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Communications Regulation

DotEcon Report

Review of the Satellite Earth Station Licensing Regime

Consultant Report

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SES licensing review

Assessment of responses to second consultation

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Executive Summary

This report considers responses to ComReg's second consultation on the satellite earth station (SES) licensing review (ComReg Document 22/56) on matters within the scope of DotEcon's previous report to ComReg (ComReg Document 22/56a).

ComReg received five responses, commenting on:

- licence types;
- licence duration;
- bands available;
- information policy (publishing of licence data);
- the licensing process and coordination between operators;
- licence fees; and
- technical conditions.

Licence types

In our previous report, we recommended that:

- ComReg adjusts the definition of Fixed Earth Station (FES) licences to allow operators to use multiple antennas within a circle of 500m radius under a single licence;
- Transportable Earth Station (TES) licences continue to be available; and
- Teleport facility licences be removed from the SES licensing framework.

There was general support from stakeholders on the proposed changes and these recommendations still stand.

Eutelsat highlighted that some receive-only SES might require interference protection and, therefore, need a licence. We broadly agree and suggest that ComReg make protected receive-only licences available. However, to avoid the risk of potential abuse, we recommend that receive-only FES licences are available, at ComReg's discretion, to operators who can provide adequate evidence of their need for interference protection.

SpaceX has suggested that ComReg make available one-year commercial licences in new and innovative spectrum, similar to the ComReg's current Test & Trial (T&T) regime but allowing for commercial operations. We would have concerns about ComReg allowing for commercial use of spectrum in bands not yet assigned for the use case by the ECC without very good reason. There is risk that use of the spectrum would does not match the usage and technical conditions ultimately required by subsequent harmonisation decisions, leading to complexity and disruption in making changes if spectrum is already deployed for commercial services. It would also be inappropriate if such temporary licences

could be used by operators to gain an unfair toehold on the spectrum.

Licence duration

Our previous recommendation was for SES licences to have a 12-month term, with the expectation of being able to renew licences annually. Amazon Kuiper and SpaceX both considered that longer licences would be preferrable. SpaceX argued that aligning licences with the typical technology life cycle would give operators more certainty and reduce the administrative burden on ComReg.

Longer licences give certainty over access to spectrum, but operators may still face risks due to changes being required due to unexpected spectrum management issues arising within a dynamic sector (for example due to changes in harmonization measures and technical standards). In any case, none of the proposals for longer licences align with economic life of significant ground station assets (e.g. antennas, civil engineering). Annual licences are not problematic in a regime where operators have strong expectations of being able to renew existing licences due to there being little spectrum scarcity.

Therefore, we maintain our recommendation that a 12-month term is appropriate for SES licences, with the option to renew and reasonable expectations that access to the spectrum would not be revoked without very good reason and with sufficient notice. We disagree with Amazon Kuiper that licences should be indefinite and automatically renewed as that could unduly restrict ComReg in its ability to carry out its spectrum management duties if circumstances were to change.

AWS has suggested that SES licences lasting for less than one year might be appropriate for short-term use cases, as with the current framework. We agree that these might be useful in a small number of cases. Our recommendation is that ComReg could make short-term (temporary) licences available without the need for a notification period (required with full annual licences) to support fast access. However, to mitigate the risk of operators misusing these licences, these should be assigned without automatic renewal rights. ComReg should reserve the right to refuse a short-term application, require an applicant to provide evidence that it will not cause interference to others, or require the applicant to engage with other stakeholders if there are any concerns over potential interference issues.

Bands available

The respondents to the consultation all supported (or did not object to) the proposals to open the following frequencies for SES:

- the frequency ranges 401 – 402 MHz, 402 – 403 MHz, 2025 – 2110 MHz and 2200 – 2290 MHz (in accordance with the ITU allocation)
- the full 27.5 - 30 GHz range in the Ka-band; and

- the frequency ranges 37.5 – 40.5 GHz, 47.2 – 50.2 GHz and 50.4 – 52.4 in the Q/V bands (in accordance with ERC Decision (00)02 and ECC Decision (21)01)

Our recommendations in relation to these bands stand.

Amazon Kuiper requested clarification on whether the 17.2 – 20.2 GHz frequency range would also be opened up. This spectrum is already available for SES, with 19.7 – 20.2 GHz listed in the guidelines for SES licences, and the other 2 GHz available for licence-exempt operation.

OneWeb and Eutelsat have between them suggested the 40.5 – 43.5 GHz range in the Q/V bands could also be made available for SES. Since publication of the consultation documents, the ECC has published ECC Decision (22)06 and related ECC Recommendations (22)01 and 22(02), which set out harmonised technical conditions for introducing MFCN in the band along with guidelines for ensuring coexistence with SES in the 39.5 – 43.5 GHz band. Whilst the 40.5 – 43.5 GHz range has not yet been formally designated for SES at CEPT level, given the developments in the band and the fact that it is allocated for SES by the ITU, ComReg may consider opening these frequencies now if considered appropriate.

SpaceX has asked ComReg to make available commercial SES licences in the E-band immediately rather than waiting for international harmonisation measures. It argues that doing so is necessary to meet growing demand, that harmonisation measures could be implemented at a later date, and that there would be no resulting risk of creating a first mover advantage or spectrum scarcity. Whilst the E-band is likely to be used by SES in the future, we do not see any strong argument for why ComReg needs to deviate from its general approach of aligning its spectrum management with the relevant international recommendations/decisions, in particular as technical studies in relation to the band are already underway and significant amounts of additional spectrum will likely be opened by ComReg for SES in other bands to support short-term growth in demand.

Information policy

Our previous report highlighted the need for relevant parties to have access to information about existing SES deployments if operator coordination is to form an important part of the SES licensing process. We recognised the potential for security concerns resulting from certain information being publicly available and suggested that in those cases the information could be made available only to a limited group of authorised parties.

Most operators supported the proposals to publish data on SES and fixed links sites. However, AWS believes some of the information ComReg has proposed to publish is confidential and could facilitate harm to SES infrastructure from non-industry actors. AWS suggests that operators should be allowed to opt-out of sharing information, but could be required to provide further information on a case-by-

case basis, and that information is shared only with industry operators.

We continue to recommend that ComReg provides information on other satellite operations as well as terrestrial services – it is difficult to see how a system relying on operator coordination could operate otherwise. However, in some exceptional cases it might be relevant to restrict access to this information. Allowing operators to opt-out of providing information at will would undermine the intention to use a light-touch licensing regime. A balanced approach might be as follows:

- licence data is in the public domain by default;
- such data would be *partially* redacted if the licensee can demonstrate sufficient need to ComReg (although the existence of a licence would still need to be published);
- the redacted information would be available to relevant parties on request to ComReg and subject to non-disclosure obligations.

We understand that ComReg will conduct a separate consultation process on the publication of licence data in due course.

Sharing and compatibility of NGSO

In our previous report we set out proposals for a FES licensing process that supports coordination of SES licences through good faith negotiations between operators, but also provides a framework for ComReg if such coordination breaks down or is ineffective. This involves a formalisation of the existing first-come first-served approach by giving prioritisation of interference protection to operators based on when their licences were first issued, and a notification process (triggered by a new application) during which concerns over potential interference from the new licence could be raised and resolved. During this notification process, the burden of proof for whether a new licence would create harmful interference for others would depend on whether or not the new licensee was to be within some critical distance (20km) of an existing SES site, to minimise the risk of incumbents abusing the system to preclude access to others.

Amazon Kuiper supports the proposed licensing process. However, OneWeb asks ComReg to be mindful not to contradict the ITU coordination procedures (which deals with coordination of satellite systems as the space level) which it believes is the best and most logical approach to operator coordination. SpaceX believes operator-to-operator coordination is best for efficient sharing of spectrum and removes the need for regulatory intervention, with the proposed notification process potentially duplicating and undermining private coordination efforts.

We do not agree that the proposed approach either conflicts with the ITU coordination procedure or undermines private negotiations between operators. If private negotiations are successful and there are no legitimate objections to a new SES licence in Ireland, then

there should be a very limited role for either ComReg or the notification process to play in the granting of that licence. There would be no technical conditions for coexistence between SES imposed by ComReg by default that would undermine any private agreement.

Whilst the intention is for ComReg to apply a light touch approach to coordination, there needs to be some backstop for dealing with situations where, for example, negotiations have broken down, disputes have arisen that are not covered by the ITU rules or any resulting coordination agreement (noting that ITU leaves earth station licensing as a matter for NRAs to manage), or unexpected interference has occurred. The recommended licensing process provides a framework that sets out the balance of rights and obligations between incumbents and entrants, as well as ComReg's general approach to resolving any disputes, all of which should, in fact, help to make private negotiations more likely to succeed.

SpaceX expresses concern that an incumbent that has not adopted basic spectrum sharing technologies could then claim a large 'keep-out zone' and prevent others from deploying. It suggests that ComReg should instead incentivise operators to adopt spectrum sharing policies that support coexistence within reasonable proximity to other operators and prevent operators from being able to leverage inefficiency to curb competition.

We disagree with SpaceX that under our proposed approach there is a significant risk of incumbents unduly precluding access to others. There is some potential for operators to try to block or delay access to spectrum for others, although this is the case under any licensing regime that gives existing licensees protection from interference from newer users. However, the proposed licensing process is designed to limit the incentives and power of incumbents to unduly preclude access to others. An existing licensee would need to provide sufficient evidence of interference issues from a new SES beyond a certain distance (20km) of their site for ComReg to consider blocking the application, while ComReg would reserve the right to address any disputes on a case-by-case basis, for example considering any perceived abuse of the system or lack of coordination efforts on the part of the incumbent.

We also disagree that setting up a licensing framework that incentivises adoption of spectrum sharing technologies is necessary. We anticipate that operators will naturally increase their use of spectrum-sharing technologies in the future, as spectrum and SES sites become more heavily used, but it would not be appropriate to compel incumbents to replace existing equipment early.

We continue to recommend that the proposed licensing process is appropriate and that it would not undermine or conflict with the existing ITU coordination procedures.

Fees

The previous recommendation regarding fees was to set SES licence prices such that the total fees covered ComReg's administrative costs. However, to avoid pricing off low value users, we suggested setting fees that are linear in bandwidth licensed, so that high bandwidth users would pay a larger share of the administrative costs than low bandwidth users. Specifically, we suggested an SES licence fee should be calculated as:

- €100 (the small incremental cost of each licence); plus
- €30 per MHz of spectrum licensed.

In response to the fees proposals, ComReg received two broad types of comment:

- some stakeholders requested clarification on what would be subject to fees, in particular given the proposed new licence structure where an FES licence allows for use of multiple antennas at a single site; and
- some stakeholders raised concerns that the new fee structure would lead to prohibitively high prices for very large bandwidth users.

In terms of how fees would be determined and what fees cover, our recommendation is as follows:

- Fees would be based on bandwidth, where the frequencies used for the fee calculation are those subject to interference protection under a SES licences (e.g. bandwidth used on a licence-exempt basis would not affect the fees);
- FES fees would effectively be for SES sites, where the fee for a site would be based on the total bandwidth (across all bands and licences) licensed for use at that site;
- If frequencies are added to a site part way through the term of the existing licence(s) for that site, the operator would initially pay for the additional spectrum on a pro rata basis for the remainder of the existing licence term.

Some operators (Eutelsat, OneWeb and SpaceX) have expressed concern that the level of fees could be excessive for some users, especially once the Q/V bands (and subsequently the E-band) are available and large bandwidths are used.

We acknowledge this point and recognise that it was not necessarily fully accounted for in the previous proposals. There are benefits to attracting high bandwidth SES operators to Ireland and need to be cautious over unnecessarily pricing off those users. Moreover, setting fees to be linear in bandwidth as proposed could lead to substantial over- or under-recovery of administrative costs if there are large changes in bandwidth used (which we might expect based on feedback from stakeholders).

