Cross Broder RF Interference Management

ITU CoE training on Spectrum Engineering & Cross-border Radio Frequency Coordination

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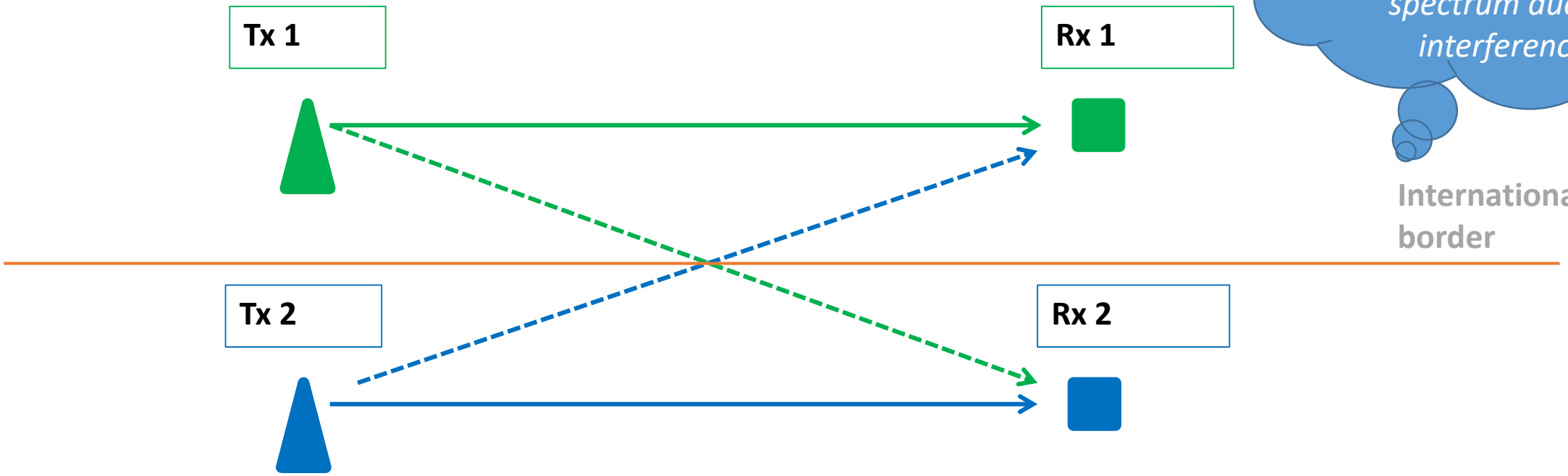
What to expect in these slides

- ✓ Interference?
- ✓ Approaches to address cross border RF interference issues
- ✓ Advantages and Dis-advantages of Coordination
- ✓ Situation in Asia-Pacific
- ✓ Going Forward and suggestions to address the issue
- ✓ Conclusion

Interference

! Imagine losing all the financial contribution to exchequer due to inability to use spectrum due to interference



Interference:
Any signal received from Transmitter different than the intended one

RR 1.166 (interference):
The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.

International concept of Interference

- **1.167 Permissible interference:**
  - *Observed or predicted interference which complies with quantitative interference and sharing criteria contained in these Regulations or in ITU-R Recommendations or in special agreements as provided for in these Regulations.*

- **1.168 Accepted interference:**
  - *Interference at a higher level than that defined as permissible interference and which has been agreed upon between two or more administrations without prejudice to other administrations.*

- **1.169 Harmful interference:**
  - *Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations (CS).*

International roles of SM

- Supporting harmonized global frequency allocations,
- Providing and supporting common standards to achieve the highest level of interoperability and to enable successful interconnection between various systems,
- **Contribution and supporting regional agreements on utilization of specific frequency bands,**
- **Protection of governed national frequency assignments while recognizing frequency assignments of other governments,**
- **Protection of internationally assigned frequency from harmful interference,**
- Encouraging new technologies to move toward industrial methods utilizing radio frequency spectrum and orbital positions more efficiently,
- Exchanging gained experience and profession to promote spectrum management activity of concerned administrations,
- **To cooperate with international treaties with the aim of promotion of availability and reliability of radiocommunication anywhere anytime**

Approaches to address cross border RF interference issues

Managing cross Border Interferences

Global Frameworks

- International Organizations

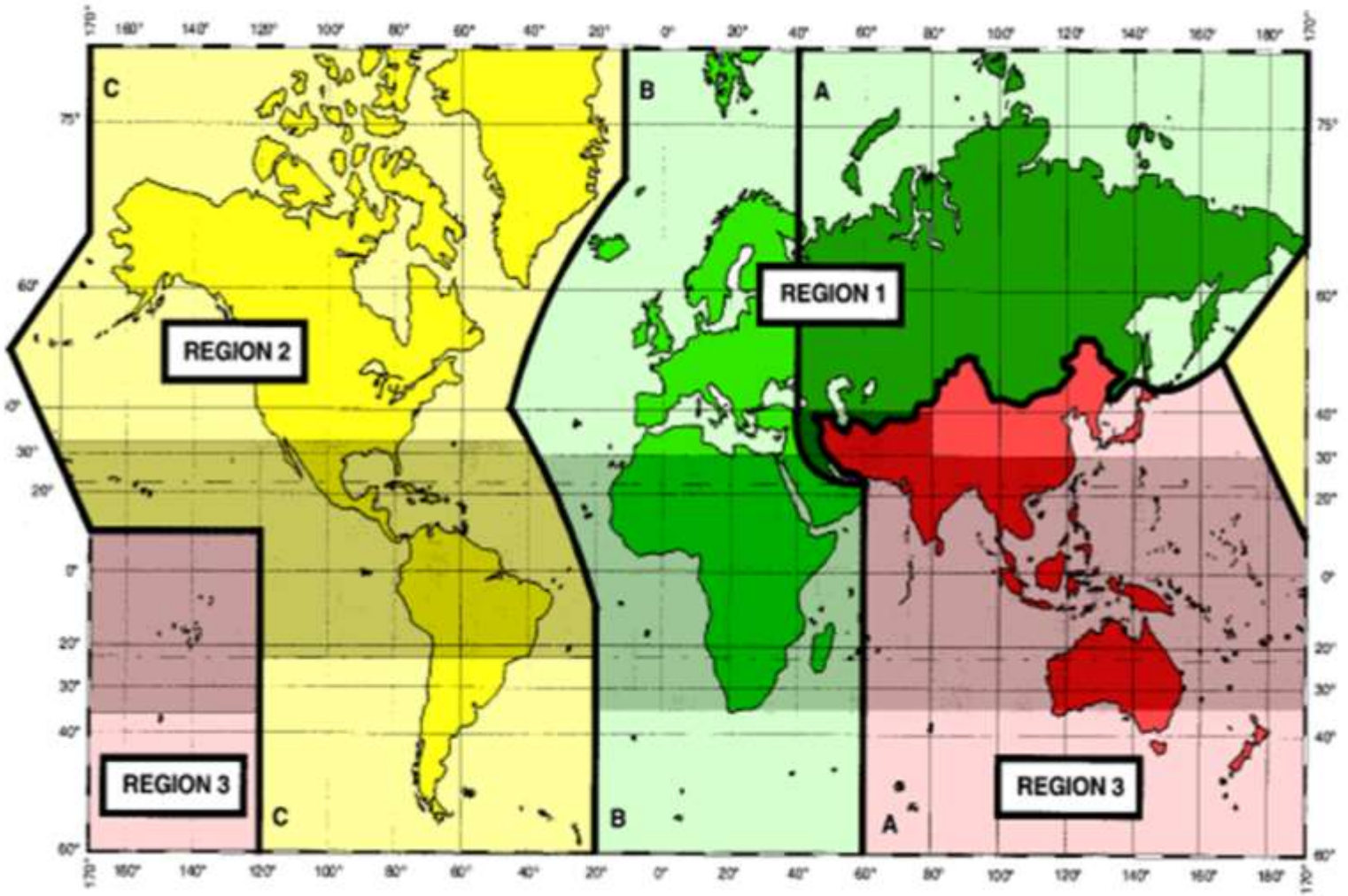
Regional Frameworks

- Regional Organizations

Bilateral/MultiLateral/subregional Frameworks

- Agreements between countries

Frequency Coordination at Global Level



The shaded part represents the Tropical Zones as defined in Nos. 5.16 to 5.20 and 5.21

- **Example**
  - ITU Radio Regulations
    - *Article 5 Allocation Table*
    - *Annexures for plans*
- **Pros:**
  - Easier to implement with global backing of Admins
  - More acceptance once agreed
  - Economies of scale
- ***Cons***
  - Difficult to agree to a global solution
  - Flexible and not tailor made for any region/country situation

Frequency Coordination at Regional Level

Regional co-ordination on spectrum Management

- Exchange information and experiences to foster the harmonization of spectrum management rules
- Facilitating efficient and flexible use of the spectrum
- Coordinating the Use of Technical Standards across Regions
- Managing interference by establishment of a common framework
- Prepare common positions to be presented to regional, then global instances

- **Example**
  - APT Plans
- **Pros:**
  - Relatively easier to implement due to acceptance of regional Admins
  - Economies of scale
- ***Cons***
  - Less difficult to agree than a global solution
    - *Challenge to agree if region is diverse*
  - Still Flexible and not tailor made for any geographical situation

Regional Organizations

Name	Official website
APT - Télécommunauté Asie-Pacifique - Asia-Pacific Telecommunity - Telecomunidad Asia-Pacífico, BANGKOK, Thailand	www.apt.int
ASMG- Arab Spectrum Management Group	http://asmg.ae
ATU - Union africaine des télécommunications - African Telecommunications Union - Unión Africana de Telecomunicaciones, NAIROBI, Kenya	www.atu-uat.org
CANTO - Association des entreprises nationales de télécommunications des Caraïbes - Caribbean Association of National Telecommunication Organizations - Asociación de Organizaciones Nacionales de Telecomunicaciones del Caribe, PORT OF SPAIN, Trinidad and Tobago	www.canto.org
CEPT - Conférence européenne des Administrations des postes et des télécommunications - European Conference of Postal and Telecommunications Administrations - Conferencia Europea de Administraciones de Correos y Telecomunicaciones, VALLETTA, Malta	www.cept.org
CITEL - Commission interaméricaine de télécommunications - Inter-American Telecommunication Commission - Comisión Interamericana de Telecomunicaciones, WASHINGTON, D.C., United States	www.citel.oas.org
COMTELCA - Commission technique régionale des télécommunications - Telecommunications Regional Technical Commission - Comisión Técnica Regional de Telecomunicaciones, TEGUCIGALPA, M.D.C., Honduras	www.comtelca.org
COPTAC - Conférence des Postes et Télécommunications de l'Afrique centrale - Conference of Posts and Telecommunications of Central Africa - Conferencia de Correos y Telecomunicaciones de África Central, YAOUNDE, Cameroon	n/a
CTU - Union des télécommunications des Caraïbes - Caribbean Telecommunications Union - Unión de Telecomunicaciones del Caribe, PORT-OF-SPAIN, Trinidad and Tobago	http://www.ctu.int/
ETSI - Institut européen des normes de télécommunication - European Telecommunications Standards Institute - Instituto Europeo de Normas de Telecomunicaciones, SOPHIA ANTIPOLIS CEDEX, France	www.etsi.org
LAS - Ligue des Etats Arabes - League of Arab States - Liga de los Estados Árabes, CAIRO, Egypt	www.arableagueonline.org
RCC - Communauté régionale des communications - Regional Commonwealth in the Field of Communications - Comunidad Regional de Comunicaciones, MOSCOW, Russian Federation	www.rcc.org.ru

Bilateral

Bilateral /Multi-Lateral / sub-regional Arrangement

Cross-border co-ordination by harmonizing the use of frequency spectrum.

develop means of resolving instances of unexpected harmful interference

- **Example**
  - Trilateral meeting between IND-MLA-SNG
  - Agreements of Thailand with Neighbors
- **Pros:**
  - Relatively easier to agree
  - Very specific solution to a particular problem
- **Cons**
  - Difficult to implement
    - *To common from neutral administrations to implement*
  - Difficult to plan nationally with multiple arrangements with several neighbors

Advantages and Dis-Advantages of Coordination

Advantages of Coordination

- AIM: Optimise spectrum usage
- Administrations obliged to co-ordinate frequencies before assigning them
- Administrations obliged to ensure harmonised application of technical provisions
- Quick assignment of preferential frequencies
- Transparent decisions through agreed assessment procedures
- Quick assessment of interference through data exchange

Advantages of Coordination

- **The agreement may also cover issues related to coordinated use of Infrastructure belonging to different Admins for RF monitoring**

  Neighboring countries are increasingly endeavoring to provide harmonized radio communications to facilitate cross-frontier operations by adopting common specifications. This phenomenon is a very marked one encourages the countries concerned to set up harmonized or even integrated monitoring facilities by using identical procedures and, under certain circumstances, a common infrastructure.

  This would make monitoring services more efficient and also lead to lower and, therefore, more readily acceptable financial investments for monitoring infrastructure.

- **Resolution ITU-R 23 refers to the need of**

Cooperation between monitoring stations of different administrations should be encouraged and improved with a view to exchanging monitoring information concerning terrestrial and space stations emissions, and to settling harmful interference caused by transmitting stations that are difficult to identify or cannot be identified;

Advantages of Coordination

Coordinated use of Infrastructure belonging to different Admins for Monitoring: Examples

× **Collaboration below 30 MHz**

- **Avoiding overlapping of activities by monitoring stations covering the same area**
  close cooperation can be organized between these stations so that they can take part, in turn, in a specific monitoring programme. For this purpose, the part of the spectrum to be monitored can be divided into sub-bands that each monitoring station taking part in the programme will explore in turn in accordance with a predetermined timetable

- **Arrangements can be implemented either for particular purposes, for instance during special monitoring programmes organized by the Bureau, or they can be of a more permanent nature**

- **Determination of the location of a transmitter and its identification, particularly in the case of harmful interference**

Advantages of Coordination

Collaboration Above 30 MHz

- **First category:**

  Cases in which the regional authorities on both sides of the frontier are authorized to enter into direct contact, for example, only when the frequencies concerned are the direct responsibility of the regional center (frequencies to be specified), on the basis of RR No. 16.3; the cooperation can be to

  - *carry out measurements from their own territory on transmitters in the neighboring country, at its request, and transmitting the results to it;*
  - *authorizing a mobile team from the neighboring country to come and take measurements itself;*
  - *mutual assistance in both cases.*

- **Second category:**

  - *Joint establishment of a plan for the distribution of monitoring stations in frontier areas;*
  - *Definition of the interfaces to enable each country to take measurements of transmitters located on its own territory from any station in the frontier area;*
  - *Establishment of a schedule for installing harmonized monitoring facilities.*

Advantages of Coordination

- **Third category:**
  - *Exchange of lists of authorized networks in the frontier areas of each country, together with their technical characteristics, so that "foreign" transmitters are no longer regarded as unknown;*
  - *Exchange of such lists using automatic remote data transmission procedures.*

The first category is to be regarded as the initial step while the second and third categories constitute longerterm objectives.

Arrangements of this kind exist in many parts of the world, particularly in congested areas.

- The longstanding arrangements among Canada, Mexico, and the USA constitute a typical example of such cooperation.

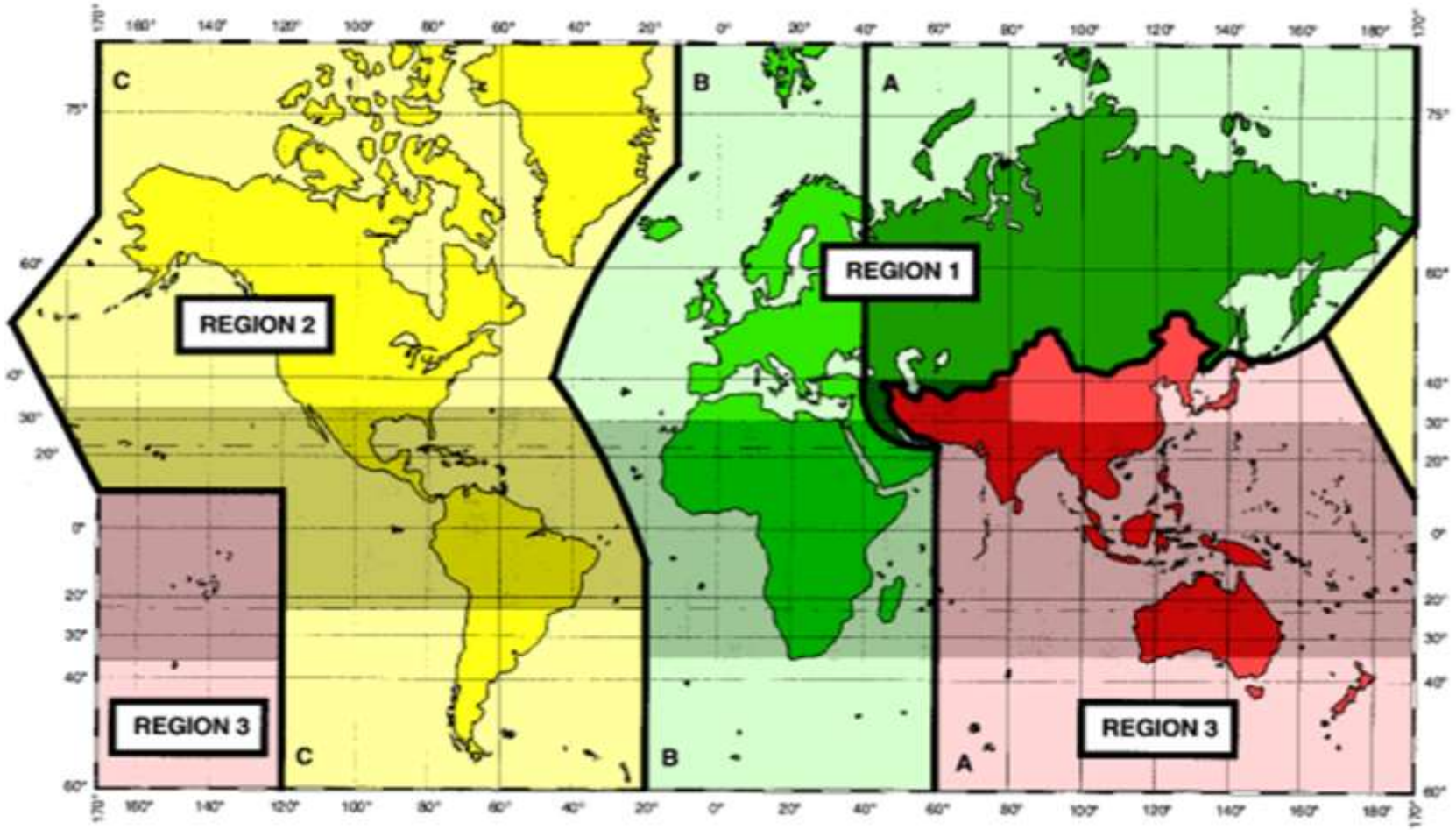
- The need for such collaboration is also exigent in the European area where, for instance, France, Germany and Switzerland entered into an agreement of the first category in 1993

Dis-advantages of Coordination

- Increase in administrative work and costs (complex procedures, longer turnaround times, topographical database)
- Detailed input data required from operators (geographical data, antenna parameters)
- Customers affected by changes in usage rights: Various consequences
- Limits also to preferential frequencies, limits may vary from case to case
- More work in application processing.

