

26/04/2023

Appendix 1 to the decision to issue an Open Invitation Part 2 to apply for licence to use radio transmitters in the 900 MHz, 2.1 GHz and 2.6 GHz bands (ref. no. 21-10605)

Open Invitation Part 2 to apply for licences to use radio transmitters in the 900 MHz, 2.1 GHz and 2.6 GHz bands

Final date to confirm application: 17 May 2023

Planned auction start date: 19 September 2023

This document is a non-binding translation to English of the Swedish Open Invitation Part 2 and its appendices published 26 April 2023

Open Invitation Part 2 to apply for licences to use radio transmitters in the 900 MHz, 2.1 GHz and 2.6 GHz bands

Reference number

21-10605

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1. Introduction

1.1 Open invitation in two parts

On 15 June 2022, the Swedish Post and Telecom Authority (PTS) decided to limit the number of licences and to issue Open Invitation Part 1 to apply for licences to use radio transmitters in the frequency ranges:

- 880–915 MHz and 925–960 MHz (900 MHz band)
- 1920–1980 MHz and 2110–2170 MHz (2.1 GHz band)
- 2500–2690 MHz (2.6 GHz band)

The decision to issue an open invitation to apply states that the invitation is issued in two parts: Open Invitation Part 1 (OI Part 1) and Open Invitation Part 2 (OI Part 2).

OI Part 1 (already published): includes information regarding the protection of Sweden's security, PTS consultation of applications with the Swedish Security Service and the Swedish Armed Forces, description of the application process and decisions on licences and payment.

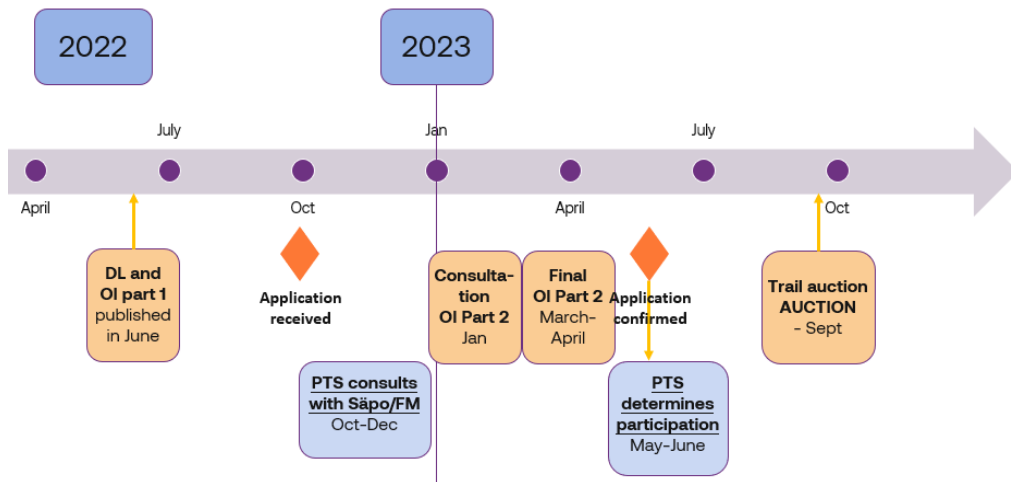
OI Part 2 (this document): includes rules for the auction procedure, provisions on the assignment of licences and the payment of auction proceeds following the auction, as well as the conditions to which licences to use radio transmitters will be subject.

The licensing process shall take place in a tendering procedure where the price that the applicant is willing to pay for the licence shall be the deciding factor (auction), in accordance with the rules set out in OI Part 1 and OI Part 2.

1.2 Process and set times leading to auction

The illustration below (Figure 1), also available in OI Part 1, clarifies the process of the procedure and the preliminary timetable for the different steps leading to the auction.

Figure 1 Auction procedure with the main steps leading to the auction



Please note the following important preliminary set times:

Jan 2023	Consultation of OI Part 2
March-April 2023	Final version of OI Part 2
17 May 2023	Applicants confirm their applications
12 Sept. 2023	Trial auction
19 Sept. 2023	Auction start

The process for confirming application is described in Section 2.

PTS estimates the auction to last up to ten working days but applicants should be prepared for it to take longer. PTS intends to hold trial auctions and recommends all applicants that have been approved to participate. All approved applicants will receive an invitation.

PTS does not intend to publicly disclose approved bidders before the auction has ended, as such information is likely to affect the outcome or otherwise defeat the purpose of the auction procedure itself.

2. Conditions for confirmation of application and participation in the auction

2.1 Confirmation of application

Applicants (i.e., those who have submitted an application for licence to use radio transmitters in the 900 MHz, 2.1 GHz and 2.6 GHz bands in accordance with OI Part 1) whose radio usage is not assumed to cause harm to Sweden's security will, after the final version of the OI Part 2 has been published, have to confirm their participation.

Confirmation shall be submitted in a sealed envelope labelled "*Bekräftelse av ansökan 900 MHz-, 2,1 GHz- och 2,6 GHz-auktionen*".

Confirmation can be handed in at the reception desk at PTS, Hälsingegatan 38, 113 43 Stockholm, Monday to Friday, 8 a.m. to 5 p.m., or sent by post to the following address:

Post- och telestyrelsen
Box 6101
102 32 Stockholm

Other requirements for the confirmation are found in the Sections 2.2 and 2.3.

Only applicants who confirm their application will be finally approved as bidders in the auction. Applications not confirmed by the deadline may be rejected. Once the confirmation has been received, PTS will evaluate whether it is complete (in accordance with the requirements set out in Section 2). PTS tentatively intends to notify qualified bidders during the month of May.

2.2 Conditions for confirmation and participation in the auction

2.2.1 Conditions for confirmation of application

- Confirmation shall be made using the form provided by PTS (see Appendix D) and submitted in original.
- Confirmation must be received by PTS no later than 17 May 2023
- The confirmation may not contain false information
- The confirmation must be signed by an authorised signatory or holder of power attorney (see Sections 2.3.1 and 2.3.2)

2.2.2 Rules for participation in the auction

- Bids placed in the auction must originate with the bidder
- At the time of the auction, the bidder must be in compliance with the applicable provisions of OI Part 1 and OI Part 2
- Two or more bidders may not coordinate their bidding or in any other way collaborate during the auction procedure
 - Collaboration between bidders during the auctions could affect the outcome. Bidders are therefore prohibited from coordinating their bidding or collaborating in some other way during the auction procedure. An agreement on collaboration that is entered into before the auction procedure is initiated is also covered by this prohibition. Discussion between bidders about the auction could also be interpreted as collaboration. If PTS becomes aware that two or more bidders are collaborating, PTS may exclude them from the auction.
- Approved applicants may refrain from bidding in the auction.

2.3 Appendices to the application confirmation

2.3.1 Extract from the registry of the Swedish Companies Registration Office

If any information about the applicant, such as the authorised signatory, has changed compared to what was provided at the time of application (application pursuant to OI Part 1), a new extract from the registry of the Swedish Companies Registration Office (or equivalent for foreign applicants) certifying the new information must be attached to the application confirmation. Rules for the extract are set out below.

If the registry extract or equivalent is not in Swedish or English, a Swedish or English translation shall be attached to the application. If it is not clearly apparent from the extract that the person who has signed the application form (or power of attorney pursuant to Section 2.3.2) is an authorised signatory for the application, the authorisation of the signatory must be certified by other means, with references to relevant legislation.

2.3.2 Original power of attorney

If the person who has signed the confirmation is not an authorised signatory, an original power of attorney shall be submitted with the confirmation form. The power of attorney shall be signed by an authorised signatory for the applicant.

3. Licence to use radio transmitters

3.1 General information on licences and licence conditions

The award refers to *national licences* to use radio transmitters, for terrestrial systems capable of providing electronic communications services, in the following frequency ranges:

- 880–915 MHz and 925–960 MHz (900 MHz band)
- 1920–1980 MHz and 2110–2170 MHz (2.1 GHz band)
- 2500–2690 MHz (2.6 GHz band)

The licences and conditions applicable to each band are described below. Common conditions for all three frequency bands are described in Section 3.5.

The licence conditions applicable to each frequency band are set out in Appendix A (Licence conditions for the 900 MHz band), Appendix B (Licence conditions for the 2.1 GHz band) and Appendix C (Licence conditions for the 2.6 GHz band). Following the auction, each licence will be subject to the applicable conditions pursuant to the OI Part 2 and said Appendices. Minor adjustments to licence conditions may occur in connection with final decisions on the licences to use radio transmitters.

Decisions regarding the licence and the associated conditions will be made close to the conclusion of the auction.

3.2 Licences and conditions in the 900 MHz band

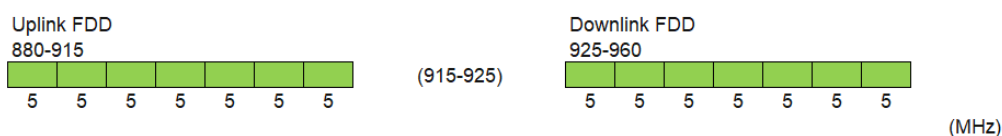
3.2.1 Number of licences to award

It follows from PTS decision to limit the number of licences¹ that the 900 MHz band is divided into frequency blocks according to Figure 2 and includes:

- 5 blocks of 2×5 MHz (FDD²) each. One (1) of these blocks is frequency-specific and located at the bottom of the band (see Section 4.3.1).
- 1 block of 2×10 MHz (FDD) subject to a coverage and deployment obligation. Rules for the placement of this block can be found in Section 4.4.3.

A bidder can win several blocks in the auction and a licence can thus consist of several blocks.

Figure 2 The figure shows the block division in the 900 MHz band. The block subject to coverage and deployment obligation is not specifically delineated.



3.2.2 Licence duration

Licence and licence conditions are valid from 1 January 2026 through 31 December 2048.

3.2.3 Technical conditions

To enable coexistence between licence holders in the 900 MHz band and to protect usages in adjacent frequency bands technical conditions are set out. All technical conditions for the 900 MHz band are set out in Appendix A.

