

# Radiofrequency Spectrum Management Plan

## Rio 2016 Olympic and Paralympic Games

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AUTORIDADE PÚBLICA OLÍMPICA



Ministério das  
Comunicações

Ministério do  
Esporte



Note to the English version: Extreme care has been engaged in the translation of the document. Specialized professionals were involved. However, in case of conflicting texts, the Portuguese version of the document must be considered.

# Contents

1.	Introduction	3
1.1	Purpose	4
1.2	Scope	4
1.3	Update of Plan	6
1.4	Definitions, Acronyms and Abbreviations	6
1.5	References	8
2.	Technology and Services	9
2.1	Devices	9
2.2	Trunked Radio Communication Network	10
2.3	Audio Links	10
2.4	Video Links	11
2.5	Satellite Services	11
2.6	Telemetry and Telecommand	12
2.7	Wireless Local Area Networks (WLANs)	12
3.	Operating Plan	14
3.1	Spectrum Desks	14
3.2	Testing and Tagging	14
3.3	Spectrum Request Management	16
3.4	Frequency Map	18
3.5	Test Events	24
3.6	Olympic and Paralympic Torch Relay	24
3.7	Monitoring and enforcement	25
4.	Complementary Activities	26
4.1	Technological Innovation	26
4.2	Use of Radiofrequency Equipment at Games Time	26
4.3	Spectrum Use Requests	27
5.	Schedule and Programmed Deliveries	29
5.1	Milestones	29
5.2	Consolidated Schedule	30
6.	Information and Communication with Users	31
6.1	Information	31
6.2	Communication	31
7.	Appendices	32
	Appendix 1 - Games Venues (September 2013 version)	33
	Appendix 2 - Communication Channels	34
	Appendix 3 - London 2012 Olympic Games Spectrum Usage Reference	36

## 1. Introduction

The Olympic and Paralympic Games are the biggest sports events on the planet. The last edition involved the participation of around 15,000 athletes from 200 countries.

The Rio 2016 Games should attract around 21,500 accredited media, a public of 9 million people, 4,000 Organising Committee employees (at Games time), more than 25,000 people including athletes, federations and national committees, and over 60,000 volunteers to operate in their organisation.

The 2016 Games in Rio de Janeiro will demand enormous communications resources for their organisation, to transmit sounds and images of the Games to billions of spectators, for security, for coordination, and in various other forms of communication.

Frequency spectrum is an essential resource to guarantee the success of communications needed for the Olympic and Paralympic Games to take place in the city of Rio de Janeiro in the period between 5 August and 18 September 2016. In addition to Rio de Janeiro, football events will also be held in the cities of São Paulo, Brasília, Belo Horizonte and Salvador.

When Rio de Janeiro submitted its bid to host the 2016 Games, the Brazilian government made a commitment to the IOC to guarantee the spectrum needed for the Games, in accordance with item 16.9 of the Candidature File, as described below:

### **16.9 - Frequency Reservation and Services**

Free to Games clients

*The Federal Government, through the Ministry of Communications and ANATEL, guaranteed to review legislation, regulations and decrees, or approve new legislation or regulations, as necessary, to ensure that no fee will be charged to athletes, the IOC, the Rio 2016 Organising Committee, NOCs, NPCs, IFs, the press, members of Rights-Holding Broadcasters or Olympic partners, for frequency allocation reservation and services in the period beginning one month before the Opening Ceremony of the Olympic Games and ending one week after the Closing Ceremony of the Paralympic Games, further undertaking to do so quickly and efficiently.*

The aforementioned guarantee is provided for in article 13 of the Olympic Act, approved by Law 12,035 of 1 October 2009, as follows.

*Article 13. The availability of the entire radiofrequency spectrum and signals needed to organise and stage the Rio 2016 Games is assured, guaranteeing their assignment, management and control during the period from 5 July to 25 September 2016.*

The main element for success in this case will therefore be management of radiofrequency spectrum before and during the 2016 Games.

## 1.1 Purpose

The aim of this document is to establish an action plan for the Telecommunications Workgroup with regard to Management of Radiofrequency Spectrum, including: (i) spectrum planning; (ii) authorisation and licensing of spectrum usage; (iii) testing and tagging; (iv) monitoring, enforcement, and management of interferences.

## 1.2 Scope

Spectrum management during the Rio 2016 Games has the following objectives:

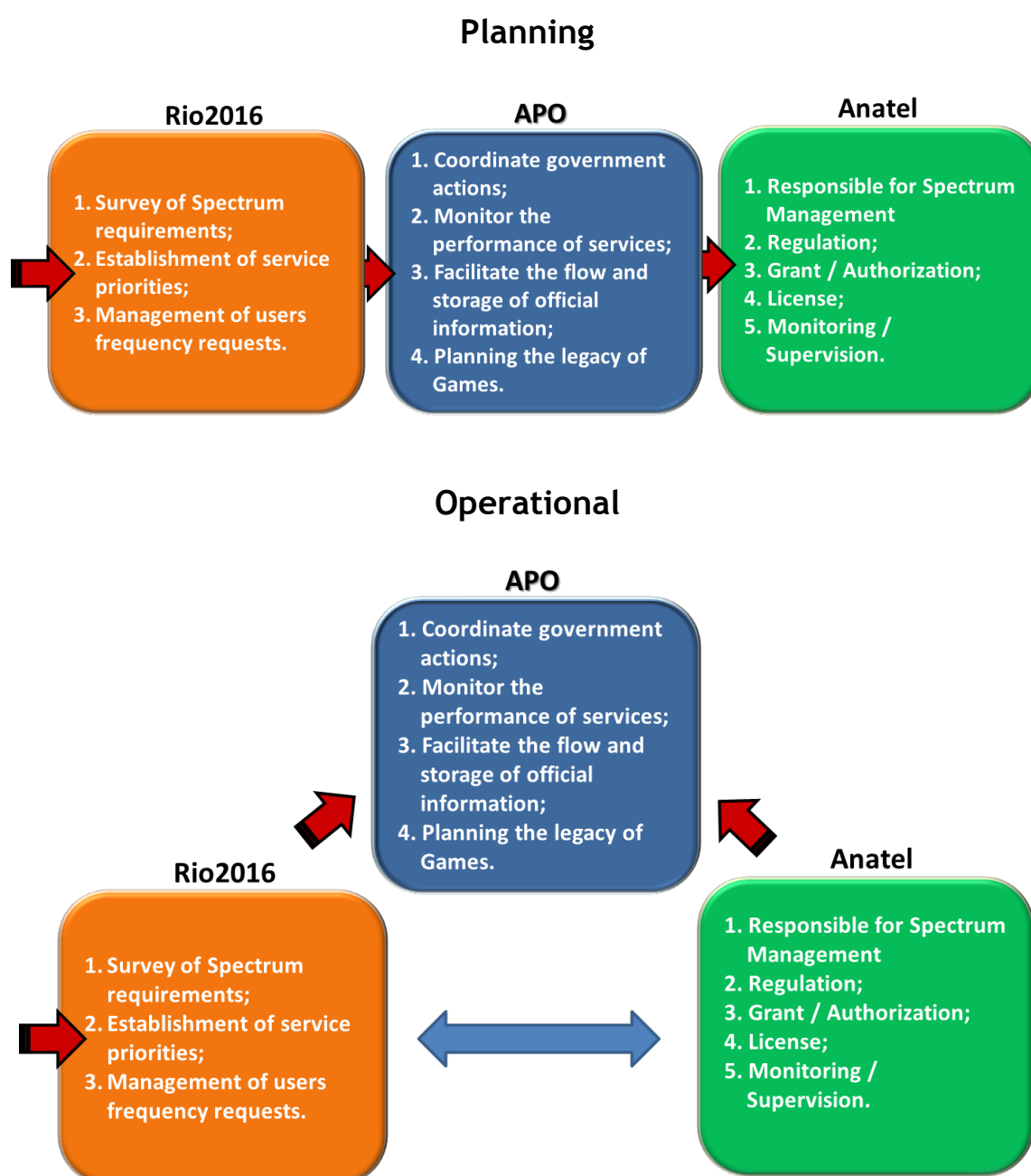
- Define actions to prioritise the meeting of requests related to the use of spectrum, seeking alternatives to optimise spectrum demands.
- Guarantee the availability of a computerised system to register requests for temporary use of radiofrequency and for their respective analysis.
- Define radiofrequency usage planning based on information provided by the Rio 2016 Committee, identifying spectrum that may be made available.
- Guarantee the effective management of harmful interferences during the Games, ensuring that users have high-quality spectrum.
- Control access of radiofrequency-emitting equipment to the locations where the Rio 2016 Games will be held, including through testing and tagging.
- Guarantee compliance with prevailing legislation and regulations.
- Guarantee the disclosure of up-to-date information about spectrum management.
- Provide authorisations for temporary use of spectrum for the Games.
- Meet demand with the lowest possible cost to the government, other spectrum users, citizens and consumers.

