illegal repeaters could be deployed without causing undue interference and/or the likelihood of an adverse impact on the technical quality of EE’s services. Based on planning levels and typical repeater gains, there is a large proportion of EE’s network where repeater installation may cause significant interference for EE customers.
 - Further, illegal repeaters cannot be easily monitored, accessed or controlled remotely. This means that even if we are able to detect that interference is being caused by an illegal repeater, locating the

repeater and then being able to switch it off is both resource intensive and likely to lead to prolonged harmful interference.

- Notwithstanding this, there is unlikely to be any incremental benefit from making illegal end-user installed repeaters legal under a licence exemption, given the legal indoor coverage solutions already available to consumers in the market.
- EE fails to see how a move to licence exemption would promote any of the statutory duties to which Ofcom is required to have regard when exercising its functions under the WTA – certainly not to any extent sufficient to counteract the material risks of harm to the MNOs and their customers that this move would create.

2.2. Following on from this we participated in a joint working group with Ofcom and the other MNOs, in which we clearly explained our concerns about interference.

2.3. We note that the points we made in our response to the CFI and in the technical working group remain valid and are supported by evidence that we provided to Ofcom. It is incumbent on Ofcom to set out the reasoning behind its proposals, which should demonstrate that it has taken into account stakeholders' views.

2.4. Whilst we welcomed Ofcom's engagement, and recognise that a small number of our proposals have been accepted by Ofcom (e.g. that repeaters would be restricted to operating over a single operator), Ofcom has failed to properly consider the body of evidence we have provided to it on the harmful effects of illegal repeaters and the, albeit limited, ways in which these might be mitigated to some degree.

2.5. One of Ofcom's key consultation principles is to explain what it is intending to do, and why, showing how respondents' views helped to shape its proposals. Despite this, in the Consultation, Ofcom makes no reference to the advice and evidence put forward by EE and other stakeholders in response to the CFI or how they helped shape its proposal to legalise repeaters.

3. Ofcom's proposals fail to address its policy objective

3.1. Ofcom claims that its proposals will improve coverage within a consumer's home or vehicle without causing harm to the mobile operators' networks. The consultation notes that the PA Report identifies four scenarios (§ 3.11) where a weaker signal can be experienced by the consumer, although for some of these cases, such as shadowing due to other buildings, or terrain obstruction in hilly areas, it is unclear how a simple indoor repeater could improve signal reception. In such cases the reception of the wanted signal from a base station would require the repeater to use an antenna mounted outdoors, potentially at some distance from the home, although we believe that this does not align with the proposals presented here by Ofcom.

3.2. It is unclear how legalising self-install repeaters will improve coverage over and above existing in-building coverage solutions provided by MNOs, whilst at the same time not causing harmful interference. As noted above, EE already deploys repeaters in its network and these are rigorously tested and only deployed where we are satisfied the risk of interference is minimal. A consumer installed repeater would need to meet similar standards to even be considered safe from causing interference. Notwithstanding the fact that the technical requirements Ofcom are proposing are likely to fall short of these standards, it is unclear how the repeaters Ofcom proposes to legalise, which like MNO repeaters could only operate over a single licenced operator at a given time, could bring any incremental improvement to the solutions already offered by EE and other MNOs. Ofcom has failed to provide any quantitative or qualitative evidence to

substantiate this. This is a glaring omission, particularly given the significant risk of harmful interference and costs to MNOs that are likely to result from its proposals.

- 3.3. A defining characteristic of both femto cells and legal smart repeaters that we deploy is that we are able to switch them off remotely if they are found to cause harmful interference to our network. Customers agree to this condition when purchasing one of these devices. In contrast illegal repeaters cannot be easily monitored, accessed or controlled remotely. This means that even if we are able to detect that interference is being caused by an illegal repeater, locating the repeater and then being able to switch it off is both resource intensive and likely to lead to prolonged harmful interference.
- 3.4. Against this background, it would be inappropriate and an error of judgement if Ofcom were to make illegal repeaters licence exempt. Notwithstanding the significant potential for repeaters to cause interference, there is unlikely to be any incremental benefit from making illegal end-user installed repeaters legal under a licence exemption, given the legal indoor coverage solutions already available to consumers in the market.