3.2.3.1 Regulation and use

The licences in the 900 MHz band are subject to conditions in accordance with Commission Implementing Decision (EU) 2022/173³, and in addition with as few

¹ Decision to limit the number of licences in the 900 MHz, 2.1 GHz and 2.6 GHz frequency bands of 15 June 2022 (21-10605-82), https://www.pts.se/globalassets/startpage/dokument/icke-legala-dokument/remisser/2022/radio/900_2100_2600/eng/engelsk-oversattning---decision-to-limit-the-number-of-licences.pdf

² FDD - Frequency Division Duplex

³ Commission Implementing Decision (EU) 2022/173 of 7 February 2022 on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing electronic communications services in the Union and repealing Decision 2009/766/EC

limiting conditions as possible to enable efficient use of the frequency range over time, with flexibility for technological development.

3.2.3.2 *Radiated power of base stations within their own frequency block*

To ensure a level playing field for deployment in the 700 MHz, 800 MHz and 900 MHz bands, the maximum power of base stations is limited based on the base station's antenna height.

3.2.3.3 *Radiated power of terminals within their own frequency block*

The limit for the maximum average power of terminals, in accordance with EU Implementing Decision 2022/173 (see Section 3.2.3.1), is regulated by the Post and Telecom Authority's regulations on exemptions from licence requirement for the use of certain radio transmitters (the exemption regulations). The licences therefore do not include any specific conditions to this effect.

3.2.4 Conditions for the protection of other use

For coexistence with systems used for train communications (GSM-R⁴ and its successors) below 925 MHz, as defined in Commission Implementing Decision (EU) 2021/1730⁵, there are conditions on the maximum permitted signal strength in 925–960 MHz and 919.4–925 MHz along the railway. These conditions apply to both existing and future railway lines. It is up to the licence holder to contact managers of railway infrastructure in order to obtain information about railway lines which have been, or are being, equipped with such systems during the licence period. Conditions are set out in Appendix A.

3.2.5 Coverage and deployment conditions

In order to improve current mobile coverage, one (1) frequency block of 2×10 MHz in the 900 MHz band is subject to coverage and deployment conditions.

The bidder who is successful in winning this frequency block in the auction shall comply with the coverage and deployment conditions set out in Appendix A.

⁴ GSM-R - Global System for Mobile Communications for railways

⁵ Commission Implementing Decision (EU) 2021/1730 of 28 September 2021 on the harmonised use of the paired frequency bands 874,4-880,0 MHz and 919,4-925,0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio

3.2.5.1 Coverage through new masts

PTS has identified coverage gaps based on the areas defined for the follow-up of the mobility objective⁶ in the Government's broadband strategy. The coverage gaps identified include areas where no operator has coverage with a speed of 10 Mbit/s in downlink.

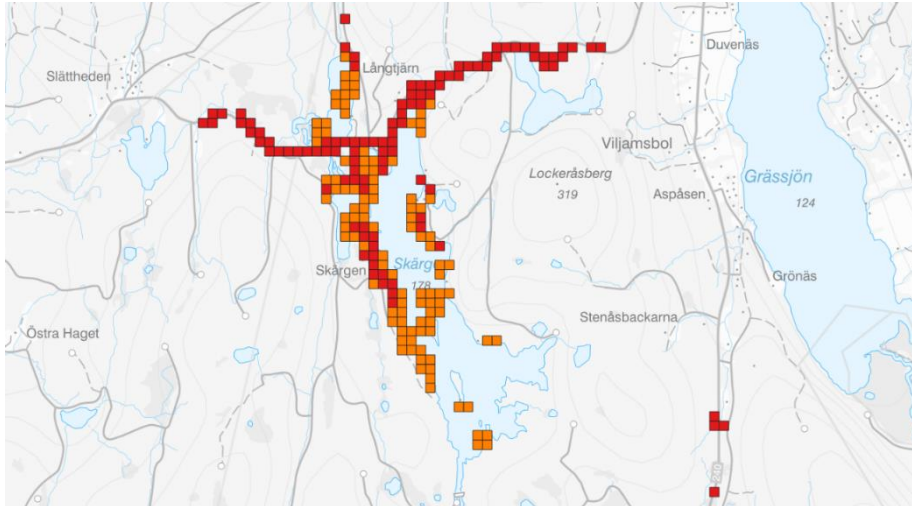
The licence holder shall achieve coverage for mobile services⁷, by deploying new masts in areas where there are coverage gaps. The licence holder is free to choose the location of the new masts. The total area of coverage gaps to be covered, and the criteria to be met by a new mast, are specified in the licence conditions. The licence condition regarding capacity and performance is considered to make it possible to receive data at a speed of 10 Mbit/s.

The coverage and deployment conditions are based on 100×100 m grid geometries, where each grid square containing some form of coverage gap. In Appendix A1, PTS provides geodata, in the form of a compressed GeoPackage file, for the 100×100 m grid squares that contain coverage gaps. For each grid square is shown the margin of signal attenuation, relative to a terminal free of body contact, that is necessary for the grid square to be considered covered. Figure 3 shows an example of how geodata look. A margin of 8 dB applies to orange grid squares and 16 dB to red grid squares.

⁶ Methodological appendix, *PTS mobiltäcknings- och bredbandskartläggning 2021* (PTS Mobile Coverage and Broadband Survey 2021)

⁷ Mobile services is the nomenclature used in *Sverige helt uppkopplat 2025 – en bredbandsstrategi* (N2016/08008/D) (A Completely Connected Sweden by 2025—a Broadband Strategy). The strategy defines current broadband objectives, including the mobility objective.

Figure 3 Example of geodata for an area with 100×100 m grid squares containing coverage gaps



In some geographical areas, there may be limited opportunities for building new masts. This applies, for example, to national parks as well as in areas where the Swedish Armed Forces have placed height restrictions on structures or low-flight areas. PTS has taken these circumstances into account in determining the total area of coverage gaps to be covered and the distribution of coverage gaps to be covered per region⁸. However, coverage gaps within national parks or areas where the Swedish Armed Forces have placed height restrictions on structures or low-flight areas have not been excluded. They are therefore available for the licence holder to choose from and are included in Appendix A1.

3.2.5.2 Monitoring

PTS has prepared an outline supervision plan for monitoring the conditions. The plan can be found in Appendix A2 and may be amended as necessary.

3.3 Licences and conditions 2.1 GHz band

3.3.1 Number of licences to award

It follows from PTS decision to limit the number of licences⁹ that the 2.1 GHz band is divided into frequency blocks according to Figure 4 and includes:

⁸ Götaland, Svealand and Norrland

⁹ Decision to limit the number of licences in the 900 MHz, 2.1 GHz and 2.6 GHz frequency bands of 15 June 2022 (21-10605-82), <https://www.pts.se/globalassets/startpage/dokument/icke-legala->

- 12 blocks of 2×5 MHz (FDD) each

A bidder can win several blocks in the auction and a licence can thus consist of several blocks.

Figure 4 The figure shows the block division in the 2.1 GHz band



3.3.2 Licence duration

Licence and licence conditions are valid from 1 January 2026 through 31 December 2050.

3.3.3 Technical conditions

To enable coexistence between licence holders in the 2.1 GHz band and to protect usages in adjacent frequency bands technical conditions are set out. All technical conditions for the 2.1 GHz band are set out in Appendix B.

3.3.3.1 Regulation and use

The licences in the 2.1 GHz band are subject to conditions in accordance with Commission Implementing Decision (EU) 2012/688¹⁰, and in addition with as few limiting conditions as possible to enable efficient use of the frequency range over time, with flexibility for technological development.

3.3.3.2 Radiated power of base stations within their own frequency block

PTS does not impose a limit on the maximum power of base station transmitters within their own assigned block.

3.3.3.3 Radiated power of terminals within their own frequency block

The limit for the maximum average power of terminals, in accordance with EU Implementing Decision 2012/688 (see Section 3.3.3.1), is regulated by the Post and

[dokument/remisser/2022/radio/900_2100_2600/eng/engelsk-oversattning---decision-to-limit-the-number-of-licences.pdf](#)

¹⁰ Commission Implementing Decision of 5 November 2012 on the harmonisation of the frequency bands 1920 - 1980 MHz and 2110 - 2170 MHz for terrestrial systems capable of providing electronic communications services in the Union, as amended by Commission Implementing Decision (EU) 2020/667 of 6 May 2020.

Telecom Authority's regulations on exemptions from licence requirement for the use of certain radio transmitters (the exemption regulations). The licences therefore do not include any specific conditions to this effect, except for a condition allowing the licence holder to use (under certain conditions) a higher power than the limit for fixed terminals installed outside urban areas¹¹.

3.3.4 Coverage and deployment conditions

In order to improve connectivity for railway passengers, bidders who win at least 40 MHz of spectrum in the 2.1 GHz and/or 2.6 GHz bands in the auction will have their licences subject to conditions on coverage and deployment along high-traffic railways.

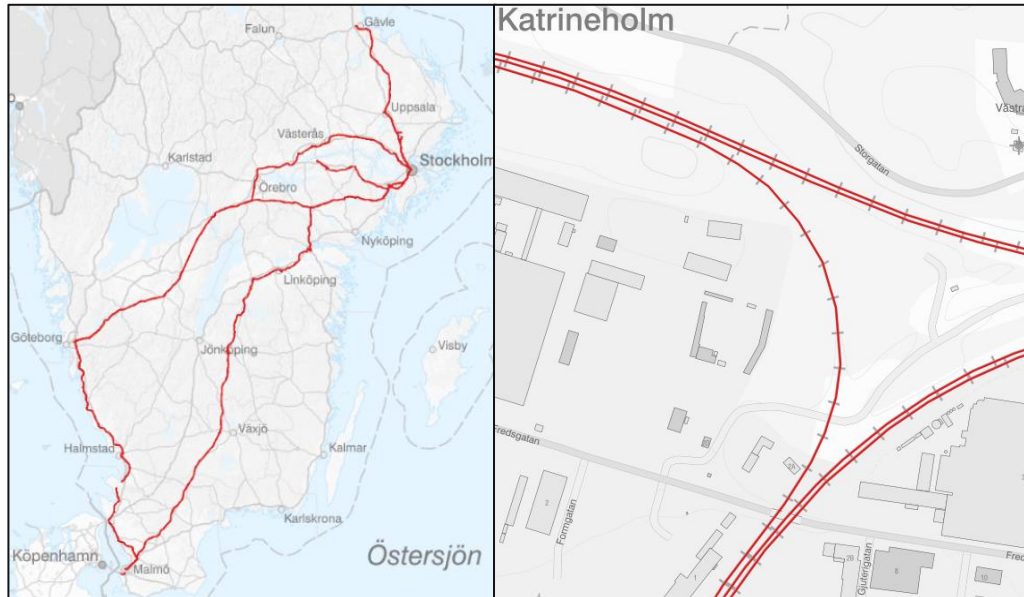
Bidders who win at least 40 MHz in the auction shall comply with the coverage and deployment conditions set out in Appendix B.

