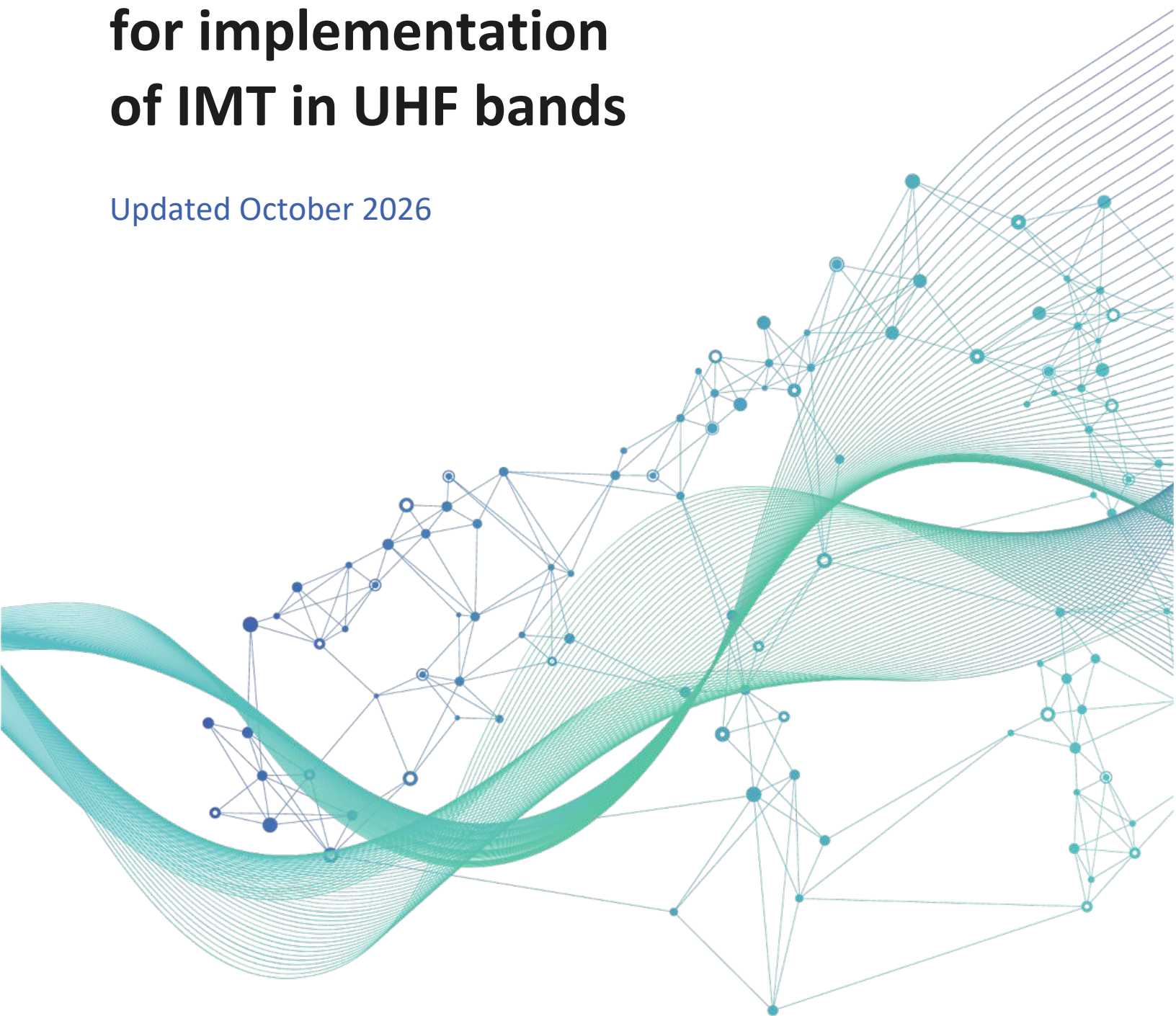




Guidelines for implementation of IMT in UHF bands

Updated October 2026



Acknowledgements



This report was drafted by Telecommunications Management Group, Inc. (TMG), a consulting firm specializing in the information and communication technologies (ICT) sector. For over 30 years, TMG has assisted public and private sector entities around the world on ICT policy and regulatory matters. Our team focuses on providing insight and developing strategies to assist clients on technology and market trends, the development mobile services; spectrum policy and management; broadband and ICT strategies; economic assessments and valuations, among other matters.



This report was commissioned by the GSMA, a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. GSMA's vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.



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1. Executive summary

The 600 MHz band offers administrations an opportunity to expand mobile broadband coverage and capacity using spectrum with favourable propagation characteristics. It can support wide-area and rural coverage, improve indoor connectivity, strengthen service to transport corridors and other critical infrastructure, and complement higher-frequency spectrum used for 5G and future evolution towards 6G. Since the band was first identified for International Mobile Telecommunications (IMT) at WRC-15, a growing number of countries have introduced IMT or established a regulatory basis for future implementation.¹

At the same time, the band remains in use for Digital Terrestrial Television (DTT) in many countries, with digital switchover and broadcasting-network changes progressing at different rates.² Neighbouring administrations may therefore adopt different frequency arrangements, services and implementation timelines. The resulting cross-border situations range from aligned IMT deployment on both sides of a border to situations where IMT is deployed in one country while DTT continues to operate in the same frequencies of a neighbouring country.

This report updates the TMG's October 2023 Guidelines for implementation of IMT in UHF bands and presents detailed coexistence case studies and modelling of interference scenarios supporting the implementation of IMT in the 600 MHz band. It also provides key technical findings related to IMT-DTT coexistence, existing experiences related to the use of UHF bands, and relevant frequency arrangements and ecosystem developments for consideration.

The evidence presented in this report demonstrates that implementation of IMT in the 600 MHz band is feasible while maintaining protection of broadcasting and other relevant services. There is no single coexistence solution or universally applicable coordination distance. Administrations can draw on established regulatory frameworks, bilateral and multilateral agreements, system-specific technical studies and practical mitigation measures to develop arrangements appropriate to each border and deployment scenario.

1.1. Existing experiences in the use of UHF bands

Although cross-border implementation experience specifically in the 600 MHz band remains limited, the introduction of IMT in the 700 MHz and 800 MHz bands provides strong precedents. These experiences show how harmonised frequency arrangements, coordinated service migration, common technical conditions and effective interference-resolution procedures can support large-scale changes in UHF spectrum use.

Bilateral agreements allow two neighbouring administrations to translate international or regional obligations into practical conditions for a specific border. Multilateral frameworks can complement these agreements by establishing common technical principles and procedures across several countries. Neither approach is inherently preferable in all circumstances: bilateral agreements are well suited to border-

¹ See also ITU, Radio Regulations, 2024 Edition, RR Nos. **5.295A**, **5.296A**, **5.307A** and **5.308A**, available at: <https://www.itu.int/pub/R-REG-RR-2024>.

² See also GSMA, Digital Switchover: Unlocking Additional Low Bands in Emerging Markets, Modified in October 2025, available at: <https://www.gsma.com/connectivity-for-good/spectrum/digital-switchover-unlocking-additional-low-bands-in-emerging-markets/>.

specific conditions, while multilateral arrangements can simplify implementation where a wider group of administrations pursues similar objectives. Figure 1 indicates some of the lessons from the existing experiences reviewed.

Figure 1: Lessons from existing cross border coordination agreements



Source: TMG.

The overall lesson is that successful spectrum transitions depend on both a stable regulatory framework and continuing cooperation between administrations. Agreements should be sufficiently clear to provide regulatory certainty, but sufficiently adaptable to respond to changes in assignments, technologies and implementation schedules.

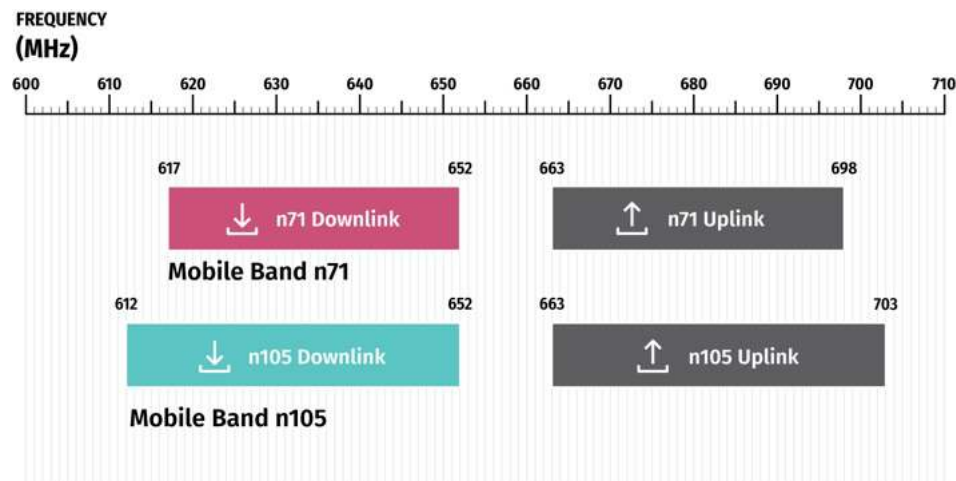
1.2. Frequency arrangements and ecosystem developments

Recommendation ITU-R M.1036 includes frequency arrangements relevant to the upper UHF range, while 3rd Generation Partnership Project (3GPP) standardised the 600 MHz band IMT arrangements as band n71 in 2018 and band n105 in 2022. Band n71 uses 617-652 MHz paired with 663-698 MHz, providing 2×35 MHz. Band n105 extends the lower edge to 612 MHz and the upper edge to 703 MHz, providing 2×40 MHz.

Band n71 currently has a more mature commercial ecosystem. As of mid-2026, approximately ten networks, seven using 5G and three using 4G, were operating in the band, supported by more than 1,100 commercial devices.³ Band n105 provides an additional 5 MHz in each direction and has been adopted by the Asia-Pacific Telecommunity as a harmonised arrangement. Its ecosystem may continue to develop as further regulatory processes and spectrum assignments progress, including in notable markets such as India. Devices and chipsets that are compatible with both the bands n71 and n105 are also expected to be developed as the ecosystem matures.

³ GSMA Intelligence, May 2026.

Figure 2: Frequency arrangements for the 600 MHz band



Source: TMG.

Selection of a frequency arrangement should consider more than available bandwidth. Relevant factors include regional harmonisation, neighbouring countries' plans, ecosystem maturity, incumbent use, transition requirements and compatibility with other services. Band n105 requires solutions to ensure compatibility with the Radio Astronomy Service (RAS) in 608-614 MHz and, in some countries, broadband Public Protection and Disaster Relief (PPDR) use around 698-703 MHz in the same area.

RAS compatibility in the band n105 is geographically localised because relevant facilities are concentrated in a limited number of countries, but studies indicate that substantial coordination distances may be required around some RAS sites. At the same time, site-specific shielding and other mitigation measures can materially reduce them. PPDR considerations similarly depend on national deployment choices. Where dedicated PPDR systems are planned or operational, targeted coordination may be needed; commercial or hybrid IMT networks using standardised mission-critical capabilities may provide an alternative implementation option. Neither RAS nor PPDR is expected to constitute a widespread limitation on use of the 600 MHz band, provided that relevant sites and national deployments are considered.

1.3. Key technical findings

The technical studies confirm that IMT-DTT coexistence cannot be characterised by a single coordination distance. Results depend on the interference direction, frequency overlap, transmitter power and height, antenna characteristics, receiver criteria, terrain, clutter and propagation path. Even locations at similar distances from a border can produce different results, particularly where one path is inland, and another is coastal or largely over water, or if the protection of IMT is considered regarding the uplink or downlink directions.

- **Planning triggers and protection criteria for DTT serve different purposes.** Under the representative assumptions considered, the GE06 planning methodology produced a coordination distance between an IMT base station and a DTT receiver of approximately 92 km, while a DVB-T2 receiver-based assessment including antenna discrimination indicated a distance of approximately 14 km. The GE06 value indicates when coordination may be required; the receiver-based value assesses protection under the specified technical conditions.

- **DTT interference into IMT base stations is generally the most challenging scenario.** High-power, elevated and non-directional DTT transmitters can create interference contours extending substantially beyond their service areas into the IMT uplink.
- **User-equipment interference is generally more localised.** Across the case studies, DTT interference into IMT user equipment and IMT user equipment interference into DTT reception were less restrictive than the equivalent base-station cases.
- **Distance alone is not a sufficient predictor.** Terrain shielding, clutter, antenna orientation, spectral overlap and land or sea propagation can influence in the coexistence outcomes.
- **Practical engineering can improve coexistence.** Site selection, antenna orientation, front-to-back ratio, polarisation discrimination, frequency offsets, filtering and terrain shielding can reduce interference and preserve service coverage.

Three detailed case studies were considered under different conditions, further validating the key technical findings:

- **Finland-Russian Federation:** full IMT co-channel operation with contrasting DTT transmitters. The study shows the influence of transmitter power and directivity and demonstrates that site placement, antenna orientation and cross-polarisation discrimination can maintain useful IMT coverage close to the border.
- **Germany-Poland:** partial frequency overlap and three IMT deployment locations. The study shows how coexistence improves with separation distance and how antenna discrimination, improved front-to-back ratio and modest frequency offsets can assist a deployment closer to the border.
- **Nigeria-Benin:** full co-channel operation under coastal, near-border and inland conditions. The contrast between Lagos and Abeokuta shows that broadly similar separation distances can produce very different results because of over-water propagation, terrain and clutter. The study also demonstrates how base-station orientation and improved front-to-back ratio can protect DTT reception in a challenging scenario.

The results further show that practical engineering measures can play an important role in facilitating coexistence. Appropriate site selection, antenna orientation, antenna discrimination, terrain shielding and other mitigation techniques can significantly reduce interference and improve coexistence performance. These findings reinforce the value of flexible, implementation-oriented coordination approaches that take account of actual deployment characteristics while maintaining protection of incumbent services.

Figure 3: Summary of findings from the three coexistence case studies

FINLAND – RUSSIA	GERMANY – POLAND	NIGERIA – BENIN
High-power DTT environment	Partial spectral overlap	Full co-channel scenario
Terrain-sensitive paths	GE06 vs DVB-T2 comparison	Strong dependence on deployment location
DTT → IMT BS dominant	Antenna discrimination important	Mitigation measures required in some cases
Practical mitigation effective	Coexistence generally achievable	Outcomes vary significantly by scenario

Common findings across all case studies

- DTT → IMT BS often represents the dominant interference path.
- Terrain and clutter strongly influence results.
- IMT UE → DTT generally produces limited impacts.
- Site-specific engineering measures can significantly improve coexistence.

Source: TMG.

1.4. Recommendations

Administrations should consider the 600 MHz band as a viable option for strengthening mobile coverage and capacity while developing implementation arrangements that reflect national requirements and cross-border conditions. Decisions should be supported by a clear national roadmap, early engagement with neighbouring administrations and technical analysis proportionate to the actual interference risk.

1.4.1. National spectrum planning

Administrations considering IMT in the 600 MHz band should:

1. **Define a national roadmap.** Establish the intended frequency arrangement, implementation milestones, geographic priorities and relationship with future DTT use or migration.
2. **Assess actual spectrum use.** Identify the DTT channels, transmitters and other services operating in the relevant frequency ranges, particularly within border areas.
3. **Consider regional harmonisation.** Evaluate neighbouring countries' frequency arrangements and plans, even where no immediate national coexistence constraint is present.
4. **Review spectrum requirements periodically.** Account for changes in broadcasting demand, media distribution, mobile-network requirements and ecosystem development.
5. **Assess RAS and PPDR where relevant.** Focus analysis on actual facilities, assignments and national deployment plans rather than applying general restrictions across the entire country.
6. **Preserve implementation flexibility.** Where full-band IMT implementation is not immediately possible, consider phased release, frequency segmentation or geographically limited deployment.

1.4.2. Bilateral and multilateral coordination

Countries wishing to use the 600 MHz band for IMT networks will first benefit from understanding their neighbours' plans for the band, including the level of deployment of DTT in each channel. Depending on the initial assessment of the current and future spectrum use in the border area, agreements may be:

- (i) straightforward border agreements to enable interference-free deployment of the same service in both countries;
- (ii) agreements to accommodate plans for releasing the band for IMT use over time; or
- (iii) agreements to ensure the coexistence of DTT broadcasting and IMT transmissions on either side of the border.

A bilateral agreement should, as applicable:

- define its geographic and frequency scope;
- identify the services and stations potentially affected;
- establish coordination triggers and notification procedures;
- specify the technical data and propagation methodologies to be exchanged and applied;
- distinguish between relevant interference paths, including base-station and user-equipment cases;
- allow system-specific or path-specific analysis after an initial regulatory trigger;
- specify available technical and operational mitigation measures;
- provide procedures for resolving harmful interference;
- include transitional provisions where band use differs across the border; and
- provide for periodic review as assignments and implementation plans evolve.

GE06-based criteria should remain an initial regulatory reference where applicable. However, an exceedance of a planning threshold should not automatically be interpreted as harmful interference at an actual receiver, as GE06 thresholds were developed for broadcasting planning and are intentionally conservative. Bilateral agreements can provide procedures for evaluating protection using station-specific parameters, terrain, clutter, receiver performance and practical mitigation measures before final deployment conditions are established.

The flowchart in Figure 4 shows the main aspects and steps that countries wishing to implement IMT networks in the 600 MHz band should consider when developing bilateral agreements for spectrum use at the border. These general guidelines can be adjusted to consider the unique needs and characteristics of each country.

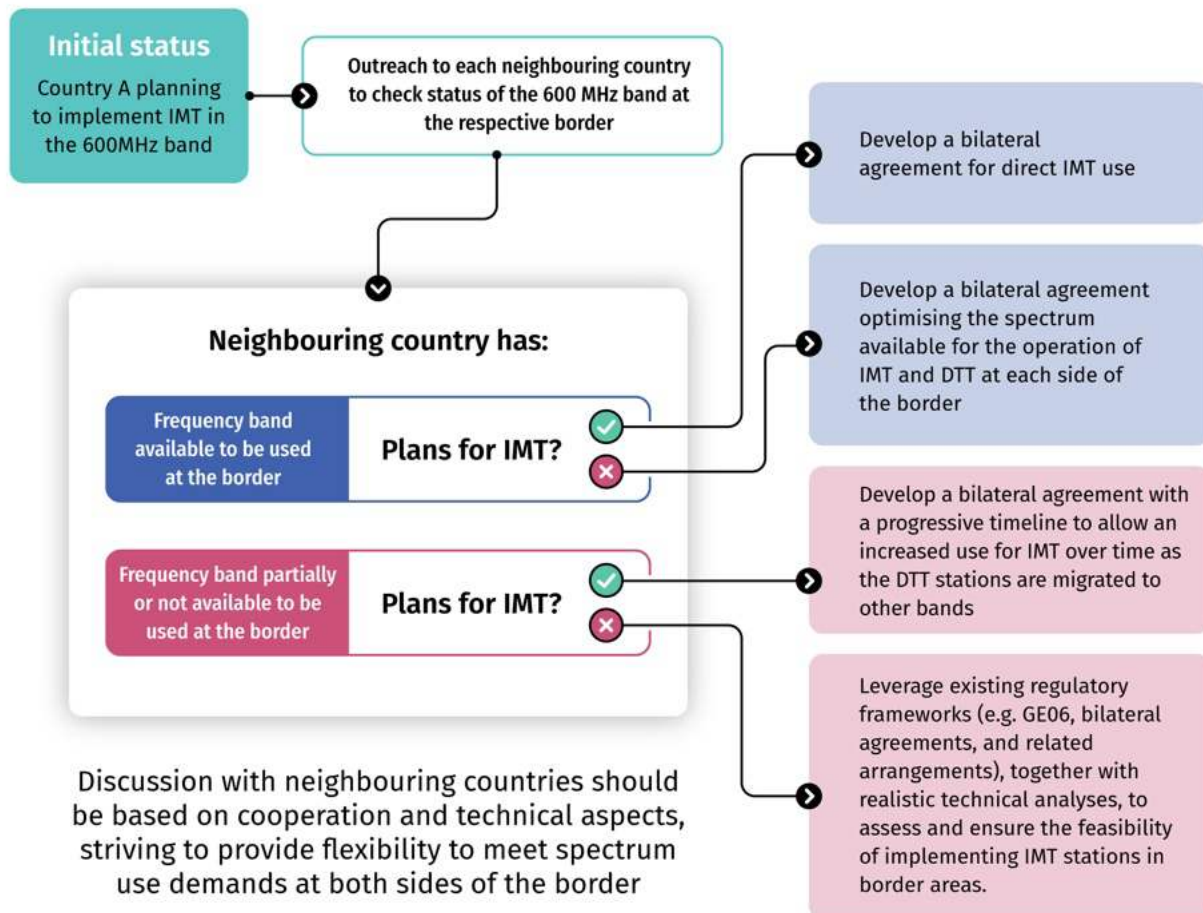
The overall objective is not to prescribe a single coordination methodology or separation distance. It is to give administrations a structured set of regulatory and engineering tools through which IMT can be introduced efficiently while maintaining appropriate protection of DTT, RAS, PPDR and other relevant services. A clear, technically

Bilateral agreements for the 600 MHz band help countries to:

- Have flexibility to meet spectrum demands for both IMT and DTT broadcasting applications.
- Ensure interference-free operations in their border areas.
- Review their spectrum needs in border areas and update their spectrum plans while facilitating border agreements.
- Understand the needs of the communities in border areas and identify possible cooperation initiatives with neighbouring countries.

grounded and adaptable coordination framework can support investment certainty, efficient use of spectrum and the progressive implementation of IMT in the 600 MHz band.

Figure 4: Recommendations for the development of a bilateral agreement for the 600 MHz band



Source: TMG.

2. Guidelines for implementation of IMT in UHF bands

This section provides guidance to administrations considering the implementation of IMT in the 600 MHz band and the development of associated cross-border coordination arrangements. It focuses on technical, regulatory and operational considerations that may be used to support bilateral or multilateral agreements, while retaining sufficient flexibility to accommodate different national uses of the band.

The future use of the 600 MHz band varies across administrations. While some countries have already introduced IMT or are progressing plans for its implementation, others continue to rely on the band for DTT and may follow different migration timelines. As a result, neighbouring countries may adopt different approaches to the use of the band, creating a need for coordination mechanisms that support coexistence between services and provide certainty for network deployment in border areas.

Experience from existing coordination agreements in the sub-1 GHz bands demonstrates that a range of approaches can be used to manage coexistence, including frequency planning measures, technical coordination procedures, coordination zones, interference assessment methodologies and practical mitigation techniques. Building on these experiences, the following sections provide guidance on the development of coordination frameworks for the 600 MHz band, including coexistence with DTT, compatibility with other services, and the practical implementation of bilateral and multilateral agreements.

2.1. Frequency arrangements and ecosystem developments in the 600 MHz band

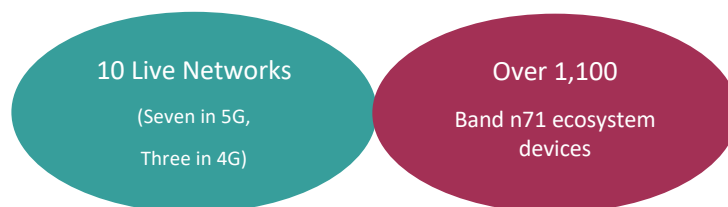
The 600 MHz band is increasingly being considered for IMT deployment because of its favourable propagation characteristics and ability to support wide-area coverage and improved indoor penetration. Recommendation ITU-R M.1036 identifies three frequency arrangements relevant to this range: arrangement A8 (698-703/753-758 MHz), arrangement A12 (617-652/663-698 MHz) and arrangement A13 (612-652/663-703 MHz).⁴ The corresponding 3GPP frequency arrangements for widescale IMT deployment are band n71 (617-652 MHz/663-698 MHz) and band n105 (612-652 MHz/663-703 MHz). These arrangements provide alternative implementation options for administrations, reflecting different regulatory and spectrum availability conditions.

Band n71 is currently the most mature IMT arrangement in the 600 MHz range, with commercial deployments already in operation and broad device support. As of mid-2026, approximately 10 networks (seven using 5G and three using 4G technologies) were operating in the band, supported by more than 1,100 commercial devices.⁵

⁴ ITU, Recommendation ITU-R M.1036, Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications in the bands identified for IMT in the Radio Regulations, available at: <https://www.itu.int/rec/R-REC-M.1036/en>.

⁵ GSMA Intelligence, May 2026.

Figure 5: Status of IMT in the 600 MHz band



Source: GSMA Intelligence.

Band n105 extends the available paired spectrum from 2×35 MHz to 2×40 MHz and has been adopted by the Asia-Pacific Telecommunity (APT) as a harmonised frequency arrangement for IMT implementation in the 600 MHz band.⁶ While the ecosystem remains less mature than that of band n71, ongoing regulatory review and planned spectrum assignments in major markets, including India, are expected to support continued device development and economies of scale.⁷

Figure 6: Comparison of spectrum available below 1 GHz when using band n71 and n105



Source: GSMA.

Several administrations have already introduced IMT in the 600 MHz band, while others are considering future implementation as part of the long-term evolution of mobile broadband networks. Countries such as Canada, Saudi Arabia and the United States are actively using the band for mobile services, while additional administrations – including those that supported IMT-related provisions at WRC-23 – are expected to follow. At the same time, changing patterns of media consumption and the increasing cost of maintaining terrestrial broadcasting networks are prompting some administrations to review the long-term use of UHF spectrum, including future options for DTT delivery and alternative uses of the band.⁸

⁶ Asia-Pacific Telecommunity (APT), APT Report on Frequency Arrangements for IMT in the Band 470-703 MHz, September 2024, https://apt.int/sites/default/files/report/2024/09/APT_AWG_REP-79_Rev_2_APT-AWG-REP-79%28Rev.2%29.docx.

⁷ Telecom Regulatory Authority of India, Consultation Paper on the Auction of Radio Frequency Spectrum in the Frequency Bands Identified for International Mobile Telecommunications (IMT), September 2025, https://www.trai.gov.in/sites/default/files/2025-09/CP_30092025.pdf

⁸ UK Department for Culture, Media and Sport (DCMS), Watch This Space: A New Strategic Direction for UK Media – Green Paper and Public Consultation, June 2026, <https://www.gov.uk/government/consultations/watch-this-space-a-new-strategic-direction-for-uk-media-green-paper-and-public-consultation/watch-this-space-a-new-strategic-direction-for-uk-media-green-paper-and-public-consultation#consultation-questions>.

Nevertheless, continued use of the band by DTT and other incumbent services remains an important consideration in many countries. Consequently, administrations may need to balance ecosystem maturity, spectrum capacity, regional harmonisation objectives and coexistence requirements when selecting a frequency arrangement and implementation strategy for the band.