4. Unintended consequences of legalising mobile repeaters

Ofcom's proposals risk proliferation of illegal repeaters

- 4.1. EE has serious concerns that any proposal to legalise mobile repeaters, without any control over certification, would provide significant scope for illegal repeaters to hide behind apparently legitimate operations and lead to a proliferation of illegal repeaters. At present the use of any consumer installed mobile repeaters is illegal, which is a clear and unambiguous situation. If these proposals are implemented, then some repeaters would be permitted, whilst others would not. It is not clear how consumers are expected to clearly recognise which devices are permitted, and which are not. The result of this uncertainty would likely be an increase in use of illegal repeaters that cause harmful interference on the network which adversely affects the quality of mobile services for consumers.
- 4.2. Ofcom has also not considered the significant difficulties and costs associated with a qualified exemption regime, in particular relating to policing the use of repeaters (including monitoring and enforcement). Since Ofcom has failed to quantify any countervailing benefit whatsoever to these risks and costs, a qualified exemption regime would therefore clearly not be proportionate, and the correct approach is a complete ban.

Harmful interference caused by illegal repeaters leads to consumer harm

- 4.3. The use of illegal mobile repeaters inherently causes degradation in the sensitivity of the base station from which they are retransmitting. This is generically referred to as 'interference'. Based on planning levels and typical repeater gains, there is a large proportion of EE's network where repeater installation may cause significant interference for EE customers.
- 4.4. In real terms this degradation will have the effect of either causing customers, near the edge of coverage on a cell, to drop their call involuntarily, or poor call quality resulting in broken speech. The worse the degradation, the larger the area affected.¹ These are risks that EE needs to manage even for a good quality repeater with a bandwidth limited to specific carriers.

¹ For examples of the impact of illegal repeaters on the performance of a cell please see Annexes 1,2 and 3 to our response to Ofcom's May 2014 CFI on mobile repeaters, see annexes 1, 2, and 3 of our response.

4.5. Any loss of service or degradation in service is likely to lead to significant consumer harm, in terms of time and financial loss. Dropped calls could potentially result in the customer having to call back, which would mean the customer paying in terms of usage from their bundle, in the case of PAYM customers, or call credit in the case of PAYG customers. A complete loss of service would leave customers without valuable mobile voice, messaging and data services and could leave some customers stranded or vulnerable where there is no available substitute, whilst a degraded service would require the network to compensate by re-allocating resources to the potential detriment of all users in the cell.

Diverting resources away from important customer services and network improvements

4.6. With the proliferation of illegal repeaters we would expect an increased number of calls coming into our contact centre relating to a loss of service or degradation in service caused by illegal repeaters. We also anticipate that some consumers that use illegal repeaters are likely to contact their network provider when they experience problems with their illegal repeater, even though they are not the responsibility of the provider. Together these two factors are likely to drive a significant increase in call volumes entirely related to illegal repeaters, which diverts important resources away from day to day customer services.

4.7. As part of the investigations to identify suspected illegal repeaters, and thereby protect affected customers, we are also required to employ dedicated interference engineers. This again diverts important resources, this time away from network improvement works and deployment.

Increased costs of enforcement

4.8. Making illegal end-user installed repeaters licence exempt is likely to result in making enforcement action nearly impossible, with Ofcom having to prove whether an allegedly exempt device actually met the requirements set out by Ofcom for each and every specific case. Given that Ofcom and MNOs already face difficulty in identifying illegal repeaters and then enforcing existing conformity requirements (CE marking) of these devices, introducing a qualification regime adds an additional layer of complexity and is therefore likely to make monitoring and enforcement more burdensome and difficult.