3.3.4.1 Coverage and capacity

Designated stretches of high-traffic railway lines are shown in Appendix B1. To this end, PTS provides geodata, in the form of a compressed GeoPackage file, for the tracks along the designated railway lines to which the conditions refer. Figure 5 shows the geographical extent of the designated railway lines and a detailed example of the tracks indicated along a section of one stretch. Tunnels are not included in the designated railway lines.

¹¹ Urban areas are areas with more than 200 inhabitants and less than 200 metres between houses, according to the definition of urban areas used by Statistics Sweden.

Figure 5 Designated high-traffic railway lines for coverage and deployment conditions, and example of indicated tracks.



The coverage level and how coverage is to be calculated are specified in the licence conditions.

3.3.4.2 Monitoring

PTS has prepared an outline supervision plan for monitoring the conditions. The plan can be found in Appendix B2 and may be amended as necessary.

3.4 Licences and conditions in the 2.6 GHz band

3.4.1 Number of licences to award

It follows from PTS decision to limit the number of licences¹² that the 2.6 GHz band is divided into frequency blocks according to Figure 6 and includes:

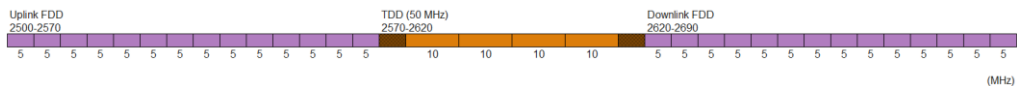
- 14 blocks of 2×5 MHz (FDD) each

¹² Decision to limit the number of licences in the 900 MHz, 2.1 GHz and 2.6 GHz frequency bands of 15 June 2022 (21-10605-82), https://www.pts.se/globalassets/startpage/dokument/icke-legala-dokument/remisser/2022/radio/900_2100_2600/eng/engelsk-oversatning---decision-to-limit-the-number-of-licences.pdf

- 4 blocks of 1×10 MHz (TDD¹³) each (2570–2575 MHz and 2615–2620 MHz, with limited usability, will be assigned the one assigned the respective adjacent 10 MHz block)

A bidder can win several blocks in the auction and a licence can thus consist of several blocks.

Figure 6 The figure shows the block division in the 2.6 GHz band



3.4.2 Licence duration

Licence and licence conditions are valid from 1 January 2026 through 31 December 2050.

3.4.3 Technical conditions

To enable coexistence between licence holders in the 2.6 GHz band and to protect usages in adjacent frequency bands technical conditions are set out. All technical conditions for the 2.6 GHz band are set out in Appendix C.

3.4.3.1 Regulation and use

The licences in the 2.6 GHz band are subject to conditions in accordance with Commission Decision 2008/ 477/ EG ¹⁴, and in addition with as few limiting conditions as possible to enable efficient use of the frequency range over time, with flexibility for technological development.

3.4.3.2 Radiated power of base stations within their own frequency block

PTS does not impose a limit on the maximum power of base station transmitters in their own assigned block within 2575–2690 MHz. In the 2570–2575 MHz range, a limit on the maximum power of base station transmitters is introduced.

3.4.3.3 Radiated power of terminals within their own frequency block

The limit for the maximum average power of terminals, in accordance with EU Decision 2008/477 (see Section 3.4.3.1), is regulated by the PTS regulations on exemptions from licence requirement for the use of certain radio transmitters (the

¹³ TDD - Time Division Duplex

¹⁴ Commission Decision of 13 June 2008 on the harmonisation of the 2500 - 2690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community, as amended by Commission Implementing Decision (EU) 2020/636 of 8 May 2020.

exemption regulations). The licences therefore do not include any specific conditions to this effect.

3.4.3.4 Synchronisation

Licence holders in the 2570–2620 MHz frequency band may agree among themselves on the conditions for synchronisation in the band. In the event that the licence holders are unable to reach an agreement, PTS has defined conditions for synchronisation that the licence holders must comply with. As part of these conditions, PTS has defined two different so-called frame structures. One frame structure enables synchronisation of networks based on LTE¹⁵ and NR¹⁶, respectively, while the other is adapted for synchronisation of networks based entirely on NR.

3.4.4 Conditions for the protection of other use

According to the Swedish frequency plan¹⁷, the frequency range 2690–2700 MHz is reserved exclusively for radio astronomy. According to the ITU-R Radio Regulations Article 5, the band 2690–2700 MHz is globally allocated for radio astronomy, earth exploration via satellite (passive) and space research (passive) on a co-primary basis. In addition, according to footnote FN 5.340 of the Radio Regulations, all radio transmissions are prohibited in that band. Conditions for the protection of the activities of the Onsala Space Observatory, in the frequency range 2690–2700 MHz, are set out in Appendix C.

3.4.5 Coverage and deployment conditions

In order to improve connectivity for railway passengers, bidders who win at least 40 MHz of spectrum in the 2.1 GHz and/or 2.6 GHz bands in the auction will have their licences subject to conditions on coverage and deployment along high-traffic railways. See the description of the conditions in Section 3.3.4. Licence conditions are set out in Appendix C.

3.5 Common conditions for the 900 MHz, 2.1 GHz and 2.6 GHz bands

3.5.1 Sharing conditions

The use of the 900 MHz, 2.1 GHz and 2.6 GHz bands shall be prioritised and protected from harmful interference. The licence holder shall contribute in making

¹⁵ Long Term Evolution (4G)

¹⁶ New Radio (access technology for 5G)

¹⁷ The Swedish Post and Telecom Authority's *Allmänna råd* (PTSFS 2019:1) *om den svenska frekvensplanen* (General advice on the Swedish frequency plan)

information on the use and any current and planned deployment available in a suitable way to enable sharing of frequency range.

Parties involved and PTS may need to collaborate on the forms of how information about the use can be shared.

3.5.2 Conditions on coordination

3.5.2.1 Coordination with the Swedish Armed Forces

The licence holders shall obtain the consent from the Swedish Armed Forces for all new installations of radio transmitters and changes to existing installations of radio transmitters according to the conditions set out in Appendices A, B and C.

3.5.2.2 Coordination with other countries

Conditions are set out in Appendices A, B and C. Information on existing coordination agreements for block licences can be found on PTS's website (coordination agreements - block licences¹⁸).

3.5.3 Conditions regarding requirements that are of importance to the national security of Sweden

A prerequisite for an application for a licence to use radio transmitters to be approved is that, pursuant to Chapter 3, Section 6, point 7 of the Act (2022:482) on Electronic Communication (LEK), it can be assumed that the radio usage will not cause harm to the national security of Sweden. According to Chapter 3, Section 12 of LEK, a licence to use radio transmitters can be subject to conditions regarding, amongst others, requirements that are of importance to the national security of Sweden. Pursuant to Chapter 11, Section 7 of LEK, it is furthermore possible to revoke a licence and to amend the licence conditions immediately if the radio usage has caused harm to the national security of Sweden or if it can be assumed that the radio usage will cause such harm. According to chapter 3, Section 13, Regulation (2022:511) on Electronic Communication (FEK), PTS must consult with the Swedish Armed Forces and the Swedish Security Service in matters of licences to use radio transmitters according to Chapter 3 (LEK). The aim of the consultation is to clarify

1. whether the radio usage according to the application for a licence or for permission to transfer of lease a licence can be assumed to cause harm to the national security of Sweden, and
2. the need to make such licence subject to conditions regarding requirements that are of importance to the national security of Sweden and, if so, which conditions.

¹⁸ <https://www.pts.se/en/english-b/radio/coordination-agreements/>

In the consultation with the Swedish Security Service and the Swedish Armed Forces (the consultation authorities), which took place during the period Oct-Dec and is described in the OI Part 1, it has emerged that there is a need to make licences to use radio transmitters subject to conditions regarding requirements that are important to the national security of Sweden. In their opinions to PTS, the consultations authorities have pointed both to more general threats to the national security of Sweden and to security risks identified in the documents submitted by the applicants. The consultation authorities have also referred to the assessment regarding conditions for the protection of the national security of Sweden that was made during the assignment of licences to use radio transmitters in the 3.5 GHz- and 2.3 GHz-bands

By decision of 20 January 2021, reference number 18-8496, PTS granted licences for the use of radio transmitters in the 3,5 GHz- and the 2.3 GHz-bands and established conditions for the use of radio transmitters in these frequency bands. Two of the conditions that applied to the protection of the national security of Sweden were appealed by Huawei Technologies Sweden AB. The Court of Appeal rejected the appeal by judgement on 22 June 2022 in cases no. 5222-21 and 5223-21. PTS' decision has thereby become legally binding.

The following describes the conditions for protection of the national security of Sweden set by PTS in this assignment. The detailed conditions are set out in Appendices A, B and C.

3.5.3.1 General conditions for protection of the national security of Sweden

PTS has formulated a general condition for protection of the national security of Sweden, which states that the licence holder must take the technical and organizational measures required to ensure that the radio usage does not cause harm to the national security of Sweden.

The assessment of potential security risks, and of their management, is based, among other things, on the documentation provided by the applicants in their application. The documentation submitted by the applicants (responses to Appendices B1 and B2) in accordance with OI Part 1 includes, among other things, descriptions of network deployment in the 900 MHz, 2.1 GHz and 2.6 GHz frequency bands and security measures relating to these networks based on the consultation authorities' policy document on the national security of Sweden¹⁹. It is assumed that

¹⁹ Consultation authorities' document: Guiding principles for consultation with the Swedish Security service and Swedish Armed Forces, (ref. no. 21-10605-94), https://www.pts.se/globalassets/startpage/dokument/icke-legala-dokument/remisser/2022/radio/900_2100_2600/eng/engelsk-oversattning---appendix-b2-consultation-with-the-swedish-security-service-and-armed-forces.pdf

licence holders will observe the principles and the criteria set out in this guidance document throughout the period of validity of their licence.

3.5.3.2 *Requirement to exclude equipment from certain suppliers*

Based on the consultation authorities' opinions, the PTS acknowledges that even in the current assignment of licences to use radio transmitters, there is a need for licence conditions that prohibit the use of products from certain suppliers.