Situation in Asia-Pacific

Welcome To ASP: Predominantly Region 3



Note the diversity in

- **Geography**
  - *Archipelagos*
  - *Island sates*
  - *Landlocked*
  - *Himalayas*
- **Level of Development in ICTs**
  - *IDI index rankings range from 1 to 164*

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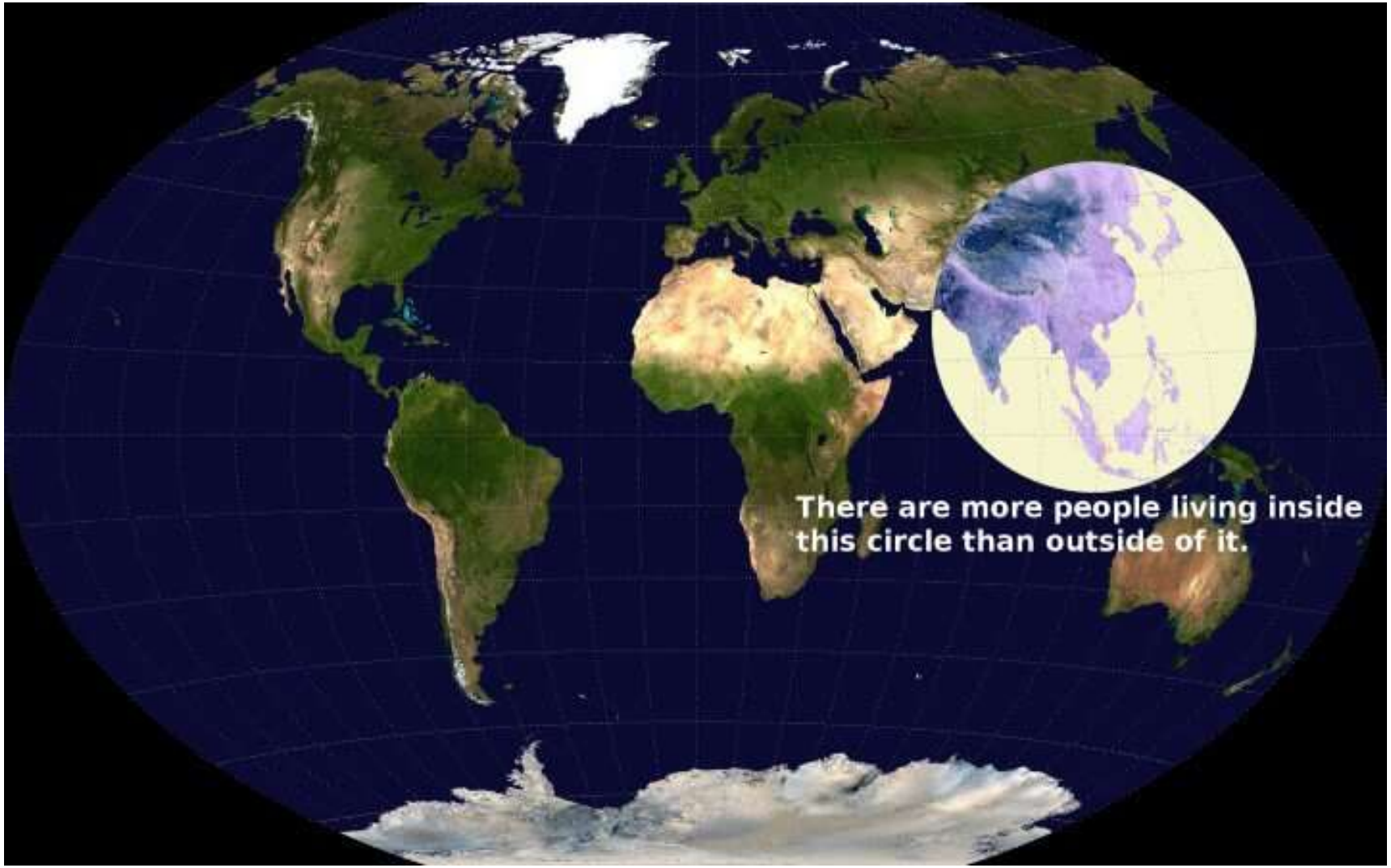
Understanding the need of Framework on cross border RF Management



Source: http://brilliantmaps.com/population-circle/

Cross Border RF Interference Mitigation

- **Some Facts**
  - *Significant population concentration on the border areas of countries in e.g. Cambodia - Lao P.D.R – Thailand - Vietnam etc.*

  - *Interference Issues always exist has primarily due to nonexistence of any formal agreement on the management of this issue at regional and/or sub-regional level.*

- **Some Examples of Sub-regional approaches in ASEAN to address the issue**

  - ***Indonesia-Malaysia-Singapore*** *under the trilateral forum between the three countries;*
  - ***Singapore-Malaysia-Brunei*** *using Frequency Assignment and Coordination, Singapore, Malaysia and Brunei Darussalam (FACSMAB) platform.*
  - *Bilateral agreements of Lao P.D.R with Vietnam and Thailand separately.*
  - *Activities of* ***SAARC*** *in South-Asia*

Recognition of Cross Border RF Interference issue

- **ASEAN**

  ASEAN ICT MASTERPLAN 2020

  6.1.3 (*Harmonize Telecommunication Regulations)*

  "Recognizing the potential for cross-border spectrum conflict in light of new technologies such as unlicensed and dynamic spectrum allocation, this aims to develop a guideline, based on best practices, for managing such developments regionally) "

- **SAARC**

  Recognized Areas of Cooperation

Information And Poverty Alleviation

II. Telecommunications and ICT

Cross border interference on Radio Signals

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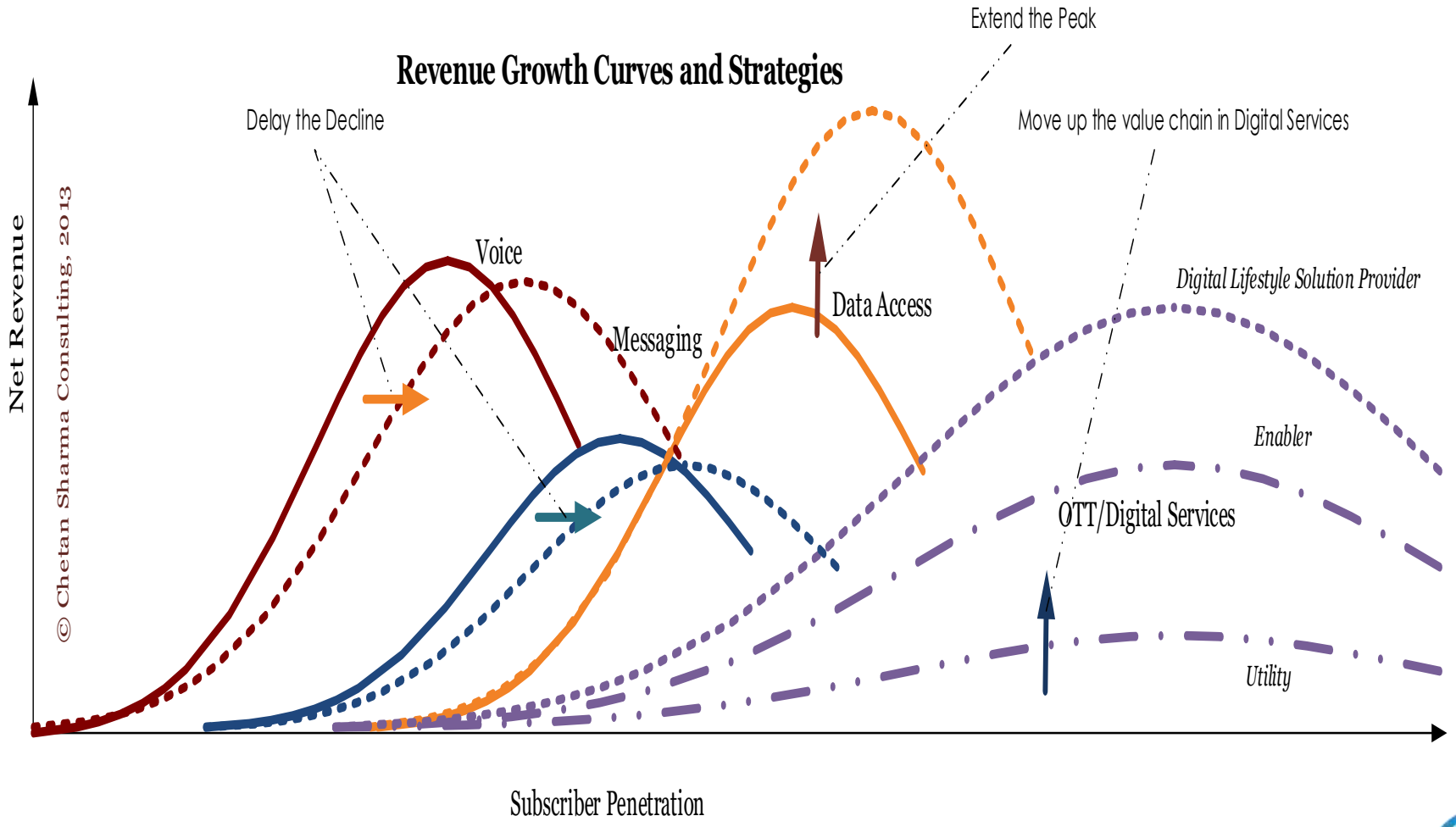
Going Forward and suggestions to address the issue

What we know now?

4th wave of growth in telecom sector



Current wave is defined by its complexity

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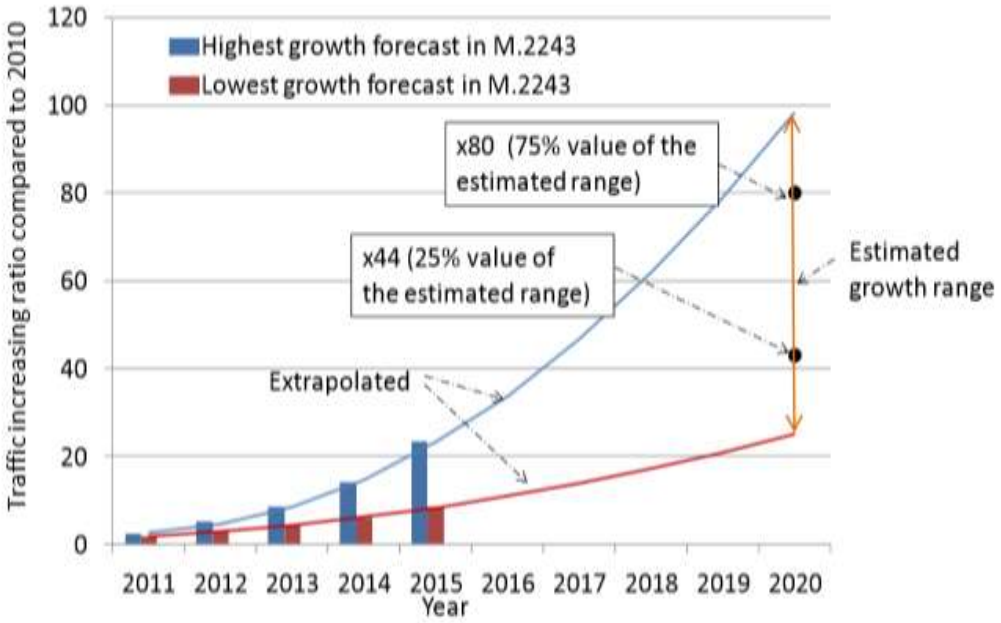
What we know now?

Demand of Content – Internet Traffic Explosion



37% of Internet traffic during prime time is online video

Video	Smartphones	Mobile Internet	Machine-to-Machine
~ 70% of internet traffic **by 2014**	**2.5 billion** devices **by 2015** **32x** increase per km^2	~ 70% of mobile traffic **by 2014**	**3x** growth in the **next five years**

Mobile broadband networks are at the heart of this trend ...

Source: ITU Report M. 2290-0 and Alcatel Lucent

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What we know now?

More sensitive Networks

BS reference sensitivity levels for FDD based BS as per 3GPP TS 25.104 V12.1.0 (2013-09)

BS Class	Reference measurement channel data rate	BS reference sensitivity level (dBm)	BER
Wide Area BS	12.2 kbps	**-121**	BER shall not exceed 0.001
Medium Range BS	12.2 kbps	**-111**	BER shall not exceed 0.001
Local Area / Home BS	12.2 kbps	**-107**	BER shall not exceed 0.001

Source: 3GPP TS 25.104 V12.1.0 (2013-09)

Granting Access to Spectrum

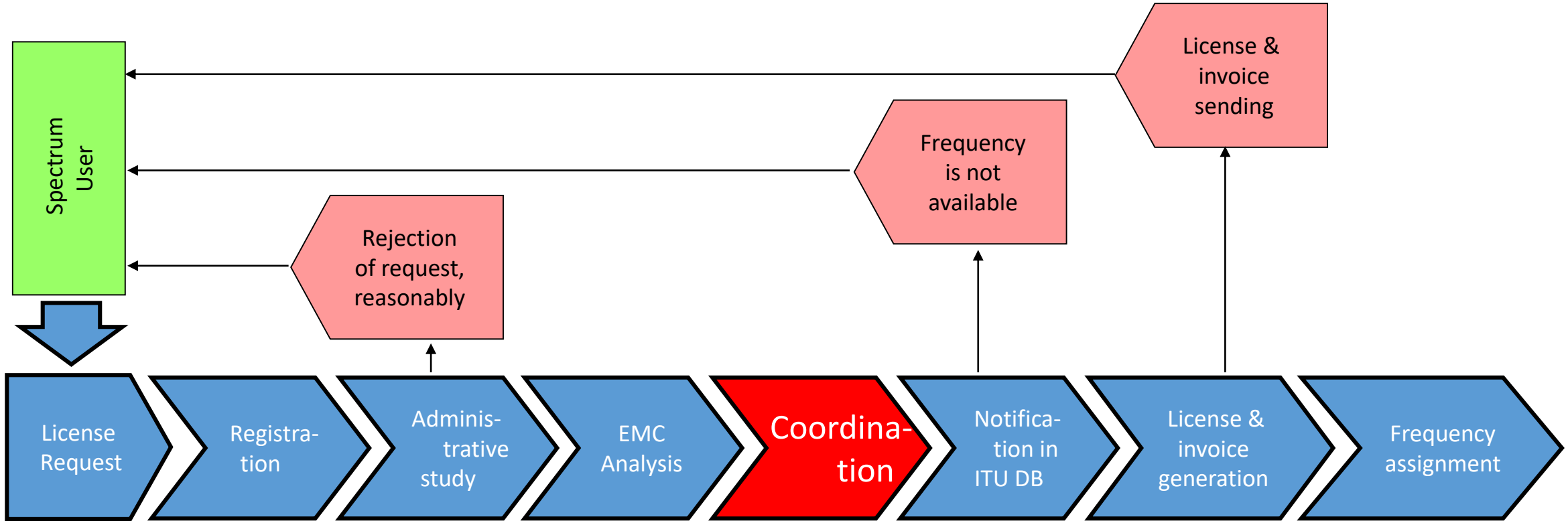
UK : Study Case

SM method	% of spectrum allocated in the UK *(source: Ofcom)*	
	Year 2000	**Year 2010**
Administrative	96 %	22 %
Market	0 %	71 %
Commons *(Unlicensed Spectrum)*	4 %	7 %

The Cross border interference coordination is different as it involves two administrations working under different national frameworks.

Effective implementation requires Administrative way of Management

General Procedure for Licensing



Official request	*Folder Creation*	*Processing, administrative and technical analysis*	*Coordination study & submission to ITU**	*Fee calculation and licensing, collection of some fees*

* *ITU notification is not required for each cases, and that a bi/multilateral agreement is stronger than the RR (see Article 6 of the RR)*

Example - National Spectrum Licensing workflow

- **Request for Licensing received by office**
  - *Ensure all the technical parameters are there in application (establish a minimum required info. criteria)*
  - *Detailed backend technical evaluation*

Need for Coordination Established

How to coordinate?

Co-ordination request and all technical characteristics of radio network/equipment sent to all administrations affected to enable accurate assessment of interference

Administrations affected assess possibility of interference to own stations;

No possibility of interference: obliged to agree to request

If assessments produce different results, administrations can agree to operation on a trial basis; **field strength calculations replaced with agreed field strength measurements**

Principle of Cross border coordination

Traditional way

- Case to case basis: Resolve when issue arises
  - *Takes long time as network has already been rolled out*

- Longstanding multiple arrangements designed around lower frequencies (HF or Max VHF)
  - *Difficult to plan nationally with multiple arrangements with several neighbors*

Better Way

- Assign spectrum only when coordination is achieved with neighboring countries
- One common coordination framework
  - *Easier to implement*

How to prepare cross border agreements

A cross border Agreement - Components

1. Definitions
2. General
3. Technical provisions
4. Procedures
5. Report of harmful interference
6. Revision of this Agreement
7. Accession to this Agreement
8. Withdrawal from this Agreement
9. Status of co-ordinations prior to this Agreement
10. Languages of the Agreement
11. Entry into force of Agreement
12. Annexes for technical and administrative details

Rec. ITU-R SM.1049-1

(A METHOD OF SPECTRUM MANAGEMENT TO BE USED FOR AIDING FREQUENCY ASSIGNMENT FOR TERRESTRIAL SERVICES IN BORDER AREAS)

A cross border Agreement - Components

Definitions

- Terms used in the agreement :
  Preferably same as in the RR
- Full Details of Administration involved in the Agreement
  Full Name etc.
- Details of Frequencies with repect to each radio services covered by the agreement
- Categories of frequencies for coordination
  - *Preferential frequencies*
  - *Shared frequencies*
  - *Frequencies for planned radio communication networks*
  - *Frequencies used on the basis of geographical network plans*
  - *Frequencies used on the basis of arrangements between operators*
  - *Others*

A cross border Agreement - Components

Definitions

- Frequency Register

  The Frequency Register cosnists of lists set out by every Administration indicating its co-ordinated frequencies as per the categorization of frequencies

- Other articles defining:
  - *Administration affected*
  - *Harmful interference*
  - *Programs*
  - *Data Exchange*

Annexures could be used for Details

A cross border Agreement - Components

General

- Set out responsibility of each Administration invovled in following clauses of the Agreements andits procedure

- May also clearly define that this agreement/framework in no way affects the rights and obligations of the Administrations arising from other international, regional, multilateral, bilateral and intergovernmental agreements

A coordination agreement on regional level should be **flexible** enough to allow the countries involved in bilateral coordination to change the mentioned coordination arrangements e.g. time limits with mutual consent

A cross border Agreement - Components

Technical Provisions

- Articles related to the technical co-ordination of a radio station and the evaluation with reference to relevant applicable Annexes for detials

Procedures

- Detailed Administrative and technical with clearly defined time limits for each procedure of RF coordination.

