Draft Light Licensing Regulations
for the 4 GHz Frequency Band

First Version
August 2023

## Version Control Table

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1. Introduction

In accordance with the Telecommunications and Information Technology Act (the ‘Act’) issued by Royal Decree No. (M/106) and dated 2/11/1443 AH, the Act’s Bylaw, and the Communications, Space and Technology Commission (CST) Ordinance (Ordinance), CST issued the Light-Licensing Regulations for the 4 GHz Frequency Band. The regulations aligns with CST’s goals to achieve efficient use of spectrum, enable emerging technologies, and promote competition and transparency in spectrum management.

The Kingdom is seeing increasing demand for access to spectrum for new, localized, wireless applications in frequency bands that are currently allocated for other services. CST seeks to facilitate innovation and encourage investment in new wireless services by enabling private 5G networks through light licensing in the 4000-4200 MHz band. The 4 GHz light licensing regulations enable spectrum sharing with incumbent users and it ensure the protection of adjacent incumbents such as radio altimeters in the 4200-4400 MHz band from harmful interference.

In addition, CST plans to release another public consultation for the light licensing regulations for the 6 GHz frequency band later this year. The light licensing in the 6 GHz utilizes the Automated Frequency Coordination System (AFC) to enable WiFi6E standard power operations for indoor and outdoor, and support a wide range of application such as industrials, public amenities and warehouses. Therefore, CST recognizes that there are similarities between the use cases and applications of private 5G networks and WiFi6E where one of the two would suffice. Thus, CST wishes that readers will consider those similarities when reviewing this document and provide their feedback on the use of either technology, i.e., 5G or Wi-Fi when answering the consultation questions.

**Kindly answer the following questions (1-4), from end-user perspective:**

**Q1:** Do you have any plans for private wireless networks deployment? If yes, please share some details.

**Q2:** What applications do you currently use and/or planning to implement through private wireless networks?

**Q3:** Please elaborate on how light licensing in the 4GHz band can satisfy your demand for private wireless network deployment?

**Q4:** Are you currently running your own network? What are the pros and cons of running your own network?
Kindly answer the following questions (5-8), from service-provider perspective:

Q5: What is your vision for private wireless networks as a service provider?

Q6: What applications do private wireless networks enable?

Q7: Please elaborate on how light licensing in the 4GHz band can utilize 5G capabilities for applications in Q6?

Q8: If service providers were allowed to obtain a 4 GHz light-license, would you be interested to provide infrastructure only or provide infrastructure and operating the network for the end-user?

2. Definitions

The words and phrases that are defined in the Act, the Light-Licensing Regulations, and other decisions issued by CST will have the same meaning when used in this Document, and the following words and expressions will have the meanings associated with them, unless clearly indicated otherwise.

2.1. **4 GHz Light License**: A license authorizing base station and user terminal deployments in the 4 GHz band subject to the provisions of this Document.

2.2. **Low-power license**: A 4 GHz Light License which authorizes low-power operations, as specified in this Document, of any number of base stations within a 50-meter radius centered on the coordinate specified in the license, as well as any connected user terminals.

2.3. **Medium-power license**: A 4 GHz Light License which authorizes medium-power operations, as specified in this Document, of one base station as well as any connected user terminals.

2.4. **Indoor**: Inside a premises delimited by walls and a ceiling or roof; and which are wholly enclosed except for doors, windows, or passageways. For the avoidance of doubt, this definition does not encompass any moving vehicles such as cars, ships, trains, or aircraft.

2.5. **Outdoor**: A location inside a campus but not delimited by walls and a ceiling or roof.

2.6. **Base station**: A fixed transceiver which may be deployed indoors or outdoors and communicates with fixed or mobile terminals in the same network.
2.7. **User terminal**: A fixed or mobile transceiver which may be deployed indoors or outdoors and communicates with base stations in the same network.

2.8. **Public Telecommunications Network**: National or international wire or wireless telecommunication system (or systems) intended to provide a public telecommunications and information technology service in specific areas and to specific users.

2.9. **Private wireless network**: A wireless network that is not connected directly to a public telecommunications network, and is intended to provide service in specific areas and to specific users.

2.10. **Effective Isotropic Radiated Power (EIRP)**: This is the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

2.11. **Power Flux Density (PFD)**: The amount of power flow through a unit area within a unit bandwidth.

2.12. **Total Radiated Power (TRP)**: A radio frequency (RF) engineering term used to describe the sum of all power radiated by an antenna connected to a transmitter.

2.13. **3rd Generation Partnership Project (3GPP)**: A body that develops standards for mobile technology.

3. **Scope of 4 GHz Light-License Document**

This document shall apply to lightly licensed users in the 4 GHz band for the purpose of deploying private wireless networks.

4. **Eligibility**

4.1. Any national organization or private entity with a commercial registration license in the Kingdom may apply for a 4 GHz Light License so long as such organizations and entities comply with applicable CST regulations, including the provisions set forth in this document.

4.2. Only applicants and light-licensed users that have a valid ownership right to the premises on which the light-licensed radio station will be located, or a right to use such premises (e.g., a lease) or valid authorization from the holder of such a right will be eligible to hold a 4 GHz Light License.

4.3. Nothing in this Document should be construed to limit the ability of light-licensed users to contract with a third party for the development and operation of their light-licensed network.
CST is considering the possibility of limiting the eligibility of access to the 4 GHz Light License for only an authorized operator. The possible options are as follow:

1. The eligibility for the light license in the 4 GHz frequency band is limited to license holders of Facilities-Based Unified Telecommunications Services license.