The suppliers listed in the licence conditions are those that might be considered today when supplying products for use in core network functions. In view of the long period of validity of the licences, conditions may of course change.

As stated above, Chapter 11, Section 7, third paragraph of LEK grants PTS the right to revoke a licence and to amend the licence conditions without further notice if the radio usage has caused harm to the national security of Sweden or if it can be assumed that the radio usage will cause such harm. If the Swedish Armed Forces or the Security Service so request, PTS will according to Chapter 10, Section 3 of FEK examine whether there are grounds to revoke the licence or change the licence conditions.

The principles of the consultation authorities²⁰ require operators to provide information concerning, among other things, measures taken in the communications networks which may affect confidentiality, resilience, accessibility, oversight or control.

The condition concerning suppliers who may not be used for central functions in the networks may thus be adjusted during the licence period.

3.5.3.3 *Redundant national source for common time reference*

Synchronisation through Global Navigation Satellite Systems (GNSS) implies a dependence on functions controlled from abroad. For the purposes of protecting the national security of Sweden, PTS considers that a redundant national solution for time synchronisation is required. The licences to use radio transmitters are therefore subject to the condition of a redundant national time synchronisation solution.

²⁰ Consultation authorities' document: Guiding principles for consultation with the Swedish Security service and Swedish Armed Forces, (ref. no. 21-10605-94), https://www.pts.se/globalassets/startpage/dokument/icke-legala-dokument/remisser/2022/radio/900_2100_2600/eng/engelsk-oversattning---appendix-b2-consultation-with-the-swedish-security-service-and-armed-forces.pdf

3.5.3.4 *Dependence of central functions on functions and staff abroad*

When central functions are dependent on functions or staff located abroad, situations where connections between Sweden and abroad are cut off can cause serious damage to network functionality. This could endanger the national security of Sweden.

A licence conditions is therefore required to ensure that, where necessary, functions or staff located abroad on which central functions are dependent, are phased out and replaced by functions or staff located in Sweden. Such a condition does not exclude the possibility of temporary network interconnections to foreign countries, where applicants have indicated that this is part of their solution to ensure redundant operation, provided that such interconnections are initiated and monitored from Sweden.

3.5.3.5 *Relationship to other applicable provisions*

The presentation in Section 3.5.3 of the proposed conditions concerning the national security of Sweden began with a general condition requiring that the technical and organisational measures, necessary to ensure that the radio use according to the licence does not cause harm to the national security of Sweden, must be taken. In this context, PTS would like to point out the importance of licence holders also being subject to other provisions aimed at increasing the security of their operations.

The Protective Security Act (2018:585) and other protective security legislation contains provisions that apply to anyone conducting security-sensitive activities. Pursuant to Chapter 8, Section 1 of the Protective Security Ordinance, PTS is the supervisory authority under the Protective Security Act in the area of electronic communications. PTS has also issued regulations on protective security, PTSFS 2021:2.

Chapters 8 and 9 LEK contain provisions on security, processing of traffic data and protection of privacy. These provisions aim to maintain a sufficient level of security for the networks and services covered by the rules.

In accordance with LEK, PTS has also issued regulations and general recommendations (PTSFS 2022:11) on security in networks and services (the Security Regulations). In this context, PTS would particularly like to point out that licence holders have an obligation to monitor external events that may affect the security of networks and services. The Security Regulations require providers to carry out risk analyses, inter alia, before acquiring assets, information processing assets or relationships, before hiring contractors and before planned changes. A new risk analysis for assets, information processing assets and relationships shall also be

carried out after previously unknown threats relevant to the risk analysis have been identified.

3.5.4 Other conditions

3.5.4.1 Information about coordination between licence holders

The licence conditions allow the affected licence holders to agree on how to comply with the technical conditions in a coordinated manner. This coordination means that, if there are several licence holders in the available frequency range in the 900, 2.1 GHz and 2.6 GHz band respectively, they can deviate from certain technical requirements in the licence conditions. The coordination must not entail deviations that affect a third party.

4. Auction procedure

4.1 General

4.1.1 Electronic online auction system

The award for assigning licences in the 900 MHz-, 2.1 GHz and 2.6 GHz bands will be held in an auction over the internet via an electronic Auction System (AS) with an English user interface. PTS will organize the auction in collaboration with an external supplier. The auction system will be tested in a trial auction, which PTS will organise. The entire auction procedure will be carried out through the electronic online auction system over the internet.

4.1.2 Login information and internet connection

The electronic online auction system is provided by PTS.

The contact person nominated by the bidder will, well ahead of the auction, receive the following information about the auction system: login details, a bidder's manual in English and a telephone number for support. Support via the telephone number will be in Swedish.

Bidders are responsible for their own participation, for example, that their computers and internet connections and other equipment are in order, that the right personnel participate and that the login details are kept secure.

4.1.3 Prior to the auction

PTS will contact the applicants that are approved to participate as bidders in the auction for additional information.

The auction is scheduled to start September 19th, 2023. If the starting date needs to be postponed, PTS will inform about the change on the authority's website <https://www.pts.se/900-2100-2600> and also directly inform each bidder's contact person of the change.

PTS plans to test the auction system through a trial auction on September 12th, 2023. PTS recommends that all bidders participate in the trial auction so as to assure themselves that their equipment functions correctly and that they understand the auction procedure.

The bidders will, before the auction, be given an auction schedule as well as a plan for how and when PTS intends to communicate the result of the auction on the authority's website.

4.2 Glossary - Auction procedure

Below is a description of the terms used in section 4, for the auction procedure and rules.

- **Activity** - a bidder's activity in a given clock round is equal to the sum of eligibility points of all the lots that are included in the bidder's clock bid.
- **Clock auction** - the first part of the auction, consisting of one or more clock rounds and potentially an exit bids round.
- **Clock bid** - a bid consisting of the lots, from one or more lot categories, that a bidder bids on in a clock round.
- **Clock price** - the price per lot, within a lot category, that the auctioneer sets in each clock round.
- **Clock round** - a round, and a time period set by PTS (and potentially extendable by the bidder), in the first part of the auction, in which a bidder has the possibility to place a clock bid.
- **Clock round with reduction in total demand / Clock round with reduction in activity** - a clock round in which the bidder places a clock bid on lots that correspond to fewer eligibility points, in total, than in the previous clock round.
- **Eligibility** - a bidder's eligibility is the maximum number of eligibility points that the bidder can bid for in a clock round. In the first clock round, the eligibility is given by the spectrum caps. For any clock round that follows, the eligibility is given by the activity in the bidder's clock bid in the preceding clock round.
- **Eligibility points** - one (1) eligibility point corresponds to 10 MHz of frequency range, regardless of FDD or TDD, see Table 1.
- **Exit bid** - a bid for one or several lots in a lot category, placed in the eventual exit bids round.
- **Exit bids round** - a round that follows after the final clock round, if, in one or more lot categories, demand in the category is less than the number of available lots.
- **Extension** - an additional time period (up to 30 minutes) that a bidder can use, in a clock round, to place its clock bid.
- **Generic frequency range** - a frequency range which does not refer to a specific position in a frequency band.
- **Lot** - a block offered in the clock auction, consisting of a given amount of bandwidth in a given frequency range.

- **Lot category** – a grouping of lots with similar characteristics.
- **Placement stage / Placement round** – the final stage of the auction, where, for each frequency band, the specific positions in the band are decided (for those bidders having won at least one lot).
- **Reserve price** – the price per lot at which bidding starts in each lot category.
- **Spectrum cap** – the maximum amount of frequencies in one or more frequency bands for the use of radio transmitters that can be assigned to a licence for a single bidder.

4.3 Prerequisites and Auction format

The frequency bands 900 MHz, 2.1 GHz and 2.6 GHz will be auctioned in a simultaneous process. Below is a description of the auction's different lot categories and lots, followed by the rules regarding spectrum caps and eligibility. Thereafter follows a synoptic description of the auction procedure, which consists of a clock auction and the placement stage.

4.3.1 Lot categories, lots and eligibility points

The frequency bands are divided into lot categories, each of which in turn is made up of at least one (1) lot to be auctioned, as shown in Table 1.

During the clock auction, lots in the 900 MHz band are frequency generic, except for the lot in the A1 lot category. Within each of the lot categories B, C1 and C2, the lots are frequency generic.

Table 1 Lot categories and lots in the auction

Lot category	Frequency band	Description	Lot size	Lots available	Eligibility points per lot	Reserve price per lot
A1	900 MHz FDD	Fixed frequency block: 880-885 / 925-930 MHz	2×5 MHz	1	1	150 MSEK
A2	900 MHz FDD	Frequency-generic lots	2×5 MHz	4	1	150 MSEK
A3	900 MHz FDD	Frequency-generic lot*	2×10 MHz	1	2	0 SEK
B	2.1 GHz FDD	Frequency-generic lots**	2×5 MHz	12	1	35 MSEK
C1	2.6 GHz FDD	Frequency-generic lots**	2×5 MHz	14	1	35 MSEK
C2	2.6 GHz TDD	Frequency-generic lots**	10 MHz	4	1	35 MSEK

* The lot in the A3 lot category is associated with conditions regarding coverage and deployment (see section 3.2.5). Also note that the lot has two (2) eligibility points.

** For bidders winning at least 40 MHz of frequency range in the 2.1 GHz and/or the 2.6 GHz bands, there are conditions regarding coverage and deployment (see section 3.3.4).

4.3.2 Spectrum caps

A spectrum cap of 2x20 MHz applies for the assignment of the 900 MHz band and a spectrum cap of 120 MHz (regardless of FDD or TDD) applies for the assignment of the 2.1 GHz and the 2.6 GHz bands. The spectrum caps imply that no bidder can bid for more than the specified amount of frequency range.

The spectrum caps apply during the entire auction procedure, that is, also in the event of an exit bids round (pursuant to section 4.4.2).

4.3.3 Eligibility

A bidder's initial eligibility is 16, which follows from the two spectrum caps.

The spectrum caps imply that the eligibility is limited to four (4), for the 900 MHz band, and to 12, for the 2.1 GHz and the 2.6 GHz bands.

4.3.4 Clock auction with an eventual exit bids round, and placement stage

The auction procedure consists of a clock auction and a placement stage. In the clock auction, it is determined how much frequency range each bidder procures. In the placement stage, it is determined where in each frequency band the procured frequency range is located.²¹ The rules that govern the bidding process are described in section 4.4.2 and in section 4.4.3.