4.9. We firmly believe that a licence exemption would open the floodgates to vast amounts of (likely sub-standard) equipment being deployed by users in an uncoordinated way. This would seriously compromise Ofcom's ability to enforce effectively, which could in turn lead to consumer harm through reduced mobile services availability and quality.

Distorting competition and incentives to invest

4.10. As the operator with the most customers, any interference caused by a repeater is likely to impact a disproportionately large number of EE customers compared to other networks. This has the potential to cause disproportionately large reputational damage to EE, which could distort competition.

4.11. In areas where illegal repeaters are frequently deployed incentives to improve coverage may be reduced at the margin by the increased risk of interference and the subsequent costs of enforcement and compensating customers for loss or degradation of service. This is particularly problematic given that illegal repeaters are likely to be used in areas where there is already limited or no indoor coverage, and where network investment is most needed.

5. The need for an impact assessment

- 5.1. Given the potential for repeaters to cause consumer harm and the lack of any obvious countervailing incremental benefits from legalising repeaters Ofcom must conduct an impact assessment before making a regulatory intervention.
- 5.2. This would involve estimating the likely incremental benefits to users of repeaters, should they be legalised under the proposed conditions, over and above the benefits of operator authorised repeaters. Ofcom should then consider the countervailing consumer harm to other users resulting from use of the repeaters, including harm from loss or degradation of voice and data services. Ofcom and other bodies have previously estimated the consumer cost from a loss of voice and data services in other contexts and used this to inform policy decisions. These estimates have typically indicated that consumer harm from loss of service is not immaterial.
- 5.3. We see no reason why Ofcom would not use estimates available to it to inform its decision here. Any decision to take forward the current proposals without consideration of the costs and benefits would indicate that Ofcom's decision is pre-determined without consideration of the evidence available to it.

6. Problems with Ofcom's current technical specification

- 6.1. Notwithstanding the lack of evidence-based justification for making repeaters legal, EE also believes there are aspects of Ofcom's technical requirements which lack transparency and/or are fundamentally flawed.

Flaws in the specification

Frequency band

- 6.2. Ofcom's proposed technical requirements for indoor repeaters limit their operation to a single operator and any frequency bands which they operate, but allows for future reconfiguration onto a different network. Whilst we agree that any licensed repeater should only operate on a single network, we have serious concerns around the use of repeaters on all frequency bands. This could result in a single device potentially transmitting in all mobile spectrum frequencies. However even limiting the repeater to a single operator's frequency bands does not take account of the varied and dynamic nature in which the bands are used. There is a range of technologies (2G/GSM, 3G/CDMA and 4G/LTE), with voice traffic over circuit switched or VoLTE bearers. The use of these technologies across the bands will change with time, and channels may be moved slightly accordingly. Will the repeaters be amplifying all of the signals within the operator's sub-bands without knowledge of the occupancy?
- 6.3. These problems are compounded by the specific characteristics and coexistence arrangements around each of the bands. For example as Ofcom is aware for the 2.6 GHz band there are requirements on licensees to mitigate against radar interference. Whilst the marginal increase in interference from a single repeater is unlikely to be significant, we are determining the cumulative interference into the radar from all Base Stations; Ofcom have assumed that there could be 50 consumer repeaters for each Base Station and hence the aggregate effect of these repeaters could significantly add to the total interference. However under Ofcom's current proposals repeaters would be able to operate in this frequency without operators' knowledge, and therefore operators have no way of mitigating interference where the repeaters are installed.
- 6.4. A similar problem is likely to arise in the 800 MHz band where there are requirements to minimise interference with TV. The potential interference from Base Stations is carefully calculated by "at800" for each residential property, and advise homeowners accordingly. A repeater installed could inadvertently

interfere with DTT reception, either for the homeowner using the repeater or their neighbour, leaving them unaware of how or why they are now suffering interference, and without any support from “at800”.