Whilst ComReg may adjust the fees over time to account for changes in bandwidth used, some short-term over- or under- recovery is inevitable when fee parameters are based on demand and set to

achieve a specific total amount. It is not feasible to build expectations about demand changes into the fee formula, but adjusting the fee structure to use a model that is concave in bandwidth would help to mitigate the impact of sudden large changes in bandwidth used on total receipts from SES fees. This would also reduce the fees to be paid by large bandwidth users relatively to the previous (linear) proposal.

We therefore propose that fees (for a specific site) are determined by the formula:

$$f(B) = c + \alpha B^{\lambda}$$

Where B is the bandwidth in use at the site, $c = €100$ is the marginal cost to ComReg of issuing a licence, α is set such that total revenue matches ComReg's total administrative costs, and the parameter $\lambda \in [0,1]$ determines the concavity of the fees.

The lower the value of λ the lower the impact of a large change in bandwidth used on total fees and the lower the cost of large bandwidth licences relative to the previously proposed linear approach. However, a smaller λ raises fees for smaller users.

We recommend that setting $\lambda = 0.75$ provides a reasonable balance between these competing objectives. For fees to match administrative costs given current licences, it would then be necessary to then set $\alpha = 150$. The formula for calculating fees for a given site would therefore be:

$$f(B) = 100 + 150 \times B^{3/4}$$

Technical conditions

Several respondents provided comments/questions on the propose technical conditions applicable to SES licences.

Amazon Kuiper has asked for clarification on the polarization aspect of the licence conditions and the parameters associated with downlink operations in the Ka-band.

Our understanding is that there are no explicit restrictions on the polarization SES can use and see no reason why any should be introduced. However, we note that ComReg intends to publish data on antenna polarization as part of its information policy to support coordination between operators.

We are unclear on what clarification is required regarding downlink in the Ka-band, but highlight that parameters for downlink in the 17.7 – 20.2 GHz band are provided in ComReg 20/47 and relevant international harmonisation decisions, while the conditions for licensed downlink operations are set out in ComReg's SES guidelines.

SpaceX supports ComReg applying in international best practice (and incorporating the relevant ECC/ITU recommendations) when setting power limits, but suggests a main EIRP limit of 60 dBW should not be applied to FES. Our understanding is that ComReg

does not currently set explicit power limits for SES operations (other than in close proximity to airports) but instead limits licensees' non-ionising radiation (NIR) emissions. In its consultation document (ComReg 22/56) ComReg highlighted that it takes into account power limits set by the ECC/ITU when processing SES licence applications, and that it intends to make it clear in the guidelines that these limits will apply. We do not believe that this would be misaligned with the request submitted by SpaceX.

SpaceX has also asked that restrictions on SES operations around airports be aligned with ECC Report 272, suggesting the protection of airports in Ireland is overly conservative. At present, the ComReg SES guidelines set out tighter restrictions on SES near airports than proposed in ECC Report 272. However, the guidelines also include provisions for those restrictions to be relaxed (i.e. for SES operation within an airport exclusion zone) with the prior agreement of the airport operator, so there is no reason an SES operator cannot coordinate with the relevant authorities to negotiate access to infrastructure. We do not see a convincing reason why the current approach is too restrictive, in particular as there is no clear evidence of it causing any problems in practice.

1 Introduction

In July 2022 ComReg published its second consultation document of the satellite earth station (SES) licensing review (ComReg Document 22/56), alongside DotEcon's report on our conclusions and recommendations for the SES licensing framework (ComReg Document 22/56a).

This report covers our assessment of the responses to that consultation, and updates or clarifications to our recommendations where necessary.

ComReg received five submissions to the consultation, with stakeholders providing comments on a range of issues related to the licence types available, the spectrum open for SES, the proposed new licensing process and fee schedule, and technical licence conditions. The remainder of this report is structured as follows:

- Section 2 covers our recommendations on licence types;
- Section 3 sets out the comments received and our assessment in relation to licence duration;
- Section 4 discusses the bands that could potentially be opened up for use by SES;
- Section 5 sets out our views on the policy for making licence data available to others;
- Section 6 covers the proposals on the licensing process and coordination between operators; and
- Section 7 discusses the comments received in relation to fees and our suggestion for a modification to the fee structure previously proposed;
- Section 8 covers the other technical conditions on which respondents have commented.

2 Licence types

In our previous report, we recommended that the definition of an FES licence be revised so that any number of antennas could be operated at a given site under a single licence. We suggested that a SES site could be defined as a geographical area with a 500m radius around a given point, but invited comments on whether this is an appropriate size.

With the new FES licence definition, we did not see any benefit in keeping the existing teleport licence type, which has never been used, despite being included as an option in ComReg's SES framework for many years. Therefore, we recommended removing teleport licences from the guidelines to simplify the regime.

TES licences are distinct from FES licences and we expect them to continue to be required for certain use cases (e.g. remote news gathering). Therefore, we recommend that TES licences remain a part of the SES framework without any changes to the definition of these licences.

2.1 Views of respondents

Revised licence definitions

Stakeholders support both the removal of teleport licence and the proposal to allow multiple antennas to be operated under one FES licence. Amazon Kuiper, OneWeb and SpaceX have all explicitly expressed support for both changes, suggesting they will helpfully simplify the licensing framework and application process. Furthermore, in relation to the adjustment to the SES licence definition, SpaceX states that this will increase deployment flexibility, while OneWeb submits that this is more aligned to charging based on the opportunity cost of spectrum use.

Eutelsat also agrees with the proposal to allow multiple antennas to operate under a single FES licence, but also states that it supports the proposal to remove TES licences. Eutelsat has confirmed that this was simply an accidental reference to TES rather than teleport facility licences but, for the avoidance of doubt, neither DotEcon nor ComReg have suggested removing TES licences from the framework.

Clarification on LEO definition

Both Amazon Kuiper and SpaceX request that ComReg amend its definition of a low Earth orbit (LEO), which is too narrow and would not include the orbits of either operator. Kuiper points to the EC definition (as per its Digital Transformation Monitor publication), which defines the altitude for a LEO system as between 160 km and 2,000 km.

Receive-only licences

Eutelsat notes that, in some cases, receive-only SES might require interference protection and, therefore, need to hold an FSS licence.

Even if harmful interference is not expected in the short run, protection is nevertheless important as interference could emerge in the future in some bands unless the SES receives protection. Eutelsat argues that this is particularly relevant because satellite operators need long-term certainty that they will be able to operate their SES.

Commercial T&T licences

SpaceX recommends that, in addition to offering long-term licences, ComReg considers one-year commercial licences in new and innovative spectrum beyond the T&T program. It claims this model has been successfully adopted in other markets to demonstrate the efficiency of new technology.

2.2 Assessment and recommendations

Revised definition of FES and removal of teleport licences

There is general support for allowing multiple antennas at a site and for removing teleport facility licences from ComReg's SES framework, with no respondents objecting to either proposal. We welcome the further comments submitted on why these changes would be beneficial (e.g. by simplifying the guidelines) and both recommendations stand.

ComReg did not receive any comments on the appropriate size of an SES site. We suggested a radius of 500m, which is in line with SES licensing in other countries (e.g. the UK) and should be sufficiently small that multiple antennas do not impose additional costs on ComReg when assessing applications or if it has to inspect a site. We have no reason to change our view that a 500m radius around a central point (implying a circle of 1km diameter) is a reasonable size for defining an earth station site, and this remains our recommendation.

Therefore, an FES licence will grant the holder the right to use specific frequencies within 500m of a specific point (with that circle being referred to as a site). For the avoidance of doubt, antennas can be deployed anywhere within that site. The centre point of the site does not have to be an antenna and does not change if an additional antenna is deployed. We do not expect this to create interference problems because the details of the antennas are recorded (and shared with other operators) and the site is small relative to likely separation distances between SES.

Definition of LEO orbits

We agree with Amazon Kuiper and SpaceX that the definition of LEO given by ComReg excludes some systems, such as theirs, and we note that we had used the definition of an orbital period of 128 minutes or less (meaning altitude of up to ~2,000 km). While these comments provide helpful factual context, they do not affect any of our recommendations or ComReg's proposals.

Protected receive-only operation

Similarly, we understand that Eutelsat does not disagree with the proposals for receive-only licences, but that its comments on the

protected receive-only operation are intended to underline its importance for some operators. As set out in our previous report, we agree with Eutelsat that receive-only licences should be available, as some use cases (such as Earth exploration, meteorological satellite services and space research services) might have legitimate need for protected operations with unidirectional traffic. However, receive-only licences are not essential for operators (as they are for transmit operations) in particular as many receive-only use cases can operate effectively without interference protection and can do so using the available licence exempt spectrum. If receive-only licences were widely available, there might be concerns of potential abuse by operators seeking to prevent access to others at low cost, with receive-only operations also being relatively difficult to verify. Therefore, our recommendation that receive-only FES licences are available at ComReg's discretion, to operators who can provide evidence of their need for interference protection, stands. This should not preclude access to interference protection when required for valid reasons.

Commercial use of Test and Trial

The T&T programme allows for operators to test new technologies in "*innovative new spectrum*", but SpaceX has suggested ComReg should go beyond this to grant one-year commercial licences in bands not available for standard SES licences.

The T&T licensing scheme itself is not linked to any specific technology or use case. It is managed by ComReg under a separate regime to SES licensing and is subject to separate regulations and is, therefore, not part of the SES licensing review. In any case, whether as an amendment to the T&T scheme or implemented through a separate framework (e.g. as part of the SES licensing framework) we would not recommend making new spectrum that is not designated by the ECC for SES available for commercial licences without very good reason.

We recognise that operators are keen to get access to spectrum as early as possible and that there are benefits to avoiding undue delays in rolling out services. However, there are also risks associated with making spectrum available too early, before the relevant technical studies and international harmonisation decisions have been completed.

There is risk of unnecessary administrative complexity and possibly even difficulty in ComReg meeting its spectrum management obligations if the use of spectrum resulting from licences issued does not match the usage / technical conditions ultimately recommended by any harmonisation decisions. This is particularly the case if spectrum is being used commercially (rather than for testing and trials), as revoking access to operators (e.g. to meet obligations under ECC Decisions) would impact on services already deployed. Even though the licences proposed by SpaceX are short and could technically be made unavailable for renewal on expiry, the decision to remove access to the spectrum could, even if the risk is relatively

low, cause potential detrimental impact on consumers if such licences are used as the basis for full commercial services. Further, it would be inappropriate if such licences could be used by operators to achieve an unfair/unhelpful toehold on spectrum by virtue of already serving a significant number of customers.

SpaceX has claimed that this approach has been successful elsewhere but has not provided any examples. Temporary or early spectrum authorisations to SES in other jurisdictions do not appear to be common, and we are not aware of formal experimental or trial licence regimes that allow for commercial use. ComReg has been clear that providing early access to spectrum (through the T&T scheme) is not for commercial operation or a substitute for standard licences, but rather to allow experimentation and to de-risk development of new services. There is no obvious rationale to deviate from that general approach specifically for SES. Therefore, we do not see need for making spectrum available for commercial use before the relevant harmonisation decision or technical measures are in place, in particular where services using those bands are still in development and there is no clearly established use case or ecosystem. Therefore, we recommend that ComReg should not offer early access to "new and innovative spectrum" for commercial use, as suggested by SpaceX.

3 Licence duration

At present, FSES licences typically run for 12 months (with the option to renew on licence expiry), but longer licences (up to 60 months) may be granted on request from the operator.

We recommended that ComReg remove the option for longer licences, so that all SES licences would be annual in future. This simplification was recommended because:

- take up of longer licences has been low, and operators appear to be comfortable with annually renewable licences;
- annual licences support the proposed sharing and compatibility framework, discussed below; and
- provided that operators have reasonable expectations that they will be able to renew their licences, there should still be sufficient long-term certainty to support investment.