In the clock rounds, bidders bid for the number of lots, within each lot category, that they wish to procure at the set clock price. In the first clock round the clock price, for each lot category, equals the reserve price for the lot category. The auctioneer then raises the clock price, in subsequent clock rounds, in those lot categories where demand exceeds supply. In other lot categories, the clock price remains unchanged. This process, with clock price increases in successive clock rounds, continues until there is no lot category in which demand exceeds supply. That is, the final clock round is the clock round in which none of the lot categories has a demand that exceeds supply. Clock bids in the final clock round become winning bids, at the round's clock prices.

If, after the final clock round, there is one or more lot categories where supply is greater than demand, an exit bids round will be held. Depending on earlier demand reductions and the price levels at which these demand reductions took place, bidders can, in the exit bids round, place one or more exit bid(s), on remaining lots. Each individual exit bid can only contain lots from one lot category. Within each lot

²¹ The A1 lot category contains only one lot. This is a fixed frequency lot.

category, the combination of exit bids that maximises the value of the lots involved, win the lots in question.

In the placement stage of the auction, the position within each frequency band is determined, for the frequency generic lots won during the clock auction. The placement stage is undertaken through a simultaneous process, independent across bands, with one placement procedure for each of the 900 MHz, 2.1 GHz and 2.6 GHz bands. Bidders are presented with placement options in the auction system and may then bid (if they wish - bidding on placement is not compulsory), and the value-maximising combinations are identified for each frequency band. The price that a bidder then pays for placement is based on how much loss of value the bidder causes other bidders. All placement options, regardless of whether a bidder is active or not in the placement round, result in the bidder being assigned a contiguous frequency range for FDD or TDD in the relevant band (also see the wording below specifically regarding the 2.6 GHz band).

The sum of the clock prices for a winning clock bid, successful exit bids (if any) and payments for placement (if any), constitute the bidder's total auction payment.

4.4 Auction rules

4.4.1 General

In addition to the information in section 4.4, the above glossary and prerequisites (from sections 4.2 and 4.3) shall also be considered as part of the auction rules.

At the start of the action, the electronic auction system displays information regarding the lot categories and lots that are part of the auction, and, privately to each bidder, the bidder's initial eligibility.

4.4.2 Clock auction with an eventual exit bids round

4.4.2.1 Eligibility and activity

The main part of the auction consists of one or more clock rounds. In the first clock round each bidder has the initial eligibility.

For each clock round that follows, a bidder's eligibility equals the activity from the preceding clock round.

4.4.2.2 Extensions

Each bidder has three (3) single-use extension rights that can be used during the clock rounds. Bidders can only use one (1) extension, up to 30 minutes, per clock round. An extension will be triggered automatically if the bidder has any remaining

extension right and, according to the bidder's eligibility, has the possibility to make a clock bid, but has not submitted a clock bid by the scheduled end time of the round. Only those bidders who have triggered an extension will be able to submit bids during the extension period. A clock round that has been extended will end when the last bidder using an extension right has placed its bid, or when the extension period expires.

4.4.2.3 *Bidding in clock rounds*

In each clock round PTS specifies the clock price for each lot category and each bidder submits a clock bid according to the bidder's eligibility.

In the first clock round the clock price, for each lot category, equals the reserve price for that lot category.

A clock bid specifies the number of lots, in each lot category, that the bidder wishes to buy at the lot category's current clock price. The bid amount is calculated automatically by multiplying, for each lot category, the number of lots by the current clock price, and then summing up across lot categories. If the clock bid becomes a winning bid, then the bidder wins all the lots included in the clock bid (across all lot categories) and will be required to pay the full bid amount. Clock bids are binding only for the round in which they are submitted and will not be considered in any future rounds. If a bidder does not place a bid before the end of the clock round (including any round extension for that bidder), the bidder will automatically be deemed to have submitted a clock bid for zero (0) lots in each lot category.

At the end of each clock round, and for each lot category, PTS will:

- calculate demand in the lot category as the sum of the number of lots specified by all bidders in their clock bids for that round, and
- assess if there is a need to increase the clock price, which is the case if demand in the lot category exceeds the available supply.

If the clock price is to be increased, in one or more lot categories, PTS will determine the new clock price by applying an appropriate increment for the next clock round (in other lot categories, the clock price remains unchanged). Such increments can be a percentage increase over the current clock price or an amount in SEK.²²

If, for each lot category, demand in the lot category is no larger than the available supply, then no further clock rounds are undertaken. Bidders will then win with their

²² A lot category that starts with a zero reserve price, may get a price increase that, per MHz, is in parity with price increases for lot categories with similar characteristics, depending on how the clock rounds develop.

clock bid in the final clock round, and will be assigned the lots in their winning bid at a price equal to the winning bid amount.

4.4.2.4 Information to bidders, between clock rounds and after the final clock round

If a new clock round is to be held, PTS will inform about the start- and end times of the new clock round, the categories for which the clock price will be increased, and the new clock price for each lot category. In addition, each bidder is, privately, informed about

- the bidder's clock bid in the most recent clock round
- the bidder's remaining eligibility
- the number of extension rights remaining to the bidder

After the final clock round, PTS will, privately, inform each bidder regarding

- the bidder's winning clock bid and the price for the clock bid.

PTS will also inform bidders about whether an exit bids round will be held, which is the case if any lot category, after the final clock round, contains till then unsold lots. Only in such a case should the information in section 4.4.2.5 be considered (otherwise, skip to section 4.4.2.6).

If an exit bids round is to be held, PTS will inform bidders about the start- and end time of the exit bids round and about which lot categories contain till then unsold lots, along with the number of lots in each lot category. Each bidder is also, privately, informed about

- the constraints that apply to the bidder for the submission of exit bids.

4.4.2.5 Eventual exit bids round, after the final clock round

Information in this section (4.4.2.5) applies if and only if an exit bids round is to be held.

Exit bids give bidders an opportunity to bid on lots (within one or more lot categories) that are unsold after the final clock round. Exit bids are binding.

Exit bids are placed in a single, sealed bid, exit bids round. Exit bids are not placed in clock rounds.

The exit bids round starts at a time communicated after the clock rounds and bidders will be given a predefined period of time to place their exit bids, without extension possibilities.

Exit bids are placed separately for each lot category and are evaluated separately for each lot category.

The price level for exit bids and the number of lots that can be included in an exit bid are determined by a bidder's reductions in total demand during the clock rounds (the number of eligibility points).

Each reduction in a bidder's total demand generates the right to, in the exit bids round, place exit bid(s) in the price range that is determined by the clock price in the clock round immediately preceding the demand reduction and the clock price in the round in which the demand reduction was made. Exit bids may be placed also at the end points of the price interval. That is, if a bidder's total demand has been reduced between two consecutive clock rounds, n and $n + 1$, with price levels p_n and p_{n+1} , exit bid(s) are constrained to the closed price interval $[p_n, p_{n+1}]$.

The number of eligibility points with which a bidder has reduced its total demand in a clock round puts a constraint on the maximum number of eligibility points that can be included in an exit bid. If a bidder, for instance, between clock rounds n and $n + 1$, has reduced its total demand with two lots, each worth one (1) eligibility point, then no individual exit bid, linked to this reduction in total demand, can contain lots worth more than two (2) eligibility points in total.

A bidder who, in a clock round, has reduced its total demand with more than one (1) eligibility point²³, can, in the exit bids round, place several exit bids related to this reduction in total demand (if such lots are available in the exit bids round, such as 1+1 C1 lots). The sum of eligibility points for the lots included in the exit bids cannot exceed the number of eligibility points with which total demand was reduced. A bidder who has reduced its total demand on more than one occasion can, furthermore, place exit bids in different price ranges (if the clock price has been raised between the clock rounds for which the reductions in total demand were made). These and other cases are exemplified in section 4.5.2

Exit bids can be placed in all lot categories included in the exit bids round. That is, each bidder who has reduced total demand during the clock rounds can, if in compliance with the rules in this section (4.4.2.5), place exit bids in all lot categories included in the exit bids round.

Notwithstanding the above aspects, the number of lots in an exit bid can never exceed the number of lots available in the lot category.

²³ For instance, a bidder's reduction of demand with two lots in the C1 category, while demand in other lot categories is maintained, constitutes a reduction in total demand with two eligibility points.

When the exit bids round starts, the electronic auction system presents, privately to each bidder, the restrictions that apply as to which exit bids the bidder can place (information regarding in which clock round(s) the bidder has reduced its total demand and the exit bid restrictions that follow therefrom). The electronic auction system will only accept exit bids that comply with the rules described in this section (4.4.2.5).

The value of an exit bid is the bid price per lot times the number of lots included in the exit bid.

For each lot category, the winning exit bids are the combination of exit bids that achieves the highest value (calculated as the sum of exit bid values across all of the exit bids in the combination) out of those exit bid combinations that can be assigned to bidders given the number of lots available. In the evaluation of exit bids, lots that potentially could remain unsold are valued at zero.²⁴ In situations where exit bid combinations generate the same value, a random draw will be made. The evaluation of exit bids is exemplified in section 4.5.2.7. Winning bidders pay the amount of their respective exit bids.

Such is the procedure through which PTS determines the number of lots each bidder wins through exit bids and the prices to be paid.

4.4.2.6 Information following the conclusion of the clock auction

After the clock auction, PTS will, privately, inform each bidder about the bidder's winning clock bid and the price of the winning clock bid, as well as the bidder's winning exit bids and the price for such exit bids.

PTS will also inform all bidders who have won at least one lot in the clock auction about the scheduled start- and end times of the placement stage (section 4.4.3).

4.4.3 Placement stage

The placement stage follows upon the finalized clock auction. The placement stage consists of a single placement round, which in turn consists of simultaneous and independent placement procedures for the 900 MHz, 2.1 GHz and 2.6 GHz bands. In the placement round, the bidders place bid(s) for one or several specific placement options, in the relevant frequency bands. Participation in the placement stage is voluntary.

²⁴ For instance, if there is an exit bids round with two lots from a lot category with reserve price 50, and where the two existing exit bids are, respectively, one bid at the price level of 90 for one lot, and one bid at the price level of 110 for two lots, then the latter bid wins.

Any unsold lots are assigned to a notional UNSOLD bidder.

The placement options available to each bidder will be established by PTS on the basis of all possible candidate band plans. The candidate band plans are calculated by considering the possible alternative orderings of bidders having won frequency range in the band. In each candidate band plan each bidder will be assigned the bandwidth it has won in the clock auction. All placement options, regardless of whether a bidder is active or not in the placement round, result, for each bidder, in the assignment of a contiguous frequency range for FDD and TDD, respectively, in the frequency band in question.