Users of spectrum for the Games, guarantee-holders, the “Olympic and Paralympic Family” are as follows:

- Athletes.
- International Olympic Committee (IOC).
- International Paralympic Committee (IPC).
- Rio 2016 Organising Committee (Rio 2016).
- National Olympic and Paralympic Committees (NOCs / NPCs).
- International Sports Federations (IFs).
- Press (media).
- Olympic Broadcast Service (OBS).
- Rights-Holding Broadcasters (RHBs).
- Sponsors.

The main entities related to spectrum management for the Rio 2016 Games are: The National Telecommunications Regulator Agency (ANATEL), The Games Organising Committee (Rio 2016) and The Federal Government, through the Ministry of Communications and the Public Olympic Authority (APO).

The basic responsibilities of each entity concerning spectrum management issues are shown in Figure 1, below.



*Figure 01 - Responsibilities of entities related to spectrum management*

The Telecom Working Group, due to specific technical and operational conditions, may invite governmental or non-governmental entities that are regular spectrum users in the country to participate in its activities, provided that this is related to the execution of the Radiofrequency Spectrum Management Plan.

Certain actions that may be taken in advance to facilitate the frequency management process have been identified, including the following:

- Clear and objective communication with stakeholders.
- Prior contact with major spectrum users (OBS and RHBs), giving them the due prioritisation.
- As much as possible, simplify and optimise communication, providing users with contact points inside Rio 2016.
- Align teams from the entities involved with spectrum management in order to cope with demands before and during the Games.
- Forewarn users, especially the biggest ones, about the risks of making last-minute demands, which always negatively affect radiofrequency usage assignment and authorisation.

The following points must be considered:

- Spectrum demand tends to exceed supply for use in major events. Accordingly, Rio 2016, as a demander of spectrum from ANATEL, should make a thorough analysis of requests, proactively raising awareness of usage/needs among users.
- Rio 2016 and ANATEL should act to optimise the process of requesting spectrum and find ways to strongly discourage unnecessary requests.
- Non-critical operational demands should be questioned by those responsible for spectrum.
- Rio 2016 will be the demander of spectrum from ANATEL, and ANATEL will be responsible for authorisations for temporary use of spectrum. Accordingly, the Committee will conduct a prior analysis before submitting requests to ANATEL for approval.

### 1.3 Update of Plan

Updates of this plan will be made through official statements and revisions of this document, which will be divulged in the appropriate channels.

### 1.4 Definitions, Acronyms and Abbreviations

- . **ADS:** Audio Distribution Services
- . **FA:** Functional Area of the Rio 2016 Organising Committee
- . **ANATEL:** National Telecommunications Agency
- . **APO:** Olympic Public Authority (Portuguese acronym)
- . **CCTV:** Television Closed Circuit
- . **COB:** Brazilian Olympic Committee (Portuguese acronym)
- . **IOC:** International Olympic Committee
- . **NOC:** National Olympic Committee
- . **NPC:** National Paralympic Committee
- . **DFS:** Dynamic frequency selection
- . **DVB-T:** Digital video broadcast - Terrestrial

- . **EHF:** Extremely high frequency
- . **EIRP:** Effective isotropically radiated power
- . **ENG:** Electronic newsgathering
- . **ERC:** European Radiocommunications Committee
- . **IF:** International Sports Federation
- . **FIFA:** Fédération Internationale de Football Association
- . **FSS:** Fixed satellite service
- . **GHz:** Gigahertz
- . **GPS:** Global positioning system
- . **GT TELECOM:** Telecommunications Workgroup for the 2016 Games, formed by ANATEL, APO, MINICOM and Rio 2016
- . **HD:** High definition
- . **IBC:** International broadcast centre
- . **IEM:** In-ear monitor
- . **IP:** Internet protocol
- . **MHz:** Megahertz
- . **MINICOM:** Ministry of Communications
- . **MNO:** Mobile-network operator
- . **MPC:** Main press centre
- . **MSS:** Mobile satellite services
- . **mW:** Milliwatt
- . **NBC:** National broadcasting company
- . **NOC:** National Olympic Committee
- . **NPC:** National Paralympic Committee
- . **OB:** Outside broadcasting
- . **OBS:** Olympic Broadcasting Services
- . **PDFF:** Brazilian Frequency Band Assignment, Allocation and Distribution Plan (Portuguese acronym)
- . **PES:** Permanent earth station
- . **PMR:** Private mobile radio
- . **PMSE:** Programme-making and special events
- . **RHB:** Rights-holding broadcaster
- . **Rio 2016:** Organising Committee of the 2016 Rio de Janeiro Olympic and Paralympic Games
- . **RNSS:** Radio navigation satellite services
- . **R&TTE:** Radio and telecommunications terminal equipment
- . **SAB:** Services ancillary to broadcasting
- . **SAP:** Services ancillary to programme making
- . **SARC:** Ancillary and related broadcasting services (Portuguese acronym)
- . **SCM:** Multimedia Communication Service
- . **SHF:** Super high frequency
- . **SLA:** Service level agreement
- . **SLE:** Specialized Mobile Service
- . **SLP:** Private Limited Service
- . **SMA:** Aeronautical Mobile Service
- . **SME:** Specialist mobile service (Portuguese acronym) (PMR)
- . **SMP:** Personal mobile service (Portuguese acronym)
- . **STFC:** Public Switched Telephone Network (PSTN)
- . **TES:** Transportable earth station
- . **UHF:** Ultra high frequency
- . **Venues:** Games locations
- . **W:** Watt
- . **WLAN:** Wireless local area network