3.1 Views of respondents

AWS agrees with the proposal for 12-month licences, whereas Amazon Kuiper and SpaceX would prefer access to licences with longer durations. In particular:

- Amazon Kuiper proposes ten-year renewable licences, to provide regulatory certainty; and
- SpaceX suggests licence duration should be at least five years, which it argues aligns with ComReg's objectives and the life cycle of LEO satellites.

Furthermore, SpaceX argues that aligning licence terms with the typical life cycle of the underlying technology provides important certainty to operators without sacrificing flexibility to address international harmonisations (which also operate in multi-year cycles). It also suggests that multi-year licences would reduce the burden on ComReg and operators by reducing the number of renewals required.

If a ten-year licence is not offered, Amazon Kuiper requests confirmation that the proposed one-year licences would have an indefinite term, subject to payment of fees, and that no additional paperwork would be required for renewal.

Alongside the one-year licence, AWS suggests ComReg should offer shorter licences, with a minimum duration of one month, for short-term use cases (with pro-rated fees), as per the current licensing framework.

3.2 Assessment and recommendations

Licence durations of more than one year

Our previous report recognised the benefits of longer licence durations in providing certainty over access to spectrum. However, provided operators have reasonable expectations of being able to renew their licences each year (as under the current framework and as proposed following this review), having one-year licence terms should not create any significant uncertainty over access to the spectrum over the duration of operators' investment cycles.

None of the arguments offered by stakeholders provide strong evidence for why this is not the case. Therefore, we remain of the view that one-year licence terms, with the option to renew, is a reasonable approach. This should not create any significant issues for either operators or ComReg within the context of a light touch regime for licensing where there is a high expectation of existing licences being readily renewable.

While this is a matter for ComReg to assess, we doubt that multi-year licences are likely to reduce the administrative burden on ComReg (as suggested by SpaceX and Amazon Kuiper). This is because ComReg is well used to managing annually renewable licences, where renewals are far simpler than processing new licence applications. If multi-year licences were used it would still be necessary to reconfirm regularly that information provided on initial licensing was still valid; therefore, there is little reduction in administrative burden for licensees either.

Contrary to Amazon Kuiper's suggestions, ComReg cannot, and should not, guarantee indefinite access to spectrum. Circumstances may change such that current spectrum allocations are no longer appropriate (e.g. European Directives/Decisions require the spectrum to be used for alternative services) or should be allowed to adjust (e.g. if current assignments do not support efficient spectrum use). Granting indefinite access to stakeholders would unduly restrict ComReg in its ability to carry out its spectrum management duties and we do not recommend such an approach.

However, it is reasonable for operators to expect (interference free) access to the spectrum for a sufficient duration to make a return on investments, and this is not precluded by the proposed licensing framework. We would not expect ComReg to remove access to spectrum for SES or block licence renewals without good reason (e.g. violation of licence conditions or bands being repurposed at an international level). Furthermore, we would recommend that, if access to the spectrum did need to be revoked, licensees are given as much warning as possible. In any case, operators are likely to be aware of any developments outside ComReg's control that might lead to spectrum being repurposed prior to ComReg making the necessary changes to the SES framework.

Option to renew if longer licences were available

Absent any need for ComReg to revoke access to spectrum, operators will be able to renew their SES licences each year. Increasing licence duration would not significantly increase certainty over the profitability of ground station investments for two reasons:

- It would not remove the underlying risk for potential future changes to the spectrum licensing regime caused by changes in international coordination agreements. The main mitigation for this risk is providing a notice period before any changes were made;
- The longer five- to ten-year licences suggested by some consultees are much shorter than the asset lives of significant ground station equipment (such as antennas, buildings, access roads, power infrastructure, fibre connectivity and so on). Therefore, even if longer licences were used, investment incentives would still depend on having good expectations of licence renewal.

On the other hand, longer licences may complicate the process for assigning licences now and in the future. The multi-year cycles on which international harmonisation measure are introduced, which SpaceX refers to, are unlikely to align with licence expiry.

If longer licences were to be used (which we consider unjustified), then ComReg should not include an automatic right to renew, as suggested by Amazon Kuiper. The relevant considerations for licensing may be very different in 5-10 years compared with now, in particular in an industry that is changing rapidly and where future developments are uncertain. Allowing incumbents to renew SES licences on expiry may, therefore, not be the most appropriate approach to meeting ComReg's statutory objectives if the new licences would also run for a significant duration. For example, the competitive environment might have changed such that scarcity of spectrum (that we do not see at present) has arisen and that a competitive award process is more suitable for establishing an efficient assignment. We, therefore, do not recommend that ComReg binds itself to any particular method for allocating spectrum far into in the future.

Temporary licences

FES licences with a duration of less than one year (temporary licences) could also continue to be available, as suggested by AWS. However, ComReg should ensure these are compatible with, and do not undermine, the revised licensing process and notification period for full FES licences. In most respects, we expect that temporary licences would be the same as full FES licences. However, to facilitate relatively fast access but also to avoid the risk of operators abusing the system to undermine the notification process associated with full annual licences, we suggest that:

- temporary licences would typically not be required to go through the new notification process, but ComReg would still need to apply its standard checks on potential interference and

may, at its discretion, require the applicant to provide evidence that it would not create harmful interference and/or engage with other operators already using the spectrum applied for;
- temporary licences would not be assigned with automatic renewal rights and would not give the licensee any priority of access to the spectrum or interference protection beyond expiry of the licence; and
- ComReg should reserve the right to review applications for temporary licences on a case-by-case basis and refuse the licence if it has any concerns (e.g. in relation to potential interference).

4 Frequency bands

In our previous report, we recommended that ComReg could consider adding frequencies in several bands to the SES guidelines, in particular:

- some frequency ranges below 3 GHz (specifically 401 – 402 MHz, 402 – 403 MHz, 2025 – 2110 MHz and 2200 – 2290 MHz) could be opened to SES in accordance with the ITU allocation;
- the full 27.5 – 30 GHz range in the Ka-band should be listed in the guidelines for clarity (at present, only 500 MHz is included, but ComReg has issued licences for greater amounts of spectrum in the band); and
- in the Q/V bands ComReg should consider implementing ERC Decision (00)02 and ECC Decision (21)01 regarding use of the frequency ranges 37.5 – 40.5 GHz, 47.2 – 50.2 GHz and 50.4 – 52.4 for FSS.

Other high frequency bands that may eventually be used by SES were considered, but technical standards and corresponding CEPT decisions are not yet in place, and demand from operators for these bands in the immediate future appears limited. Therefore, we recommended that the E-band should not be opened to SES at this point. ComReg should continue monitoring developments in this band, along with other parts of the Q/V bands and frequencies above 100 GHz. These might then be opened in the future, once the relevant CEPT recommendations have been developed.

We did not recommend closing any of the bands currently open to SES.

4.1 Views of respondents

Ka-band

Stakeholders appear to support the proposal to make the full 27.5-30 GHz range of the Ka-band available. Amazon Kuiper, OneWeb, Eutelsat and SpaceX all welcomed the proposal in their responses, noting that the band is particularly important for many satellite operators, who have already invested heavily in the band, and that making it available will support the provision of satellite services. No consultation respondent objected to the proposal.

Amazon Kuiper requested clarification on whether the 17.7-20.2 GHz range of frequencies (the other part of the Ka-band) would be available for SES receive operation.

Sub-3 GHz

AWS supports opening the S-band and UHF band to align with ITU allocation for EESS, specifically:

- Earth-to-space communication in the 2025 – 2110 MHz and 401 – 403 MHz ranges; and

- space-to-Earth communication in 2200 – 2300 MHz.

It argues that opening additional bands, at a minimum on a secondary basis, is critical for innovation and growth in Ireland. Based on current usage patterns, AWS submits that it is possible to allow competing services to exist harmoniously in those bands, as evidenced by the use of these bands under Test & Trial licences.

Eutelsat agrees with AWS, stating that the S-band (2025 – 2100 MHz and 2200 – 2290 MHz) is useful for space operation services (including telemetry and telecommand of satellites) and opening the band could contribute to the development of the satellite industry in Ireland.

Furthermore, Eutelsat welcomes ComReg's statement that the 3.8 – 4.2 GHz band (C-band) will continue to be made available for SES licensing, because this band is fundamental for satellite services given its unique characteristics (rain resilience, ubiquitous coverage). Eutelsat notes that the EC mandate to CEPT on technical conditions for shared use of the band by terrestrial wireless broadband operators asks for protection and possible future evolution and development of incumbent spectrum users in the band (i.e. receiving SES).

Q/V bands

Amazon Kuiper, Eutelsat, and OneWeb support ComReg's proposals to open the 47.2 – 50.2 GHz and 50.4 – 52.4 GHz ranges in the Q/V bands, while no consultation respondents have objected. Eutelsat and OneWeb have also suggested that further spectrum in the Q/V bands could be opened to SES, in particular:

- 37.5 – 42.5 GHz (space-to-Earth), based on the updated ERC Decision (00)02 and ECC Decision (02)04; and
- Eutelsat suggests 42.5 – 43.5 GHz (Earth-to-space) be made available, noting that the ECC recommendations under consultation as of August 2022 (ECC Decision (22)06, and Recommendations (22)01 and (22)02) would keep the possibility of SES operation in 40.5 – 43.5 GHz, even if the band is made available to MFCN.

E-band and frequencies above 100 GHz

SpaceX submits that ComReg should issue commercial SES licences for the E-band immediately, rather than waiting for international harmonisation measures to be put in place, although early access to the bands would be subject to these future harmonisation measures. SpaceX claims that the band is needed to meet growing consumer demand for high-speed, low-latency broadband, and that opening it would not create significant risks because there are:

- no first mover advantages from early access to the band; and
- no risk of spectrum scarcity, given the abundance of spectrum in the band and its physical characteristics.

SpaceX supports the proposed monitoring of bands above 100 GHz that may be opened to SES in the future. It notes that several promising bands are allocated by the ITU to SES on a co-primary

basis, and that of these, bands nearest to 100 GHz will be more useful in the near term. It suggests that ComReg should aim to maximise value to consumers by eventually making some of this spectrum available and that in doing so it should consider the effects of atmosphere attenuation on various use cases.

4.2 Assessment and recommendations

Ka-band

The Ka-band is of particular importance to many SES operators and ComReg has already issued some licences for use of more than 500 MHz (the amount currently listed in the guidelines) in the band. Consultation respondents have again emphasised their reliance on this band and supported the proposal to include the full 27.5 – 30 GHz range in the SES guidelines. No respondent has objected to this proposal. Therefore, our recommendation is to open the full 2.5 GHz in the Ka-band.

The corresponding space-to-Earth range of the Ka-band (17.7 – 20.2 GHz) is already open in Ireland, with the frequencies 19.7 – 20.2 GHz listed in the guidelines for SES licences, and the other 2 GHz available for licence-exempt operation.[1] These contiguous ranges are listed separately because they are covered by separate CEPT recommendations, owing to the fact that the 17.7 – 19.7 GHz range is shared with fixed links. We understand that Amazon Kuiper is interested in using this range for satellite terminals, and that this is indeed possible already on a licence-exempt basis. As discussed in our previous report, we expect that the technical rules derived from the relevant CEPT documents would be sufficient for fixed links (including P-MP operation) and licence-exempt satellite terminals to coexist in the band. ComReg could include the full range in the SES guidelines, but there does not appear to be strong demand for this.

Sub-3 GHz bands

AWS and Eutelsat support the proposal to open spectrum in the UHF and S bands to SES, and no stakeholders have opposed the suggestion. Therefore, we maintain the view that ComReg should consider adding the sub-3 GHz ranges listed above to the SES framework.

Q/V bands

The proposal to open the 47.2 – 50.2 GHz and 50.4 – 52.4 GHz ranges to SES (both for Earth-to-space transmission) in line with ECC Decision (21)01 was widely supported by consultation respondents. We therefore recommend ComReg proceeds with making these frequencies available for SES.