2. The eligibility for the light license in the 4 GHz frequency band is limited to the license holders of Specialized Wireless Telecommunication Services license.

3. Dividing the 4GHz band among the national organizations or private entities as specified in section (4.1) and license holders of Facilities-Based Unified Telecommunications Services license or license holders of Specialized Wireless Telecommunication Services license.

Q9: Are any of the above eligibility options more economically and regulatory feasible than the position in section 4? Please provide benchmarking evidence to support your answer.

Q10: Do you have another alternative approach to the eligibility conditions for the 4 GHz Light License?

Q11: Are there any other matters related to the eligibility that CST should consider?

5. 4 GHz Light-License Types

5.1 Applicants for a 4 GHz Light License may apply for either a low-power or medium-power license, consistent with the requirements provided in this Document. requirements will ensure adequate protection of incumbents in the 4 GHz band and radio altimeter operations in the adjacent band.
5.2. To the extent a wider operational area is desired, a user may file additional light-license applications, which will also be subject to the requirements specified in this Document.

![Light-License Types Diagram](image)

**Figure 1: Low Power and Medium Power Operational Schemes**

6. **License Term and Renewal**

6.1. 4 GHz Light Licenses are granted for a period of five Gregorian years, unless modified, suspended, or terminated by CST. The license term commences once CST issues the license.

6.2. 4 GHz Light Licenses can be renewed for additional five Gregorian-year terms upon request from the user within 30 days before the expiration of the current license.

6.3. CST retains the right to reject any request for new applications or renewal in accordance with the applicable CST regulations and directions.

Q12: What is your input regarding the available license term (5 years) for 4 GHz Light License? Do you recommend a period less than 5 years? Why?

Q13: Are there any other matters related to the license term and renewal that CST should consider?
7. License Modification and Cancellation

7.1. Licensees may request to update the technical parameters of their 4 GHz light license, and CST – at its discretion - has the right to review the update request and accept or reject it.

7.2. CST has the right to update or cancel the 4 GHz light license if it appears that the licensee is not complying with the light-licensing regulations for the 4 GHz frequency band or for other reasons that CST deems relevant.

Q14: Are there any other matters related to the license modification and cancellation that CST should consider?

8. Fees

8.1. 4 GHz Light Licenses are subject to annual fees, which are calculated using the “Frequency Licensing Fees Regulations” published on CST’s website. The annual fee differs based on the geographical location of the license as shown the table (1) below:

<table>
<thead>
<tr>
<th>Bandwidth Authorized (MHz)</th>
<th>Radio Station in High-Usage City Fee (SAR)</th>
<th>Radio Station in Other City Fee (SAR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>16000</td>
<td>8000</td>
</tr>
<tr>
<td>40</td>
<td>32000</td>
<td>16000</td>
</tr>
<tr>
<td>60</td>
<td>48000</td>
<td>24000</td>
</tr>
<tr>
<td>80</td>
<td>64000</td>
<td>32000</td>
</tr>
<tr>
<td>100</td>
<td>80000</td>
<td>40000</td>
</tr>
</tbody>
</table>

Table 1: The annual fee applicable to the 4 GHz Light License

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1. High-Usage City and Low-Usage City has been defined in “Frequency Licensing Fees Regulations” (Fees Regulation) published on CST’s website.
8.2. A light-licensed user must pay an annual fee in accordance with the table in Section 8.1 within 60 days following receipt of an invoice from CST. A failure to timely pay an annual fee may result in the termination of the light-licensed user’s authorization.

Q15: Are there any other matters related to frequency fees that CST should consider?

9. Application Process

9.1. Applicants for a 4 GHz Light License will need to complete the applicable form which is attached hereto as Appendix B.

9.2. Applicants must submit the application form via email or other medium that CST makes available.

9.3. Light-license applications can be submitted at any time and CST will review such applications on a per location, per frequency, first-come, first-served basis vis-à-vis other light-licensees in the 4 GHz band.

9.4. Each light-license application will be analyzed by CST to determine if proposed operations would coexist with incumbent users and existing light licensees, using the coordination approach specified in this document.

9.5. CST will notify the applicant of the outcome of CST’s review and, if successfully coordinated, assign the applicant a frequency to transmit on in the location specified in the application.

9.6. CST will also send an invoice and request the initial annual fee which is due to CST within 60 days of the invoice date. After the payment, the license will be issued electronically.

9.7. When an application is rejected, CST may provide feedback to the applicant upon request, including providing applicants with information on the margins by which the coordination thresholds were exceeded.

Q16: Are there any other matters related to the application process that CST should consider?
10. Frequency Assignments

CST allows those who request a 4 GHz Light License the option to choose from one up to five adjacent channels with a bandwidth of 20 MHz per channel. Additionally, CST—at its discretion—may license different bandwidths if needed.

Q17: Is there an actual need for channels greater than 20 MHz? If yes, please justify your answer with evidence detailing the uses cases and actual need.

Q18: Are there any other matters related to frequency assignments that CST should consider?

11. General Conditions

11.1 Commencement of operations.

11.1.1 All light-licensed users must commence operations within 6 months of the start of the light-license term. The 4 GHz Light License will automatically terminate without further notification from CST if a light-licensed user fails to meet this requirement. Light-licensed users must notify CST by email within 10 days of commencing operations and provide their license number in the subject line of the email.