## 1.5 References

Item	Title
01	Frequency Planning Olympics London 2012_Results. OFCOM - December 2012
02	Basic Requirements for Coordination of Frequency Spectrum for the Rio 2016 Games. Rio 2016 - November 2012
03	Presentation: "Coordination of Spectrum for the Rio 2016 Olympic and Paralympic Games". Rio 2016 - 7 December 2012
04	Preliminary Work Plan, Frequency Coordination Group. Rio 2016 - February 2012
05	General Plan for Spectrum Management Activities for the 2016 Olympic and Paralympic Games. ANATEL - May 2013
06	Presentation: "Spectrum Management - Rio 2016 Olympic and Paralympic Games". APO and ANATEL, 6th Meeting, Technical Project Review - August 2013
07	OFCOM and the London 2012 Olympic and Paralympic Games, 18 December 2012
08	Guide to Radio Spectrum for the London 2012 Olympic and Paralympic Games - OFC 150 Olympic indd, 20/04/12
09	Telecommunications Parts 2B and 3A - Spectrum Planning and Management - Presentation by Jean Benoit Gauthier (IOC), Emma Young (LOCOG) and Peter Bury (OFCOM), International Olympic Committee, 15/11/12
10	PO.TEC.12 - Operating Policy - Approval and Use of Wireless Devices, Laurent Bodusseau, 03/12/10
11	PO.TEC.15 - Operating Policy - Managing Radiofrequency Interference and Monitoring, Laurent Bodusseau, 16/05/11
12	SOCHI 2014, Spectrum Order Portal Application Guide, version 1.3, March 2013, Sochi 2014 Spectrum Management - How to Apply for Spectrum Using the Rate Card Portal
13	Spectrum Management Service Delivery Concept, Presentation, Sochi 2014
14	Venues Telecom Infra Services, V7, Rio 2016



## 2. Technology and Services

### 2.1 Devices

Table 01 below presents some wireless devices normally used in Olympic and Paralympic Games, and this situation should repeat itself in the 2016 Games.

Type	Users	Comments
Wireless cameras	Presenters + sports	Major use in Games
PMR - Handhelds	All	Basically security
Mobile microwave links	Broadcasters of sounds and images, and sports	Heavily used in aerial shots, generally in TV coverage of outdoor events
PMR 446	Mainly NOCs/NPCs	Important for NOCs/NPCs - Coordination must only request 8 channels with 38 CTCSS codes, as at the previous event
Telemetry and telecommand	Omega and broadcasters	Large telemetry demand to control wireless cameras and timing and scoreboard systems
Talkback	Broadcasters, ceremonies, presenters	Use of international federations for reflink systems
Wireless microphones	Broadcasters, ceremonies, presenters	High demand. Various fixed frequencies demanded for the Games.
In-ear monitors	Broadcasters, ceremonies, presenters	
Wi-Fi	All	Heavy use in private offices. Should be requested at competition venues.
Point-to-point links	Broadcasters	Difficulties in exact location of links
Satellite uplink	Broadcasters	Use in earth stations and at Games venues
Non-licensable devices	All	Must be coordinated by Rio 2016
Audio description services	Rio 2016	Spectrum team planning
WCATV	Broadcasting	Very high demand for spectrum. Should be avoided, if possible. Consider using Wi-Fi for this service.
Camera triggers	Press	Used by professional press photographers, mainly at sports events.

*Table 01 - Wireless devices*

## 2.2 Trunked Radio Communication Network

During the 2016 Games, Rio 2016 should offer a trunked radio communications network with the aim of providing a communications means to the members of the Committee itself, security, transport and other entities involved on the games organization.

This is a complementary network for existing collective interest telecommunications service users, yet to be defined, designed so as not to conflict with existing definitions regulated by ANATEL. It is intended that, at the end of the Games, the network will become a legacy for the community.

The implemented network must cover all Rio 2016 Games venues, as well as the main public locations in the city of Rio de Janeiro, for example, airports and main transportation roads between the venues. The design must provide for the RF channelization reuse whenever feasible.

## 2.3 Audio Links

The classic technologies used for audio at the Games are wireless microphones, talkback systems, in-ear monitors (IEMs) and audio distribution systems (ADSs).

Wireless microphones, generally used by broadcasters, sport presenters and event organisers, may be handheld or attached to the person's lapel, with transmitters that are built-in or attached to the body. They are still predominantly analogue, although digital wireless microphones already exist and are used for some specific purposes. Technology is evolving and there are now systems that perform spectrum management for wireless microphones.

IEMs are generally used by broadcasters or event participants to listen to their own voice or feedback mix. They may generally share spectrum with wireless microphones and they may be considered jointly in spectrum management.

The biggest demands for wireless microphones and IEMs at past Games were for the opening and closing ceremonies, which to a certain extent puts their use within Rio 2016's control.

Based on other games, we can consider as a reference the use of 350 wireless microphones and 100 IEMs at the opening ceremony of the Rio Games.

A technical report by the European Radio communications Committee (ERC) reported on the use of 12 wireless microphones in a single TV channel (8 MHz) without separation between users. For short distances such as 3 to 6 metres away, spectrum usage efficiency would be better, reaching up to 23 microphones shared in one channel during peak demand. It will be possible to share microphones and IEMs without there being any harmful interference between them, if used by different users.

Spectrum management for wireless microphones and IEMs is a topic that should be treated in a special manner, given that the allocation of channels must follow specific rules for this type of device. The simple granting of free channels does not meet spectrum requirements for the use of these devices.

Talkback systems are generally used by broadcasters, allowing production heads to guide their team members, such as camera operators, reporters and presenters.

There are no plans to move this equipment between Games venues, since this would hinder frequency allocation if it were routine. Talkback employs SME-type radio technology and tends to operate in the same spectrum band. The 430 to 500 MHz band seems interesting for this technology.

Audio distribution systems (ADSs) retransmit material ready for public consumption. They cover events and have other objectives of temporary nature. Rio 2016 may use this technology at selected venues in order to improve spectator ambience.