OneWeb and Eutelsat have both suggested that ComReg also opens the whole 37.5 – 42.5 GHz (space-to-Earth) range for SES, while

[1] ComReg 20/47R2

Eutelsat further proposes that 42.5 – 43.5 GHz (Earth-to-space) could be made available.

In March 2022, the ECC published an update to ERC Decision (00)02 that designates the full 37.5 – 40.5 GHz range for coordinated FSS earth stations. We highlighted this in our previous report, setting out our expectation that ComReg would likely implement the Decision in line with its general policy of following European harmonisation measures. We also noted that the ECC was engaged in further work regarding a review of coordinated FSS use in the 40.5 – 42.5 GHz band and recommended ComReg monitors developments in that band.

Since then, the ECC has since published ECC Decision (22)06, which provides harmonised technical conditions for MFCN in the band 40.5 – 43.5 GHz, along with two related recommendations:

- ECC Recommendation (22)01 provides guidelines for supporting the introduction of MFCN in 40.5 - 43.5 GHz whilst ensuring the possibility for coexistence with:
    1. receiving FSS earth stations in 40.5 – 42.5 GHz; and
    2. transmitting FSS earth stations in 42.5 – 43.5 GHz.
- ECC Recommendation (22)02 sets out measures to facilitate compatibility between MFCN operating in 40.5 – 43.5 GHz and receiving FSS earth stations using 39.5 – 40.5 GHz.

As highlighted by OneWeb, ECC Decision (02)04, published in March 2002, also indicates that "*[t]he band 40.5 – 42.5 GHz could also be used by coordinated FSS gateways*", although the Decision itself is related only to use of the frequencies for uncoordinated earth stations.

Our position regarding the 37.5 – 40.5 GHz part of the band remains unchanged, and we anticipate that ComReg will implement ERC Decision (00)02 in accordance with its standard approach.

Regarding the higher frequencies, 40.5 – 43.5 GHz, the recent ECC publications (along with the ITU allocation for the band) strongly suggest that the spectrum is expected to be used by satellite earth stations as well as MFCN, and that (as indicated by Eutelsat) the ECC is developing a framework to support coexistence between the two. To the best of our knowledge, the Decision and Recommendations published to date have primarily been concerned with use of the frequencies for MFCN, and no Decision designating the band for coordinated SES at a European level has yet been approved. Therefore, there should not be any obligation on ComReg to make the frequencies available before the ECC publishes any corresponding harmonisation measures for SES. On the other hand, given the development of the ECC deployment guidelines highlighted above, that the 40.5 – 43.5 GHz band is allocated for FSS earth stations in the ITU Radio Regulations, and that use of the Q/V

bands (including the 40.5 – 43.5 GHz range) is generally seen as the next step for SES, ComReg may consider making the spectrum available sooner with limited risk if it considers appropriate. In this case, ComReg would need to closely monitor developments in relation to the band, and implement any forthcoming ECC harmonisation measures as they arise. Operators should also be aware of the need to implement any future ECC Decisions when planning their deployments.

E-band

It is likely that the E-band will be used by SES in the future, but we proposed that ComReg waits for harmonisation of the band at the European level before adding it to the SES licensing framework. SpaceX is the only stakeholder to suggest that this might be prohibitive, but in our view has not provided any convincing evidence why ComReg should not continue with this approach.

First, SpaceX highlights that there is plenty of spectrum despite years of terrestrial use and it suggests that the current lack of spectrum scarcity (both for terrestrial services in the E-band and SES generally) means that there is little risk in offering early access to the band. However, terrestrial use of the band (i.e. for fixed links) is increasing with demand for higher bandwidth links and development of new technology (e.g. multi-band aggregation technologies); we cannot necessarily assume that conflicting demand or interference cannot arise in the future, despite the physical characteristics of the band.

Second, SpaceX suggests that ComReg could make the spectrum available subject to any future harmonisation decisions. However, implementing harmonisation decisions/recommendations becomes harder (due to the potential disruption to services and consumers, and possible legal implications) if existing spectrum assignments conflict with any harmonisation measures. In such a scenario, operators might have invested significantly into deploying infrastructure using those frequencies, and services are being provided to consumers.

Therefore, whilst not guaranteed, granting access to the 70/80 GHz bands before technical studies and any resulting international harmonisation has been completed could put ComReg in a position where it would find it very difficult to implement subsequent international decisions / recommendations in a timely and efficient manner.

Third, we note that, unlike the UHF and S bands (where there are grounds for potentially making spectrum available to SES without ECC Decisions being in place):

- the band is not yet widely used in other countries (noting, for example, that the FCC has deferred consideration of SpaceX's recent request to access the band); and
- there are ongoing studies into the use of the band (set to be completed in time for WRC-27).

In general, ComReg aligns its spectrum management with relevant international recommendations/decisions and does not depart from that approach without good reason. Given that the band is already being considered by the relevant bodies, with technical studies in progress, and there being no pre-existing usage/ecosystem for the band for SES, it would be prudent not to rush into open the band, particularly as ComReg is already planning to open a significant amount of spectrum in the Q/V bands to SES in the relatively near future. Instead, we recommend that ComReg proceeds with its previous proposal to monitor developments in the E-band with a view to making it available to SES in a timely manner if/when appropriate. The same applies to other high frequency bands that might be used for SES in the future.

5 Information policy

In our previous report, we highlighted that providing information on both satellite and terrestrial stations is necessary if operator coordination is to be relied upon as a means of avoiding interference.

ComReg explained that, in keeping with its 'open by default' approach to data, and provisions in the EECC for making data publicly available, it intends to publish the following information for both SES and fixed links:

- the location of each site;
- the name of the operator of that site; and
- various technical details (e.g. bandwidth, power, azimuth, beamwidth).

We recognised there may be security concerns around publishing data relating to some stations, and in these cases the information might be only provided to operators registered with ComReg. However, these would be exceptional cases, and commercial sensitivity alone would not be a reason to restrict information.

5.1 Views of respondents

Amazon Kuiper, Eutelsat and SpaceX support the proposals to publish information on SES and fixed links sites, which they agree will help operators plan their networks and avoid interference.

AWS expressed concern that some of the specific information ComReg proposed to publish would be considered confidential, in particular the licensee name alongside SES coordinates. It submits that putting SES locations in the public domain could facilitate harm to SES infrastructure by non-industry actors, and it notes that not all licensees will be affected in the same way by publication of technical information about their sites. Therefore, AWS recommends that ComReg allows operators to opt out of sharing information such as the coordinates of their sites linked to the operator's name, on security grounds. Operators who opted out would be required to provide alternative contact details and further information on a case-by-case basis. More generally, AWS suggests that access to information is limited to industry operators, such as licensees and applicants.

5.2 Assessment and recommendations

We continue to recommend that ComReg provides information on other satellite operations as well as terrestrial services, to facilitate coordination between operators and avoid harmful interference. It is

difficult to see how a system relying on coordination amongst licensees could operate otherwise. Coordination amongst users cannot occur without access to information at least on frequencies in use, location, power levels and antenna parameters of other licensees.

Nevertheless, as suggested in our previous report, it may be appropriate to restrict this information (on an exceptional basis) to those with genuine need in cases where there are security concerns.

AWS's concerns primarily relate to security threats from non-industry parties; therefore, restricting access to information to existing licensees and bone fide potential licensees would seem sufficient to resolve this issue. However, such restrictions should not inhibit new and potential licensees, remembering that not all may be telecommunications operators (in the sense of holding a general authorisation from ComReg).

Allowing licensees to opt out from providing information about their licences being shared, even if only amongst a restricted group of qualifying operators and potential operators, would undermine the intention to use a light-touch licensing regime relying on coordination amongst licensees and potential licensees. Given such a choice, individual licensees would have little *individual* incentive to make their own licence data available, and indeed some possible incentive to withhold it to raise barriers to new licensees and to hide commercial strategies. This is despite licensees *collectively* benefitting from access to other licensees' data by avoiding the need for more intrusive regulatory measures to manage potential interference if coordination amongst licensees were not feasible. Furthermore, the burden of proving a need to access others' licence data would likely fall most heavily on potential licensees not currently active in satellite ground services or fixed links. Therefore, we cannot see how such a general opt-out regime could be compatible with an approach based on coordination amongst licensees and avoid risks of creating entry barriers.

Given these competing requirements, a reasonable approach might be:

- for licence data, to the extent possible, to be in the public domain as a default;
- for such data to be *partially* redacted if the licensee could demonstrate to ComReg's satisfaction that there were sufficient security concerns from publishing complete information to outweigh the benefits of that information being made public to support coordination (including use of that information amongst both existing licensees and potential new licensees); and
- for the redacted information be available to both existing and potential licensees on request to ComReg and subject to non-

disclosure obligations, but with consent not typically being withheld unless ComReg had good reason.

Where such a redaction of licence data occurred, it is clearly still necessary that the existence of a licence be published, otherwise other licensees would not even know to request further information from ComReg. The potential sensitive information would appear limited to the precise location of the earth station.

It is also important that the release of redacted information be subject to ComReg's discretion, operating within a previously set out framework, rather than the licensee have a veto right to prevent information being shared with others. Otherwise, it is quite plausible that withholding of licence data could be used as a strategy to frustrate new entrants.

We understand that ComReg will be conducting a separate consultation on the publication of radio licence information in due course.

6 Sharing and compatibility of NGSO

The existing satellite licensing regime is one in which there are rarely harmful interference problems between satellite earth stations or between earth stations and other users (primarily fixed links). We anticipate there will be a growing risk of interference following the increased deployment of NGSO earth stations. In theory, this risk can be substantially mitigated through operator coordination, but to ensure this coordination is effective, we recommended formalising the first-come-first-served rights given to licensees.

In particular, we suggested that ComReg should:

- make explicit how the licence system currently operates in terms of prioritisation and protections offered to existing users;
- maximise the opportunity for licensees and potential licensees to resolve interference issues amongst themselves (an approach that is broadly supported by stakeholders), including through the provision of information; and
- ensure that pre-emptive licensing cannot be used to exclude competitors.

ComReg would protect earlier licence users (both SES and terrestrial operators) from interference from earth stations that came into operation later. As part of the licensing process, ComReg would notify stakeholders of a new SES application, and incumbent SES licensees would have the opportunity to raise any concerns at this stage. We would expect many cases be resolved by negotiations between operators.

We also recommended that the burden of proof that there is, or is not likely to be, harmful interference would be shared between incumbents and entrants such that:

- beyond some critical distance (we proposed 20 km) that burden falls on the incumbent; and
- within that distance the burden falls on the entrant.

In both cases, operators would be required to negotiate in good faith and to present evidence to ComReg to support any claims made regarding interference.

We noted that this notification process would not be suitable for fixed links or TES, because of the number of operators and the lack of a fixed location respectively. ComReg would continue with its current approach to interference assessment for these cases.

6.1 Views of respondents

Stakeholders have mixed views on the proposed notification process

The three consultation respondents that commented on the sharing and compatibility proposals offered mixed views on whether they should be adopted:

- Amazon Kuiper agrees with the proposals;
- OneWeb asks that ComReg is mindful not to contradict the ITU coordination procedures; and
- SpaceX urges ComReg not to adopt the proposed notification process for new NGSO applications.

Amazon Kuiper supports the introduction of the notification process as well as the confirmation that it would not be used for coordination between SES and fixed links.

OneWeb first notes that it is straightforward to avoid interference between GSO and NGSO Earth stations, using the technical restrictions defined by the ITU. It then explains that, while agreeing that inter-operator coordination is necessary to avoid interference between NGSO systems, OneWeb holds the view this is best dealt with through the ITU coordination procedures, which typically include discussions on separation distances between Earth stations as well as any other measures to mitigate interference. Absent a formal agreement between NGSO operators, and irrelevant of when SES licences are granted in Ireland, the ITU Radio Regulations require the later filed system to eliminate any interference into the earlier filed system. OneWeb submits that this is the most logical approach to operator coordination, because:

- it can take years to secure access to spectrum at the ITU level, make and deploy satellites; and
- later filed systems benefit from hindsight and information on the details of earlier systems, whereas it is difficult to modify already deployed satellites, making it more appropriate for later filed systems to plan around earlier filed ones.