11.1.2 Light-licensed users must continue to operate consistent with their 4 GHz Light License, and any subsequently authorized modification, throughout the applicable term and any renewal terms. An operator that fails to comply with this condition may have their license revoked upon 30-days’ notice. Nevertheless, operators may cease operations for limited periods of time not to exceed 60 days for maintenance or as otherwise required or permitted by CST.

Q19: Would 6 months be sufficient to commence operation a private network? If no, please provide reasoning and supported evidence.

Q20: Is the 60-day timeline enough for maintenance stoppage? If no, please provide reasoning and supported evidence for alternative time limits.
11.2. Frequency tuning.

11.2.1. CST reserves the right to reassign authorized frequencies of a light-licensed user to address spectrum planning or interference concerns, or for any other purpose deemed necessary by CST. Light-licensed users will be informed of the new frequencies and provided time to transition to such frequencies accordingly.

11.2.2. light-licensed users should deploy equipment which is capable of being tuned throughout the 4000-4200 MHz band.

11.3. Equipment Type Approval

11.3.1. All equipment must be type approved by CST before imported into the Kingdom.

11.3.2. All equipment must:

11.3.2.1. Comply with relevant technical specifications published on CST website.

11.3.2.2. Comply with technical conditions in section (12) and appendix (A).

11.3.2.3. Obtaining a certificate for type approval from CST before applying for a customs clearance.

11.4. Licensee records.

11.4.1. Light-licensed users must keep records of their deployed equipment, frequencies used for transmit and receive operations, and records of an ownership right to the premises where the equipment is located (or a right to operate there) and light-licensed users must provide such information upon request by CST within three business days. This will allow CST to respond to interference complaints when reported and investigate the source of interference.

11.4.2. All base stations and fixed terminals for both the low- and medium-power licenses, licensees will be required to keep an accurate record of the location to within 5 meters and antenna information (antenna type and height above ground).

11.5. Mobile Network Codes (MNC)
Licensees must comply with the National Numbering Plan - published on CST website - and the conditions and obligations it specifies for mobile phones used in private wireless networks.

Q21: Are there any other matters related to the general conditions that CST should consider?

12. Technical Requirements

The following section stipulates the equipment parameters for the authorization of low-power licenses and medium-power licenses. These requirements are designed to ensure the efficient use of spectrum in the Kingdom by facilitating compatible uses with services in the 4 GHz band and adjacent bands.

12.1. Power levels and emission limits.

12.1.1. Low- and medium- power light-licensed base stations are limited to a maximum EIRP and emission limits based on the number of 20 MHz channels assigned as shown in the following table.

<table>
<thead>
<tr>
<th>Bandwidth (MHz)</th>
<th>Low Power Base Station EIRP Limit (dBm)</th>
<th>Medium Power Base Station EIRP Limit (dBm)</th>
<th>Attenuation Required 0-5 MHz from Channel Edge (dB)</th>
<th>Attenuation Required Beyond 5 MHz from Channel Edge (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>24</td>
<td>42</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>40</td>
<td>27</td>
<td>45</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>60</td>
<td>29</td>
<td>47</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>48</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>100</td>
<td>31</td>
<td>49</td>
<td>45</td>
<td>53</td>
</tr>
</tbody>
</table>

Table 2: Technical Specification for Low- and medium-power light-licensed base stations

12.1.2. Mobile user terminals are subject to the following maximum TRP and emission limits as shown in the table below.
12.1.3. Fixed user terminals are subject to the following maximum EIRP and emission limits as shown in the table below.

<table>
<thead>
<tr>
<th>Bandwidth (MHz)</th>
<th>Fixed Terminal EIRP (dBm)</th>
<th>Attenuation Required 0-5 MHz from Channel Edge (dB)</th>
<th>Attenuation Required Beyond 5 MHz from Channel Edge (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>41</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>40</td>
<td>44</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>60</td>
<td>46</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>80</td>
<td>47</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>100</td>
<td>48</td>
<td>45</td>
<td>53</td>
</tr>
</tbody>
</table>

*Table 4: Technical Specification for Fixed user terminals*

12.2. Antenna height.

<table>
<thead>
<tr>
<th>License Type</th>
<th>Maximum antenna Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-power license - Outdoor</td>
<td>10</td>
</tr>
<tr>
<td>Medium-power license - Outdoor</td>
<td>60</td>
</tr>
<tr>
<td>Low / Medium-power license - Indoor</td>
<td>No restrictions</td>
</tr>
</tbody>
</table>

*Table 5: Antenna height restrictions*

12.3. Antenna location (indoor/outdoor).
12.3.1. Antennas are permitted to be installed either indoors or outdoors. If outdoor antennas are included as part of a low-power license, then coordination areas will be calculated assuming outdoor operation at a height of 10 meters. Thus, applicants whose operations are only indoors are discouraged from selecting outdoors in their application form as this could increase the difficulty in achieving coordination, which may result in rejection of the application.

12.4. Geographic restrictions for medium-power licenses.

12.4.1. Considering the higher transmit power of the medium-power license and corresponding larger potential interference area, CST will generally grant medium-power light licenses on a per base station basis and for deployments outside of high-usage cities (i.e., Other Cities only), where they are unlikely to constrain low-power light-licensed users.

12.4.2. Notwithstanding the limitation in Section 12.4.1, applicants may apply to operate a base station under a medium-power license in “High-Usage Cities”, however, such requests are not routinely granted and such applicants must supplement their application with a showing of why the proposed operations would not cause harmful interference to incumbent licenses or unduly constrict low-power licensees (including, for example, a showing that the medium-power license is within a geographic area that is owned or leased entirely by the light-licensed user).