- Preferred way is to provide the procedural details in accordance to each category of frequencies

A cross border Agreement - Components

- **Others Provisions:**

- Report of harmful interference
- Revision of this Agreement
- Accession to this Agreement
- Withdrawal from this Agreement
- Status of co-ordinations prior to this Agreement
- Languages of the Agreement
- Entry into force of Agreement

A cross border Agreement - Components

Annexes

- Can be categorized with respect to the RF services involved in the agreement
- Contain all technical details
- Example of Annexures:
  - *Maximum permissible interference field strengths and maximum cross-border ranges of harmful interference for frequencies requiring co-ordination*
  - *Data exchange (methods and details of the contents of the lists)*
  - *Measurement procedures*
  - *Propagation curves to be used for coordination w.r.t each service*
  - *Determination of the interference field strength*
  - *Coding instructions for antenna diagrams*
  - *Method for combining the horizontal and vertical antenna*
  - *Triggers for co-ordination in the Fixed Service*

A cross border Agreement - Components

1. Definitions
2. General
3. Technical provisions
4. Procedures
5. Report of harmful interference
6. Revision of this Agreement
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(A METHOD OF SPECTRUM MANAGEMENT TO BE USED FOR AIDING FREQUENCY ASSIGNMENT FOR TERRESTRIAL SERVICES IN BORDER AREAS)

ITU, with support from its partners, is assisting countries in ASP to prepare frameworks that countries can use to further develop a multi country cross-border interference management solution

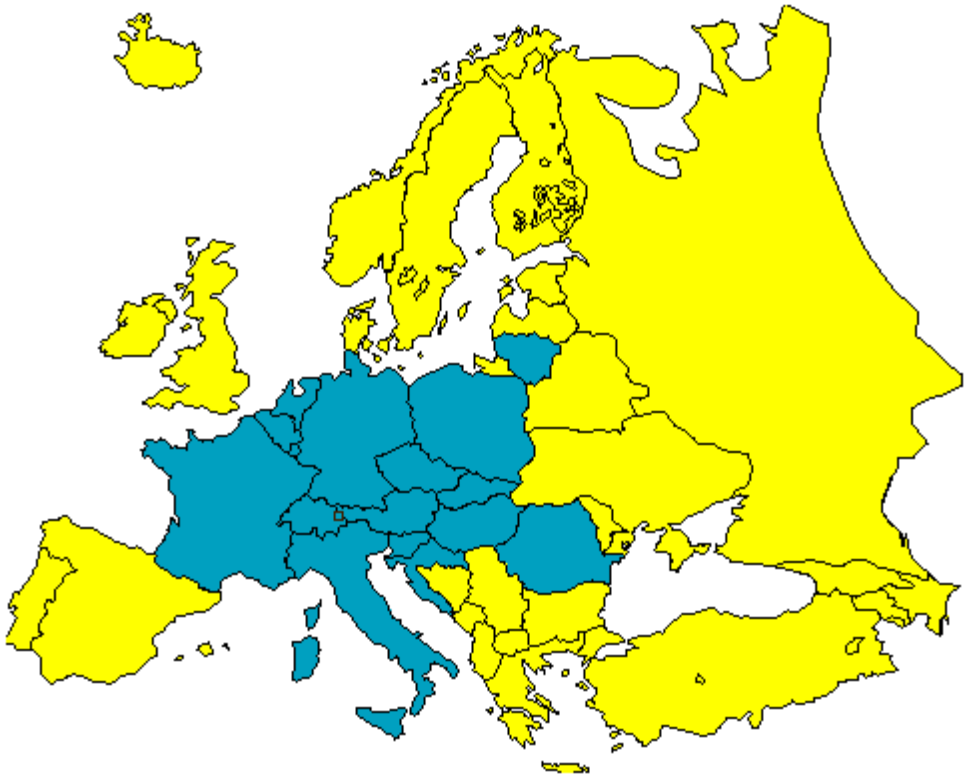
Examples: HCM and HCM4A

HCM Agreement - European

- **HCM Agreement** is the official designation of the Agreement between **17** European Administrations namely:

Austria, Belgium, the Czech Republic, Germany, France, Hungary, the Netherlands, Croatia, Italy, Liechtenstein, Lithuania, Luxembourg, Poland, Romania, the Slovak Republic, Slovenia and Switzerland

- Deals with Coordination of frequencies between **29.7 MHz and 43.5 GHz** for **fixed** service and **land mobile** service



Cross border frequency coordination

Harmonized Calculation Method (HCM) Agreement

1. Co-ordination request and all technical characteristics of radio network/equipment sent to all administrations affected to enable accurate assessment of interference

2. Administrations affected assess possibility of interference to own stations; → no possibility of interference: obliged to agree to request

3. If assessments produce different results, → administrations can agree to operation on a trial basis; field strength calculations replaced with agreed field strength measurements

4. Administrations exchange lists of co-ordinated assignments with technical characteristics, administrative reference data, conditions

HCM4A

- Based on HCM Agreement used in Europe BUT not a copy
- Defines technical provisions and administrative procedures;
- Enables Quick assignment of preferential frequencies;
- Transparent decisions through agreed assessment procedures;
- Quick assessment of interference through data exchange.

HCM4A – Process

Assessment

- Review of existing bilateral and multilateral cross-border frequency coordination agreements in Sub-Sahara Africa;

Multilateral agreement proposal

- Technical working group review the results of the assessment and propose a multilateral agreement

Validation workshop

- Adopt the draft agreement in line with the conclusion of the assessment

Development of HCM4A software

- Develop a release software based on HCM4A agreement (if adopted) and propose training workshops on the software

HCM4A Software tool

- Establishes general parameters, improvement and supplementation of technical provisions, individual restrictions;
- Establish models for computer-aided interference range calculations
- Optimise spectrum usage by accurate interference field strength calculations;

HCM4A – Implementation

- First phase of the project,

ITU experts contacted various administrations in subSaharan Africa and compiled information related to cross border frequency coordination through a questionnaire.

- Based on the results of the first phase of the project,

ITU team prepared a draft HCM for Africa Agreement with relevant Annexes (HCM4A). The Agreement deals with co-ordination of frequencies between 29.7 MHz and 43.5 GHz for the purposes of preventing mutual harmful interference to the Fixed and Land Mobile Services and optimising the use of the frequency spectrum on the basis of mutual agreements.

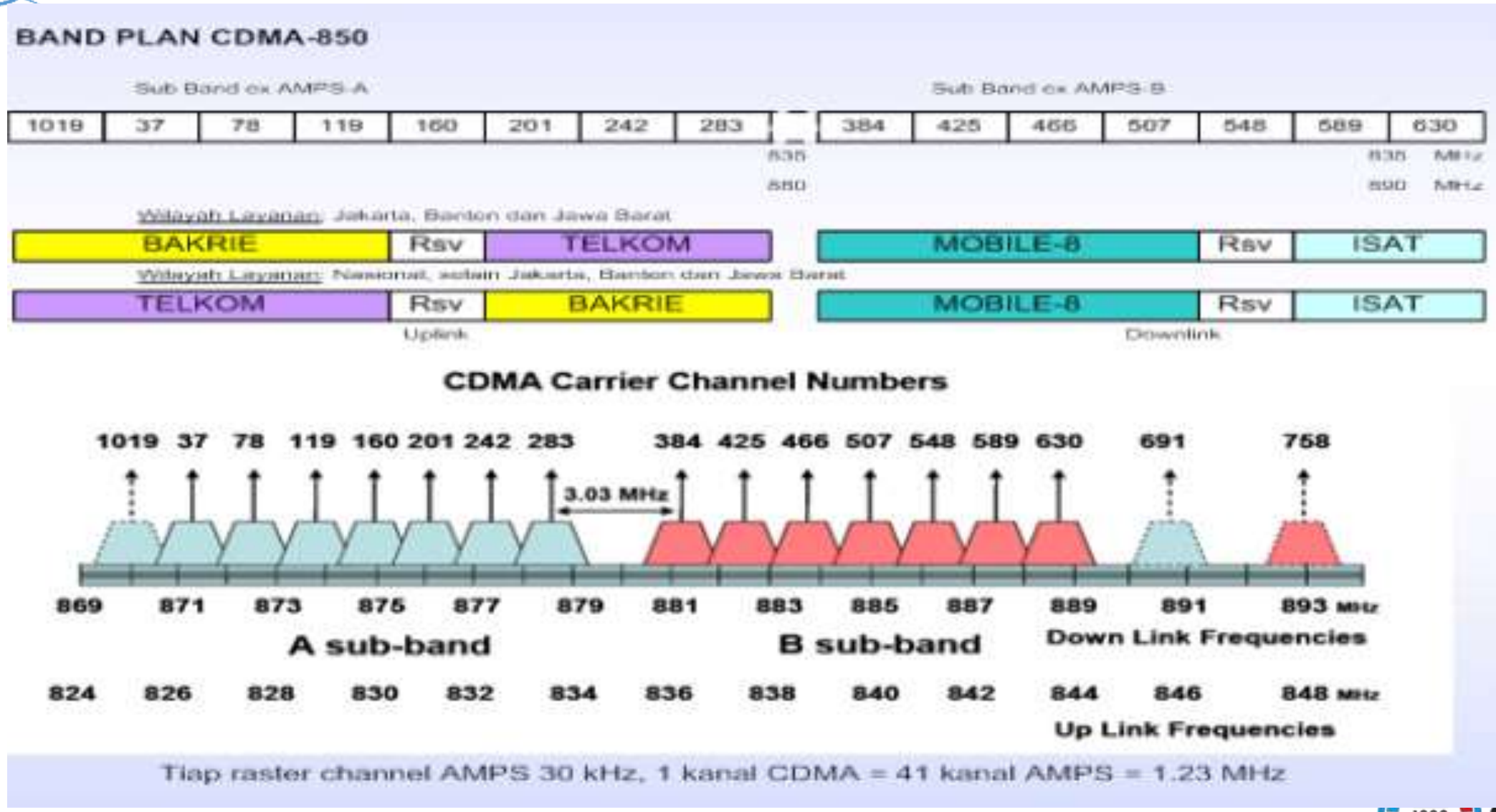
The draft HCM4A Agreement has a number of Annexes relating to Land Mobile and Fixed Service respectively.

HCM4A – Status

- Plenary meeting of HCM in the beginning of November
- Until now 19 countries are interested to sign the Agreement
- Interest from Arab countries also to have similar agreement

Examples: MLA-SNG-IND

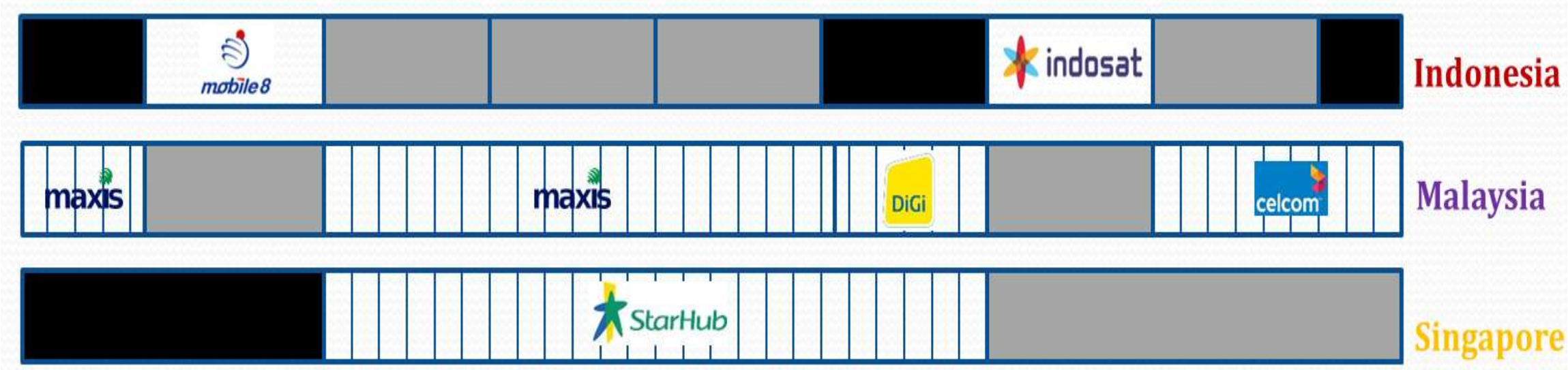
Problem



Old 850 MHz band plan in Indonesia

Problem

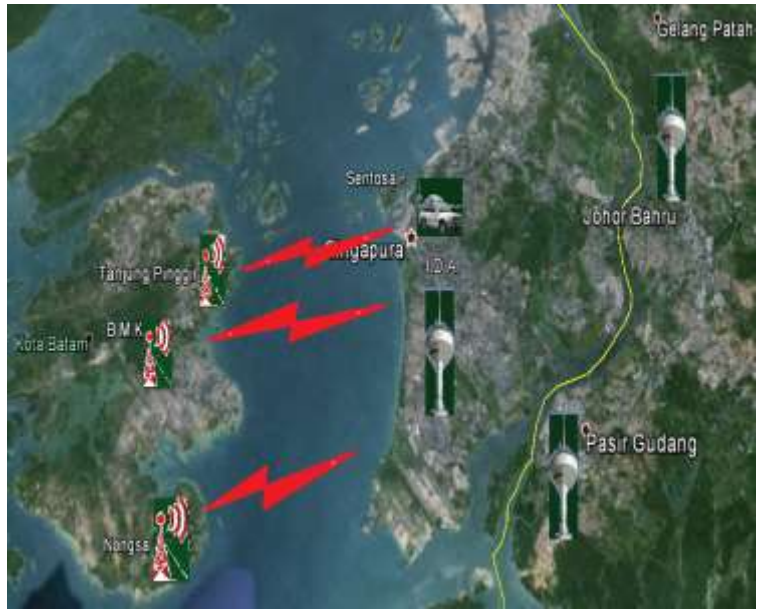
Band Splitting Arrangement before study



Project Activities … *Measurement Methodology*

Example of Methodology: Test Site Overview

Item With Reference to Fig	Explanation	Details
	Transmitter sites – Actual CDMA BTS in Indonesia sites facility provided by Smartfren and Indosat	**1. BUKIT MATA KUCING - BMK** Coordinates : N1 05 25.5 E103 58 15.4 Height from ground : 114 m TX Signal: 880.025 MHz (F1) – 30 KHz with FM **2. NONGSA** Coordinat : N1 11 43.2 E104 06 06.0 Height from ground : 65 m TX Signal: 880.125 MHz (F2) – 30 KHz with FM **3. TANJUNG PINGGIR** Coordinat : N1 08 22.4 E103 55 18.9 Height from ground : 43 m TX Signal: 887.015 MHz (F3) – 30 KHz with FM
	Receiver sites – Fixed Monitoring station Facility provide by Malaysia or Singapore where applicable	**1. IDA Fixed Monitoring Station (SNG)** Coordinat : N 1,325110; E103,945190 Height from ground : 82 m **2. JOHOR BARU (MLA)** Coordinat : N1,468676 E103,904111 Height from ground : 171 m **3. PASIR GUDANG (MLA)** Coordinat : N1,4686 08 22.4 E103 55 18.9 Height from ground : 68 m
	Receiver site – Mobile Monitoring Van at fixed location provided by Singapore	**Mobile Monitoring Van at fixed location – SNG** Coordinat : N1 18 02.4 E103 54 41.9 Height from ground : 15 m



Note:
The transmitting test signal frequencies were assigned under the condition that these frequencies will not interfere with the networks of the operators at 3 different countries.

Under this criterion, the available frequency band was so limited, that finding 3 slots for 200 KHz GSM equivalent bandwidth is not possible. As a compromise, 30 KHz FM signals were used.

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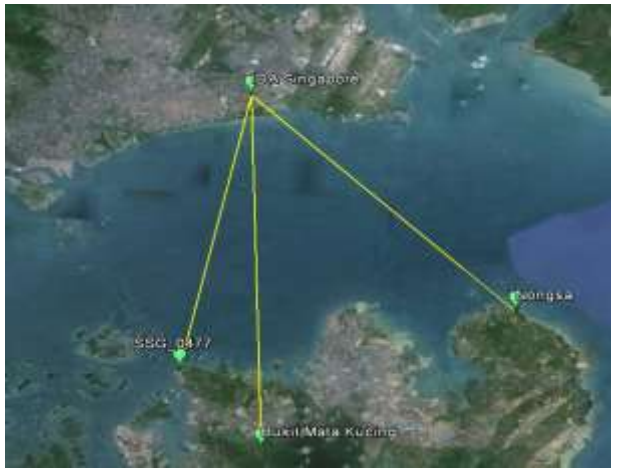
Project Activities *… Preliminary Simulation*

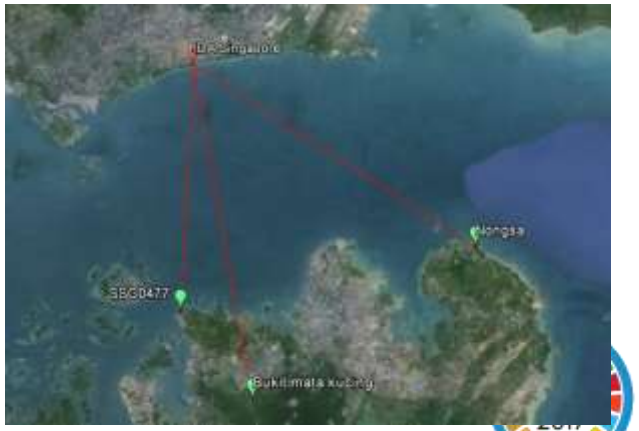
➢ Preliminary Simulation using agreed Measurement Methodology

- Undertaken to approximate the extent of Interference received and to cross relate with the actual measurements

Results of these measurements showed:

1. *The highest theoretical mitigation objective is at **36.80 dB** for Singapore*
2. *Tilting the antenna at Batam area could reduce the mitigation objective by 15 dB into (36.80 – 15) dB = 21.80 dB. If a special purpose antenna is used which has side lobe rejection up to 20 dB then the mitigation objective is reduced to (36.80 -20) dB = 16.80 dB.*
3. *Lowering down the antenna heights at both sides could reduce the mitigation objective by another 20 dB into (16.80 – 20) dB = -3.20 dB. (3.2 dB mitigation margin)*
4. *Reducing the transmitted power by 10 dB could further provide -13.20 dB mitigation margins. This margin might be required to compensate additive effects of CDMA signals (CDMA correction factors) whenever necessary (the factor which increases the reception of CDMA signals by ~13 dB).*





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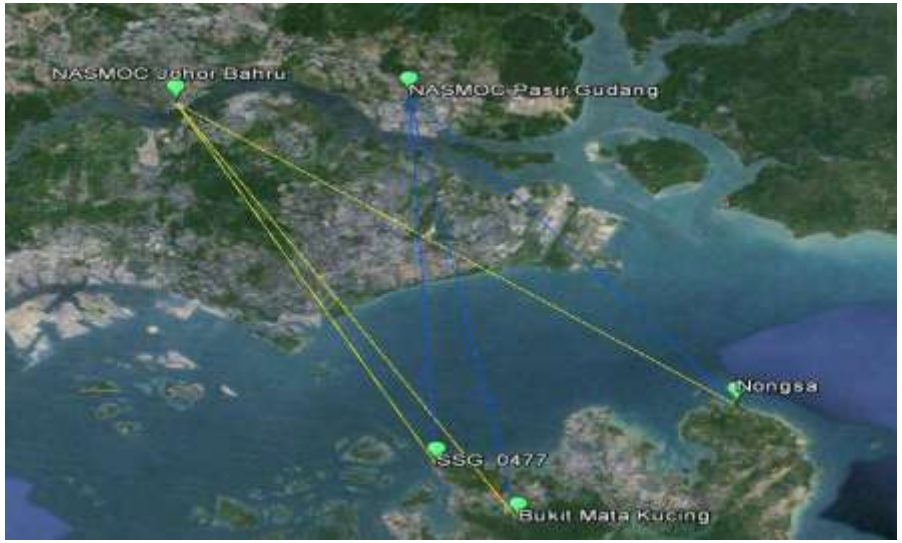
Project Activities *… Preliminary Simulation*

Results of simulation *contd….*:

5. *Reversing the direction of the antenna (the use of reflectors) could give extra isolation if necessary since the front to back ratio of the antenna is in the order of 35 dB*

6. *Overall, as the worst case there are requirements to lower down the antennas to below 25 m ASL, tilting antenna more than 10 degrees, and reduce the operating power to below 28 dBm if it is required to isolate CDMA from EGSM networks.*



Microsoft Word Document

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Project Activities *… TX & Rx Config. Plans*

- **Different configurations of Transmitter and Receivers were tested over the period of 4 days**

- **Mock pre-tests performed to ensure that operational networks do not have any effect during the testing procedure.**

- **Due regard was given to ensure that all practically possible configurations were tested**

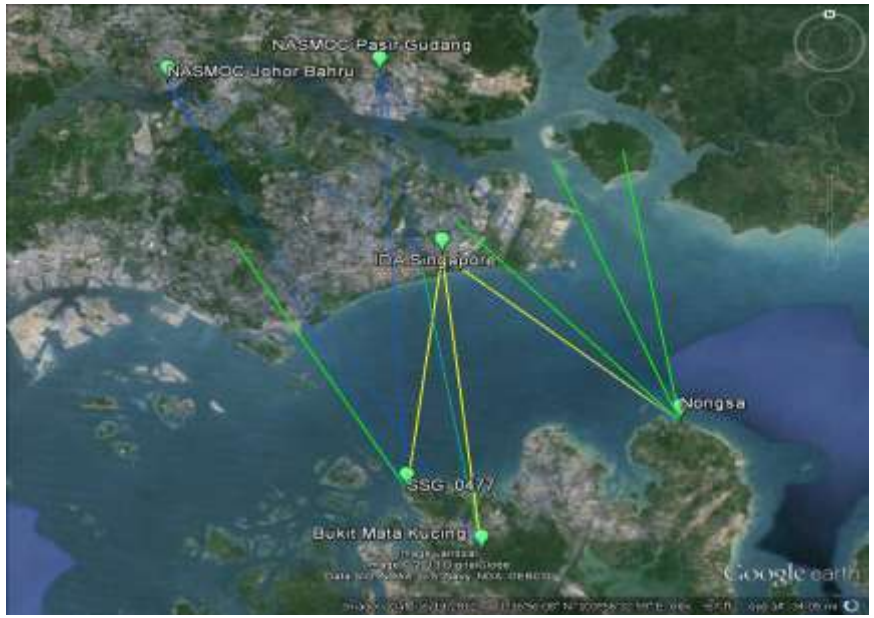
Microsoft Word
7 - 2013 Documen

Microsoft Word
Document

Project Activities *… TX and Rx configurations*

- **12 configurations at each transmitter involving changes in:**
  - Power output
  - Antenna Height (*not similar across all identified Tx sites*)
  - Antenna tilting
  - Inward Transmission only

- **Fixed Receivers**
  - Geographically separated at 4 locations
  - Different heights



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Conclusion of Study

Maximum unwanted signal during the study

As per the results obtained, the largest mitigation challenge was at IDA Fixed Station where the C/N reached 34.0 dB with respect to noise floor, or (34 -12) = 22 dB with respect to EGSM threshold, because of the exceptional antenna height.