2.2. 600 MHz border scenarios among neighbouring countries

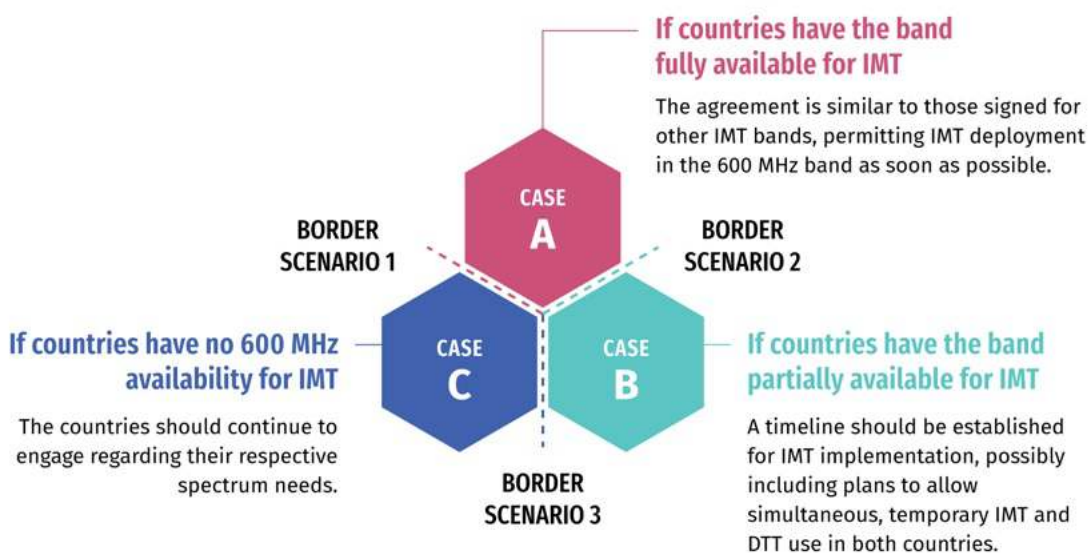
Neighbouring countries may follow different approaches to the use of the 600 MHz band, reflecting national regulatory priorities, continued use of DTT, and differing timelines for IMT implementation. As a result, a range of coexistence and coordination situations may arise in border areas.

In practice, the status of the 600 MHz band in each neighbouring country can be broadly categorised into three implementation cases:

- **Case A – Countries with the band fully available for IMT:** the band is available, or largely available, for IMT deployment;
- **Case B – Countries with the band partially available for IMT:** part of the band remains in use by DTT or other services, or a transition towards IMT is underway;
- **Case C – Countries with the band not currently available for IMT:** the band remains dedicated to incumbent services and there are no immediate plans for IMT implementation.

These implementation cases may occur in different ways across a border area, resulting in the three border scenarios shown in Figure 7 and summarised in Table 1.

Figure 7: The 600 MHz implementation cases and associated border scenarios



Source: TMG.

The complexity of coordination generally depends on the degree of alignment between neighbouring administrations. Where both countries are pursuing similar implementation strategies, coordination can typically build on approaches already used in other mobile broadband bands. More complex

arrangements may be required where one administration introduces IMT while the neighbouring administration continues to use part or all the band for DTT or other services.

Table 1: Typical border scenarios

Scenario	Combination	Coordination objective
BORDER SCENARIO 1	Case A vs C	Enable IMT deployment while protecting incumbent services.
BORDER SCENARIO 2	Case A vs B	Facilitate a phased transition towards harmonised IMT use.
BORDER SCENARIO 3	Case B vs C	Support future implementation while maintaining incumbent protection.

Source: TMG.

2.2.1. Border scenario 1: Case A vs Case C

This scenario generally presents the greatest coordination challenge, as IMT deployment on one side of the border must coexist with incumbent services on the other. Coordination typically focuses on identifying potentially affected DTT assignments, applying agreed coordination criteria and implementing practical mitigation measures where necessary. In some cases, administrations may also consider future migration or reconfiguration of DTT assignments to facilitate longer-term harmonisation.

2.2.2. Border scenario 2: Case A vs Case B

This scenario is characterised by a transition period in which one administration has already implemented IMT while the neighbouring administration is still migrating services or only partially introducing IMT. Coordination arrangements may therefore include migration timelines, temporary sharing and frequency segmentation mechanisms, priority frequency ranges, coordination trigger values and progressive relaxation of restrictions as existing DTT services are cleared or reconfigured.

2.2.3. Border scenario 3: Case B vs Case C

This scenario is typically associated with longer-term planning. Coordination arrangements may seek to maintain protection of existing DTT services while preserving future implementation options for IMT. Early bilateral engagement, realistic protection criteria and limited deployment opportunities can help reduce barriers to future implementation and facilitate eventual alignment in the use of the band.

2.2.4. Key aspects to be considered by neighbouring countries

The specific coordination measures applied in each scenario may include transitional arrangements, geographic or frequency-based sharing, coordination trigger levels and targeted technical or operational mitigation measures. The appropriate combination of these measures will depend on the services involved, the extent of spectrum availability and the future plans of the administrations concerned.

Regardless of the scenario, early engagement between neighbouring administrations can significantly reduce implementation complexity and support coordination frameworks that accommodate both current and future use of the 600 MHz band.

2.3. Considerations for bilateral agreements on the use of the 600 MHz band

Bilateral agreements are a key mechanism for managing cross-border use of the 600 MHz band and enabling implementation of IMT while protecting incumbent services. Such agreements provide a

common framework through which neighbouring administrations can define technical conditions, coordination methodologies and administrative procedures that reflect their respective use of the band.

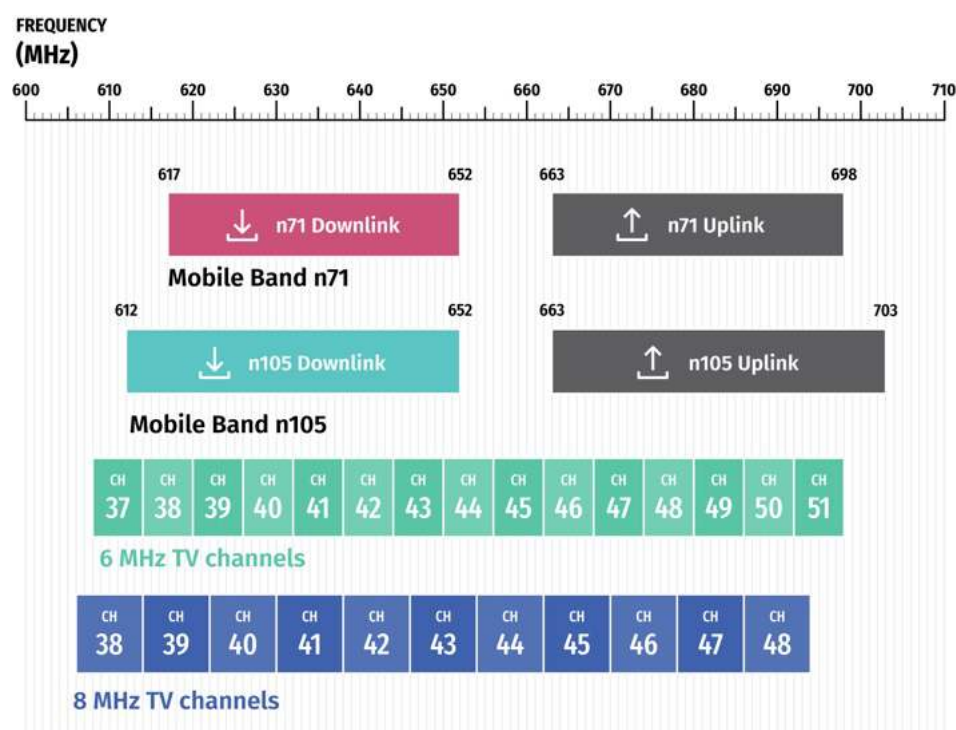
The specific provisions of an agreement will depend on national spectrum use, implementation timelines and the services operating on each side of the border. In practice, agreements typically address topics such as frequency arrangements, coordination zones, station notification procedures, information exchange, coexistence criteria and measures for resolving cases of harmful interference. They should also maintain sufficient flexibility to accommodate changes in spectrum use over time, including the progressive introduction of IMT and the migration or continued operation of broadcasting services.

The following subsections identify key elements that administrations may consider when developing bilateral agreements for implementation of IMT in the 600 MHz band.

2.3.1. Identification of affected frequency ranges and stations

Administrations should perform a detailed assessment of spectrum use in border areas to identify potential overlaps between IMT and DTT operations. This includes mapping DTT assignments against IMT uplink and downlink frequency ranges under the selected frequency arrangement, as shown in Figure 8.

Figure 8: Identification of overlapping DTT channels and IMT frequency arrangements in the 600 MHz band



Source: TMG.

In many cases, only a subset of the 600 MHz band may be affected, such as specific DTT channels overlapping with IMT uplink or downlink ranges. This enables coordination to focus on a limited number of channels and stations, reducing the overall complexity of bilateral agreements, especially noting that IMT uplink part is more relevant for the analysis.

In addition to identifying overlapping frequencies, administrations should determine which DTT and IMT stations may be affected, taking into account their geographic location and service areas. In many cases, only a limited number of assignments require detailed coordination.

2.3.2. Definition of coordination triggers and distances

A key element of bilateral agreements is the definition of coordination triggers, which determine when coordination between administrations is required for the deployment or modification of stations.

Regulatory frameworks such as the GE06 Agreement and the provisions associated with ITU Radio Regulations (RR) No. 5.295A provide a starting point for defining coordination triggers. These planning-based criteria were developed for broadcasting coordination purposes and generally result in conservative coordination requirements that are independent of actual receiver locations or deployment characteristics. Furthermore, as discussed in Section 4.2, system-level analyses based on DVB-T2 or IMT receiver protection criteria can result in substantially different coordination distances than those derived from GE06 planning thresholds.

Consequently, coordination triggers may also be established using system-level criteria derived from DTT service requirements, such as the minimum field strength and protection ratios for DVB-T2 or other DTT technologies, or from IMT receiver protection criteria. Compared with coordination triggers based solely on GE06 field strength thresholds, these system-level approaches generally result in shorter coordination distances, reflecting the actual interference mechanisms more accurately and remaining consistent with the interference areas. As a result, the coordination distances derived under a bilateral agreement may differ significantly depending on the trigger criterion adopted, such as those examples shown in Table 2.

Table 2: Examples of coordination distances depending on trigger definition

Interference scenario	Trigger basis	Indicative distance	Comments
IMT BS → DTT RX	GE06 (18.229 dBμV/m at border)	92 km from IMT BS	Conservative, independent of DTT coverage
IMT BS → DTT RX	DTT service-based (35.3 dBμV/m)	33 km from IMT BS	Within DTT service contour
IMT BS → DTT RX	DTT service-based with 16 dB antenna discrimination	14 km from IMT BS	Reduced coupling due to antenna discrimination
IMT UE → DTT RX	DTT service-based with 16 dB antenna discrimination	1 km from UE clusters	Typically limited to cell edge
DTT TX → IMT BS	IMT system-based (I/N=-6 dB)	Up to 204 km from DTT TX	Consistent with IMT base station protection thresholds

Source: TMG.

The coordination distances presented in Table 2 are indicative and are intended to serve as a reference for administrations developing bilateral agreements. In practice, the appropriate coordination distance should be determined taking into account local conditions, including terrain, station locations, network deployment, and other relevant technical factors. Existing bilateral agreements demonstrate that coordination distances may be either shorter or longer than those listed depending on the specific cross-border scenario.

GE06-based criteria may be used as an initial trigger for coordination, while system-level analyses can be used to establish coordination requirements that more closely reflect actual deployment conditions, enabling more efficient spectrum use while ensuring protection against harmful interference for the relevant stations in the border areas.

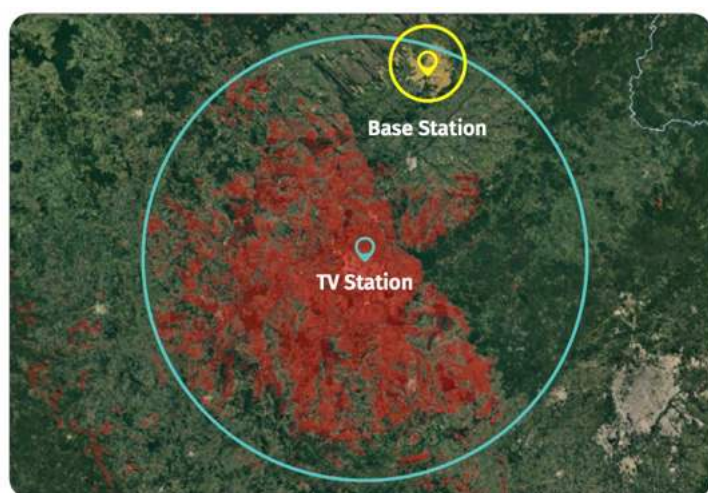
2.3.3. Review of existing stations and practical implementation

Bilateral agreements should be based on the actual deployment of DTT and IMT stations rather than solely on generic planning assumptions. In many border areas, only a subset of frequencies, channels or stations require coordination, allowing coexistence assessments to focus on the assignments that are most likely to be affected.

Where a proposed station lies within a coordination area, compatibility should be assessed using the actual technical parameters, terrain and propagation conditions relevant to the deployment. In many cases, site-specific analysis demonstrates that coexistence can be achieved without harmful interference.

Figure 9 illustrates such a case. Although the relative locations of the DTT station and the IMT base station would normally trigger coordination, the terrain profile prevents the DTT interference from reaching the IMT service area.

Figure 9: DTT station interference contour (blue) and area (red) vs. IMT base station service contour and coverage area (yellow)



Source: TMG.

The case studies presented in Section 4.3 demonstrate that coordination requirements are strongly influenced by factors such as terrain, clutter, transmitter power, antenna discrimination and frequency overlap. Across all scenarios, coexistence outcomes were shown to depend more on actual deployment characteristics than on geographic separation alone, reinforcing the value of site-specific assessments and practical engineering measures.

2.3.4. Mitigation techniques and operational measures

Where coexistence concerns are identified, bilateral agreements should define the technical and operational measures that may be used to reduce interference and facilitate implementation of IMT and DTT services.

Mitigation measures may include optimization of IMT network deployment through antenna orientation, downtilt, transmit power control, site placement, or the use of filters. For DTT systems, measures such as antenna reorientation, transmit power adjustment, and, where appropriate, channel reorganization may be considered. Frequency planning techniques, including channel segmentation, selective filtering, guard bands, or other measures to reduce frequency overlap, may also be applied to improve coexistence.

Bilateral agreements may apply different coordination conditions depending on the station type, interference path or frequency arrangement involved, allowing coexistence measures to be tailored to the characteristics of each scenario.

In practice, effective coexistence is typically achieved through a combination of these measures, supported by system-level analysis and the specific technical and operational characteristics of the networks involved. This approach provides greater flexibility for network deployment while ensuring protection against harmful interference and promoting efficient use of the 600 MHz band.

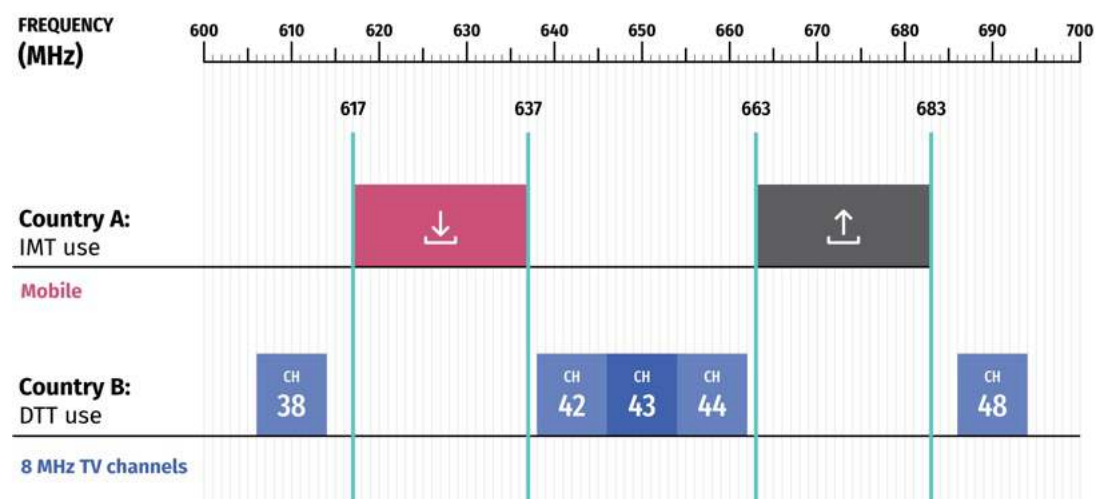
2.3.5. Transitional arrangements and spectrum segmentation

Where full coexistence between IMT and DTT systems is not immediately feasible, bilateral agreements may include transitional arrangements to enable the progressive introduction of IMT while maintaining the continuity of DTT services. Although the migration of DTT services to channels below 614 MHz (or lower) should generally be considered the preferred long-term solution, as it minimizes the potential for harmful interference, this may not always be possible within the required timeframe. In such cases, administrations may agree on temporary spectrum-sharing or spectrum-segmentation arrangements that allow both services to operate during the transition period.

One possible approach is to divide the use of the 600 MHz band in the border area so that IMT deployment is prioritised in one portion of the band, especially focusing on the IMT uplink range, while neighbouring administrations continue operating DTT services in other channels. Depending on national requirements, administrations may also agree to leave specific channels unused in border areas to facilitate coexistence, or to implement geographic separation between services where appropriate. In addition, measures such as the implementation of Single Frequency Networks (SFNs) or the reorganization of DTT channel assignments can reduce spectrum requirements for broadcasting and facilitate the migration process.

Figure 10 illustrates an example of spectrum segmentation in which the administration deploying IMT gives priority to the lower portion of the 600 MHz band while allowing neighbouring DTT services to continue operating in selected higher-frequency channels during the transition period.

Figure 10: Example of spectrum segmentation in the 600 MHz band at the border between neighbouring countries



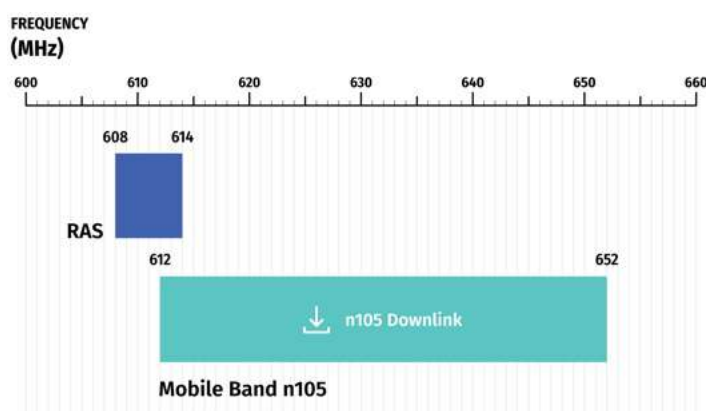
Source: TMG.

Transitional arrangements should be reviewed periodically as spectrum requirements, network deployments, and migration plans evolve. Bilateral agreements should therefore provide sufficient flexibility to allow administrations to progressively expand IMT spectrum use, reorganize DTT assignments, or revise spectrum segmentation arrangements as national deployment objectives and service requirements change.

2.3.6. Coexistence with the radio astronomy service

The use of frequency arrangements extending down to 612 MHz, particularly band n105 (612-652 MHz/663-703 MHz), requires consideration of compatibility with the radio astronomy service (RAS), which operates in the adjacent 608-614 MHz frequency band. Frequency arrangements that do not extend below 617 MHz, such as band n71, provide additional spectral separation from the RAS allocation and therefore present reduced coexistence constraints. Nevertheless, compatibility should be assessed taking into account the specific frequency arrangement and deployment scenario under consideration.

Figure 11: Identification of overlapping RAS and IMT frequency arrangements in the 600 MHz band



Source: TMG.

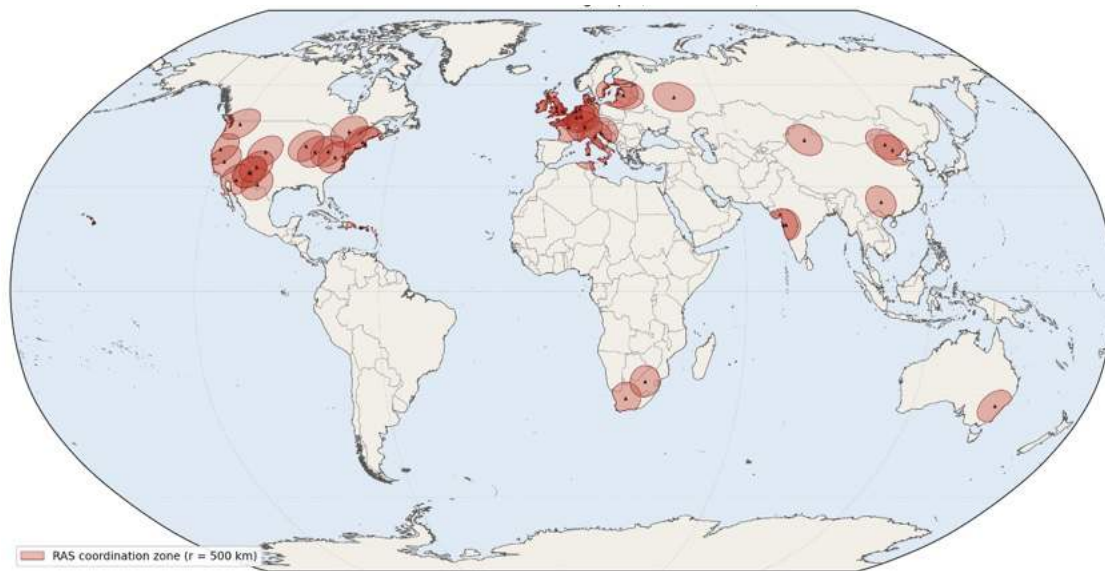
Although RAS is allocated in this band on a primary basis only in certain countries, ITU Radio Regulations No. 5.149 calls on administrations to take all practicable steps to protect radio astronomy observations from harmful interference.⁹ Consequently, compatibility with nearby RAS facilities should be considered where relevant.

Based on the preliminary studies presented in Section 4.4, protection of RAS may require coordination distances up to several hundred kilometres, depending on the IMT deployment configuration and interference scenario. Additional analysis is under way with different types of IMT use and scenarios with RAS to conclude on possible compatibility measures.

The practical impact of these constraints is further limited by the geographic distribution of RAS stations. Based on ITU data, approximately 110 RAS stations operate in this frequency range worldwide, concentrated in a relatively small number of countries. Consequently, even where substantial coordination distances may be required, the number of potentially affected areas remains limited, as shown in Figure 12.

⁹ ITU, Radio Regulations, 2024 Edition, RR No. 5.149, <https://www.itu.int/pub/R-REG-RR-2024>.

Figure 12: Global distribution of RAS stations and indicative 500 km coordination zones



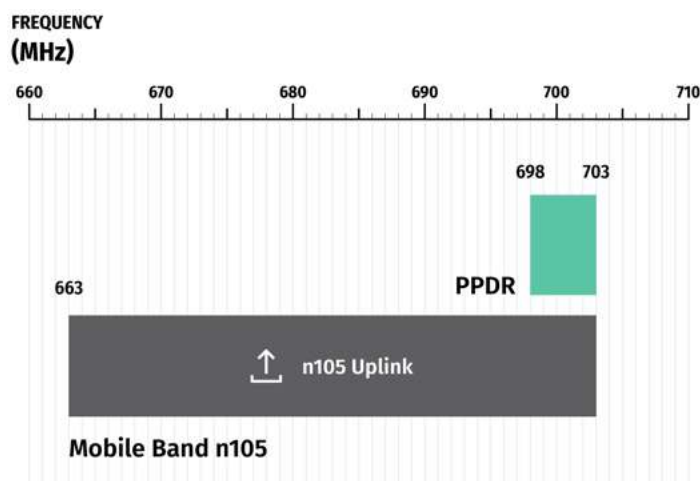
Source: TMG.

Overall, the preliminary studies presented in Section 4.4 indicate that implementation of IMT in the 600 MHz band, including wider arrangements such as band n105, remains feasible in most parts of the world provided that appropriate consideration is given to the protection of nearby RAS facilities and, where necessary, the application of site-specific compatibility measures.

2.3.7. Coexistence with Public Protection and Disaster Relief services

Frequency arrangements extending up to 703 MHz, particularly band n105 (612-652 MHz/663-703 MHz), may require consideration of compatibility with broadband Public Protection and Disaster Relief (PPDR) systems operating in the adjacent 698-703 MHz band. In some regions, this spectrum is identified for broadband PPDR applications through 3GPP band n68, creating either a co-channel or adjacent-band coexistence scenario at the upper edge of the 600 MHz IMT band.

Figure 13: Identification of overlapping PPDR and IMT frequency arrangements in the 600 MHz band



Source: TMG.

In practice, broadband PPDR deployment in this spectrum has remained limited in many countries, with some administrations retaining the band for future implementation, studying alternative deployment approaches, or supporting PPDR functionality through commercial mobile broadband networks. Consequently, coexistence requirements depend largely on national spectrum arrangements and the extent of PPDR deployment.

Where broadband PPDR systems have not been deployed and there are no active deployment plans, coexistence is unlikely to impose significant constraints on implementation of IMT in the upper portion of the 600 MHz band. Where PPDR networks are planned or operational, compatibility can generally be addressed through targeted coordination based on the technical characteristics of the affected networks. In parallel, the evolution of 3GPP Mission Critical Services (MCX) enables mission-critical voice, data and video services to be delivered through commercial or hybrid IMT networks using standardised priority, pre-emption and quality-of-service mechanisms. This provides administrations with additional options for supporting broadband PPDR requirements while benefiting from broader IMT ecosystem and economies of scale.

Overall, the available evidence indicates that broadband PPDR use in the 698-703 MHz range is unlikely to represent a widespread constraint on implementation of IMT in the 600 MHz band, including wider arrangements such as band n105, provided that specific national PPDR deployments are taken into account during the coordination process. Where broadband PPDR requirements exist, coexistence can generally be addressed through targeted technical and operational measures or through integration within broader IMT-based mission-critical communications frameworks.

2.4. Key elements and structure of bilateral agreements

The previous sections have illustrated that coordination requirements in the 600 MHz band depend on the frequency arrangement adopted, the services operating in the band, the characteristics of the stations involved and the specific conditions of the border area. While international and regional regulatory frameworks, including the Radio Regulations and, where applicable, the GE06 Agreement, provide some basis for cross-border coordination, they do not by themselves determine the technical conditions that neighbouring administrations may ultimately apply in practice.

Bilateral agreements provide the mechanism through which neighbouring administrations translate these regulatory obligations into practical coordination arrangements. They allow administrations to consider actual deployment conditions, agreed technical assumptions and future implementation plans when defining the conditions for spectrum use in border areas. They may also complement broader multilateral frameworks by addressing conditions that are specific to an individual border.

A bilateral agreement should first define its scope, including the geographic area of application, the frequency ranges covered, the services concerned and the overall objectives of the coordination framework. It should then establish the technical conditions applicable on both sides of the border, including frequency arrangements, coordination triggers, engineering methodologies and any assumptions to be used when evaluating coexistence between services.

The agreement should also describe the coordination process itself, including station notification procedures, exchange of technical information, compatibility assessments and mechanisms for resolving cases of harmful interference. Where appropriate, it may further define transitional arrangements, mitigation techniques, operational restrictions or other measures intended to facilitate coexistence during implementation of the agreed spectrum plan.

Figure 14: Structure of bilateral agreements

Source: TMG.

The technical analyses and case studies presented demonstrate the value of complementing regulatory coordination triggers with system-level engineering assessments based on actual deployment conditions. Regulatory criteria, such as border field-strength limits or distances from the border, provide an important initial indication of when coordination may be required. However, bilateral agreements can establish procedures that allow administrations to consider terrain, station characteristics, service contours, mitigation measures and other practical factors before determining the conditions that should apply in a specific case. This approach enables coordination requirements to better reflect the actual risk of harmful interference while supporting more efficient use of spectrum.

