



National Telecommunications Agency Brazil

Compatibility Between 4G Services and Digital Television in the 700 MHz Band

**Brazilian studies and regulations on the coexistence of IMT Services
operating in the 698 MHz to 806 MHz Band and Digital Television using
Channels 14 to 51**

Summary

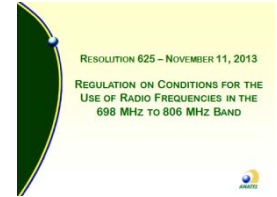


- Regulation on the conditions for the use of the 698 to 806 MHz Band
- Coexistence Tests between IMT (LTE) and Digital TV in the 700 MHz Band
 - Laboratory Tests
 - Field Tests
- Regulation on the Coexistence of IMT and DTV in the 700 MHz Band
- Conclusions

The 698 MHz to 806 MHz Band



- The conditions for the use of the band were established by Anatel **Resolution 625**, dated **November 11, 2013**
 - Additional Allocation of the band to the **Mobile Service** on a primary basis
 - Maintained the allocation of the band to **TV Broadcasting until future date** to be determined by Anatel according to instructions from the Ministry of Communications
 - Established the channeling (**APT arrangement**) and technical characteristics of the systems (**Maximum Power; OOB Emissions;..**)
- Resolution 625 will only enter into force after the publication of the notice for the auction of the Band
- The notice of the auction is conditioned by:
 - **Reallocation of television stations** currently using Channels 52 to 69
 - Publication of a **regulation against mutual interference** between IMT and DTV services, considering the results of tests conducted by Anatel



Coexistence Tests – General Aspects



Scope

- The tests intended to identify the **conditions** that make the coexistence between systems possible, eventual **critical situations** and possible **mitigation techniques**
- For practical evaluation of interference situations the tests were conducted in two specific conditions:
 - **Laboratory tests** in confined environment in the lab of the National Institute of Telecommunications-INATEL, in Santa Rita do Sapucaí-MG
 - **Field tests** involving the installation of transmission and reception equipment of an LTE system (eNodeB) in a station of the Brazilian telecom operator Oi and Digital Television transmission and reception systems in the town of Pirenópolis-GO
- For the assessment of possible mutual interference scenarios, in field testing, a television transmission system using the Brazilian DTV Standard (**ISDB-T**) was employed, as well as a **LTE** communication system operating in the 698 MHz to 806 MHz band in compliance with the regulation approved by Resolution 625

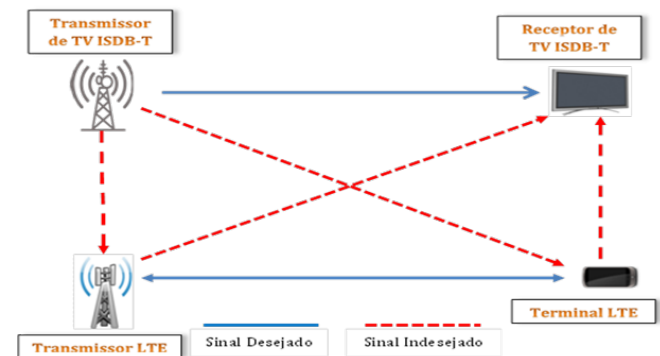
Coexistence Tests – General Aspects



Scenarios

- One or more LTE transmitters operating in the 698 MHz a 806 MHz band, interfering in Digital TV reception in the following conditions:
 - TV reception using an **outdoor antenna**
 - TV reception using an **indoor antenna**
 - TV reception using **amplified** outdoor antennas
 - TV reception in **mobile terminals** (one-seg)

- One or more Digital TV transmitters operating in channels from 14 to 51 interfering in the **reception** of **Base Stations** and **mobile terminals** of LTE systems operating in the 698 MHz a 806 MHz band



Coexistence Tests – General Aspects



Types of Interference

- From LTE transmitters operating in the 698 MHz a 806 MHz band, in DTV reception
 - TV Receiver **Overload**
 - Degradation due to unstable operation of the receiver **AGC**
 - Interference due to **“Image Channel”**
 - Interference due to **Unwanted Emissions**
- From DTV transmitters operating in Channels 14 to 51, in the reception of LTE base stations and terminals
 - Receiver **Overload**
 - Interference due to **Unwanted Emissions**

Coexistence Tests – General Aspects



Mitigation Techniques

- Variation of the **distance** between transmitters and receivers
- Use of additional **filters**, both in transmission and reception, so as to minimize the emission or reception of unwanted signals
- Variation of the **transmission power**
- Variation in **characteristics** and **positioning** of transmitting and receiving antennas