Mitigation

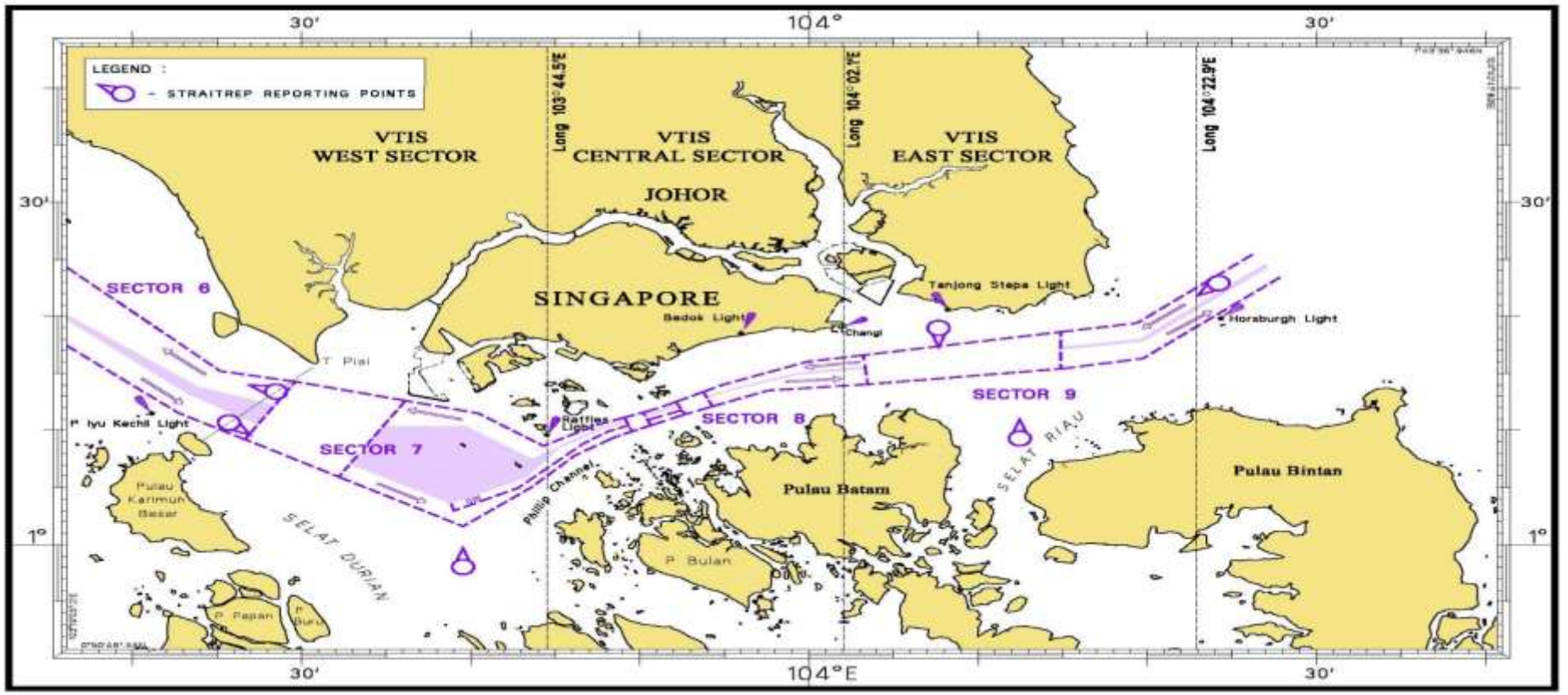
A combination of 10 degrees* tilting which yield 20 dB additional loss and 10 dB power level reduction. In addition, putting antenna reflector, i.e. by making the antenna direction towards Indonesia could provide 30dB isolation, if needed.

** Only 5 degree tilting was used in practical measurements. This figure is based on extrapolation of the results observed from practical study.*

Recommendations

➢ Creating Network Isolation

- Recommended not to allow antenna beams of transmitting antennas in border region to be directed towards other countries (*a practice observed in order to tap into the market of the visiting ships in the Singapore Strait).*



STRAITREP OPERATIONAL AREA (SECTORS 7 TO 9) Appendix 2

CELEBRATING 25 YEARS OF ACHIEVEMENTS

Examples: Assessment for priority setting for cross border coordination and developing a coordination framework

Assessment and Priority Determination

Cambodia

	Thailand	Lao P.D.R	Vietnam	Coast Line
Geographic Border topography (Plain, Mountainous, Water, Forest)	803 Km Mixed (Mostly Mountains and forest with main gateway to Thailand through Poipet city being plain)	541 Km Mixed (Forest and Plain)	1,228 Km Mixed (Mostly plain but few forests in between)	443 Km
Population Density around border areas	High density at border near Poipet rest low.	Low	High	High
Cambodia Coordination Priorities	**A F G I H K M E**	**I H**	**A F G I H K M E**	

Key for Frequency Bands requiring coordination

A	VHF BS Sound Band	**H**	MS 1710-1785
B	MS bands within 137-174 MHz	**I**	MS 1805-1880 MHz
C	FS 140.5-141 MHz	**J**	MS 1885-2025MHz
D	VHF TV band	**K**	MS 2110-2200 MHz
E	MS bands within 401-470 MHz	**L**	MS 2300-2400 MHz
F	UHF TV band	**M**	MS 2500-2690 MHz
G	MS 790-960 MHz(790-862/862-962 MHz)	**N**	MS 3400-3600 MHz

Color Coding for the required priority

- Highest: **RED**
- Medium: **BLUE**
- Lowest: **GREEN**

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Assessment and Priority Determination

Lao

	Thailand	Cambodia	Myanmar	China	Vietnam
Geographic Border topography (Plain, Mountainous, Water, Forest)	1754 Km Mostly Fresh Water (Mekong River) but also plain land in in Northern and southern parts	541 Km Plain	235 Km Fresh Water (Mekong River)	423 Km Mountainous	2130 km Mountainous
Population Density around border areas	High	Low	Low	Low to medium	Medium
Lao P.D.R Coordination Priorities	**H G I J K L A F P**			**H**	**P**

Key for Frequency Bands requiring coordination

A	VHF BS Sound Band	**I**	MS 1710-1785
B	MS bands within 137-174 MHz	**J**	MS 1805-1880 MHz
C	FS 140.5-141 MHz	**K**	MS 1885-2025MHz
D	VHF TV band	**L**	MS 2110-2200 MHz
E	MS bands within 401-470 MHz	**M**	MS 2300-2400 MHz
F	UHF TV band	**N**	MS 2500-2690 MHz
G	MS 703- 748//758-803 MHz	**O**	MS 3400-3600 MHz
H	MS 790-960 MHz(790-862/862-962 MHz)	**P**	VHF Sound BC to Aeronautical

Color Coding for the required priority

- Highest: **RED**
- Medium: **BLUE**
- Lowest: **GREEN**

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Conclusion

- Issues of Cross Border Interference are going to grow in future
- A regional framework required to prevent rather than cure cross border interference issues
- Regional or sub-regional solutions more effective in implementation and addressing very specific problems
- ITU remains ready to support in development of harmonized solutions to growing problem.

I Thank U

"Committed to connecting the WORLD"

ITU Study Group Meetings
ITU-D (Res. 9) and ITU-R SG1

Your active participation in and contribution to these is most welcome!

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Reference slides for further study

Radio Interference Prediction

Helps in

- Planning and co-ordinating a station
- Determine if special protection required?
- Determine if Co-ordination required?
- Having reference values for calculation of interfering field strength at specified height on border
- Having reference values for calculation of cross-border interference range according to prediction method, band, etc.

Need to consider

- Station's technical characteristics
- Frequency offset and bandwidth of stations affected
- Use of specific propagation curves

Radio Interference Prediction - Example

Interference field strength based on ITU-R P.1546

*(Method for **point-to-area predictions** for terrestrial services in the frequency range 30 MHz to 3 000 MHz)*

- **Determine Type of Propagation path**
- **Determine Nominal Time percentages and Nominal frequencies**
- **Estimate field strength while factoring in:**
  - *Terrain clearance angle*
  - *Tropospheric scattering*
  - *Receiving antenna height*
  - *Clutter around the transmitting/base terminal*
  - *Slope-path correction*
  - *Adjustment for different climatic regions etc.*

Field Strength Measurements - Ways

Basic two ways of measurements

- **At a monitoring station;**
- **Along a route (Mobile)**

Time durations can vary and the measurements can be more complex involving coordinated use of mutiple measurements equipments at different geographical sites

Field Strength Measurements - Categories

The term "measurement of field strength" is intended to apply to four general categories of measurement:

- Measurements performed with portable or mobile facilities, to obtain relatively instantaneous or **short-term data at one or several locations**;
- Measurements performed with mobile facilities to obtain **statistical parameters** of coverage in the field of mobile radio;
- **Short-term measurements at a fixed location**, generally in support of other monitoring operations;
- **Long-term measurements** involving field strength recordings and analysis of chart records, respectively storage and analysis of measured data using computers.

Field Strength Measurements - Types

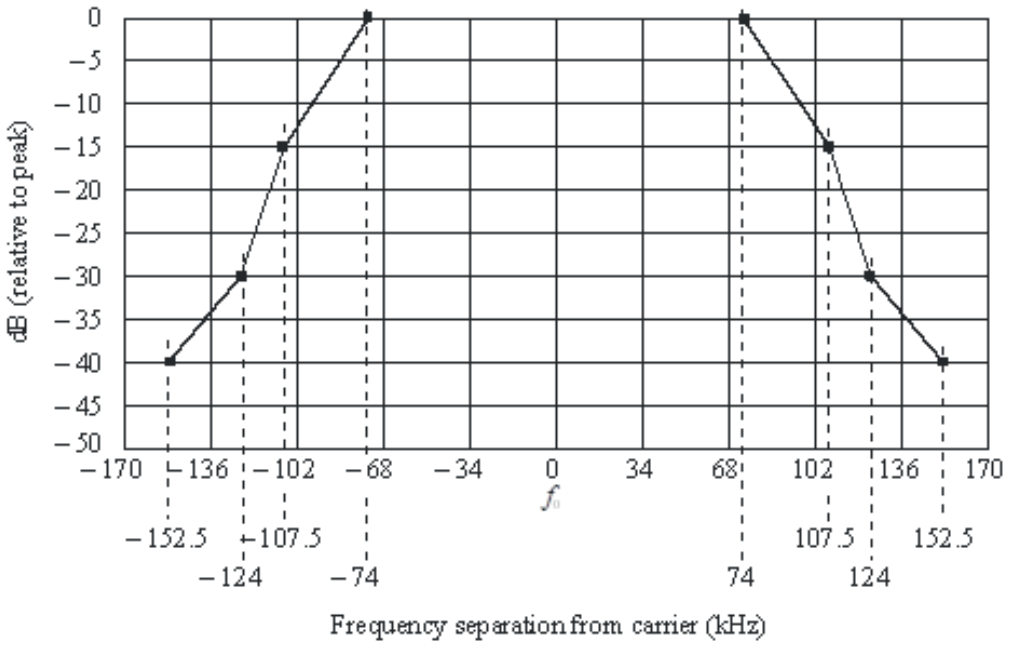
Two types of measurements:

- **Simple “go-no go” test based on a spectrum mask**
- **Method used when the values of the deviation and modulation power are required**

Field Strength Measurements - Deviation

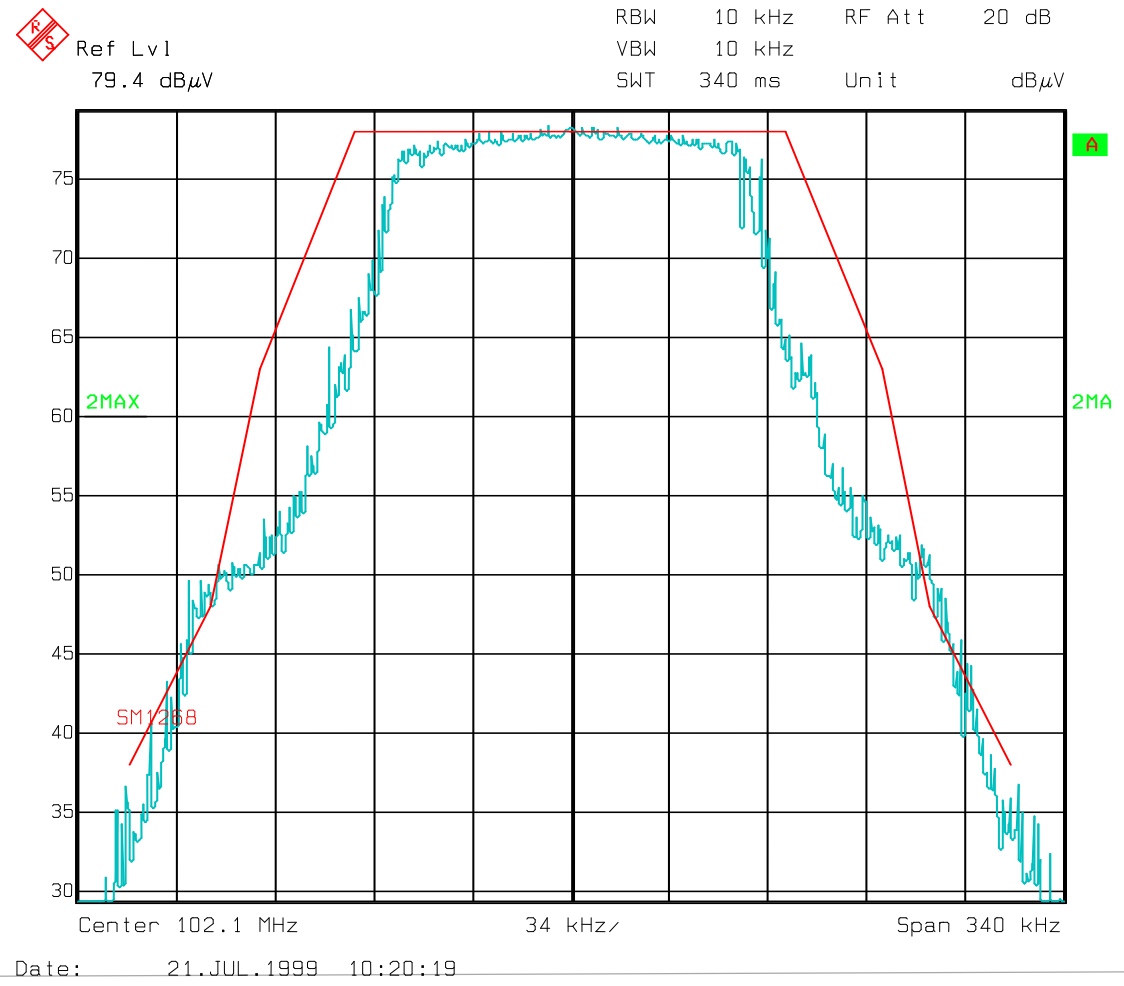
Mask method

- May be used as a verification to indicate whether the frequency deviation of an FM broadcasting station exceeds the limits;
- Cannot be applied on transmissions with 50 kHz peak deviation due to the fact that no appropriate spectrum mask is available;



Field Strength Measurements - Deviation

Example Spectrum Mask measurement



Field Strength Measurements - Deviation

Method when the values of the deviation and modulation power are required.

Example

The protection ratios specified in Recommendation ITU-R BS.412 for the planning of FM sound broadcasting transmitters ***apply on the condition that*** *a peak deviation of ±75 kHz is not exceeded and that the average modulation power over any interval of 60 s does not exceed that of a single sinusoidal tone which causes a peak deviation of ±19 kHz.*

Field Strength Measurements - Frequency

Conventional methods are :

1. Beat Frequency (BF) method
2. Offset Frequency (OF) method
3. Direct Lissajous (DL) method
4. Frequency Counter (FC) method
5. Frequency Discriminator (FD) method
6. Phase Recording (PR) method
7. Swept Spectrum Analyser (SSA) method.

At monitoring stations most of the time the methods DL, FC and SSA are used as these methods cover all types of frequency measurements. The other methods are included for completeness but are in practice not used anymore and not available due to the introduction of Digital signal processing (e.g. FFT, IFM…), which is now generalized in measuring equipment.

Field Strength Measurements - Frequency

Digital Signal Processing (DSP) based methods are :

- Instantaneous Frequency Measurement (IFM) method
- FFT method.

DSP methods should be preferable on Monitoring Stations.