SpaceX highlights that good faith operator-to-operator coordination is best for efficient sharing of satellite spectrum between operators and argues this removes the need for regulatory interventions or conservative rules (e.g. minimum separation distances). SpaceX says it has significant experience in effective operator-to-operator negotiations. Therefore, SpaceX urges ComReg not to adopt the proposed notification process for new NGSO applications which it believes would duplicate and potentially undermine private coordination efforts, encouraging inefficiency and inviting gamesmanship with no interference benefits. For example, SpaceX submits that an incumbent that has failed to adopt basic spectrum-sharing technologies could claim a massive keep-out zone preventing others from deploying.

Instead, SpaceX suggests that ComReg should incentivise operators to adopt spectrum sharing policies that permit coexistence within reasonable proximity to other operators while preventing opportunities for operators to leverage inefficiency to curb competition. Furthermore, it urges ComReg to develop automated tools that speed up the licensing process.

AWS argues that sharing and compatibility measures strengthen the case for opening new bands

AWS has not commented specifically on the proposed notification process, but has noted more generally that co-existence among SES and between SES and fixed links can be successfully implemented, and, therefore, opening new bands (that are internationally harmonised for SES use) will not create harmful interference. AWS submits that:

- it is not aware of any interference with terrestrial fixed links or others in relation to its use over several years and further, AWS ground stations can coexist with other users in similar bands without causing interference; and
- AWS notes other stakeholders' views that prevention/mitigation of harmful interference between SES is best managed by cooperation/coordination between operators, in accordance with ITU coordination obligations.

6.2 Assessment and recommendations

The proposed notification process and framework for sharing and compatibility of NGSO SES are intended to formalise and clarify the first-come, first-served (FCFS) principle that is already in the guidelines, and also to support an approach to coordination of SES licences that largely relies upon good faith negotiations between operators with limited input from ComReg. We believe that this neither conflicts with the ITU coordination procedures, as suggested by OneWeb, nor risks undermining incentives for operators in private negotiations, as claimed by SpaceX. In fact, being clear on the balance of rights between incumbents and entrants, and ComReg's broad approach to resolving any disputes, provides a starting point that makes operator-to-operator coordination more likely to succeed.

In summary, once a SES licence has been issued, it grants the holder the right to operate its earth station free from harmful interference from other licensees in Ireland (whether SES operators or operators of terrestrial services), on a first-come-first-served basis. This means that, in the unlikely event that harmful interference had arisen and been investigated by ComReg, either between SES or between SES and a fixed link (i.e. involving only the terrestrial parts of satellite or fixed networks), the earlier licensed station would take priority. This protection is specific to earth stations and additional to the ITU rules (which deliberately leave earth station licensing as a matter for NRAs).

During the application process, subject to the findings of its own analysis, ComReg would typically issue a licence if:

- no incumbent beyond the critical distance from the proposed site has presented evidence that the new SES would cause harmful interference; and
- either no objection is raised by an incumbent within the critical distance of the proposed new site (in practice mostly probably as there was no such incumbent), or the entrant has submitted evidence it can coexist/resolved the issue raised by the incumbent through operator-to-operator negotiations.

Any coordination process is bound to be imperfect and it is possible that, in rare cases, harmful interference will arise. This includes cases in which it is unclear whether the issue relates more to the terrestrial or space segment of a satellite system (e.g. satellites 'seeing' transmission from another operators earth station). The exact process for evaluating the evidence and resolving any disputes would depend on the specific case at hand; these scenarios are almost by definition complicated cases that cannot be avoided with certainty simply by setting rules in advance. Therefore, it is appropriate for ComReg to apply a general condition to SES operators that requires them to coordinate in good faith with each other, both during the notification process for new earth stations and once the SES are operational.

ComReg is responsible for SES licensing, and this process complements the ITU procedure

The proposed process is consistent with the ITU's approach. It does not in any way prevent operators from forming coordination agreements with one another in accordance with the ITU Coordination Procedures and without any restrictions or intervention from ComReg. These agreements may even, as suggested by OneWeb, include provisions around SES deployments, and the proposed licensing process for Ireland does not prevent or undermine this.

In the ITU process, Member States act on behalf of satellite operators in a coordination process that is set out in Articles 9 and 11 of the Radio Regulations. All parties are required to negotiate in good faith, but later filed systems must prevent interference to earlier filed systems in cases where a coordination agreement has not been reached.[2] However, licensing of Earth stations remains the responsibility of NRAs, and it is appropriate for national licensing regimes to include additional rules that complement the ITU process. Providing protection to incumbent SES supports efficient investment, given that SES operators need certainty that they will be able to continue operating free from harmful interference for an

[2] https://www.itu.int/en/ITU-R/space/WRS16space/ART-9.pdf

https://www.itu.int/en/ITU-R/terrestrial/workshops/wrs12/Miscellaneous/Article11RevWRC12.pdf

https://www.itu.int/hub/2022/02/itu-space-interference-free-satellite-orbits-leo/

extended period once infrastructure has been deployed. This protection can be offered at little cost, as operators typically have considerable flexibility over where to deploy earth stations.

Furthermore, if there are provisions for Earth stations in coordination agreements that have come out of the ITU process, these could be used as evidence in the ComReg notification process. Therefore, the two procedures support each other rather than conflict. We also note that this point has been raised in other jurisdictions, e.g. in Ofcom's recent NGSO consultation[3], in which Ofcom clarified that its own national licensing process would neither conflict with nor attempt to replace the ITU procedures.

Framework around private coordination

We disagree with SpaceX that ComReg's proposals undermine private coordination efforts. On the contrary, the goal of the proposal is to minimise the need for regulator intervention, allowing operators to come to solutions themselves. However, if private coordination is to be a key part of the licensing process, ComReg must ensure that:

- incumbent operators are provided with sufficient protection if there is no agreement between operators (subject to incumbents having limited ability to block access to others without good reason); and
- ComReg maintains the requirement for operators of existing SES to coordinate in good faith and has in place a process for assessing further technical evidence if there is a conflict.

Notifying incumbent operators of new applications is appropriate as it ensures incumbent SES operators have an opportunity to raise any concerns before a licence is granted and any significant progress is made with deployment of the new site. It should also help the applicant to avoid scenarios where significant investment is made in deploying equipment that subsequently causes interference and needs subsequent modification or re-siting. However, the notification process need not play a role if operators have formed agreements amongst themselves. Furthermore, it should offer limited incentives/scope for incumbent operators to refuse negotiations in favour of trying to block access to new entrants. We, therefore, see no reason why the process would undermine effective coordination between operators.

If there were no coordination agreement between the operator of a new SES and an incumbent SES operator, there is scope for the incumbent to raise objections to the new site if either:

- the new SES is within a certain distance of the incumbent, in which case ComReg would, by default, not issue a new licence if there is any objection from the incumbent; or

[3] https://www.ofcom.org.uk/__data/assets/pdf_file/0018/229311/statement-ngso-licensing.pdf

- the new SES is beyond a certain distance of the incumbent, in which case the incumbent would need to provide ComReg with sufficient evidence that the new earth station would generate unavoidable interference issues.

Some operators could in theory attempt to use the process as a platform to deny or delay access to spectrum for others by making false claims of interference or simply invoking incumbency rights (where applicable) to block a new SES application. However, the potential to make a complaint about interference from a new SES or claim a large 'keep-out zone' is present under any regime where incumbents are given priority in terms of interference protection. Our recommendations merely formalise the process for dealing with such claims and establish a rule for where the burden of proof lies depending on how far apart the existing and new earth stations are.

Shifting the burden of proof to the incumbent once at a certain separation distance should help to limit the incentives and power of incumbents to make false claims aimed at restricting access to others and to encourage negotiation between operators. Provided the critical distance at which the burden of proof changes is relatively small, there should be limited incentive for incumbents to try to block others for anti-competitive reasons. We understand that satellite operators have flexibility over where they put their earth stations, so should be able to locate elsewhere (even if slightly less optimal) at a location where the incumbent would then need to prove any claims of interference issues. Unless those claims are genuine and well founded, the incumbent would not be able to keep the entrant out of the market and achieve the desired competitive gain.

Moreover, whilst the default position would be for ComReg to not issue a licence for a new SES within a certain distance of an existing SES if there is objection from the incumbent, that does not necessarily mean the incumbent has unilateral power to keep the new station out of locations even within that distance (e.g. in the event that the entrant can sufficiently demonstrate the incumbent has not negotiated in good faith and/or that coexistence between the two SES is viable). ComReg would also have the flexibility to take account of any suspected abuse of the process in how it deals with any conflict between SES operators should it become involved. We, therefore, do not see any significant likelihood of gamesmanship as described by SpaceX.

Whilst we recognise that these proposals could add a little time to the application process that would not otherwise be present, in most cases we would expect the difference to be a matter of just a few weeks (assuming no objections are raised to the application) which with adequate planning and given the scale of the deployments we would not expect to make any practical difference to the time taken to roll out. In any case, there is also a reduction in the potential for subsequent disputes and greater certainty, which aids investors.

Overall, SpaceX's comments stress the need to allow entrants to make use of the ample space for new SES, while OneWeb's are concerned with protecting the interference-free operation of existing operators. Neither of these objectives are wrong in themselves, but they could conflict and a framework such as the one proposed is necessary to stop the two from clashing. As the proposed process limits incumbent operators' ability to claim protection beyond what they need, there is little scope for operators to "*leverage inefficiency*" as SpaceX claims. Furthermore, there would be a process through which incumbents' claims that they need protection can be contested.

We anticipate that operators will increasingly use spectrum-sharing technologies as spectrum and sites become more heavily used, without ComReg needing to create specific incentives to do so. Furthermore, incumbent operators cannot reasonably be compelled to replace their existing equipment or risk losing their licences or interference protection. As highlighted by OneWeb, incumbent operators may use less efficient technologies purely because of operating before the latest equipment was available. This is the consequence of prioritising incumbents in line with the ITU framework.

Coexistence with terrestrial services

AWS supports the view that coexistence between SES and terrestrial services (primarily fixed links) is feasible without interference issues, while Amazon Kuiper welcomes the confirmation that the formal coordination process does not apply to fixed links. We still believe this is the correct approach to coexistence with fixed links but, to clarify, although there should be no need for formal coordination, operators looking to deploy a new SES may still find it beneficial to engage with any nearby FS operators where possible to minimise the potential for interference issues to be identified by ComReg. By doing so, potential new licensees may be able to make modifications to accommodate FS operators to allow applications to pass and avoid the need for subsequent modification and resubmission of new licence applications.

7 Fees

Opportunity costs for SES are likely to be low or zero, because there is limited potential for scarcity of sites in Ireland for the foreseeable future. Therefore, the main aim of the fees is to cover ComReg's administrative costs of running the SES licensing scheme, which are largely fixed.

We recommended that ComReg shares out these fixed costs across users such that higher value operators pay greater fees, to avoid pricing off lower value users. We recommended that bandwidth use was a reasonable proxy for value, and therefore the proposed fees should be:

- €100 (the small incremental cost of each licence); plus
- €30 per MHz of spectrum in the licence.

7.1 Views of respondents

Stakeholders agree with the overall principle of setting fees to cover administrative costs, but have mixed views on whether distributing those costs in proportion to bandwidth is appropriate.

Amazon Kuiper and AWS agree with proposed fees, but have asked for further clarity on the following points:

- Amazon Kuiper asks for clarification that, for transmit and receive licences, only the transmit spectrum would be charged for; and
- AWS makes two additional proposals with the aim of eliminating redundant spectrum fees for operators repeatedly accessing the same spectrum bandwidth common for TT&C systems:
    1. Asks for clarification on whether two AWS earth stations operating immediately next to each other using the same frequencies and bandwidth at any given time would be covered by a single fee.
    2. TT&C licensees often need to make separate frequency authorisation requests for overlapping frequencies. AWS proposes that ComReg ensures operators are only charged for the total bandwidth in use at a given time to avoid TT&C operators paying more for the same spectrum.

