25th October 2024

Shri Akhilesh Kumar Trivedi Advisor (Network, Spectrum and Licensing) Telecom Regulatory Authority of India

Subject: SpaceX and Starlink India's Response to Consultation Paper on "Terms and Conditions for Assignment of Spectrum for Certain Satellite-Based Commercial Communication Services"

Dear Sir,

Please find enclosed SpaceX and Starlink India's submission to the ongoing consultation on the crucial issue of assignment of spectrum for satellite services. It is critical that TRAI and the Government of India ensure and recommend access to all bands allocated to satellite services under the NFAP, on a shared basis for all satellite service providers, and at a spectrum access charge that is focused on administrative cost recovery.

This will enable affordable access to broadband via satellite for those who need it the most, enable the establishment of a satellite broadband ecosystem that is focused on the long-term, and align operators' contributions with sectoral performance.

We thank TRAI for the opportunity to participate in this consultation.

Sincerely,

Parnil Urdhwareshe

Director Starlink Satellite Communications Private Limited

Visit us at <u>www.starlink.com</u> and <u>www.spacex.com</u>

Responses to Select Questions / Issues -

Terms and Conditions for the Assignment of Spectrum for Certain Satellite-Based Commercial Communication Services

Q1. Which frequency band(s)/ range(s) should be considered for the assignment to NGSO based Fixed Satellite Services for providing data communication and Internet service? Please provide a detailed response separately for the user link and feeder link.

AND

Q2. Which frequency band(s)/ range(s) should be considered for the assignment to GSO/NGSO based Mobile Satellite Services for providing voice, text, data, and Internet service. Please provide a detailed response separately for the user link and feeder link.

Several of the world's largest satellite operators (including SpaceX) are taking substantial steps in preparation for providing Indian citizens with universal access to broadband of the quality that urban users currently take for granted. Ensuring that next-generation satellite systems have predictable access to shared spectrum (now and in the future) is the single most important factor towards achieving this shared goal.

SpaceX and Starlink India thus strongly recommend ensuring the availability of all frequency bands allocated to satellite services (FSS and MSS) under the Indian National Frequency Allocation Plan and at the International Telecommunications Union. These include –

| Frequency band | Space to Earth (GHz) | Earth to Space (GHz) | Service |
|----------------|----------------------|--------------------------|----------|
| VHF | 0.137-0.138 | 0.148-0.15005 | FSS |
| Ku band | 10.7-12.75 | 12.75-13.25 | |
| | | 13.75-14.0 | |
| | | 14.0-14.5 | FSS |
| | | 14.5-14.8 | |
| | | 17.3-18.1 | |
| Ka Band | 17.7-21.2 | 27-31 | FSS /MSS |
| Q/V Band | 37.5-43.5 | 47.2-50.2 | FSS |
| | | 50.4-51.4 | |
| E Band | 71-76 | 81-86 | FSS |
| D Band | 123-130 | Please see footnote.¹ | FSS |

¹We recommend including frequencies ranging from 123 to 130 GHz, 158.5 to 164 GHz, and 167 to 174.5 GHz (which are

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| 158.5 to 164 | |
|--------------|--|
| 167 to 174.5 | |

Consistent with submissions made during the TRAI's previous consultations on assignment of spectrum for space-based services, as well as on the assignment of spectrum in E&V bands, SpaceX and Starlink India submit that - in addition to the critical workhorse Ku-Band and Ka-Band spectrum - it is equally important for the TRAI to prioritise the availability of spectrum allocated to satellite services in higher bands for use by FSS gateway earth stations on a non-exclusive basis.

It is well-established that with proper coordination, satellite spectrum can be simultaneously used by numerous satellite operators on a shared basis (as well as with certain fixed-link users). At the same time, the total capacity that can be unlocked by any one satellite FSS gateway station within the Ka-band is still finite. As next-generation systems such as Starlink finally enable affordable broadband access for millions of unconnected people around the world, consumer demand from users unserved by terrestrial networks will soon begin to outstrip the carrying capacity achievable through limited numbers of Ka-band gateways alone. As a result, satellite operators (including SpaceX) have been developing and deploying gateways that can augment network capacity and performance through the use of higher bands. Moreover, the pencil-thin beams that are characteristic of these higher frequencies make them easier to coordinate and can even be administered using a simple database.