ITU Reports and Recomm. on Measurements

Category	Report/Recommendation Details
General	• Recommendation ITU-R SM.1050 • Recommendation ITU-R SM.1723 • Recommendation ITU-R SM.1794 • ITU Spectrum Monitoring Handbook, 2011, Chapter 1
Direction finding measurement and location determination	• Recommendation ITU-R SM.854 • Recommendation ITU-R SM.1598 • ITU Spectrum Monitoring Handbook, 2011, Section 4.7
Spectrum and channel Occupancy measurement	• Recommendation ITU-R SM.1880 • Report ITU-R SM.2256 • ITU Spectrum Monitoring Handbook, 2011, Section 4.10
Unwanted emissions	• Recommendation ITU-R SM.328 • Recommendation ITU-R SM.329 • Recommendation ITU-R SM.1752 • Recommendation ITU-R SM.1792 • ITU Spectrum Monitoring Handbook, 2011, Section 4.12
Measurement on digital broadcasting systems	• Recommendation ITU-R SM.1682 • Recommendation ITU-R SM.1792 • ITU Spectrum Monitoring Handbook, 2011,Sections 4.11 and 5.2
Mobile monitoring	• Recommendation ITU-R SM.1708 • Recommendation ITU-R SM.1723 • ITU Spectrum Monitoring Handbook, 2011,Section 2.4.2
Standard data exchange format at monitoring stations	• Recommendation ITU-R SM.1809

ITU Reports and Recomm. on Measurements

Category	Report/Recommendation Details
Frequency	• Recommendation ITU-R SM.377 • ITU Spectrum Monitoring Handbook, 2011, Section 4.2
Field strength (see also Radio Regulations Art. 21)	• Recommendation ITU-R P.845 • Recommendation ITU-R SM.378 • Recommendation ITU-R SM.1447 • Recommendation ITU-R SM.1708 • ITU Spectrum Monitoring Handbook, 2011, Section 4.10
Modulation	• Recommendation ITU-R SM. 1268 • ITU Spectrum Monitoring Handbook, 2011, Sections 4.6 and 4.8
Bandwidth	• Recommendation ITU-R SM.443 • ITU Spectrum Monitoring Handbook, 2011, Section 4.5
Identification	• Recommendation ITU-R SM.1052 • Recommendation ITU-R SM.1600 • ITU Spectrum Monitoring Handbook, 2011, Section 4.8
Signal analysis	• ITU Spectrum Monitoring Handbook, 2011, Section 4.8
Measurements related to inspection of radio installations	• Report ITU-R SM.2130

ITU Reports and Recomm. on Measurements

Category	Report/Recommendation Details
Selectivity of monitoring receivers	• Recommendation ITU-R SM.1836 • Report ITU-R SM.2125
IP3 of monitoring receivers	• Recommendation ITU-R SM.1837 • Report ITU-R SM.2125
Noise figure of monitoring receivers	• Recommendation ITU-R SM.1838 • Report ITU-R SM.2125
Scanning speed of monitoring receivers	• Recommendation ITU-R SM.1839 • Report ITU-R SM.2125
Sensitivity of monitoring receivers	• Recommendation ITU-R SM.1840 • Report ITU-R SM.2125
Other parameters	• Report ITU-R SM.2125
Selectivity of monitoring receivers	• Recommendation ITU-R SM.1836 • Report ITU-R SM.2125

Calculation of Interference : Example FX and MS (Germany)

Calculation of Interference : Fixed, Mobile

Based on previous introduction of IT-supported frequency co-ordination following examples shall illustrate evaluation of co-ordination obligation and interference calculations in fixed and mobile service:

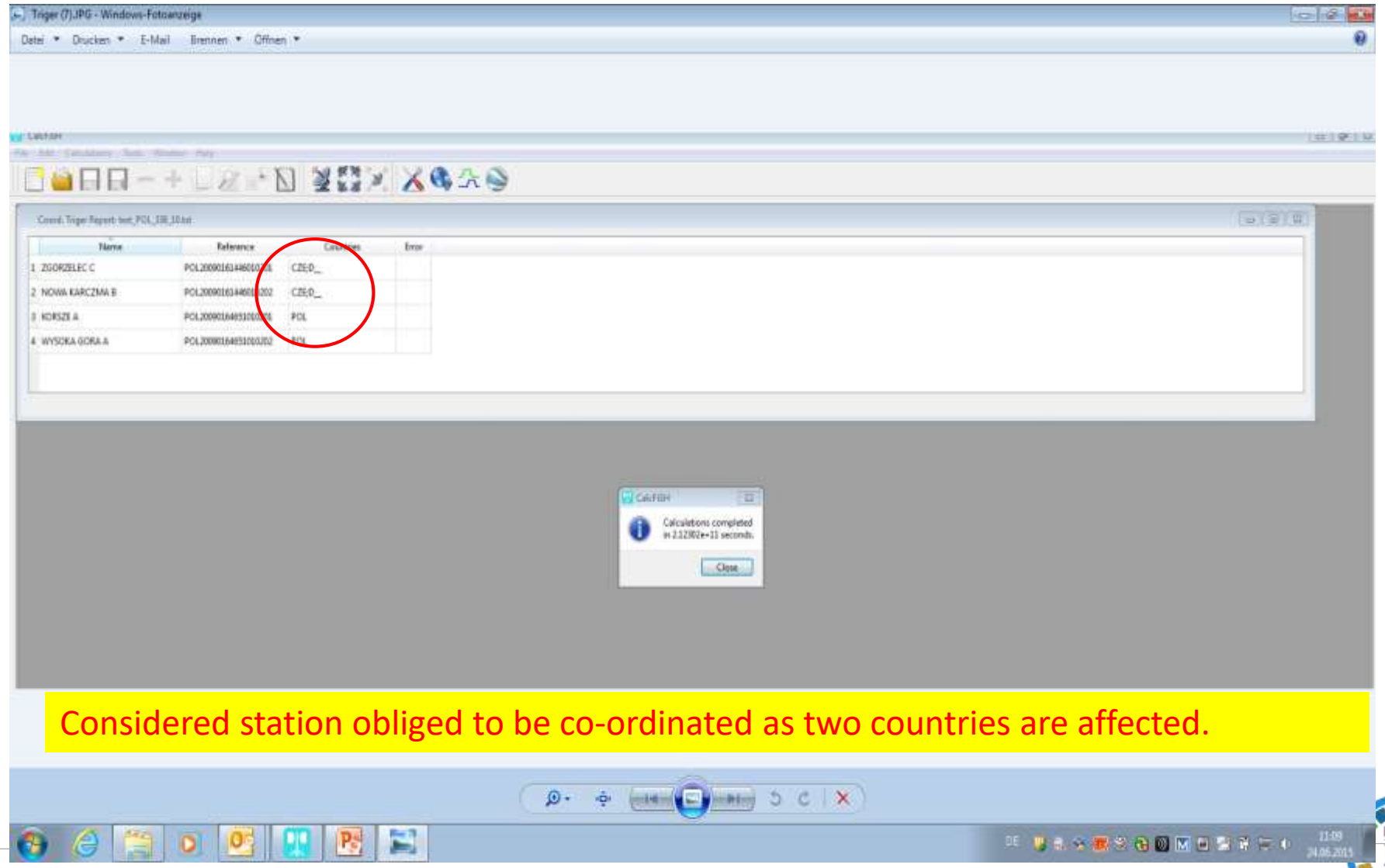
Fixed Service (CalcFiSH):

- Co-ordination Distance (determination of affected country)
- Threshold Degradation (stations: point-to-point)

Mobile Service (HCM-MS and GREKO/FLAP):

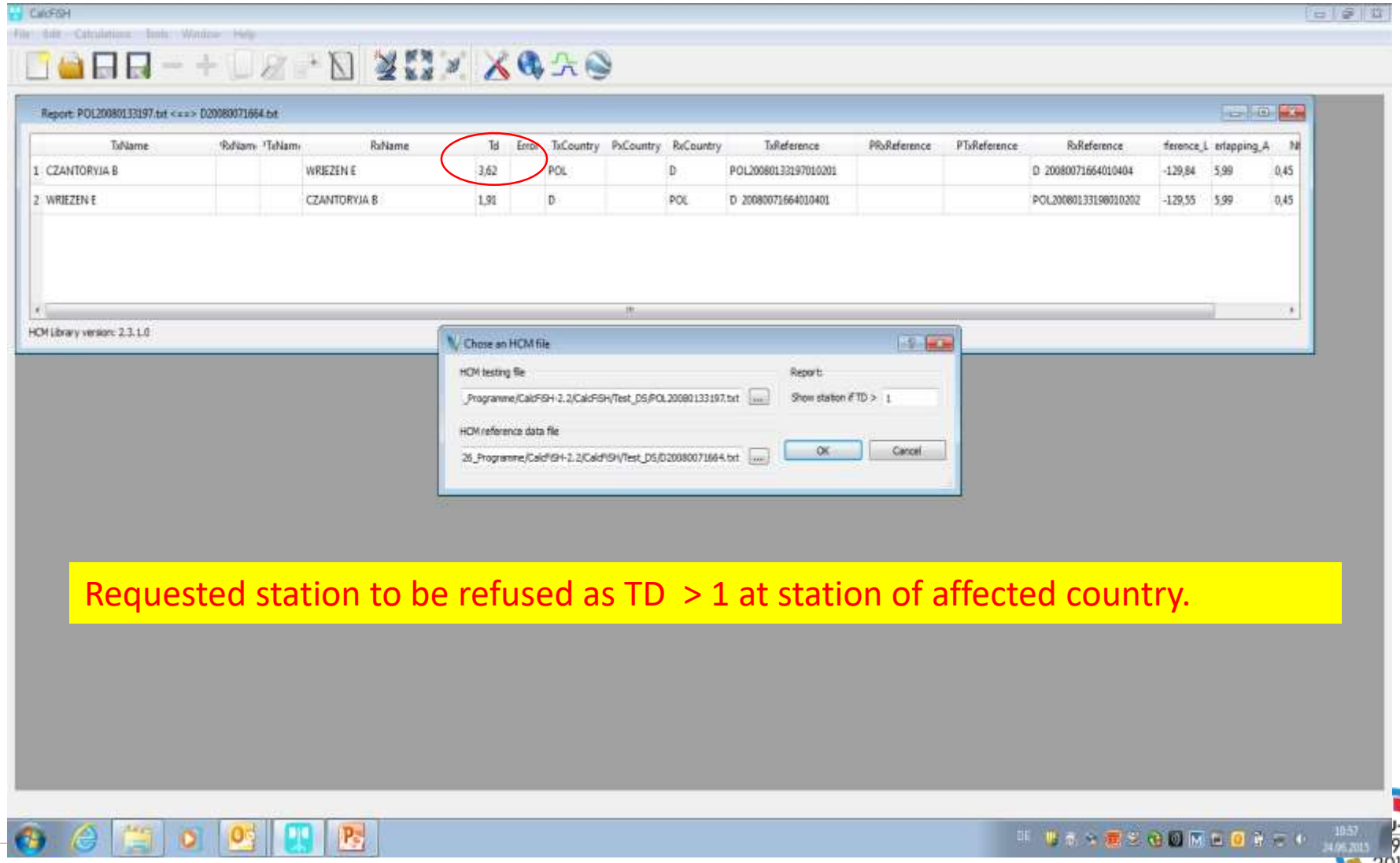
- Co-ordination Trigger (determination of PM on border-line)
- Cross Border Range (determination of PM on CBR-line)
- Preferential Condition (determination of PM on x-km-line)
- Stations: Point-to-Point (determination of PM at counter-stations)
- Point-to-Area prediction (propagation from a station to an area)

Calculation of Interference : Fixed, Mobile



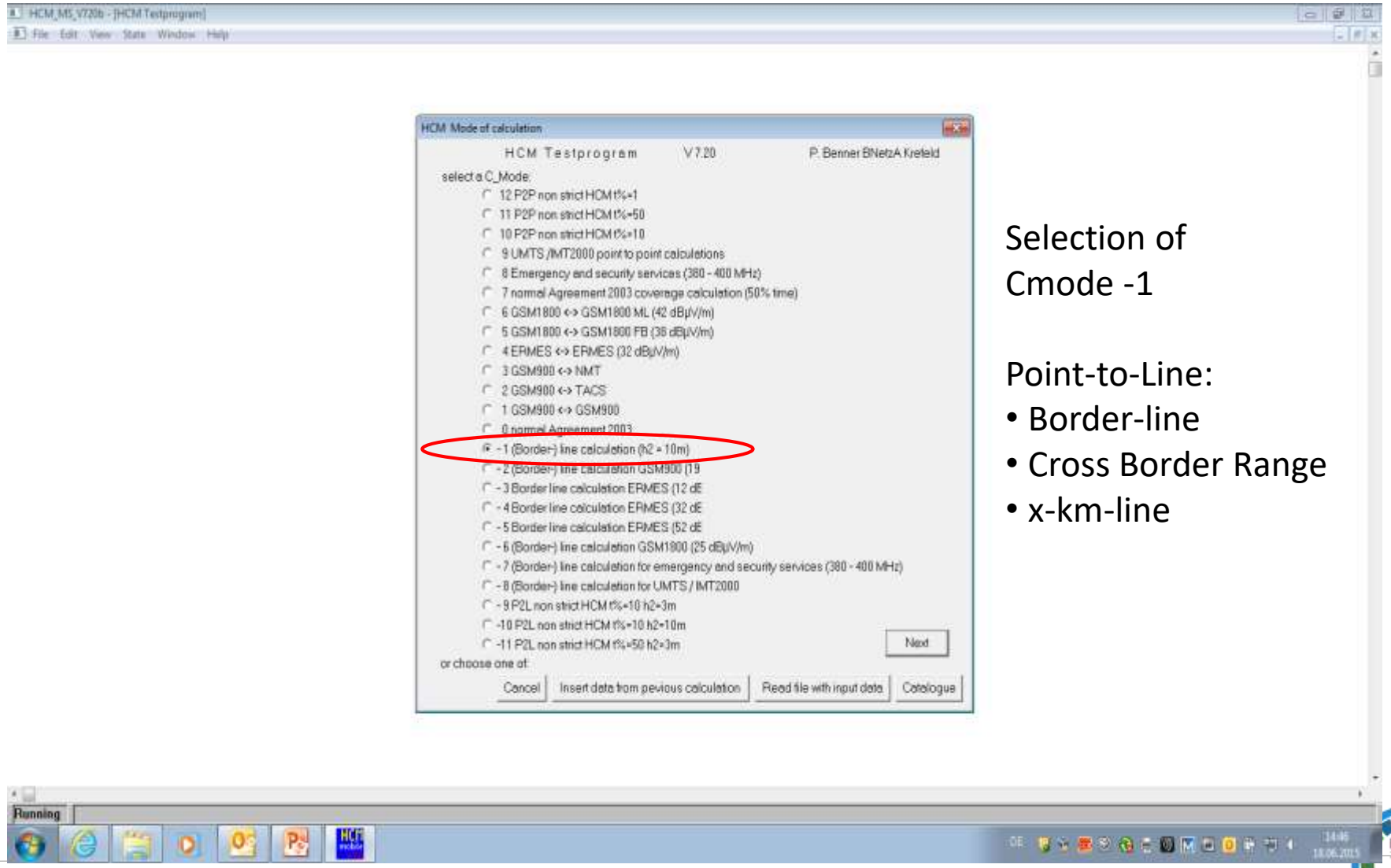
Considered station obliged to be co-ordinated as two countries are affected.

Calculation of Interference : Fixed, Mobile



Requested station to be refused as TD > 1 at station of affected country.

Calculation of Interference : Fixed, Mobile

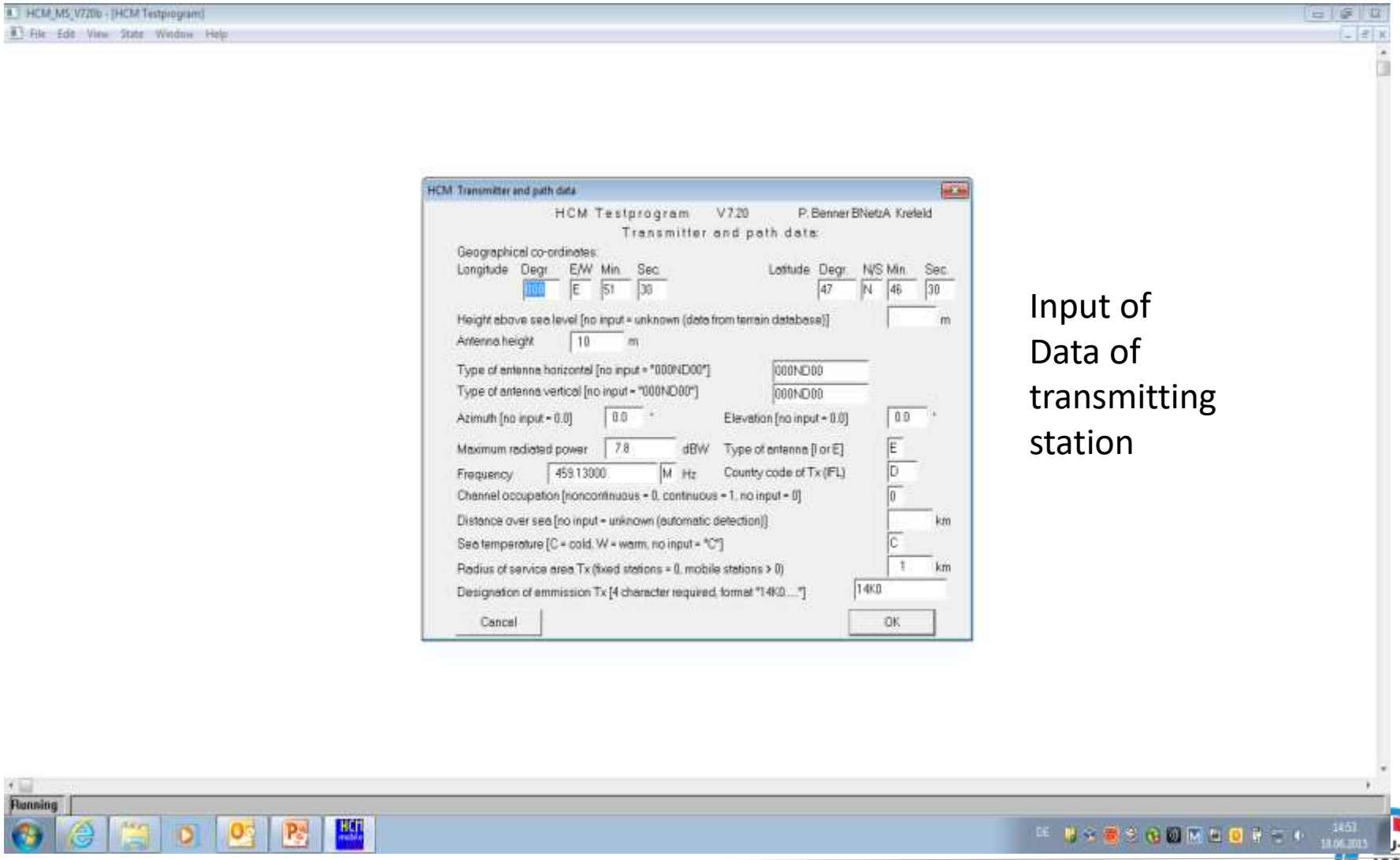


Selection of Cmode -1

Point-to-Line:

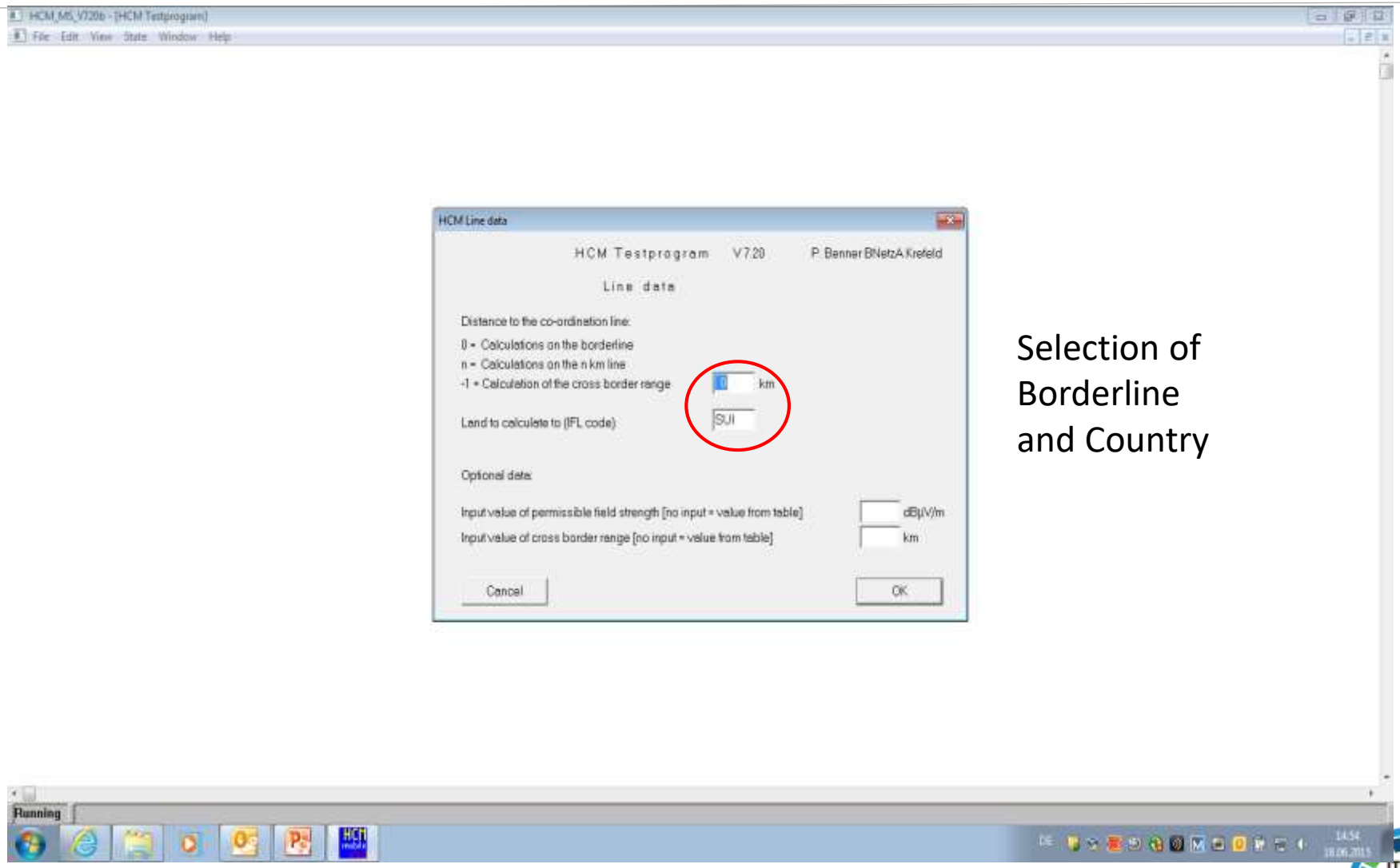
- Border-line
- Cross Border Range
- x-km-line