## **2.4 Video Links**

Video links include wireless cameras and point-to-point links. They are basically used by broadcasters to film and report on live events, and for CCTV for security purposes.

The use of wireless cameras is directly linked to broadcasting needs. By their nature, these cameras should be the biggest demanders of spectrum during the Games, not least because, besides OBS, around 200 Rights-Holding Broadcasters (RHBs) are expected to broadcast at the Rio Games.

Cameras are natural candidates for careful spectrum management, in order to avoid harmful interference. During peak moments, one may expect there to be up to 75 (benchmark number) wireless cameras being used simultaneously at the main Games venues.

We also expect these cameras to be used for aerial shots, of the marathon, for example, and due to these shots' propagation nature, this reduces the capacity for spectrum reuse, while the band of usable spectrum is also limited by the mobility of these links and difficulties in obtaining lines of sight. This will certainly affect the needs for effective isotropically radiated power (EIRP) for the uplink transmission. For this reason, it is advisable to limit, as much as possible, the number of available channels for this purpose. Merely as a benchmark, we estimate there will be nine to ten cameras being used simultaneously for this purpose.

Point-to-point links should be used to connect games venues or to provide video signals for an external reporting van, for example. We expect the fibre optic networks installed at Games venues to reduce the demand for these links, serving backups and connections between them.

## **2.5 Satellite Services**

Satellite services may be fixed or mobile. They may also provide radionavigation services, such as location services.

Fixed satellite services (FSS) use earth stations installed and operating at known and determined locations to transmit and receive satellite signals. They should be used by broadcasters to convey audio and video signals during external reporting, to studios, or directly to national and international broadcasting networks.

There may be two types of application, one permanent earth station (PES) and one transportable earth station (TES) - Satellite Newsgathering Terminals. The IBC should certainly be a user of these PES stations. Eventually, another venues, such the ones used to Games opening and closing ceremonies, may also use them. The expectation in terms of spectrum management is that these stations will be planned well in advance and their licences may be issued in the normal licensing process.

With regard to the TESs, they are transportable by nature, but they transmit from a fixed location at a given moment. The demand for this service at Games time is likely to be high. There are some usage restrictions such as near airports and other locations where existing services need to be protected. Also in this case, the management expectation is that spectrum requirements will be stated in advance and that licences will be issued in the normal process.

Mobile satellite services (MSS) operate globally through constellations of geostationary and non-geostationary satellites, normally in the 1 to 3 GHz band. They support voice and data services and also broadband video transmission. They are also used to complement earth links for defence and security services.

Finally, one may highlight radionavigation satellite services (RNSS), also known as SAT NAV, which provide signals for security, business and consumer devices. GPS is a classic example of this service. They are likely to be used in the Games, operating in an unlicensed band.

## **2.6 Telemetry and Telecommand**

Telemetry is the use of radio communications to automatically measure and record information remotely. Telemetry is capable of remotely initiating, modifying and finalising the operation of a given piece of compatible equipment.

Telemetry and telecommand services should be used in the 2016 Games to remotely control cameras, camera triggers and other equipment, in addition to localised data communications. The spectrum used is normally located in unlicensed bands, although to avoid interferences, there also exists deployments in some licensed bands such as 430-470 MHz. The band immediately before 410-430 MHz has also been considered by the industry for equipment of this nature.

As a benchmark, around 600 camera triggers should be used by 1,400 accredited photographers at the Rio 2016 Games.

Also note that many items of wireless equipment used to record times and on scoreboards make use of telemetry and telecommand technology.

## **2.7 Wireless Local Area Networks (WLANs)**

Networks also known as Wi-Fi and Hot Spots. WLANs will be provided by Rio 2016 for specific clients, although Games venue designs call for maximum physical (cabled) connectivity for Rio 2016 itself and its partners.

Spectrum for WLANs is unlicensed. Accordingly, the use of private routers will only be permitted at Games venues if they are coordinated and authorised in advance by Rio 2016.

### **3. Operating Plan**

#### **3.1 Spectrum Desks**

Spectrum Desks will be the interfaces between Rio 2016's Technology Operations Centre (TOC) and users, in order to manage spectrum during the Games. They will be situated at the following strategic locations: the IBC, MPC, Fort Copacabana, Mário Filho Stadium (Maracanã), João Havelange Stadium (Engenhão), Marina da Glória, the Athletes' Village and a Games venue in the Deodoro Cluster.

In addition, there will be an office in each of the football host cities (Brasília, São Paulo, Belo Horizonte and Salvador). The Spectrum Desks operating hours will be announced in due course.

These offices will basically have the following purposes:

- Give attention to requesting users in general;
- Verify equipment at the location;
- Coordinate ANATEL's testing and tagging activities;
- Coordinate WLAN activities on-site;
- Store and recharge technical equipment required for management.

In the Spectrum Desks the responsible employees will assess radiofrequency emitting equipment to ensure it complies with the specifications of the authorisation provided by ANATEL. The assessments will be visual and technical to confirm whether the technical characteristics are in accordance with ANATEL's authorisations and Rio 2016's terms and conditions.

It is important to pay attention to the accreditation of the technical teams that will need to have access to Games venues and that will be working in the offices.

One must guarantee the minimum necessary material resources for office operations (desks, chairs, printers, etc.), yet to be defined.

#### **3.2 Testing and Tagging**

At Games time, ANATEL enforcement agents will be in the Spectrum Desks to conduct preliminary tests, with the aim of checking whether the telecommunications devices are correctly configured, in accordance with the parameters described in the authorisation for the temporary use of radiofrequency issued by ANATEL.

The testing and tagging procedure encompasses radio frequency emitting devices.

All users who request temporary use of radiofrequency must present their equipment for testing and tagging. The tag "Use not permitted" will be attached to all equipment that fails compliance testing and whose irregularity cannot be rectified during the testing period.

Each cluster of venues will be associated with a distinct colour to identify radio frequency emitting equipment and permit its access to the site. Approved devices will be marked with a tag of the cluster's specific colour, indicating that its transportation and operation at that site are authorised.



Security teams will be instructed to direct any people operating an untagged telecommunications device or carrying devices with tags associated with another cluster (incorrect colour) to the nearest spectrum office. Equipment whose usage is not permitted must be turned off by the security teams under Rio 2016's coordination.

The ANATEL team will be orientated to approach any people operating untagged equipment or carrying devices with tags associated with another cluster (incorrect colour) or non-permitted usage tags (whose operation is prohibited).

