Interference scenarios for the Upper 6 GHz band

Overall view and deeper analysis of the IMT-RAS and FSS-IMT interference scenarios in The Netherlands

Document properties

Document title	**Interference scenarios for the Upper 6 GHz band - Overall view and deeper analysis of the IMT-RAS and FSS-IMT interference scenarios in The Netherlands**
Authors	**Maria Raftopoulou, Yohan Toh, Pieter Nooren (TNO)**
Reviewer	**Ljupco Jorguseski (TNO)**
Dissemination level	**Public**
Status of the document	**Final**
Version	**1.0**
Work Package	**WP4.5 Technology-Policy Co-Development**
Deliverable	**D4.5.1**
Contractual delivery date	**December 2025**
Delivery date	**9 December 2025**
File name	**FNS6G_2025_Upper_6_GHz_v1.0.docx**

Major contributions to impact pathways

Sustainable earning power	X
Digital autonomy and reliability	
Sustainability	

Summary

The Upper 6 GHz (U6) band (6425 – 7125 MHz) is the subject of technical and policy-related studies across Europe. These studies are relevant for the development of International Mobile Telecommunications (IMT) technology, including 6G, and its deployment in mobile networks, as the U6 band has been identified for the terrestrial component of IMT during the 2023 World Radiocommunication Conference (WRC-23) for Region 1 that includes Europe. Additionally, the U6 band is relevant for the development of Wi-Fi, as according to WRC-23, the U6 band can be also used for the deployment of radio local area networks.

The two potential new services, i.e., IMT and Wi-Fi, in the U6 band may lead to harmful interferences, as multiple services are already operational in the U6 band. An extensive inventory of current and potential future uses of the U6 band per radio service have been presented in an earlier report, as part of the Future Network Services (FNS) programme, the Dutch multi-year public-private programme on 6G development. To investigate the potential harmful interferences both between these two new services and between each of these new services and the existing services in the U6 band, technical studies have been performed in the European Conference of Postal and Telecommunications Administration (CEPT). Based on these studies, and other relevant studies, this report provides a high-level overview showing the identified potential harmful interferences.

Moreover, this report provides an analysis where it was identified that four potential harmful interferences exhibit (or can exhibit) Dutch-specific elements and those elements are not addressed in any of the existing studies. For two of the identified interferences, additional analyses have been performed to evaluate the coexistence of the services in The Netherlands. The analysis for the other two inferences is left for future work. An overview of each potential harmful interference is given:

- **IMT to Wi-Fi and Wi-Fi to IMT:** This report does not further analyse these two interferences, as during the writing, the Radio Spectrum Policy Group (RSPG) was developing its final opinion on the use of the U6 band, in particular by IMT and Wi-Fi. The opinion has recently been published and will be studied to determine whether it contains new input for a follow-up country-specific analysis.
- **Fixed Satellite Service Earth-to-Space (FSS ES) to IMT:** This report presents detailed simulations showing that harmful interference from commercial FSS ES can probably be avoided or limited to a small geographical area with careful IMT base station site planning and the use of advanced beamforming techniques. Since the simulation study was done for the smallest elevation angle, the coordination area could be (considerably) lower for those FSS ES stations with larger elevation angles. Therefore, the service impact from the current commercial FSS ES on mobile networks in The Netherlands is expected to be low.
- **IMT to Radio Astronomy Service (RAS):** This report provides a detailed analysis of several publicly available studies that show strong interference from IMT to RAS, even though they are based on different assumptions. From those studies, only the study by the Committee on Radio Astronomy Frequencies (CRAF) provides results specific to the Westerbork telescope, with some considered parameters underestimating the results and some others overestimating the results. However, even under different assumptions and configurations, the coordination zone between IMT and RAS is significant, given the size of The Netherlands, and cross-border coordination might also be necessary. Depending on the required protections for RAS and potential mitigation arrangements, IMT use of the RAS band and the adjacent guard bands may prove impracticable or even impossible in a major portion of The Netherlands.

Table of contents

1. Introduction

1.1. Current and potential future uses

With the evolution and development of mobile network technologies, the availability of spectrum is a key topic. One of the bands under consideration for International Mobile Telecommunications (IMT) is the Upper 6 GHz (U6) band, i.e. 6425 – 7125 MHz. The U6 band has been identified for the terrestrial component of IMT during the 2023 World Radiocommunication Conference (WRC-23) [1][1] for Region 1 (that includes Europe). According to WRC-23, the U6 band can be also used for the implementation of Radio LANs making it relevant for the development of Wi-Fi technology as well.

As part of the Future Network Services (FNS) programme [2], the Dutch multi-year public-private programme on 6G development, an earlier report [3] has been published providing an extensive analysis of potential future uses of the U6 band in The Netherlands, including IMT and Wi-Fi. A short overview of these uses is provided in Table 1.

Table 1: Overview of new services considered for future use in the U6 band.

Potential future use	Characterisation of use in The Netherlands
IMT	Mobile network services provided by nationwide macrocellular (public) networks and potentially also by local networks
Wi-Fi	Indoor network access in consumer and business settings, and very local connectivity

While new services are considered for deployment in the U6 band, there are already multiple services operating in (parts of) the U6 band. In The Netherlands, the existing services include Fixed Service (FS), Fixed Satellite Service Earth-to-Space (FSS ES, commercial and defence), Ultra-Wideband (UWB), Earth Exploration-Satellite Service (EESS), and Radio Astronomy Service (RAS). Due to the high interest of existing and new services on the U6 band, there are multiple studies across Europe addressing technical and policy aspects related to service coexistence. These studies can assist in decision making for the existing and potential new users, which is primarily done at the European level. Focusing on the situation in The Netherlands, the earlier FNS report [3] provides an extensive inventory of the existing uses of the U6 band per radio service, including their current deployment and an outlook. The overview of these existing uses is provided in Table 2.

Table 2: Overview of services currently operating in the U6 band.

Existing use	Characterisation of use in The Netherlands	Outlook
FS	Long microwave links in ring networks for communication services on North Sea	Stable/ Slightly growing
FSS ES commercial	Uplink to geostationary satellites from ground stations in Burum and Biddinghuizen	Stable
FSS ES defence	Uplink to geostationary satellites	Stable/ Growing

UWB	Short-range communication and positioning, e.g., in smart trackers or automotive	Growing
EESS	Passive collection of environmental data by satellites, e.g., sea-surface temperature	Stable
RAS	Passive collection of cosmic radio signals by the telescope in Westerbork	Stable

1.2. Scope and research question

In Europe, many key discussions on spectrum take place in the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT), with participation of policy makers, regulators and industry from 48 European countries. Given the interest in the U6 band for existing and potential future uses, studies are performed to evaluate potential coexistence of services and new harmful interferences that may arise due to the introduction of new uses. Such studies have been submitted by various organisations/administrations to ECC, which specifically assess, among others, the feasibility and sharing between IMT, Wi-Fi, and incumbents. The ECC reviews and consolidates these studies and publishes ECC reports (such as the ones in [4]-[7]). Reports that have been produced by the ECC in response to a mandate issued by the Radio Spectrum Committee are often used as the technical basis for legislation by the European Commission.

This report addresses the topic of service coexistence and potential harmful interferences between the current and future uses in the U6 band with focus on the situation in The Netherlands. As a starting point, the CEPT ECC studies have been examined to identify which parts can be directly applied to the Dutch situation and which parts require specific attention or further investigation. This step was necessary because the ECC studies are based on agreed assumptions (e.g. deployment characteristics) that are sufficiently representative for Europe, but could be different from those that apply to The Netherlands. This would imply that certain results from the ECC studies may not be fully applicable to the Dutch situation. Moreover, other relevant studies have also been taken into account in this report, such as the consultation by Ofcom [8] that provides an analysis and proposal for the United Kingdom in relation to IMT and Wi-Fi coexistence and their interference to existing uses. By focusing to the specifics of the situation in The Netherlands, the analysis is this report aims to support the Dutch policy discussion and to contribute results back to the European discussion, where applicable.

After identifying which potential harmful interferences between uses in the U6 band exhibit Dutch-specific elements, two additional analyses have been performed to investigate two of these interferences in more detail and identify the limitations and challenges for coexistence. In particular, the one additional analysis is performed based on new simulations representing the actual situation in The Netherlands, whereas the second analysis is based on detailing the available ECC studies. Note that this report does not provide an in-depth analysis on all identified potential harmful interferences that exhibit Dutch elements, as some of those interferences are left for future work. Moreover, potential mitigation solutions to allow coexistence between the various uses are out of scope. Therefore, the research question that this report addresses is:

"Which potential harmful interferences between uses of the U6 band have Dutch-specific elements, and for those interferences what is the effect on service coexistence in The Netherlands?"

The analyses in this report addressing this research question have been developed in the FNS programme [2] and more specifically in the policy-technology co-development task within FNS, where spectrum is one of the key topics. The FNS partners contributing to the technology-policy work are (in alphabetical order) the Dutch Authority for Digital Infrastructure, Ericsson, KPN, Liberty Global, Ministry of Economic Affairs, Nokia, Odido, and TNO. It is important to note that the role of FNS as a research and innovation project is to provide analysis, and inputs to policy makers at the Dutch and European Union levels. The FNS programme itself does not have a role in policy decisions.

The remainder of this report is organised as follows: Chapter 2 provides the high-level study for potential harmful interferences and identifies which interferences have Dutch-specific elements. Then, in Chapters 0 and 4, the more detailed analyses on the interference from FSS ES to IMT and from IMT to RAS are presented, respectively. These two analyses were performed as they have been identified to exhibit Dutch-specific elements. Finally, Chapter 5 concludes the report and provides recommendations for future work.

2. High-level study for interference

2.1. Study approach and assumptions

The first goal of this report is to identify which potential harmful interferences may arise from the introduction of new uses in the U6 band that have Dutch-specific elements. This high-level analysis identifying these interferences takes into account inputs from existing reports, such as ECC reports, the earlier FNS report, and others, as well as inputs obtained by interviews. With regards to the existing ECC reports, the following reports have been used mostly:

- Feasibility of a potential shared use of the U6 band between IMT and Wi-Fi [4],
- Coexistence of IMT with incumbents in the U6 band (draft report) [5], and
- Sharing and compatibility studies related to Wi-Fi in the U6 band [6].

Note that the work in ECC related to this topic has progressed substantially through the completion of studies. The study on the coexistence of IMT with incumbents [5] is in its final stages and available as a draft version[1]. No large changes are expected that will impact the analysis on the potential harmful interferences identified in the high-level analysis, and whether those interferences exhibit Dutch-specific elements.

To identify which potential harmful interferences have Dutch-specific elements, it is important to compare the considered deployments in the existing reports with the (expected) deployments in The Netherlands. Therefore, the outcome of this high-level analysis strongly depends on the deployment assumptions for the U6 band uses, in particular for IMT and Wi-Fi, which are not yet deployed in the U6 band in The Netherlands. Key inputs on the deployments considered in this high-level analysis are based on the earlier FNS report [3], which includes the (expected) deployments that were collected through extensive interview rounds with stakeholders for all U6 band uses. In particular, for the current uses in the U6 band in The Netherlands, which are FS, FSS ES, UWB, EESS, and RAS, public sources were used to determine their current deployments and interviews to validate them. Therefore, the high-level analysis performed in this report is based on the reported current deployments, in combination with forward-looking views for future use from the earlier performed interviews, as reported in [3].

To determine the (expected) deployment scenarios of IMT and Wi-Fi, additional inputs have been requested and obtained from IMT and Wi-Fi stakeholders via interviews. For IMT, it has been identified that a likely deployment scenario is to reuse the existing 3.5 GHz grid of macro cells. Moreover, it is assumed that the IMT base stations will be transmitting with full power, i.e. 73 – 83 dBm/100MHz, providing both outdoor and indoor coverage[2], and capacity nationwide. Furthermore, this deployment scenario considers that the IMT base stations will be operating in the whole U6 band.

Regarding the considered deployment scenario for Wi-Fi, it is assumed that it will occur both in dense environments (in terms of hotspots), as well as in less dense environments. Specifically, for the traditional Low-Power Indoor (LPI) mode of operation, the deployment is assumed to be indoor only and especially in high density areas. For the Very Low Power (VLP) mode of operation, used for very local connectivity,

[1] At the time of writing of this report, the draft ECC Report on the coexistence of IMT with incumbents has been finalised for public consultation.

[2] Several mobile network operators and network vendors have pointed out that indoor coverage is limited at the bottom of this range and that they consider full power to be at the top of this range.

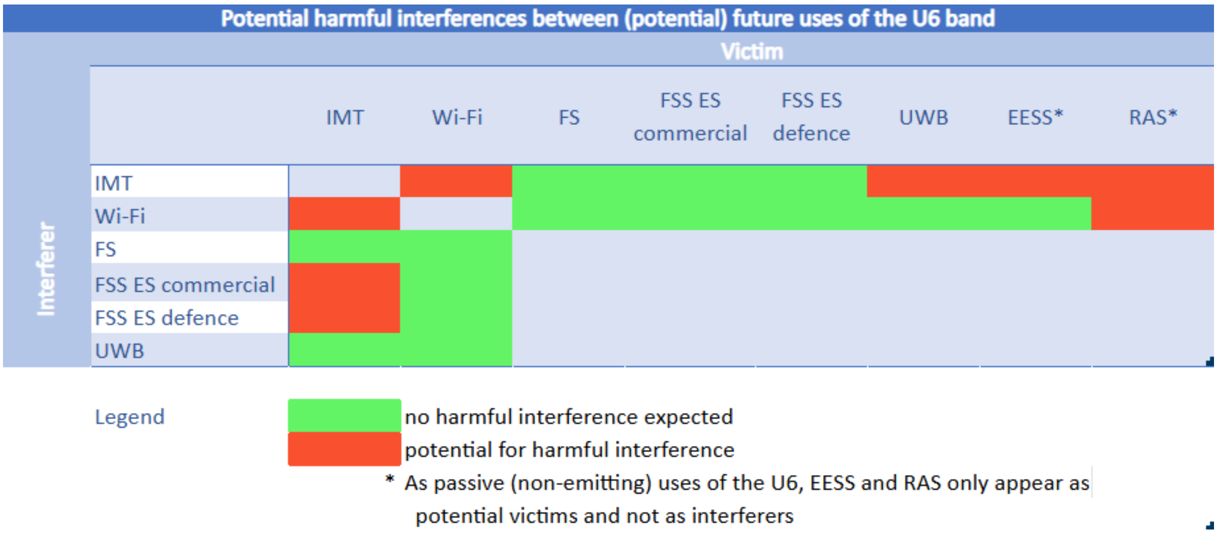
deployment is assumed to be both indoor and outdoor and potentially everywhere. Furthermore, and similarly to the IMT deployment, it is assumed that Wi-Fi will be operating in the whole U6 band.