Ultimately, bilateral agreements are one of the principal tools available to neighbouring administrations for implementing IMT in the 600 MHz band while protecting existing services. A clear and adaptable agreement can accommodate different implementation timelines, support future evolution in the use of spectrum use and provide the regulatory certainty needed for long-term network planning and investment.

3. Relevant border agreement experiences

Although implementation of IMT in the 600 MHz band is still emerging in many regions, administrations have accumulated valuable experience from the introduction of mobile broadband services in the 700 MHz and 800 MHz bands.¹⁰ The examples presented in this section illustrate different approaches to cross-border coordination, including IMT deployment on both sides of a border, coexistence between IMT and DTT services, and the application of multilateral coordination frameworks.¹¹ Together, they provide practical lessons that complement the technical and regulatory guidance presented in Section 2.

3.1. Bilateral agreement experiences

The following examples illustrate three bilateral coordination scenarios relevant to future implementation of IMT in the 600 MHz band:

1. **Mexico-United States:** coordinated implementation of IMT on both sides of a border through harmonised frequency arrangements and migration of broadcasting services.
2. **Colombia and neighbouring countries:** coexistence between IMT and DTT services where neighbouring administrations follow different implementation timelines and spectrum-use strategies.
3. **Germany-Poland:** evolution of an existing coordination framework to accommodate new deployment requirements, including commercial mobile broadband and public safety broadband services.

Together, these examples demonstrate that successful cross-border coordination can be achieved through different regulatory and technical approaches depending on the circumstances of the administrations involved. They also show how existing coordination frameworks developed for the 700 MHz and 800 MHz bands can provide useful foundations for future implementation of IMT in the 600 MHz band.

3.1.1. Mexico-United States: coordinated implementation of IMT in the 600 MHz band

Key lesson: harmonised frequency arrangements and coordinated transition processes can significantly simplify implementation of IMT in border areas, even where commercial deployment timelines differ between neighbouring countries.

Mexico and the United States provide one of the earliest examples of cross-border implementation of IMT in the 600 MHz band and illustrate the situation where neighbouring administrations pursue a broadly harmonised approach to spectrum use, and both could be described as in Case A in Section 2.2. Following the repurposing of the band from broadcasting to mobile broadband services, both administrations

¹⁰ ITU, Report ITU-R M.2480-1, National approaches of some countries on the implementation of terrestrial IMT systems in bands identified for IMT, December 2021, https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2480-1-2022-PDF-E.pdf.

¹¹ ITU, Cross-border coordination issues for fixed and mobile services, 2020, https://www.itu.int/en/ITU-R/terrestrial/workshops/WRS-20/Documents/Cross_border_coordination_for_FXM_WRS-2020.pdf.

adopted compatible frequency arrangements and coordinated the migration of digital television assignments, including stations located in border areas.^{12 13}

Although implementation timelines differed, with the United States completing its 600 MHz transition in 2020 while Mexico has not yet completed a corresponding spectrum award, both administrations cooperated on the migration of television assignments in border areas and adopted compatible spectrum arrangements for the band.¹⁴

The use of a common frequency arrangement significantly simplified cross-border spectrum management. Rather than requiring spectrum segmentation or differentiated usage conditions near the border, coordination could build on existing bilateral mechanisms and cooperation on the migration of broadcasting assignments. The Mexico-United States experience demonstrates how harmonised frequency arrangements, coordinated transition processes and established bilateral procedures can facilitate the introduction of IMT in border areas while maximising the spectrum available for mobile broadband services.

3.1.2. Colombia and neighbouring countries: IMT-DTT coexistence

Key lesson: coexistence between IMT and DTT services can be addressed through progressive coordination supported by targeted technical studies and agreed compatibility methodologies.

Colombia provides a practical example of Border Scenario 1 (Case A vs Case C) described in Section 2.2, in which one administration introduces IMT in the 600 MHz band while neighbouring countries continue to use the spectrum for DTT broadcasting services. Following the identification of the 600 MHz band for IMT,¹⁵ Colombia initiated technical studies and bilateral discussions with neighbouring administrations, including Brazil, Ecuador and Peru, to assess coexistence scenarios and establish a framework for future coordination arrangements.¹⁶

The main challenge in this scenario is the coexistence of IMT and DTT services operating in the same frequency range on opposite sides of a border. Consequently, coordination efforts have focused on developing technical studies, compatibility methodologies and measurement procedures capable of assessing interference between IMT networks and DTT systems. This illustrates the importance of system-level analyses when neighbouring administrations follow different implementation timelines or spectrum-use strategies.

Discussions on future use of the 600 MHz band have taken place alongside Colombia's ongoing transition from analogue to digital television and the continued implementation of mobile broadband services in

¹² Federal Communications Commission (FCC), Mexico Agreements by Frequency, <https://www.fcc.gov/mexican-agreements-frequency>.

¹³ Instituto Federal de Telecomunicaciones (IFT), *México se convertirá en el primer país del mundo en liberar la banda de 600 MHz para 5G*, March 2018, <https://www.ift.org.mx/comunicacion-y-medios/comunicados-ift/es/mexico-se-convertira-en-el-primer-pais-del-mundo-en-liberar-la-banda-de-600-mhz-para-5g-comunicado>.

¹⁴ Instituto Federal de Telecomunicaciones (IFT), *Reubicación de los canales de televisión localizados en la zona de coordinación por debajo del canal 37*, <https://www.ift.org.mx/espectro-radioelectrico/reubicacion-de-los-canales-de-television-localizados-en-la-zona-de-coordinacion-por-debajo-del-canal>.

¹⁵ ITU Radio Regulations, 2024 Edition, RR Nos. 5.308 and 5.308A, <https://www.itu.int/pub/R-REG-RR-2024>.

¹⁶ Conversations with the Colombian administration regarding progress of bilateral coordination discussions for implementation of IMT in the 600 MHz band, June 2023, updated in May 2026.

lower UHF bands. These activities demonstrate that administrations can progress spectrum transitions and coordination discussions in parallel.¹⁷

The Colombian experience also demonstrates how coordination frameworks can be tailored to local circumstances. Existing agreements between Colombia and neighbouring administrations have established coordination zones and technical conditions that reflect the characteristics of specific border areas. For example, the Colombia-Ecuador agreement applies coordination zones of 6 km for IMT base stations and 15 km for DTT stations, illustrating how targeted technical conditions may be more effective than applying uniform coordination distances across all borders.¹⁸

3.1.3. Germany-Poland: coordination of MFCN and PPDR in the 700 MHz band

Key lesson: bilateral agreements should be viewed as adaptable frameworks that can evolve alongside changes in technology, deployment requirements, and spectrum use.

In May 2024, the telecommunications regulators of Germany and Poland signed an updated technical agreement governing the use of the 694-791 MHz band for terrestrial broadband communications systems in border areas.¹⁹ The agreement replaced an earlier arrangement concluded in 2019 and demonstrates how bilateral frameworks can evolve over time to accommodate new spectrum uses and policy objectives. Of relevance to the 600 MHz band, the agreement incorporates coordination provisions applicable to both commercial Mobile/Fixed Communications Networks (MFCN) and Broadband Public Protection and Disaster Relief (BB-PPDR) systems.

The agreement establishes common technical conditions and coordination procedures for stations operating near the border, including coordination triggers, field-strength criteria, preferential frequency arrangements and procedures for resolving cases of harmful interference. By defining shared technical assumptions and operational processes, the framework provides regulatory certainty while supporting efficient spectrum use on both sides of the border.

The Germany-Poland experience illustrates that bilateral agreements should be viewed as adaptable frameworks rather than static documents. As technologies, services and spectrum requirements evolve, coordination arrangements can be updated to accommodate new deployment scenarios while maintaining protection of existing systems. This approach is particularly relevant to future implementation of the 600 MHz band, where administrations may need to accommodate different

¹⁷ Ministry of Information and Communications Technologies (MinTIC), *Resultados de la Subasta del Espectro Radioeléctrico*, 20 December 2019, <https://mintic.gov.co/portal/715/w3-article-124713.html>; MinTIC, *Gobierno presenta Plan de Implementación de la Televisión Digital Terrestre, que iniciará operación en marzo de 2025*, 29 November 2024, <https://mintic.gov.co/portal/715/w3-article-398912.html>; and TAVI Latam, *Colombia: MinTIC realizará las primeras fases del apagón analógico en marzo y en mayo en la región sur*, January 2025, <https://taviatam.com/colombia-mintic-realizara-las-primeras-fases-del-apagon-analogico-en-marzo-y-en-mayo-en-la-region-sur/>.

¹⁸ Interview with the International Office of the ICT Ministry of Colombia, June 2023; MINTEL Ecuador, *Ministros de Ecuador y Colombia firman convenio para mejorar la comunicación móvil terrestre en zona de frontera*, February 2015, <https://www.telecomunicaciones.gob.ec/ministros-de-ecuador-y-colombia-firman-convenio-para-mejorar-la-comunicacion-movil-terrestre-en-zona-de-frontera/>; and MINTEL Ecuador, *Servicios móviles libres de interferencias en zona de frontera Ecuador-Colombia*, <https://www.telecomunicaciones.gob.ec/servicios-moviles-libres-de-interferencias-en-zona-de-frontera-ecuador-colombia/>.

¹⁹ President of the Office of Electronic Communications (UKE) of Poland and the Federal Network Agency (BNetzA) of Germany, Technical Agreement concerning the use of the frequency band 694–791 MHz for terrestrial systems capable of providing wireless broadband electronic communications services in border areas, signed May 2024, https://bip.uke.gov.pl/gfx/bip/userfiles/_shared/bip_czestotliwosci/7_umowy_miedzynarodowe/7.5./700_mhz_2024-05-3106-25_pl-de.pdf.

combinations of commercial IMT services, public-safety broadband applications and future spectrum-use requirements.

3.2. Multilateral coordination frameworks

Multilateral coordination frameworks complement bilateral agreements by providing common technical principles, harmonised spectrum arrangements and coordination procedures across multiple administrations. The following examples illustrate how such frameworks have supported implementation of IMT in UHF bands and provide relevant precedents for future use of the 600 MHz band.

3.2.1. European 800 MHz coordination framework

Key lesson: harmonised technical conditions and multilateral coordination frameworks can facilitate large-scale spectrum transitions while supporting efficient spectrum use and effective management of cross-border interference.

The implementation of IMT in the 800 MHz band represents one of the most mature examples of coordinated spectrum repurposing in the UHF range. Following the adoption of harmonised technical conditions for the 790-862 MHz band in the European Union, administrations progressively transitioned the band from broadcasting to mobile broadband services through a combination of national migration plans, bilateral agreements, and multilateral coordination frameworks.²⁰

A defining feature of the European approach was the use of common technical conditions and harmonised frequency arrangements across multiple countries. This reduced the complexity of cross-border coordination, supported consistent implementation of IMT and enabled administrations to manage interference risks during the migration process. In regions involving multiple neighbouring countries, multilateral agreements also reduced the need for numerous bilateral negotiations by providing a common framework for coordination.

One example is the multilateral agreement between Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland governing the use of the 790-862 MHz band in border areas.²¹ The agreement established common coordination procedures, field-strength limits and preferential frequency arrangements, providing a predictable and transparent framework for spectrum use across the participating countries.

The European 800 MHz experience demonstrates the value of harmonised frequency arrangements, common technical assumptions and coordinated migration strategies when implementing IMT across a wider region. These principles remain directly relevant to future implementation of the 600 MHz band, particularly where several neighbouring administrations pursue similar spectrum-transition objectives.

²⁰ European Commission, Commission Decision 2010/267/EU on harmonised technical conditions of use in the 790-862 MHz frequency band for terrestrial systems capable of providing electronic communications services in the European Union, May 2010, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010D0267>.

²¹ Agreement between the administrations of Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland on frequency planning and frequency coordination at border areas for terrestrial systems capable of providing electronic communications services in the frequency band 790-862 MHz, Brussels, 22 November 2017, <https://www.rdi.nl/site/binaries/site-content/collections/documenten/2017/oktober/2/internationale-overeenkomsten/Multilateral+Agreement+800+MHz.pdf>.

3.2.2. European 700 MHz coordination framework

Key lesson: regional coordination mechanisms, harmonised frequency arrangements and multilateral agreements can significantly simplify cross-border implementation of IMT where multiple administrations pursue similar spectrum transition objectives.

The European transition of the 700 MHz band represents one of the largest coordinated spectrum re-planning exercises undertaken in the UHF range. Following the decision to repurpose the 694-790 MHz band from broadcasting to mobile broadband services, administrations across Europe undertook extensive coordination activities to support DTT migration and the introduction of IMT.²²

A key feature of the process was the combination of harmonised technical conditions, coordinated migration planning and regional coordination mechanisms. Because changes in one country could affect services in several neighbouring administrations, CEPT and the European Communications Office (ECO) established processes to support information exchange and facilitate cross-border coordination during implementation.

The transition also resulted in a series of bilateral and multilateral agreements. One example is the agreement between Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland governing the use of the frequency ranges 703-733 MHz and 758-788 MHz in border areas, establishing common technical conditions and coordination procedures for IMT deployment.²³

The European 700 MHz experience demonstrates the importance of coordinated migration strategies, harmonised frequency arrangements and regional coordination mechanisms when multiple countries transition from broadcasting to mobile broadband services. These lessons are particularly relevant to future implementation of the 600 MHz band, where similar coexistence and migration considerations may arise.

3.2.3. The GE06 Agreement and new services

Key lesson: multilateral planning frameworks such as GE06 provide a foundation for cross-border coordination, but practical implementation may require additional technical analysis and bilateral discussions to reflect real-world deployment conditions as GE06 thresholds are intentionally conservative.

The GE06 Agreement provides the regulatory framework governing digital terrestrial broadcasting and other primary terrestrial services in parts of ITU Regions 1 and 3 in the VHF and UHF bands.²⁴ In addition

²² European Communications Office (ECO), ECC 700 MHz Coordination Information Repository, established to support bilateral and multilateral coordination associated with the reallocation of the 700 MHz band from broadcasting to mobile services in Europe, <https://cept.org/ecc/tools-and-services/ecc-700-mhz-coordination-information-repository>.

²³ Agreement between the administrations of Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland on frequency usage and frequency coordination in border areas for terrestrial systems capable of providing wireless broadband electronic communications services in the frequency bands 703-733 MHz / 758-788 MHz, 23 May 2017, <https://www.rdi.nl/site/binaries/site-content/collections/documenten/2017/oktober/2/internationale-overeenkomsten/Multilateral+Agreement+700+MHz.pdf>.

²⁴ ITU, Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06), Geneva, 2006, <https://www.itu.int/pub/R-ACT-RRC.14>.

to establishing a coordinated DTT planning framework, GE06 defines procedures through which administrations may introduce new terrestrial services or modify existing assignments.²⁵

The introduction of new services under the GE06 framework is primarily supported through the coordination and notification procedures contained in Articles 4 and 5 of the Agreement. These procedures provide a common multilateral framework that enables administrations to assess the impact of spectrum changes on neighbouring countries and to maintain protection of existing assignments.²⁶

Experience from the implementation of IMT in the 700 MHz and 800 MHz bands has demonstrated both the value and the limitations of planning-based approaches. While GE06 provides an essential regulatory foundation for coordination, some of the planning assumptions and field-strength thresholds used within the framework can result in coordination requirements that are more conservative than those derived from service-specific technical studies. As a result, administrations have increasingly complemented GE06 procedures with system-level analyses and bilateral coordination arrangements when assessing the introduction of IMT networks in UHF bands.

The GE06 experience demonstrates that regional planning agreements and practical engineering assessments serve complementary roles. Together, they provide a framework through which administrations can maintain regulatory certainty while ensuring that coordination requirements remain proportionate to actual deployment conditions and interference risks.

3.2.4. APT harmonised frequency arrangement for the 600 MHz band

Key lesson: harmonised frequency arrangements can simplify future coordination, support ecosystem development and reduce implementation complexity by providing administrations with a common technical framework.

In 2024, the Asia-Pacific Telecommunity (APT) adopted a harmonised frequency arrangement for IMT in the 600 MHz band to support administrations considering implementation of mobile broadband services in the 470-703 MHz range.²⁷ The framework provides a common basis for future spectrum planning and cross-border coordination within the region.

A key objective of the arrangement was to maintain compatibility with the existing IMT ecosystem while providing flexibility to address coexistence requirements with services operating below 614 MHz. The resulting framework is aligned with the 3GPP band n105 ecosystem and supports future development of devices and networks in the 600 MHz band.

From a coordination perspective, harmonised band plans can reduce implementation complexity by limiting the number of frequency arrangements that neighbouring administrations need to consider. This allows coordination discussions to focus on deployment conditions and coexistence requirements rather than differences in band plan approaches.

²⁵ ITU, Rules of Procedure, Section A10: Rules concerning the Regional Agreement relating to the planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (GE06), <https://www.itu.int/pub/R-REG-ROP/en>.

²⁶ ITU, Primary terrestrial services other than broadcasting in the planning area and bands governed by the Regional Agreement GE06, available at: <https://www.itu.int/en/ITU-R/terrestrial/fmd/Documents/fxm-GE06-report.pdf>.

²⁷ Asia-Pacific Telecommunity (APT), APT Report on Frequency Arrangements for IMT in the Band 470-703 MHz, September 2024, https://apt.int/sites/default/files/report/2024/09/APT_AWG_REP-79_Rev_2_APT-AWG-REP-79%28Rev.2%29.docx.

The APT arrangement illustrates how regional harmonisation can support both ecosystem development and future cross-border coordination. These benefits may become increasingly important as additional administrations consider implementation of IMT in the 600 MHz band.

3.3. Lessons from cross-border interference cases

While bilateral agreements and multilateral frameworks provide the basis for cross-border coordination, practical experience demonstrates that interference issues may still arise during spectrum transitions and network deployment. The following examples illustrate how administrations have identified, investigated and resolved cross-border interference involving broadcasting and mobile broadband services in UHF bands.

These cases demonstrate the importance of timely information exchange, effective interference-resolution procedures and continued cooperation between administrations. They also highlight how experience gained from addressing real-world interference can inform future implementation of IMT in the 600 MHz band.

3.3.1. Interference from broadcasting into IMT systems

Key lesson: differences in national implementation timelines can create temporary interference risks during spectrum transitions, highlighting the importance of early coordination and migration planning.

Experience from the 700 MHz and 800 MHz transitions demonstrated that broadcasting transmissions operating in one country can create interference into IMT networks in neighbouring administrations when spectrum migration occurs on different timelines.²⁸

One example involved potential interference from Spanish DTT transmitters operating in the upper UHF channels into IMT base stations deployed in France following the introduction of mobile broadband services in the 800 MHz band. Technical studies conducted within the ITU framework showed that DTT transmissions in Spain, operating on frequencies overlapping the IMT uplink band in France, could affect mobile base-station receivers across the border. The issue was addressed through coordination between the administrations and the progressive migration of broadcasting services from the affected frequencies.²⁹

This case demonstrates that temporary coexistence challenges can arise during spectrum transitions, particularly where neighbouring administrations follow different implementation schedules. It also illustrates how early coordination, technical studies and coordinated migration plans can resolve interference concerns without affecting the long-term implementation of mobile broadband services.

3.3.2. Interference between broadcasting networks

Key lesson: the resolution of existing cross-border broadcasting interference can be an important prerequisite for subsequent spectrum transitions and the introduction of new services.

²⁸ ITU, National field reports on the introduction of IMT in bands with co-primary allocation to the broadcasting and mobile services, Report ITU-R BT.2301-4, September 2022, https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2301-4-2022-PDF-E.pdf.

²⁹ ITU-R Study Groups, Interference from broadcasting transmissions into mobile base stations: Case study Spain-France, 14 February 2022.

Cross-border interference can arise not only between broadcasting and mobile services, but also between broadcasting networks operating in neighbouring countries. Such cases can persist for many years and may require sustained bilateral coordination and, in some instances, intervention through established international mechanisms.

One example involved interference from Italian DTT transmitters affecting Croatian broadcasting services along the Adriatic coast. The issue required extensive coordination between the two administrations and formal engagement through the ITU framework before a resolution was achieved.³⁰ Resolution of the interference helped provide the regulatory certainty needed to support subsequent spectrum-planning activities, including the continued transition of UHF spectrum towards mobile broadband use.³¹

This case illustrates the importance of addressing legacy interference issues as part of broader spectrum-transition programmes. It also demonstrates the value of established coordination and dispute-resolution mechanisms in supporting future changes in spectrum use.

3.4. Key lessons from cross-border coordination experiences

The experiences reviewed demonstrate that successful implementation of IMT in UHF bands is supported by a combination of harmonised spectrum arrangements, effective coordination frameworks and sustained cooperation between administrations. Existing examples show that both bilateral agreements and multilateral frameworks can provide effective mechanisms for managing spectrum transitions, supporting coexistence between services and facilitating the introduction of mobile broadband networks in border areas.

The examples also demonstrate that coordination requirements are highly dependent on the specific deployment scenario. Harmonised frequency arrangements can simplify implementation and reduce coordination complexity, while situations involving coexistence between IMT and DTT services often require detailed technical studies and tailored coordination measures. Experience from the 700 MHz and 800 MHz transitions further shows that coordination frameworks should be adaptable and capable of evolving as technologies, deployment requirements and spectrum-use priorities change.

Finally, practical interference cases highlight the importance of early engagement, timely exchange of technical information and effective interference-resolution procedures. Together, these experiences demonstrate that successful spectrum transitions rely not only on regulatory frameworks, but also on the ability of administrations to apply technical analysis, practical mitigation measures and cooperative coordination processes that reflect local deployment conditions.

³⁰ ITU, Reports received by the Radiocommunication Bureau concerning harmful interference between Italy and its neighbouring countries, <https://www.itu.int/md/R11-MMHI-SP/en>.

³¹ Chris Dziadul, Italian interference of Croatian TV channels ends, May 2022, <https://www.broadbandtvnews.com/2022/05/12/italian-interference-of-croatian-tv-channels-ends/>; see also Italy stops Croatia TV signal interference, August 2022, <https://www.broadbandtvnews.com/2022/08/12/italy-stops-croatia-tv-signal-interference/>.

4. Technical studies supporting IMT in the 600 MHz

This section presents the technical studies that support the implementation of IMT in the 600 MHz band and complement the regulatory and coordination experiences discussed in the previous sections. The objective is not only to evaluate coexistence between IMT and incumbent services, but also to illustrate how different technical assumptions, deployment conditions and coordination approaches can influence implementation outcomes. The section addresses three main topics:

- **Coordination methodologies and distances**, including a comparison between planning-based approaches derived from the GE06 framework and system-level analyses based on DTT and IMT protection criteria.
- **Detailed coexistence case studies**, examining representative cross-border scenarios in Europe and Africa. These studies illustrate how terrain, frequency overlap, transmitter characteristics and local deployment conditions influence coordination requirements and the effectiveness of mitigation measures.
- **Compatibility with the RAS** in the co-channel or adjacent 608-614 MHz band, including an assessment of coordination distances and the potential impact of practical mitigation techniques.

Together, the studies presented in this section provide a technical reference for the implementation of IMT in the 600 MHz band under a range of deployment, coordination and coexistence scenarios. They highlight the diversity of conditions that administrations may encounter in practice and provide quantitative evidence to support technical assessments, coordination discussions and future spectrum-planning decisions.

4.1. Common study assumptions

The analyses presented in this section examine representative coexistence scenarios between IMT and DTT systems that may arise during implementation of IMT in the 600 MHz band. Unless otherwise stated, the same technical assumptions, protection criteria and propagation methodologies are applied throughout the generic analyses and case studies. Where case-study-specific parameters are used, these are identified separately in the relevant subsection.

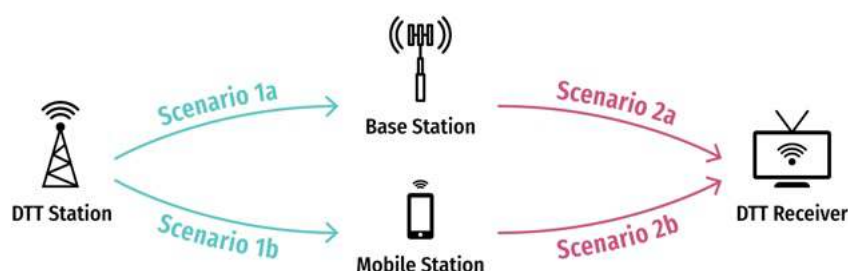
4.1.1. Coexistence scenarios

The studies consider four principal interference scenarios that may occur when neighbouring administrations adopt different spectrum-use strategies or implementation timelines, as illustrated in Figure 15, including:

- **Scenario 1a:** DTT transmitter → IMT base station receiver.;
- **Scenario 1b:** DTT transmitter → IMT user equipment receiver;
- **Scenario 2a:** IMT base station transmitter → DTT receiver; and
- **Scenario 2b:** IMT user equipment transmitter → DTT receiver.

These scenarios cover both directions of interference and represent the most relevant coexistence cases for cross-border implementation of IMT in the 600 MHz band.

Figure 15: Coexistence scenarios between IMT and DTT services



Source: TMG.

4.1.2. IMT parameters

The IMT parameters are based on the characteristics used in recent ITU-R sharing and compatibility studies for sub-1 GHz IMT systems and are representative of a rural macro deployment environment.³² Unless otherwise stated, the parameters are those summarised in Table 3.

Table 3: IMT parameters used in the analyses

PARAMETER	VALUE
Deployment type	Rural macro
Duplex mode	FDD
Channel bandwidth	10 MHz
Base station antenna height	30 m
Sectorisation	3 sectors
Downtilt	3°
Antenna pattern	Recommendation ITU-R F.1336
Antenna polarisation	Linear (V-Pol) / ±45°
Base station antenna gain	15 dBi
Feeder loss	3 dB
Base station transmit power	46 dBm / 10 MHz
Base station e.i.r.p.	58 dBm / 10 MHz
Base station receiver noise figure	5 dB
Network loading factor	20%
User equipment height	1.5 m
User equipment antenna gain	-3 dBi
User equipment body loss	4 dB
User equipment maximum transmit power	23 dBm
User equipment receiver noise figure	9 dB
Protection criterion	I/N = -6 dB

Source: TMG based on ITU and 3GPP.

³² ITU-R Working Party 5D, Characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23, June 2021, https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0716!H4-N4.04!MSW-E.docx; based on 3GPP TS 38.104, NR; Base Station radio transmission and reception, http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/, and 3GPP TS 38.101, NR; User Equipment radio transmission and reception, http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/. The same assumptions are reflected in the ITU-R WP 5D documents in preparation for WRC-27.

Based on the receiver sensitivities specified in 3GPP TS 36.104 and TS 36.101, the reference sensitivity is -101.5 dBm for the IMT base station receiver and -94.2 dBm for the UE receiver, resulting in minimum required signal-to-noise ratios (SNR/SINR) of approximately -2.5 dB for IMT base stations and 1 dB for user equipment.

4.1.3. DTT parameters

Unless otherwise stated, generic calculations use a representative DTT transmitter with 5 kW e.r.p. and 150 m antenna height, while actual transmitter characteristics are applied in the detailed case studies.³³ The parameters are summarised in Table 4.