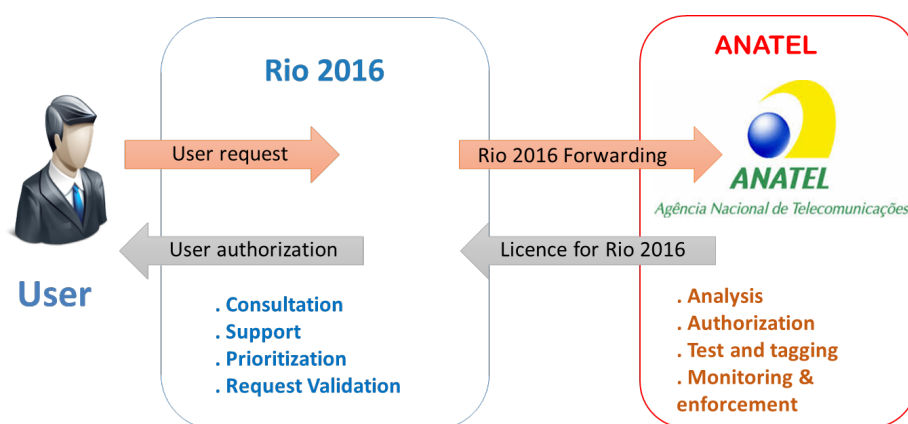
Testing and tagging procedures outside spectrum offices may be conducted by ANATEL's team, preferably before the Games begin, provided that one proves that it is impossible for the accredited user to remove the equipment from a venue where there is no office for this purpose. However, this measure will be conditional upon previous scheduling and the existence of suitable resources (power, network, equipment in working order) for the execution of tests.

### 3.3 Spectrum Request Management

The management of spectrum demands made by users in the Olympic and Paralympic Families must be conducted by Rio 2016, using as a demand management tool the Spectrum Request Portal.

In cases where there are large numbers of simultaneous spectrum requests, Rio 2016 will also make available another complementary tool. Both request tools (Portal and Spreadsheet) will be described in detail in due course through an Informative Spectrum Bulletin.

Figure 02 below shows the authorisation model for the 2016 Games, and Figure 03 presents the standard spectrum request adopted by Rio 2016 for processing and subsequent forwarding to ANATEL in order to obtain authorisations.



**Figure 02 - Spectrum authorization logical model for the 2016 Games**



**Rate Card**

Home Catalogue My orders New standard requests Spectrum requests My account Reports

Spectrum request : create new

Please enter your wireless equipment details in the form below. When finished click Save to proceed to the next step.

**Request summary**

Status:	In Progress	Date created:	Recorded when request is submitted
Spectrum request number:	Available after Save	Last update:	23/02/2011
Contact:	Andrew.Lebianco@london2012.com	030 2012 0168	Andrew.Lebianco@london2012.com <a href="#">Add new contact</a>
* Games period:	Olympic Games		
* Start date:	27/06/2012		
* End date:	26/08/2012		
* Location:	Lord's Cricket Ground (LCG)		
* Spectrum service:	Handheld (walkie/talkie)		

\* = compulsory field

[Save](#) [View all requests](#)

**Figure 03 - Spectrum request system via Rate Card Portal**

The Spectrum Portal has been used in previous versions of the Olympic and Paralympic Games, so that users should not have difficulties dealing with the procedure.

However, as mentioned before, a spreadsheet will also be provided for cases in which there are large numbers of requests. This will be a complementary procedure including external services to analyse, map and manage radiofrequencies, designed to obtain temporary spectrum use authorisations from ANATEL, pursuant to the terms of the prevailing regulations.

Some important parameters must be specified on the Spectrum Request form, such as:

- Usage period, with start and end dates;
- Spectrum usage location;
- Technical characteristics of the equipment;
- Desired frequency bands;
- Other information provided for in regulations.

After registration of requests in Rio 2016's tool and prior analysis of demand, registration of requests for temporary use of radiofrequencies at ANATEL will be conducted using the agency's electronic system, which will provide for the proper technical feasibility study.

In order for members of the Olympic and Paralympic Families to request the temporary use of spectrum from Rio 2016, the following documents are involved:

**- Advance spectrum request spreadsheet for bulky submissions (mainly OBS and some RHB):**

- A spreadsheet, initially in Excel format, with a simplified configuration reflecting, in the most agile manner possible, the spaces to be completed on the Spectrum Portal.
- The spreadsheet's final format must be agreed upon by users, Rio 2016 and the other parties involved, so that it is agile for requesters and there is no lack of essential data for spectrum requests. It will be published on a future Spectrum Newsletter.

- The purpose of the existence of this spreadsheet is to save frequency requesters the work of inputting large volumes of requests on the Spectrum Portal, which would generate the risk of errors.
- If coordinated in advance with Rio 2016, the use of this spreadsheet may be extended to other users, provided that demands for large numbers of simultaneous system input requests are proven.

**- *Spectrum Request Portal:***

- Electronic portal found on the Rio 2016 Rate Card portal, where interested parties should input their details to request frequencies for temporary use.

**- *Mosaico system:***

- ANATEL's electronic system to manage and control frequency spectrum. It is the Regulatory Agency's tool for this purpose.
- It will not be accessed by requesters from the Olympic and Paralympic Families. Only Rio 2016 and/or a specialised company hired by it will input the pre-assessed requests.

**- *Official document to grant or refuse temporary use of spectrum:***

- The document that proves authorisation is the "Act of Authorisation of Temporary Use of Spectrum", issued by ANATEL, and authorising, for the period indicated, the temporary use of spectrum under the conditions established in it.
- Acts of authorisation of temporary use by members of the Olympic and Paralympic Families will be issued on behalf of the Rio 2016 Committee and will be made available on the Mosaico system for printing.

### **3.4 Frequency Map**

The frequency map produced and disclosed by ANATEL presents the frequencies that may be used temporarily for staging the Games.

In accordance with Brazilian legislation, it is necessary to have authorisation from the Regulatory Agency to use spectrum in any telecommunications service. This obligation only excludes the use of radiofrequency by restricted radiation devices, defined by the Agency, and frequency bands assigned for exclusively military purposes.

For the 2016 Games, ANATEL may authorise the temporary use of spectrum, in line with demand, in order to ensure effective spectrum management.

Table 02 shows the frequency bands normally used in the indicated applications, which were considered when producing the initial version of the frequency map presented in Table 03.

Service	Band (MHz)	
Terrestrial radio (TETRA)	144	148
Terrestrial radio (TETRA)	152	154
Terrestrial radio (TETRA)	430	440
Terrestrial radio (TETRA)	915	917
Talkback/audio	48	54
Talkback/audio	72	76
Talkback/audio	144	148
Talkback/audio	410	430
Talkback/audio	440	450
Microphones	54	72
Microphones	76	88
Microphones	174	216
Microphones	470	608
Microphones	614	806
Camera	1990	2110
Camera	2170	2500
Camera	2700	3400
Camera	3600	4800
Camera	5460	8500
Satellite uplinks	Bands C, Ku and Ka	

**Table 02 - Spectrum bands considered in analysis**

Table 03 represents a macro-level analysis of the possibility of using radiofrequency bands to stage the Games based on the document *Basic Requirements for Coordination of Frequency Spectrum for the Rio 2016 Games* submitted by Rio 2016.