Apart from the abovementioned deployment assumptions, other considerations were also regarded as useful for the analysis on each potential harmful interference. One example is the Radio Spectrum Policy Group (RSPG) draft opinion [9], which indicates a clear preference for a segmentation solution in the context of a prioritised band split between IMT and Wi-Fi, in which each would have non-prioritised access to the portion of the band assigned to the other, if it does not cause harmful interference to the other. The RSPG has recently (in November 2025) published its final opinion [10], in which it has agreed a prioritised use of the band 6585-7125 MHz for IMT. RSPG intends to decide on the exact use of the remaining 160 MHz (6425-6585 MHz) after WRC-27. In parallel, the RSPG recommends, among other things, to study the possible Wi-Fi operation as a non-prioritised user in areas where IMT coverage is unavailable. The analysis in this report does not address the RSPG final opinion, as it appeared during the completion of the report. It will be used to determine whether it contains new input for a follow-up country-specific analysis in future work. Furthermore, additional deployment assumptions have been considered from various studies. These deployment assumptions are mentioned explicitly where they are found relevant for the analysis.

2.2. Overview of potential harmful interferences

Annex I presents the analysis on potential harmful interferences in The Netherlands, between the potential new uses of the U6 band, i.e. IMT and Wi-Fi, and the existing uses, which is based on [3]-[16]. Based on that analysis, a high-level overview of the outcomes can be derived, as shown in Table 3, with each entry in the table detailed in Annex I. The entries in Table 3 marked with red colour imply that a use (interferer) has the potential to cause harmful interference to another use (victim). When no harmful interference is expected, the green colour is used. Note that Table 3 does not show potential harmful interferences among the existing uses, i.e. FS, FSS ES, UWB[3], EESS and RAS, as those uses already co-exist in the U6 band under current arrangements.

Table 3: High-level overview of potential harmful interferences in The Netherlands in the U6 band.



[3] UWB applications operate on a non-interference and non-protected (NINP) basis.

For each of the eight identified potential harmful interferences in The Netherlands, an additional analysis has been done to indicate whether the interferences exhibit Dutch-specific elements. This analysis is important as any potential harmful interferences that are specific to The Netherlands will require a more in-depth study to understand the exact impact that they will have. The analysis to identify if the interferences exhibit Dutch-specific elements is also presented in Annex I, and the overview of the key points and conclusions are presented below.

2.2.1. Interferences that need to be investigated further

Based on the analysis in Annex I, the potential harmful interferences in The Netherlands that exhibit Dutch-specific elements are from IMT to Wi-Fi, from Wi-Fi to IMT, from FSS ES to IMT and from IMT to RAS. For the FSS ES to IMT interference, no separation has been made between FSS ES defence and FSS ES commercial because no information is available related to the characteristics of FSS ES defence. For the purposes of this report, it was assumed that FSS ES defence has characteristics similar to FSS ES commercial. Because of this assumption, the results for FSS ES commercial do not automatically apply to FSS ES defence. More details about each interference are presented below:

- **Interference from IMT to Wi-Fi and from Wi-Fi to IMT**: The potential IMT deployment in The Netherlands is expected to be (almost) nationwide. Assuming that Wi-Fi will also be deployed nationwide, interference will be created nationwide. This nationwide deployment scenario is different from deployments in several other countries, which are expected to have IMT deployment only in densely populated areas. However, the existing ECC studies on the feasibility of shared IMT and Wi-Fi use are relevant for the analysis of the Dutch situation, because they address the case of dense urban areas. An open point is whether there are further Dutch-specific elements in the Dutch profile and usage scenarios that do require further interference studies. Such an element could be related to the current, historical and future building construction approaches in The Netherlands, and whether these approaches would show relevant differences compared to those in other European countries. For the further analysis of interference from IMT to Wi-Fi and from Wi-Fi to IMT in The Netherlands, the guidance from the recent RSPG final opinion [10] will be used to determine whether it contains new input for a follow-up country-specific analysis in future work.
- **Interference from FSS ES to IMT**: For both commercial and defence use of FSS ES, the combination of the flat landscape and the relatively low elevation angles of satellite earth stations towards geostationary satellites required in The Netherlands needs to be investigated further.
- **Interference from IMT to RAS**: The Dutch-specific elements affecting interference such as flat landscape and surroundings of the Westerbork telescope need to be investigated further. The sizes of the coordination zones vary strongly between IMT-RAS interference studies in ECC, showing that the coexistence between these two uses needs careful examination.

For the four identified potential harmful interferences, separate analyses are required to understand in more detail the impact of the caused interference. In this report, the analyses for interference from FSS ES to IMT and from IMT to RAS are detailed in Chapters 0 and 4, respectively. The analysis of interference between IMT and Wi-Fi is left for future work and it will be performed later on, based on the RSPG final opinion on the U6 band.

2.2.2. Other potential harmful interferences

The other potential harmful interferences in The Netherlands that have been identified and shown in Table 3 do not required additional analysis. In particular, the interferences from IMT to UWB and from IMT to EESS are relevant for The Netherlands but the existing analyses ([8], [13], [14]) are sufficient, as both interferences do not exhibit any Dutch-specific elements. The interference from Wi-Fi to RAS is also relevant for The Netherlands but any Dutch-specific elements are already taken into consideration in the analysis by ECC [6]. Therefore, for these three potential interferences, it is not required to perform additional investigations.

3. Interference from FSS ES to IMT

FSS are satellite communication systems that connect ground stations (also known as earth stations) to geostationary satellites in space. The Netherlands has several commercial ground stations concentrated in two locations, namely Burum and Biddinghuizen [3]. These ground stations use the U6 band for Earth-to-Space (ES) transmissions. With the potential allocation of this band for IMT, a substantial deployment of IMT base stations is expected as part of future mobile network infrastructure. Consequently, there is a potential risk of interference from FSS ES transmissions affecting nearby IMT base station receivers[4]. A study by the International Telecommunication Union Radiocommunication Sector (ITU-R) [16] was performed for the Lower 6 GHz band on the interference from an FSS ES station to a single IMT base station. The study showed the minimum coordination distance that should be maintained to protect the outdoor IMT base station from co-frequency, in-band interference (depending on the azimuth bearing of the IMT base station) in a geographic area with mildly hilly terrain. The reported coordination distances are given below, where the largest distances are in the main beam direction of the ground station.

- 10 – 78 km for a macro cell in a suburban environment, and
- 6 – 33 km for a macro cell in an urban environment.

The above study considered a ground station in Mississippi (in the USA), whose latitude is much lower than the latitudes of ground stations in The Netherlands. Considering the relatively high latitude of The Netherlands, ground stations typically operate with lower elevation angles than ground stations in many other parts of Europe. Moreover, in combination with the flat landscape of The Netherlands different results can be expected. Therefore, it can be concluded based on the ITU-R study that potential harmful interference is expected from FSS ES to IMT. However, the results are insufficient to draw any immediate conclusions for the situation in The Netherlands and thus, additional investigation is needed to determine the potential harmful interference for the Dutch-specific scenario.

This chapter presents the simulation study on the potential impact of FSS ES transmission on IMT base station receivers operating in the U6 band. The assessment specifically considers the actual FSS ES deployment within The Netherlands, alongside the influence of the surrounding terrain on signal propagation.

3.1. Interference scenario

The interference scenario considered in our simulation study is depicted in Figure 1. An FSS ES earth station is transmitting signals at an elevation angle directed toward a geostationary satellite. This transmission has the potential to cause interference with nearby IMT base stations. A simulation is performed to determine what coordination distance should be used to ensure that the IMT base stations remain unaffected by potential interference originating from the FSS ES transmission.

[4] Although the FSS ES transmissions may also cause interference to nearby UEs, our simulation focuses exclusively on the impact on IMT base stations. This approach is considered adequate because UEs cannot operate correctly if the associated IMT base stations experience interference.

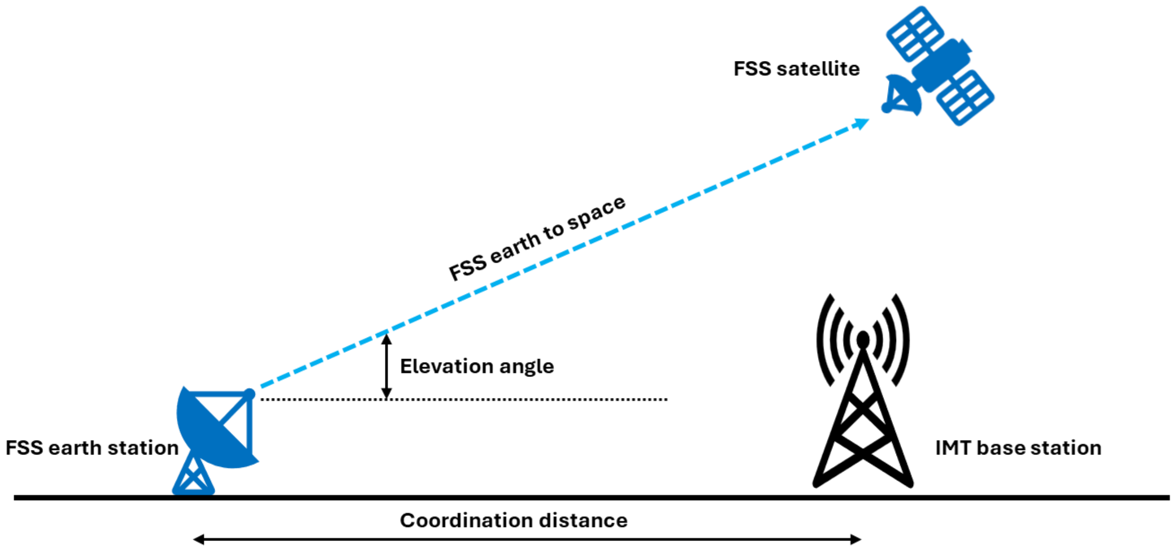


Figure 1: Interference scenario from FSS ES transmission to IMT base station receiver

According to the data [3] provided by the Dutch Authority for Digital Infrastructure, there are currently seven licensed sites operating permanent earth stations in The Netherlands in the 6425–7125 MHz band. These FSS ES stations are located in Burum and Biddinghuizen and their properties are summarised in Table 4.

Table 4: Summary of the FSS ES stations on the U6 band in The Netherlands

FSS ES station	Latitude	Longitude	GEO satellite	Elevation angle (°)
Burum 9	53.285278	6.217500	54 W	8.7
Burum 10	53.285278	6.218611	64 E	10.0
Burum 12	53.285278	6.217500	15.5 W	25.9
Burum 16	53.286944	6.216944	25 E	26.7
Burum 18	53.283889	6.216111	25 E	26.7
Burum 19	53.283889	6.216111	25 E	26.710
Biddinghuizen 03	52.462972	5.709667	49 E	18.061

3.2. Simulation parameters

For the simulation purpose, the FSS ES station with the smallest elevation angle has been chosen, which represents the worst-case scenario to determine the maximum coordination distance in terms of interference on the IMT base stations. The parameters of this FSS ES station are given in Table 5.

Table 5: FSS ES station parameters

Parameter	Value
Location of FSS ES station	53.285278, 6.217500
Antenna height above ground	10 m

Antenna elevation angle	8.7°
Off-axis antenna gain	Rec. ITU-R S.465-6
EIRP	56 dBW
Bandwidth	18 MHz
Centre frequency	6439 MHz

The IMT base station parameters are taken from ITU-R Report S.2367-0 [16] and summarised in Table 6. The base station antenna height of 25 m is slightly lower than the typical antenna height of 35 – 40 m in The Netherlands, as reported in the Antenneregister [21]. It is noted that similar studies have been conducted in this ITU-R report for Lower 6 GHz band and for a specific FSS ES station located in Mississippi.

Table 6: IMT base station parameters

Parameter	Value
Base station type	Macro cell
Antenna height above ground	25 m
Receiver noise figure	5 dB
Noise power density	-200.6 dBW/Hz
Assumed single entry I/N requirement	-9 dB
Maximum permitted single entry interference power density	-209.6 dBW/Hz

With the FSS ES station location and antenna pointing fixed, a hypothetical IMT receiving base station is successively placed at many locations around the FSS ES station. At each location the Interference/Noise (I/N) at the IMT receiver is calculated taking into account the propagation loss on the interference path and the off-axis antenna gains of the FSS ES station. Subsequently, locations where the I/N exceeds the single-entry protection criterion are determined, resulting in coordination areas within which an IMT base station is subject to excessive level of interference from the FSS ES station.

3.3. Propagation model

The ITU-R P.452 [17] propagation model is used to compute the path loss from the FSS ES station towards the IMT base station. This ITU-R P.452 model provides a comprehensive path loss prediction model for evaluating interference between radio stations operating in the frequency range between 0.1 GHz to 50 GHz. The model includes different propagation mechanisms, such as line of sight, diffraction, tropospheric scatter as well as anomalous propagation like ducting. It is widely used in spectrum management and radio planning, especially for long-distance (up to several hundred kilometres) terrestrial links. The latest version of the model, namely ITU-R P.452-18 is used in the simulation. It is important to note that in [16] the older version of the model was used, namely ITU-R P.452-14. The main difference is that in ITU-R P.452-14, the clutter losses are calculated based only on the clutter information at the transmitter and the receiver. However, the ITU-R P.452-18 offers a more realistic model by requiring detailed geographic data along the entire path, not just at the two endpoints. The ITU-R P.452-18 improves loss estimation in environments with complex obstructions by considering interactions between terrain and clutter along the path.

In the simulation, a time percentage of 50% has been used which refers to the path loss median value. This 50% time percentage is more representative of average propagation conditions over time. The geographic data are taken from Actueel Hoogtebestand Nederland (AHN) [18]. AHN contains the detailed height information for the whole Netherlands. The AHN data are freely available via Publieke Dienstverlening Op de Kaart in the following type:

- Digital Terrain Model (DTM), also called terrain data. DTM contains the height of the ground in meter.
- Digital Surface Model (DSM), also called clutter data. DSM includes the height of buildings and vegetation in meter.