Eutelsat, OneWeb and SpaceX have all put forward concerns that the level of the fees for some users could be excessive, particularly once the Q/V bands come into use, with operators using large bandwidths.

Eutelsat argues that the fees are very expensive for large bandwidths and these large bandwidths are common in bands in which satellite systems are now being deployed –systems in the Ka and Q/V bands use much greater bandwidths than their predecessors, and E-band stations will use still more spectrum when these come into use. It notes that the fee for a single Earth station using the full 2.5 GHz of the Ka band would cover more than half of ComReg's administrative costs. Therefore, Eutelsat recommends that ComReg caps fees for projects at higher frequencies or for larger bandwidths, to facilitate market entry in Ireland.

OneWeb is encouraged by the fact that the proposed fees are lower than the existing fees. Nevertheless, it submits that the fees would be prohibitively high both for its current generation of Earth stations, which use 2 GHz of uplink and 1.3 GHz of downlink spectrum in the Ka band, and for its next generation, for which it will need 6 GHz of Q/V band spectrum within 5 years. It claims that a constant per MHz charge is not reflective of the greater availability of spectrum and lower chance of congestion in the higher frequency bands. Therefore, OneWeb suggests that ComReg should use band factors, such that per MHz charges decline as the frequency of the band increases (this fee structure is used elsewhere, for example Australia).

SpaceX agrees that the role of the fees should be administrative cost recovery, and that there is no case for charging different (per MHz) fees for different spectrum bands in an attempt to capture their value. However, it disagrees that bandwidth-based fees meet ComReg's objectives and instead recommends that ComReg charges a flat fee for all licences. SpaceX also highlights that *"DotEcon previously noted that 'there is no obvious rationale' for consumption based fees, and the RIA does not explain how greater bandwidth use results in higher administrative costs for ComReg"*.

In SpaceX's view, fees based on bandwidth undermine the value of an administrative cost recovery model and ComReg's objectives, and will harm competition, innovation, investment and consumers, without any offsetting benefits. In particular, SpaceX suggests that that efficient use of the high frequency bands (Q/V bands and above) will become too costly. As a result, operators will either limit their technological capacities or not deploy SES in Ireland.

Furthermore, SpaceX claims that the proposed fees would negatively affect consumers by taxing efficient use of large bandwidths in high frequency bands. This is on the basis that, faced with high fees, operators would either:

- pass on the cost to consumers; or
- divert resources from improving service quality and customer service.

7.2 Assessment and recommendations

The comments from consultation respondents relating to the fees fall into two broad categories:

- clarification questions around what is subject to the fees (e.g. transmit only or all spectrum); and
- views on structuring the administrative cost charging regime according to bandwidth, which is the subject of the RIA.

What is covered by the fees

Counting bandwidth

By way of clarification, our recommendation is that licence fees be based on the bandwidth licensed for protected operation. Therefore, to respond to Amazon Kuiper's query, it is not the case that only transmit frequencies would be charged for. There is no obvious reason why receive frequencies should be excluded from the fee calculation if subject to interference protection, and Amazon Kuiper has not provided any compelling rationale for why they should be excluded.

However, we note that earlier in this review there was some confusion regarding the terminology around transmit-only licences, because operators often use receive frequencies on a licence exempt/non-protected basis alongside a 'transmit-only' licence. Such operators would indeed only pay for the transmit frequencies if other frequencies are used for receiving only on a non-protected basis.

It is helpful to clarify at this point how the bandwidth for calculating SES licence fees would be counted under our recommendation, as this was not necessarily clear from earlier reports and is important with respect to the adjusted fee model we recommend below. Recall that each SES licence would be for specific frequencies at a specific site (defined by a circle with a 500m radius around a specified central geographical point). The licensee would be authorised to use the licensed frequencies with as many antennas as it likes within the boundary of the site.

However, an operator may wish to use multiple frequency ranges at the same site, either within a particular band or across multiple bands. Broadly speaking, we see two equivalent approaches as to how this might work practically:

1. An operator has multiple, coterminous licences at the same site, with separate licences required for non-contiguous frequencies and for frequencies added to a site at different times.

2. All frequencies used at a site would be covered by a single licence, with new frequencies added or existing frequencies removed via a licence amendment.[4]

Which approach to take is ComReg's decision, but would make no difference to what operators would need to pay. The choice may be affected, for example, by preferences over the legal framing of licences or implementation requirements, but this does not affect the principle of aggregating spectrum at a site for calculating the associated fees. For the purpose of the discussions and examples below we have largely assumed approach 1 would apply (i.e. multiple coterminous licences at the same site are associated), but if option 2 were used instead then the arguments and examples would still apply with minimal adjustments. Therefore, the difference between approaches is largely semantic and both involve site-based charging.

Under approach 1, an SES operator may therefore have multiple licences linked to the same site, for example:

- if the operator wishes to use frequencies in multiple bands at that site; and/or
- if the operator needed to add frequencies to a pre-existing site (even if in the same band as spectrum already licensed at the site) it would need to do so by applying for a separate licence for those frequencies.

An operator's annual fees for its SES licences in Ireland would then generally be calculated as follows:

- For each SES site the operator has licences for, establish the bandwidth licensed at that site, which is the total quantum of unique frequencies licensed for protected use at the site (which may be covered by multiple licences, all with the same site definition). The bandwidth is inputted into the fee formula (set out below) to determine a fee that would cover use of those frequencies at the site in question.
- If the operator has multiple SES sites, sum the applicable fees for each of those sites to give the total SES licence fees for that operator.

[4] Note that adding frequencies via a licence amendment would need to be subject to the same notification and coordination processes as if they were subject to a new application, and priority of interference protection in relation to the new frequencies would be based on the date they were added and not the issue date of the original licence.

Figure 1: Example calculation of bandwidth for determination of SES fees

Suppose an operator has three SES licences (A, B and C), as set out in the table below.

Licence	SES site	Transmit frequencies (GHz)	Protected receive frequencies (GHz)
A	X	27.5 – 29.5	19.8 – 20
B	X	29.5 – 30	–
C	Y	27.5 – 29.5	–

The operator has two licences at SES site X i.e. licences A and B have *exactly* the same geographical central location. Both are for spectrum in the Ka-band but suppose, for example, that the 29.5 – 30 MHz portion (licence B) was added for use at pre-existing SES site X where the operator already held licence A, requiring a second licence for the extra bandwidth at that site. Note that licences A and B combined allow the operator to use the full 27.5 – 30 GHz and 19.8 – 20 GHz ranges anywhere, and with as many antennas as desired, within the area covered by site X (subject to other relevant licence conditions).

The operator would be liable to pay a fee for protected use of the frequencies at site X, with the total bandwidth to be included in the fee calculation coming to 2.7 GHz across both licences.

The operator has a third SES licence, allowing it to use 2 GHz of spectrum in the 27.5 – 29.5 GHz range at SES site Y, where Y has a different central point to site X.

The operator must also pay a fee to use those frequencies at Y, even though the frequencies overlap with those used at site X and, for the avoidance of doubt, even if the geographical area covered by site Y overlaps with (but is not identical to) site X – if the sites are not the same then multiple fees would apply.

To summarise, the operator needs to pay:

- a fee to use 2.7 GHz of spectrum at site X (covering licences A and B); plus
- a fee to use 2 GHz of spectrum at site Y (covering licence C).

Note that if ComReg were to apply this approach of aggregating frequencies at a site for the purpose of calculating fees, it is important that if there are multiple licences linked to a site they are coterminous so that there is clarity about the total bandwidth licenced at that site over the entire duration of a licence. Whenever a licence is added to an existing site, the expiry date would be set to coincide with other licences at the site, so the licence may initially run for less than a full year before being renewable annually. In this case we anticipate the operator would pay a pro-rata fee for shorter initial licence term. This approach simplifies the calculation and

charging of annual fees and, importantly, avoids the possibility that operators could get a quantity discount from paying fees based on a certain bandwidth at a site, but then let a licence expire part-way through the year.

If all frequencies at a site are included in a single licence then there is no issue around ensuring licence terms are aligned. However, there would still be a need for an initial fee that covers the remainder of the year up to the expiry of the licence if spectrum if added to a licence in the course of a year.

There will also be a need to have in place a process for moving from the current licensing framework to the new one, in particular in terms of licence definition and applicable fees. The approach to this will depend somewhat on the structure of licences at a site (single licence or multiple coterminous licences) but needs to account for the possibility that some licensees may currently have multiple licences that will be linked to the same site under the new regime. Figure 2 below provides examples of how this might work under the two approaches of structuring licences at a site. It can be seen that the approaches are equivalent.

Figure 2: Example process for moving current licences at a common site into the new framework

Suppose that we have a single site with three existing licences A, B and C for different frequencies held by the same party. These licences are not currently coterminous. Licence A expires first, then Licence B, then Licence C. Consider the two entirely equivalent ways of structuring licences under the new charging framework:

- As multiple, coterminous licences held at the same site by one party, but being subject to a single fee determined by the total bandwidth at that site across all these licences;
- As a single licence at that site across multiple frequency bands.

In moving from the existing licences to new licences, under the first model:

- Licence A expires, so a new licence A' is granted for a part-year until expiry of Licence B. A pro-rata fee is charged for A', based on the period A' is in force and the increase in annual fee that results under the new charging formula from adding the bandwidth under A' to existing bandwidth held under B and C.
- Licence A' and Licence B expire, and new Licences A'' and B' are granted up to the termination of Licence C. A single fee is charged for A'' and B', based on increase in annual fee that results under the new charging formula from adding the bandwidth under A'' and B' to existing bandwidth C, pro-rated for the relevant period.
- Once Licence C expires, new coterminous licences are granted with a single fee charged on the total bandwidth.

Under the second model, the spectrum in each renewed licence is wrapped into the next one to expire:

- Licence A expires, so Licence B is modified to include the spectrum in Licence A for its remainder. An additional fee is charged (calculated as above) for this modification.
- Licence B expires, so Licence C is modified to include the spectrum in the revised Licence B until its expiry. An additional fee is charged (calculated as above) for this modification.
- Licence C expires and is renewed.

AWS has raised two points in relation to how licensed spectrum would count towards the calculation of fees, specifically it:

- asks for clarification that two antennas immediately next to each other, using the same frequencies, would be covered by a single licence fee; and
- proposes that fees for licences with overlapping frequency ranges should be based on "*total actual spectrum usage by a licensee*" and avoid double counting spectrum in the fee calculations.

Based on our understanding of AWS' comments, we believe that the concerns raised should be addressed by the process for calculating bandwidth for the determination of fees as set out above.

With respect to AWS' query on whether two antennas next to each other would be covered by the same fee, its interpretation appears to be correct, provided that all antennas in question are used under licences with a common site definition. Having two antennas operating within a common SES site using spectrum licensed for that site makes no difference to the fees the operator needs to pay, regardless of whether or not the frequencies used by those antennas overlaps or if the frequencies are used under multiple licences.

AWS provides the example of its own setup where it has "*twin earth stations, located immediately next to each other, both using the same frequencies and bandwidth at any given time*". If, under the revised SES licensing regime, those two earth stations (which we take to mean antennas) are located within the bounds of a common SES site and operate using frequencies for which AWS has a licence at that site, operation of those antennas would be covered by the same licence fee. To be clear, however, if the two antennas are located such that they do not both fall within the bounds of a single SES site (as defined by AWS' licence(s)) then use of those antennas would be covered by different fees, even if they use the same frequencies. However, provided they are sufficiently close (less than 1km apart) and there are no other restricting factors, ensuring they are within the same SES site would just be a matter of choosing a suitable common site definition.