A comparison was made between the frequency bands indicated in the cited document and the Brazilian Frequency Band Assignment, Allocation and Distribution Plan (known by Portuguese acronym PDFF), the ANATEL document that indicates the assignment and regulation of the conditions for using different frequency bands for providing telecommunications services.

In the case of temporary use of radiofrequencies, especially in major events, the prevailing regulations, approved by Resolution 457 (in the review phase), permit frequency bands to be used in special conditions to provide different services from those provided for in the PDFF, in shared form.

Table 03 indicates, for each frequency band contained in the document received from Rio 2016, the type of usage planned, the band's allocation in Brazil (in accordance with the PDFF) and its status in terms of the possibility of usage at Games time.

The bands with “NO” status are those that are assigned for the provision of services of primary nature, and in principle they may not be shared with other applications.

The bands highlighted as “MAYBE” are bands or channels not in use at the location, allocated for broadcasting and some other services, whose use during the Games is possible, but depends on prior negotiation with other government entities (including MINICOM and the Public Security Secretariat).

In the case of the 450 MHz to 470 MHz band, it should be clarified that it is currently used to provide various services and its availability will depend on an analysis of specific demands for each type of planned use.

The other frequency bands, with “OK” status, may in principle be used for the planned application, shared with existing services.

The availability of frequency bands for use in the Games will continue to be evaluated based on the table and new information that may be received from Rio 2016, to be consolidated in future versions of this Plan.

Service	Band (MHz)		Allocation	Status	Comments
Terrestrial radio (TETRA)	68.08125	87.49375	Broadcasting		MAYBE
Terrestrial radio (TETRA)	70.5	71.5	Broadcasting		MAYBE
Terrestrial radio (TETRA)	80	81.5	Broadcasting		MAYBE
Terrestrial radio (TETRA)	137.9625	138.0375	SLP	OK	
Terrestrial radio (TETRA)	138.1125	138.2125	SLP	NO	* exclusive use
Terrestrial radio (TETRA)	143	144	SLP	NO	* exclusive use
Terrestrial radio (TETRA)	146	148	Amateur radio	OK	
Terrestrial radio (TETRA)	152	154	SLP, SARC, SLE	OK	
Terrestrial radio (TETRA)	154	156	SLP, SARC, SLE	NO	* exclusive use
Terrestrial radio (TETRA)	168.3125	168.8375	SLP, SLE (ESC)	OK	
Terrestrial radio (TETRA)	173.9875	174.4125	SLP, Broadcasting		MAYBE
Terrestrial radio (TETRA)	193.2	207.5	Broadcasting		MAYBE
Terrestrial radio (TETRA)	385	399.9	(Public Security)		MAYBE

Service	Band (MHz)		Allocation	Status	Comments
Terrestrial radio (TETRA)	430	440	Amateur radio	OK	
Terrestrial radio (TETRA)	450	470	...		
Terrestrial radio (TETRA)	453.0063	466.0875	...		
Terrestrial radio (TETRA)	870	872	SMP	NO	
Terrestrial radio (TETRA)	915	917	506	OK	* except for special supervision and control channels
Talkback	47.55	48.8	SLP (ESC)	NO	* exclusive use
Talkback	52	52.95	Amateur radio	OK	
Talkback	74.68125	74.71875	-	OK	
Talkback	75.2625	75.3	-	OK	
Talkback	76.8	76.84	Broadcasting		MAYBE
Talkback	78.18	78.25	Broadcasting		MAYBE
Talkback	86.8	86.84	Broadcasting		MAYBE
Talkback	140.98	141	SLP	OK	
Talkback	141	141.48	SLP	OK	
Talkback	181.69	181.8	Broadcasting		MAYBE
Talkback	189.69	189.8	Broadcasting		MAYBE
Talkback	211.9	212.19	Broadcasting		MAYBE
Talkback	427.76	428.01	All	OK	
Talkback	442.26	442.51	All	OK	
Talkback	446.425	446.51	All	OK	
Talkback	454.98	455.47	SMP SCM STFC		
Talkback	457.25	457.47	SMP SCM STFC		
Talkback	461.23	461.25	SMP SCM STFC		
Talkback	462.75	463	SMP SCM STFC		
Talkback	467.26	469.87	SMP SCM STFC		
Talkback	470	478	Broadcasting		MAYBE
Talkback	494	502	Broadcasting		MAYBE
Audio	53.7	54	Amateur radio	OK	
Audio	54	55.75	Broadcasting		MAYBE

Service	Band (MHz)		Allocation	Status	Comments
Audio	48.7	52.7	SLP, Amateur radio	OK	
Audio	48.425	48.425	SLP (ESC)	OK	* except for special supervision and control channels
Audio	48.475	48.475	SLP (ESC)	OK	* except for special supervision and control channels
Audio	48.525	48.525	SLP (ESC)	OK	* except for special supervision and control channels
Audio	52.875	52.875	SLP (ESC)	OK	* except for special supervision and control channels
Audio	52.925	52.925	SLP (ESC)	OK	* except for special supervision and control channels
Audio	60.75	62.75	Broadcasting		MAYBE
Audio	191.7	191.7	Broadcasting		MAYBE
Audio	199.9	199.9	Broadcasting		MAYBE
Audio	200.1	200.1	Broadcasting		MAYBE
Audio	215.2687	215.4938	Broadcasting		MAYBE
Audio	425.3375	425.3375	SCM SME	OK	
Audio	425.3875	425.3875	SCM SME	OK	
Audio	425.4375	425.4375	SCM SME	OK	
Audio	425.4875	425.4875	SCM SME	OK	
Audio	425.5375	425.5375	SCM SME	OK	
Audio	446.5125	446.5125	SCM SMP STFC	OK	
Audio	447.5125	447.5125	SCM SMP STFC	OK	
Audio	454.9875	454.9875	SCM SMP STFC	OK	
Audio	455.475	455.475	SCM SMP STFC	OK	
Audio	467.2625	469.875	SCM SMP STFC	OK	
Audio	1488	1491	-	OK	
Audio	1517	1525	-	OK	
Camera	1300	1320	SMA (Attrib.)		MAYBE

Service	Band (MHz)		Allocation	Status	Comments
Camera	1660	1670	RAS (Attrib.)		MAYBE
Camera	2010	2025	-	OK	
Camera	2025	2110	All	OK	
Camera	2200	2300	All	OK	
Camera	2310	2390	SARC	OK*	* Shared use with SARC
Camera	2390	2410	SARC	OK*	* Shared use with SARC
Camera	2483	2500	SARC	OK*	* Shared use with SARC
Camera	2500	2690	SMP	NO	
Camera	2700	3100	-	OK	
Camera	3100	3300	-	OK	
Camera	3300	3400	SARC	OK*	* Shared use with SARC
Camera	3400	3440	SMP	NO	
Camera	3500	3580	SMP	NO	
Camera	3690	3920	All	OK	
Camera	4010	4200	All	OK	
Camera	4400	4800	All	OK	
Camera	5472	5588	-	OK	
Camera	5682.5	5702.5	-	OK	
Camera	5705	5725	-	OK	
Camera	5732.5	5752.5	-	OK	
Camera	5770	5790	-	OK	
Camera	5795	5815	-	OK	
Camera	5850	5875	All	OK	
Camera	5905	5925	All	OK	
Camera	5925	7125	SARC	OK*	* Shared use with SARC
Camera	7125	7250	SARC	OK*	* Shared use with SARC
Camera	7300	7425	SARC	OK*	* Shared use with SARC
Camera	8460	8500	-	OK	
Camera	61000	615000	-	OK	