Q22: Please provide your input regarding the technical conditions in subsections (12-1 to 21-4) and how they fit operational needs of private wireless applications?

Q23: Are there any other considerations for the technical conditions that CST should take into account?

12.5. Protection of Incumbent Users

CST recognizes the importance of fixed-satellite service (FSS), radio altimeter operations, and mobile network operations within the Kingdom. CST has determined that, consistent with the technical and operational conditions provided in this Document, that such operations will be protected while enabling new light-licensed users.

12.5.1. Protection of FSS.
12.5.1.1. Light licensed base stations shall not exceed a PFD limit of -101 dBm/m²/MHz at any FSS earth station antenna. CST will evaluate each proposed light license area using Analyzer tool. The PFD will be calculated using the EIRP of the base station. Propagation loss will be calculated using ITU-R P.452. Indoor base station antenna heights will be assumed to be 5 meters for the purposes of calculating the PFD, and building losses for indoor locations will be calculated using ITU-R Recommendation P.2109.

12.5.1.2. To ensure FSS earth station operations in the 4000-4200 MHz band can be adequately protected, CST will issue a public notice establishing a registration period for receive-only earth stations operating within the Kingdom. FSS receive-only earth station licensees requesting protection will be required to register their use with CST within 6 months of the adoption of this document (Registration Deadline). FSS receive-only earth station licensees that register within the period will receive interference protection. FSS receive-only earth station licensees that fail to register within the period may continue to operate, but will be afforded no interference protection vis-à-vis light-licensed users.

12.5.1.3. CST will continue to permit new FSS earth station registrations following the Registration Deadline; however, CST strongly encourages FSS earth station registrants to site their stations in areas that will avoid inhibiting incumbent light-licensed users, and reserves the right to reject any FSS earth station registrations that fail to do so.

12.5.1.4. FSS operations in the adjacent bands will be sufficiently protected from blocking interference by in-band desensitization thresholds applicable to light-licensed users in the 4000-4200 MHz band.

12.5.2. Protection of radio altimeters.

12.5.2.1. Radio altimeters operate in the 4200-4400 MHz band, adjacent to the light licensed 4000-4200 MHz band.

12.5.2.2. CST recognizes the need to protect radio altimeters from harmful interference. CST will apply a conservative approach, defined in ITU-R Recommendation M.2059, to mitigate the possibility of harmful interference to radio altimeter operations. 4 GHz Light Licenses are subject to limits on power levels, separation distances, and OOB power density to ensure radio altimeters in the band will not experience harmful interference and that there will be no impact on the safety of air travel in the Kingdom.
12.5.2.3. To adequately protect radio altimeters, CST will limit the light licenses that may be granted near airport or helipad locations as shown in the table below.

<table>
<thead>
<tr>
<th>Distance from airport or helipad</th>
<th>0-1 km</th>
<th>1-6 km</th>
<th>&gt;6 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categories of permitted light licenses</td>
<td>None</td>
<td>Low power indoor only</td>
<td>Low power and medium power</td>
</tr>
</tbody>
</table>

12.5.2.4. Notwithstanding the foregoing protections, to the extent harmful interference occurs to radio altimeters, affected users should notify CST as soon as practicable. CST considers the possibility of interference to radio altimeters as a public safety matter requiring immediate attention and CST retains its authority to require a light-licensed user or users suspected of causing interference to cease operations immediately upon the filing of a complaint. CST may continue to require such light-licensed users to cease operations until a subsequent investigation and mitigation of the harmful interference is completed. CST may also establish stricter limits or additional safeguards as needed to ensure the safety of air operations in the Kingdom.

12.5.2.5. To ensure adjacent-band radio altimeter operations can be adequately protected, CST will coordinate with relevant authorities within the Kingdom to issue a public notice establishing a registration period for all airports and helipads within the Kingdom. All such airports and helipads will be required to register and provide their precise latitude and longitude within 6 months of the adoption of this Document. CST anticipates that this list will be regularly updated and CST will use this list in its coordination approach for all 4 GHz Light Licenses. In the event a new airport or helipad is sited where light-licensed users are currently operating, such light-licensed users may be required to modify or cease transmissions.

12.5.3. Protection of Mobile Network Operations.

12.5.3.1. CST recognizes the need to protect mobile network operations operating below 4000 MHz band from harmful interference caused by light-licensed users. Accordingly, CST has reserved the 4000-4020 MHz segment as a guard band.

12.5.3.2. The guard band, in conjunction with the power levels and emission mask requirements for low power and medium power light licenses will ensure that no harmful interference is caused to
services operating in the adjacent band below 4000 MHz. Such protections are described in additional detail in Appendix A.

12.6. International Agreements.

12.6.1. CST will take into account international obligations prior to assigning any spectrum in a 4 GHz Light License.

12.7. Nothing in this section is intended to prevent light-licensed users from arriving at agreements with incumbent operators in order to provide services at parameters that vary from this Document, so long as such agreements ensure that operations not cause harmful interference to any incumbent operators or light-licensed users that are not party to the agreement. Any such operations must be reflected in the light-licensed user’s application or any modification thereto, along with a certification that the agreement with the incumbent operator will ensure harmful interference is mitigated consistent with this Document.

12.8. CST has the right to impose additional technical requirement not mentioned in this section if proven that potential harmful interference could occur to incumbent operations or other licensee in the band.