To keep pace with consumers' growing need for high-speed, low-latency service (as well as ensure adequate capacity for emergencies), the TRAI must recommend enabling access to additional higher-band spectrum identified for satellite use within India's National Frequency Allocation Plan for shared use by FSS gateway earth stations.

Q3. What should be the maximum period of assignment of spectrum for -

- (a) NGSO based Fixed Satellite Services for providing datacommunication and Internet services; and
- (b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response along with international practice in this regard.

SpaceX and Starlink India recommend that spectrum for NGSO based satellite services should be assigned for a twenty-year period. Given that satellite spectrum (unlike IMT spectrum) will be assigned to operators on a shared basis, assigning spectrum for a twenty-year period will not diminish the ability of future satellite market entrants to also access the same spectrum when they need it.

The value of next generation satellite broadband systems such as Starlink in enabling universal and affordable access to real broadband has been demonstrated beyond doubt over the past few

allocated to FSS, although currently only in the space-to-Earth direction which appears to be imbalanced with respect to the Earth-to-space direction in those frequencies). Today, the fixed-satellite service is allocated to FSS at the ITU and under the Indian National Frequency Allocation Table on a co-primary basis in a number of promising spectrum bands above 100 GHz, including several bands in the Space-to-Earth direction (e.g., 123-130 GHz, 158.5-164 GHz, 167-174.5 GHz, and 232-240 GHz) and others in the Earth-to-Space direction (e.g., 209-226 GHz and 265-275 GHz). In terms of prioritization of these frequencies for assignment, frequencies closer to 100 GHz—including the 120-170 and 210-310 GHz bands—are more useful to serve consumers of fixed-satellite services in the near term than even higher frequency bands. All of these frequencies allow NGSO operations under India's NFAP 2022.

years. SpaceX and Starlink India submit that the TRAI's assessment of the appropriate period of spectrum assignment should thus be guided by a simple principle – maximizing accessibility to next generation satellite broadband for any and all Indians who want and need it.

Indian users who seek access to affordable next-generation satellite broadband services such as Starlink are likely doing so because their current options are too expensive, too unreliable, or non-existent. As a result, the TRAI must ensure that satellite broadband services are affordable, reliable, and universally available. Doing so requires the TRAI to recommend initial conditions for satellite broadband providers that are favourable, predictable, and fair.

The TRAI correctly recognizes the importance of ensuring sufficient certainty for satellite broadband providers to be able to plan for the recovery of their capital investments. Longer and more predictable time horizons of continued access to critical spectrum will incentivize all satellite operators to focus on affordable pricing and longer-term business plans – thus maximizing the number of users who can access these services. This is essential for ensuring that satellite broadband serves those who need it the most as soon as possible, while also supporting the establishment of a healthy satellite broadband ecosystem.

Conversely, short periods of validity (and thus reduced predictability) will force the satellite broadband industry to focus on the short-term by prioritizing the recouping of costs as quickly as possible, thus diminishing operators' ability to focus on maximizing affordability at scale Deploying satellite service at scale in India will require major investments that require long-term certainty. Without the confidence of a longer-term license, satellite operators will be forced to limit their investments to hedge against uncertainty. As a result, service to India will be more limited, providing fewer people access and lower quality options.

Q4. For assigning spectrum for NGSO-based communication services, whether every ITU filing should be treated as a separate satellite system? Please provide a detailed response along with international practice in this regard.

SpaceX and Starlink India submit that the number of ITU filings has no association with the assignment of spectrum for NGSO-based communication services, and strongly recommend against the TRAI forcing such an association.

NGSO authorisations by both the Ministry of Communications as well as IN-SPACe are correctly granted based on the overall systems, not individual filings. This is for the simple reason that the satellite broadband *service* is enabled by the overall NGSO systems, irrespective of the number of ITU filings. Once an NGSO system is authorised to provide service, it would be counter-productive to artificially restrict access to critical spectrum, increase satellite operators/licensee input costs, and reduce affordability for end-users, on the basis of an immaterial and extraneous non-technical factor such as the number of ITU filings. This is especially because multiple ITU filings for NGSO systems is an established and accepted practice by the ITU itself to address shortcomings in its processes—not technical realities.²

- Q5. Whether the provisions of ITU-RR are sufficient to resolve interference related challenges and coordination issues? If not, whatadditional conditions should be prescribed while assigning frequency spectrum for
 - (a) NGSO based Fixed Satellite Services for providing datacommunication and

² https://docs.fcc.gov/public/attachments/FCC-22-91A1.pdf

Internet services; and

(b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response alongwith international practice in this regard.