**Table 03 - Spreadsheet analysing radiofrequency requirements for use in the Games**

Authorisations for the temporary use of spectrum by members of the Olympic and Paralympic Family will be issued by ANATEL on behalf of Rio 2016, which must provide information to interested parties about the opening of the frequency request and reservation process, as well as compile and validate the requests received for subsequent submission to ANATEL's authorisation process.

All authorisations for the temporary use of spectrum by the entities described in Item 16.9 of the candidature file, in the established period, received via Rio 2016, will be issued free of charge to the requester, in accordance with article 13 of Law 12,035/2009, which approved the Olympic Act.

### **3.5 Test Events**

In preparation for the 2016 Games, various test events will be held, in order to test the infrastructure at different competition and non-competition venues. These test events should be initiated in July 2015 and continue until the eve of the Olympics, in May 2016.

As of this moment, the government guarantees provided to the IOC about the free temporary use of spectrum during the 2016 Games are not valid for test events. The period of free use starts on 5 July 2016 and ends one week after the Paralympic Games' closing ceremony.

However, the federal government is currently studying a proposal to alter the legislation and regulations in order for temporary spectrum use to also be authorised free of charge during test events.

Test events may also be used to test the procedure for authorising temporary spectrum use adopted by Rio 2016 and ANATEL. Irrespective of the test event period, this process may be tested on other occasions considered interesting by the parties involved. Rio 2016's coordination entities and participants may request frequencies through the usual process established in accordance with ANATEL regulations regarding temporary spectrum use.

ANATEL and Rio 2016 will work together to ensure the regulatory body's involvement in test events, in order to approach and improve the monitoring and enforcement process during the 2016 Games.

It is expected that the 2014 World Cup's matches may help support the expected demand for spectrum for the 2016 Games, especially in terms of football matches in stadiums, including those outside Rio de Janeiro.

### **3.6 Olympic and Paralympic Torch Relay**

In relation to the Olympic and Paralympic torch relay until the torches' arrival at the Games' opening and closing ceremonies, it is expected that the route(s) will be defined in 2014, which is important to those involved in spectrum management, in order to administer demand and authorisation for temporary use as necessary, since this activity, as well as the Games, is covered by the spectrum guarantees provided to the IOC by the Brazilian government.



### **3.7 Monitoring and enforcement**

ANATEL will execute spectrum usage monitoring and enforcement actions in the regions where activities related to the 2016 Games will be held, in order to identify in advance possible cases of harmful interference with systems whose use is expected at Games time and take preventive action.

ANATEL must be aligned with the competent public security entities in the case of harsher action, in order to curb and eliminate the improper use of frequency and possible harmful interference with systems identified during the Games.

Enforcement teams will be available at the main Games venues to provide a rapid response if needed.

We will examine the possibility of using and installing a network of radiofrequency sensors both inside and outside Games venues, to enable the entities involved with spectrum management to quickly identify the location of origin of sources of interference, if they exist.

## **4. Complementary Activities**

### **4.1 Technological Innovation**

With regard to technological innovation, it is expected that there will be a legacy for the city, but it should be clear to the technical areas involved that Rio 2016's telecommunications services will be provided based on proven, reliable technology, which is vital to the normal progress of telecommunications operations at Games time.

Rio 2016's partners may show their innovations during the Games, but system operations must be underpinned by tested and mature technology. Accordingly, the technologies will all be frozen in August 2014. Any new technology presented after this date will not be considered or authorised in Games operations.

Users expecting to use new technologies during the Games, until the date of their freezing, may request authorisation to test them in advance, especially in cases that optimise spectrum use. In this case, ANATEL may analyse and verify the possibility of authorising the temporary use of spectrum for rehearsal and testing purposes.

### **4.2 Use of Radiofrequency Equipment at Games Time**

In order to protect duly authorised systems, all devices that use radiofrequencies (with some exceptions), such as wireless cameras and microphones, walkie-talkies, access points and remote camera trigger mechanisms, among others, even if they are independent of operating licences, will need to be authorised in advance for them to be used at Games venues.

The above procedure excludes devices such as mobile phones, smartphones, key chains, devices using Bluetooth technology, tablets, notebooks, wireless keyboards and wireless mice.

Entry into Games venues will only be authorised for equipment that is authorised and properly identified with the tag, as described in Item 3.2.

Any users, including spectators, in possession of equipment not approved in advance, may not access Games venues. The security area will inspect devices at entrances to all Games venues, verifying whether items are on the list of restricted devices.

All spectrum users must operate in accordance with the terms of their authorisations, including transmitting at the frequency licensed in advance, and using equipment duly tested and tagged by ANATEL.

Any non-compliance with the above will signify a situation of irregularity in Brazil, leading ANATEL to demand an immediate interruption to transmissions, and a "Use not permitted" tag will be attached to the equipment involved. The user must then rectify the irregularity and go to one of the Spectrum Desks for further testing and possible tagging.

Stricter enforcement actions may be taken, in accordance with applicable Brazilian legislation, such as the seizure of the user's equipment and the filing of criminal charges. In this case, Rio 2016 may immediately cancel this user's access accreditation.

Authorisations for the temporary use of spectrum by members of the Olympic and Paralympic Family will be issued by ANATEL on behalf of Rio 2016, which will be legally responsible for them. A list of authorisations issued with the real spectrum users is Rio 2016's responsibility and may be verified through the Rate Card Spectrum Portal.

Rio 2016 must provide a wireless internet service (Wi-Fi) at certain Games venues. Users who intend to use private networks must request coordination from Rio 2016. Requests for coordination of private Wi-Fi networks will also be made via Spectrum Request Portal I (<http://ratecard.Rio2016.com>).

The period for requesting coordination of private Wi-Fi networks from Rio 2016 will be the same for all requests. The Rio 2016 Spectrum Portal should be available as of February 2015.

Guarantees related to the use of spectrum offered by the Brazilian government do not apply to various services that will nevertheless demand frequencies for the 2016 Games. These services may be placed into two categories: public and private.

The public services in question basically provide support for the organisation of the Games, such as military services, public security and emergency services, public transport, civil construction, catering, maritime services, health services and other services provided by third parties. If there is additional demand for spectrum from this group of users, the assumption is that it will be met through the normal authorisation processes. Exceptional cases will be handled individually by ANATEL and Rio 2016.