Q24: Do you have any input regarding the protection of incumbent conditions mentioned in subsection (5-12)? Please provide evidence to your response.

Q25: Are there use cases that might not be satisfied because of the technical conditions? If yes, please provide evidence.

Q26: Are there any other matters related to technical conditions that CST should consider?

13. Compatibility with Other 4 GHz Light-Licensed Users

13.1. CST generally seeks to ensure that light-licensed users may coexist in the 4 GHz band and adopts technical rules to minimize the likelihood of intra-service interference between such users.

13.2. Frequency re-use.

13.2.1. 4 GHz Light Licenses are subject to a frequency re-use distance to prevent intra-service interference amongst light-licensed users. Light-licensed stations will use I/N = -6 dB as a criterion to ensure
compatibility with other light-licensed stations. The system noise level will be calculated using the formula set out in Appendix A.

13.3. Time division duplex.

13.3.1. All light-licensed base stations shall use TDD, consistent with 3GPP band n77 which is identified for TDD duplex mode. Use of TDD also allows for synchronization to mitigate interference between light-licensed users, if required.

13.4. Light-licensed user cooperation.

13.4.1. In addition to complying with the specific transmission terms, conditions and limitations set out in this Document, the light-licensed user must liaise and co-operate with other low-/medium-power light-licensed users in good faith (if necessary, adjusting transmission power and other technical parameters of transmission) in such a way that harmful interference is not caused by one network deployment to that of another licensee within the band.

13.5. Synchronization.

13.5.1. Light-licensed users that operate in very close proximity to each other using adjacent channels may cause interference to each other. In these situations, impacted light-licensed users should coordinate consistent with Section 13.4.1, above.

13.5.2. CST will generally not require synchronization unless light-licensed users in adjacent channels cause interference to each other and are unable to resolve such interference through self-coordination.

13.5.3. If light-licensed users are unable to come to an agreement, CST may require licensees to adopt a synchronization regime considering factors such as: which user deployed first in an area; time or geographic area of use; and/or other relevant factors.

Light-licensed users should take into account the possibility that CST will require synchronization to resolve interference complaints. In the event that CST exercises a synchronization requirement, any equipment not capable of synchronization will be required to cease operations.

Q27: Is there any input on CST’s approach for achieving compatibility between light licensees? Please provide detailed answers.

Q28: Are there any other matters related to compatibility that CST should consider?
14. Coordination Approach

14.1. To analyze the coexistence of proposed deployments in light-license applications with incumbent users and with other light-licensed users in the 4 GHz band, CST will collect information provided by light-license applicants, including all relevant technical information.

14.1.1. CST will use the technical information to perform assessments consistent with this Document to determine permissible transmission power levels available at the requested location and frequency, and to register the location of low-power licensed areas, and of medium-power licensed base stations for use in evaluating future light-license applications.

14.1.2. Each requested base station (or authorized area in the case of low-power license requests) will be assessed to ensure that it does not cause interference to, or receive interference from, other light-licensed users.

14.1.3. CST will not take into account other base stations of the same licensee in our coordination approach as we consider that the licensee is responsible for managing interference in its own network(s).

14.2. CST will use the technical data in light license applications to verify that requested base stations do not exceed the protection criteria at FSS earth stations.

14.3. CST will verify that applications are not accepted within keep-out zones around airports and helipads where radio altimeters are expected to be in use.

14.4. Potential light-licensed users must provide this information for inclusion by CST in the manual coordination tool. As the light licensing regime in the 4 GHz band matures, CST will explore streamlining the process with an automated technical coordination tool.

14.5. Coordination areas.

14.5.1. CST will apply band-specific coordination radius for applicant transmitting stations. The table below provides coordination radius per band and product type, including inter-service with FSS earth stations and intra-service (with low- and medium-power light-licensed users).

<table>
<thead>
<tr>
<th>4.0–4.2 GHz</th>
<th>Coordination Radius (FSS)</th>
<th>Coordination Radius Low</th>
<th>Coordination Radius Medium Power</th>
<th>Coordination Radius Medium</th>
</tr>
</thead>
</table>

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14.5.2. The coordination radius is intended to be a conservative upper limit to ensure the coordination tool captures any incumbent radio stations which could potentially suffer harmful interference from a proposed light-license base station. The coordination radius is not intended to suggest that all radio stations within that limit would suffer harmful interference from light-licensed operations.

<table>
<thead>
<tr>
<th>Earth Station (Km)</th>
<th>Power to Low Power (km)</th>
<th>Power to Low Power (km)</th>
<th>Power to Medium Power (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>30</td>
<td>50</td>
<td>65</td>
</tr>
</tbody>
</table>

Q29: Is there any input on CST’s approach for coordination? Please provide detailed answers.

Q30: Are there any other matters related to the coordination approach that CST should consider?

15. Future Use of Automated Coordination Systems

CST aims to enable data-driven spectrum management by utilizing smart databases systems for automated spectrum licensing. Thus, licensees must align with CST’s future adoption of automated frequency coordination systems and the technical and regulatory conditions that follows such an approach.