Calculation of Interference : Fixed, Mobile



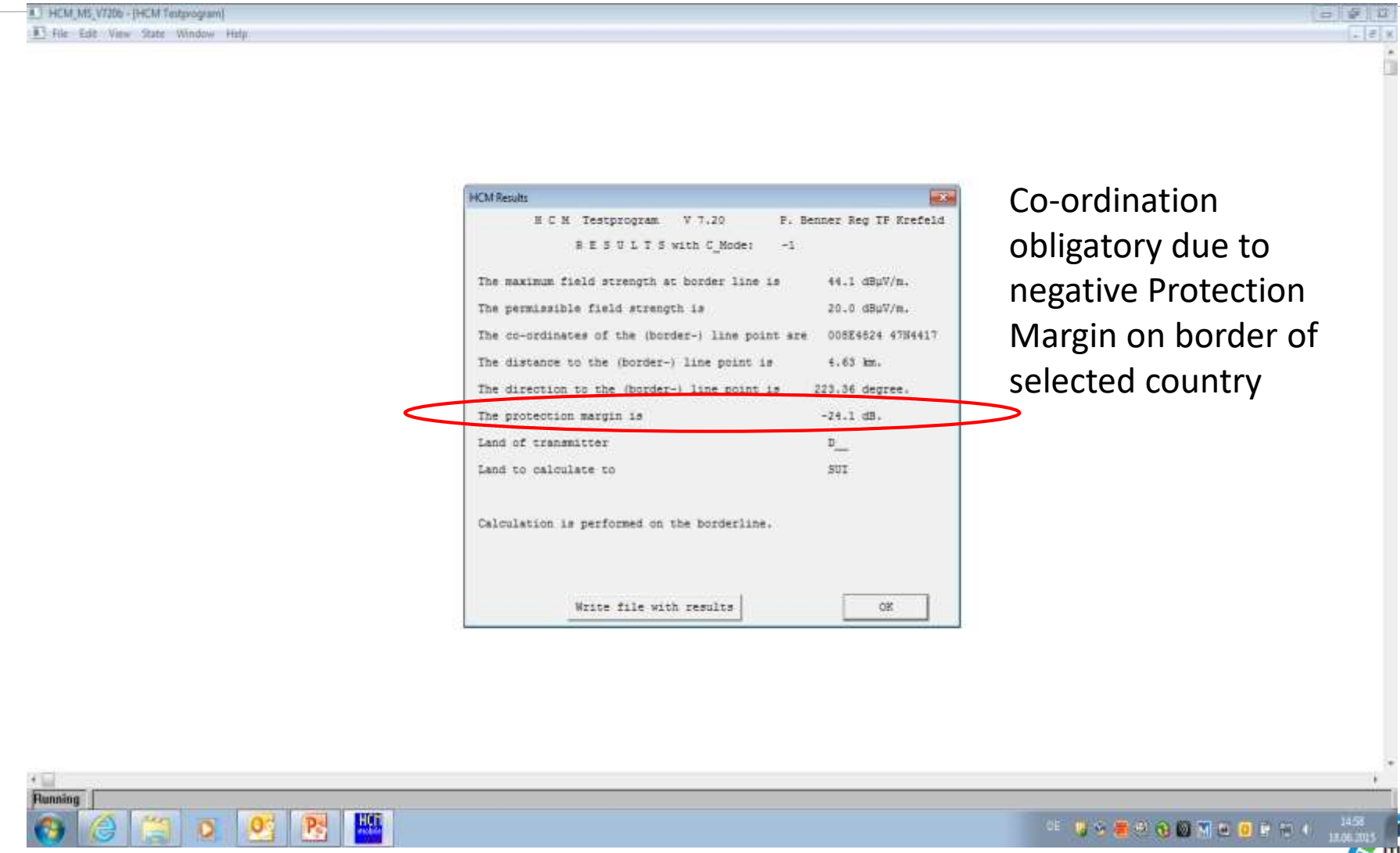
Input of Data of transmitting station

Calculation of Interference : Fixed, Mobile



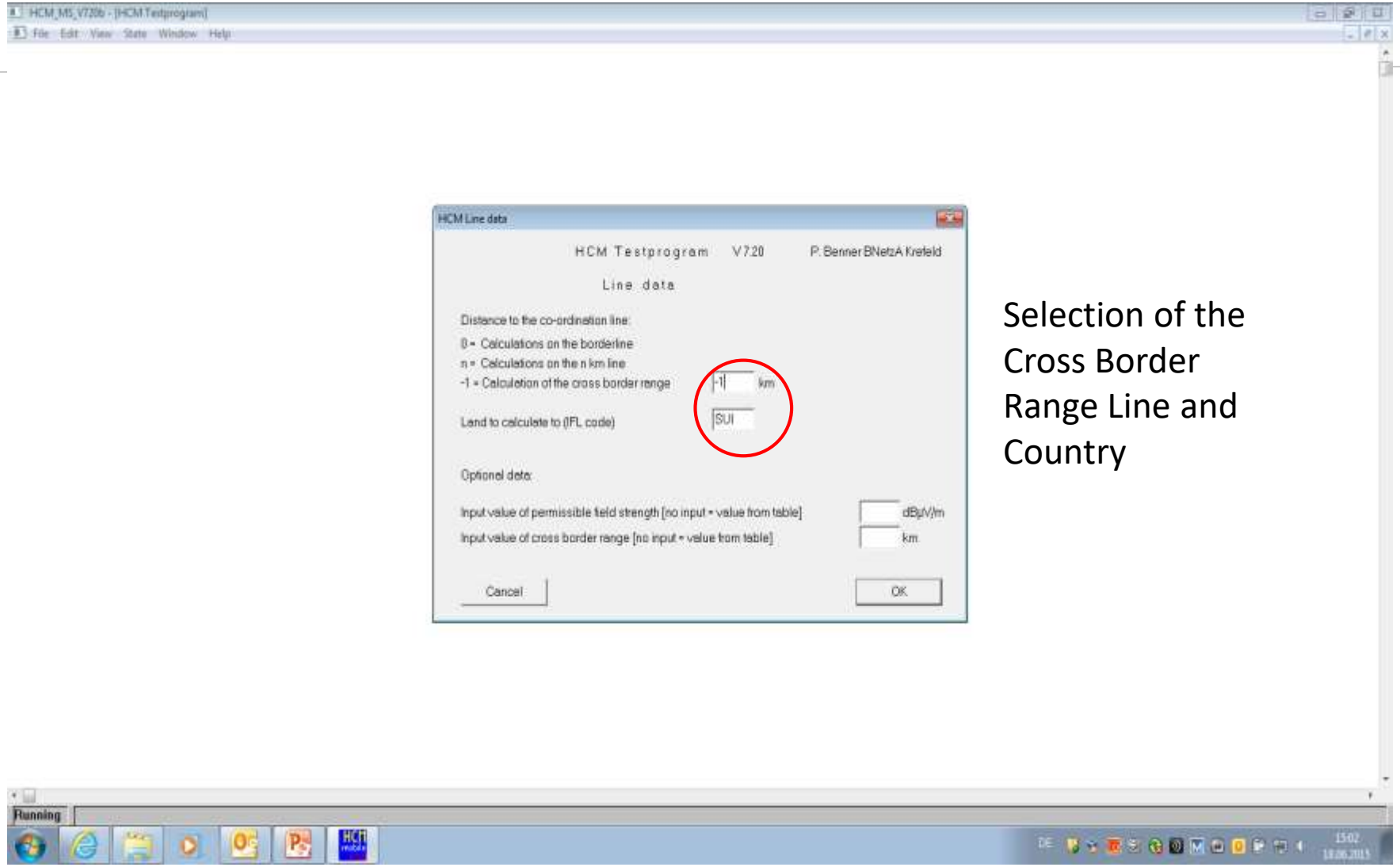
Selection of Borderline and Country

Calculation of Interference : Fixed, Mobile



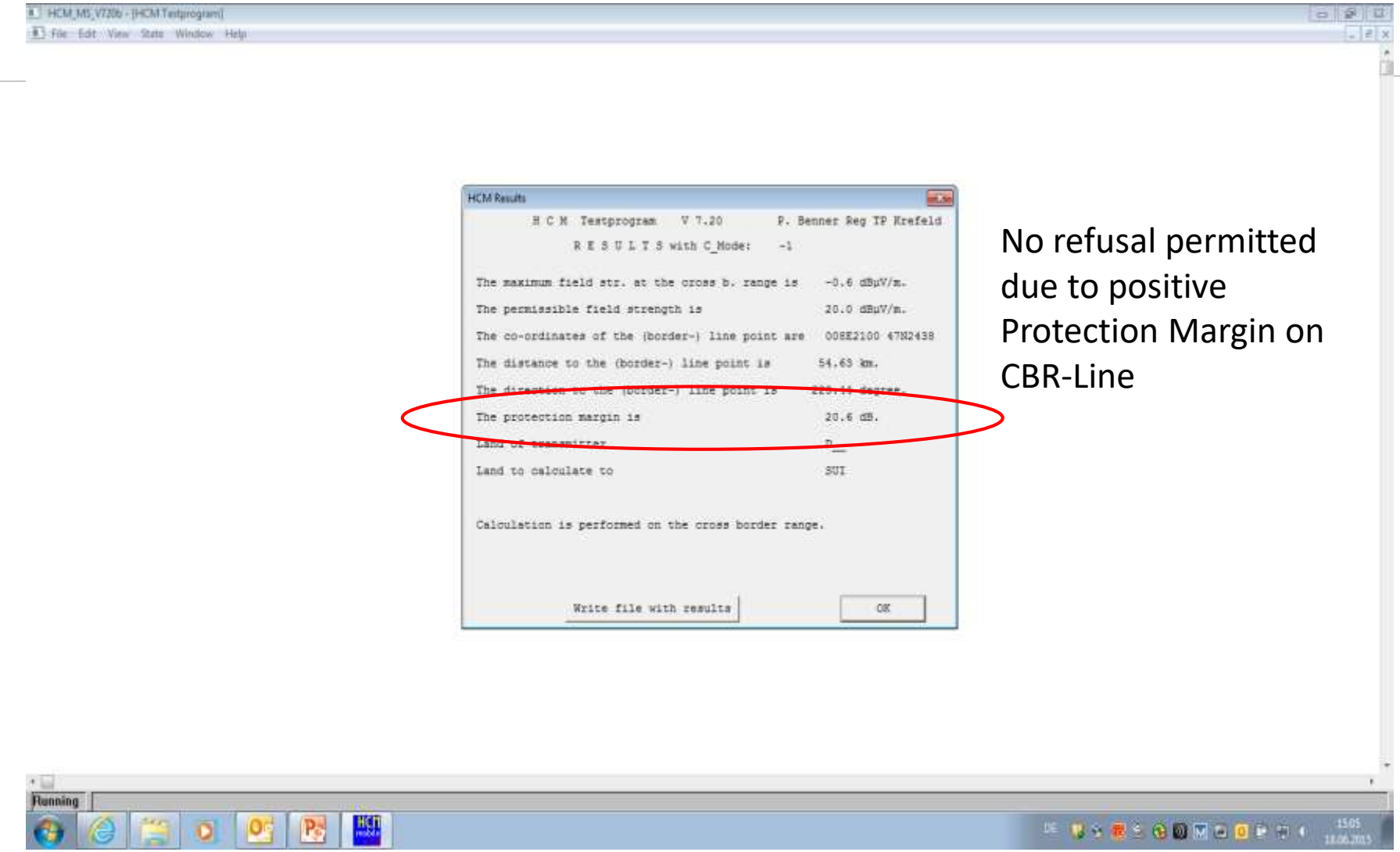
Co-ordination obligatory due to negative Protection Margin on border of selected country

Calculation of Interference : Fixed, Mobile



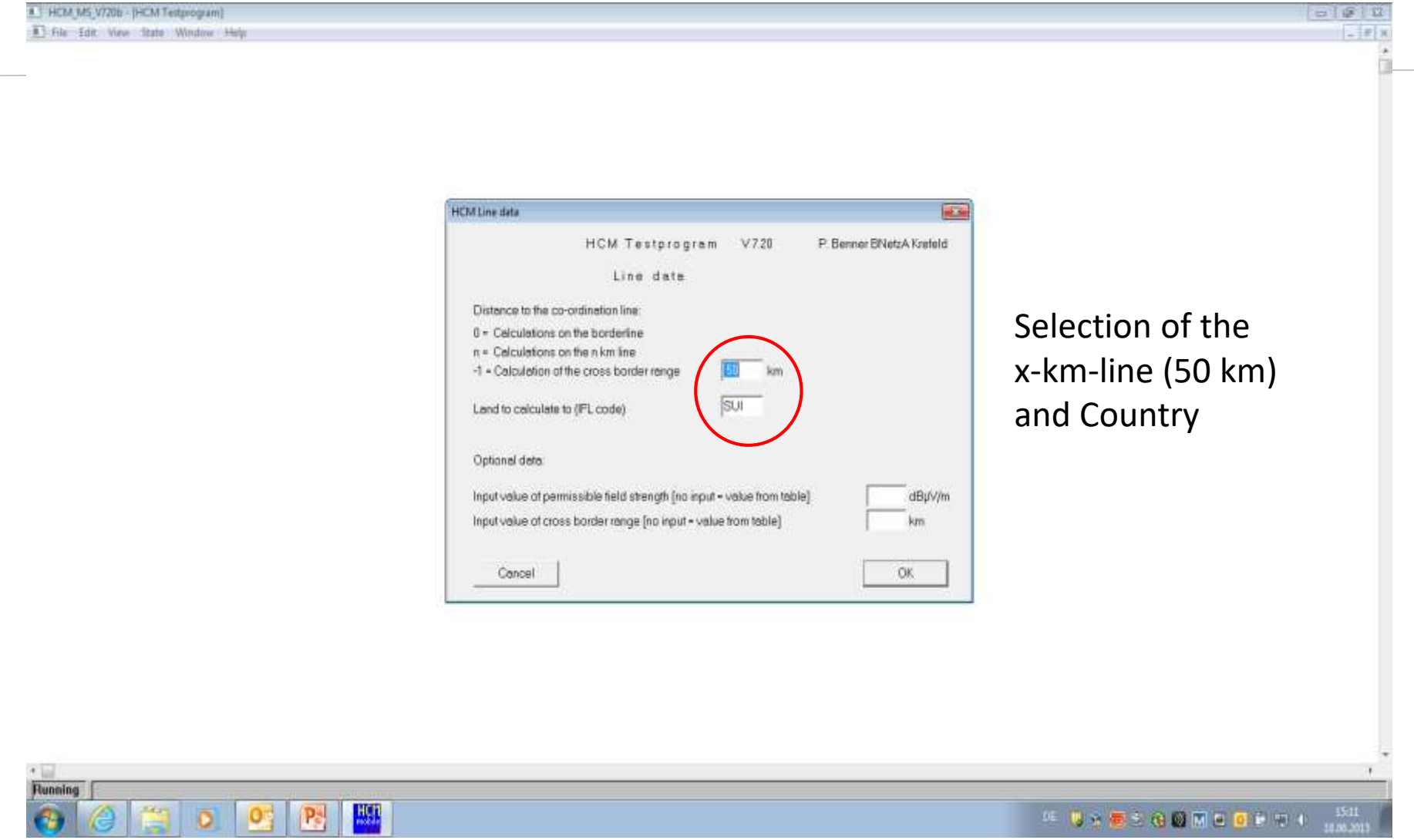
Selection of the Cross Border Range Line and Country

Calculation of Interference: Fixed, Mobile



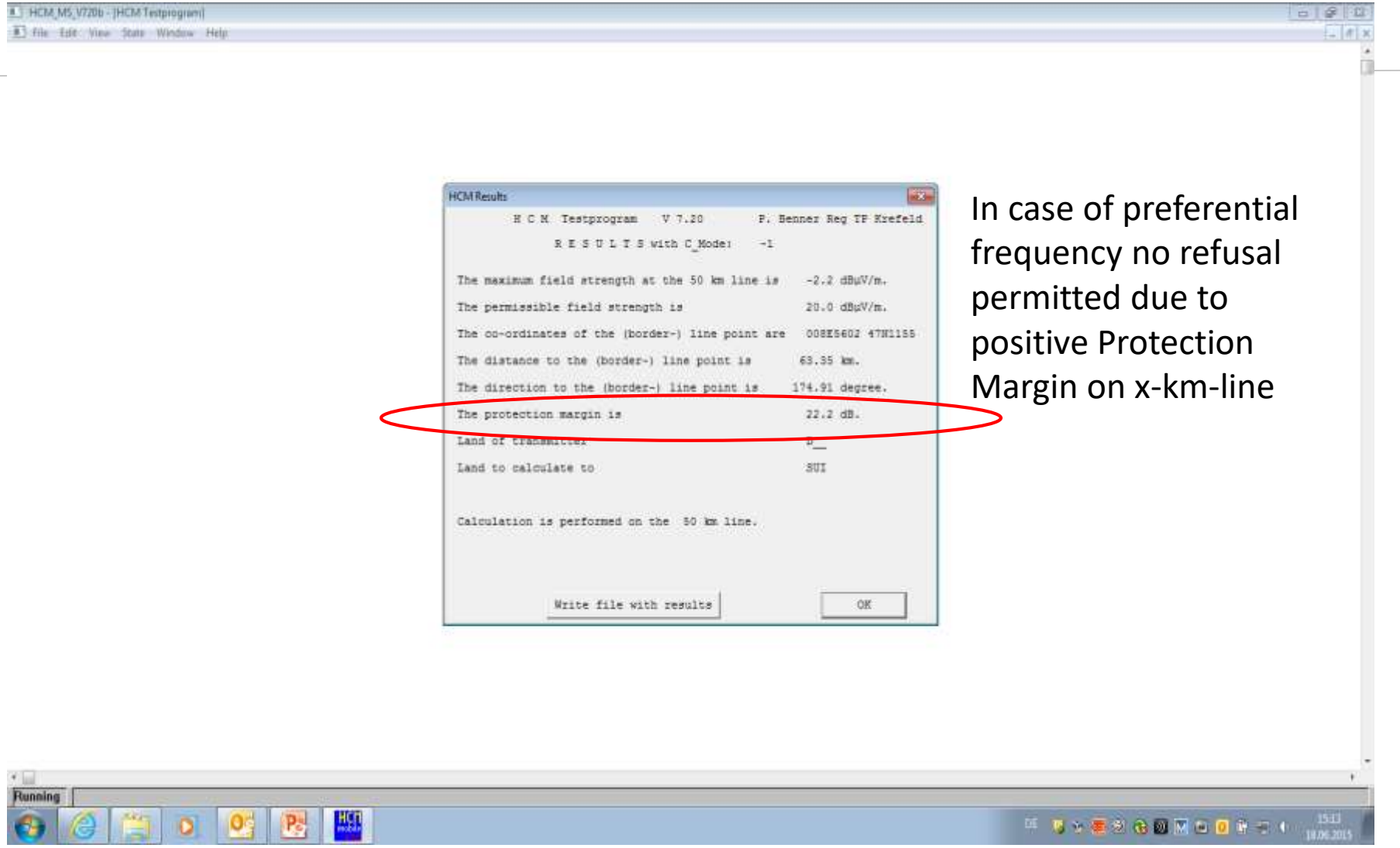
No refusal permitted due to positive Protection Margin on CBR-Line