The AHN data is provided in raster format with a resolution of 0.5 m x 0.5 m. For the simulation purpose, the corresponding tiles covering the target area has been downloaded and have been resampled to 100 m x 100 m resolution. This makes the amount of data more manageable for the simulation area of 130 km x 65 km. Figure 2 and Figure 3 show the AHN DTM and DSM map respectively, for the simulation area with the red dot indicating the position of the FSS ES station.

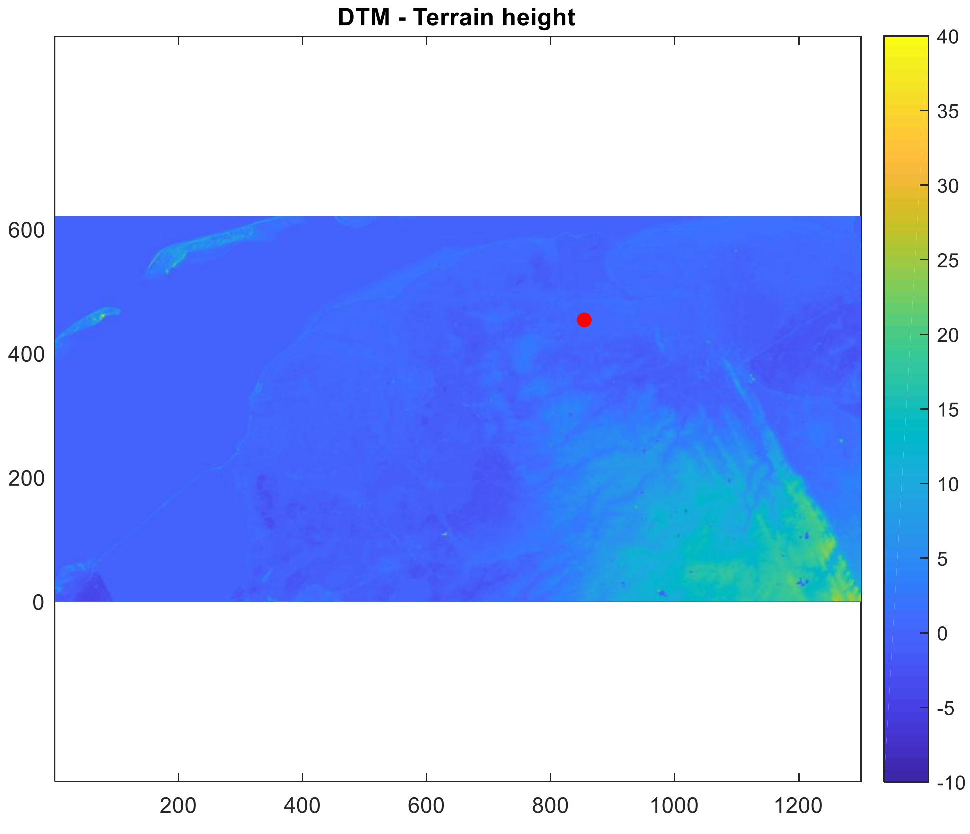


Figure 2: AHN DTM map with the red dot indicating the location of the FSS ES station used in the simulation. The unit of the X- and Y-axis is given in 100 m x 100 m pixel. The legend shows the height of each pixel.

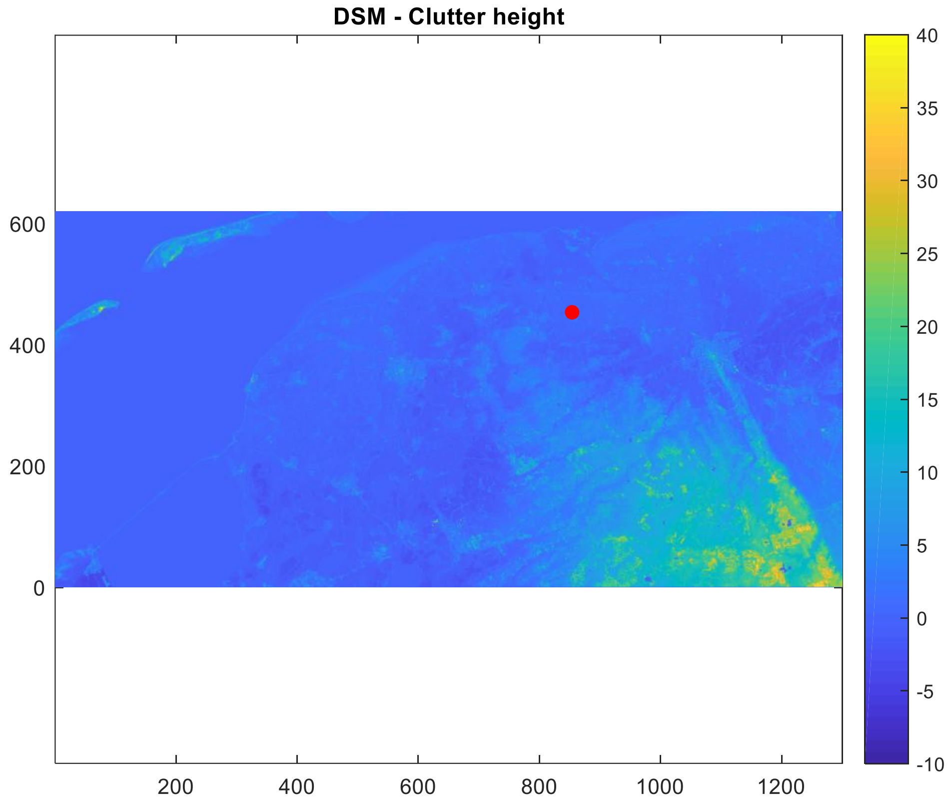


Figure 3: AHN DSM map with the red dot indicating the location of the FSS ES station used in the simulation. The unit of the X- and Y-axis is given in 100 m x 100 m pixel. The legend shows the height of each pixel.

3.4. Simulation results

Using the ITU-R P.452 propagation model, the path loss is computed for each 100 m x 100 m pixel in the simulation area. The resulted path loss is shown in Figure 4. After applying the off-axis antenna gain on the FSS ES station according to Recommendation ITU-R S.465-6 [19], Figure 5 is obtained.

To determine the coordination distance, we calculate the required path loss taken into account the Effective Isotropic Radiated Power (EIRP) of the FSS ES station and the maximum permitted interference power on IMT. The calculation is shown below.

- FSS ES transmit power density = 56 dBW/18 MHz = -16.55 dBW/Hz
- IMT protection threshold = -209.6 dBW/Hz
- The required path loss = -16.55 – (-209.6) = 193.05 dB

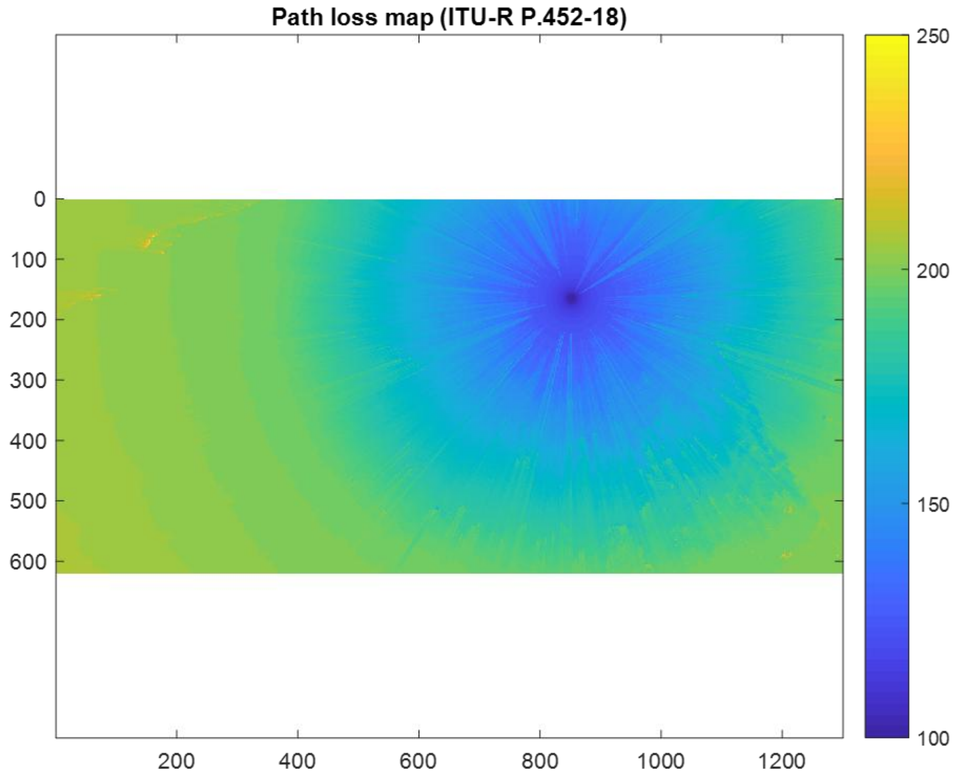


Figure 4: Path loss map computed using ITU-R P.452-18 model. The legend indicates the path loss in dB.

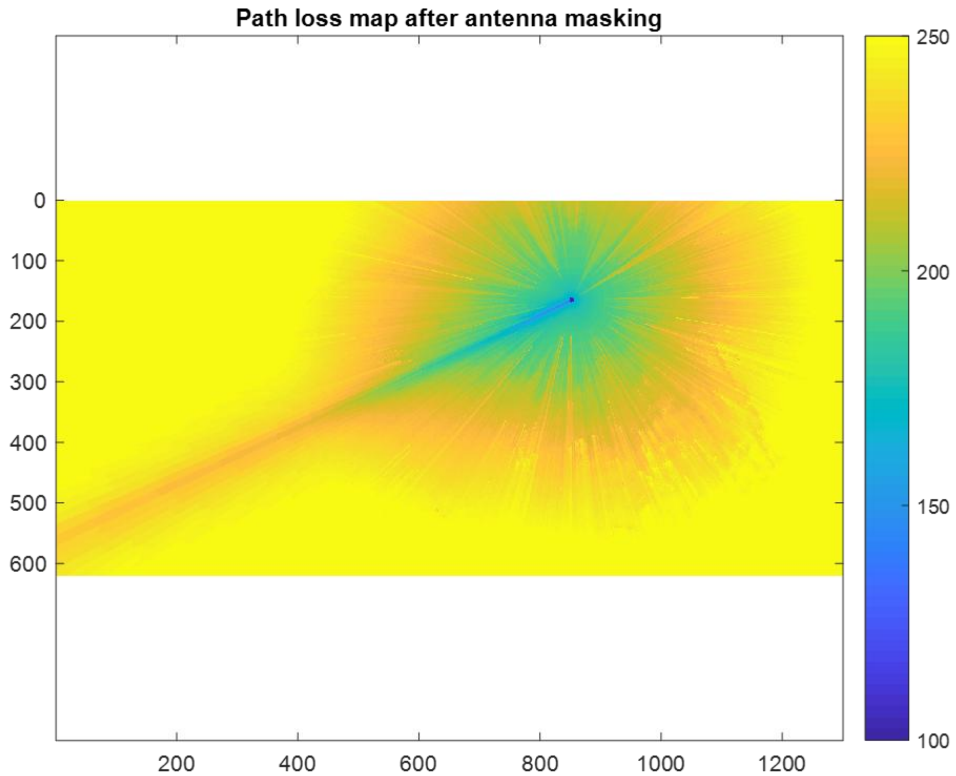


Figure 5: Path loss map after applying off-axis antenna masking on the FSS ES site.

With the required path loss known, the coordination area can be determined by removing the pixels with path loss value larger than 193 dB. Figure 6 shows the coordination area around the FSS ES station assuming a 0 dBi antenna gain on the IMT base station[5]. The maximum coordination distance at the azimuth direction towards the satellite is around 30 km.

However, it is expected that the IMT base station will support advanced beamforming and null-steering capability. Null-steering is a method to suppress the unwanted spatial emission by inserting nulls in its radiation pattern on the direction of the interference. Consequently, a targeted nulling in the direction of the FSS ES station can be done, which will add additional suppression towards this unwanted interference. A sensitivity analysis has been performed assuming an additional 10 dB and 20 dB suppression due to null-steering. The results are shown in Figure 7 and Figure 8, respectively. It can be seen that the coordination area has shrunk significantly from 30 km to 24 km and 16 km, respectively.

In Figure 9, the resulted coordination areas with 0 dBi antenna gain, 10 dB and 20 dB suppression are shown together on top of the map of The Netherlands.

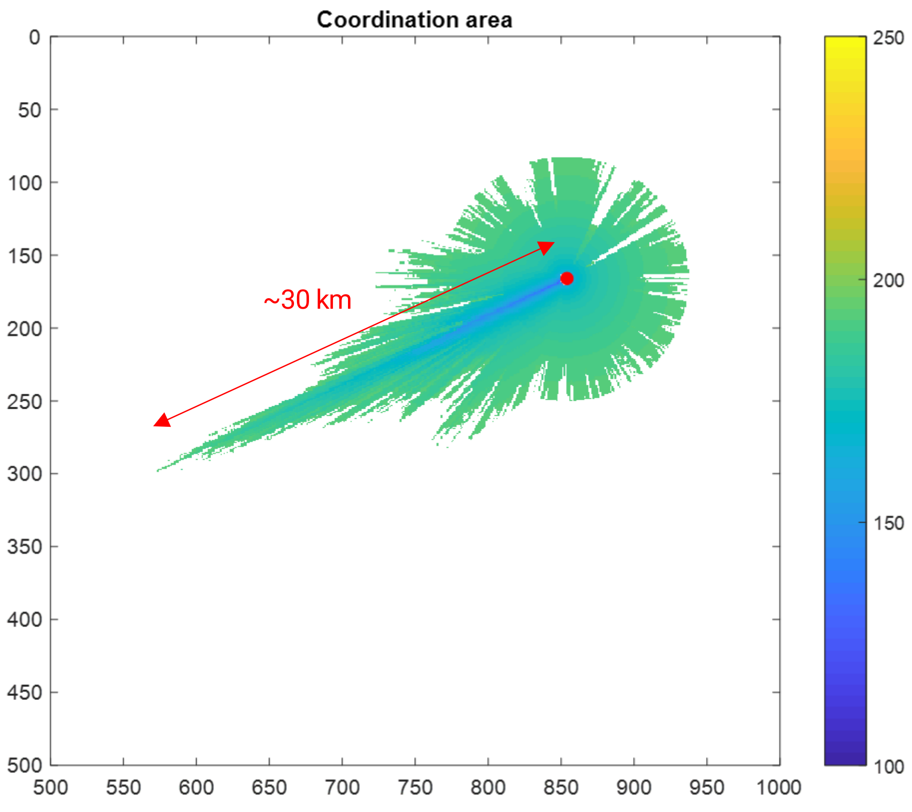


Figure 6: Coordination area for the IMT base station due to the FSS ES station in Burum, assuming a 0 dBi antenna gain on the IMT base station.