With regard to AWS' other comment regarding double counting of overlapping frequencies under different licences, we note that this would not happen at a given SES site under the proposed approach. In particular, there should not be any need for multiple licences at the same site with frequencies that overlap, even if the licences are granted at different times, since a licence allows for use of the corresponding frequencies anywhere and with any number of antennas within the site. Therefore, if an operator wants to use currently licensed spectrum plus additional frequencies at an existing site (with either an existing antenna or a new one), it would only need a licence for the additional frequencies rather than one that overlaps with the existing licence. For the avoidance of doubt, however, if an operator has two licences for the same frequencies but at different SES sites, fees would apply separately for use of those frequencies at each site.

Structure and level of fees

Most of the comments on the fees relate to the proposal to distribute administrative costs according to bandwidth, and in particular Eutelsat, OneWeb and SpaceX's concern that this will lead

to excessively high fees for some operators as they begin to operate in the Q/V bands (and eventually higher frequencies), where large amounts of spectrum are available. We remain of the view that setting fees based on bandwidth use – the high-level approach that formed ComReg's preferred option in its Draft RIA – is appropriate. However, our proposed implementation of bandwidth charges does leave a risk of over-recovery of administrative costs and can be improved to mitigate the issues raised by the consultation respondents.

Pricing principles

Given that opportunity costs are expected to be minimal, the key issue for setting fees is how to best allocate ComReg's administrative costs of licensing and enforcement in line with ComReg's objectives. Some elements of ComReg's costs may depend on the type of user a licence is issued to (e.g. a higher bandwidth user could be more likely to be using the same spectrum as neighbouring fixed links and therefore create a greater expected cost of monitoring potential interference/enforcing licence conditions). However, such cost differences are small and difficult to measure. Therefore, for practical purposes, ComReg's administrative costs can be taken to be largely fixed and not varying significantly in the short term with the number of applications/licences.

The question in setting appropriate fees then is primarily about how to distribute these fixed administrative costs across licensees. In our previous report, we recommended an approach where fees were linear in bandwidth licensed (plus a small fixed charge). This was based on the view that higher-value users should ideally bear a larger share of the fixed cost to ensure that marginal, lower-value uses are not priced-off. Since we cannot expect to optimise the cost sharing rule with any precision, we instead adopted a broad-brush approach based on the principle that bandwidth is a reasonable proxy for the value of a licence because, under some simplifying assumptions, the theoretical information carrying capacity of a channel is proportional to bandwidth.[5]

Nevertheless, it is also possible to deter high value users from applying for SES licences, especially if the alternative for those operators is to deploy earth stations in countries where licences fees are lower. Loss of potential licensees means that fixed costs of the licensing system then need to be recovered from a smaller set of users, increasing licence fees for all remaining users. Therefore, we also need to be cautious about pricing off higher bandwidth users, especially taking into account their larger individual contributions,

[5] Using the Shannon-Hartley theorem, the information carrying capacity of a noisy channel is subject to constant returns to scale (i.e. linear in bandwidth) if the signal power per Hz is kept constant, but there are diminishing returns if the signal power density (per Hz) decreases as bandwidth increases. In practical applications, it is probably reasonable to suppose that the signal power density can be maintained with increasing bandwidth up to some point.

otherwise the attempt to recover administrative costs while accommodating smaller users could become self-defeating.

Potential for over-recovery costs

Whilst we remain of the view that the principles behind charging a greater proportion of the administrative costs to high value users remain sound, and that bandwidth is likely to be a reasonable proxy for value, we also recognise that (in line with feedback from stakeholders) bandwidth requirements are likely to increase significantly over the next few years. This creates the potential for significant uncertainty in the revenue that the fee regime may raise and, therefore, a risk of over- or under-recovery of administrative costs.

Currently, there is 4.5 GHz of bandwidth in use across all SES licences. A single Ka band SES uses 2 GHz of spectrum for some use cases, and expectations are that next generation earth stations that could be deployed in the medium term will be using significantly more spectrum in the Q/V bands (and later in even higher frequencies). Under the proposed fixed linear charge per MHz, there is a risk of significant over-recovery of administrative costs if there is substantial unanticipated growth in bandwidth in use. Such a scenario could readily be caused by a small number of large new users. Growth in bandwidth will probably occur in large jumps (when new SES are installed and/or a new band comes into use), and it is highly uncertain when these will occur, so pre-emptively anticipating such changes or building assumptions about bandwidth growth into the pricing model for SES licences is not a realistic option, as then there would be a risk of significant under-recovery of costs if anticipated growth did not occur.

Of course, licence fees do not necessarily need to remain static for long periods. We expect that ComReg will monitor the level of spectrum used by SES licensees as part of its spectrum management. It may, therefore, occasionally adjust the level of the fees so that revenue from SES licences broadly tracks administrative costs over the longer term. However, there is need to set fees that are predictable for licensees and any review and resetting of fees takes time. As a result, it is not possible to avoid over- or under-recovery of administrative costs in the short term, due to outturn demand for licences being different to that assumed when fees were set.

Concave pricing formula

To mitigate the risk of substantial over-recovery, we recommend that ComReg uses a concave pricing formula (rather than the linear approach previously suggested) where the marginal price per MHz falls as the amount of bandwidth licensed increases. The result is that large increases in bandwidth used would have a smaller impact on the total fees received by ComReg compared with using a fee formula that is linear in bandwidth. This limits the extent to which significant over-recovery might occur as a result of a large (and relatively sudden) increase in bandwidth.

Concave pricing would also improve incentives (relative to the linear approach) for larger users to locate earth stations in Ireland, particularly once large bandwidths in the Q/V bands become available. Attracting these users to Ireland is desirable as it is likely to come with significant external benefits to the Irish economy, for example economic activity from deployment of earth stations and associated infrastructure, as well as infrastructure developments that might be available to others under sharing arrangements. Moreover, if ComReg were in the longer run to adjust the level of the fees in response to issuing additional licences (in particular those using large bandwidth), this would eventually reduce fees for all SES operators.

These large bandwidth users, as we understand, tend to have a relatively high degree of flexibility in terms of where they can deploy their earth stations. Therefore, we need to consider the risk of setting fees for large bandwidth licences too high with the effect that Ireland is no longer an attractive option for deployment. Several responses to the consultation suggested that the linear fee model as proposed could result in prohibitively high prices for SES utilising the higher frequency bands when available.

Given the above considerations, we recommend an adjustment to the SES licensing fee structure such that ComReg continues with its preferred RIA option of setting fees based on bandwidth (and no other parameters) but implements this using a *concave pricing formula*. In particular, we propose one of the form:

$$f(B) = c + \alpha B^{\lambda}$$

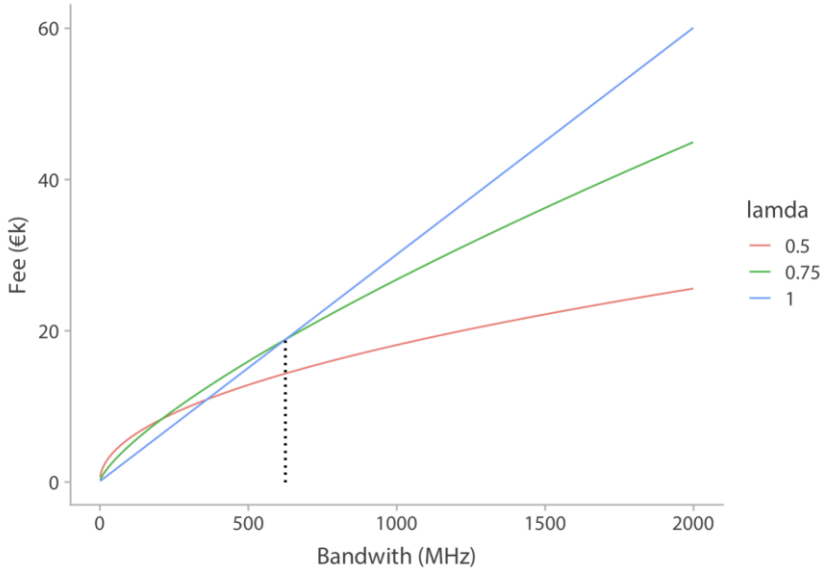
where B is the bandwidth in use at a site, $c = €100$ is the marginal cost to ComReg of issuing a licence and α is set such that total revenue matches ComReg's total administrative costs. The parameter $\lambda \in [0,1]$ determines the concavity of the fees. It nests both the previously proposed linear fee formula (if $\lambda = 1$) and SpaceX's proposal for a flat fee (if $\lambda = 0$).

The parameter λ needs to balance two objectives. The more concave the fees (i.e. the smaller is λ), the lower the risk of over/under recovery of costs following a large change in bandwidth use and the greater the incentives for large bandwidth users to deploy in Ireland. On the other hand, because total fees across all licensees ultimately need to cover ComReg's fixed administrative costs, making the pricing more concave also necessarily increases fees for sufficiently small bandwidths relative to the linear model (although fees remain low in absolute terms) which risks undermining the objective of keeping prices reasonable for low-value users.

Figure 2 shows the fees for the range of bandwidths currently in use under the linear formula and two concave schedules with $\lambda = 0.75$ and $\lambda = 0.5$ (with the value of α in each case set differently so that the total resulting fees across existing licensees is equal to ComReg's administrative costs). Any site using a bandwidth to the left of the

dotted line would be charged more under the concave approach with $\lambda = 0.75$ compared with the linear approach, whereas bandwidths to the right of the dotted line would pay less.

Figure 3: Fees using the concave formula for bandwidths currently in use



The formula should be sufficiently concave to materially lower Q/V band, but going further risks pricing off low bandwidth users

A starting point is to consider the principle that if ComReg adjusts the level of the fees following a significant change in bandwidth use, the effect on fees should not be too large, in order to:

- minimise uncertainty for operators over the longer run level of the fees; and
- ensure the fees stay broadly in line with administrative costs without ComReg having to frequently review the fees.

We can consider a realistic example of adding a large new user and find the largest value of λ such that, if this new user were added, revenue would only be, say, 10% greater than administrative costs.

The largest SES in operation in Ireland currently uses 2 GHz. Stakeholders have suggested they will use as much as 10 GHz in the future, once higher frequency bands are opened. In all likelihood, we expect that new individual SES will not individually use this much spectrum in the immediate future, but on the other hand there could be multiple large SES licences added. In the foreseeable future (in particular when the Q/V bands are open, but the E-band is not yet available), then a high bandwidth site may use up to around 5 GHz.

If we set $\lambda = 0.75$, then a completely new 5 GHz SES licence would lead to a 66% increase in revenue given the current user base. If it was added to an existing 2 GHz Ka band SES licence, then it would only increase revenue by 33%. This is well below the over-recovery of 116% and 72% respectively that would arise under the linear approach, but some significant increase in licence fee revenue is practically unavoidable if large increases in bandwidth in use occur (we note that, at present, total bandwidth across all SES licences is

only 4.5 GHz). The table below sets out the extent to which revenue would exceed administrative costs in a range of scenarios, under different values of λ. We also note that if using $\lambda = 0.75$, a 5 GHz site would cost approximately twice as much as a 2 GHz site, compared with 2.5 times under the linear approach (and a 10 GHz licence would be charged around 3.3 times the fees of a 2 GHz SES licence, compared with five times under the linear formula). Therefore, this degree of concavity is broadly is in line with our aim of not deterring higher value operators from using new bands.

Table 1: Over-recovery of costs given large increases in bandwidth in use

Scenario	Over-recovery as % of admin. cost		
	$\lambda = 1$	$\lambda = 0.75$	$\lambda = 0.5$
New 5 GHz site	116	66	29
Expansion of existing site from 2 GHz to 5 GHz	72	33	10
New 2.5 GHz site	61	39	21
New 2 GHz site	49	33	18
New 1 GHz site	27	20	13

Setting $\lambda = 0.75$ should give a sufficiently concave function to mitigate the risk of substantial over-recovery and moderate fees for new, very high bandwidth SES, whereas larger λ values would create greater increases in revenue and set higher fees for larger users beyond the existing bandwidths in use. However, these criteria are compatible with smaller values of λ.