Calculation of Interference : Fixed, Mobile



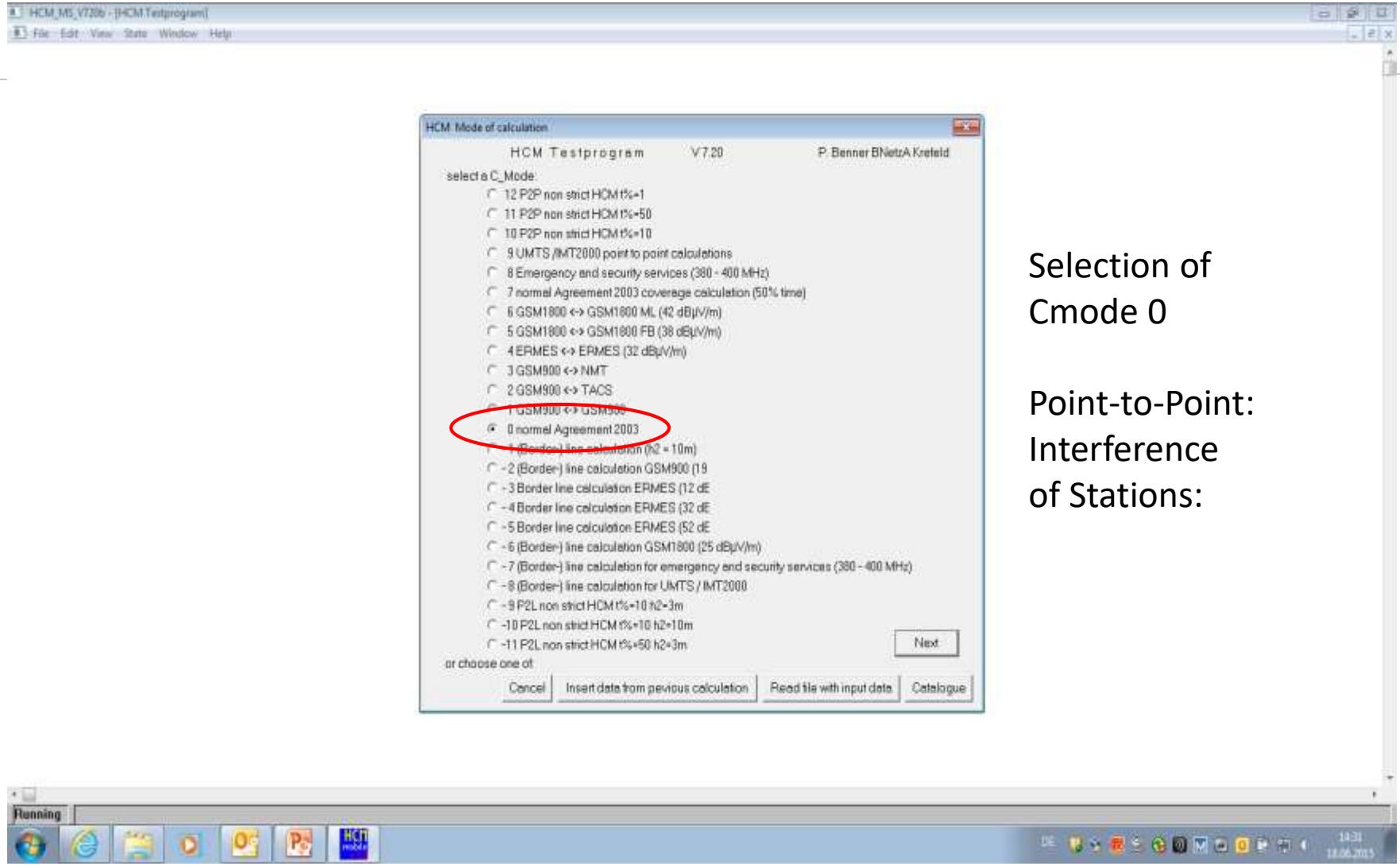
Selection of the x-km-line (50 km) and Country

Calculation of Interference : Fixed, Mobile



In case of preferential frequency no refusal permitted due to positive Protection Margin on x-km-line

Calculation of Interference : Fixed, Mobile



Selection of Cmode 0

Point-to-Point: Interference of Stations:

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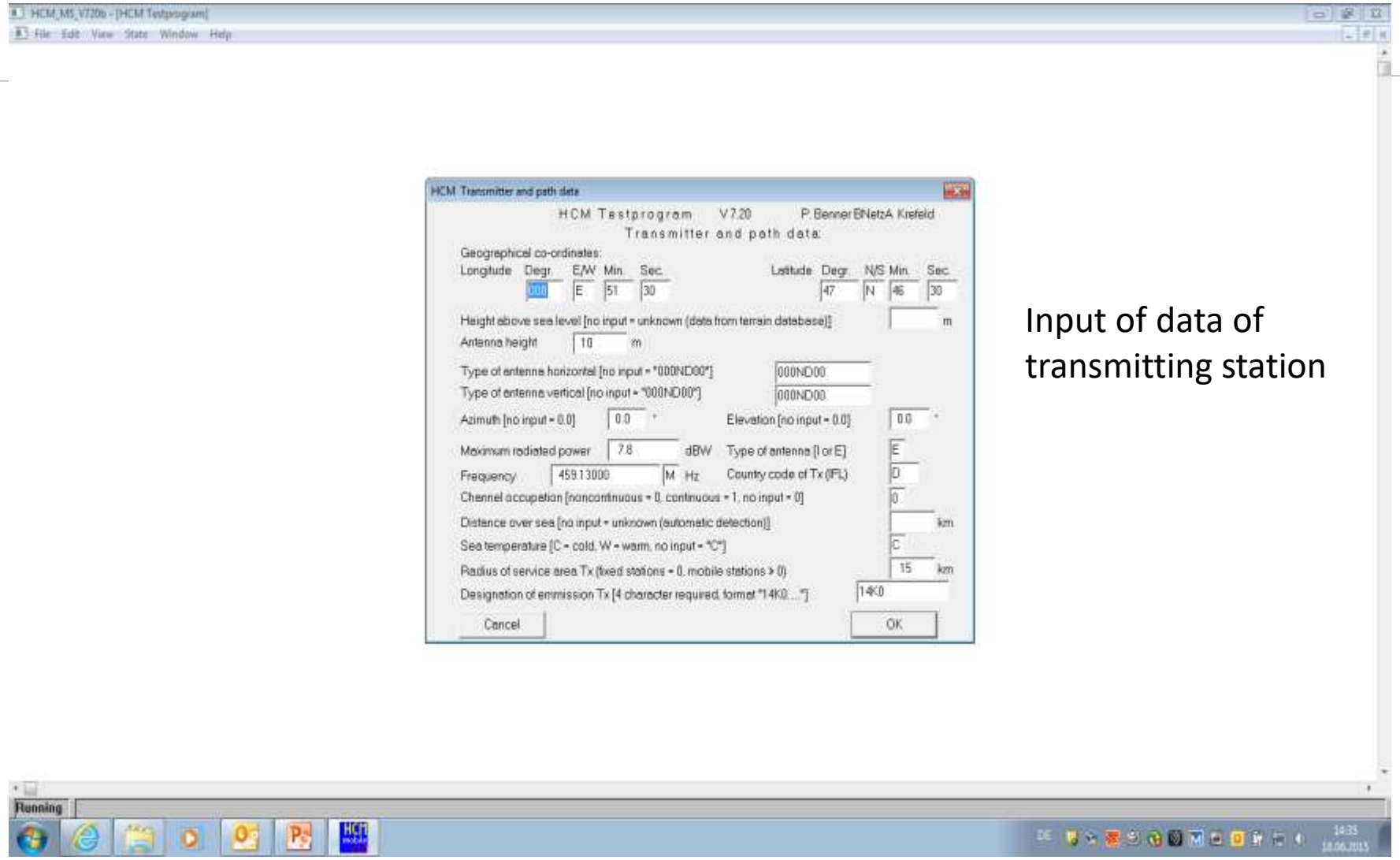
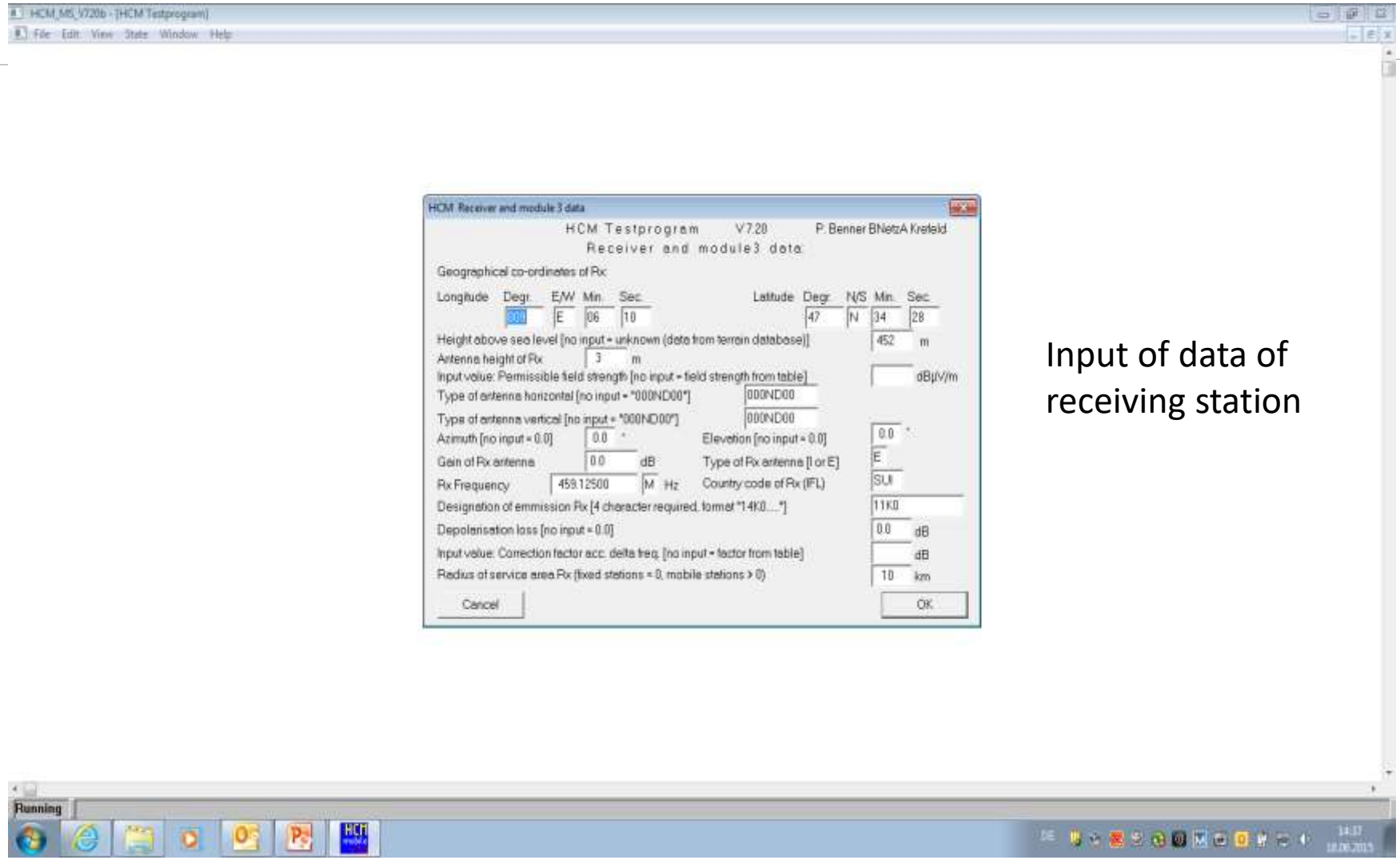
Calculation of Interference: Fixed, Mobile