If a frequency band has only one possible placement option for each bidder (one candidate band plan), no placement procedure will be held for the band. A bidder participates in a band's placement procedure only if the bidder has multiple placement options in the band.

At the start of the placement stage, and in advance of the scheduled bidding round, each bidder gets information, privately, about its placement options.

The following three subsections (4.4.3.1 - 4.4.3.3) describe constraints imposed upon the three frequency bands, thus affecting which candidate band plans and placement options are possible.

4.4.3.1 Information specifically regarding the placement procedure for the 900 MHz band (lot categories A1, A2 and A3)

The bidder who has won the lot in the A1 category will automatically be placed lowest in the band.

If the lot in the A1 category has been sold then any unsold lots in the 900 MHz band (bidder UNSOLD) will be placed as a contiguous frequency range at the top of the frequency band. Otherwise, any unsold lots will be placed, as a contiguous frequency range, at the bottom of the band.

4.4.3.2 Information specifically regarding the placement procedure for the 2.1 GHz band (lot category B)

In all candidate band plans, any unsold lots in the 2.1 GHz band (bidder UNSOLD) will be placed, as a contiguous frequency range, either at the top or at the bottom of the frequency band.

4.4.3.3 Information specifically regarding the placement procedure for the 2.6 GHz band (lot categories C1 and C2)

The placement procedure is conducted for the whole band, i.e., for FDD and TDD frequencies together. Bidders who have won both FDD and TDD lots can therefore express preferences with respect to how such frequencies are placed in relation to each other.

In all candidate band plans, any unsold 2.6 GHz FDD-lots (bidder UNSOLD) will be placed as a contiguous frequency range. In all candidate plans, any unsold 2.6 GHz TDD-lots (bidder UNSOLD) will be placed as a contiguous frequency range. There are no other restrictions as to where, within the relevant part of the frequency band, any unsold lots are placed.

4.4.3.4 The bidding process for each frequency band's placement procedure

The placement procedure will be conducted as a single, sealed, bidding round, in which bidders can place bids for their placement options by specifying a bid amount for each option. These bids express the maximum amount bidders would be prepared to pay for being assigned a particular placement option. Bids placed in the placement stage are binding.

Bid amounts must not be lower than zero (0) SEK and must be in whole SEK, but can otherwise be chosen freely.

Bid amounts for any placement option for which a bidder does not specify a bid amount are set to zero (0). If a bidder fails to place bids before the scheduled end of the bidding round, then the bid amounts for all its placement options will be set to zero (0). There are no extension rights in the placement stage.

4.4.3.5 Value-maximising band plan, for each frequency band's placement procedure

At the end of the placement round, PTS will, for each frequency band, select the value-maximising band plan. The value of each candidate band plan is calculated as the sum of bids made by bidders for the assignment options they would be assigned in that plan. If there is more than one value-maximising band plan, one of these will be drawn at random, thus becoming the winning band plan for that frequency band.

Any unsold frequency range (bidder UNSOLD) is given the value zero for the calculations in this section (4.4.3.5) and the next section (4.4.3.6).

Bidders will be assigned the option corresponding to the winning band plan and shall pay a price determined as set out below.

4.4.3.6 *Price determination, for each frequency band's placement procedure*

The information below is further developed with a mathematical description in annex E.

The prices that bidders shall pay for the placement option they are assigned in each frequency band are based on opportunity cost.

For each possible subset of bidders, including subsets consisting of individual bidders, the opportunity cost is calculated as follows:

- identify the highest value that could be obtained across all candidate band plans if the bids made by the bidders in the subset were zero (0) SEK, and
- subtract from this value the bids of the winning band plan, excluding the bids from the subset of bidders.²⁵

Any unsold frequency range (bidder UNSOLD) is given the value zero for the calculations in this section.

The price the bidder must pay for its winning placement option must meet the following conditions:

- the sum of individual prices for each possible subset of bidders cannot exceed the sum of their winning bids.
- the sum of individual prices for each possible subset of bidders must be at least the opportunity cost for the subset.
- the sum of individual prices must be the smallest possible subject to prices satisfying the two conditions above.
- the sum obtained by, for each individual bidder, raising to the power of two the following expression:

the bidder's individual price minus the bidder's opportunity cost

and then summing these squared expressions, must be the smallest possible across all prices that satisfy the conditions above.

These conditions yield a unique solution for the prices in each frequency band.

4.4.3.7 *Information after the conclusion of the placement stage*

After the placement stage, PTS will, privately, inform each bidder about

²⁵ The opportunity cost can be interpreted as the loss in value that the bid(s) from a subset of bidder(s) incur on another (subset of) bidder(s).

- the bidder's assigned frequencies and their price

4.5 Auction examples

The following examples shall be seen as fictitious regarding, for example, the bidding behavior of individual bidders, bid levels and the number of bidders.

4.5.1 Examples clock rounds

Each example shall be viewed as an isolated example unless stated otherwise.

4.5.1.1 Example 1 - Clock round with an increase of the clock price

Following a given clock round, in lot categories A1, A3 and C2, demand equals supply. In these lot categories the clock price is therefore not increased in the next clock round. In lot category B demand is less than supply, hence the clock price is also not increased in the next clock round. In lot categories A2 and C1 demand exceeds supply. The clock price in the A2 and C1 categories is increased in the next clock round.

After the clock round in question, bidders are informed that, in the next clock round, clock prices in the A1, A3, B and C2 categories will not change, whereas clock prices in the A2 and C1 categories will increase. The next clock round's clock prices are posted.

4.5.1.2 Example 2 – Final clock round, without a subsequent exit bids round

Following a given clock round, demand equals supply in all lot categories. The clock rounds and the clock auction are concluded and the placement stage follows.

4.5.1.3 Example 3 - Final clock round, with a subsequent exit bids round

Following a given clock round, in lot categories A1, A2, A3, C1 and C2, demand equals supply. In lot category B demand is one (1) lot less than supply. No further clock rounds are undertaken and an exit bids round follows.

4.5.2 Examples exit bids round

Examples 1 and 2 (sections 4.5.2.1-4.5.2.2), preferably read together, illustrate bidder reduction in total demand and the right to place exit bids in an eventual exit bids round.

Examples 3-6 (sections 4.5.2.3-4.5.2.6), preferably read together, describe which exit bids that can be placed in an exit bids round, in four fictitious examples.

Example 7 (section 4.5.2.7) illustrate the determination of winning exit bids.

4.5.2.1 Example 1 - Reduction in total demand and exit bids

A bidder places clock bids according to Table 2 in clock rounds n to $n + 5$:

Table 2 A bidder's clock bids in example 1

Frequency band	900 MHz			2.1 GHz	2.6 GHz		Number of eligibility points	Reduction in total demand
	A1	A2	A3		FDD	TDD		
Lot category	A1	A2	A3	B	C1	C2		
<i>Round n</i>	1	3	0	12	0	0	16	
<i>Round n+1</i>	0	4	0	0	8	4	16	0
<i>Round n+2</i>	1	3	0	4	4	4	16	0
<i>Round n+3</i>	1	2	0	4	4	4	15	1
<i>Round n+4</i>	1	2	0	2	4	4	13	2
<i>Round n+5</i>	1	2	0	0	4	4	11	2

The clock price, in each lot category, evolves according to Table 3:

Table 3 Clock prices in example 1

Frequency band	900 MHz			2.1 GHz	2.6 GHz	
	A1	A2	A3		FDD	TDD
Lot category	A1	A2	A3	B	C1	C2
<i>Round n</i>	300	300	300	150	150	150
<i>Round n+1</i>	330	330	360	165	150	150
<i>Round n+2</i>	360	360	420	165	165	165
<i>Round n+3</i>	380	380	460	180	180	180
<i>Round n+4</i>	400	400	500	195	195	195
<i>Round n+5</i>	400	420	500	195	210	195

After the clock bid in clock round n , the bidder switches, in clock round $n + 1$, part of its demand, from lot category A1 to lot category A2 and from lot category B to lot categories C1 and C2. The bidder does not reduce its total demand, and therefore, no right to place an exit bid, in an eventual exit bids round²⁶, is generated.

In clock round $n + 2$ the bidder switches part of its demand, from lot category A2 to lot category A1 and from lot category C1 to lot category B. The bidder does not reduce its total demand and therefore, as above, no right to place an exit bid, in an eventual exit bids round, is generated.

In clock round $n + 3$ the bidder reduces its total demand with one (1) eligibility point. In an eventual exit bids round the bidder can, related to this reduction, in one (1) category with lots available, place one (1) exit bid corresponding to one (1) eligibility point, in the closed price interval given by the clock prices in clock rounds $n + 2$ and $n + 3$ (for example, [360,380] for a lot in the A2 category).

In clock round $n + 4$ the bidder reduces its total demand with two (2) eligibility points. In an eventual exit bids round the bidder can, related to this reduction, in up to two (2)

²⁶ As the clock rounds in the example progress at least until clock round $n + 5$, an eventual exit bids round would take place, after clock round $n + 5$, or after some later clock round.

categories with lots available, place exit bids that correspond to a maximum of two (2) eligibility points in total, in the closed price interval given by the clock prices in clock rounds $n + 3$ and $n + 4$ (for example, [180,195] for lots in the B category).

In clock round $n + 5$ the bidder reduces its total demand with two (2) eligibility points. In an eventual exit bids round the bidder can, related to this reduction, in up to two (2) categories with lots available, place exit bids that correspond to a maximum of two (2) eligibility points in total, in the closed price interval given by the clock prices in clock rounds $n + 4$ and $n + 5$ (for example, at the price 195 – the [195,195] interval – for lots in the B category).

Suppose the lot in the A3 category (which has two (2) eligibility points) were included in an eventual exit bids round. The bidder could then place exit bids on this lot in the price intervals given by the two latter reductions in total demand, but not in the price interval given by the A3 category clock prices in clock rounds $n + 2$ and $n + 3$, as the reduction in total demand in this case was only one (1) eligibility point.