Table 4: DTT parameters used in the analyses

PARAMETER	VALUE
System	DVB-T2
Channel bandwidth	8 MHz
Reception mode	Fixed rooftop
Receiving antenna height	10 m
Representative transmitter height	150 m
Representative transmitter e.r.p.	5 kW
Receiving antenna discrimination	Recommendation ITU-R BT.419

Source: TMG based on ITU.

Where system-level compatibility is assessed, DVB-T2 receiver protection follows Recommendations ITU-R BT.2033 and BT.419 assumptions.³⁴ The analyses assume a minimum service field strength of 54.3 dB(μ V/m), a co-channel protection ratio of 19 dB between DVB-T2 and IMT systems, and a receiving antenna discrimination of 16 dB. These assumptions are used to derive the permissible interfering field strengths applied in the coexistence studies.

4.1.4. Propagation models

Two propagation methodologies are used throughout the analyses.³⁵

- Recommendation ITU-R P.1546 is applied for GE06-based calculations and point-to-area coverage assessments.
- Recommendation ITU-R P.1812 is applied for path-specific studies that account for actual terrain and clutter effects.

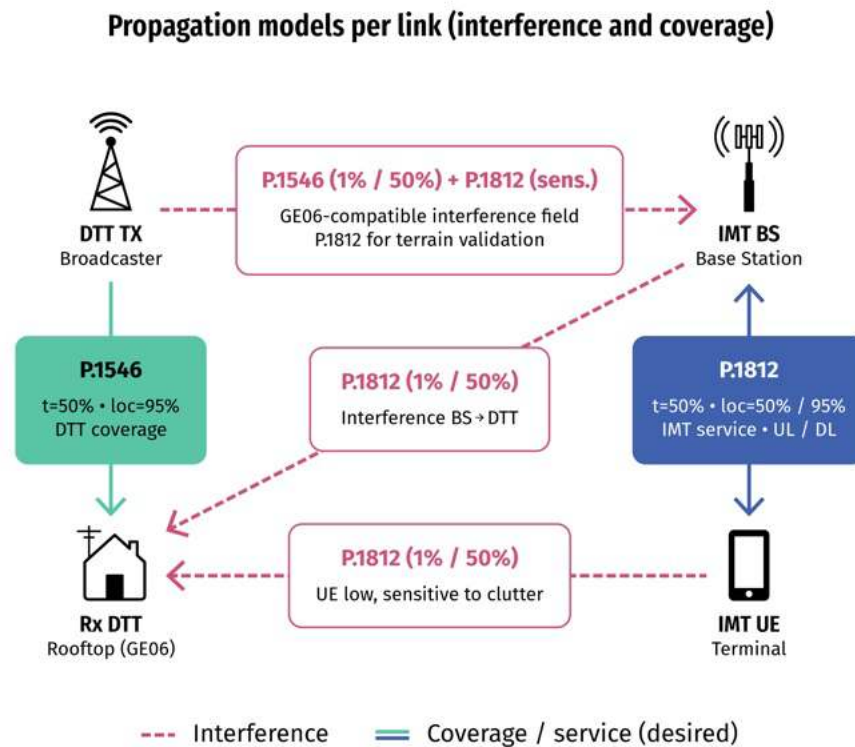
³³ ITU, Report ITU-R BT.2383-5, Typical electrical and mechanical characteristics of terrestrial broadcast transmitting systems, September 2023, <https://www.itu.int/pub/R-REP-BT.2383>; Recommendation ITU-R BT.419-3, Directivity and polarization discrimination of antennas in the reception of television broadcasting, <https://www.itu.int/rec/R-REC-BT.419/en>.

³⁴ ITU, Recommendation ITU-R BT.2033-2, Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands, available at: <https://www.itu.int/pub/R-REC-BT.2033>; Report ITU-R BT.2383-5, Typical electrical and mechanical characteristics of terrestrial broadcast transmitting systems, <https://www.itu.int/pub/R-REP-BT.2383>; and Recommendation ITU-R BT.419-3, Directivity and polarization discrimination of antennas in the reception of television broadcasting, <https://www.itu.int/rec/R-REC-BT.419/en>.

³⁵ ITU, Recommendation ITU-R P.1546, Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to $4\,000$ MHz, available at: <https://www.itu.int/rec/r-rec-p.1546>; and Recommendation ITU-R P.1812, A path-specific propagation prediction method for point-to-area terrestrial services in the frequency range 30 MHz to 6 GHz, <https://www.itu.int/rec/r-rec-p.1812>.

The choice of propagation model and associated time and location percentages depends on the interference scenario and protection objective being evaluated, as detailed in Figure 16.

Figure 16: Propagation models used in the analyses



Source: TMG.

4.2. Coordination methodologies and distances

4.2.1. Coordination distance derived from the GE06 framework

The GE06 Agreement provides the regulatory basis for protecting broadcasting services from cross-border interference within its planning area. For implementation of IMT in the 470-694 MHz band, RR No. **5.295A** requires that mobile stations do not exceed a GE06-derived field-strength value at the border of a neighbouring administration for more than 1% of the time. This value acts as a coordination trigger indicating when administrations may need to undertake bilateral coordination before deploying stations near a border.

For the DTT digital-only case, the applicable GE06 coordination value is 23 dB(μV/m). Applying the GE06 multiple-entry correction factor of 4.771 dB results in an equivalent single-entry coordination trigger of **18.229 dB(μV/m)** at the national border.

Using the IMT parameters described in Section 4.1.2 and the GE06 propagation assumptions (Recommendation ITU-R P.1546, 1% time and 50% locations), the coordination distance is obtained by identifying the separation at which the predicted field strength falls to the GE06 trigger value. The resulting distance is approximately **92 km**.

It is important to note that this distance represents a planning-based coordination trigger rather than a receiver-protection distance. The calculation assumes protection at the national border regardless of the presence of an actual DTT receiver and incorporates conservative planning assumptions intended to facilitate coordination between administrations. Consequently, the resulting distance identifies situations that may require further analysis but does not necessarily represent the distance at which harmful interference to DTT reception would occur in practice.

The GE06 result therefore provides a useful regulatory reference point against which alternative system-level coexistence assessments can be compared.

4.2.2. System-specific coordination distances

While the GE06 methodology provides a planning-based coordination trigger at the national border, system-specific analyses assess the protection requirements of actual DVB-T2 receivers, as well as the impact on IMT stations. This approach considers the characteristics of the wanted and interfering systems and evaluates the conditions under which harmful interference may occur at the receiver location.

Based on the DTT parameters detailed in Section 4.1.3, the analysis assumes a minimum service field strength of 54.3 dB(μ V/m), a co-channel protection ratio of 19 dB between a DVB-T2 receiver and an IMT transmitter, and a receiving-antenna discrimination of 16 dB, resulting in a maximum permissible interfering field strength of **51.3 dB(μ V/m)** at the DTT receiver location.

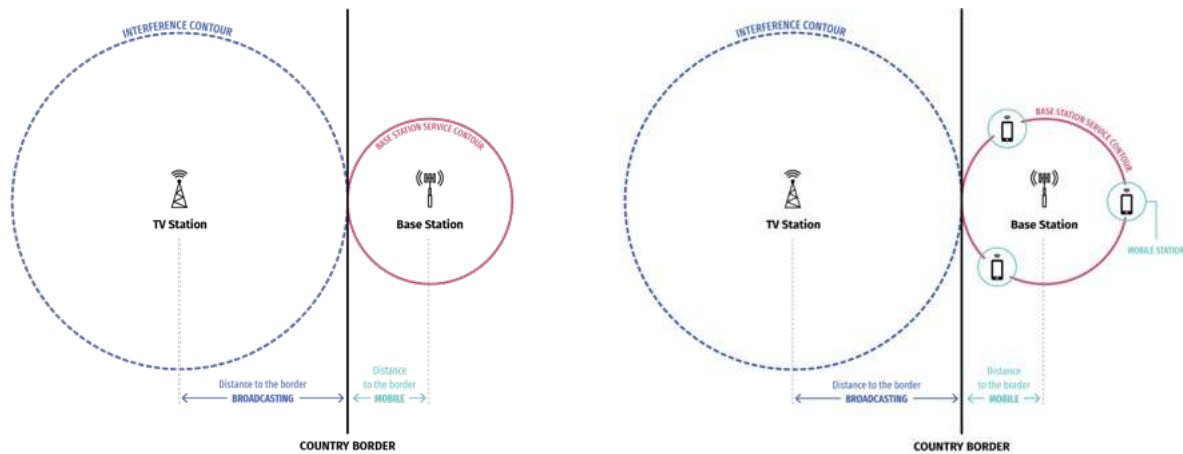
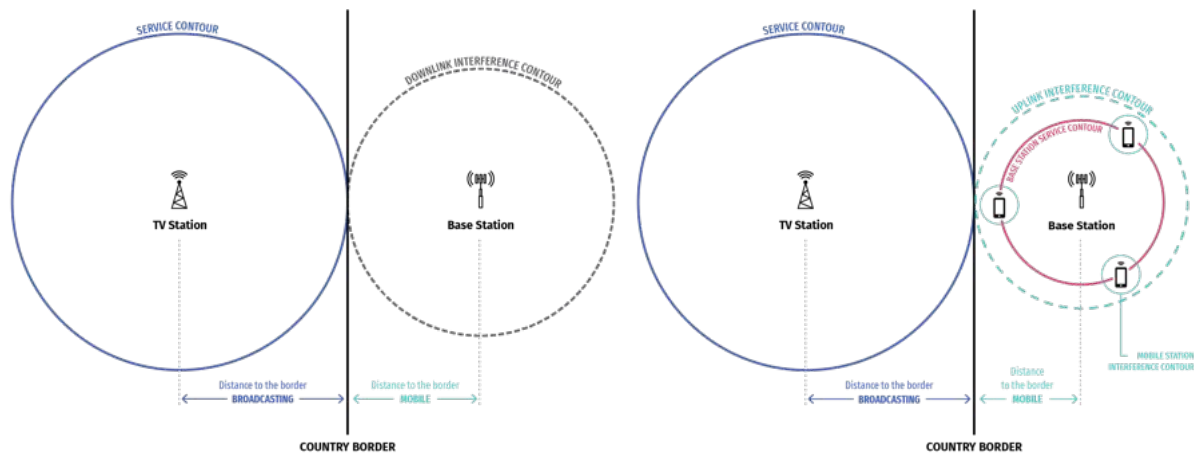
Using the IMT assumptions defined in Section 4.1.2 and the same propagation methodology applied in the GE06 assessment (Recommendation ITU-R P.1546, 1% time and 50% locations), the corresponding coordination distance is approximately **14 km**. Unlike the GE06 trigger, this criterion is directly linked to DVB-T2 receiver performance and therefore provides an estimate of the separation required to avoid harmful interference under the assumed coexistence conditions.

In addition to coordination distances, coexistence can also be evaluated using service and interference contours. Service contours define the area within which the wanted service can be received with the required quality, while interference contours define the area within which the interfering signal exceeds the applicable protection criterion. Comparing these contours provides a useful indication of the likelihood and geographic extent of coexistence constraints.

Using the parameters in Section 4.1.3 and Recommendation ITU-R P.1546, the representative DVB-T2 transmitter service contour for 50% time and 95% locations with a field strength of **54.3 dB(μ V/m)** is approximately **24 km**. Corresponding DTT interference contour associated with protection of an IMT base station may vary considering a maximum permissible interfering field strength from approximately **20 to 40 dB(μ V/m)** depending on the antenna discrimination considered.³⁶ This leads to corresponding distances for 1% time and 50% locations from approximately **84 to 204 km**. By comparison, the representative IMT base station service contour is approximately **12 km**, while the interference contour associated with an IMT user-equipment transmitter extends to only **1 km**, reflecting the significantly lower transmit power and antenna height of the mobile terminal. The scenario and contours are shown in Figure 17.

³⁶ See also ITU, Report BT.2337-1, Sharing and compatibility studies between digital terrestrial television broadcasting and terrestrial mobile broadband applications, including IMT, in the frequency band 470-694/698 MHz, Table 14, available at: <https://www.itu.int/pub/R-REP-BT.2337-1-2018>.

Figure 17: Service and interference contours for representative IMT-DTT coexistence scenarios

SCENARIO 1**SCENARIO 2**

Source: TMG.

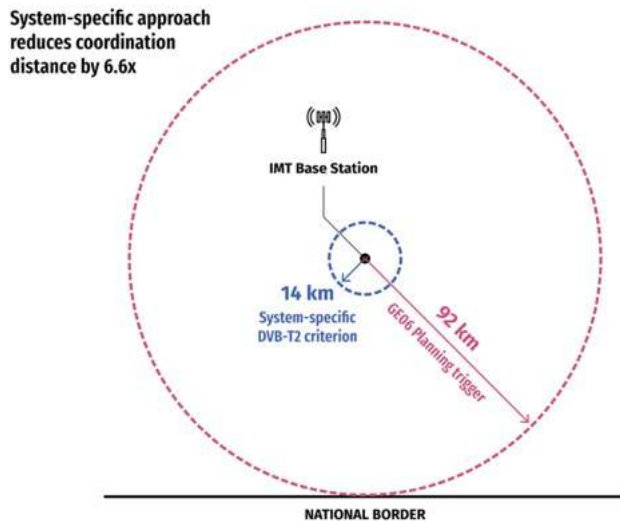
These results illustrate how the relative sizes of service and interference contours vary depending on the interference direction considered. High-power DTT transmitters may create interference contours extending significantly beyond the corresponding IMT service area, whereas interference from IMT systems into DVB-T2 receivers is typically more localised. Such relationships provide a useful framework for understanding the more detailed coexistence results presented in the following case studies.

4.2.3. Comparison of coordination approaches

The analyses demonstrate that coordination distances can vary significantly depending on the methodology applied. Using the assumptions defined in Section 4.1, the GE06 planning methodology results in a coordination distance of approximately 92 km, whereas the system-specific DVB-T2 coexistence assessment results in a distance of approximately 14 km. The latter is therefore around 6.6 times smaller than the distance derived using the GE06 framework.

The difference reflects the objectives of the two approaches. The GE06 methodology provides a planning-based coordination trigger intended to identify situations that may require further coordination between administrations. By contrast, the system-specific assessment evaluates the protection requirements of actual receivers and the conditions under which harmful interference may occur under the assumed coexistence scenario.

Figure 18: Comparison of GE06 and system-specific coordination distances



Source: TMG.

The comparison illustrates that coordination distances should not be regarded as fixed values, but rather as outputs that depend on the protection criteria, propagation assumptions and technical characteristics considered in the analysis. Consequently, GE06-based calculations provide an important regulatory reference for coordination, while system-specific studies can provide additional insight into actual coexistence conditions. Together, the two approaches provide complementary information that can support the definition of coordination zones and the development of bilateral agreements for implementation of IMT in the 600 MHz band.

4.3. Detailed case studies

The analyses presented in Section 4.2 are based on representative system parameters and propagation assumptions intended to illustrate the coordination distances resulting from different assessment methodologies. In practice, coexistence outcomes depend on the specific characteristics of each border area and the deployment conditions of the systems involved.

To complement the generic analyses, this section presents three case studies representing different geographical, operational and regulatory scenarios. The studies examine coexistence between IMT and DTT services using actual station characteristics, terrain profiles and propagation paths, providing practical examples of how coordination requirements may vary under real deployment conditions.

Together, the case studies illustrate how technical assessments can be applied to support cross-border coordination and coexistence between IMT and DTT services and provide practical context for the coordination approaches discussed in the previous sections.

4.3.1. Finland and Russian Federation

4.3.1.1. Study objective and scenario

This case study assesses bidirectional interference between an IMT network deployed in the Lappeenranta region in Finland and DVB-T2 transmitters operating in the Vyborg region in the Russian Federation near the common border. It considers interference from DTT into IMT base-station and user-equipment receivers, and from IMT base stations and user equipment into fixed DTT reception. The assessment uses actual station characteristics and terrain and clutter data for the border region.

The study assumes co-channel operation in two 8 MHz television channels. DTT channel 40, centred at 626 MHz, overlaps the IMT downlink, while DTT channel 45, centred at 666 MHz, overlaps the IMT uplink, as previously detailed in Figure 8. This represents a challenging coexistence configuration in both interference directions.

The IMT parameters and protection criteria follow the common assumptions in Section 4.1. The case-specific broadcasting parameters are shown in Table 5, including their channel/frequency, detailed location, effective radiated power (e.r.p.), antenna height and pattern, as per the GE06 plan.³⁷

Table 5: Russian Federation case-specific DVB-T2 transmitter characteristics

Station	Channel and frequency	e.r.p.	Antenna height	Pattern
Vyborg (Pappula)	45 / 666 MHz	64.6 kW (48.1 dBW)	190 m	Non-directional
Svetogorsk	45 / 666 MHz	0.5 kW (27 dBW)	70 m	Directional
Svetogorsk	40 / 626 MHz	0.5 kW (27 dBW)	70 m	Directional

Source: TMG based on ITU data.

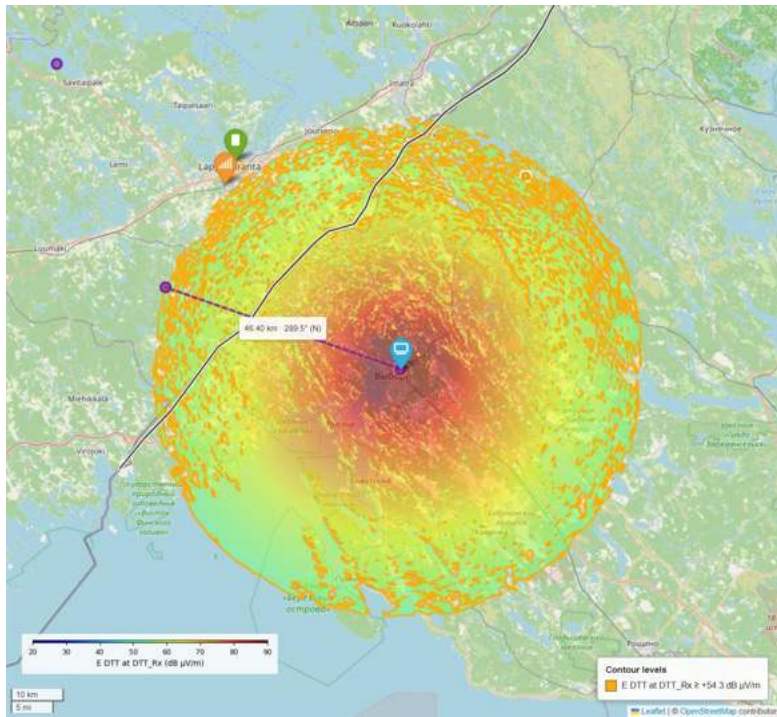
Recommendation ITU-R P.1546 is used for DTT coverage, GE06-compatible cross-border field strengths and the baseline DTT-to-IMT interference assessment. Recommendation ITU-R P.1812 is used for path-specific IMT coverage and IMT-to-DTT interference calculations, incorporating terrain, clutter, diffraction and shielding. The relevant time and location percentages are those defined in Section 4.1.4.

4.3.1.2. DTT into IMT

The high-power Vyborg transmitter produces the largest DTT interference footprint. Its channel 45 transmission affects the IMT uplink and may constrain IMT base-station siting over a border area, even after off-axis discrimination is considered. The result illustrates the influence of the transmitter's high e.r.p., elevated antenna and non-directional pattern.

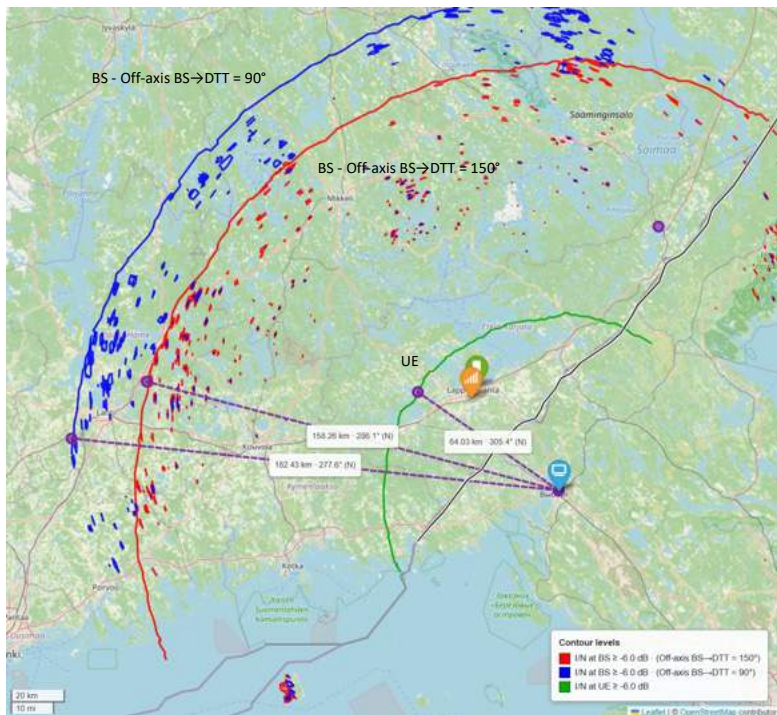
³⁷ ITU, eQuery for Broadcasting Plans, available at: <https://www.itu.int/ITU-R/eTerrestrial/eBroadcasting>.

Figure 19: Vyborg DTT coverage area



Source: TMG.

Figure 20: Vyborg DTT interference towards IMT base stations in Lappeenranta

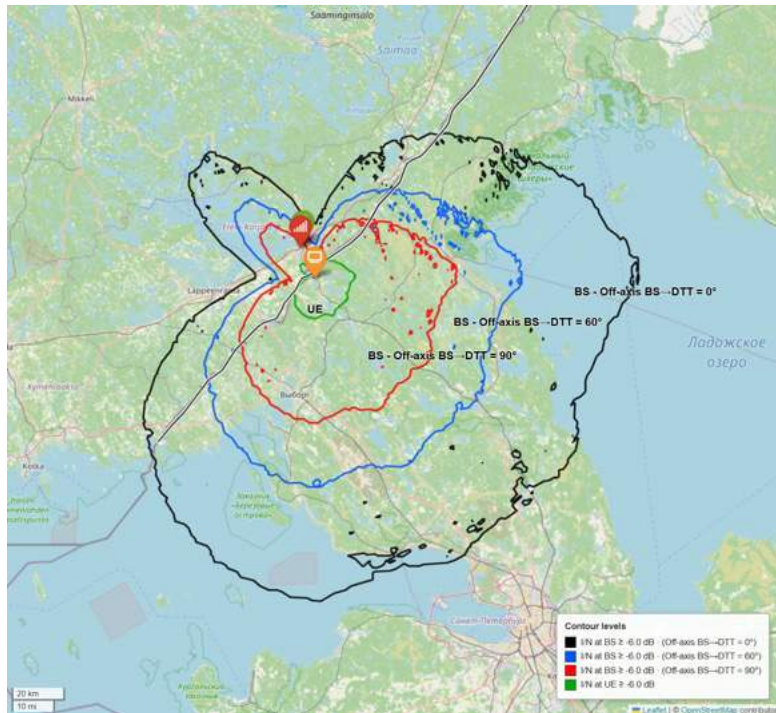


DTT contours for IMT I/N = -6 dB levels at BS receiver at 90° (blue) and 150° (red) off-axis angles, and UE receiver (green).

Source: TMG.

The Svetogorsk DTT station produces a substantially smaller interference area because of its much lower transmit power and directional antenna pattern. With the nominal IMT deployment, most of the intended area satisfies the $I/N \leq -6$ dB criterion; the remaining affected area is concentrated near the border and in the direction of the DTT main beam. Off-axis discrimination reduces the coupling where the IMT base-station antenna is directed away from Svetogorsk.

Figure 21: Svetogorsk DTT interference towards IMT base stations in Lappeenranta

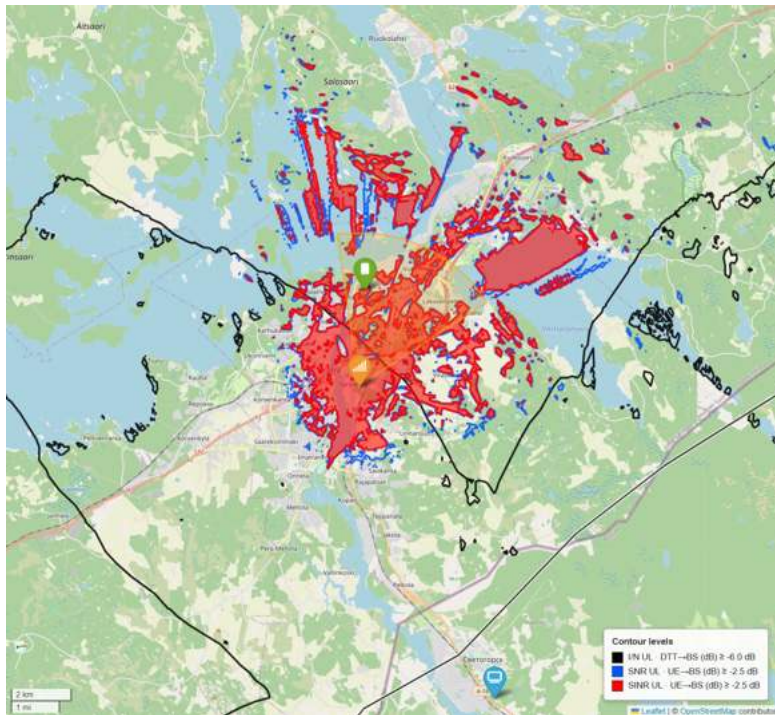


DTT contours for IMT $I/N = -6$ dB levels for channel 45 at BS receiver at 90° (red), 60° (blue), and 0° (black) off-axis angles, and for channel 40 at UE receiver (green).

Source: TMG.

The study further demonstrates that coexistence can be improved through practical network design measures. The base-station position and antenna orientation were then adjusted to increase discrimination towards the Svetogorsk station. With the base-station azimuth set to 24°, its boresight is 132° off-axis from the DTT transmitter. The study also applies 12 dB cross-polarisation discrimination between the horizontally polarised DTT signal and the vertically polarised IMT base-station antenna. Under these assumptions, the $I/N \leq -6$ dB criterion is satisfied across the assessed uplink signal.

Figure 22: Effect of Svetogorsk DTT interference on IMT uplink coverage in Lappeenranta after base-station optimisation



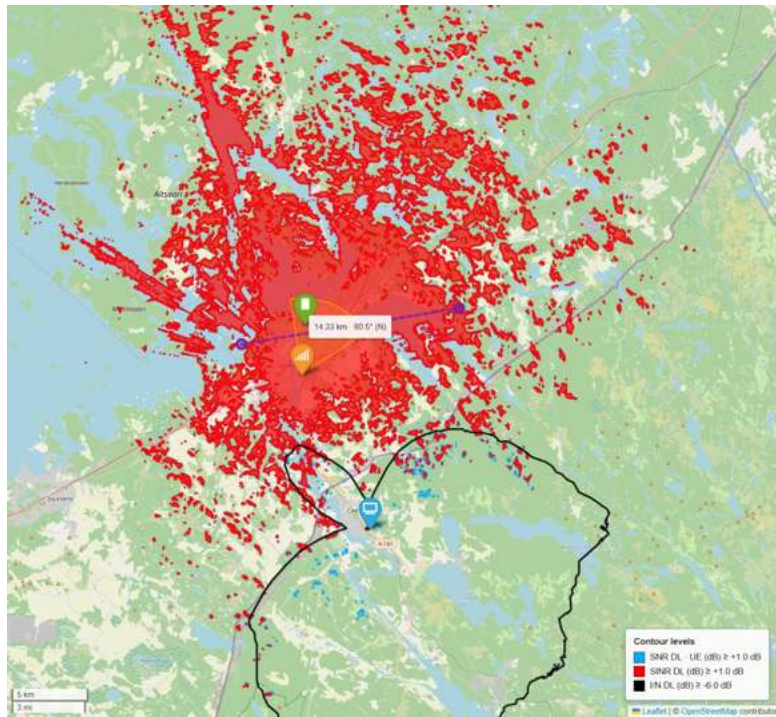
Effect of Svetogorsk channel 45 on the adjusted IMT base-station deployment. Blue shows uplink coverage without DTT interference; red shows the area degraded by DTT interference.