SpaceX and Starlink India submit that the provisions of the ITU-RR are sufficient to resolve any possible interference issues, and that the sharing of satellite spectrum should be left to mutual coordination that allows operators to coordinate in good faith and reach agreements that best meet the needs of their specific systems.

Coordination is the "gold standard" for ensuring efficient spectrum sharing that promotes competition and high-quality service for consumers. SpaceX has extensive experience coordinating with other satellite operators and has successfully reached global coordination agreements with dozens of other operators. Further, SpaceX shares all of the spectrum it uses worldwide with other operators and services, and has not received any substantiated claims of actual harmful interference based on its operations.

NGSO satellite networks are designed to share the spectrum allocated to them (and allow future entrants into the same spectrum bands), rather than requiring exclusive spectrum access that precludes competition. Indeed, spectrum sharing across the entirety of the globally harmonized FSS bands is a core aspect of these systems. Next generation satellite systems have thus made sizable investments towards cutting-edge technology to optimize the use of the same spectrum by several different operators at once in order to best serve consumers with a variety of solutions.

Because well-designed NGSO satellite systems are designed for global operations, a sharing environment based on mutual coordination is fundamental to how such systems optimise frequency use. Well-designed systems leverage (1) advanced satellites that use narrow and steerable beams, (2) extremely advanced user terminals that immediately react to interference, and (3) systems that leverage the propagation characteristics of higher frequency bands to incorporate reuse and sharing of spectrum as baseline design parameters alongside global coordination with other operators. As a result, operating such systems depend on globally harmonious approaches to spectrum use, technology, and regulatory environments.

SpaceX urges the TRAI to adopt a framework that encourages inter-operator coordination and includes a mandate for good faith coordination, but does not condition operation on completed coordination. This will put the incentive on both operators to actively engage, but not give incumbents the ability, or incentive, to act anti-competitively.

- Q6. For satellite earth station gateways of different satellite systems operating in the same frequency range, whether there is a need to prescribe a protection distance or any other measures to avoid interference from each other—
 - (a) Between the gateways of GSO and NGSO systems; and
 - (b) Between the gateways of NGSO systems?

If yes, please provide a detailed response alongwith international practice in this regard.

The TRAI need not establish minimum protection distances to enable satellite operators to share

spectrum. These minimum separation distances have the perverse effect of constraining efficient sharing and reducing incentives for operators to improve their systems to better share spectrum with others.

Gateways can easily be coordinated to allow them to coexist in close proximity, and the specifics of this involve a routine engineering analysis to assess potential interference issues given the technical and physical characteristics of the sites at issue, include exact location, terrain, fencing, etc. In fact, SpaceX routinely coordinates gateway placements with other operators. Conversely, allowing operators to claim large exclusion zones if they designed their systems to be particularly sensitive to interference would only encourage poor system design and anti-competitive tactics.

Rather than adopting an arbitrary separation distance, the TRAI should adopt a simple coordination framework that encourages cooperation, competition, and efficient use of spectrum. For example, if coordination between two gateway operators is not able to be completed after good-faith efforts, the TRAI could consider a spectrum-splitting last resort. In such a last resort, operators would have to evenly split available spectrum (1) only in the event of in-line events, (2) only for the duration of in-line events, and (3) only if they have not completed private coordination before they both commence service. Ideally, this backstop would never be used because the prospect of non-ideal spectrum splitting will incentivize both operators to find a better solution through coordination. To create further incentives to build efficient systems, regulators could also consider awarding first choice in the split to the more efficient, flexible, and robust system. But in no event, should the TRAI reward poor system design and exclusionary tactics by granting exclusion zones to operators that fail to invest in robust systems designed to facilitate sharing.