4.5.2.2 Example 2 – Reduction in total demand and exit bids

A bidder places clock bids according to Table 4 in clock rounds n to $n + 5$:

Table 4 A bidder's clock bids in example 2

Frequency band	900 MHz			2.1 GHz	2.6 GHz		Number of eligibility points	Reduction in total demand
	A1	A2	A3		FDD	TDD		
Lot category	A1	A2	A3	B	C1	C2		
<i>Round n</i>	0	0	0	0	12	0	12	
<i>Round n+1</i>	0	0	0	0	12	0	12	0
<i>Round n+2</i>	0	0	0	0	12	0	12	0
<i>Round n+3</i>	0	0	0	0	11	0	11	1
<i>Round n+4</i>	0	0	0	0	9	0	9	2
<i>Round n+5</i>	0	0	0	0	7	0	7	2

Assume the same clock prices as in example 1.

The right to place exit bids, in an eventual exit bids round, is the same as for the bidder in example 1. The exit bid possibilities are determined by the clock rounds in which the bidder reduced its total demand and the number of eligibility points associated with these reductions.

4.5.2.3 Example 3 – Possible exit bids

The lists of exit bid possibilities in examples 3-6 below should be understood as mutually exclusive exit bid possibilities, that is, exactly one of the possibilities can be used. In examples 3-6, the same clock prices are used for lot category C1.

A bidder places clock bids according to Table 5 in clock rounds m to $m + 5$:

Table 5 A bidder's clock bids in example 3

Frequency band	900 MHz			2.1 GHz	2.6 GHz		Number of eligibility points	Reduction in total demand
	A1	A2	A3		B	FDD		
Lot category					C1	C2		
Round m	0	0	1	6	0	0	8	
Round $m+1$	0	0	1	6	0	0	8	0
Round $m+2$	0	0	1	5	0	0	7	1
Round $m+3$	0	0	1	5	0	0	7	0
Round $m+4$	0	0	1	3	0	0	5	2
Round $m+5$	0	0	1	3	0	0	5	0

Assume that clock round $m + 5$ is the final clock round. Further, assume that lot category C1 contains one (1) unsold lot and that the clock prices in lot category C1 have evolved according to Table 6.

Table 6 Clock prices in example 3

Frequency band	900 MHz			2.1 GHz	2.6 GHz	
	A1	A2	A3		B	FDD
Lot category					C1	C2
Round m					172	
Round $m+1$					180	
Round $m+2$					180	
Round $m+3$					190	
Round $m+4$					200	
Round $m+5$					200	

The bidder has twice reduced its total demand, with one (1) eligibility point between clock rounds $m + 1$ and $m + 2$ and with two (2) eligibility points between clock rounds $m + 3$ and $m + 4$. The bidder can not, however, place exit bids for two lots (2) in the C1 lot category as there is only one lot available. The exit bid possibilities are as follows:

- one exit bid, on one C1-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]) and one exit bid, on one C1-lot, in the price interval [190,200]

The third alternative is included in order to show the complete list of options. However, with one (1) lot unsold, the higher bid would always win over the lower bid. Such theoretically possible courses of action, where one or more of the possible courses of action could never result in a winning exit bid, are not included in the following examples.

4.5.2.4 Example 4 - Possible exit bids

All conditions are as in example 3 (section 4.5.2.3), except that the C1 lot category now contains two unsold lots, after the final clock round. As a result of the bidder's

reduction in total demand, with one (1) eligibility point between clock rounds $m + 1$ and $m + 2$ and with two (2) eligibility points between clock rounds $m + 3$ and $m + 4$, the bidder can place one of the following:

- one exit bid, on one C1-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, in the price interval [190,200], and one additional exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on two C1-lots, in the price interval $[2 \times 190, 2 \times 200]$ ²⁷
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]) and one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]), and one exit bid, on two C1-lots, in the price interval $[2 \times 190, 2 \times 200]$

If the bidder is only interested in one (1) C1-lot in the exit bids round then only the first two of these possible exit bid possibilities are relevant.

4.5.2.5 Example 5 - Possible exit bids

A bidder places clock bids according to Table 7 in clock rounds m to $m + 5$:

Table 7 A bidder's clock bids in example 5

Frequency band	900 MHz			2.1 GHz	2.6 GHz		Number of eligibility points	Reduction in total demand
	A1	A2	A3		B	FDD		
Lot category					C1	C2		
Round m	0	0	1	6	0	0	8	
Round $m+1$	0	2	0	6	0	0	8	0
Round $m+2$	0	0	1	4	0	0	6	2
Round $m+3$	1	1	0	4	0	0	6	0
Round $m+4$	0	0	1	2	0	0	4	2
Round $m+5$	0	0	1	2	0	0	4	0

Assume that clock round $m + 5$ is the final clock round. Assume that the C1 lot category contains two unsold lots and that clock prices in the C1 lot category have evolved as in examples 3-4 (sections 4.5.2.3 - 4.5.2.4).

The bidder has twice reduced its total demand, with two (2) eligibility points between clock rounds $m + 1$ and $m + 2$ and with two (2) eligibility points between clock rounds $m + 3$ and $m + 4$. As a result of these reductions in total demand, the bidder can place one of the following:

²⁷ That is, the price per lot is the same, for the two lots, and lies in the [190,200] interval. A similar notation is used in examples 4-5.

- one exit bid, on one C1-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]), and one additional exit bid, on one C1-lot, at a price of 180
- one exit bid, on two C1-lots, at a price of 360 (interval [2 × 180,2 × 180])

- one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, in the price interval [190,200], and one additional exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on two C1-lots, in the price interval [2 × 190,2 × 200]

- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]) and one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on two C1-lots, at a price of 360 (interval [2 × 180,2 × 180]), and one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]), and one exit bid, on two C1-lots, in the price interval [2 × 190,2 × 200]

4.5.2.6 Example 6 - Possible exit bids

If in examples 3-5 (sections 4.5.2.3- 4.5.2.5), there had been, instead of in lot category C1, unsold lots in another lot category, with one (1) eligibility point per lot, the same exit bids rules and possibilities would apply (albeit with the clock price ranges of the other lot category).

Exemplified below is instead a case in which there are unsold lots in two different categories.

A bidder has twice reduced its total demand with two (2) eligibility points, as shown below (assume clock bids are as in example 5, section 4.5.2.5). Assume the same clock prices as in examples 3-5 (sections 4.5.2.3- 4.5.2.5) in the C1 lot category, as well as the same clock prices also in the C2 lot category. Assume that $m + 5$ is the final clock round. Also assume that after the final clock round there is one unsold lot in the C1 lot category and one unsold lot in the C2 lot category.

Clock bids (Table 8) and clock prices relevant for the example (Table 9) are as follows:

Table 8 A bidder's clock bid in example 6

Frequency band	900 MHz			2.1 GHz	2.6 GHz		Number of eligibility points	Reduction in total demand
	A1	A2	A3		FDD	TDD		
Lot category				B	C1	C2		
Round m	0	0	1	6	0	0	8	
Round $m+1$	0	2	0	6	0	0	8	0
Round $m+2$	0	0	1	4	0	0	6	2
Round $m+3$	1	1	0	4	0	0	6	0
Round $m+4$	0	0	1	2	0	0	4	2
Round $m+5$	0	0	1	2	0	0	4	0

Table 9 Clock prices in example 6

Frequency band	900 MHz			2.1 GHz	2.6 GHz	
	A1	A2	A3		B	FDD
Lot category					C1	C2
Round m					172	172
Round $m+1$					180	180
Round $m+2$					180	180
Round $m+3$					190	190
Round $m+4$					200	200
Round $m+5$					200	200

The bidder has twice reduced its total demand, with two (2) eligibility points between clock rounds $m + 1$ and $m + 2$ and with two (2) eligibility points between clock rounds $m + 3$ and $m + 4$. As a result of these reductions in total demand the bidder can place one of the following:

- one exit bid, on one C1-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, in the price interval [190,200]
- one exit bid, on one C2-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C2-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]) and one exit bid, on one C2-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, in the price interval [190,200] and one exit bid, on one C2-lot, at a price of 180 (interval [180,180])
- one exit bid, on one C1-lot, at a price of 180 (interval [180,180]) and one exit bid, on one C2-lot, in the price interval [190,200]
- one exit bid, on one C1-lot, in the price interval [190,200] and one exit bid, on one C2-lot, in the price interval [190,200]

4.5.2.7 Example 7 - Winning exit bids

In the exit bids round there are two lots in the B category. Bidders 1, 2 and 3 have all previously reduced their total demand and have the possibility to bid on the available lots. The bidders placed exit bids according to Table 10:

Table 10 Exit bids in example 7

Bidder	Number of B-lots in exit bid	Price per lot	Total bid amount
Bidder 1	1	211	211
Bidder 1	1	210	210
Bidder 2	1	215	215
Bidder 2	1	200	200
Bidder 3	1	208	208
Bidder 3	2	212	424

As there are two lots available, the auctioneer can accept either two exit bids each for one (1) lot or one exit bid for two (2) lots.

The highest total bid value in this case would be the sum of 211+215, that is, consisting of one exit bid for one (1) lot from bidder 1 and one exit bid for one (1) lot from bidder 2. Bidder 1 is assigned one B-lot at the price of 211 and bidder 2 is assigned one B-lot at the price of 215.

4.5.3 Examples Placement stage

The examples below are independent of each other. For the purpose of simplification, the examples only illustrate one of the two paired parts in the frequency range for FDD.

4.5.3.1 Example 1 - Placement stage

The entire frequency range in the 900 MHz band has been sold, to two bidders. No placement procedure is held for the band, as the bidder who won the lot in the A1 category will have the other 900 MHz lots won placed contiguous with the lot in the A1 category.

4.5.3.2 Example 2 - Placement stage

The entire frequency range in the 900 MHz band has been sold, to three bidders, as follows:

- Bidder 1 (2x10 MHz): Two lots in lot category A2
- Bidder 2 (2x10 MHz): The lot in lot category A3
- Bidder 3 (2x15 MHz): The lot in lot category A1 + two lots in lot category A2

Bidder 3 will, in all candidate band plans, be assigned the lowest 2x15 MHz in the 900 MHz band. Bidder 3 will not participate in the placement procedure for the 900 MHz band and will not pay for placement in the 900 MHz band.