Source: TMG.

The analysis indicates that useful IMT uplink coverage can be retained close to the border after site and antenna optimisation. The study indicates a covered area more than 3 km wide on the Finnish side under the assessed configuration.

DTT interference into IMT user equipment is less restrictive. The wanted IMT downlink is transmitted by the base station at substantially higher power than the UE uplink, and the study shows that the affected part of the downlink service area remains limited.

Figure 23: Effect of Svetogorsk DTT interference on IMT downlink coverage in Lappeenranta after base-station optimisation



Effect of Svetogorsk channel 40 into IMT user equipment. Blue shows downlink coverage without DTT interference; red shows the area degraded by DTT interference.

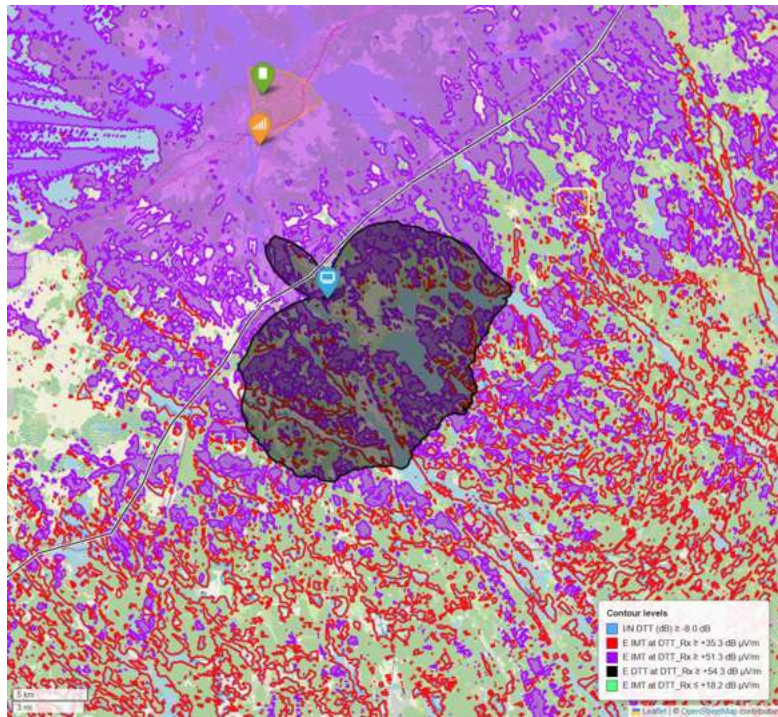
Source: TMG.

4.3.1.3. IMT into DTT

Interference from the IMT base station into fixed DVB-T2 reception was assessed using both the GE06 cross-border trigger and the receiver-based protection criterion defined in Section 4.1.3. The GE06 assessment applies at the national border independently of the presence of a receiver. The system-specific assessment applies within the DTT service area and includes the DVB-T2 protection ratio and 16 dB receiving-antenna discrimination.

For the adjusted IMT base-station deployment, the GE06 threshold identifies a broad coordination area, while the 51.3 dB(μ V/m) receiver-based criterion produces a more limited affected area. The comparison illustrates the different purposes of the two criteria rather than an inconsistency between them: one is a regulatory coordination trigger, and the other assesses protection of fixed DVB-T2 reception under the stated assumptions.

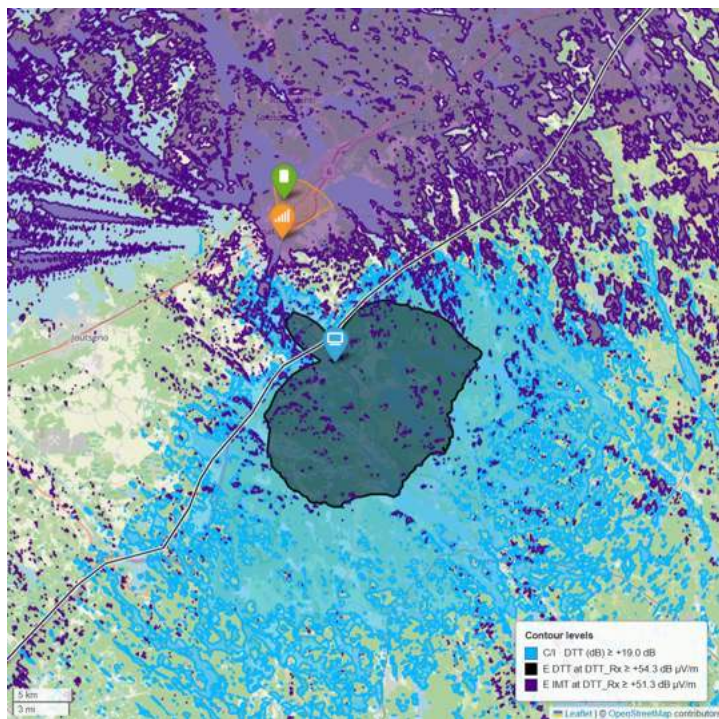
Figure 24: Lappeenranta IMT base-station interference towards Svetogorsk DTT reception



Comparison of GE06 field-strength triggers and DVB-T2 receiver-protection criteria for the Lappeenranta IMT downlink interference into Svetogorsk DTT channel 40.

Source: TMG.

Figure 25: Lappeenranta IMT base-station interference towards Svetogorsk DTT reception considering clutter over terrain

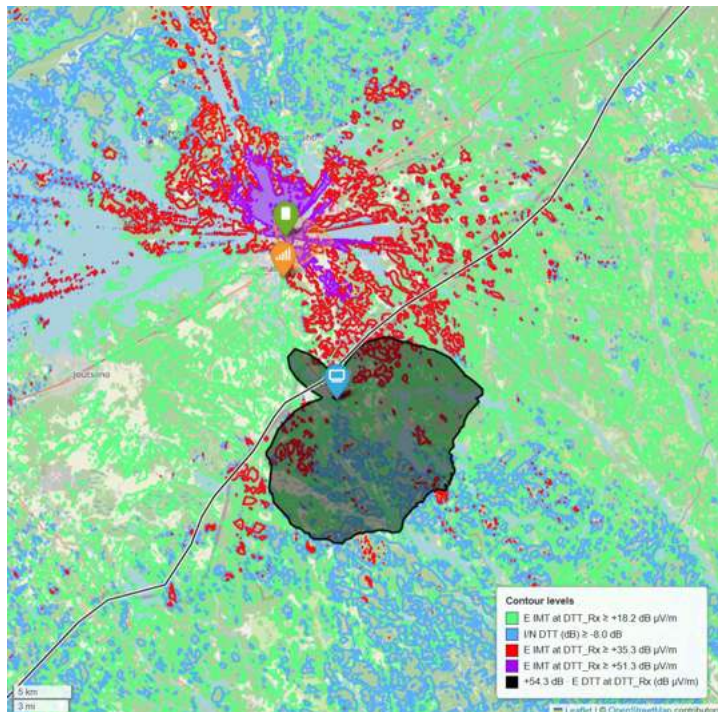


DVB-T2 receiver-protection criteria for the Lappeenranta IMT downlink interference into Svetogorsk DTT channel 40 considering clutter over terrain.

Source: TMG.

Interference from IMT user equipment into DVB-T2 reception is considerably more limited. Under the assessed configuration, the DTT service contour remains protected. This outcome reflects the lower UE transmit power, power control and low antenna height, which increase propagation loss towards DTT in comparison with the IMT base-station case.

Figure 26: Lappeenranta IMT UE interference towards Svetogorsk DTT reception



Comparison of GE06 field-strength triggers and DVB-T2 receiver-protection criteria for the Lappeenranta IMT uplink interference into Svetogorsk DTT channel 45.

Source: TMG.

4.3.1.4. Key findings of the Finland and Russian Federation case study

The study identifies DTT interference into the IMT base-station receiver as the most challenging scenario, particularly for high-power, elevated and non-directional broadcasting transmitters. The contrast between Vyborg and Svetogorsk shows that DTT transmitter power and antenna directivity materially affect the extent of the interference footprint.

For the lower-power Svetogorsk DTT station, optimisation of IMT site location and antenna orientation, together with cross-polarisation discrimination, maintained the $I/N \leq -6$ dB criterion across the assessed uplink cell and retained a covered area of more than 3 km wide on the Finnish side. DTT interference into IMT user equipment was less restrictive, while IMT user-equipment interference did not compromise the assessed DVB-T2 service area.

The IMT base-station analysis also confirms that GE06 and receiver-based DVB-T2 criteria serve different purposes and can produce substantially different affected areas. The case therefore supports that GE06

be used as an initial regulatory coordination reference, complemented by path-specific analysis and practical site engineering when administrations assess actual deployment conditions.

4.3.2. Germany and Poland

4.3.2.1. Study objective and scenario

This case study assesses bidirectional interference between IMT networks deployed in Germany and DVB-T2 broadcasting services operating in Poland near the common border. The analysis considers interference from DTT into IMT base-station and user-equipment receivers, and from IMT base stations and user equipment into fixed DTT reception. The assessment uses actual transmitter characteristics, terrain and clutter information representative of the Germany-Poland border region.

Unlike the Finland-Russian Federation case study, the coexistence scenario is based on partial spectral overlap between IMT and DTT. The analysis considers DTT channels 38 and 45 and IMT operation in 3GPP band n105. DTT channel 38 overlaps only the upper 2 MHz of the IMT downlink block, while DTT channel 45 overlaps the upper 7 MHz of the IMT uplink block, as previously detailed in Figure 8. This partial-overlap arrangement creates a less demanding coexistence environment than the fully co-channel scenario examined in Section 4.3.1.

The IMT parameters and protection criteria follow the common assumptions in Section 4.1. The case-specific broadcasting parameters are shown in Table 6, including their channel/frequency, detailed location, e.r.p., antenna height and pattern, as per the GE06 plan and national information.³⁸

Table 6: Poland case-specific DVB-T2 transmitter characteristics

Station	Channel and frequency	e.r.p.	Antenna height	Pattern
Zielona Góra / Jemiołów	45 / 666 MHz	100 kW (50 dBW)	305 m	Non-directional
Zielona Góra / Jemiołów	38 / 610 MHz	80 kW (49 dBW)	305 m	Non-directional

Source: TMG based on ITU and Emitel data.

Recommendation ITU-R P.1546 is used for DTT coverage, GE06-compatible cross-border field strengths and the baseline DTT-to-IMT interference assessment. Recommendation ITU-R P.1812 is used for path-specific IMT coverage and IMT-to-DTT interference calculations, incorporating terrain, clutter, diffraction and shielding. The relevant time and location percentages are those defined in Section 4.1.4.

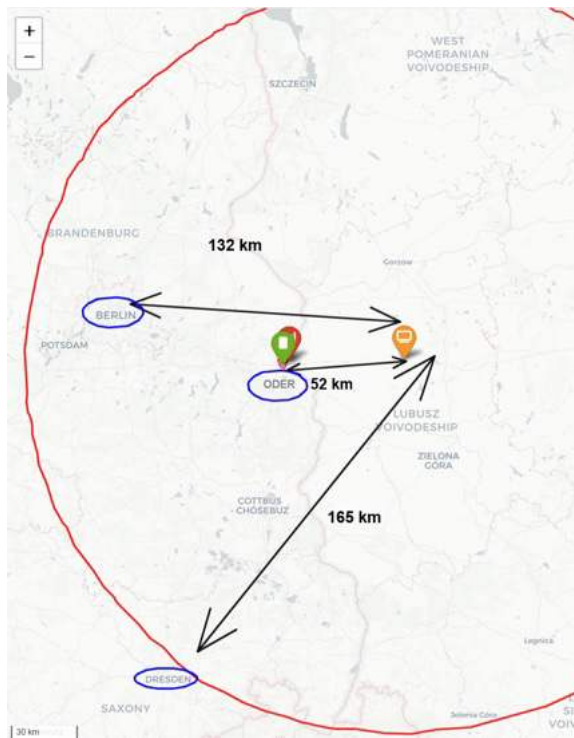
Three representative deployment scenarios are evaluated on the German side of the border:

- Frankfurt (Oder), approximately 52 km from the Polish DTT station;
- Berlin, approximately 132 km from the Polish DTT station;
- Dresden, approximately 165 km from the Polish DTT station.

These scenarios illustrate how coexistence conditions evolve as the separation distance between IMT deployments and DTT transmitters increases.

³⁸ ITU, eQuery for Broadcasting Plans, available at: <https://www.itu.int/ITU-R/eTerrestrial/eBroadcasting>; see also Emitel, EmiMaps, available at: <https://emimaps.emitel.pl>.

Figure 27: Germany-Poland study scenarios



Location of the Frankfurt (Oder), Berlin and Dresden in Germany deployment scenarios relative to the Zielona Góra / Jemiołów DTT transmitter in Poland and its interference contour.

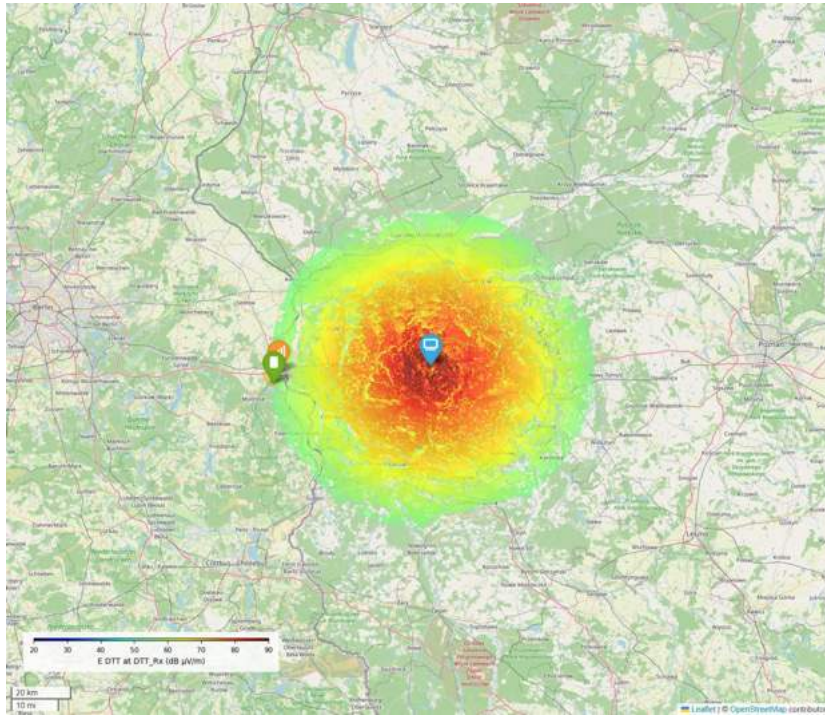
Source: TMG.

4.3.2.2. DTT into IMT

The DTT into IMT assessment focused on interference from the Polish Zielona Góra / Jemiołów transmitter into IMT base-station and user-equipment receivers deployed in Germany. Before evaluating specific deployment locations, the study established both the DTT service contour and the area within which DTT transmissions could exceed the IMT protection criterion of $I/N \leq -6$ dB using Recommendation ITU-R P.1546. The resulting interference contour extends significantly beyond the protected DTT service area and provides a useful indication of the region within which coexistence constraints may need to be considered.

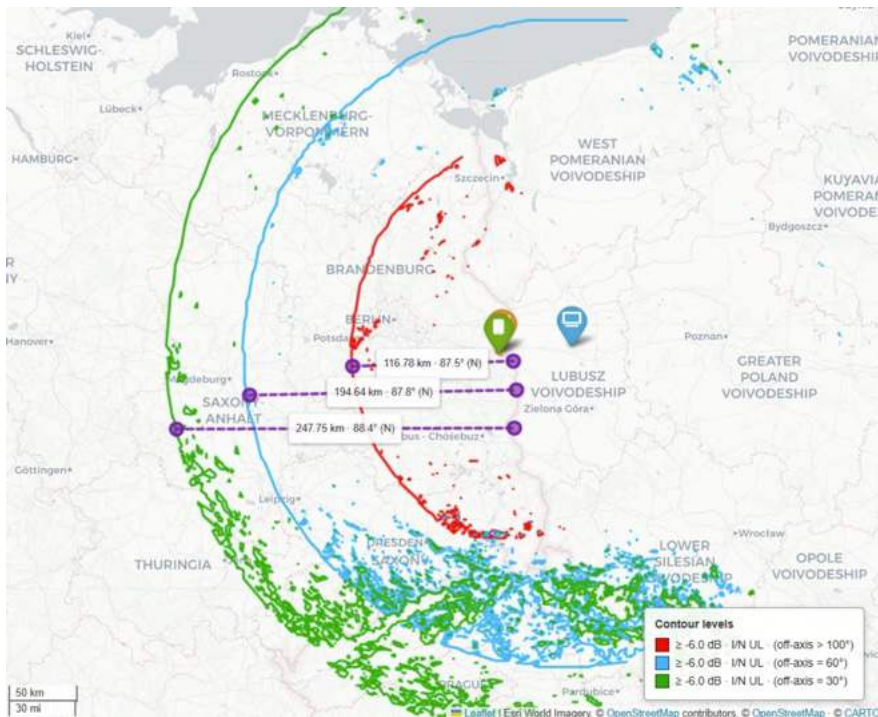
The DTT interference contour was then used to define three representative deployment scenarios within Germany. Frankfurt (Oder) represents a deployment close to the border, Berlin an intermediate-distance deployment, and Dresden a deployment outside the area where significant DTT interference is expected. Together, these scenarios illustrate how coexistence conditions evolve as the separation distance between IMT deployments and the Polish DTT transmitter increases.

Figure 28: Zielona Góra / Jemiołów DTT channel 45 coverage area



Source: TMG.

Figure 29: Zielona Góra / Jemiołów DTT interference towards IMT base stations in Germany



DTT contours for IMT I/N = -6 dB levels for channel 45 at BS receiver at 100° (red), 60° (blue), and 30° (green) off-axis angles.

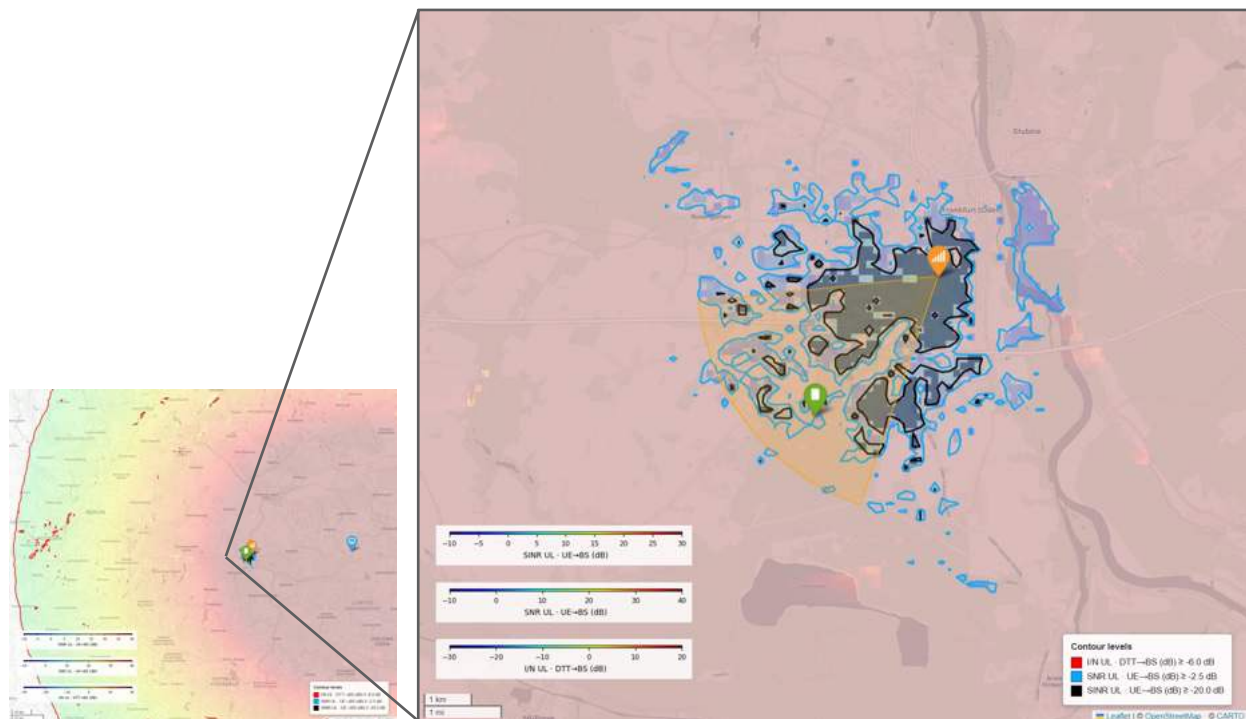
Source: TMG.

DTT interference into IMT base station

Frankfurt (Oder)

The Frankfurt (Oder) scenario represents the most challenging coexistence case. Located close to the DTT interference contour, the Polish channel 45 transmission generates interference levels exceeding the $I/N = -6$ dB criterion over much of the area considered for IMT base-station deployment. As a result, large portions of the uplink coverage area experience significant degradation, making the initial deployment configuration unsuitable without additional mitigation measures.

Figure 30: Zielona Góra / Jemiołów DTT interference towards Frankfurt (Oder) IMT base stations

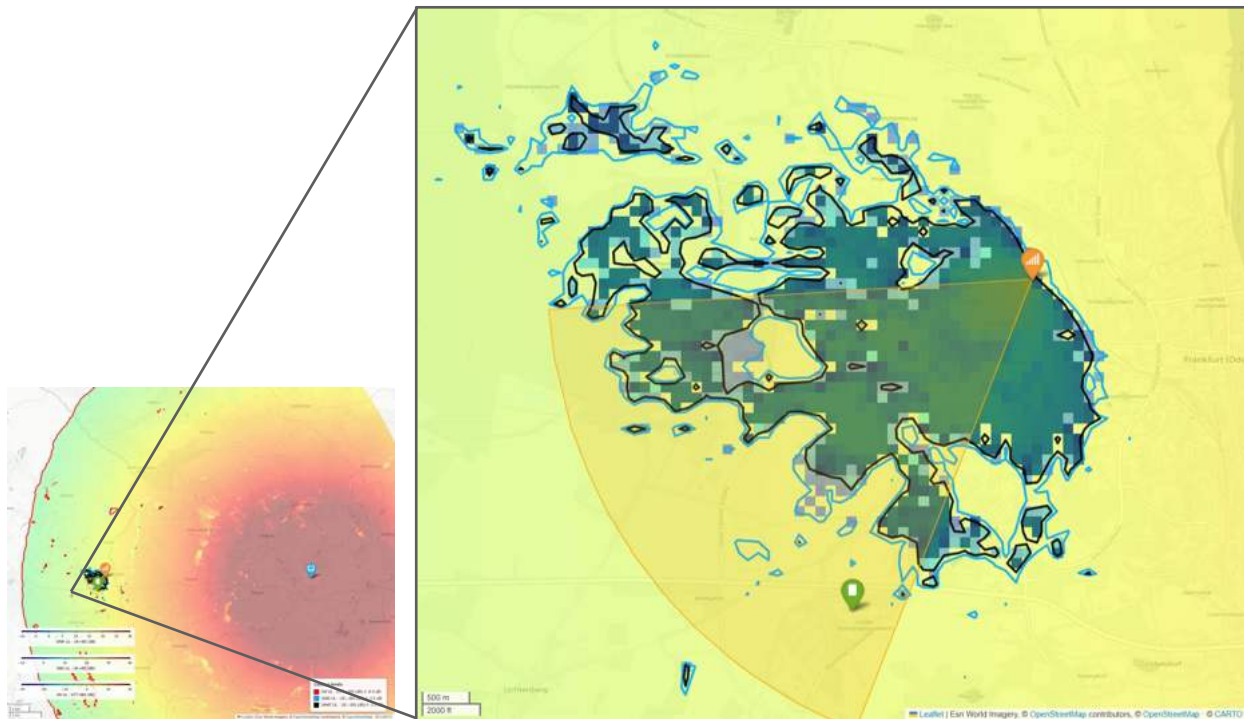


Impact of channel 45 DTT transmissions on IMT uplink reception before mitigation measures are applied. Blue shows uplink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

The study evaluated two mitigation techniques: a small frequency shift of the IMT carrier to reduce spectral overlap and the use of an antenna with an improved front-to-back ratio of 35 dB. Together, these measures reduce the interference area and allow some areas to satisfy the IMT uplink protection criterion within the planned coverage area. The results demonstrate that practical network engineering measures can materially improve coexistence performance in challenging border environments.

Figure 31: Zielona Góra / Jemiołów DTT interference towards Frankfurt (Oder) IMT base stations with mitigation measures



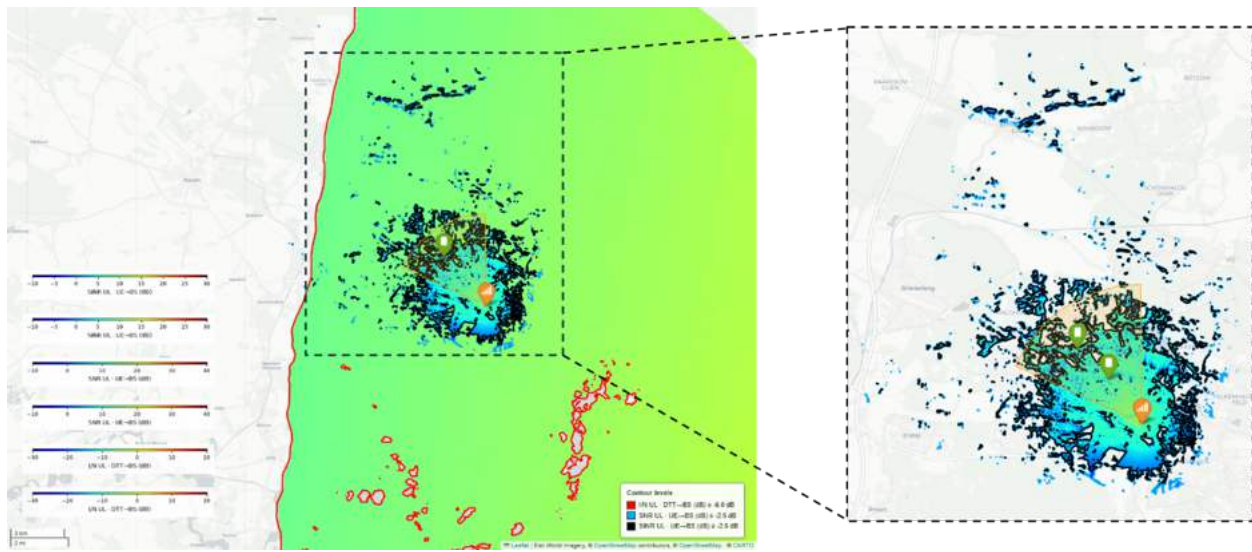
Reduction of DTT into IMT interference through partial frequency separation and increased antenna front-to-back ratio. Blue shows uplink coverage without DTT interference; black shows the area degraded by DTT interference including mitigation.