[5] In practice, IMT base stations typically have higher antenna gains. In the ITU-R study [16], an antenna gain of 18 dBi is assumed. However, the maximum antenna gain would only be realised if the antenna's azimuth and tilt are perfectly pointing to the FSS ES station, which is rather unlikely in actual deployment. A 0 dBi is used mainly as a reference for the null-steering cases.

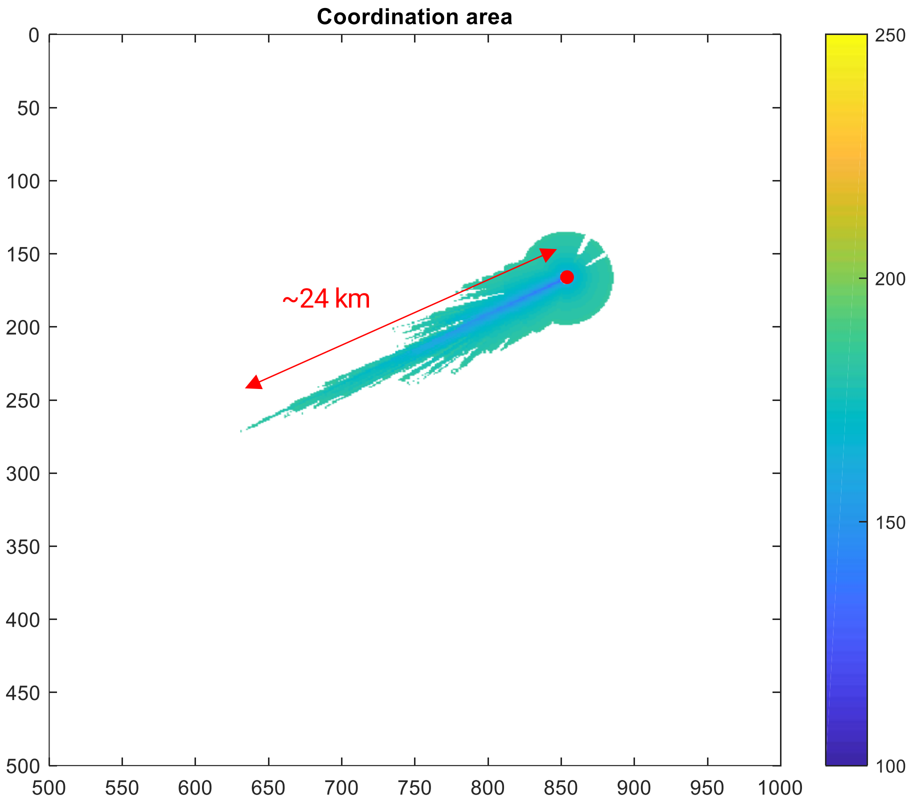


Figure 7: Coordination area for the IMT base station due to the FSS ES station in Burum, assuming a 10dB suppression due to null-steering on the IMT base station.

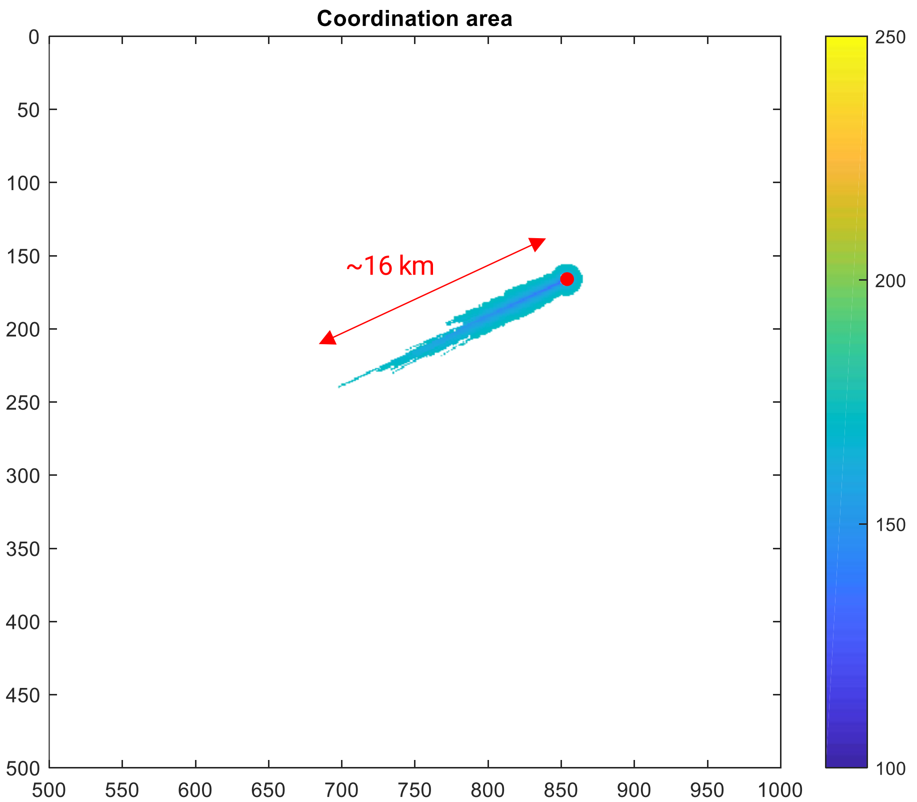


Figure 8: Coordination area for the IMT base station due to the FSS ES station in Burum, assuming a 20dB suppression due to null-steering on the IMT base station.

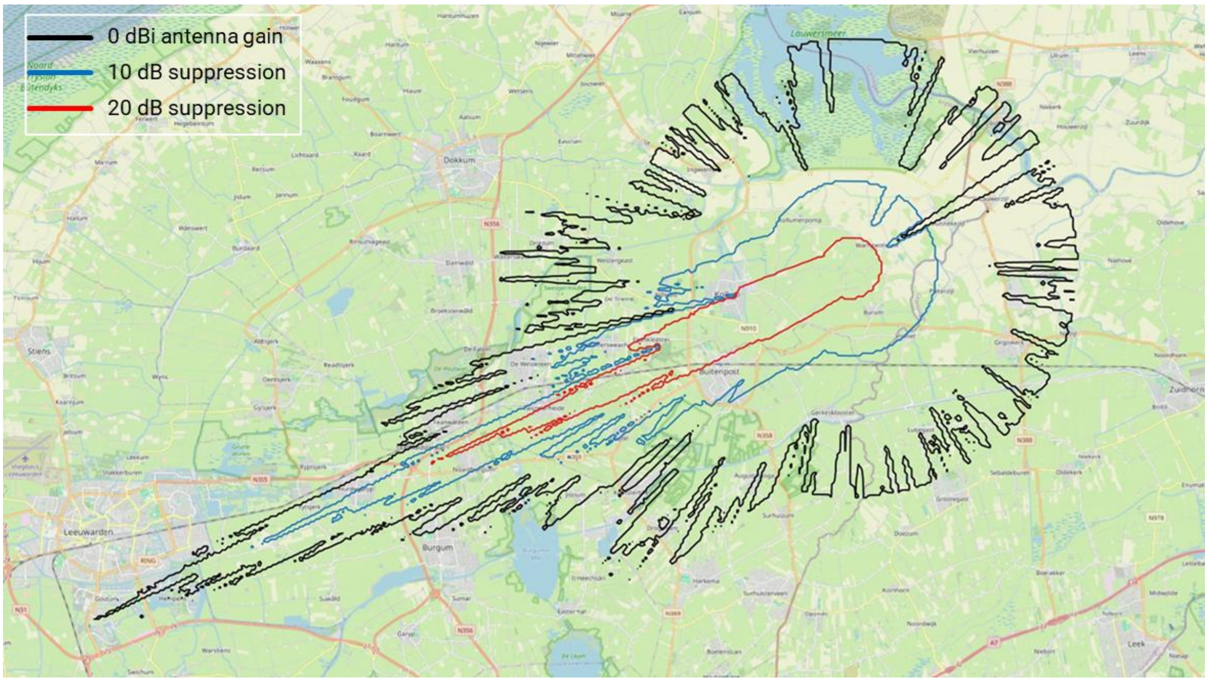


Figure 9: Coordination area for the IMT base station due to FSS ES station in Burum for 0 dBi antenna gain, 10 dB and 20 dB suppresion, plotted on the map of The Netherlands.

3.5. Summary of simulation study

A simulation study has been conducted to determine the impact of interference from a single transmitting FSS ES station to an outdoor IMT base station. Specifically, the specific Dutch case where an FSS ES station in Burum is considered with an elevation angle of 8.7 degrees above horizon. The simulation area of 130 km x 65 km covers mainly rural area with mostly flat terrain. At each location, it is assumed that the IMT base station is facing in azimuth towards the transmitting FSS ES.

The results of the simulation show the coordination area where an IMT base station would need to be protected from excessive interference from in-band FSS ES transmissions. The study also shows that in the azimuth direction towards the satellite, a minimum coordination distance of several tens of kilometres would be required to protect an outdoor macro cell IMT base station deployed in the vicinity of the FSS ES station in Burum. This coordination distance can be further reduced in the case of an IMT base station with null-steering capability.

Another method to mitigate the interference from transmitting FSS ES station is to employ frequency selective scheduling on the IMT base station. For the specific case studied where the FSS ES station only occupied 18 MHz of the U6 band, the affected IMT base station can choose not to allocate this 18 MHz spectrum to the User Equipment (UEs). It should be noted that this mitigation technique is only effective when the bandwidth occupied by the FSS ES station is relatively small compared to the channel bandwidth of the IMT base station. Considering the FSS ES station out-of-band emission attenuation of 53 dB [16], no serious interference is expected on the adjacent channel.

Since the simulation study was done for the smallest elevation angle, the coordination area could be (considerably) lower for those FSS ES stations with larger elevation angles. Overall, the performed simulation indicates that harmful interferences between an FSS ES station and IMT base stations in the U6 band can be avoided or limited to a small geographical area with careful IMT site planning and the use of advanced beamforming techniques.

4. Interference from IMT to RAS

In The Netherlands, the Westerbork telescope is operated by Astron for RAS in the 6650.0-6675.2 MHz band. The telescope is used for methanol observations, occurring in that particular frequency band, which are used to study star formations. Considering that the methanol observations can only be performed in this particular frequency band, it is of relevance to study the potential coexistence problem between IMT and RAS, which is due to interference from IMT to the Westerbork telescope. One factor which could lead to a potential coexistence problem is the flat landscape in The Netherlands, which allows for radio signals to propagate over large distances. Figure 10 shows the location of the RAS band (coloured in blue) within the U6 band[6], along with two "guard bands" (coloured in orange). Note that RAS does not have a primary allocation in the U6 band in The Netherlands. Moreover, the "guard bands" are sometimes considered in interference related studies, as it will be explained later on.

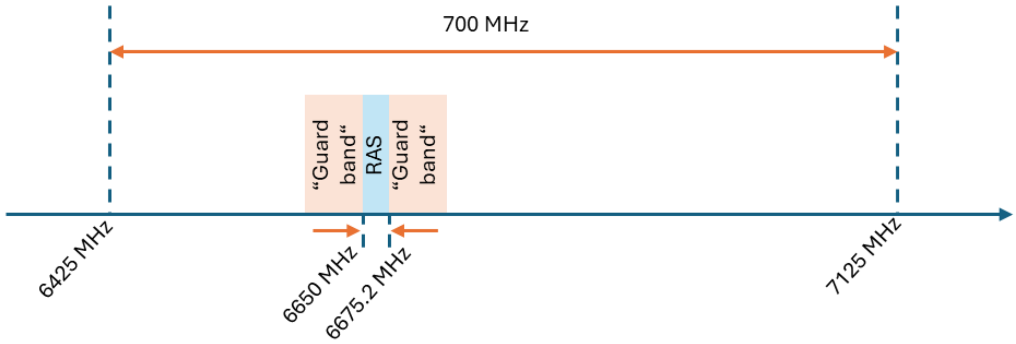


Figure 10: Illustration of the positioning of the RAS band (including two "guard bands") within the U6 band.

Multiple studies are currently being performed in the ECC in relation to the interference from IMT to RAS. These studies focus on the determination of the area size around the RAS site, where IMT and RAS need to coordinate[7] their coexistence to prevent harmful interference. Within the draft ECC report [5], six studies are presented, out of which only the study by the Committee on Radio Astronomy Frequencies (CRAF) [20] shows results specific to the Westerbork telescope. This chapter presents in more detail the results of the CRAF study as well as other key outcomes of other studies. The goal is to analyse the relevant results for the Westerbork telescope, from the draft ECC report. Note that the results shown are based on the latest draft ECC report (published in September 2025), which is expected for public consultation soon after the time of writing this report. Moreover, the detailed studies submitted to the ECC have also been considered, based on their versions in September 2025. These studies are expected to be attached to the ECC report, once it is published. Therefore, some small changes in the reported values might occur, but it is not expected that there will be a big impact on the analysis presented below.

4.1. General assumptions for the studies

For the evaluation of the various studies performed in the context of the draft ECC report, a set of radio astronomy technical parameters was considered. Specifically, the threshold interference level of -176 dBm/MHz is recommended, based on Table 2 of Recommendation ITU-R RA.769-2 [22]. The interference level to the RAS frequency band is subject to Recommendation ITU-R RA.1513 [23], stating that the maximum acceptable data loss due to interference by all stations of one service is set at 2%. The target

[6] The figure shows the entire U6 band without the prioritised band split from the recent RSPG opinion ([10], see also section 2.1).

[7] In some situations, the coordination distances are practically leading to seperation distances, where service coexistence cannot be achieved.

threshold interference level of -176 dBm/MHz was thus derived based at the 98th percentile for the protection of the RAS receiver. Note that the recommendation of 2% data loss applies when the frequency allocation to RAS is on a primary basis.

To further ensure consistency between the results of the various studies within the draft ECC report, the same set of deployment parameters has been used, as documented in the draft ECC report. Examples of such parameters include the EIRP value, which is set to 82.6 dBm/100 MHz when considering full power transmissions. Additionally, in urban areas, the base station deployment density is set to 10 base stations per km^2, leading to a cell size of 0.4 km (in a hexagonal layout). Note that it is expected that, in urban areas, the base station site as part of the infrastructure used for the 3-6 GHz deployments will be re-used/upgraded for the 6-8 GHz deployments.