Q31: Are there any other matters related light licensing regulations in the 4 GHz frequency band that CST should consider?
Appendix A
Supporting technical Information

1. International Standards

15.1. CST considered and incorporated the latest versions of the following internationally-accepted standards into its technical requirements:

15.1.1. ITU-R Report M.2109
15.1.2. ITU-R Recommendation M.2059
15.1.3. ITU-R Recommendation P.452
15.1.4. ITU-R Recommendation P.2109

2. Determining coordination distances

2.1 In order to evaluate light license applications, it is necessary to identify a radius around the proposed light license location where coexistence with existing licenses must be evaluated. This coordination distance is determined by evaluating the line-of-sight distance between the existing licensed station, and the proposed light license. The line-of-sight distance is calculated using the formula below.

\[ d_{LOS} = 4.12(\sqrt{h_1} + \sqrt{h_2}) \]

Where: \( d_{LOS} \) = line-of-sight distance (km)
\( h_1 \) = antenna height of existing license (m)
\( h_2 \) = antenna height of proposed light license (m)

2.2 Line of sight for earth stations is calculated assuming a 40-meter height for the earth station antenna, and 60-meter height for the light licensed antenna, which represents a very conservative scenario. The line-of-site distance is calculated to be about 58 km. In order to be conservative, processing of light license applications will consider all light license operations within 60 km of each earth station.

2.3 When considering other light licenses, three combinations arise when performing this line-of-sight calculation.

2.3.1 Two low power light license stations
2.3.1 When both stations are low power light licenses, then the maximum outdoor antenna height is 10 meters. If an antenna height of 10 meters is assumed for both of the light license antennas, then the calculation yields a result of 26 km. This distance is rounded off to a 30 km coordination distance between two low power light licenses.

2.3.2 One low power and one medium power light license stations

2.3.2.1 When one station is a low power light license and the other is a medium power light license, an assumed antenna height of 10 meters for the lowpower and 60 meters for the medium power light license yields a result of 44.9 km. This distance is rounded off to a 50 km coordination distance between a low power light license and a medium power light license.

2.3.3 Two medium power light license stations

2.3.3.1 When both stations are medium power light licenses, then an assumed antenna height of 60 meters is assumed for both of the light license antennas. The calculation yields a result of 63.8 km. This distance is rounded off to a 65 km coordination distance between two medium power light licenses.


3.1 ITU-R Recommendation M.2059 identifies three types of interference mechanisms applicable to radio altimeters: overload, desensitization, and false altitude reports. Analysis below uses free space propagation only because clutter and terrain are often not applicable when analyzing propagation paths to airborne platforms.

3.2 Overload.

3.2.1 Locations where radio altimeter operations are anticipated, such as airports or helipads will be protected from overload interference by limiting the base station power and/or separation distance for medium-power light licenses, and by limiting the separation distance for low-power light licenses. Overload interference is prevented by ensuring that the maximum permissible power calculated by,

\[ P = -24 + 20 \log_{10} d \]

is always greater than the actual power of the light licensed base station(s), as set forth below.

3.2.2 The limiting overload threshold for analogue altimeters listed in ITU-R M.2059 is -56 dBm. The limiting overload threshold for digital altimeters is -53 dBm. The potential for overload interference is calculated using:

\[ I = P + G - L \]
\[ I = P + G - [20 \log_{10} f + 20 \log_{10} d - 27.55] \]

Where \( I \) = Overload Interference Threshold (dBm)
\( P \) = Power (EIRP) of the Base Station (dBm)
\( G \) = Antenna Gain of the Radio Altimeter (dBi)
\( L \) = Free Space Path Loss (dB)
\( f \) = Frequency (MHz)
\( d \) = Distance (m)

Solving for Power in terms of separation distance between the base station and the aircraft location gives:

\[ P = I - G + 20 \log_{10} f + 20 \log_{10} d - 27.55 \]

For the worst-case analogue altimeter listed in ITU-R M.2059, \( I = -56 \) dBm, \( G = 13 \) dBi, \( f = 4200 \) MHz, \( P = -24 + 20 \log_{10} d \)

3.2.3 The link budget equation does not include any filter discrimination for the radio altimeter. Accordingly, this analysis is conservative and actual interference is even less likely than predicted using this formula.

3.2.4 The worst-case (i.e., highest power level) for a low-power license results in a required separation distance to prevent overload of radio altimeters of 562 meters for outdoor operations, 89 meters for indoor operations in buildings with traditional construction, and 16 meters for indoor operations in buildings with thermally efficient construction. For medium power light licenses, the required separation distance to prevent overload of radio altimeters is 4.5 km, 708 meters for indoor operations in buildings with traditional construction, and 126 meters for indoor operations in buildings with thermally efficient construction.

<table>
<thead>
<tr>
<th></th>
<th>Outdoor</th>
<th>Indoor (traditional)</th>
<th>Indoor (thermally efficient)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Power</strong></td>
<td>562 meters</td>
<td>89 meters</td>
<td>16 meters</td>
</tr>
<tr>
<td><strong>Medium Power</strong></td>
<td>4500 meters</td>
<td>708 meters</td>
<td>126 meters</td>
</tr>
</tbody>
</table>

3.3 Desensitization.

3.3.1 Desensitization interference occurs when the interfering signal falls within the passband of the radio altimeter, and effectively increases the noise floor of the receiver. The worst-case desensitization for the bandwidth and noise figure combinations for the altimeters listed in ITU-R M.2059 occurs at a
power density level of -114 dBm/MHz. Desensitization interference is prevented by ensuring that the maximum permissible power density for base station out-of-band emissions calculated by, \( P_d = -24 + 20 \log_{10} d \), is always greater than the actual power density of light licensed base station out-of-band emissions.