Filter for TV Reception



Filter for LTE Base Station



Antenna Positioning

Objectives

- Evaluation of the **maximum LTE power level** (downlink and uplink) at the input of TV receivers, which does not generate any **degradation** in the quality of DTV reception, with different frequency offsets, considering different values of the TV signal power reception
- Evaluation of the ratio of unwanted emissions of the LTE signal on the channel interfered (**ACLR**) and adjacent channel selectivity (**ACS**) of the TV receiver
- Calculation of co-channel Protection Ratio (**PR₀**) adjacent and image channel Protection Ratio (**PR**) and Overload Thresholds (**O_{th}**)
- Additionally, the effect of the use of a **low-pass filter** at the input of the TV receivers was also evaluated

Note: The laboratory tests **only** evaluated the scenarios of possible interference from IMT systems in DTV reception

Methodology

- The test setup was based on **Report BT 2215-01** issued by the International Telecommunication Union - ITU-R and followed specific procedures developed by the test team

INATEL LABORATORY



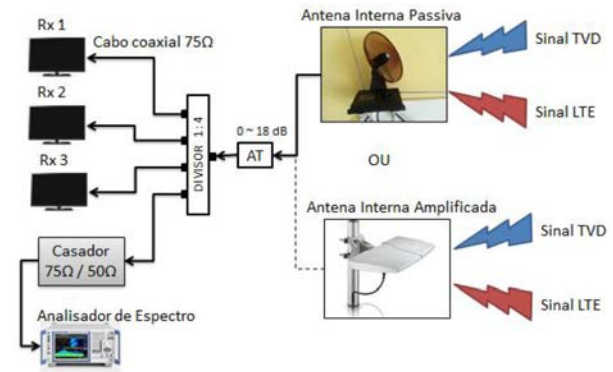
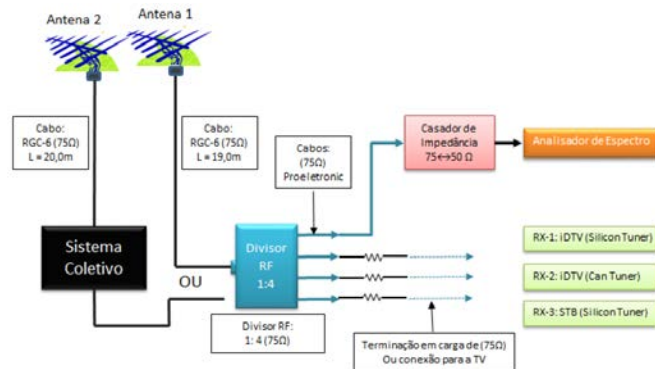
Test Setup



Measurements Room

Objectives

- Evaluate **typical scenarios** of coexistence between IMT and DTV systems, so that the results obtained may be used in drafting the regulation against harmful interference
- Determine Protection Ratios (**PR**) and Overload Threshold (**O_{TH}**) of receivers of both systems considering various real situations of reception of Digital TV and LTE systems
- Evaluate possible interference **mitigation techniques** in real world scenarios



Test Environment

- DTV: Digital **TV Transmitter** with variable power of **1.6 W to 100 W** with filters tuned for channels **38, 48** and **51**
- LTE **eNodeB**: Capable of operation in the frequency range of **703 to 738 MHz (uplink)** and **758 MHz to 793 MHz (downlink)**, with output power variable from **2 W to 40 W**
- Test Point 1 (P1): test point located at a distance of **10 m** from the LTE eNodeB antenna
- Test point 2 (P2): test point located at a distance of **50 m** from the LTE eNodeB antenna
- Test point 3 (P3): test point located at approximately **140 m** from the LTE eNodeB antenna
- Fixed point: House, approximately **230 m** from the eNodeB, where the main test setup was installed, including several types of TV receivers, antennae for UHF reception, and also equipment for measurement of received signal levels
- Receiving **Mobile Unit**: Used for reception of TV signals in the various test points. The vehicle featured a TV receiving antenna that can be adjusted to a height of up to 12 m.