The two candidate band plans (see Figure 7) determine the placement options for which bidder 1 (green) and bidder 2 (blue) can make placement bids:

Figure 7 Two candidate band plans determining placement options in example 2

Candidate band plan 1

Bidder 3			Bidder 1		Bidder 2	
5 MHz (A1)	5 MHz	5 MHz	5 MHz	5 MHz	5 MHz	5 MHz

Candidate band plan 2

Bidder 3			Bidder 2		Bidder 1	
5 MHz (A1)	5 MHz	5 MHz	5 MHz	5 MHz	5 MHz	5 MHz

In the following list are five examples of placement bids and payment:

- Bidders 1 and 2 both bid zero for both placement options. The winning band plan is selected by a random draw. None of the bidders pay for placement.
- Bidder 1 bids 100 for the placement option that follows from candidate band plan 1, other bids are zero. Band plan 1 is the value-maximising combination and determines the final placement. According to section 4.4.3.6, the loss in value that bidder 1 causes other bidders is equal to the sum of winning bids for placement had bidder 1 not participated, which would be zero, minus the bid from bidder 2 in the value maximising band plan, which is zero. The difference is zero and the payment for bidder 1 is therefore zero. The loss in value that bidder 2 causes the other bidders is equal to the sum of winning bids for placement had bidder 2 not participated, which would be 100, minus the bid from bidder 1 in the value maximising band plan, which is also 100. The difference is zero and the payment for bidder 2 is therefore zero. There is no competition regarding placement, the opportunity costs are zero, and bidders 1 and 2 therefore do not pay for placement.
- Bidder 1 and 2 both bid 100 for their respective placement option that follows from candidate band plan 1, the other bids are zero. Band plan 1 is the value-maximising combination and determines the final placement. There is no competition regarding placement, the opportunity costs are zero, and the result is the same as for the previous case, that is, no payments.
- Bidder 1 bids 100 for the placement option that follows from candidate band plan 1 and bidder 2 bids 100 for the placement option that follows from candidate band plan 2. Other bids are zero. The winning band plan is selected through a random draw and candidate band plan 1 wins and determines the final placement. The loss in value that bidder 1 causes the other bidders is 100 (the winning bid from 2 if 1 had not participated (100) minus the bid from 2 in the winning band plan (0)). The loss in value that bidder 2 causes the other bidders is 0 (the winning bid from 1 if 2 had not participated (100) minus the bid from 1 in the winning band plan (100)). Bidder 1 shall therefore pay 100 for placement and bidder 2 shall pay zero for placement.
- Bidder 1 bids 200 for the placement option that follows from candidate band plan 1 and bidder 2 bids 100 for the placement option that follows from candidate band plan 2. Other bids are zero. Candidate band plan 1 is the value-maximising combination and decides the final placement. The loss in

value that bidder 1 causes the other bidders is 100 (the winning bid from 2 if 1 had not participated (100) minus the bid from 2 in the winning band plan (0)). The loss in value that bidder 2 causes the other bidders is 0 (the winning bid from 1 if 2 had not participated (200) minus the bid from 1 in the winning band plan (200)). Bidder 1 shall therefore pay 100 for placement and bidder 2 shall pay zero for placement.

4.5.3.3 Example 3 – Placement stage

The entire frequency range in the 2.6 GHz band has been sold, to four bidders, as follows:

- Bidder 1 (2×20 MHz FDD and 40 MHz TDD): Four lots in lot category C1 and four lots in lot category C2
- Bidder 2 (2×20 MHz FDD): Four lots in lot category C1
- Bidder 3 (2×20 MHz FDD): Four lots in lot category C1
- Bidder 4 (2×10 MHz FDD): Two lots in lot category C1

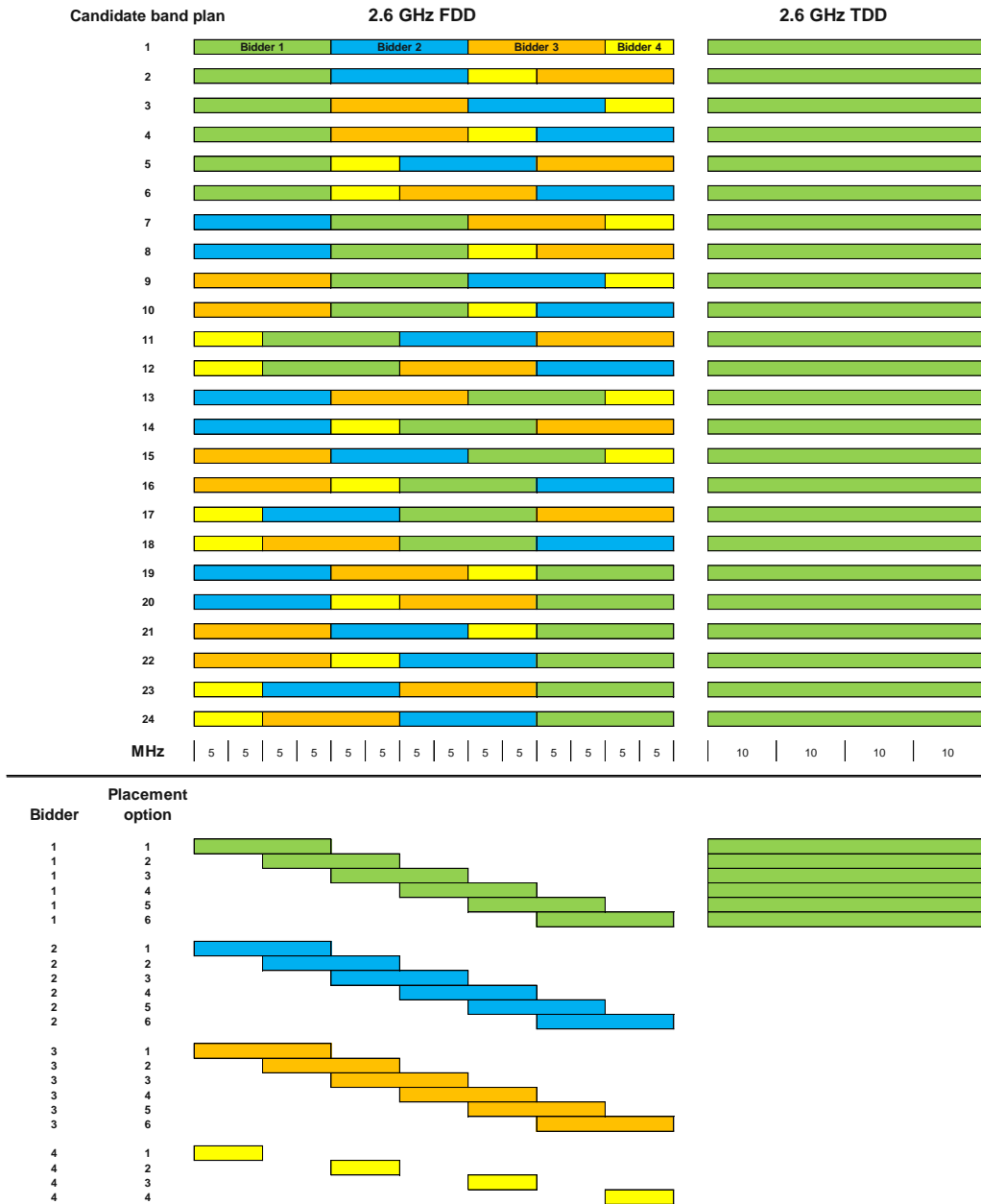
Bidder 1 has won all of the available frequency range for TDD. Figure 8 shows the candidate band plans (upper part of the figure), with bidder 1 (green), bidder 2 (blue), bidder 3 (orange) and bidder 4 (yellow), and placement options (the information which is presented to bidders, lower part of the figure).

Bidder 1 and bidder 4 are assumed to have a preference for placement at the top of the frequency range for FDD in the 2.6 GHz band. Bidder 1 bids 100 for placement at the top of the frequency band (the bidder's placement option 6, corresponding to candidate band plans 19-24). Bidder 4 bids 120 for placement at the top of the frequency band (the bidder's placement option 4, corresponding to candidate band plans 1, 3, 7, 9, 13 and 15). All other bids are zero.

The value-maximising combination is 120, and candidate band plan 7 is selected in a random draw as the final placement. Bidder 2 and 3 shall not pay for placement.²⁸ The winning band plan, if bidder 1 had not participated, would have had a value of 120, which equals the sum of the bids from bidders 2-4 in the winning band plan. Bidder 1 shall therefore not pay for placement. If bidder 4 had not participated then the winning band plan bid would have had a value of 100, whereas the sum of the bids from bidders 1-3 in the winning band plan is 0. Bidder 4 shall therefore pay 100 for placement.

²⁸ With bids of zero from bidders 2 and 3 the opportunity cost calculations are simplified (section 4.4.3.6). For example, the value loss that the subset consisting of bidders 4 and 2 cause bidders 1 and 3 is the same as the value loss bidder 4 causes bidders 3, 2 and 1.

Figure 8 Candidate band plans, and placement options, in the placement stage, according to example 3



5. Payment of auction proceeds

5.1 Payment of auction proceeds

Section 5.2 av the Open Invitation part 1 contains the conditions for payment of the auction proceeds. In addition to what is provided there, the winning bidder is required to pay 50% of the auctions proceeds in connection with the conclusion of the auction and the decisions of PTS regarding the assignment of licences. The remaining 50% of the auction proceeds must be paid at the end of 2025, i.e. before the licence can be used.

PTS will send invoices at these times for each respective part of the auction proceeds. The invoices shall be paid by the bidder within 30 days of the invoice date. If the amount due is not paid, the licence will be recalled by PTS.

In case of a transfer or lease of a licence, or part of a licence, before the auction proceeds for the licence have been fully paid, the transferor must pay the remainder of the proceeds before the lease or transfer is planned to take place. In accordance with Chapter 3, Sections 25 and 28 §§ of LEK, any transfer or lease of a licence is subject to permission by the Post and Telecom Authority.

Conditions as above regarding the payment of auction proceeds will be included in the licences that are assigned following the auction.

6. Appendices

- Appendix A Licence conditions 900 MHz band
- Appendix A1 100x100m grid squares containing coverage gaps (Geodata, compressed GeoPackage file)
- Appendix A2 Supervision plan for coverage and deployment conditions in the 900 MHz band
- Appendix B Licence conditions 2.1 GHz band
- Appendix B1 Designated tracks along the railway lines concerned (Geodata, compressed GeoPackage file)
- Appendix B2 Supervision plan for coverage and deployment conditions in the 2.1 GHz and 2.6 GHz bands
- Appendix C Licence conditions 2.6 GHz band
- Appendix D Confirmation of application
- Appendix E Establishing prices in the placement stage (mathematical description)