Source: TMG.

Berlin

The Berlin deployment is located approximately 132 km from the Polish DTT transmitter. At this distance, DTT interference remains observable in the uplink direction, but the resulting SINR remains close to the interference-free case. Although the I/N threshold is surpassed across portions of the service area, antenna discrimination significantly reduces the coupled interference, and coexistence can be achieved without the additional mitigation measures as required in the Frankfurt (Oder) case.

Figure 32: Zielona Góra / Jemiołów DTT interference towards Berlin IMT base stations



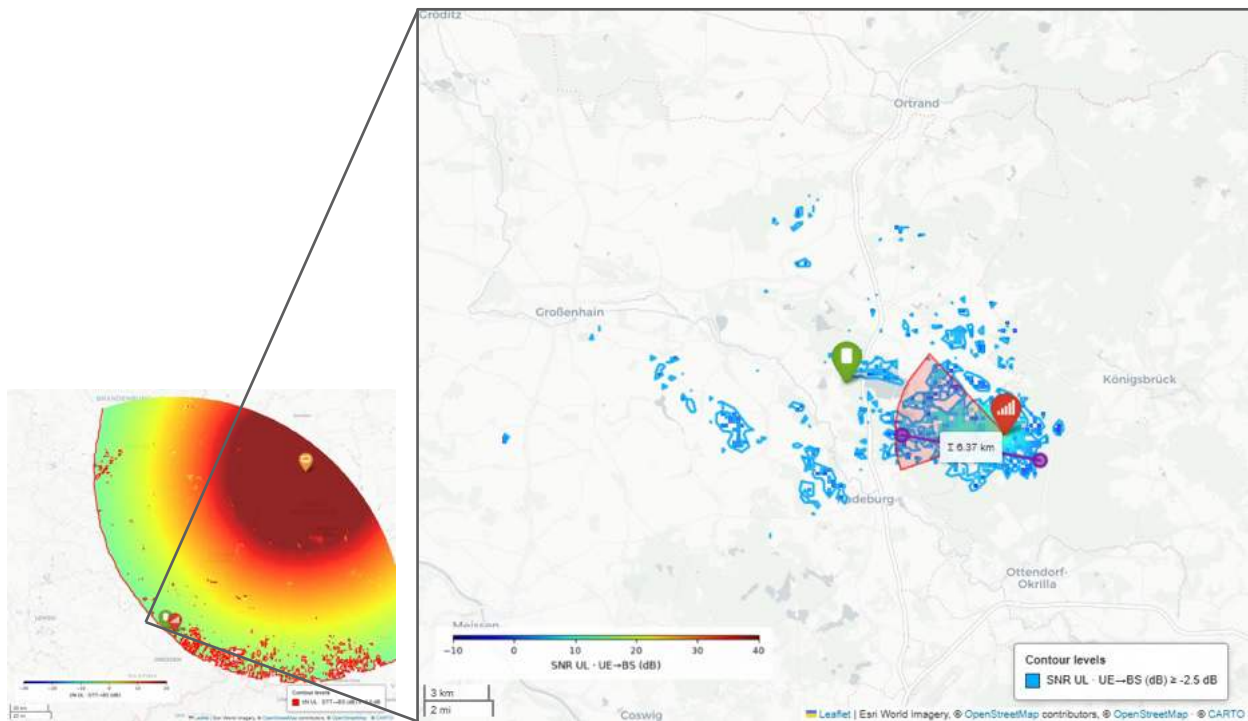
Impact of channel 45 DTT transmissions on IMT uplink performance. Blue shows uplink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

Dresden

The Dresden deployment represents the largest separation distance considered in the study, approximately 160 km from the Polish DTT transmitter. The results are broadly similar to those obtained for Berlin, but with further reduction in the impact of DTT interference. Although the DTT signal remains detectable at the IMT receiver, uplink service remains largely unaffected and coexistence is readily achievable.

Figure 33: Zielona Góra / Jemiołów DTT interference towards Dresden IMT base stations



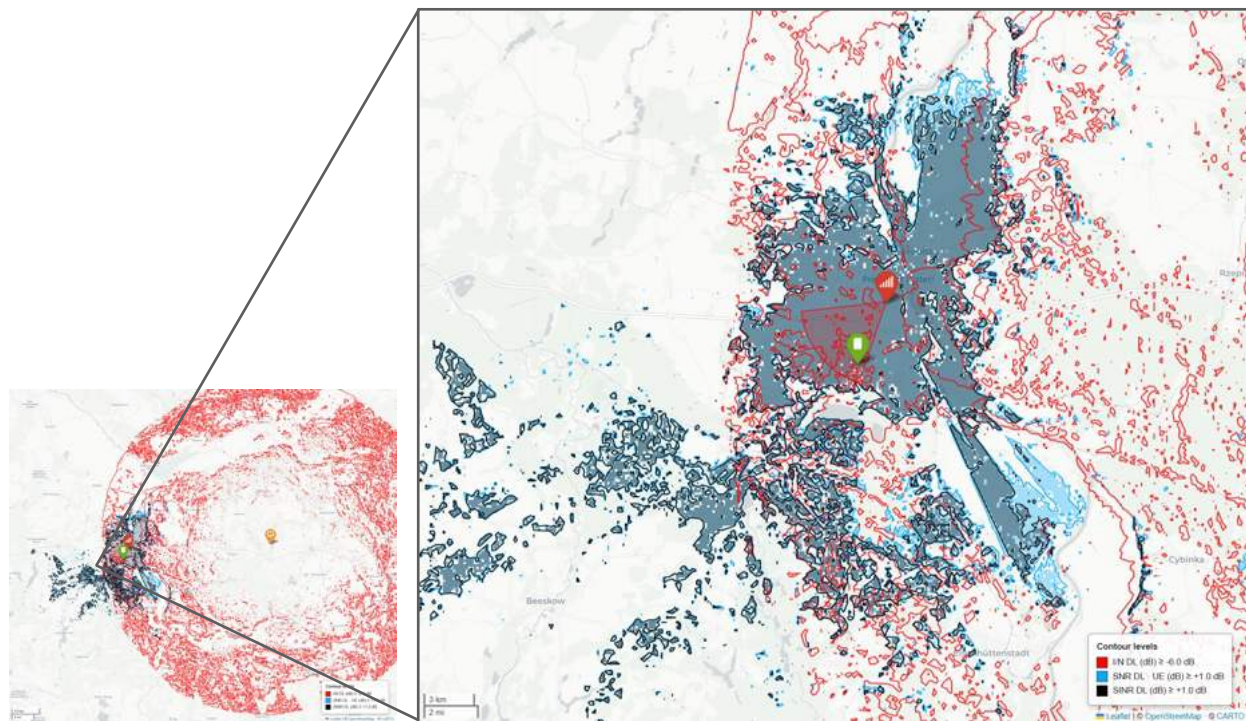
Impact of channel 45 DTT transmissions on IMT uplink performance. Blue shows uplink coverage without DTT interference; the area is not degraded by DTT interference.

Source: TMG.

DTT interference into IMT user equipment

For all three deployment scenarios, interference into IMT user equipment is considerably less restrictive than interference into the IMT base station. The downlink benefits from the higher transmit power of the IMT base station and the lower sensitivity of the interference path. Even in Frankfurt (Oder), the downlink coverage area remains largely unchanged when DTT interference is included. The effect is negligible for the Berlin and Dresden deployments.

Figure 34: Zielona Góra / Jemiołów DTT interference towards Frankfurt (Oder) IMT user equipment



Impact of channel 38 DTT transmissions on IMT downlink performance. Blue shows downlink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

These results demonstrate that DTT interference into IMT base stations represents the limiting coexistence scenario in the Germany–Poland study. They also show that separation distance, antenna discrimination and practical deployment measures can significantly influence coexistence performance, particularly for deployments located close to the border.

4.3.2.3. IMT into DTT

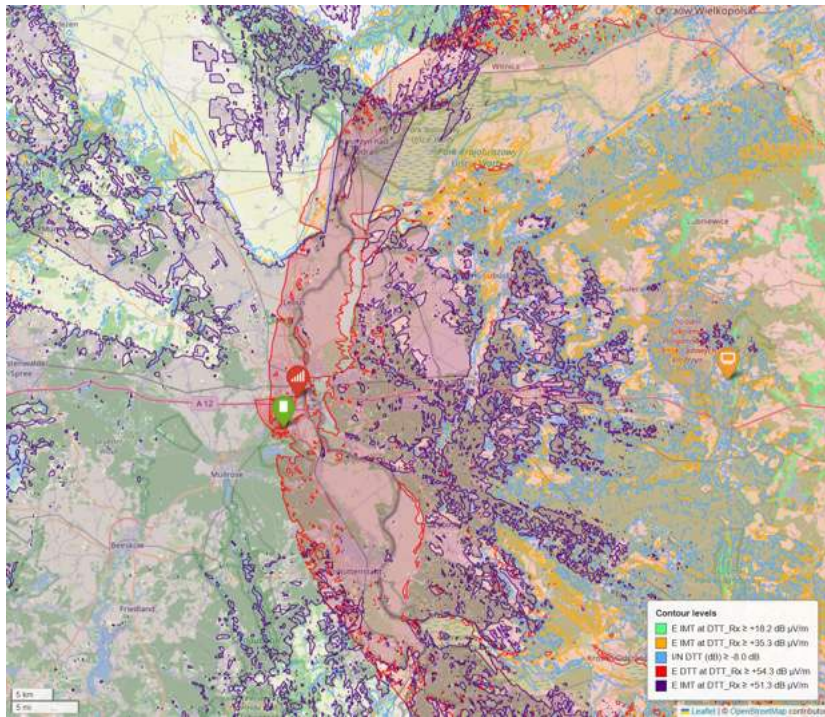
Interference from IMT systems into DVB-T2 reception was evaluated using both the GE06 cross-border trigger and the receiver-based DVB-T2 protection criterion defined in Section 4.1.3. The GE06 assessment applies at the national border independently of the presence of a receiver. The analyses considered interference from both IMT base stations and IMT user equipment towards fixed DTT reception in Poland. The objective was to compare the extent of the coordination area resulting from the GE06 methodology with that obtained using realistic DVB-T2 receiver characteristics and protection ratios.

IMT base station interference into DTT reception

Frankfurt (Oder)

The Frankfurt (Oder) deployment represents the most challenging IMT into DTT coexistence scenario considered in the study. Located close to the border, the IMT base-station downlink produces field strengths exceeding the GE06 coordination thresholds over a substantial area. When receiver-based criteria are considered, however, the affected area is significantly reduced. Most of the protected DTT service contour remains below the applicable DVB-T2 protection threshold, particularly when antenna discrimination is taken into account.

Figure 35: Frankfurt (Oder) IMT base-station interference towards Zielona Góra / Jemiołów DTT reception

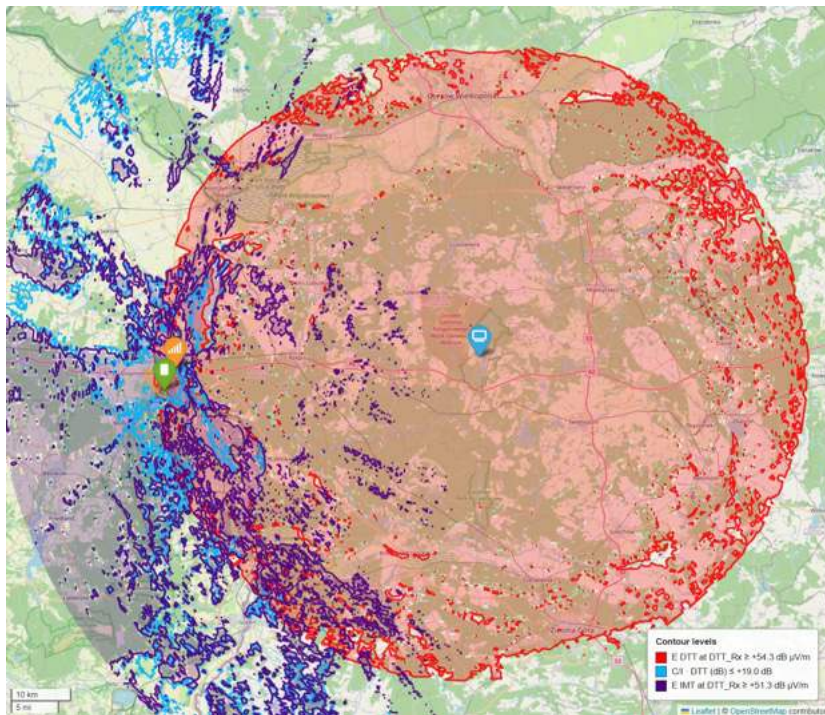


Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions partially overlapping DTT channel 38.

Source: TMG.

The study further examined the influence of terrain and clutter on the predicted interference area. When clutter losses are included, the extent of the affected region decreases noticeably, demonstrating the importance of realistic propagation modelling when assessing actual interference conditions

Figure 36: Frankfurt (Oder) IMT base-station interference towards Zielona Góra / Jemiołów DTT reception considering clutter over terrain



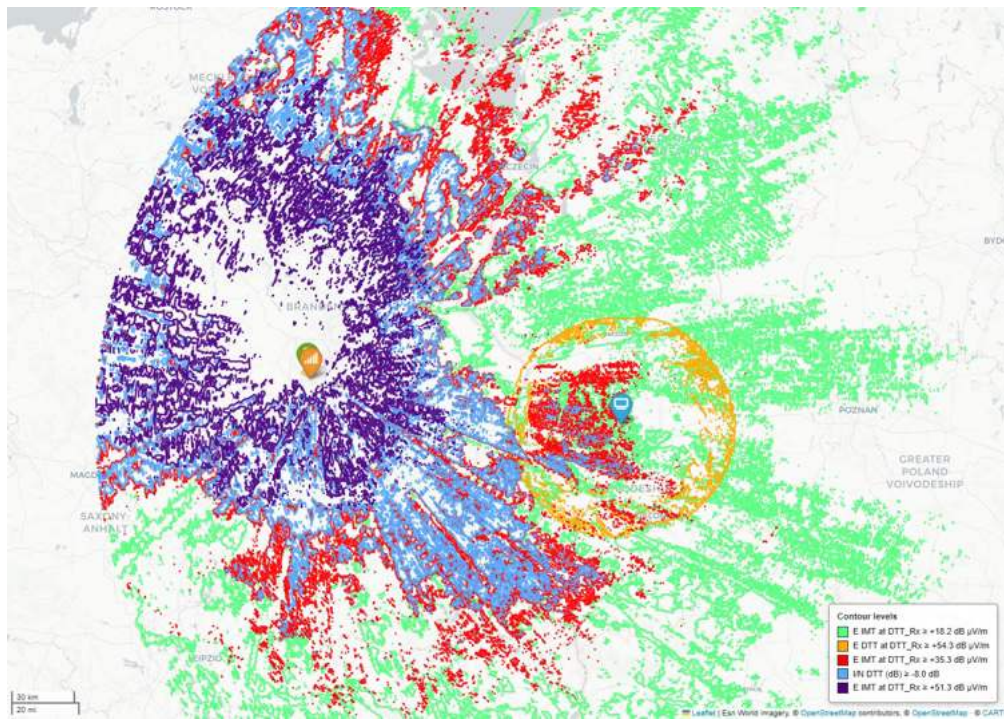
DVB-T2 receiver-protection criteria for the Frankfurt (Oder) IMT downlink interference into Zielona Góra / Jemiołów DTT channel 38 considering clutter over terrain.

Source: TMG.

Berlin

The Berlin deployment is located approximately 132 km from the Zielona Góra / Jemiołów transmitter. At this separation distance, the IMT base-station downlink generates only a limited increase in field strength within the Polish DTT service area. The resulting interference remains below the applicable DVB-T2 protection criteria across almost the entire service contour, even before antenna discrimination is applied.

Figure 37: Berlin IMT base-station interference towards Zielona Góra / Jemiołów DTT reception



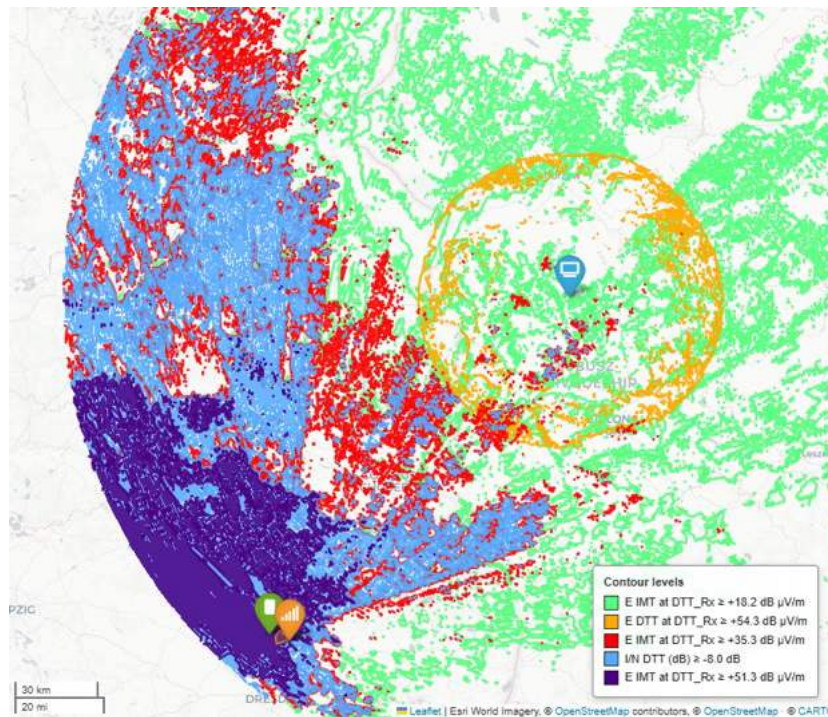
Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions partially overlapping DTT channel 38.

Source: TMG.

Dresden

The Dresden deployment represents the largest separation distance assessed in the study, approximately 160 km from the Polish transmitter. Under these conditions, the field strengths generated by both IMT base stations and user equipment remain well below the DVB-T2 protection thresholds across the protected service area. The resulting interference is limited and highly localised.

Figure 38: Dresden IMT base-station interference towards Zielona Góra / Jemiołów DTT reception



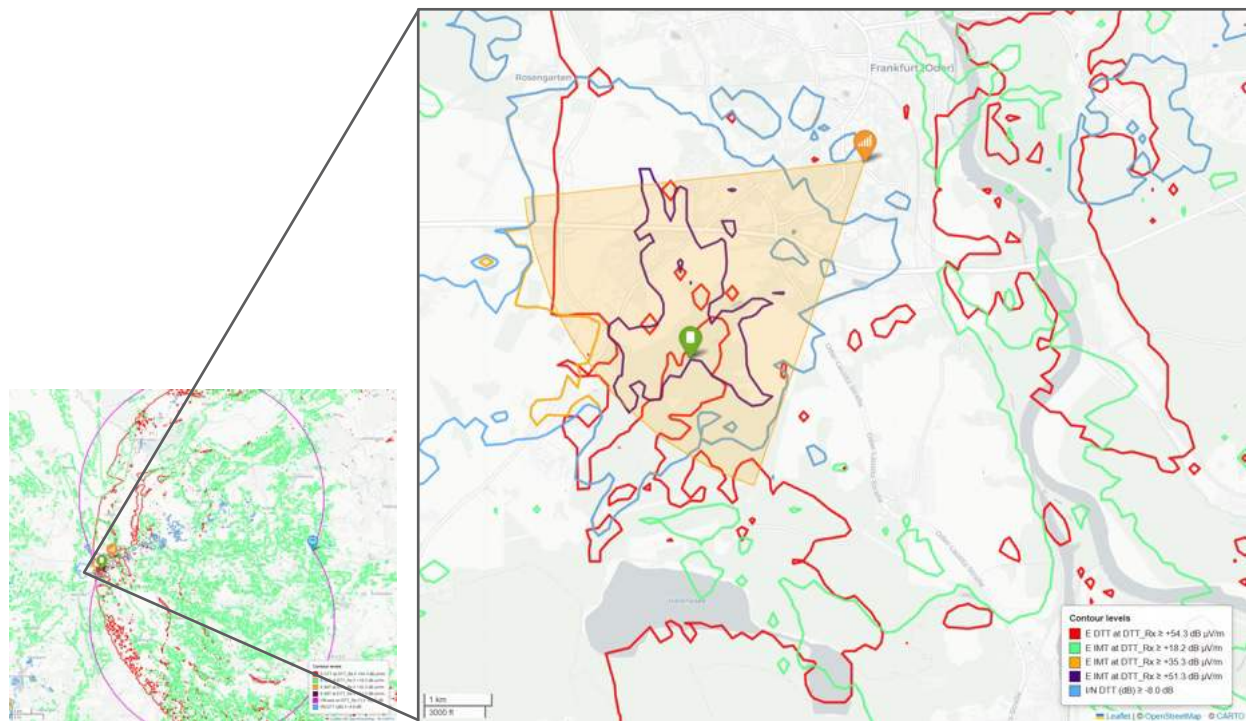
Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions partially overlapping DTT channel 38.

Source: TMG.

IMT user equipment interference into DTT reception

Interference from IMT user equipment is substantially lower. The combination of lower transmit power, power control and low antenna height results in field strengths that remain below the DVB-T2 protection thresholds throughout the protected service area. The study therefore identifies the IMT base station, rather than the user equipment, as the limiting IMT interferer.

Figure 39: Frankfurt (Oder) IMT user equipment interference towards Zielona Góra / Jemiołów DTT reception



Comparison of GE06 and DVB-T2 receiver-protection criteria for IMT uplink transmissions partially overlapping with DTT channel 45 reception.

Source: TMG.

The results demonstrate that distance is a dominant factor influencing IMT into DTT coexistence. While the Frankfurt (Oder) deployment produces field strengths that can approach or exceed receiver-based protection thresholds in limited areas, the Berlin and Dresden deployments remain largely compliant with the applicable DVB-T2 protection criteria. Across all three scenarios, receiver-based assessments identify substantially smaller affected areas than those suggested by the GE06 coordination triggers. The study therefore confirms that GE06 and DVB-T2 protection criteria serve different purposes and should be interpreted accordingly when assessing coexistence conditions and defining coordination arrangements.

4.3.2.4. Key findings of the Germany and Poland case study

This case study demonstrates that coexistence outcomes are strongly influenced by separation distance and the degree of spectral overlap between IMT and DTT systems. The results show that interference from DTT transmissions into IMT base-station receivers represents the most restrictive coexistence scenario, particularly for deployments located close to the border. However, the impact decreases significantly as the distance from the DTT transmitter increases. The partial frequency overlap between the IMT and DTT assignments also contributes to lower interference levels than those observed in the fully co-channel Finland-Russian Federation case study.

The study further demonstrates that practical engineering measures, including antenna discrimination, improved front-to-back ratio and frequency offsets, can significantly improve coexistence performance for deployments near the border. Interference from DTT into IMT user equipment and from IMT user equipment into DVB-T2 reception was found to be considerably less restrictive than the corresponding base-station scenarios.

The IMT into DTT analyses also confirm that GE06 and receiver-based DVB-T2 protection criteria serve different purposes and can produce substantially different affected areas. The case therefore reinforces the value of using GE06 as an initial coordination reference, complemented by detailed technical studies that take account of actual deployment conditions when assessing coexistence in border areas.

4.3.3. Nigeria and Benin

4.3.3.1. Study objective and scenario

This case study assesses bidirectional interference between IMT networks deployed in Nigeria and DVB-T2 broadcasting services operating in Benin near the common border. The analysis considers interference from DTT into IMT base-station and user-equipment receivers, and from IMT base stations and user equipment into fixed DTT reception. Actual transmitter characteristics and terrain and clutter data representative of the Nigeria-Benin border region are used in the assessment.

The study assumes full co-channel operation in two 8 MHz television channels. DTT channel 42, centred at 642 MHz, lies entirely within the IMT downlink, while DTT channel 47, centred at 682 MHz, lies entirely within the IMT uplink, as previously detailed in Figure 8. Channel 42 therefore represents the DTT-to-IMT UE and IMT BS-to-DTT paths, while channel 47 represents the DTT-to-IMT BS and IMT UE-to-DTT paths.

The IMT parameters and protection criteria follow the common assumptions in Section 4.1. The case-specific broadcasting parameters are shown in Table 7, including their channel/frequency, detailed location, e.r.p., antenna height and pattern, as per the GE06 plan and national information.³⁹ The two DTT transmitters are located approximately 3 km apart in the Cotonou area, close to the coast.

Table 7: Benin case-specific DVB-T2 transmitter characteristics

Station	Channel and frequency	e.r.p.	Antenna height	Pattern
Cotonou	47 / 682 MHz	1 kW (30 dBW)	96 m	Non-directional
Cotonou	42 / 642 MHz	3.16 kW (35 dBW)	55 m	Non-directional

Source: TMG based on ITU data.

Recommendation ITU-R P.1546 is used for DTT coverage, GE06-compatible cross-border field strengths and the baseline DTT-to-IMT interference assessment. Recommendation ITU-R P.1812 is used for path-specific IMT coverage and IMT-to-DTT interference calculations, incorporating terrain, clutter, diffraction and shielding. The relevant time and location percentages are those defined in Section 4.1.4.

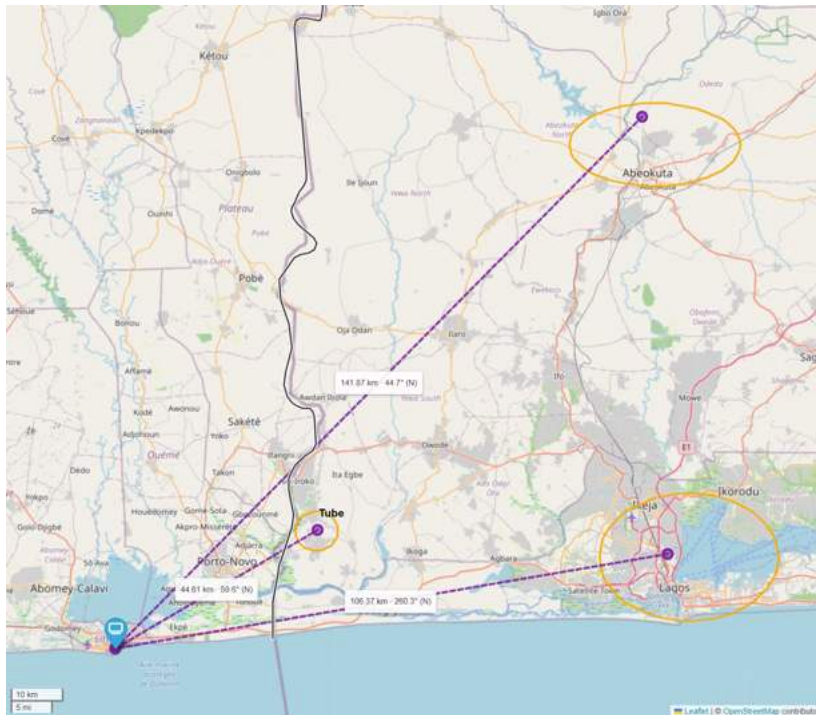
Three representative IMT deployment scenarios are evaluated on the Nigerian side:

- the rural community of Tube, near the border;
- Lagos;
- Abeokuta, an inland deployment approximately 130 km from the Beninese DTT station.