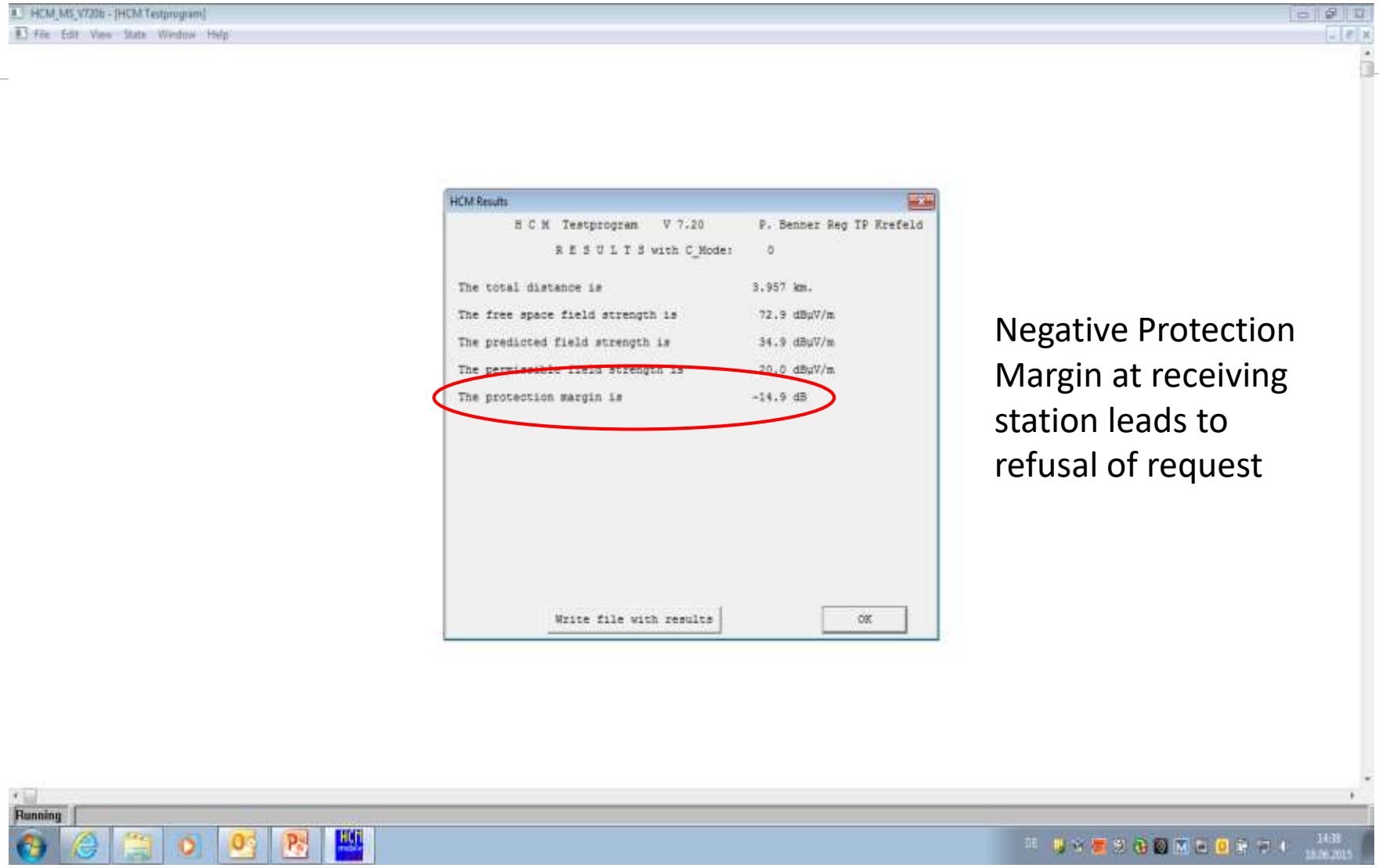
Input of data of transmitting station

Calculation of Interference: Fixed, Mobile



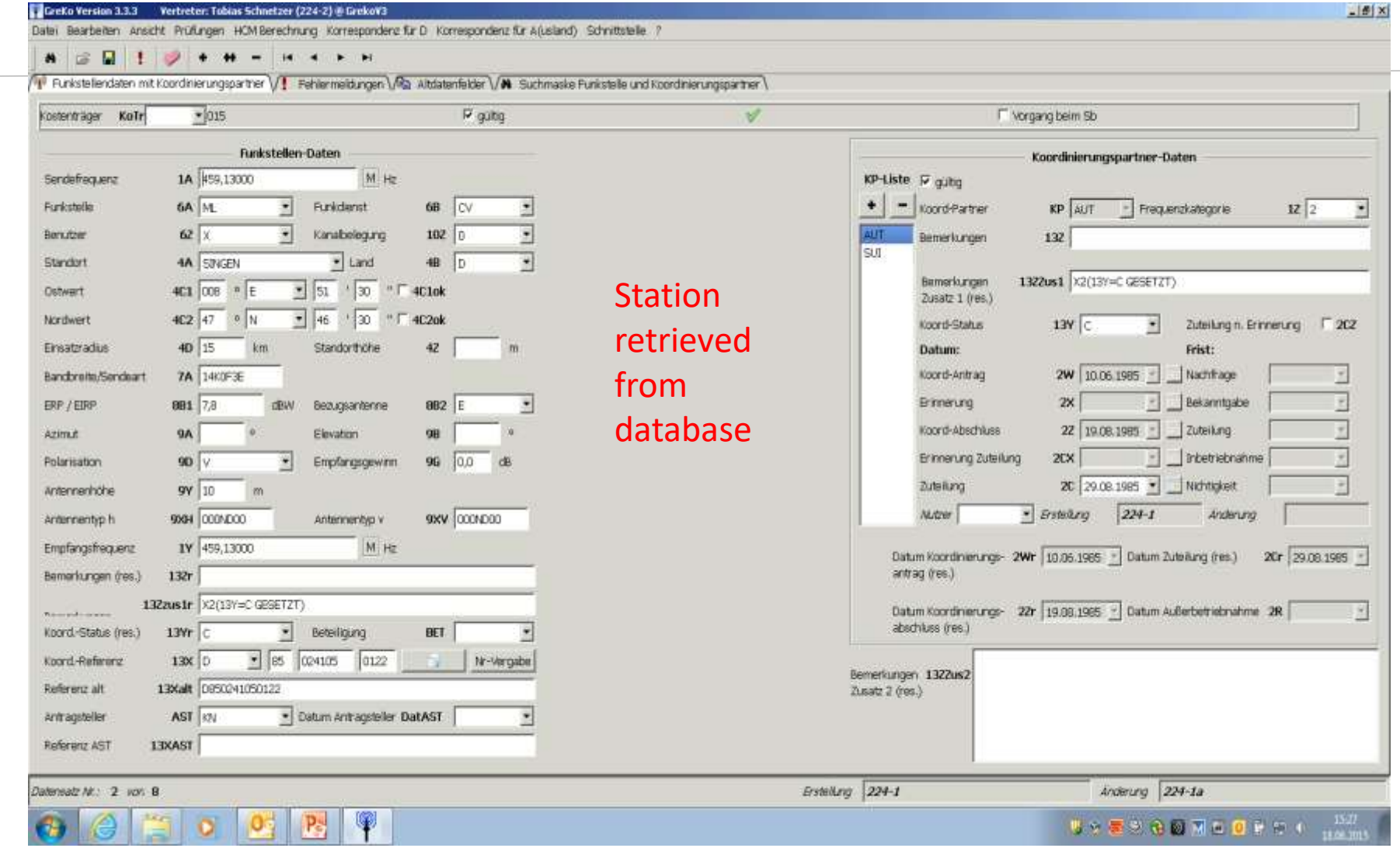
Input of data of receiving station

Calculation of Interference: Fixed, Mobile



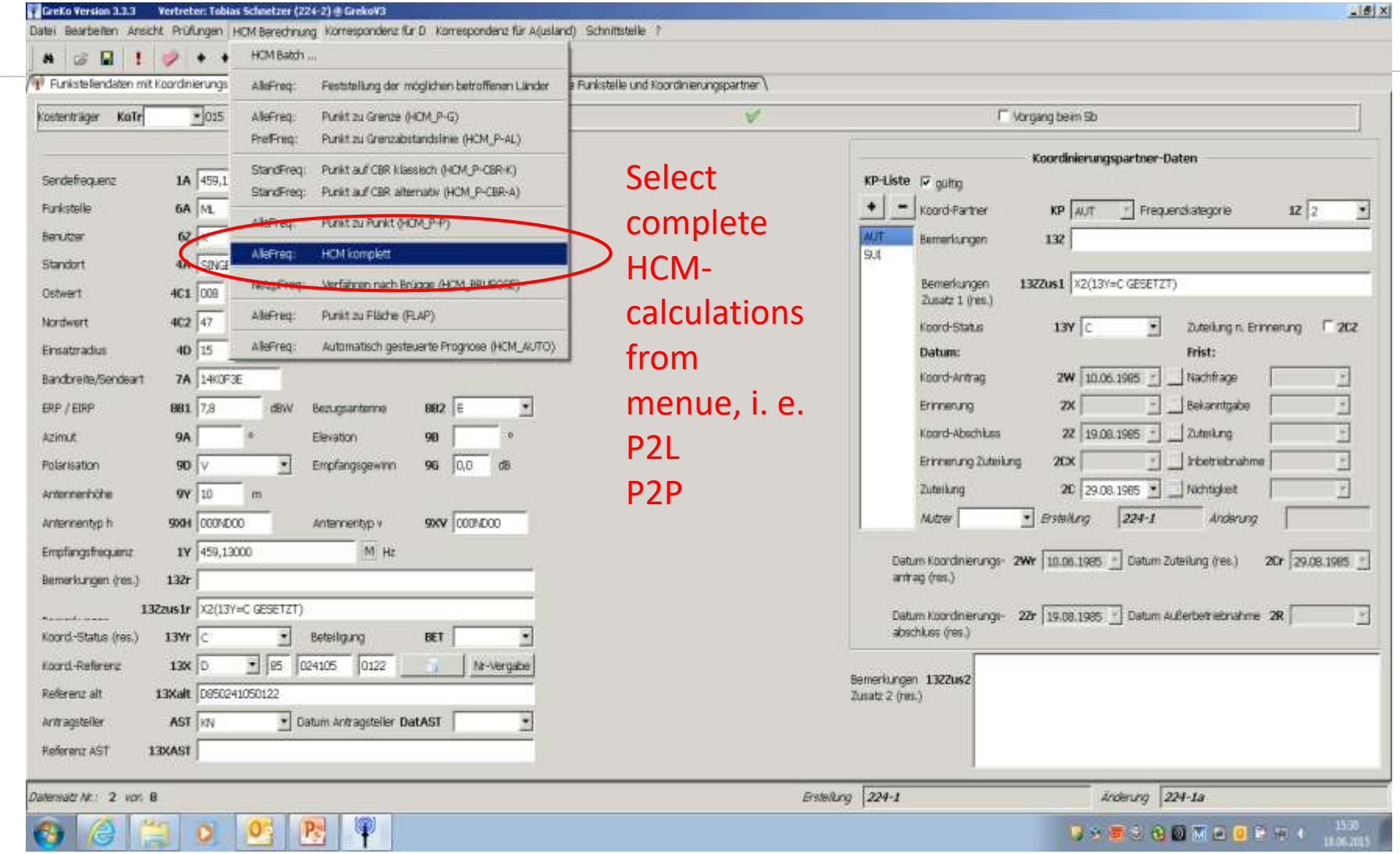
Negative Protection Margin at receiving station leads to refusal of request

Calculation of Interference: Fixed, Mobile

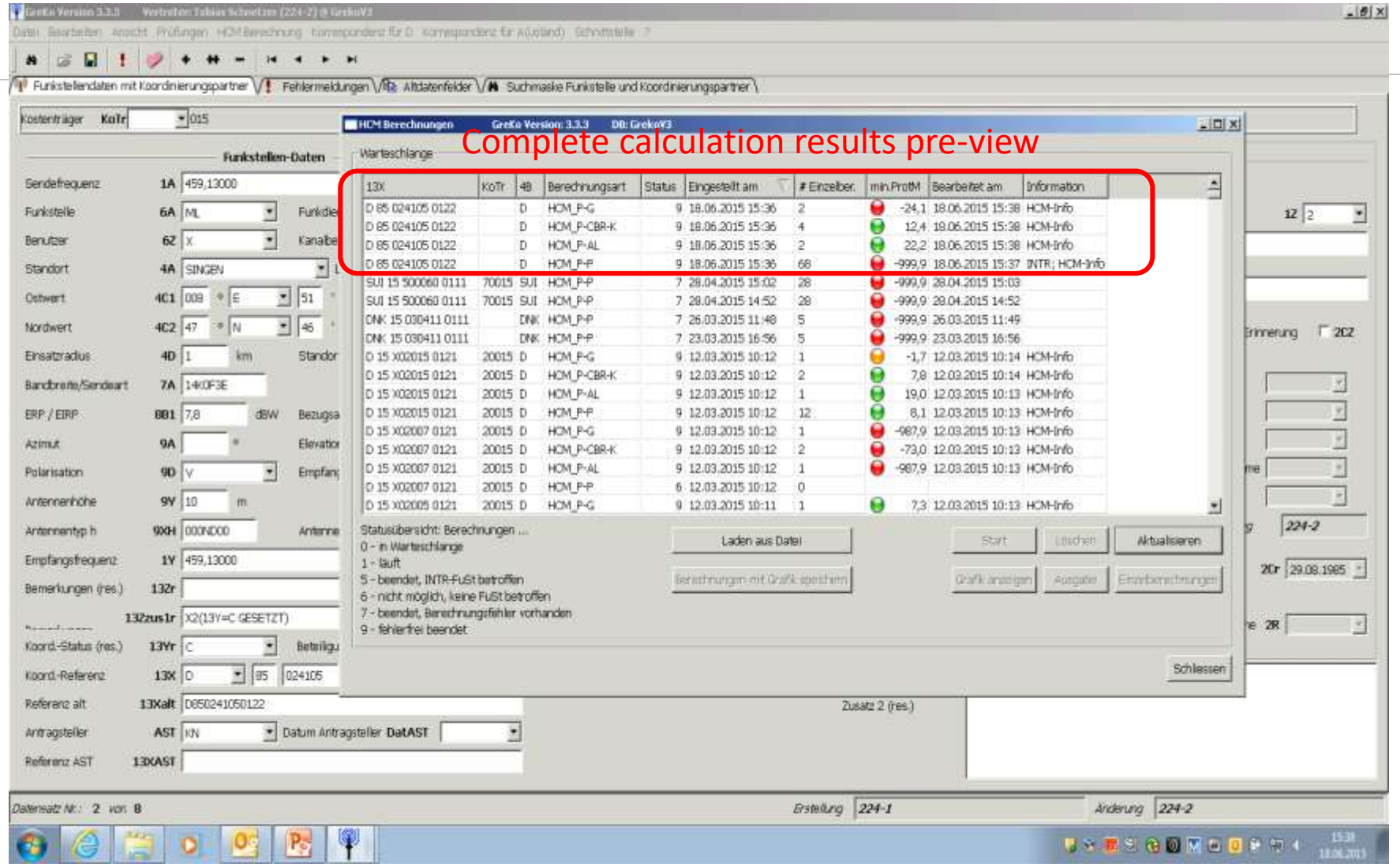


Station retrieved from database

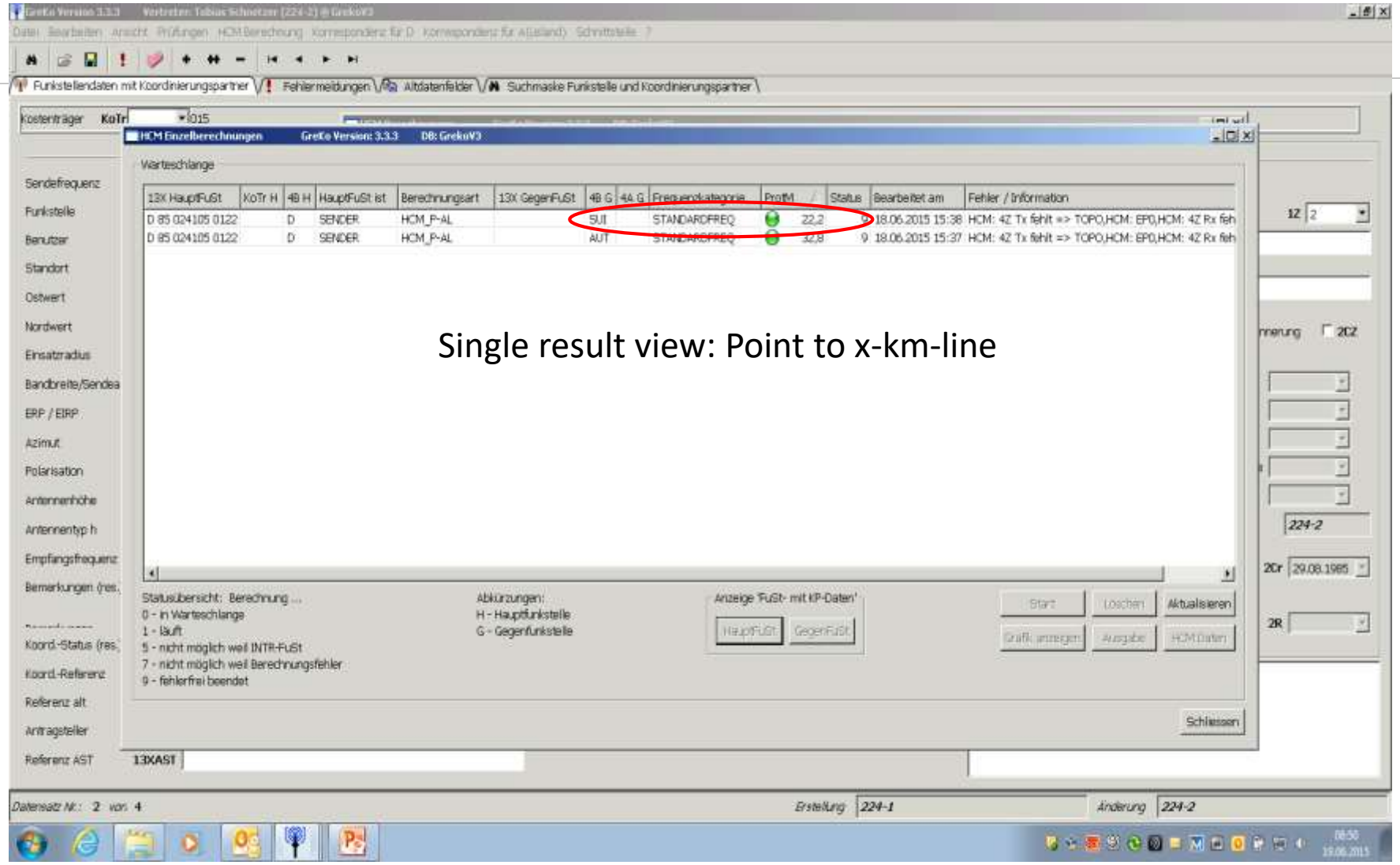
Calculation of Interference: Fixed, Mobile



Calculation of Interference: Fixed, Mobile

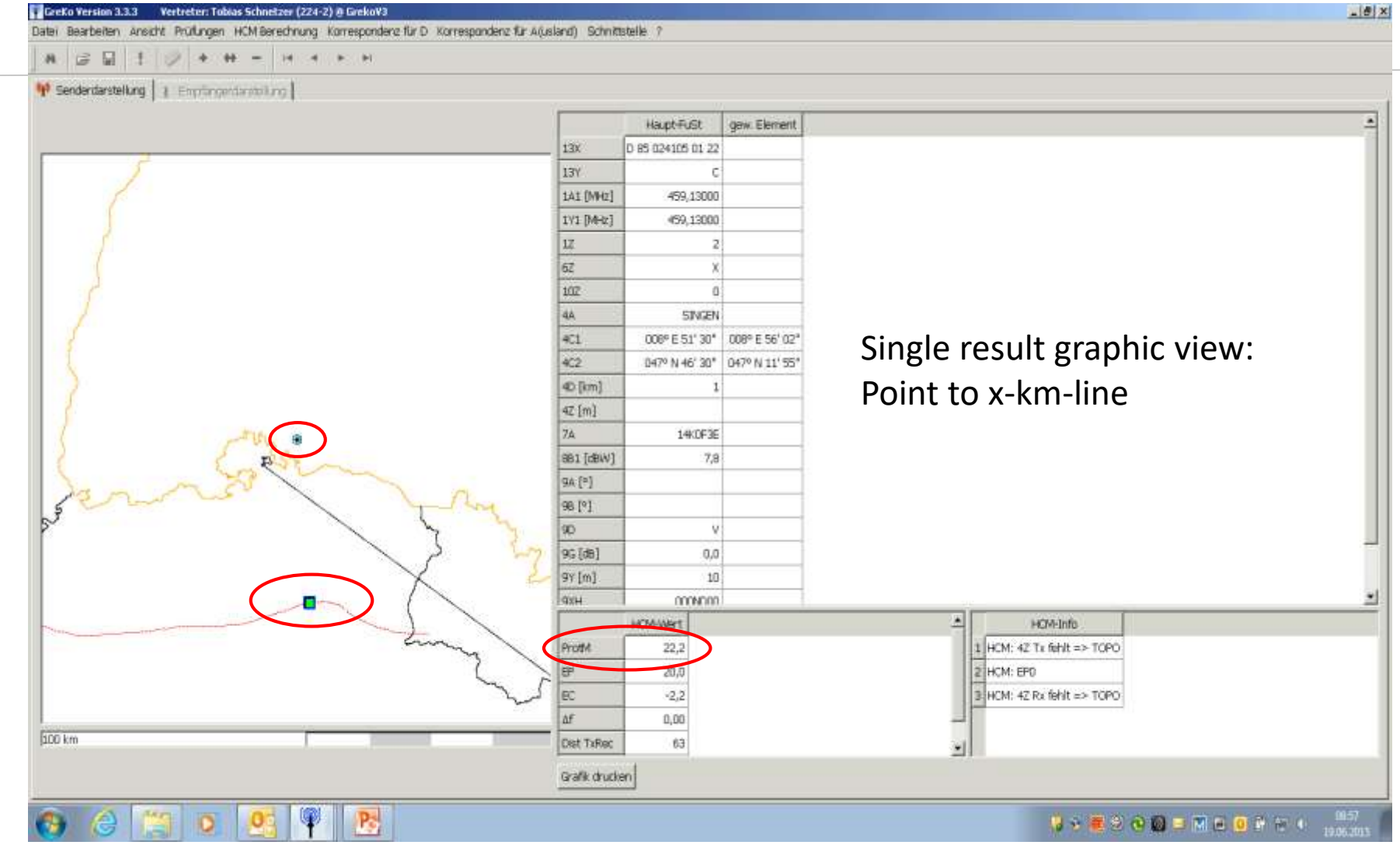


Calculation of Interference: Fixed, Mobile



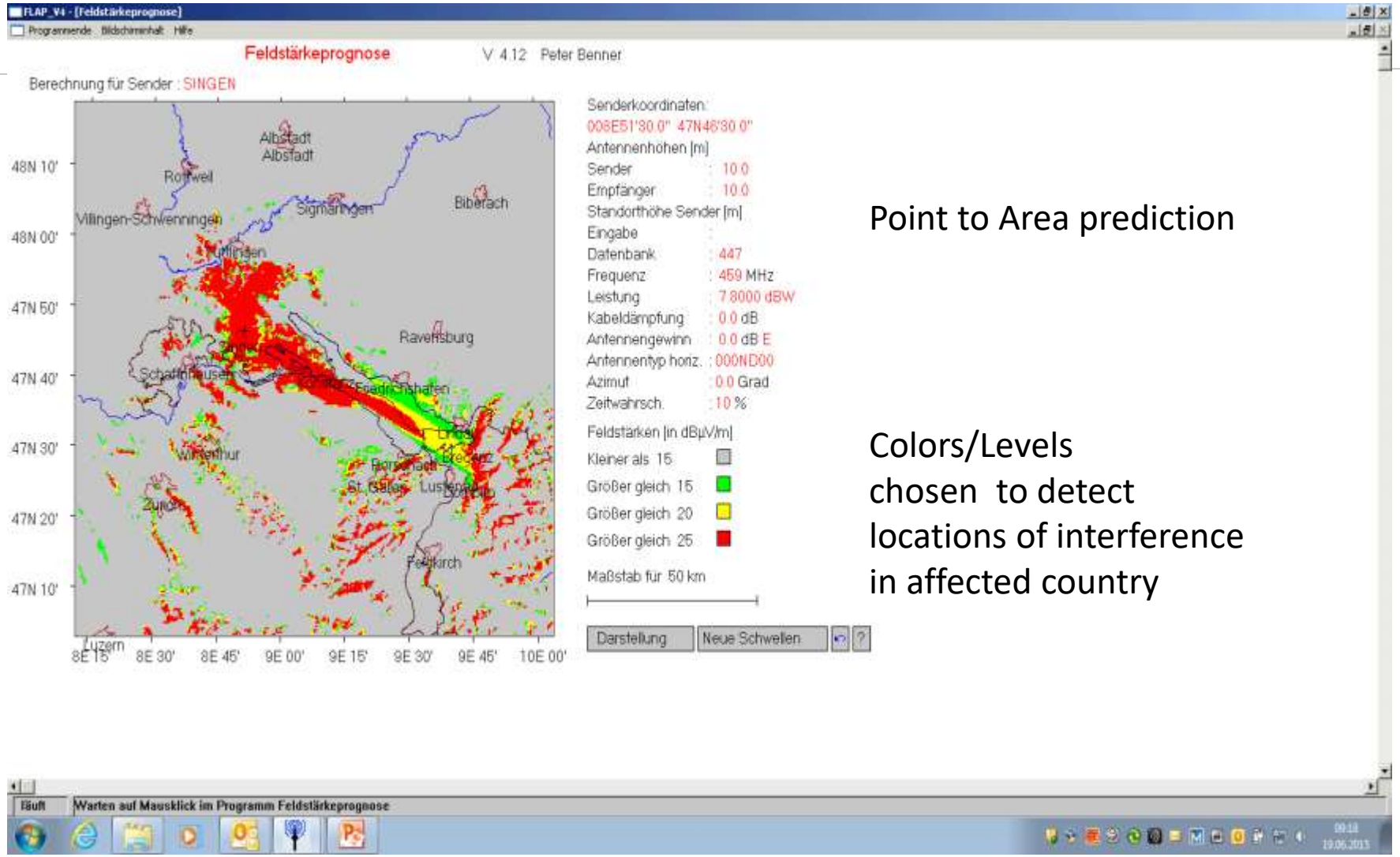
Single result view: Point to x-km-line

Calculation of Interference: Fixed, Mobile



Single result graphic view:
Point to x-km-line

Calculation of Interference: Fixed, Mobile



Point to Area prediction

Colors/Levels chosen to detect locations of interference in affected country