Q7. In case the spectrum assigned for satellite gateway links is also assigned to terrestrial networks such as Fixed Service, IMT etc., what protection distance or criterion should be included in the terms and conditions of the assignment of spectrum for satellite gateway links to avoid any interference to/ from terrestrial networks? Please provide a detailed response along with international practice in this regard.

SpaceX strongly recommends against licensing satellite gateway spectrum for terrestrial IMT use cases at this time. Next-generation satellite systems depend on full access to the assigned gateway spectrum for providing high-speed, low-latency broadband service to consumers. To achieve low-latency service and reduce infrastructure costs that can affect the affordability of broadband service for end users, satellite operators also require flexibility to place gateway sites near essential ground infrastructure, including data centres and fiber optic cables near urban areas. To enable high-quality and affordable broadband for underserved users everywhere, satellite operators must be able to deploy gateways in urban regions.

One of the goals of this consultation as outlined by the TRAI is to mitigate the risk of scarcity for gateway sites. Because IMT deployments in the satellite gateway spectrum bands typically focus on urban areas, introducing IMT into the band would make it more difficult for satellite operators to deploy gateway sites by reducing available bandwidth and reducing the ability to deploy need ground infrastructure.

SpaceX also notes that mobile use of the millimetre wave bands has been slow, if not non-existent, making it untimely to consider allowing IMT services in more MMW bands. In fact, countries that have attempted to include IMT in these spectrum bands have seen extremely low auction prices and many unsold licenses, while also unnecessarily slowing satellite deployments. If the TRAI still adopts a shared-use framework for including IMT in these bands, that framework must clarify that any IMT deployments must be secondary to satellite gateways in the band in order to avoid needlessly constraining the deployment of satellite gateways.

Q8. In case the spectrum assigned to the satellite user link is also assigned to terrestrial networks such as Fixed Service, what criterion should be included in the terms and conditions of the assignment of spectrum for satellite user links to avoid any interference to/ from terrestrial networks? Please provide a detailed response along with international practice in this regard.

SpaceX and Starlink India strongly recommend against allowing fixed link or other terrestrial services in the satellite user link bands, which would create extreme challenges for the deployment of next generation satellite services.

Satellite systems are forced to operate at extremely low power levels, which means user terminals must be very sensitive to communicate effectively with distant satellites. SpaceX has filed extensive technical details in this regard in the United States in a proceeding before the Federal Communications Commission on exploring flexible use of the 12.2-12.7 GHz band. SpaceX and other satellite operators have clearly demonstrated that the addition of any high-power terrestrial service in the satellite user terminal bands and in adjacent bands would cause devastating interference to satellite user terminals.

Q9. Whether there is a need to prescribe any conditions to mitigate the risk of scarcity of satellite gateway sites? If yes, please provide a detailed response along with international practice in this regard.

SpaceX and Starlink India submit that as long as the TRAI recommends ensuring access to sufficient spectrum, adopting coordination procedures (including a back-stop last resort only in case of failed coordination), and providing appropriate protection from other services, there should be no scarcity of gateway sites.

- Q10. In addition to the roll-out conditions recommended by TRAI for satellite-based Telecommunication Service Authorisation through its recommendations on the Framework for Service Authorisations to be granted under the Telecommunications Act, 2023 dated 18.09.2024, whether there is a need to impose certain additional roll-out obligations for the assignment of frequency spectrum for
 - (a) NGSO based Fixed Satellite Services for providing datacommunication and Internet services;
 - (b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response along with international practice in this regard.

SpaceX and Starlink India submit that there is no need for any additional roll-out obligations for the assignment of frequency spectrum beyond what has already been recommended by the TRAI for satellite-based authorization.

SpaceX and Starlink India recognise the value of rollout obligations for terrestrial mobile operators

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³ https://www.fcc.gov/ecfs/search/search-filings/results?q=(proceedings.name:(%2220-443%22))

in order to ensure that their exclusive access to spectrum is met with a concomitant usage of that spectrum in providing services to end-users. Terrestrial operators that obtain exclusive access to spectrum preclude the use of that spectrum by others, and it is essential to ensure that the spectrum they have exclusive access to does not remain fallow. However, in the case of shared access to satellite spectrum, operators are <u>not</u> precluded by each other from rolling out services in any way. Additionally, space-based communications services such as Starlink already generally provide complete geographic coverage from the initiation of service, rendering rollout obligations unnecessary.