Received Interference level can be calculated by:

\[
I = P_d + G - L
\]

Solving for \( P_d \):

\[
P_d = I - G + 20 \log_{10} f + 20 \log_{10} d - 27.55
\]

Where \( I = \) Interference Threshold (dBm/MHz)
\( P_d = \) Power Density (EIRP) of the Base Station Emissions into the Radio Altimeter Band (dBm/MHz)
\( G = \) Antenna Gain of the Radio Altimeter (dBi)
\( L = \) Free Space Path Loss (dB)
\( f = \) Frequency (MHz)
\( d = \) Distance (m)

Using \( I = -114 \), \( f = 4300 \) MHz, \( G = 10 \) dBi, the required separation distance from aircraft locations is calculated using the power density of out-of-band emissions from light-licensed base stations.

\[
P_d = -78.9 + 20 \log_{10} d
\]

The maximum OOBE power density at 4300 MHz is -25 dbm/MHz.

3.3.1.1 Building attenuation (for indoor operation)

3.3.1.1.1 Indoor operations will experience 31 dB attenuation when the signal propagates through the exterior wall of a building using ITU-R Recommendation P.2106, and assuming a thermally efficient building. Under traditional construction methods, 16 dB of loss will occur as the signal propagates through the exterior wall.

3.3.1.2 Separation distance

3.3.1.2.1 The minimum required separation distance is calculated for the maximum permitted OOBE level (-25 dBm/MHz). For low power light license base stations, the required separation distance to prevent radio altimeter desensitization is 494 meters for outdoor operations, 78 meters for light licenses located indoors in buildings using traditional construction methods, and 14 meters for light licenses located indoors in buildings using thermally efficient construction methods. For medium power light license base stations, the OOBE are the same as for low power base stations, so the required separation distance to prevent radio altimeter desensitization is the same as well.
3.3.1.2.2 To be conservative, no light licensed operations will be permitted within 1 km of airport or helipad locations. At locations between 1 km, and 6 km from airport or helipad locations, only low power indoor light licensed operations are permitted. At locations beyond 6 km from airports or helipads both low-power and medium power light licensing is available either indoors or outdoors.

3.3.1.2.3 CST will check the proposed light license location for compliance with the exclusion zones listed above. If the separation distance between the light license application and airports or helipads are not met, then the application is dismissed.

3.4 False altitudes.
3.4.1 False altitudes occur when interference signals are detected as frequency components during spectral frequency analysis of the overall intermediate frequency bandwidth. Light-license signals into the altimeter passband would be noise-like, without strong spectral features and thus False Altitude reports are not expected.

4. Protection of the Fixed satellite service
4.1 The FSS is protected by limiting the PFD at an FSS antenna location. The calculation of the threshold is given by:

\[ PFD = 10 \log_{10} \left( kT \cdot \frac{4\pi}{\lambda^2} + \frac{l}{N} + 90 \right) \quad \text{(in dBm/MHz)} \]
4.2 The in-band threshold is based on I/N = -12.2 dB, a 100K FSS earth station receiver noise temperature,\(^2\) resulting in a calculated PFD of -97 dBm/m²/MHz. The threshold is lowered by 4 dB to -131 dBW/m²/MHz to account for aggregate effects.

4.3 The in-band desensitization threshold will also be sufficient to protect FSS earth station operations in the adjacent 3700-4000 MHz band because the in-band threshold is much more restrictive than the threshold needed to prevent any blocking interference in the adjacent band. Because FSS earth stations are registered across the full 3700-4200 MHz band, all earth stations will be protected as if they are operating co-channel with the light licensed station.

5. **Protection of Mobile Network Operations below 4 GHz**

5.1 The power limit for low power light licenses is 18 dBm/5 MHz = 11 dBm/MHz. The required attenuation is 45 dB from 0-5 MHz from the channel edge under the CST mask.

\[ 11 \text{ dBm/MHz} - 45 \text{ dB} = -34 \text{ dBm/MHz} \]

The required attenuation is 53 dB beyond 5 MHz from the channel edge under the CST mask.

\[ 11 \text{ dBm/MHz} - 53 \text{ dB} = -42 \text{ dBm/MHz} \]

These levels are comparable to the emissions from digital devices (e.g., personal computers) and will be even lower at 20 MHz from the channel edge.

5.2 The power limit for medium power light licenses is 35 dBm/5 MHz = 28 dBm/MHz. The required attenuation is 45 dB from 0-5 MHz from channel edge under the CST mask.

\[ 28 \text{ dBm/MHz} - 45 \text{ dB} = -17 \text{ dBm/MHz} \]

The required attenuation is 53 dB beyond 5 MHz from the channel edge under the CST mask.

\[ 11 \text{ dBm/MHz} - 53 \text{ dB} = -25 \text{ dBm/MHz} \]

5.3 These levels are lower than emissions typically permitted from mobile services into the adjacent band using widely accepted attenuation value of 43 + 10 log P which results in unwanted emission level of -13 dBm/MHz. These levels will be even lower at 20 MHz from the channel edge.

---

\(^2\) These values are taken from ITU-R Report M.2109.
6. Compatibility with other light-licensed users

6.1 Frequency re-use

6.1.1 The system noise level will be calculated using the following formula:

\[ N = kTB + NF \]

where \( k \) is Boltzmann’s constant, \( T = 290 \) K, \( B \) = bandwidth, and \( NF \) = noise figure of the light-licensed receiver.