For comparison purposes between the simulation results, the recommended antenna height for IMT is set to 18 m in urban areas and 20 m in suburban areas. Considering the re-use of the 3.5 GHz base station deployment, the considered antenna height values are low for The Netherlands. Based on the publicly available information from the Antenna Register [21], it could be seen that many reported antenna heights in The Netherlands are above the 35 m. Moreover, two network loading factors are recommended, 20% and 50%, for wide area and small area studies, respectively. This value represents the average base station activity, considering all base stations in the network.

4.2. High-level comparison between studies

Within the draft ECC report, six studies are documented. The studies generally consider different configuration parameters, but they all aim to derive the coordination distance to ensure protection of RAS. One of the studies, submitted by Ofcom, is focused on the specific case of the United Kingdom, where six RAS receivers are located around the country. This allows for the Multi-Element Radio Linked Interferometer Network (MERLIN) operation, a technique where signals from multiple telescopes are combined to achieve higher resolution than a single telescope. Thus, more interference can be tolerated, making this study less easily comparable with the rest of the studies. For the remaining five studies, Table 7 shows the summary of the key parameters used and the range of coordination distances that have been reported by each study, which vary significantly from approximately 60 km to approximately 380 km.

Table 7: Comparison of RAS studies within the draft ECC Report.

	Study by CRAF	Study by Huawei	Study by Qualcomm	Study by Apple	Study by Nokia
Type	(i) Site-generic and (ii) site-specific	Site-generic	Site-specific (Effelsberg)	Site-generic	Site-generic
Scenario	(i) In-band, (ii) adjacent and (iii) spurious	In-band	In-band	In-band	In-band
Methodology	Monte Carlo	Monte Carlo	Monte Carlo	Monte Carlo	Monte Carlo
Protection threshold	-175.1 dBm/MHz	-175.1 dBm/MHz	-175.1 dBm/MHz	-176 dBm/MHz	-175.1 dBm/MHz
Network loading factor	20%	20%	20%	50%	(i) 20% and (ii) 50%

Propagation model	ITU-R P.452-18	ITU-R P.2001-4	ITU-R P.2001	ITU-R P.452-17	ITU-R P.452-17
Base stations subject to clutter loss	Uniformly distributed (0% - 100%)	(i) 65% and (ii) 100%	(i) 65% and (ii) 100%	(i) 50%, (ii) 65% and (iii) 100%	(i) 65% and (ii) 100%
Time percentage	Random but capped at 50%	Fixed 50%	Fixed 50%	Random but capped at 50%	(i) Random and (ii) fixed 50%
Coordination distances for in-band	220-378 km	59-148 km	60-170 km	170-384 km	60-120 km

Table 7 shows that the reported studies provide results on different scenarios considering in-band transmissions. Moreover, all studies derive results with Monte Carlo simulations[8], and the applied protection threshold for RAS is set at -175.1 dBm/MHz (or rounded down to -176 dBm/MHz). Additionally, the studies use 20% and/or 50% for the mobile network loading factor, as per ECC recommendation. The study submitted by CRAF also considers site-specific results for European RAS sites (evaluated for worst-case single interferer scenarios[9]) and a range of potential mitigation measures (evaluated for site-generic scenarios). Considering that this is the only study reporting results specifically for the Westerbork telescope, it is the most relevant for a more detailed analysis. Furthermore, the study by CRAF presents results for the adjacent and spurious domains, which are described in more detail in Section 4.3.

Different studies apply different propagation models. Both the ITU-R P.452-18 [17] and ITU-R P.2001-4 [24] models consider the same core propagation mechanisms such as line-of-sight, diffraction, tropospheric scatter and anomalous propagation. As a result, they often give comparable results in many scenarios. However, since the ITU-R P.452-18 model is primarily designed for interference protection in regulatory contexts, it may yield more conservative prediction (i.e. lower path loss values) hence larger coordination zone in certain scenarios.

In addition to the applied propagation model, the clutter loss from the Recommendation ITU-R P.2108 [25] is applied to model additional losses due to buildings and vegetation. The percentage of base stations, to which the clutter loss applies, depends on the environment around the RAS site and the height of the base station antennas. For example, if all base station antenna heights are below rooftop level, then the clutter loss applies to 100% of the base stations. The RAS studies considered different percentages for the clutter loss with different reasonings. One of the reasonings was that for urban network deployments and transmitter and receiver heights of up to 20 m, there is very high probability for non-line-of-sight transmissions, which motivates to apply clutter loss to 100% of the base stations. A lower percentage of the applied clutter loss covers scenarios with a mix of base-station antenna heights (relative to rooftop height) or a worst-case scenario (i.e. when set to 0%). According to the results, the clutter loss is identified to play a big role when determining the coordination distances. For example, the reported coordination

[8] In a Monte Carlo simulation, the same experiment is repeated with random sampling, and the simulation outcome determines the probability of different results.

[9] The worst-case single interferer scenario considers a single base station pointing directly towards the RAS station.

distances for the in-band scenario when considering a subset and all the base stations subject to clutter loss are 150-380 km and 60-220 km, respectively.

Another parameter that was differently configured in the studies is the time percentage, which refers to the percentage of time on average year, for which the calculated path loss is not exceeded [17]. Some studies considered a fixed time percentage of 50% to give a low weight on rare and/or irregular propagation effects such as ducting and tropospheric scattering, reasoning that 50% is representative of the annual average propagation conditions. Other studies modelled variable conditions by randomly drawing, at each simulation round, a time percentage value from a uniform distribution, which yielded larger coordination distances (e.g. 370-380 km for the in-band scenario with a subset of the base stations subject to clutter loss) compared to setting a fixed value (e.g. 150-170 km for the in-band scenario with a subset of the base stations subject to clutter loss). This result highlights the importance of the time percentage parameter.

It is also noteworthy that some studies provided additional results as part of potential mitigation strategies to reduce the coordination distances. Some of the mitigation strategies that were assessed were the placement of base stations so that clutter loss towards the RAS site is increased, and coordination between the base stations and the RAS site so that the base station antenna is not directed towards the RAS site.

4.3. Analysis of the study by CRAF

As previously mentioned, the study by CRAF is the most relevant for a more in-depth analysis as it provides results specific to the Westerbork telescope. This section presents in more detail the findings from their site-generic study and their study on the Westerbork telescope. Additionally, the results from the Westerbork telescope are compared to the results obtained for other RAS telescopes in Europe.

The two types of studies provided by CRAF are not directly comparable as they have been performed under different evaluation scenarios. Specifically, the site-generic study has been performed using an aggregated scenario, where the total aggregate received power from a network of base stations and UEs at the RAS site is considered. Note that the other studies presented in Table 7 considered similar evaluation approaches. For the site-specific studies, CRAF considered a worst-case single interferer scenario, where a single base station points directly towards the RAS site location.

For all evaluation scenarios, results have been presented for the in-band, adjacent and spurious domains. Even though the results are presented in terms of exclusion/separation distances, it is not implied that it will be necessary to enforce exclusion zones/areas. With appropriate coordination between the IMT base stations and the RAS site, IMT could still (partially) operate within these exclusion zones/areas. For ease of the result interpretations within this section, the three domains as used in the CRAF study are explained in more detail:

- In-band: Transmissions from the base stations are performed in the same frequency band as the RAS transmissions from space. Thus, IMT and RAS are considered to share the 6650.0-6675.2 MHz band. In this context, the separation distance indicates how far away from the RAS site, the IMT base stations may be operated in the 6650.0-6675.2 MHz band, without the need for coordination with the RAS site.
- Adjacent: "Guard bands" of 50 MHz on both sides of the 6650.0-6675.2 MHz band are applied in the CRAF study[10], as also shown in Figure 10, to further reduce the received power at the RAS site. Thus, the base stations are operating at least 50 MHz away from the 6650.0-6675.2 MHz band. In this context, the separation distance indicates how far away from the RAS site the IMT base

[10] The CRAF study does not give further background on their selection of 50 MHz as the width of the "guard bands".

stations may be operated at least 50 MHz away from the 6650.0-6675.2 MHz band, without the need for coordination with the RAS site. Note that the application of 50 MHz “guard bands” does not imply that it is sufficient to protect the RAS site from the IMT transmissions.

- Spurious: The spurious domain refers to the frequency range 100 MHz outside of the RAS transmission band [26]. Thus, the base stations are operating at least 100 MHz away from the 6650.0-6675.2 MHz band. Then, the separation distance indicates how far away from the RAS site the IMT base stations may be operated at least 100 MHz away from the 6650.0-6675.2 MHz band, without the need for coordination with the RAS site.

4.3.1. Site-generic study

Figure 11 shows the exclusion/separation distances related to the site-generic study, for the in-band, adjacent, and spurious domains. For this study, the percentage of base stations subject to clutter loss is randomly selected from a uniform distribution between 0-100%. The total aggregated received power from both the UEs and the base stations located around the RAS site were calculated from simulations, and illustrated with the blue and green lines, respectively. The red dashed line shows the RAS protection threshold set to -218.1 dB (W/50kHz), which is equivalent to -175.1 dBm/MHz and defines the required separation distance. Additionally, results were produced for both the case of the median and the 98th percentile. The 98th percentile refers to the case where a maximum data loss of 2% is allowed, whereas the median case is only used for comparison purposes. From Figure 11, it can be concluded that the emissions from the UEs are negligible regardless of the scenario. On the other hand, the emissions from the base stations could lead to very large separation distances. For the in-band scenario, the separation distance is approximately 370 km for the 98th percentile case. In the adjacent scenario, the separation distance reduces significantly to approximately 150 km. For the spurious domain, the separation distance further reduces to approximately 50 km.

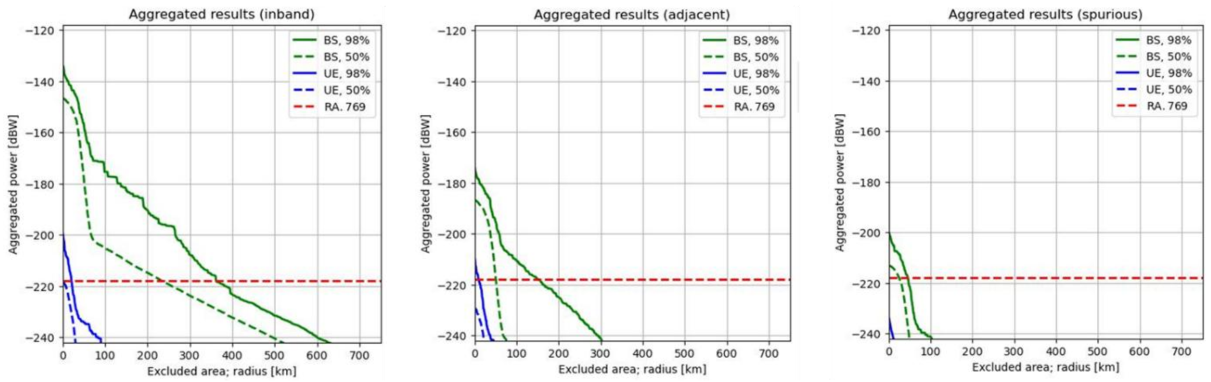


Figure 11: Exclusion/separation distances derived by the CRAF study, with the percentage of base stations subject to clutter loss being uniformly distributed from 0% to 100%, as obtained from [20].

One of the mitigation strategies that were evaluated within the CRAF study was the placement of base stations so that clutter loss towards the RAS site is increased. Thus, similar results were produced as before but with the percentage of base stations subject to clutter loss set to 100%. These results are shown in Figure 12, where it is visible that the separation distances are significantly reduced compared to the previous scenario shown in Figure 11. In particular for the case of the 98th percentile and in-band, the separation distance is now measured at approximately 220 km, which is significantly smaller than the approximately 370 km measured in the abovementioned scenario. This shows that the percentage of base stations subject to clutter loss has a big impact on the separation distance. In the adjacent scenario, the separation distance reduces further to approximately 50 km, whereas for the spurious scenario, no separation distance is required. Note that in The Netherlands, the base station antenna heights are considered to be higher than what considered in the CRAF study, thus it is expected that this scenario with 100% of the base stations subject to clutter is not representative of the Dutch situation.

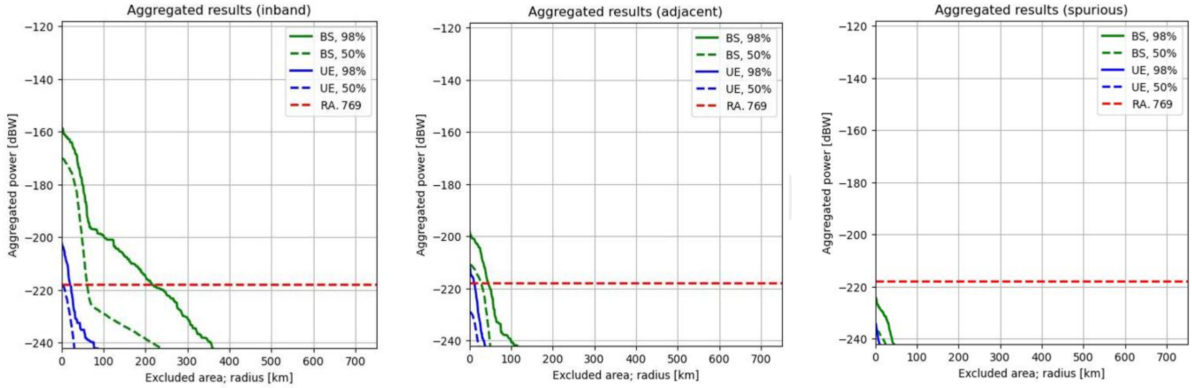


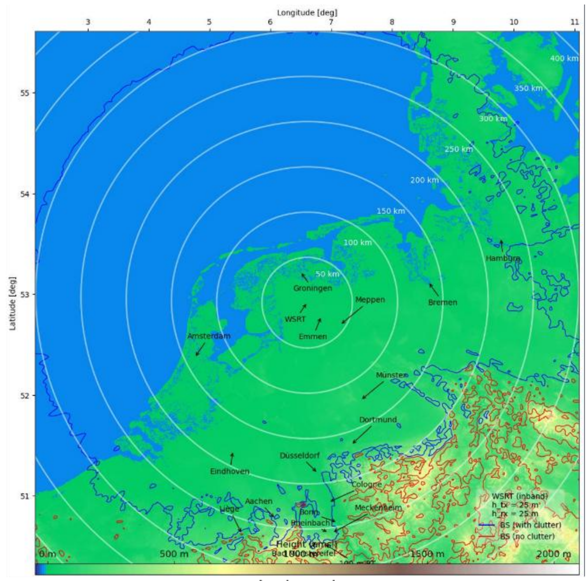
Figure 12: Exclusion/separation distances derived by the CRAF study for 100% base stations subject to clutter loss, as obtained from [20].