- 6.5. We are also concerned how reconfiguration of repeaters would be managed. If for example an MNO changes frequency allocations or carriers, this will not be communicated to third party suppliers (due to its commercially sensitive nature) and it is therefore unclear how supplier of repeaters could manage reconfiguration of repeaters to different bands or networks.
- 6.6. Mobile networks are constantly evolving, and new base stations are being built to extend coverage, particularly in areas of poor coverage which is where repeaters are most likely to be sited. The consultation has not taken consideration of the implications of such repeaters continuing to operate, possibly to a distant base station, even though there is now coverage from a new local base station, or a nearby femtocell.

Transmit Gain Control

- 6.7. Ofcom’s proposal to set the maximum gain of an indoor repeater to “BSCL - 30 dB” is based on an arbitrary assumption that a maximum of 50 users could simultaneously communicate with a single base station at any point in time via use of repeater. Ofcom provides no evidence to support the use of this assumption, and has not provided any sensitivity analysis to determine how sensitive the noise under a maximum gain of “BSCL - 30dB” is to changes in the number of simultaneous users. Furthermore, the definition of BSCL is not clear since the consultation document only stated “Where BSCL (base station coupling loss) is the path loss between the base station and the repeater, the apparatus shall determine this value by calculating the difference between the carrier power received at the repeater and the carrier power transmitted from the base station.” Does the BSCL include the antenna gains at each end of the link? A diagram showing each reference point is required.
- 6.8. We note that the maximum gain of 100dB is set unnecessarily high, and significantly higher than any repeater EE currently permits even when installed by a qualified engineer. Ofcom justification for this is very weak, merely stating that a gain at that level is unlikely in practice. Ofcom should set the maximum gain on the basis of evidence on the levels at which interference can be mitigated rather than at some arbitrary level that it considers is unlikely to ever be reached, rendering the requirement ineffective. In the interests of protecting consumers from interference we recommend that a maximum gain of not more than 70-80 dB be permitted. This accords with EE’s standards which have been carefully considered and thoroughly tested.
- 6.9. Further, with the arbitrary assumption of 50 repeaters, we note that for LTE Ofcom’s proposed maximum gain of BSCL-30dB still has significant potential to result in over-driving the gain for the typical noise figure of repeaters (which has not been defined in Ofcom’s specification). The current proposal assumes the uplink gain is equal to the downlink gain. However, from EE’s experience of deploying repeaters, the uplink gain is usually set to the level lower than the downlink gain in order to protect the noise floor of the donor macro base station.
- 6.10. In relation to Ofcom’s proposed maximum gain for in car repeaters we would expect that the gain from these devices to be controlled by a feedback loop which determines actual attenuation of the vehicle and only compensates for this. As a result we would expect that these maximums would rarely if ever be reached.

Oscillations

- 6.11. Ofcom has included a requirement that indoor repeaters should be able to detect and mitigate oscillation. However degradation of BTS will occur before reaching a state of oscillation. Ofcom’s proposal

therefore falls short of protecting consumers from the harmful effects of interference. In order to address this there must be a requirement that a repeater has gain control functionality that is sufficient to prevent a state of oscillation from ever occurring.

Automatic Standby

6.12. Ofcom proposes a requirement that the automatic standby reduces any uplink noise power to <-70dBm/MHz after 5 minutes without any active device connection, however <-70dBm/MHz is considered too high, and we propose that it should be set at <-80dBm/MHz or lower.

Lack of transparency

Transmit Power

6.13. In relation to Ofcom's proposed limitations on transmit power, Ofcom have not specified which class of handset will be considered when setting the maximum transmit power for uplink. Ofcom also needs to clarify whether when referring to the term 'power' Ofcom means radiated power or power at the output of the repeater.