The three locations allow the study to distinguish the effects of proximity, coastal or over-water propagation, and inland terrain and clutter. In particular, the comparison between Lagos and Abeokuta demonstrates that locations with broadly similar stated separation distances may produce materially different interference outcomes because of the propagation path.

³⁹ ITU, eQuery for Broadcasting Plans, available at: <https://www.itu.int/ITU-R/eTerrestrial/eBroadcasting>.

Figure 40: Nigeria-Benin study scenarios



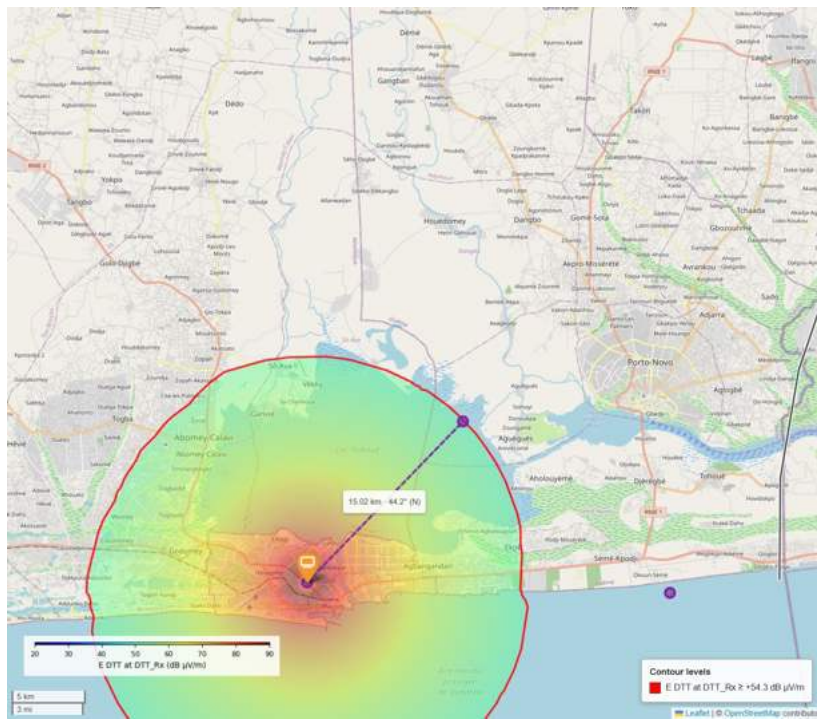
Location of the Tube, Lagos and Abeokuta IMT deployment scenarios relative to the Cotonou DTT transmitters and the national border.

Source: TMG.

4.3.3.2. DTT into IMT

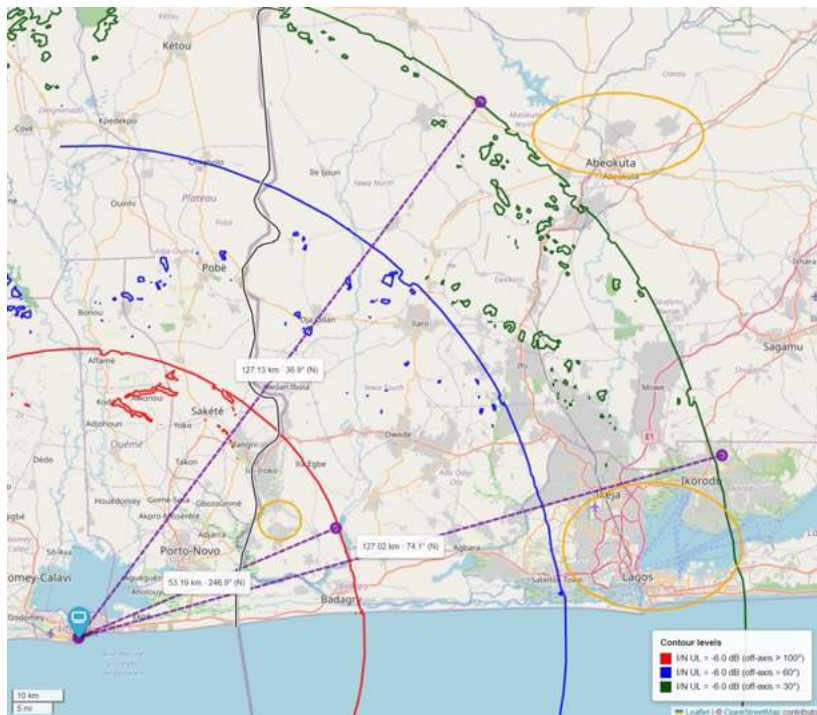
The DTT into IMT assessment considers interference from Cotonou channel 47 into IMT base-station uplink receivers and from channel 42 into IMT user-equipment downlink receivers deployed in Nigeria. Before assessing the three deployment locations, the study establishes the DTT service contour and the area within which the DTT field may exceed the IMT I/N ≤ -6 dB protection criterion. The calculated interference region extends well beyond the DTT service contour and varies with the off-axis orientation of the IMT base-station antenna.

Figure 41: Cotonou DTT channel 42 coverage area



Source: TMG.

Figure 42: Cotonou DTT interference towards IMT base stations in Nigeria



DTT contours for IMT I/N = -6 dB levels for channel 47 at BS receiver at 100° (red), 60° (blue), and 30° (green) off-axis angles.

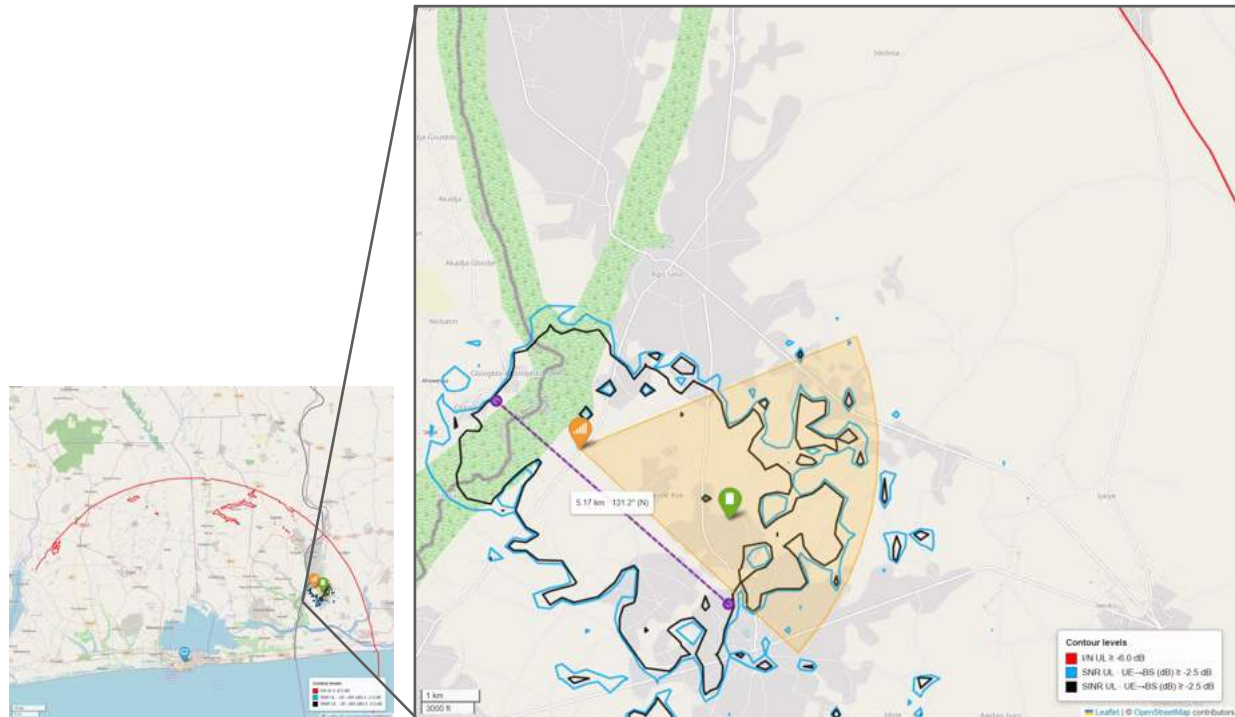
Source: TMG.

DTT interference into IMT base station

Tube

For the Tube deployment, the DTT field exceeds the $I/N \leq -6$ dB criterion within parts of the assessed IMT base-station coverage area. However, the resulting SINR contour remains closely aligned with the interference-free SINR contour, indicating that the DTT signal has only a limited effect on practical uplink coverage under the assessed configuration.

Figure 43: Cotonou DTT interference towards Tube IMT base stations



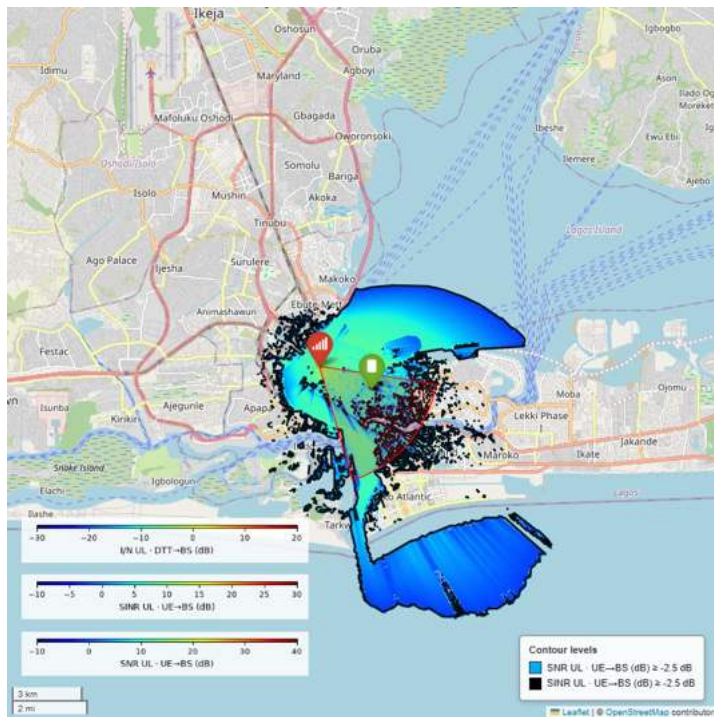
Impact of channel 47 DTT transmissions on IMT uplink reception. Blue shows uplink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

Lagos

For the Lagos deployment, the channel 47 signal remains detectable across much of the IMT service area and the $I/N \leq -6$ dB criterion is exceeded in parts of the coverage area. Nevertheless, the SINR remains close to the interference-free SINR because off-axis discrimination at the IMT base-station antenna reduces the coupled DTT signal. Under the assessed configuration, the impact on IMT uplink service is limited.

Figure 44: Cotonou DTT interference towards Lagos IMT base stations



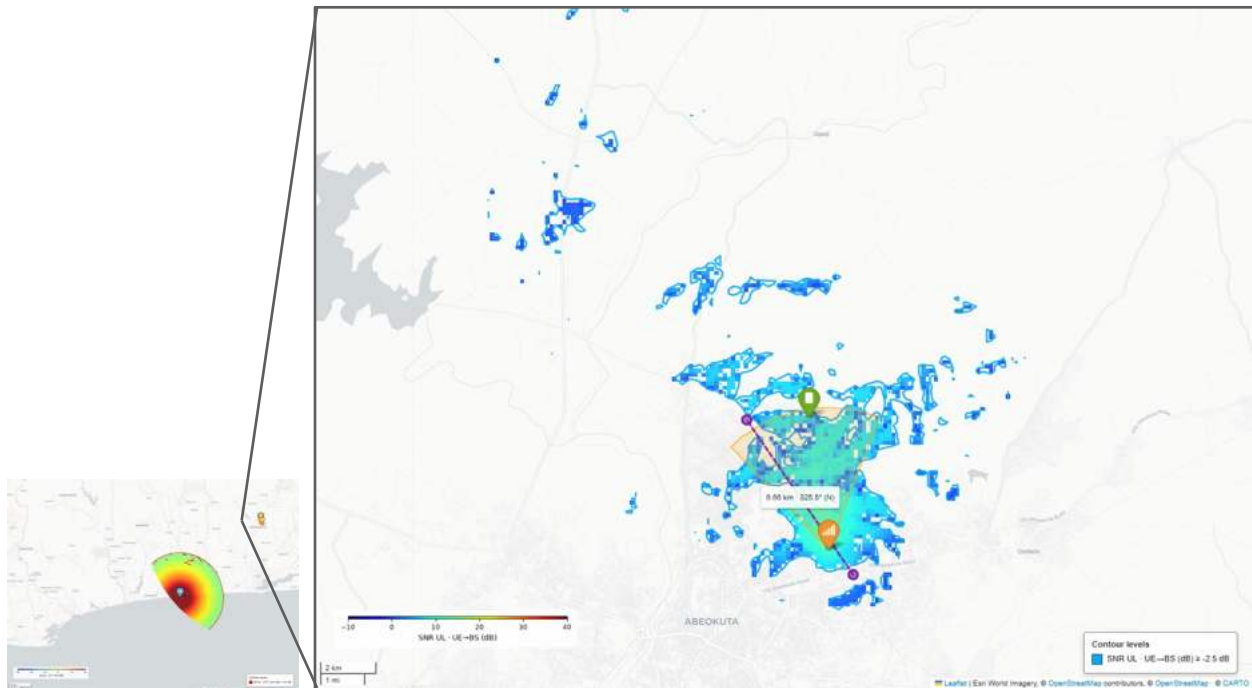
Impact of channel 47 DTT transmissions on IMT uplink reception. Blue shows uplink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

Abeokuta

The Abeokuta deployment is located approximately 130 km from the Cotonou DTT station. The $I/N \leq -6$ dB criterion is satisfied throughout the assessed IMT service area, and the resulting SINR remains effectively aligned with the interference-free SNR. Antenna off-axis discrimination further reduces the DTT signal received by the IMT base station.

Figure 45: Cotonou DTT interference towards Abeokuta IMT base stations



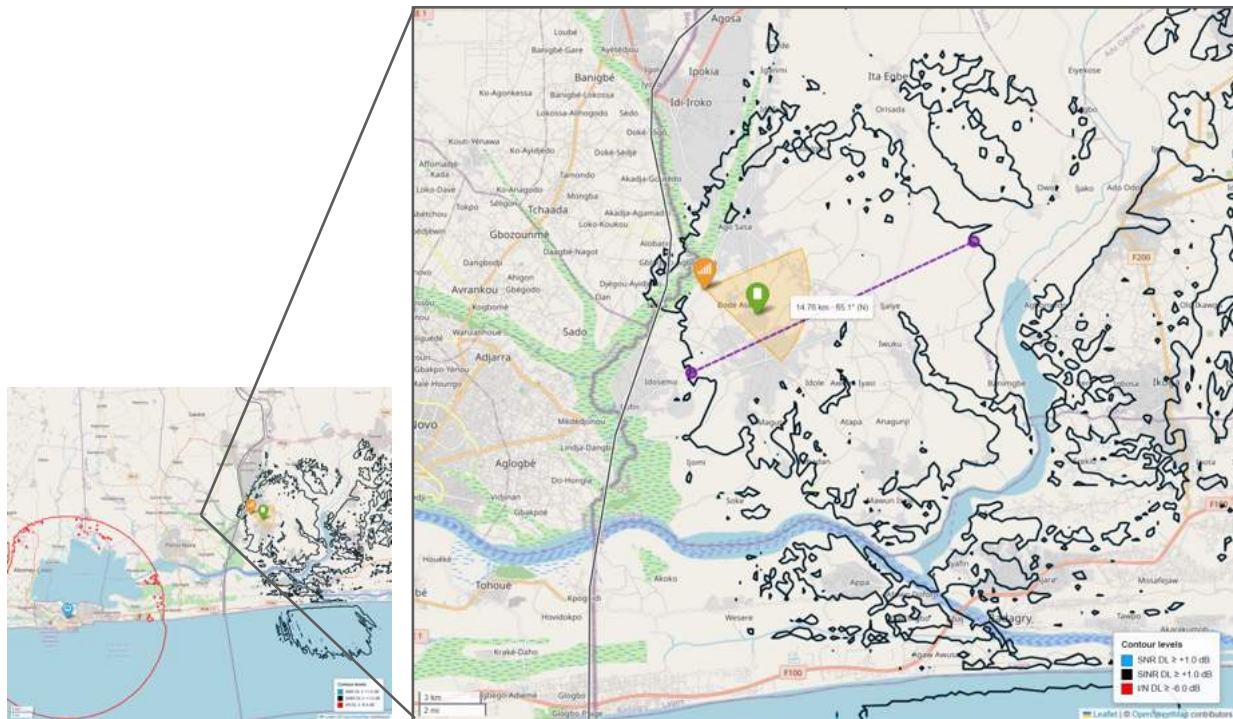
Impact of channel 47 DTT transmissions on IMT uplink performance. Blue shows uplink coverage without DTT interference; the area is not degraded by DTT interference.

Source: TMG.

DTT interference into IMT user equipment

DTT interference into IMT user equipment is less restrictive in all three scenarios. For Tube, the IMT downlink coverage remains effectively unchanged when the DTT signal is introduced. The Lagos and Abeokuta analyses similarly show little or no degradation of the interference-free downlink coverage, reflecting the stronger wanted downlink signal and the greater propagation loss affecting the DTT into UE path.

Figure 46: Cotonou DTT interference towards Tube IMT user equipment



Impact of channel 42 DTT transmissions on IMT downlink performance. Blue shows downlink coverage without DTT interference; black shows the area degraded by DTT interference.

Source: TMG.

The DTT interference into IMT results therefore identify the IMT base-station receiver as the more sensitive IMT victim but also show that an I/N exceedance does not necessarily translate directly into loss of service. Comparison of the SNR and SINR coverage maps is needed to determine the operational impact within each assessed deployment.

4.3.3.3. IMT into DTT

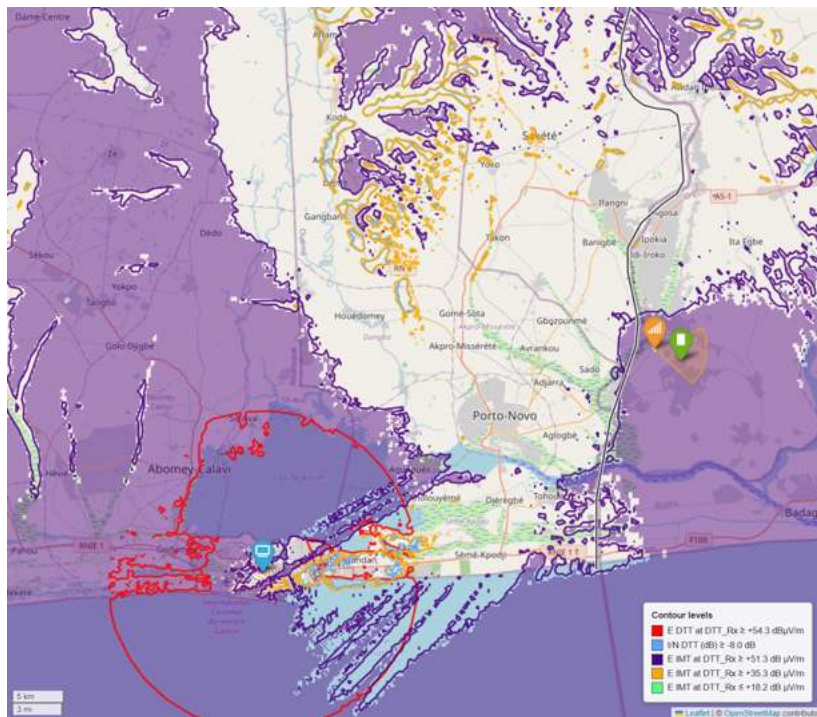
Interference from IMT into fixed DVB-T2 reception is assessed using the GE06 cross-border trigger and the receiver-based DVB-T2 criteria defined in Section 4.1.3. IMT base-station downlink interference is evaluated on channel 42, while IMT user-equipment uplink interference is evaluated on channel 47. The results differ substantially across the three locations because of terrain, clutter and propagation-path characteristics.

IMT base station interference into DTT reception

Tube

The Tube IMT base station produces high field strengths across substantial parts of the Cotonou DTT service area. Even after terrain and clutter losses and 16 dB of receiving-antenna discrimination are considered, extensive areas exceed the receiver-protection threshold, and the C/I criterion is not satisfied throughout the service area in the initial deployment configuration. This is partly due to the flat terrain around Cotonou and the limited terrain shielding along the path.

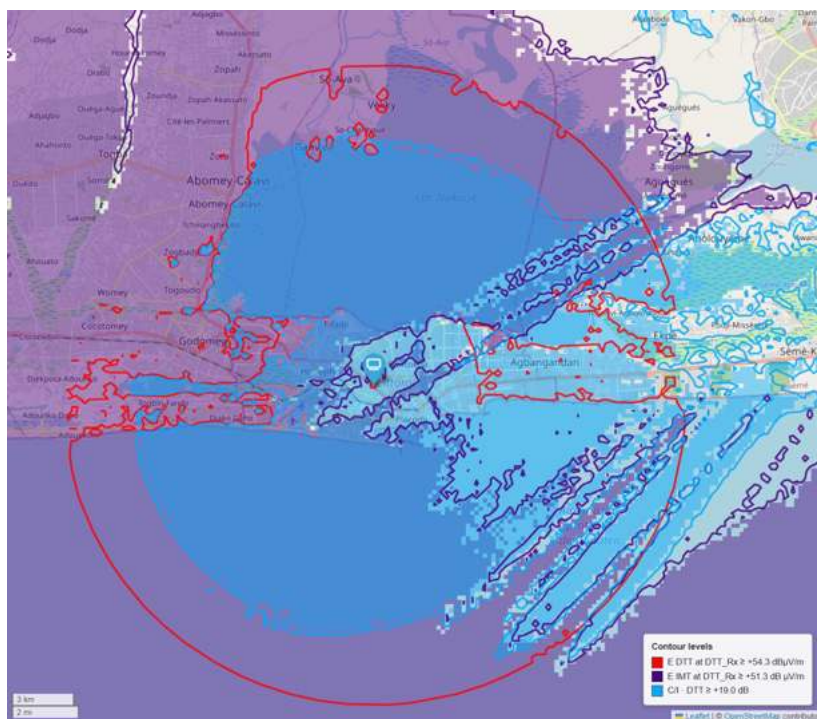
Figure 47: Tube IMT base-station interference towards Cotonou DTT reception



Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions into DTT channel 42.

Source: TMG.

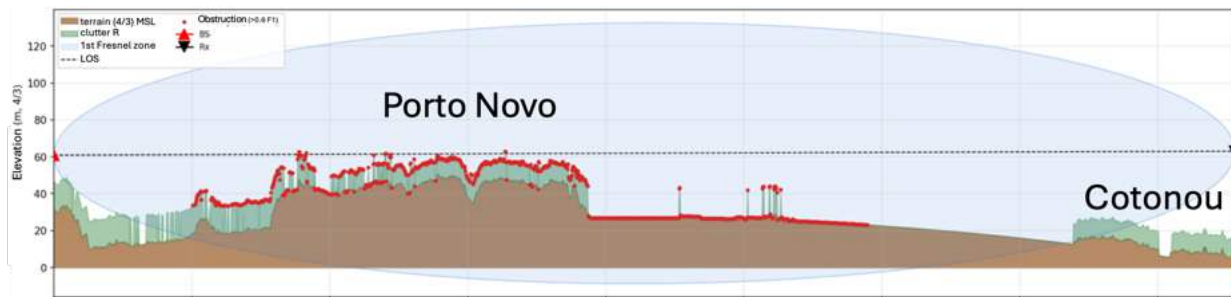
Figure 48: Tube IMT base-station interference towards Cotonou DTT reception considering clutter over terrain



DVB-T2 receiver-protection criteria for the Tube IMT downlink interference into Cotonou DTT channel 42 considering clutter over terrain.

Source: TMG.

Figure 49: Propagation profile between Tube and the Cotonou DTT station

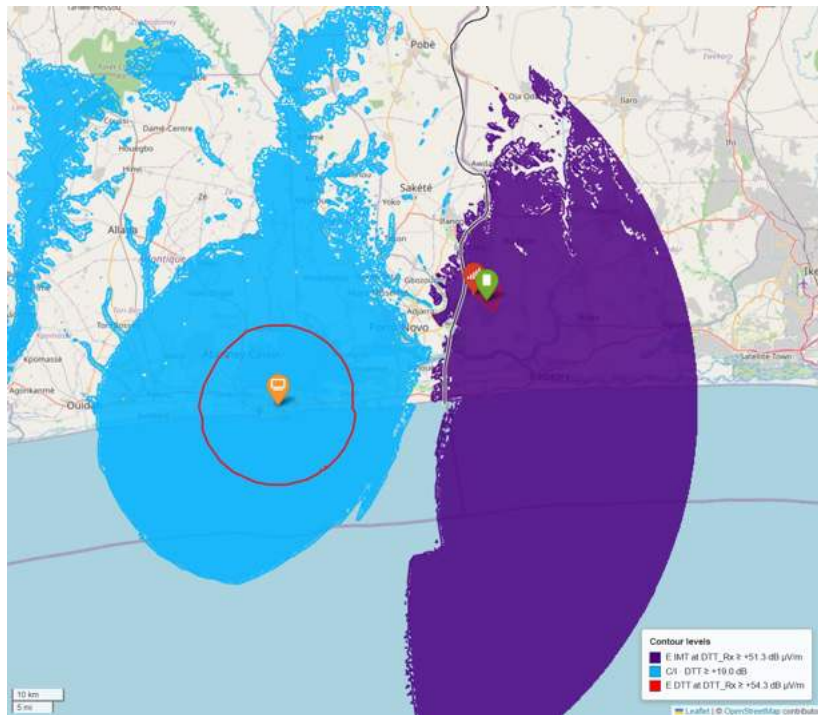


Terrain and clutter profile illustrating the limited natural shielding along the interference path.

Source: TMG.

The study evaluates an IMT base-station antenna with a 40 dB front-to-back ratio, oriented away from Benin. Under this mitigated configuration, field strengths above the DTT protection criteria are largely confined to the Nigerian side and the C/I criterion exceeds 19 dB throughout the DTT service area.