4.3.2. Study of the Westerbork telescope

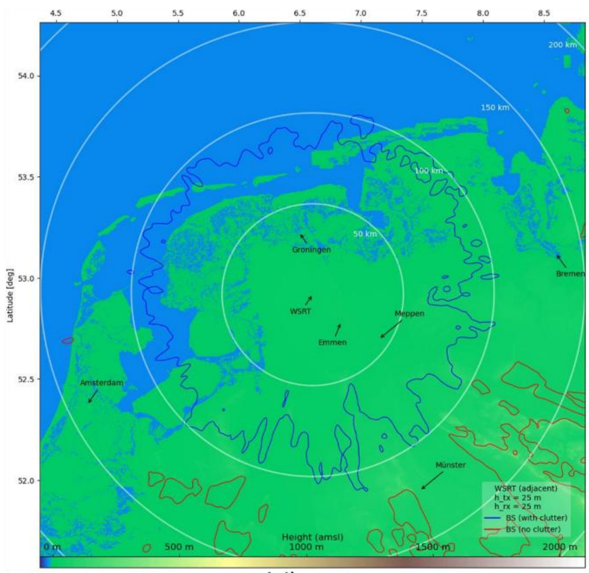
The study by CRAF also investigated the exclusion/coordination distances for different RAS sites in Europe, including the Westerbork telescope. For the site-specific studies, some parameters were set to a different value compared to the ones reported in Table 7, as the site-specific studies are performed using a worst-case single interferer scenario instead of an aggregated scenario. In particular, for the site-specific studies, the time percentage of 2% was applied, which may be considered stringent. Moreover, Lidar-based terrain data were used to provide precise height information for the clutter. These data represent DTM maps, which only provide the terrain height and not any land cover such as buildings and vegetation. The clutter height data (including building and vegetation) were taken from the Corine Land Cover dataset [27] from the Copernicus Programme. Both of these geographical data were used in the ITU-R 452-18 model. For the simulations, the clutter loss from ITU-R P.2108 has been used with a typical value of ~27 dB applied to the base station. Simulations have also been performed for the case where no clutter loss applies to the base station (denoted as the zero clutter loss case), as in Europe the base stations are often deployed above rooftops. Note that for the zero clutter loss case, only the clutter from ITU-R P.2108 was omitted, whereas the clutter-along-path correction related to the propagation model in ITU-R 452-18 was still in place.

Figure 13 shows the coordination distances for the in-band, adjacent, and spurious scenarios, as derived specifically for the Westerbork telescope. The blue and red lines illustrate the coordination distances when the clutter is applied and when there is no clutter, respectively. The white circles in the figure indicate the distance (in km) from the Westerbork telescope in steps of 50 km. For the in-band scenario, Figure 13 shows that even when clutter is considered, the coordination distance is so large that it prohibits to operate the base stations within the 6650.0-6675.2 MHz band in The Netherlands, and parts of Belgium, Germany and Denmark. For the scenario with zero clutter, the coordination distance is so large that it is not fully visible on the map. This implies that coexistence between IMT and RAS is not possible within the whole area shown on the map, with some exceptions in the Southeast where it is more mountainous terrain.

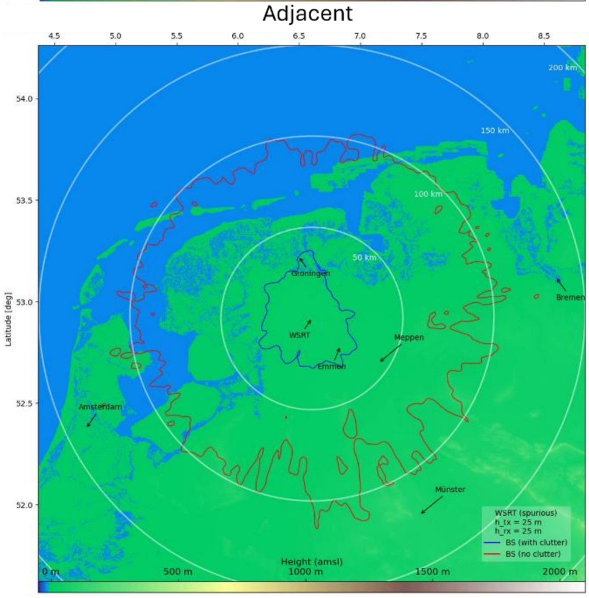
For the adjacent scenario, Figure 13 shows that the coordination distances are reduced but they are still significant, with the contour for the case with clutter covering a big part of The Netherlands and parts of Germany (coordination distance is approximately 100 km). The contour for the case with zero clutter shows coordination distances being larger than 150 km. Finally, for the spurious scenario, the coordination distances for the scenarios with clutter and with zero clutter are approximately 30 km and 100 km, respectively.



In-band



Adjacent



Spurious

Figure 13: Separation/coordination distance for the Westerbork telescope for the cases with clutter (blue) and without clutter (red), as obtained from [28].

The coordination distances observed in Figure 13 could be interpreted as challenging for the coexistence between IMT and RAS in The Netherlands. However, the derivation of these coordination distances can be considered as pessimistic as they are based on a worst-case scenario and an applied time percentage for 2%. On the other hand, the results for the scenario with clutter can be considered as optimistic because in that scenario the clutter loss is overestimated, due to the 27 dB clutter loss applied to the base station. Moreover, the antenna heights of the deployed base stations in The Netherlands on average are higher than what the CRAF study considers, which would imply that the clutter loss from the current deployment would be lower.

Regardless of how accurate and/or representative of reality the results shown in Figure 13 are, coexistence between IMT and RAS is expected to be challenging in The Netherlands due to the flat landscape of the region which cannot provide natural protection of the RAS site. It is also noteworthy that even though the results shown in Figure 13 are not directly comparable to the results shown in Table 7, Figure 11, and Figure 12, all derived coordination distances are rather large, compared to the size of The Netherlands. For example, even the smallest reported coordination distance of 60 km creates a large coordination zone around the Westerbork telescope location, which covers a large part of The Netherlands and also extends into Germany. Therefore, further study is required on the coexistence of IMT and RAS in The Netherlands, where potential mitigation strategies can be assessed, including the application of a "guard band".

4.3.3. Comparison of the Westerbork telescope to other telescopes

The study by CRAF provides similar maps to Figure 13 for other European RAS sites. Below, an analysis is provided to compare Westerbork to other telescopes in Europe, in an effort to evaluate the severity of the situation in The Netherlands. For the analysis, two telescopes have been chosen: the Effelsberg telescope in Germany and the Yebes telescope in Spain. Figure 14 shows the contours for the in-band scenario, as shown in the study by CRAF, for the three telescopes. For both cases (with and without clutter), the coordination distances are larger for the Westerbork telescope compared to the other two telescopes, which is related to the flat terrain in the region as opposed to the mountainous terrain surrounding the other two telescopes. As mentioned above, this would prohibit the coexistence of IMT and RAS in The Netherlands, and parts of Belgium, Germany and Denmark, at least without any coordination measures. In this scenario, it is implied that the whole population (~18 million) of The Netherlands and population of other big cities such as Hamburg (~1.9 million), Cologne (~1.1 million), Düsseldorf (~640.000), Dortmund (~600.000) and Liege (~200.000) will not benefit from deployments of IMT in the band that RAS operates.

In contrast to the Westerbork telescope, the Effelsberg telescope is located in a valley, which offers natural protection, and thus leads to smaller coordination distances. However, from the contours shown in Figure 14, there are cities with large populations that still fall within the contour lines, and the contour lines extend within The Netherlands, Belgium, and Luxembourg. In particular, for the case with clutter, cities such as Cologne (~1.1 million), Düsseldorf (~640.000), Eindhoven (~250.000), and Liege (~200.000) fall within the contour. For the case without clutter, the contour gets larger and additionally covers cities such as Amsterdam (~2.5 million), Frankfurt (~2.3 million), Dortmund (~600.000) and Luxembourg City (~130.000). Even though Germany is a large country in terms of land and population (~83.5 million) that could still benefit from in-band deployment in other parts of the country, it is still worthwhile to mention that some big German cities will be excluded from this in-band deployment, impacting a couple of million people.

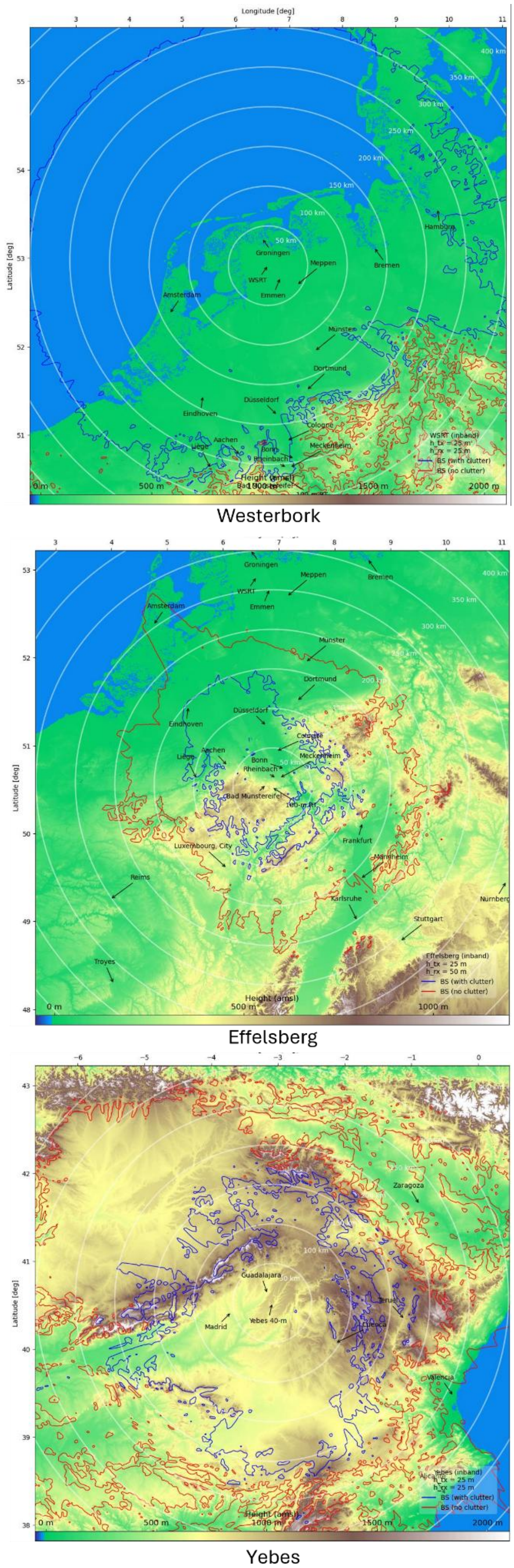


Figure 14: Separation/coordination distances for the in-band scenario for the Westerbork, Effelsberg and Yebes telescopes for the cases with clutter (blue) and without clutter (red), as obtained from [28].

The Yebes telescope in Spain is also located in a mountainous area that offers natural protection. However, the telescope is located very close to Madrid, and Figure 14 shows that the metropolitan area of Madrid (~6.8 million) is situated in the contour for both the cases with and without clutter. Similarly to Germany, Spain's land area and population within the contours compared to the total country land area and population (~48.8 million) implies that in-band deployments could still be beneficial in other areas of the country. However, in-band coexistence would not be possible in the capital city of Madrid.

Considering that in-band coexistence is prohibiting in The Netherlands (based on the result by CRAF), a similar analysis is performed for the adjacent scenario. Figure 15 shows the contour plots for the three telescopes and illustrates that for the case with clutter, only the contour size around the Westerbork telescope is significant, covering areas both in The Netherlands and Germany. On the other hand, the contour around the Effelsberg telescope is negligible and the contour around the Yebes telescope excludes the city of Madrid. Therefore, the situation in The Netherlands is significantly more challenging.

A similar conclusion can be derived also for the case without clutter, although coexistence becomes more challenging also around the other two telescopes. From Figure 15 it is unclear how big the contour around the Westerbork telescope is, but it is shown on the map that cities such as Amsterdam (~2.5 million), Groningen (~230.000), and Münster (~300.000) are within the contour area. Even though the exact size of the contour is not clearly illustrated, it can be understood that a large part of The Netherlands lies within the contour. The contour around the Effelsberg telescope covers cities such as Cologne (~1.1 million) and Düsseldorf (~640.000), whereas the contour around the Yebes telescope covers Madrid (~6.8 million).

The above analysis shows that coexistence between IMT and RAS is very challenging in The Netherlands. Even though some challenges also exist for other telescopes, which are located close to highly-populated areas, the impact is not as big as in The Netherlands, where e.g. in-band coexistence would be prohibiting across the whole country. Another observation from the analysis is that in multiple cases, the contour area covers parts of multiple countries, implying that cross-border coordination should be established. Finally, note that the cities mentioned in the analysis are only a few of the cities that lie within the contours, and thus the population numbers mentioned underestimate the total population living within the contour area.