As a result, there are already clear and strong market incentives for operators to ensure rapid rollout as long as the framework for shared access to satellite spectrum is favourable, predictable, and fair. Simply ensuring shared access based on good-faith coordination amongst all satellite operators does away with the need for rollout obligations as a pre-condition for access to spectrum or as a means of ensuring that it will be productively used.

At the same time, the TRAI should be cautious about not allowing circumstances where entities that have secured access to spectrum but are not progressing to build and operate their sites or systems still seek protections against operating systems.

Q12. Whether there is a need to prescribe timelines for processing the applications for the assignment of frequency spectrum for-

- (a) NGSO based Fixed Satellite Services for providing data communication and Internet services;
- (b) GSO/ NGSO based Mobile Satellite Services for providing voice, text, data, and Internet services?

Please provide a detailed response with justifications.

SpaceX and Starlink India strongly support the TRAI's comments on ensuring that satellite spectrum applications are processed within short and defined timelines. This is important not only because delay in spectrum assignment results in the non-utilization of satellite resources (as the TRAI correctly notes), but also because it leads to hesitation on deployment of ground infrastructure and delays the provision of affordable access to broadband services to those who need it the most.

Q14. Should spectrum charges for NGSO-based FSS providing datacommunication and Internet services, be levied:

- i. On a per MHz basis,
- ii. On a percentage of Adjusted Gross Revenue (AGR) basis, or
- iii. Through some other methodology?

Please provide a detailed justification for your answer.

SpaceX and Starlink India submit that access to shared spectrum by NGSO services in India is clearly best managed by charging operators a reasonable percentage of Adjusted Gross Revenue driven by administrative cost recovery. The TRAI's previous recommendations of charging a low

percentage of AGR are even more applicable to the NGSO environment because—simply put—such an approach will encourage all satellite operators to rapidly provide service and maximise the business case for serving those who need it the most. It will reward system efficiency and growth, while also supporting the growth of smaller operators. It is also effective in its simplicity.

As has been discussed extensively in the TRAI's previous consultations, the reasonable percentage of AGR approach is (1) immune to the current lack of information for projecting demand and supply of satellite broadband in India, (2) recognizes the fact that the spectrum is shared, (3) ensures that operators' contributions are commensurate with their success as well as the scale of their operations, (4) maintains transparency, and (5) sets the stage for a healthy market structure that can accommodate several operators of differing sizes (now and in the future).

For completeness, SpaceX and Starlink India strongly recommend against pricing access to shared spectrum on a per MHz basis. Not only is there no information for India to efficiently price satellite spectrum this way, it is also a legacy approach conceived of in a past with fundamentally different technical and business environments when satellites provided far lower service quality at far smaller scales.

Today's next generation NGSO systems *must* have access to large contiguous bands of shared spectrum to enable high quality service by operating in a manner that is frequency agile and more suitable to dynamic inter-operator coordination. Front loading disproportionately high costs via a per MHz pricing formula would simultaneously punish both large scale operations for being efficient as well as burden smaller current and future operators – eventually preventing unserved users from finally being connected. Previous attempts to levy fees on a per-megahertz basis are generally targeted to lower-frequency, exclusive-use licenses where the licensee needs only a few megahertz but gets total access to the band. In contrast, satellite systems share high frequencies, meaning they must use many more megahertz to operate and they never get exclusive use to any bands. The per-megahertz approach is fundamentally incompatible with next-generation satellite systems.

- Q15. In case it is decided that spectrum charges for NGSO-based FSS providing data communication and Internet services should be levied on a per MHz basis, should these charges be calculated based on:
 - i. The Department of Telecommunications (DoT) order dated December 11, 2023, or
 - ii. An alternative approach (please specify)?

Please provide a detailed justification to support your answer.

AND

- Q19. If it is determined that spectrum charges for GSO/NGSO-based MSS providing voice, text, data, and Internet services should be levied on a per MHz basis, should these charges be calculated based on:
 - i. The Department of Telecommunications (DoT) order datedDecember 11, 2023, or
 - ii. An alternative approach (please specify)?

Please provide a detailed justification to support your answer.