6.1.2 For low-power stations, \( NF = 13 \) dB, and for medium-power stations, \( NF = 10 \) dB. CST will evaluate light license applications to ensure that the protection criteria is met for previously issued light licenses. CST will use the ATDI HTZ tool using the ITU-R P.452 propagation model to ensure the protection criteria will be met.
Appendix B

4000-4200 MHz Light-License
Application Form

See the notes at the end of the form for assistance in completing this form.
This application form provides CST with the information needed to assign a frequency. Note that some of
the information provided in this form (marked with a ‘*’) may be provided to future applicants to assist them
with frequency selection.

A: Details of Light-License User or Applicant

<table>
<thead>
<tr>
<th>Full Name of Applicant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company/Organization *</td>
</tr>
<tr>
<td>Company Registration Number ii</td>
</tr>
<tr>
<td>Building</td>
</tr>
<tr>
<td>Street</td>
</tr>
<tr>
<td>City</td>
</tr>
<tr>
<td>Region</td>
</tr>
<tr>
<td>Post/Zip Code</td>
</tr>
<tr>
<td>Responsible Department</td>
</tr>
<tr>
<td>Telephone</td>
</tr>
<tr>
<td>Email Address</td>
</tr>
</tbody>
</table>
B: Contact for technical queries if different to above

<table>
<thead>
<tr>
<th>Full Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Company/Organization</td>
<td></td>
</tr>
<tr>
<td>Company Registration Number</td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td></td>
</tr>
<tr>
<td>Street</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
</tr>
<tr>
<td>Post/Zip Code</td>
<td></td>
</tr>
<tr>
<td>Responsible Department</td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
</tr>
<tr>
<td>Email Address</td>
<td></td>
</tr>
</tbody>
</table>

C: Site Details

Note: For low-power licenses, the coordinates must be the center of the 50-meter license area. For medium-power licenses, the coordinates must be the location of the medium-power base station antenna. The supplied latitude and longitude of the antenna must be accurate to 5m or better. For low-power licenses, if the location given is not accurate enough to place it within the recorded 50m service area, the application may be rejected.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location (name)</td>
<td></td>
</tr>
</tbody>
</table>
### Latitude *

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of 5G base station(s)</td>
<td></td>
</tr>
<tr>
<td>- Medium Power</td>
<td></td>
</tr>
<tr>
<td>- Low-Power</td>
<td></td>
</tr>
<tr>
<td>Indoor or Outdoor</td>
<td></td>
</tr>
<tr>
<td>- Outdoor</td>
<td></td>
</tr>
<tr>
<td>- Indoor</td>
<td></td>
</tr>
<tr>
<td>Base Station Manufacturer and Model Number(s)</td>
<td></td>
</tr>
<tr>
<td>Frequency requested: (Centre frequency (MHz)) *</td>
<td></td>
</tr>
<tr>
<td>Channel width requested (MHz):</td>
<td>20</td>
</tr>
<tr>
<td>- 40</td>
<td></td>
</tr>
<tr>
<td>- 60</td>
<td></td>
</tr>
<tr>
<td>- 80</td>
<td></td>
</tr>
<tr>
<td>- 100 (standard)</td>
<td></td>
</tr>
<tr>
<td>Transmitter Output Power (dBm)</td>
<td></td>
</tr>
<tr>
<td>Total Radiated Power (dBm)</td>
<td></td>
</tr>
<tr>
<td>Antenna Manufacturer and Model Number: (Note iv)</td>
<td></td>
</tr>
<tr>
<td>☐ Antenna Down-tilt</td>
<td>☐ Electrical (state here):</td>
</tr>
<tr>
<td>☐ Physical (state here):</td>
<td></td>
</tr>
<tr>
<td>Antenna Azimuth (Note v)</td>
<td></td>
</tr>
<tr>
<td>(if directional):</td>
<td></td>
</tr>
<tr>
<td>Antenna Gain (dBi): (Note vi)</td>
<td></td>
</tr>
<tr>
<td>Antenna height above ground (meters): *</td>
<td></td>
</tr>
</tbody>
</table>

**E: Ownership**

Applicant certifies that it has a valid ownership right to the premises on which the light-license base stations will be located, or a right to use such premises (e.g., a lease) or valid authorization from the holder of such a right will be eligible to obtain a light license.

**F: Additional Information**

To the extent an applicant’s use requires additional explanation, please provide those details here.

|                                                                 |                                                                 |
|                                                                |                                                                |
|                                                                |                                                                |
|                                                                |                                                                |
|                                                                |                                                                |
|                                                                |                                                                |

**G: Declaration**

In order to ensure protection of incumbent users, applications will be validated before an authorization to use the spectrum is issued. This may mean that, in addition to some applications being denied, light licenses may be subject to additional restrictions such as:

geographic,
indoor / outdoor,
power, and
azimuth / down-tilt.

Licensees may use the assigned spectrum subject to any geographic limitations, technical or service obligations and use conditions as specified in the license.

I certify that I am authorized to sign on behalf of the applicant and that the information given in this form is accurate.

Name/Signature of Applicant:  Position Held:

Date:

NOTES:

i. This is the responsible person (light-licensed user), who will be legally responsible for maintaining the operation of this service within the licensed parameters.

ii. This must be the registration number of a Legal Entity registered in the Kingdom of Saudi Arabia. A license will not be issued to an entity not registered in the Kingdom.

iii. An engineering contact who can answer technical queries about the proposed license and the equipment.

iv. Enter the manufacturer and the model number of the antenna.

v. If omnidirectional, write ‘omnidirectional’ in this box.

vi. Be careful to include the antenna gain in dBi (relative to an isotropic source).