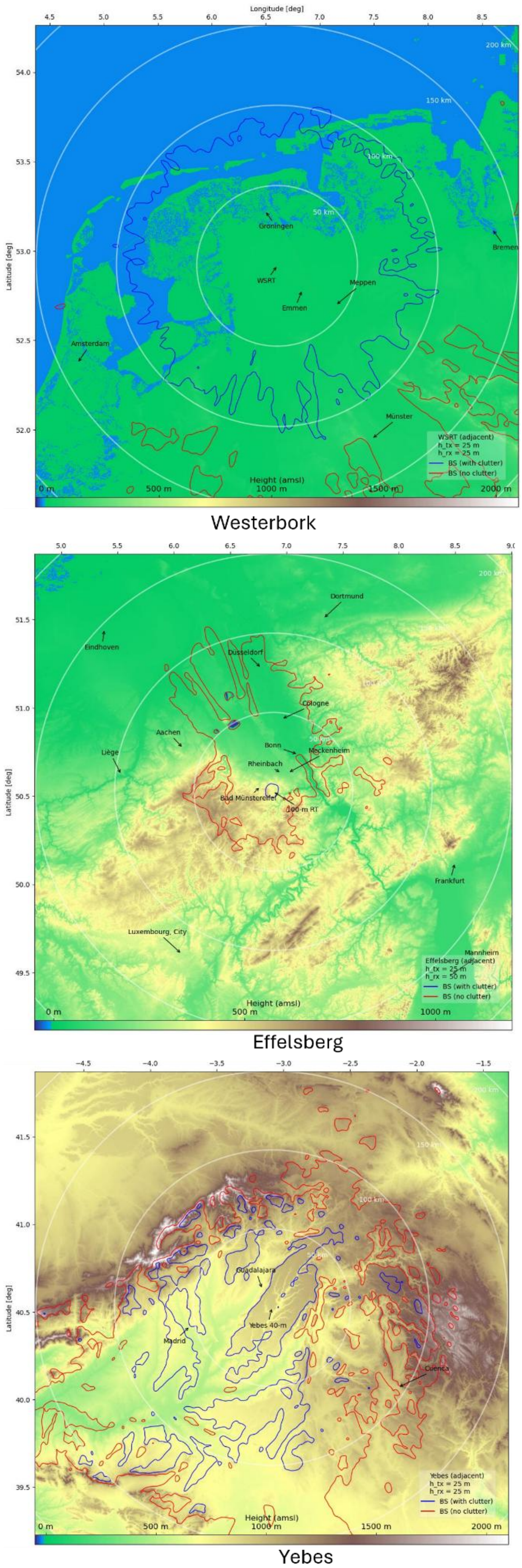


Figure 15: Separation/coordination distances for the adjacent scenario for the Westerbork, Effelsberg and Yebes telescopes for the cases with clutter (blue) and without clutter (red), as obtained from [28].

5. Conclusions and recommendations

5.1. Conclusions

This report has studied potential harmful interferences that may arise from the introduction of new services in the U6 band, where multiple services are already operational. Through various studies submitted to ECC, as well as other relevant studies, a high-level overview has been created showing the identified potential harmful interferences. As follow-on step, an analysis has been performed to identify which of the potential harmful interferences exhibit Dutch-specific elements.

From the identified potential harmful interferences, four have been identified to exhibit potential Dutch-specific elements and would require further analysis to investigate the exact impact of the interference, and whether or not service coexistence is possible: **IMT to Wi-Fi**, **Wi-Fi to IMT, FSS ES to IMT** and **IMT to RAS.**

Potential interferences from **IMT to Wi-Fi** and from **Wi-Fi to IMT**

The potential IMT deployment in the U6 band in The Netherlands is expected to be (almost) nationwide, also creating interferences nationwide. This is different from deployment assumptions for several countries, where IMT is deployed in the U6 band in densely populated areas only. For the further analysis of IMT to Wi-Fi and from Wi-Fi to IMT interference in The Netherlands, the guidance from the recent RSPG final opinion will be used to determine whether it contains new input for a follow-up country-specific analysis in future work.

Potential interferences from **FSS ES to IMT**

For the interference from FSS ES to IMT, the detailed simulation performed for this report shows that harmful interference can probably be avoided or limited to a small geographical area with careful IMT base station site planning and the use of advanced beamforming techniques in 6G. The coordination area where an IMT base station would need to be protected from in-band FSS ES transmissions extends furthest in a narrow stretch in the azimuth direction towards the satellite. Without specific further measures, the simulation shows a coordination distance of about 30 km in that specific direction. This distance is reduced to 24 or 16 km with different uses of the so-called null-steering techniques, where the IMT systems selectively suppress signals received from direction of the FSS ES station. As the locations of FSS ES for the Ministry of Defence are not publicly known, use of mitigation techniques is at least more challenging.

Potential interferences from **IMT to RAS**

In The Netherlands, the issue of IMT to RAS interference revolves around interferences on the measurements in the U6 band performed at the Westerbork telescope. A detailed analysis of several publicly available studies shows that there can be strong interferences from IMT to RAS, which make coexistence challenging or even impossible on part of U6.

- The studies for ECC use different assumptions which makes a straightforward comparison difficult, but they all show a substantial coordination distance between IMT bases stations and the RAS telescope, varying between 60 and over 300 km.
- The CRAF study is the only study that takes into account the specific conditions for the Westerbork telescope, by including the terrain heights and, through that, the influence of the flat landscape in

The Netherlands. Some of the underlying assumptions are expected to lead to an overestimation of the coordination distance, while other assumptions lead to an underestimation. For the in-band scenario, where IMT operates in the same band as the telescope, the coordination zone is such that no IMT base stations could be placed in The Netherlands (and even parts of Belgium and Germany) without interfering with the telescope measurements. In the adjacent scenario, with a 50 MHz guard band on each side of the RAS transmission band, the coordination zone is reduced but still covers an area of approximately 100 km radius around the telescope.

- Given the size of the coordination areas in the simulations for the Westerbork telescope, protecting it from interference would also require cross-border coordination with Germany and even Belgium.
- In comparison to the Dutch situation, the IMT and RAS coexistence in other countries is less challenging, mostly because of the location of the telescopes and the landscape around it relative to major population areas. Still, for certain telescopes and simulation assumptions, the coordination zones can cover major cities with millions of inhabitants.

5.2. Recommendations

- Based on the recent RSPG final opinion on the U6 band, it can be evaluated if a further analysis on the interference between **Wi-Fi and IMT** is required. There could be further Dutch-specific elements in the Dutch profile and usage scenarios that do require further interference studies. Such an element could be related to the current, historical and future building construction approaches in The Netherlands, and whether these approaches would show relevant differences compared to those in other European countries.
- The interference from IMT on the measurements performed at the Westerbork telescope need to be analysed further. The proposed starting point for this is the careful evaluation of the assumptions for the studies, both on the deployment of IMT and on the specific characteristics and use of the Westerbork telescope. This would help to gain a more in-depth understanding of the size of the coordination zone and, as a potential follow-up, potential mitigation measures. To come to a shared understanding, this would require the involvement of the Ministry of Economic Affairs, the Dutch Authority for Digital Infrastructure, Astron and the Dutch mobile operators.

6. List of acronyms

AHN	Actueel Hoogtebestand Nederland
AP	Access Point
CEPT	European Conference of Postal and Telecommunications Administrations
CRAF	Committee on Radio Astronomy Frequencies
DSM	Digital Surface Model
DTM	Digital Terrain Model
ECC	Electronic Communications Committee
EDT	Energy Detection Threshold
EESS	Earth Exploration Satellite Service
EIRP	Effective Isotropically Radiated Power
FNS	Future Network Services
FS	Fixed Service
FSS ES	Fixed Satellite Service Earth-to-Space
IMT	International Mobile Telecommunications
ITU-R	International Telecommunication Union Radiocommunication Sector
LPI	Low Power Indoor
NINP	Non-Interference and Non-Protected
RAS	Radio Astronomy Service
RLAN	Radio Local Area Network
RSPG	Radio Spectrum Policy Group
U6	Upper 6 GHz
UE	User Equipment
UWB	Ultra-WideBand
VLP	Very Low Power
WAS	Wireless Access Systems
WRC	World Radio Conference

7. References

[1] International Telecommunication Union, “World Radiocommunication Conference 2023 (WRC-23) Final Acts”, ITU Publications, Geneva, 2024.

[2] “Future Network Services: 6G for and by The Netherlands,” [Online]. Available: https://futurenetworkservices.nl/en/. [Accessed 31-10-2025].

[3] O. Batura, P. Nooren, L. Paulissen, P. Sachdeva, and Y. Toh, “Upper 6 GHz band - Overview of current and potential future use in The Netherlands”, 11 Dec. 2024.

[4] CEPT, “ECC Report 366: Feasibility of a potential shared use of the 6425-7125 MHz frequency band between Mobile/Fixed Communications Networks (MFCN) and Wireless Access Systems including Radio Local Area Networks (WAS/RLAN)”, 27 June 2025.

[5] ECC PT1, “Draft ECC Report on MFCN U6GHz vs incumbents”, 2 Oct. 2025. Retrieved October 31, 2025, https://cept.org/documents/ecc-pt1/91538/ecc-pt1-25-171_annex-29_draft-ecc-report-on-mfcn-u6ghz-vs-incumbents.

[6] CEPT, “ECC Report 364: Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 6425-7125 MHz”, Jan. 2025.

[7] CEPT, “ECC Report 302: Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz”, May 2019.

[8] Ofcom, “Consultation: Expanding access to the 6 GHz band for commercial mobile and Wi-Fi services”, Feb. 2025.

[9] Radio Spectrum Policy Group (RSPG), “Draft Opinion on Long-term vision for the upper 6 GHz band”, 17 June 2025.

[10] Radio Spectrum Policy Group (RSPG), “Opinion on Long-term vision for the upper 6 GHz band”, 12 Nov. 2025.

[11] M. Tercero, S. Sharma, M. Coldrey and J. Kronander, "Coexistence between 5G and Fixed Services," Proceedings in IEEE VTC Spring, July 2016.

[12] Ofcom, “Consultation: Enabling spectrum sharing in the upper 6 GHz band”, Feb. 2022.

[13] Car Connectivity Consortium, FiRa Consortium, “ECC PT1(25)091: UWB – Initial IMT Interference Study”, 28 Apr. 2025.

[14] Ericsson, Huawei Technologies, and Nokia Corporation, “ECC PT1(25)156: Aspects related UWB co-existence studies”, 9 Sep. 2025.

[15] UWB Alliance, “Ultra-Wideband (UWB) Aggregation and Co-existence of Wi-Fi 6E Operating in the Presence of UWB”, 11 Apr. 2023.

[16] Report ITU-R S.2367-0, “Sharing and compatibility between International Mobile Telecommunication systems and fixed-satellite service networks in the 5 850-6 425 MHz frequency range”, June 2015.

[17] Recommendation ITU-R P.452-18, “Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 100 MHz”, Aug. 2023.

[18] Dataset: Actueel Hoogtebestand Nederland (AHN), retrieved Sep. 2025.

[19] Recommendation ITU-R S.465-6, “Reference radiation pattern for earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz”, Jan. 2010

[20] ECC PT1 CG U6GHz MFCN vs incumbents, "Annexes to draft ECC Report on MFCN U6GHz vs incumbents", 12 Sep. 2025. Retrieved October 31, 2025, from https://cept.org/documents/ecc-pt1/90736/ecc-pt1-25-124r2_cg-u6ghz-mfcn-vs-incumbents-progress-report.
[21] Antenna Register, [Online]. Available: https://antenneregister.nl/viewer/. [Accessed: 6-11-2025].
[22] Recommendation ITU-R RA.769-2, "Protection criteria used for radio astronomical measurements", Mar. 2004.
[23] Recommendation ITU-R RA.1513-2, "Levels of data loss to radio astronomy observations and percentage-of-time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis", Mar. 2015.
[24] Recommendation ITU-R P.2001-4, "A general purpose wide-range terrestrial propagation model in the frequency range 30 MHz to 50 GHz", Sep. 2021.
[25] Recommendation ITU-R P.2108-1, "Prediction of clutter loss", Sep. 2021.
[26] ETSI, "TS 138 104; 5G, NR, Base Station (BS) radio transmission and reception", V18.9.0, Apr. 2025.
[27] "Europe's eyes on Earth: Looking at our planet and its environment for the benefit of Europe's citizens", [Online]. Available: https://www.copernicus.eu/en. [Accessed 31-10-2025].
[28] CRAF, "Draft ECC Report on MFCN U6GHz vs incumbents", 8 Apr. 2025. Retrieved October 31, 2025, https://cept.org/documents/ecc-pt1/90090/cg-mfcn6ghz-25-029_craf-draft-ecc-report-on-mfcn-u6ghz-vs-incumbents.

Annex I: Analysis of individual entries in interference matrix

This Annex presents the analysis on potential harmful interferences in The Netherlands, between the potential new uses of the U6 band, i.e. IMT and Wi-Fi, and the existing uses, i.e. FS, FSS ES, UWB, EESS and RAS. For each pair of new use and existing use, two analyses are carried out, one where the new use is the interferer and another one where the new use is the victim. The goal of these analyses is to identify whether harmful interference is expected, based on the Dutch-specific situation, and whether further analysis will be required. The outcome of each pairwise analysis is given as an input to the high-level overview, shown in Table 3 in Section 2.2 of the main text, by marking the relevant entry in green (no harmful interference) or red (harmful interference). Note that the scenarios where EESS and RAS are acting as interferers are not considered, because EESS and RAS are passive (non-emitting) uses of the U6 band, and thus cannot create interference to other uses.

IMT interference to Wi-Fi

The ECC report on the feasibility of a potential shared use of the U6 band between IMT and Wi-Fi includes a number of studies [4]. From those studies it is shown that significant co-channel interference can be expected on Wi-Fi LPI when considering an EIRP of 73-83 dBm/100 MHz for the IMT base stations. Specifically, Study C3 shows that for base stations operating at 71.6 dBm/80 MHz, Wi-Fi communication will be deferred in 53% of indoor locations. Moreover, Study C7 shows that for base stations operating at 67 dBm/80 MHz and 87 dBm/80 MHz, Wi-Fi will have to vacate the channel in 50% and 90% of the indoor locations, respectively.

Another aspect addressed in the studies within the ECC report [4] is the reduction of the maximum EIRP of the base stations. However, results show that that would reduce the performance of the IMT system. In particular, Study C11 shows that a reduction in the EIRP of the base stations from 82 dBm/100 MHz to 72 dBm/100 MHz and from 82 dBm/100 MHz to 57 dBm/100 MHz will lower the probability of indoor coverage at the cell-edge (5th percentile) from 80% to 50% and from 80% to 10%, respectively. Additionally, coverage predictions have been presented in Studies C4 and C5 indicating that for a base station EIRP of 74 dBm/100 MHz and 80 dBm/100 MHz, the indoor signal levels would be below the UE noise level (i.e. no service) in 50% and 36% of the locations, respectively. Finally, it has also been indicated that a reduction in the base station EIRP might lead to network densification to ensure sufficient indoor coverage and consequently this densification will lead to increasing interference to Wi-Fi.

The interference impact of IMT on Wi-Fi VLP was not addressed in the studies. However, it was suggested that energy detection could be used in Wi-Fi VLP, which allows the receiver to first measure the signal energy level on the channel, before deciding whether to transmit. Therefore, energy detection prevents VLP devices to transmit in the same way as LPI devices do and could potentially mitigate interference from IMT to Wi-Fi VLP.

Conclusion: IMT potentially causes harmful interference to Wi-Fi.