As stated above, SpaceX and Starlink India strongly recommend against spectrum charges for shared satellite spectrum being levied on a per MHz basis.

- Q16. If it is decided that spectrum charges for NGSO-based FSS providing data communication and Internet services should be levied on a percentage of AGR basis:
 - i. What should be the appropriate percentage of AGR?
 - ii. Should a minimum spectrum charge be specified to address the issue of inefficient utilization of spectrum? If yes, what methodologymay be used to determine the amount of the minimum spectrum charge?
 - iii. Is there an alternative approach that could be followed to address the issue of inefficient spectrum utilization?

Please provide a detailed justification for your answers.

AND

Q17. Considering the Adjusted Gross Revenue (AGR) based charging methodology currently followed for Commercial VSAT and in view of the enhanced scope of the Satellite service authorisation, what should be the spectrum charge, as a percentage of AGR, that should be levied on GSO-based FSS? Or,

Should some alternative spectrum charging methodology be used for determining spectrum charges for GSO-based FSS?

Please provide a detailed justification for your answer.

AND

- Q18. Should spectrum charges for GSO and NGSO-based MSS that provide voice, text, data, and Internet services be levied:
 - i. On a per MHz basis,
 - ii. On a percentage of AGR basis, or
 - iii. Through some other methodology?

Please provide a detailed justification for your answer.

AND

- Q20. If it is decided that spectrum charges for GSO/NGSO-based MSS providing voice, text, data, and Internet services should be levied on a percentage of AGR basis:
 - i. What should be the appropriate percentage?
 - ii. Should a minimum spectrum charge be specified to address the issue of

inefficient utilization of spectrum? If yes, what methodology may be used to determine the amount of the minimum spectrum charge?

iii. Is there an alternative approach that could be followed to address the issue of inefficient spectrum utilization?

Please provide a detailed justification for your answers.

SpaceX and Starlink India submit that the charge for accessing shared spectrum focus on administrative cost recovery and be set at less than 1% of Adjusted Gross Revenue (AGR). Access to satellite spectrum is shared – it is a communal resource that is not "held" by any one operator. As a result, the degree of any one operators' use does not prevent its use by another, and pricing access to shared satellite spectrum does not have the issues that affect exclusive assignments. At the same time, there are several direct benefits to an administrative cost recovery percentage –

- (1) Affordable internet for those who need it the most: The most important goal of this consultation is to make internet access more affordable for all, especially those who are not yet served by the existing market and thus need it the most. A percentage of AGR guided by administrative cost recovery will mean all satellite operators can offer broadband at lower prices, especially benefiting rural and unserved Indian users.
- (2) Level playing field: Different satellite operators have varying system sizes and operating costs, but all share the same spectrum. An administrative cost recovery based AGR percentage levels the playing field by granting smaller and newer entrants the space to invest in scaling their systems and improving quality of service. Conversely, a high percentage of AGR only creates barriers to entry for smaller operators.
- **(3) Encourages the long term:** Reasonable regulatory overheads help operators make investments in infrastructure for the long term, improving service quality improvements as well as more affordable prices for more users.
- (4) Aligns operator contributions with sectoral performance: While any percentage of AGR model allows operator contributions to scale with their market performance and revenue, a lower percentage reduces entry barriers and allows more competition amongst operators, all of whom will seek to expand their addressable user bases, resulting in greater sectoral contributions over time.

SpaceX and Starlink India also submit that a "minimum spectrum charge" is both unnecessary and could in fact decrease efficient utilization –

- It is unnecessary because the spectrum is shared, meaning (1) no one operator prevents others from using it more efficiently, and (2) all operators are incentivized to use it more efficiently in order to stay competitive.
- It is counter-productive because it will create a barrier to entry for newer and smaller operators, thus reducing competition and innovation, reducing the number of operators sharing spectrum, and reducing incentives for existing operators to use spectrum more efficiently.

The most effective way for the TRAI to prevent inefficient utilization would be to encourage market entry and healthy competition, which would also improve consumer choice and affordability. Instead of imposing minimum charges in the hope of preventing bad behavior, SpaceX and Starlink India urge the TRAI to instead focus on ensuring good faith coordination amongst operators and rewarding more efficient approaches to sharing.