Field Tests



Test Environment



Methodology

- At the test points and fixed site, measurements were made of the Digital TV signals and the signals coming from the eNodeB, for evaluation of the **interference**, **Protection Ratios** and effectiveness of **mitigation techniques**, according to specific procedures developed by the test team

FIELD INSTALATIONS



TV Transmitter Antenna



LTE Antenna and Mobile Unit



Measurements Room

Results



Laboratory Tests

- The detailed results of the laboratory tests are presented in **“Relatório de Teste Laboratorial de Interferência do LTE na Faixa de 700 MHz no ISDB-T”**



Field Tests

- The detailed results of the field testing are presented in the **“Relatório do Teste em Campo sobre Convivência do LTE na Faixa de 700 MHz com ISDB-T”**

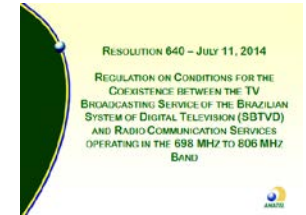


Both reports are available for **download** at Anatel’s website at the following links:

<http://www.anatel.gov.br/Portal/verificaDocumentos/documento.asp?numeroPublicacao=311026&pub=original&filtro=1&documentoPath=311026.pdf>

<http://www.anatel.gov.br/Portal/verificaDocumentos/documento.asp?numeroPublicacao=311027&pub=original&filtro=1&documentoPath=311027.pdf>

Regulation on Coexistence between IMT and DTV



- Based on the **test results** Anatel published, in **July 11, 2014**, **Resolution 640**, which approved the “Regulation on Conditions for the Coexistence between the TV Broadcasting Service of the Brazilian System of Digital Television (SBTVD) and Radio Communication Services operating in the 698 MHz to 806 MHz Band”
- The objective of the regulation was to establish **technical criteria** for mitigation of harmful interference between the two services taking into account the interference **scenarios** and **mitigation techniques** evaluated during the tests
- Proposed a **“Coexistence Matrix”** indicating, for each scenario considered, techniques or procedures that could be used to mitigate possible interferences

Regulation on Coexistence between IMT and DTV



Coexistence Matrix

I.I. Techniques for mitigation of possible interference from LTE transmitters operating in the 698 MHz a 806 MHz band, in DTV reception

Cenários	Técnicas de Mitigação					
	Utilização de Filtro na saída do transmissor da ERB	Utilização de Filtro na entrada do receptor de TV ou na entrada do amplificador do sinal de antena	Alteração na posição ou troca da antena de recepção de TV	Alteração na posição ou características da antena de transmissão da ERB	Redução da potência de transmissão da ERB	Aumento na distância entre o terminal e o receptor de TV
Interferência da ERB na recepção de TV com antena externa devido à saturação do receptor		X	X	X	X	
Interferência da ERB na recepção de TV com antena externa devido às emissões indesejáveis	X		X	X		
Interferência da ERB na recepção de TV com antena externa devido ao comportamento do CAG		X	X	X	X	
Interferência da ERB na recepção de TV com antena externa devido à frequência imagem		X	X	X	X	
Interferência da ERB na recepção de TV com antena interna devido à saturação do receptor		X	X	X	X	

Regulation on Coexistence between IMT and DTV



Coexistence Matrix

I.II. Techniques for mitigation of possible interference from DTV transmitters operating in channels 14 to 51, in the reception of Base Stations and mobile terminals of LTE systems operating in the 698 MHz a 806 MHz band

Cenários	Técnicas de Mitigação					
	Utilização de “Máscara Crítica” no transmissor do SBTVD	Utilização de Filtro na entrada do receptor da ERB	Alteração na posição ou características da antena de transmissão de TV	Alteração na posição ou características da antena de recepção da ERB	Redução da potência de transmissão da estação do SBTVD	Alteração na posição ou utilização de um terminal com maior robustez
Interferência de estações do SBTVD na recepção da ERB devido à saturação do receptor		X	X	X	X	
Interferência de estações do SBTVD na recepção da ERB devido às emissões indesejáveis	X		X	X	X	
Interferência de estações do SBTVD na recepção dos terminais móveis devido à saturação do receptor						X
Interferência de estações do SBTVD na recepção dos terminais móveis devido às emissões indesejáveis	X					X

Conclusions



- The **coexistence** between DTV stations operating in channels 14 to 51 and IMT systems operating in the 698 MHz to 806 MHz band with LTE technology **is possible**
- In some cases, the use of **mitigation techniques** to eliminate mutual harmful interference will be required
- The use of **additional filtering** in DTV receivers to eliminate frequencies above Channel 51 is an efficient means for resolving most cases of interference of LTE systems in DTV reception
- The use of **external antennas** with characteristics suitable for DTV reception, should be encouraged as a way to improve reception of the desired signal and reduce the potential for interference
- Based on the data collected during the tests, Anatel will be able to establish, in conjunction with equipment manufacturers, the **minimum technical characteristics** of receivers and devices used in mitigation of possible interferences, as well as a **conformity assessment** program

Thank You

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