If λ were to be set at a lower value, say $\lambda = 0.5$, we would be concerned that the marginal price per MHz for the lower bandwidth licensees might be too high. For example, there are a number of small bandwidth users currently with SES licences in the satellite exclusive bands, for which they are paying €100 per licence under the current framework. The smallest bandwidth licence in the satellite exclusive bands currently pays €100 and with $\lambda = 0.75$ would pay €168, whereas with the $\lambda = 0.5$ would pay €437. Setting $\lambda = 0.5$ risks pricing off these lower value users. Small bandwidth users in the non-exclusive bands would typically pay less under the new pricing structure (with $\lambda = 0.75$) than they are under the current fees, so we do not see any danger of pricing off these users.

Therefore, we recommend:

- the concavity parameter is set at $\lambda = 0.75$; and
- the level parameter is set at $\alpha = 150$ to recover administrative costs given this choice of λ.

Figure 4: Example calculation of SES fees

Consider the same setup as in the bandwidth counting example above. That is, an operator has three SES licences at two sites, as set out in the table below.

Licence	SES site	Transmit frequencies (GHz)	Protected receive frequencies (GHz)
A	X	27.5 – 29.5	19.8 – 20
B	X	29.5 – 30	–
C	Y	27.5 – 29.5	–

The operator needs to pay:

- a fee to use 2.7 GHz of spectrum at site X (covering licences A and B); plus
- a fee to use 2 GHz of spectrum at site Y (covering licence C).

Using the recommended formula and parameter values, the fee applicable for the frequencies licensed at site X is calculated as:

$$f(B_X) = c + \alpha B^{\lambda} = 100 + \left(150 \times 2700^{\frac{3}{4}}\right) = 56{,}284$$

The fee applicable for the frequencies licensed at site Y is calculated as:

$$f(B_Y) = 100 + \left(150 \times 2000^{\frac{3}{4}}\right) = 44{,}960$$

The total SES licence fees the operator would be required to pay therefore comes to €101,244.

Note that the proposed approach of combining frequencies licensed at a given site before applying the fee calculation makes a difference under the concave fee structure.

With the (previously proposed) linear approach, it would make very little difference whether fees are calculated per site or per licence (assuming frequency ranges would never overlap across licences for the same site) – the only potential difference is that doing it per licence would include more instances of the fixed element, c (i.e. the linear approach fee for licences A and B at site X would be €81,100 if charging by site and €81,200 if charging by licence).

However, with the concave formula the difference is much more significant as the per MHz charge changes depending on the bandwidth entered into the formula. For example, if fees were calculated independently for licences A and B in the example above, the fee for licence A would be €48,284 and the fee for licence B would be €15,960, giving a total of €64,244. This is almost €8,000 more than under the proposed approach of combining frequencies at each site.

As discussed above, if spectrum is added to a site part way through the term of an existing licence at the same site, the licensee would

pay for the remainder of the existing licence term, on a pro-rata basis, before an annual fee would apply for the full bandwidth on licence renewal. Figure 5 below provides an example of how this might work in practice.

Figure 5: Example calculation of pro-rata fees when adding frequencies to a site

Suppose that an operator has a licence to use 2 GHz of spectrum at a SES site.

The annual fee the operator would need to pay is:

$$f(B) = 100 + \left(150 \times 2000^{\frac{3}{4}}\right) = €44{,}960$$

Suppose now that, six months into the term of its existing licence, the operator wishes to use an additional 500 MHz at the same site. A pro-rata fee would apply for the additional spectrum for the remaining six months of the existing licence term.

For 2.5 GHz of spectrum at a given site, the annual fee would be:

$$f(B') = 100 + \left(150 \times 2500^{\frac{3}{4}}\right) = €53{,}133$$

For six months the fee would therefore be €26,567, but the operator has already effectively paid €22,480 for that period with its annual fee for 2 GHz.

The operator would initially need to pay the difference of $€26{,}567 - €22{,}480 = €4{,}087$ to cover the six months up to licence expiry, after which an annual fee of €53,133 would apply.

The new bandwidth formula resolves the issues raised by Eutelsat, OneWeb and SpaceX

We agree with the broad point advanced by Eutelsat, OneWeb and SpaceX that implementing the bandwidth charges using a linear formula might fail to meet ComReg's objectives of recovering administrative costs while encouraging efficient use of the spectrum (by not pricing off some types of SES operator), particularly if SES operators make use of new, high frequency bands in the foreseeable future. However, concerns about high prices for very large bandwidths must be balanced against ensuring that small bandwidth users are not priced off either. As set out above, a moderate concave schedule for fees as a function of bandwidth can balance these competing objectives.

We consider that the modifications to the fee schedule set out above resolve these concerns and so we do not recommend that ComReg adopts any of these respondents' alternative suggestions. We understand Eutelsat's and OneWeb's recommendations (caps at certain bandwidths/frequencies and implementing diminishing per MHz charges using band factors, respectively) as suggestions to mitigate the more general problem of fees, especially in the Q/V bands, being high enough to deter potential users. Given that a concave fee formula achieves the same objective (reducing high bandwidth fees relative to the linear proposal), we do not consider these suggestions in detail. However, we reiterate that the usual

justification for lower per MHz charges at higher frequencies (i.e. greater availability of spectrum relative to demand and, therefore, lower opportunity costs) does not apply here. The arguments put forward in ComReg's RIA and our previous report for only charging by bandwidth still hold, and a concave fee function is therefore preferable to introducing band factors.

SpaceX's statements that we had previously found no rationale for 'consumption based' fees, and that ComReg has not explained why higher bandwidth use increases administrative costs, are irrelevant. The former point is taken from a passage in our first report and was based on our understanding at the time. We have subsequently revised this view, and note that there is no reason why we (or ComReg) should be bound by preliminary statements at early stages of the review, particularly as we were also clear in that report that we would be making detailed recommendations on the fees in our second report. As explained above, ComReg's administrative costs do not vary significantly with the bandwidth being licensed, but this does not imply that all licences need to be charged a flat fee if there are other reasons for applying a different approach, as we have established. Fixed costs need to be shared across different users and simply dividing this equally across users irrespective of bandwidth used would be neither fair nor efficient.

On the contrary, we recommend that the *incremental* part of ComReg's administrative costs is recovered by a constant €100 charge for each licensee, but the remaining fixed part of costs is distributed to encourage efficient use of the spectrum by balancing the risks of pricing off different types of SES users. Therefore, it is also unlikely that the bandwidth-based fees would disadvantage consumers by taxing efficient use, as fees have been determined specifically to avoid this. It is only possible to reduce fees for higher bandwidth users by corresponding increasing them for lower bandwidth users, as fixed costs need to be recovered overall.

8 Technical conditions

Our previous report included a review of the technical conditions applying to SES licences, covering:

- the telecommunications equipment directive;
- reference standard;
- operation mode;
- maximum transmit power;
- site clearance;
- airport exclusion and notification zones;
- coordination;
- antenna diameter; and
- polarisation.

ComReg is generally well aligned with international practice for SES technical restrictions. However, we suggested that it could consider removing the site clearance rules for TES, given that these are not found in other jurisdictions and are not necessary for avoiding harmful interference (which operators are bound to do in any case).

8.1 Views of respondents

Amazon Kuiper supports the approach of aligning the technical licence conditions with international standards and European Directives and Decisions. However, it asks for further clarity in relation to:

- the polarisation aspect of the licence conditions; and
- the parameters associated with downlink operations in the Ka band.

Furthermore, it suggests putting in place a process for ensuring *"SES site locations and licensed spectrum are used for actual SES deployments"*.

SpaceX also supports incorporating the relevant ITU, CEPT and ETSI standards into ComReg's technical conditions where appropriate. It agrees that site clearance mechanisms are not required for preventing harmful interference and should be removed from the guidelines. However, it makes specific suggestions in relation to:

- Power limits, which should be aligned with international best practice. In SpaceX's view, limiting main beam EIRP to below 60 dBW would be detrimental to quality of service and conflict with the Radio Regulations, especially in the highest frequency bands. It requests that ComReg clarifies that any such limits do not apply to FES.
- Protection for airports, which should be aligned with ECC Report 272. SpaceX submits that operators often need to deploy

SES in close proximity to each other for access to other infrastructure (e.g. fibre). Therefore, overly conservative protection of airports risks unnecessarily limiting available sites for SES.

8.2 Assessment and recommendations

Site clearance

Site clearance conditions do not appear to be necessary to avoid harmful interference – we suggested that these could be dropped, and ComReg proposed to remove them from its SES guidelines. SpaceX supports this proposal, and no stakeholders have objected to it. We continue to recommend that ComReg removes the site clearance conditions.

Clarifications

Amazon Kuiper has requested clarification on two aspects of the technical conditions – those relating to polarisation and parameters for downlink Ka band operation. There are no explicit restrictions on the polarisation that SES can use, nor any suggestion or reason that some should be introduced. ComReg intends to publish antenna polarisation as part of its information policy to support coordination between operators, but this is a reporting requirement rather than a technical restriction.

It is also unclear precisely what Amazon Kuiper is referring to regarding Ka band downlink parameters. If it is referring to the 17.7-20.2 GHz band for licence-exempt terminals, then these parameters are provided in ComReg's document on licence exemptions (ComReg 20/47) and the international harmonisation decisions referenced therein (e.g. ECC/DEC/(00)07), whereas the parameters for licensed downlink operation for an SES are those in ComReg's SES guidelines.

Amazon Kuiper also suggests that ComReg should ensure licences are used for SES operation. If Kuiper' is suggesting that SES licences would be used for something other than operating an Earth station, then we cannot see that this is any great concern. As it is already the case that SES licences only grant the holder the right to operate an Earth station, there is no need to change the licence conditions to address this point. On the other hand, if Amazon Kuiper is concerned that licences would be taken out by operators who had no intention of deploying anything in the near future, then this is already taken account of in the proposed coordination process (i.e. these operators would not be able to block other potential licensees).

Power limits

ComReg does not list explicit transmit power limits for SES, except those deployed near airports. However, SES are subject to any power limits set out in relevant ECC and ITU documents. In our previous report, we suggested that, if ComReg wanted to set power limits for each band, it could do so based on ETSI standards – for bands above 12 GHz, the EIRP limits in these ETSI standards give a

range that is bounded below by 60 dBW. However, we did not suggest that ComReg necessarily needed to set specific limits if its current approach worked well. Clarifying that the power limits set in the relevant ECC Decisions and Reports and ITU recommendations apply is a suitable approach.

SpaceX has asked that power limits are aligned with international best practice (including ECC/ITU documents) and that no power limits below 60 dBW apply to FES. However, under ComReg's proposals, power limits satisfy both of these requests (although stricter limits are in place for licence-exempt terminals and it is in theory possible that stricter limits for high frequency FES could be included in future international harmonisation measures). We recommend that ComReg continues with its proposed approach of applying the technical limits set out in the relevant ECC/ITU documents and clarifying in its SES guidelines that this is the case.

We expect that, ComReg's technical conditions for operating SES near airports will also align with ECC documents, including ECC Report 272. However, we note ComReg's airport exclusion zones are stricter than the measures described in ECC Report 272, in that the ECC report defines a smaller area in which SES cannot operate, and a wedge-shaped area (of similar size to ComReg's exclusion zones) in which there are tighter power limits, but no outright ban on operating. We agree with SpaceX that SES operators benefit from being close to other infrastructure e.g. fibre, but it is not clear whether the airport exclusion zones are particularly restrictive in practice. In any case, we highlight that SES operation within an airport exclusion zone is already possible, with the prior agreement of the relevant airport operator, under the current SES guidelines.

Annex A Annex heading

[PLACEHOLDER – REMOVE ON FINAL EDIT]