The potential IMT U6 deployment in The Netherlands is expected to be (almost) nationwide, creating interferences nationwide, assuming that Wi-Fi is also deployed nationwide. This assumption is different from deployment assumptions for several other countries, such as the UK [8], where IMT is expected to be deployed in densely populated areas only. However, the existing ECC studies are still relevant for the analysis of the Dutch situation. An open point is whether there are further Dutch-specific elements in the

Dutch profile and usage scenarios that do require further spectrum studies. These could be related to current, historical and future building construction approaches in The Netherlands, if these would show relevant differences with those in other European countries.

Wi-Fi interference to IMT

Wi-Fi uses listen-before-talk to assess if a channel is occupied based on an Energy Detection Threshold (EDT) and the IMT power levels (at which IMT is still functional) are well below the EDT. When the IMT downlink signals have a power level below the EDT, the Wi-Fi Access Point (AP) would consider the channel to be available for transmissions. These transmissions could cause harmful interference to IMT, in particular to UEs, which are often closely located to Wi-Fi APs. The studies within the ECC report on the feasibility of a potential shared use of the U6 band between IMT and Wi-Fi [4] show that this is often the case in indoor locations, when considering a 300-meter cell radius and an EDT of -84 dBm/MHz.

Specifically, Studies C1 and D4 show that Wi-Fi APs fail to detect IMT downlink signals in 70% of the locations, when IMT base stations are transmitting at 73 dBm/100MHz. When the IMT power level is increased to 83 dBm/100 MHz, the Wi-Fi APs fail to detect the IMT downlink signals in fewer than 4% of the locations. Additionally, according to Study C2, Wi-Fi APs are not able to detect IMT downlink signals, because these signals are below the EDT, in around 47% of indoor locations and 0% of outdoor locations. This study is based on IMT base station power levels of 71.6 dBm/80 MHz. Moreover, the coverage analyses performed in Studies C4 and C5 state that indoor IMT signals will be below the EDT threshold at approximately 99% and 92% of indoor locations, when considering IMT base station power levels of 74 dBm/100 MHz and 80 dBm/100 MHz, respectively.

Study C9 states that the performance of IMT systems (uplink and downlink) will be degraded when Wi-Fi APs are deployed in the same frequency band as IMT without additional sharing mechanisms. Moreover, the interference will be worse for a clustered device deployment compared to a uniform device deployment. Additionally, Study C9 validated that in a Wi-Fi VLP-only scenario, the IMT downlink throughput can be impacted by 9.1% for the median IMT user, and by 40% for the cell edge user when devices follow a clustered deployment. Wi-Fi VLP was also considered in Study C10, which demonstrates that no significant interference is expected from VLP devices to both uplink and downlink IMT signals.

Conclusion: Wi-Fi will likely cause harmful interference to IMT.

Because the potential IMT deployment in The Netherlands is expected to be (almost) nationwide, the interferences will also occur nationwide, assuming that Wi-Fi is also deployed nationwide. An open point is whether there are further Dutch-specific elements in the Dutch profile and usage scenarios that do require further spectrum studies. As mentioned before, these could be related to current, historical and future building construction approaches in The Netherlands, if these would show relevant differences with those in other European countries.

IMT interference to FS

Ofcom reports in their consultation [8] that there is a potential risk of interference from IMT base stations located up to several tens of kilometres of an FS link receiver, especially if the base station is on the boresight direction of the FS link antenna. The exact distances, for which IMT base stations interfere with FS links, depend on the base station transmit power and site-specific factors including height and local clutter. Additionally, most interferences are expected for FS links in urban areas with high density IMT deployments. For FS links located outside the urban areas, Ofcom expects the risk of interference to be rather low.

In The Netherlands, almost all of the FS links are location in the Dutch Exclusive Economic Zone in the North Sea [3]. Hence, it is expected that with suitable coordination procedures (which could be more localized), the risk of interference from IMT to FS can be mitigated.

Conclusion: IMT causes a potential harmful interference on FS. However, in The Netherlands, the IMT interference on FS can be mitigated through local coordination for the few FS links located on land.

FS interference to IMT

Because almost all FS links in The Netherlands are located in the North Sea and the FS transmitters have a narrow beamwidth [3], no meaningful interference is expected from FS to IMT. Moreover, simulation results by Tercero et al [11] show that FS interference on 5G uplink and downlink is negligible compared to internal interference in the 5G network itself.

Conclusion: Potential interference form FS to IMT is expected to be negligible in The Netherlands.

Wi-Fi interference to FS

Based on the studies in the ECC report [6], it was concluded that interference from Wi-Fi LPI to FS links is unlikely, except in a few isolated cases. This conclusion is based on a wide range of deployment scenarios and operating assumptions including population density, market adoption rate of Wi-Fi, different distributions of Wi-Fi devices around FS links and representative FS link operating requirements. In some rare cases, such as when Wi-Fi APs are located very near the line of sight of the FS link, and/or when there are unfavourable conditions (e.g. low building penetration loss), there may be potential interference. A very low risk of interference from Wi-Fi LPI to FS links has also been concluded by Ofcom [8], [12].

Conclusion: Wi-Fi LPI poses very low interference risk to FS due to its low power. Combined with the specific Dutch situation where nearly all FS links are located in the North Sea [3], this means that no interference is expected from Wi-Fi LPI to FS links.

FS interference to Wi-Fi

Because almost all FS links in The Netherlands are located in the North Sea and the FS transmitters have a narrow beamwidth [3], no meaningful interference is expected from FS to Wi-Fi LPI.

To evaluate the interference of FS to Wi-Fi VLP deployed outdoors, the heights of the FS antennas should be taken into account, besides the directivity of the FS links. The FS antennas heights are usually rather high and in The Netherlands, they are between 28 m to 99 m, with the majority of them above 60 m. These heights are considerably larger than the expected antenna heights for the Wi-Fi VLP outdoor deployments. Hence, no interference is expected from FS to Wi-Fi VLP outdoor.

Conclusion: Potential interference from FS to Wi-Fi is expected to be negligible in The Netherlands.

IMT interference to FSS ES commercial

The U6 band is allocated to FSS ES on a primary basis. When WRC-23 identified the U6 for the terrestrial component of IMT, studies were made on the interference from IMT to FSS ES. This has led to a protection measure to protect FSS ES receivers on satellites from IMT interference. This is implemented through an EIRP mask that limits the power emitted by base stations as a function of the angle above the horizon.

We note that, in general, satellite stakeholders are satisfied that the EIRP mask is put into place to protect FSS ES from IMT interference. However, some satellite stakeholders are not convinced that the EIRP mask provides enough protection as they suspect that the actual IMT deployment scenarios may be different from the ones used in the construction of the EIRP mask.

Conclusion: IMT potential interference on FSS ES is expected to be negligible.

FSS ES commercial interference to IMT

A detailed analysis is presented in Chapter 0 evaluating the interference from FSS ES to IMT for the Dutch-specific situation.

Wi-Fi interference to FSS ES commercial

A study has been conducted in ECC [6] on the interference from Wi-Fi deployment on FSS ES in the U6 band. Under all studied scenarios, the interference level for satellites is more than 15 dB below the interference threshold. In particular, the interference from all Wi-Fi APs to the FSS space station is characterised by the average aggregate interference from all indoor and outdoor Wi-Fi APs that are within the satellite's view for various FSS beam configurations, such as global, regional, zone, and two spot beams. A similar study on the interference from Wi-Fi deployments to FSS ES was also conducted by ECC for the lower 6 GHz band [7]. This study also shows that the deployment of Wi-Fi in the lower 6 GHz band will not impact the operation of FSS ES.

Conclusion: No significant interference is expected from Wi-Fi to FSS ES commercial.

FSS ES commercial interference to Wi-Fi

No studies have been found on the interference from FSS ES to Wi-Fi. However, no significant interference is expected, because most Wi-Fi APs are located indoor.

Conclusion: No significant interference is expected from FSS ES commercial to Wi-Fi.

IMT interference to FSS ES defence

No FSS ES defence specific studies are available. FSS ES defence is protected by the same measure as FSS ES commercial, i.e., an EIRP mask is applied that limits the power emitted by base stations as a function of the angle above the horizon. Therefore, a similar conclusion as for the interference from IMT to FSS ES commercial can be considered.

Conclusion: IMT potential interference on FSS ES defence is expected to be negligible.

FSS ES defence interference to IMT

We have no information on the characteristics of FSS ES defence. If it is similar to FSS ES commercial, then potential harmful interference is expected from FSS ES defence to IMT. Chapter 0 presents a more detailed analysis evaluating the interference from FSS ES (commercial) to IMT for the Dutch-specific situation.

Conclusion: Potential harmful interference is expected from FSS ES defence to IMT.

Wi-Fi interference to FSS ES defence

We have no information on the characteristics of FSS ES defence. If it is similar to FSS ES commercial, then no significant interference is expected from Wi-Fi.

Conclusion: No significant harmful interference is expected from Wi-Fi to FSS ES defence.

FSS ES defence interference to Wi-Fi

No studies have been found on the interference from FSS ES defence to Wi-Fi. However, and similarly to FSS ES commercial, no significant interference is expected from FSS ES defence to Wi-Fi, because most Wi-Fi APs are located indoor.

Conclusion: No significant interference is expected from FSS ES defence to Wi-Fi.

IMT interference to UWB

A study [13] was introduced by the Car Connectivity Consortium and FiRa at ECC, related to the interference from IMT to UWB. The study was done on 8 GHz where the main UWB channel is located. The results show interference from an IMT macrocell network to outdoor UWB devices (e.g. building and vehicle access keys). Based on these results, it can be considered that similar interference may occur between UWB devices and IMT on the U6 band. On the other hand, another ECC contribution [14] mentions that the considered interference threshold used in [13] is very stringent. Moreover, Ofcom [8] concludes that no significant coexistence issues are expected between IMT and UWB, regardless of the IMT base station power level, due to the very wide bandwidth of UWB. Moreover, an analysis was also presented as part of the consultation [9] of spectrum sharing with incumbent users, which includes UWB. However, the analysis only notes that UWB applications operate on a non-interference and non-protected (NINP) basis.

Conclusion: IMT may have the potential to cause significant interference on UWB.

Given the NINP basis on which UWB operates, no further consideration of interference is required.

UWB interference to IMT

The power limits for UWB are extremely low, with maximum mean EIRP spectral density of -41.3 dBm/MHz and maximum peak EIRP of 0 dBm. In cases where the UWB transmitter is not integrated in an IMT UE, UWB should not cause any serious interference to IMT UE, due to the separation distance between the IMT UE and the UWB device. However, UWB transmitters (e.g. digital car key) are also integrated in an IMT UE. This close proximity can lead to harmful interferences on IMT UEs in the co-channel scenario, considering the UE sensitivity of -104 dBm/MHz (assuming 10 dB noise figure). Moreover, it is noted that current implementation of UWB utilises mainly the UWB channel 9 (7.7 – 8.3 GHz). UWB channel 5 (6.2 – 6.8 GHz) is used less often.

Conclusion: There is potential harmful interference from UWB to IMT UE when the UWB transmitter is integrated in an IMT UE.

Given the NINP basis on which UWB operates and no Dutch-specific element in the UWB interference to IMT, no additional investigation is needed.

Wi-Fi interference to UWB

The 6000–8500 MHz band is used by UWB equipment for sensors, location tracking, vehicle access and in a range of consumer devices [8]. An ECC study [7] has been performed to assess the interference from Wi-Fi to UWB in the lower 6 GHz band. The results showed that the probability of Wi-Fi causing a 3 dB reduction in sensitivity for location tracking devices is less than 3% of the time, and less than 2% for sensing devices. The expectation is that the probability of interference in the U6 band will be lower due to the low-power limitation of Wi-Fi LPI in the U6 band.

Conclusion: Wi-Fi is not expected to significantly interfere with UWB devices.

UWB interference to Wi-Fi

The UWB Alliance [15] showed that the presence of UWB devices had no measurable impact on Wi-Fi performance even when operating in close proximity to Wi-Fi transmitters and receivers.

Conclusion: UWB will not interfere with Wi-Fi.

IMT interference to EESS

The U6 band is used for EESS measurements. Specifically, the 6425 – 7075 MHz band is used for measurements over the ocean, whereas the 7075 – 7250 MHz band is used for measurements over land. Note that the band for measurements over land is partly falling within the U6 band. For the EESS measurements over the ocean, it is expected that there will be a high degree of geographic separation with IMT, as most IMT systems are located on land. Despite this separation, some preliminary studies by ITU-R prior to WRC-23 showed that IMT interference to EESS might occur at quite large distances over the ocean. However, in Ofcom's consulation [8], these studies were based on some quite pessimistic assumptions. Regarding the EESS measurements over land, the risk of interference from IMT is expected to be significant.

Conclusion: IMT interference to EESS can be expected on land.

Wi-Fi interference to EESS

Considering that no interference is expected from IMT to EESS for measurements over the ocean, a similar conclusion can be derived for the interference from Wi-Fi LPI. That is because compared to IMT, Wi-Fi LPI has lower transmission power and smaller footprint. For the EESS measurements over land, there will be some minor risk of interference from Wi-Fi LPI.

Conclusion: Wi-Fi interference on EESS will be negligible.

IMT interference to RAS

A detailed analysis is presented in Chapter 4 evaluating the interference from IMT to RAS, considering the Dutch-specific situation.

Wi-Fi interference to RAS

Within ECC, a study has been conducted on the interference from Wi-Fi deployments to RAS [6]. In this study, the aggregate interference from indoor and outdoor Wi-Fi APs to various European RAS stations was considered, to estimate the sizes of the impacted zones to protect the RAS stations. One of the considered RAS stations is the Westerbork telescope in The Netherlands. The size of the impacted zone for the Westerbork telescope is between 24 and 37 km, depending on the considered scenario. When Wi-Fi APs are restricted to indoor devices only, the size of the impacted zone is reduced to between 1 and 11 km, depending on the considered scenario. The size of the impacted zone for the Westerbork telescope is relatively large compared to other telescopes. This is because the Westerbork telescope is located on flat land and is surrounded by nearby villages and further away cities. The interference from Wi-Fi to RAS has also been addressed by Ofcom in their consulation [8], where they propose Wi-Fi equipment to not transmit in the band 6650 to 6675.2 MHz in order to protect the RAS measurements.

Conclusion: Interference from Wi-Fi to RAS is expected if Wi-Fi is deployed in the same frequency band as RAS. An existing ECC study [6] already takes the Dutch-specific elements into account, thus no additional investigation is needed.

This research was supported by the National Growth Fund through the Dutch 6G flagship program "Future Network Services"