Figure 50: Tube IMT base-station interference towards Cotonou DTT reception considering antenna mitigation



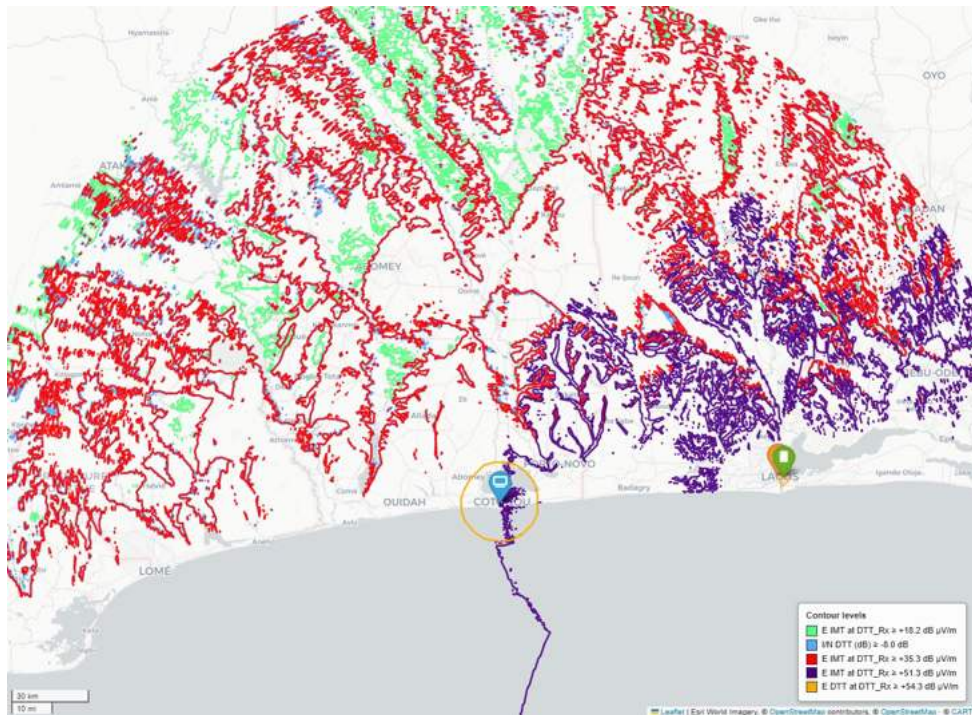
DVB-T2 receiver-protection criteria for the Tube IMT downlink interference into Cotonou DTT channel 42 considering the effect of a 40 dB front-to-back ratio and base-station orientation away from Benin.

Source: TMG.

Lagos

The Lagos base-station deployment produces the most significant unmitigated IMT into DTT interference identified in the three-location comparison. Although Lagos is approximately 132 km from the Cotonou DTT station, the shorter, largely over-water path to the protected DTT area results in field strengths above the protection criteria over substantial parts of the service area. Additional mitigation in the IMT base station, similarly to the case presented for Tube, would therefore be required.

Figure 51: Lagos IMT base-station interference towards Cotonou DTT reception



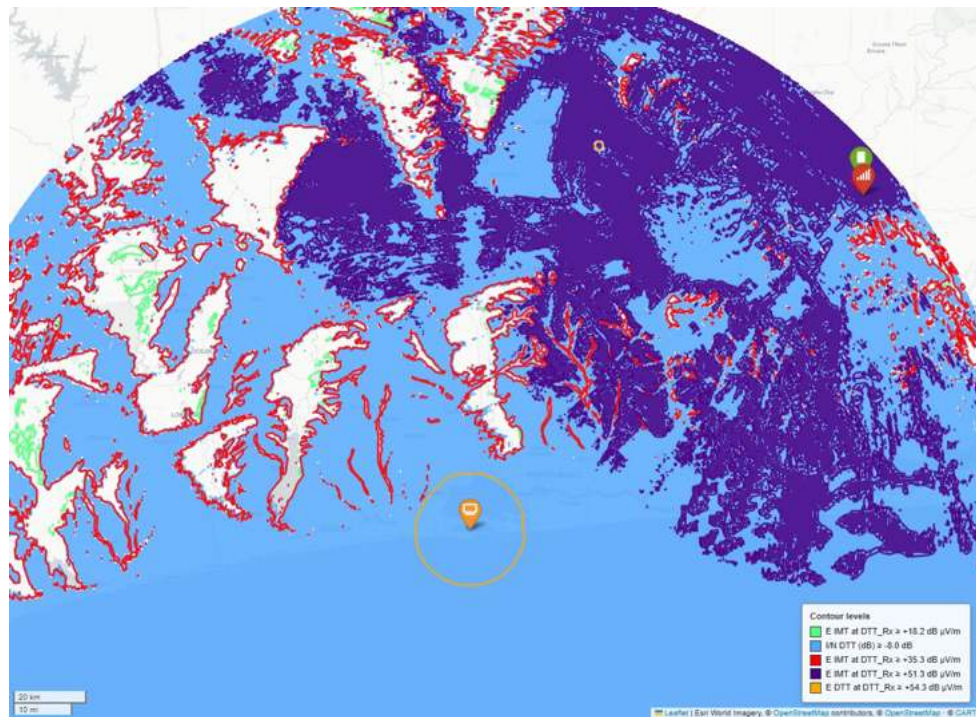
Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions into DTT channel 42.

Source: TMG.

Abeokuta

Abeokuta is also approximately 130 km from the Cotonou DTT station, but its inland propagation path produces a substantially less restrictive result. The IMT base station causes only a limited and localised increase in field strength within the DTT service area. The receiver-based protection thresholds are satisfied across almost all the protected area, and the C/I ratio remains above 30 dB despite I/N exceedances in parts of the service area.

Figure 52: Abeokuta IMT base-station interference towards Cotonou DTT reception



Comparison of GE06 field-strength triggers and receiver-based DVB-T2 protection criteria for IMT downlink transmissions into DTT channel 42.

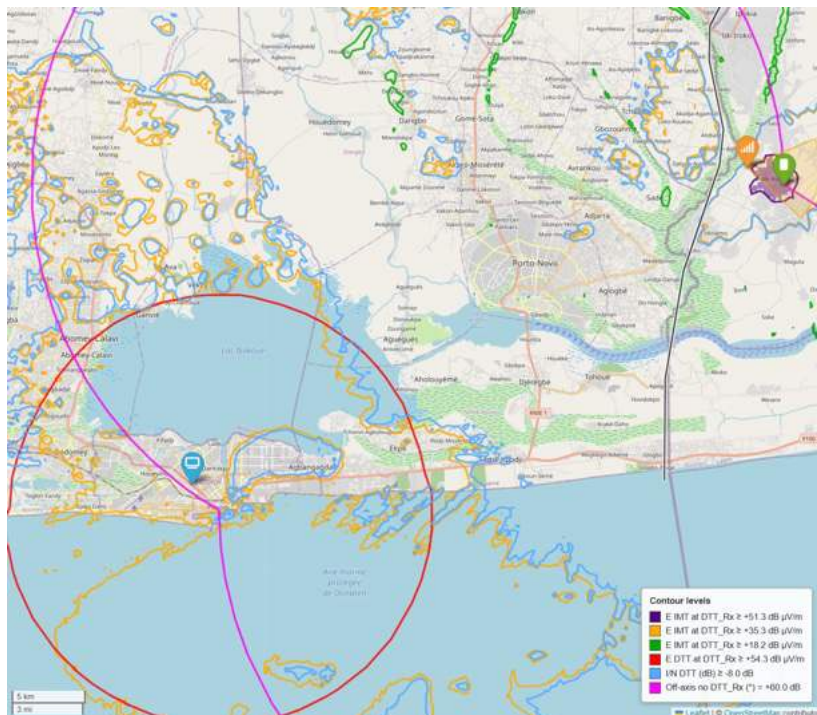
Source: TMG.

The contrast between Lagos and Abeokuta is particularly important: broadly similar cited separation distances produce different coexistence outcomes because one path is coastal and largely over water while the other is inland and subject to different propagation, terrain and clutter conditions.

IMT user equipment interference into DTT reception

Interference from IMT user equipment remains below the applicable DVB-T2 receiver-protection thresholds in all three scenarios. The combination of lower transmit power, power control and low antenna height results in field strengths that remain below the DVB-T2 protection thresholds throughout the protected service area. The study therefore identifies the IMT base station, rather than the user equipment, as the limiting IMT interferer.

Figure 53: Tube IMT user equipment interference towards Cotonou DTT reception



Comparison of GE06 and DVB-T2 receiver-protection criteria for IMT uplink transmissions overlapping with DTT channel 47 reception.

Source: TMG.

4.3.3.4. Key findings of the Nigeria and Benin case study

The study demonstrates that full co-channel operation can produce different coexistence outcomes depending on the propagation path and deployment location. Of the two DTT-to-IMT interference paths, interference into IMT base stations is the most restrictive, although its effect on service coverage remains limited in the assessed scenarios. DTT interference into IMT user equipment is consistently less significant.

IMT base-station interference into DTT reception is the main constraint. The Tube and Lagos scenarios produce substantial affected areas in their initial configurations, while the Abeokuta inland scenario remains largely compatible despite a separation distance similar to that stated for Lagos. The comparison demonstrates that coastal and over-water propagation, flat terrain and limited shielding can be more influential than separation distance alone.

The study also shows that antenna orientation and improved front-to-back ratio can reduce cross-border interference from IMT base stations, while IMT user-equipment interference remains limited in all scenarios. As in the preceding case studies, GE06 provides the initial regulatory coordination reference, while receiver-based and path-specific analyses are needed to identify actual protection requirements and appropriate mitigation measures.

4.4. Radio Astronomy Service compatibility

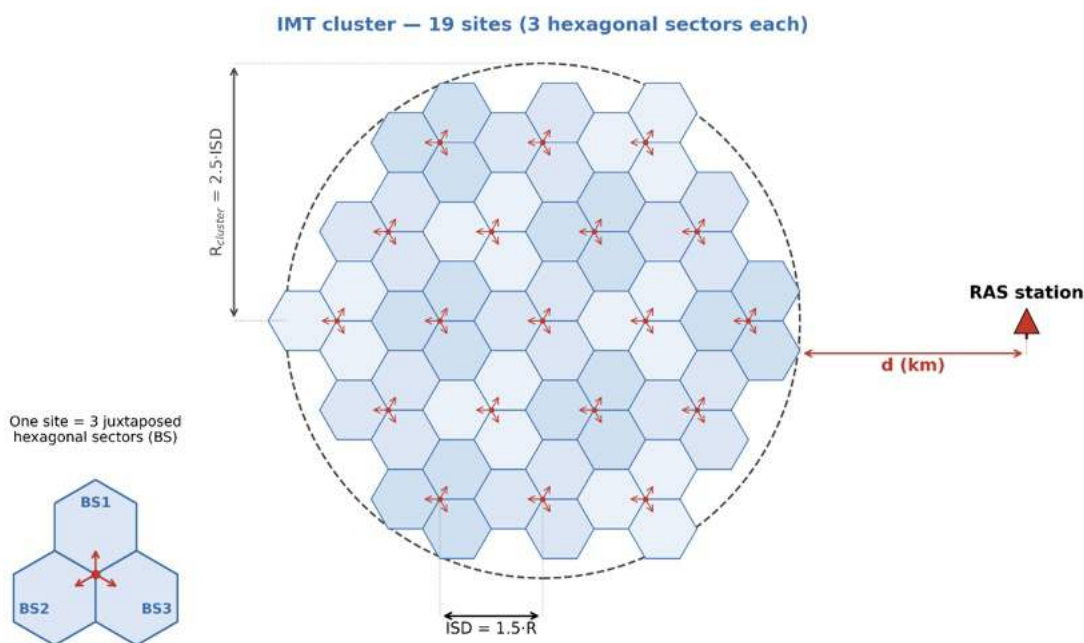
4.4.1. Study objective and scenario

RAS operates in the frequency band 608-614 MHz and supports highly sensitive scientific observations that require exceptionally low levels of radio-frequency interference. This preliminary study assesses the compatibility between IMT systems and RAS observations in the UHF band by evaluating interference from IMT downlink, uplink and sidelink transmissions into RAS stations operating in the 608-614 MHz band. Additional studies into compatibility between IMT systems and RAS observations in the UHF band are under way to further update this initial analysis.

Two deployment configurations are considered. The first assumes a 10 MHz IMT channel starting at 612 MHz, resulting in a 2 MHz overlap with the RAS allocation. The second assumes an 8 MHz IMT channel immediately adjacent to the RAS with no guard band. These configurations represent partially co-channel and adjacent-channel coexistence scenarios, respectively.

Unlike the previous coexistence studies, which focused on individual transmitter-receiver relationships, this assessment considers aggregate interference generated by an IMT network and received by a highly sensitive scientific service. A cluster of 19 IMT sites is modelled, comprising three-sector base stations and associated user equipment, in various distances from a representative RAS station.

Figure 54: IMT cluster and RAS station study geometry



Source: TMG.

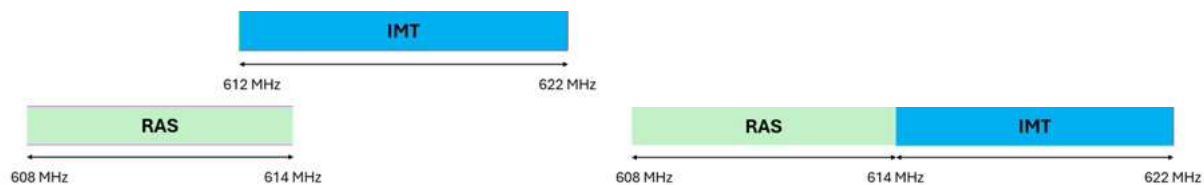
The IMT system is represented using the technical characteristics adopted by ITU-R Working Party 5D for sharing and compatibility studies in bands below 1 GHz, as detailed in Section 4.1. The deployment consists of rural macro cells with an 8 km cell radius, three-sector base stations, a 30 m antenna height and a maximum e.i.r.p. of 58 dBm per sector. Base stations employ non-AAS antennas with

Recommendation ITU-R F.1336 radiation patterns, 3° downtilt and $\pm 45^\circ$ polarisation. User equipment operates with a maximum transmit power of 23 dBm and is distributed throughout the IMT coverage area.

The RAS protection criteria defined in Recommendation ITU-R RA.769 for continuum observations in the 608-614 MHz band is -202 dBW. A representative radio telescope height of 50 m is assumed, together with the standardised 0 dBi reference side-lobe gain used in RAS compatibility studies. This approach provides a consistent basis for assessing compatibility independently of the characteristics of a specific radio telescope installation.

Three forms of IMT operation are considered. The first is conventional downlink operation, in which interference is generated by multiple high-power base stations and typically represents the most demanding compatibility scenario. The second is conventional uplink operation, where interference originates from power-controlled user terminals operating with significantly lower transmit powers. The third is sidelink operation, which enables direct device-to-device communications without routing traffic through a base station. In sidelink mode, multiple user terminals may transmit simultaneously using uplink spectrum resources, and the aggregate interference level depends primarily on the number of active terminals and their transmit power. The study evaluates a public-safety sidelink scenario derived from 3GPP TR 36.843,⁴⁰ including different numbers of simultaneously transmitting users and transmit-power configurations.

Figure 55: Partially co-channel and adjacent-channel deployment scenarios



Source: TMG.

4.4.2. Methodology

The analysis is performed using Monte Carlo simulations. For each simulation run 100,000 snapshots are generated, with the IMT cluster randomly rotated through all azimuth directions while maintaining a fixed separation distance between the edge of the IMT deployment and the RAS station. Aggregate interference levels are then calculated and compared with the Recommendation ITU-R RA.769 protection criterion.

Propagation modelling between the IMT network and the radio astronomy station is evaluated using Recommendation ITU-R P.452 with time percentage parameter p fixed at 1%, combined with Recommendations ITU-R P.2108 and P.2109 to account for clutter and building entry effects, for scenarios when applicable. The study employs terrain and clutter characteristics derived from a France-Germany border path, thereby incorporating diffraction, radio-horizon and shielding effects that would not be captured by simpler planning models.

The separation distance between the IMT cluster and the RAS station is varied to determine the minimum distance required to satisfy the RAS protection criterion.

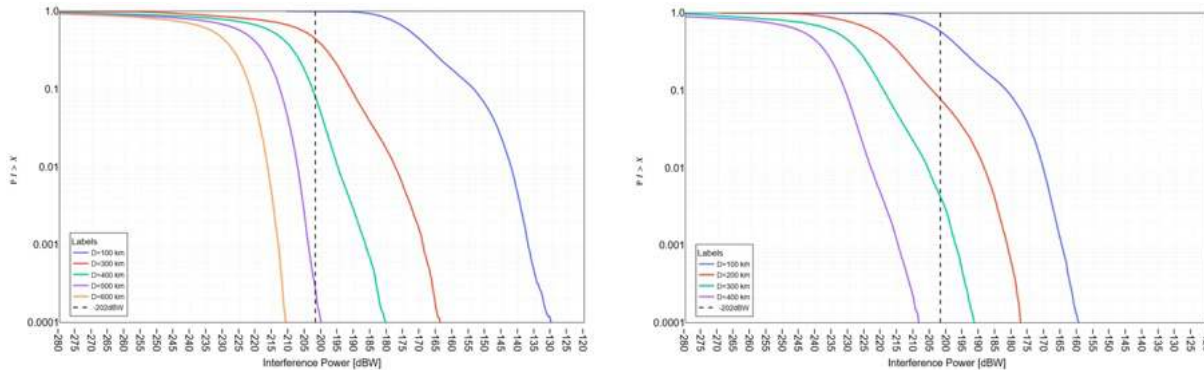
⁴⁰ 3GPP TR 36.843, Study on LTE Device to Device Proximity Services; Radio Aspects, https://www.3gpp.org/ftp/Specs/archive/36_series/36.843/.

4.4.3. Results and mitigation measures

4.4.3.1. IMT downlink interference

The IMT downlink case produces the highest aggregate interference levels. The simulations indicate that coordination distances of approximately 500 km are required for the partially co-channel scenario and approximately 400 km for the adjacent-channel scenario to satisfy the RAS protection criterion. These values reflect the cumulative effect of emissions from multiple base stations within the IMT cluster.

Figure 56: CCDF of the aggregate interference power produced by IMT (downlink) at RAS: (left) partially co-channel interference and (right) adjacent-channel interference

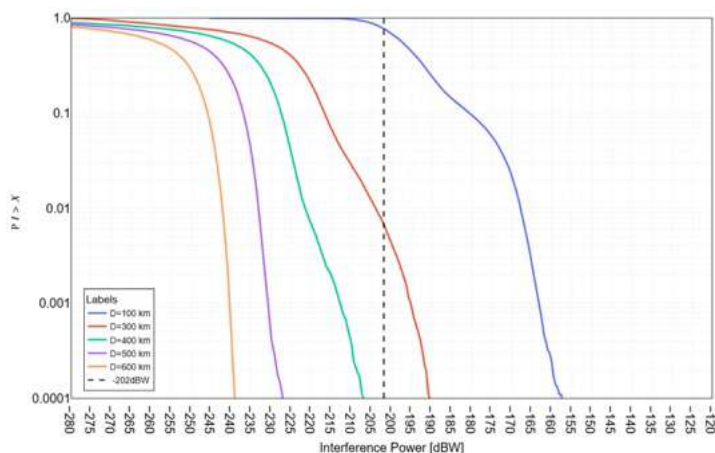


Source: TMG.

4.4.3.2. IMT uplink interference

The IMT frequency arrangement that would overlap with RAS in this range would refer to downlink, but it would be important to understand the impact of other arrangements. In the case of the uplink scenario, it produces substantially lower interference levels than the downlink scenario. The analysis indicates a reduction of approximately 25 dB in aggregate interference for low and median percentiles, resulting in significantly reduced compatibility concerns.

Figure 57: CCDF of the aggregate interference power produced by IMT (uplink – partially co-channel interference) at RAS

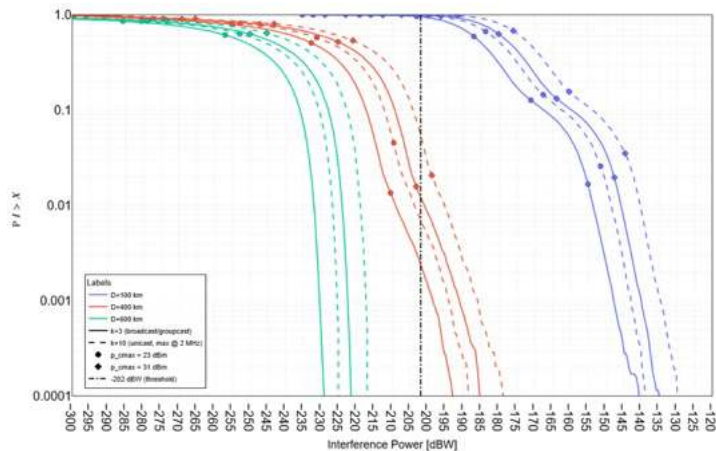


Source: TMG.

4.4.3.3. IMT sidelink interference

The sidelink scenario produces intermediate results. Depending on the number of simultaneously active devices and the transmit power adopted, coordination distances between approximately 400 km and 600 km may be required to satisfy the RAS protection criterion, if no mitigation techniques are employed. The number of active terminals becomes the dominant factor influencing aggregate interference levels.

Figure 58: CCDF of the aggregate interference power produced by IMT (sidelink – partially co-channel interference) at RAS



Source: TMG.

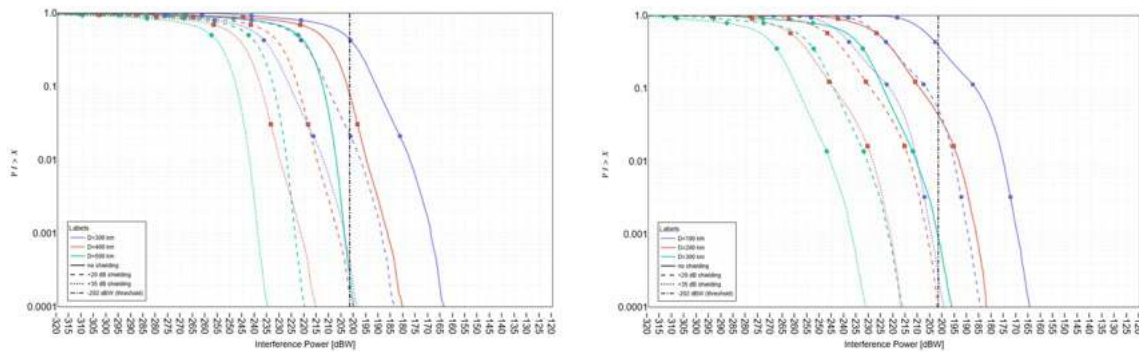
4.4.3.4. Consideration of mitigation measures to reduce required coordination distances

The analyses presented in the previous subsections indicate that protection of the RAS may require coordination distances of several hundred kilometres, depending on the deployment configuration and interference scenario considered. In practice, however, administrations may consider a range of technical and operational measures to reduce the required separation distances while maintaining compliance with the applicable RAS protection criteria.

The study evaluated mitigation measures that can either reduce the aggregate interference reaching the RAS station or reduce the overall emissions generated by the IMT network. These include the use of natural or artificial shielding near the RAS site, optimisation of network deployment parameters, management of transmit power and operational controls that limit the number of simultaneously active transmitters.

For the IMT downlink case, the use of natural or artificial shielding was found to provide the most significant reduction in aggregate interference. The results indicate that additional attenuation between the IMT deployment and the RAS station can substantially reduce the required coordination distance when compared with the baseline scenario. By contrast, increasing the base-station antenna downtilt from 3° to 6° was found to have only a limited effect on the resulting interference levels and coordination requirements. These results suggest that site-specific shielding measures are generally more effective than modifications to the base-station antenna configuration for protecting RAS observations.

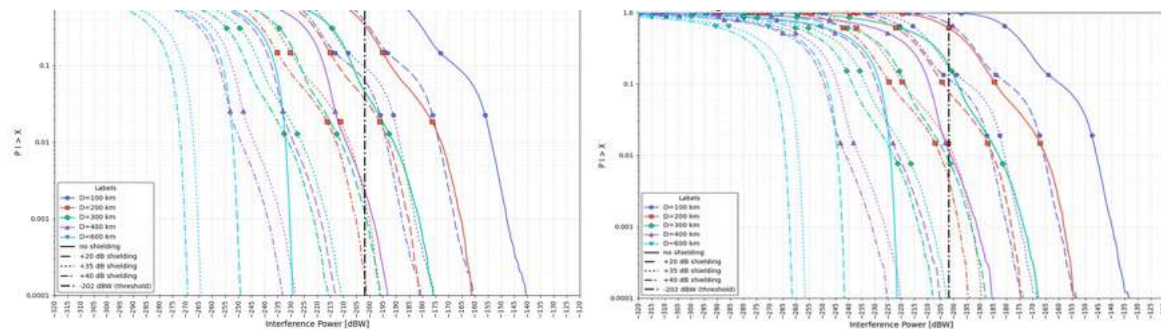
Figure 59: CCDF of the aggregate interference power produced by IMT (downlink) at RAS with artificial shielding: (left) partially co-channel interference and (right) adjacent-channel interference



Source: TMG.

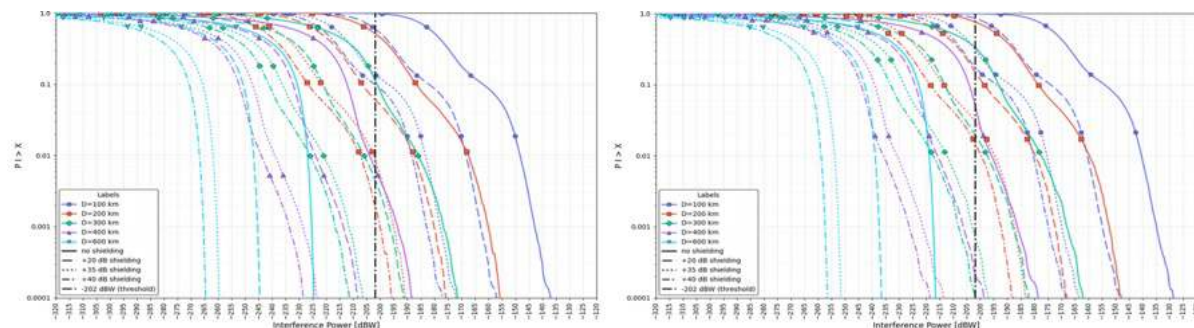
For IMT sidelink operation, the results indicate that coordination distances depend not only on the propagation environment but also on operational parameters such as the number of simultaneously transmitting user terminals and their transmit power. The simulations show that the combination of shielding measures with lower terminal transmit powers and reduced traffic loading can significantly reduce aggregate interference levels at the RAS station. Consequently, the coordination distances associated with sidelink operation are strongly dependent on the specific deployment assumptions and may be substantially reduced when appropriate mitigation measures are applied.

Figure 60: CCDF of the aggregate interference power produced by IMT (sidelink – partially co-channel interference) at RAS with artificial shielding and $k = 3$ UEs: (left) $p_{\text{cmax}} = 23$ dBm and (right) $p_{\text{cmax}} = 31$ dBm



Source: TMG.

Figure 61: CCDF of the aggregate interference power produced by IMT (sidelink – partially co-channel interference) at RAS with artificial shielding and $k = 10$ UEs: (left) $p_{\text{cmax}} = 23$ dBm and (right) $p_{\text{cmax}} = 31$ dBm



Source: TMG.

4.4.4. Preliminary findings on RAS compatibility

The preliminary analysis indicate that protection of RAS may require coordination distances of several hundred kilometres, depending on the IMT deployment configuration and interference mechanism considered. Among the scenarios evaluated, IMT downlink transmissions produce the highest aggregate interference levels, while uplink transmissions are substantially less restrictive. For sidelink operation, the results depend primarily on the number of simultaneously active terminals and their transmit power.

The study also demonstrates that coordination distances are strongly influenced by site-specific deployment conditions and mitigation measures. In the downlink case, the application of shielding measures reduced coordination distances from approximately 500 km to around 300 km under the assumptions considered. For sidelink operation, the combination of shielding, lower terminal transmit powers and reduced traffic loading reduced coordination distances from approximately 400-600 km to approximately 250-450 km. By contrast, increasing base-station antenna downtilt provided only limited additional benefit. These results highlight the importance of site-specific compatibility studies when assessing coexistence between IMT systems and radio astronomy facilities. Additional analysis is under way to assess specific scenarios that could facilitate the compatibility between these two systems.



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