Antenna

6.14. Ofcom have not made any comment on the permitted gain of the antenna for the (outdoor) part of the repeater. The implication of the consultation is that directional antennas may be needed in some cases, although there is nothing to indicate whether or how these will be limited. This should be clarified.

Transmit Gain Control

6.15. In the consultation Ofcom simply states that the uplink and downlink gain in dB of a single operator repeater, referenced to its input and output ports shall not exceed 100dB, however it is unclear exactly which reference points is referring to. As noted above, overall system gain may be larger than at the repeater itself, with BTS antenna gains varying significantly.

6.16. EE and other stakeholders would need clarification on these points before they could comment properly on the appropriateness of the specification.

7. Minimum requirements for a consumer installed repeater

7.1. We strongly oppose Ofcom's proposal to legalise consumer installed repeaters. If Ofcom nonetheless decides to take this forward, to reduce the harmful and costly effects of illegal repeaters Ofcom must as a minimum include the following features to its proposals. This is in addition to the amendments we have proposed to Ofcom's repeater specification.

- *Repeaters must only be able to operate on a single network and limited to two bands* – We agree with Ofcom's proposal to include requirements that the repeaters operate only over the frequency bands of any single licensed network operator at a given time. We propose that such repeaters should also be limited to a maximum of two bands, in order to minimise the RF power radiated, taking note of the requirement to meet the ICNIRP limit, and also to minimise the risk of further interference in other bands due to intermodulation problems; indeed intermodulation performance testing may need to be included in the specification for such repeaters. Constraining the operation to a maximum of two bands, could also reduce the frequency at which the device would need to be reconfigured to take account of network changes

- *Consumers must be clear whether any repeaters are compliant with the new regulations* – Ofcom’s current proposals only require repeaters to be self-certified to a VNS. Recognising that illegal devices have been allowed to proliferate, and hence clarity of products is required, we believe that a VNS is not appropriate for such a licence exemption vehicle for consumer use. We believe that if such devices are to be permitted, then it should be done on a more robust basis, so that consumers are clear which products being offered would be permitted and which would be illegal. If Ofcom are minded to permit such mobile phone repeaters, then it should be considered on a pan-European basis, with development of an ETSI Harmonised Standard (rather than a VNS) for such consumer repeaters to complement those identified in § 3.3 of the consultation, and with studies in CEPT if necessary.
- *Repeaters should be required to register, so that they are operating on a lightly licensed basis* – In order to maintain records of where the repeaters are, and the equipment type used, we believe that all repeaters that have not been installed the operator should be required to register on an Ofcom database (in a manner similar to the 5.8 GHz FWA links). This would facilitate the identification of devices, in the event that a problem is experienced in a given location, as well as allowing the user to be contacted in the event that they are required to change the device settings in same. This would effectively mean that the equipment is lightly licensed rather than licence exempt.
- *Mandatory labelling on repeaters* – If repeaters are to be made legal then manufacturers must be required to specify that repeaters being retailed are not affiliated with an MNO and should state the customer support number of the relevant manufacturer or installer. Without this requirement, customers purchasing these repeaters are likely to contact MNOs in the event that their repeater doesn’t work, and this will divert important resources away from providing good customer service.
- *Antenna types should be specified* – We would expect that omni antennas that pick up every surrounding cell if mounted externally should be excluded. These antennas are highly inefficient and lead to additional network signalling and higher resource use due to worse radio conditions.
- *The maximum noise figure of the repeater should be specified* – We propose that this should be no higher than 6dB, which would still be at the high end of the devices currently approved.
- *In car repeaters need to be harmonised on a pan European basis* – Since Ofcom are proposing in car repeaters, which have the ability to move outside the UK, it is not clear how these would operate in other countries. There is a risk that they might try to amplify the same bands / channels as if they were in the UK. Consequently we believe that these should also be required to comply with an appropriate ETSI Harmonised Standard for in-car repeaters, which would include appropriate mechanisms to address roaming.