The private services in question basically exist to improve the public's experience of the Games, but do not have a direct link with Rio 2016. Any demand in this case will have to follow the normal procedure for requesting the use of spectrum. These private services include non-RHB broadcasting, SMP operators, wireless CCTV and restricted communications services.

All cases of harmful interference with duly authorised systems should be reported to the Rio 2016 Technology Operations Centre (TOC), where ANATEL will be present at Games time, and the agency will then be activated to provide a solution.

## **4.3 Spectrum Use Requests**

### **4.3.1 Procedure**

For accredited users, the process of requesting radiofrequencies will take place through a company that specialises in managing spectrum requests for major events in Brazil, hired and coordinated by Rio 2016.

At the same time, Rio 2016 will use the Spectrum Request Portal as a definitive spectrum request tool. The database of authorizations that are requested by Games users, analysed and then issued or denied to Games users, all on behalf of Rio 2016, must be recorded in the appropriate fields on this portal. Request details must be transferred by the hired company to the Spectrum Portal. The name and details of the hired company will be reported in due course.

#### **4.3.2 Deadlines**

The period for temporary frequency use requests will be from March 1<sup>st</sup> 2015 to July 31<sup>st</sup> 2015. Requests received within the above period will be processed and the responses will be provided until December 30<sup>th</sup> 2015.

Late requests, if justified, may be accepted from August 1<sup>st</sup> 2015 until Games Time.

The late requests, if processed, will be answered up to two months from January 2016.

There is no guarantee that late requests will be processed and responded.

ANATEL will complete the issuing of temporary spectrum usage authorisations for the Rio 2016 Games by December 30<sup>th</sup> 2015 for the regular period requests. Late requests, if processed, will be answered up to two months from January 2016.

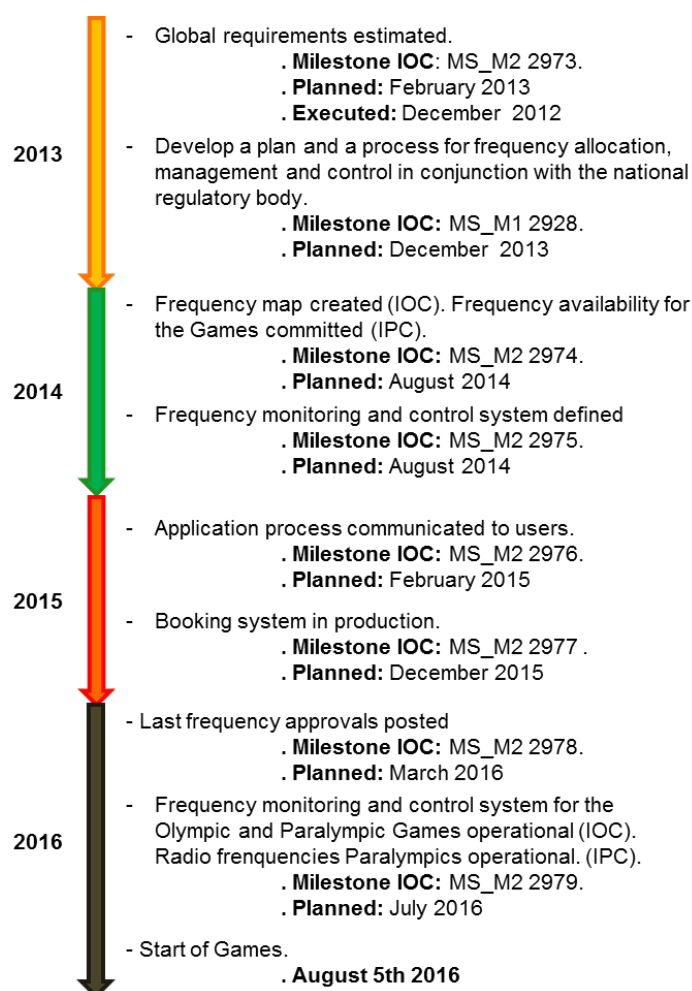
Users must adjust their equipment in accordance with the terms and conditions of the Authorisation Acts delivered by Anatel.

## 5. Schedule and Programmed Deliveries

### 5.1 Milestones

According to the IOC, the milestones directly linked to the frequency coordination plan are those shown in Figure 04 below.

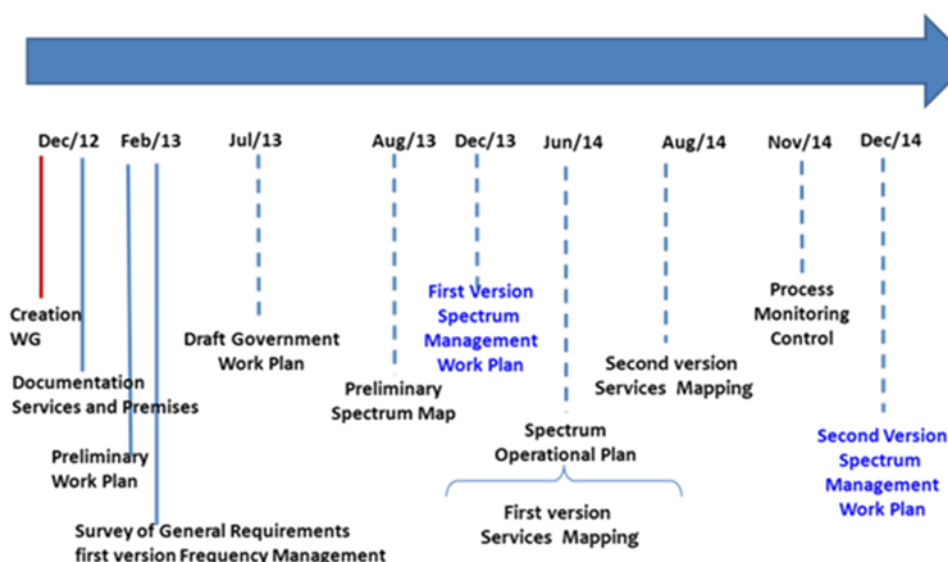
This schedule was agreed upon by the APO, ANATEL and Rio 2016 as the basic plan that will guide the entire process of managing the use of spectrum for the 2016 Games in terms of time.



**Figure 04 - Milestones in spectrum management activities agreed upon with the IOC**

With regard to MS\_M2 2975, planned for August 2014, the Telecom Workgroup, taking into consideration ANATEL's involvement with the 2014 World Cup, proposed to the IOC an alteration of the milestone to October 2014.

Figure 05 below shows details of planned actions and deliverables, as presented by the Olympic Public Authority (APO) and ANATEL during the sixth meeting of the Technical Project Review (TPR), on 30 August 2013, in Rio de Janeiro.



*Figure 05 - Timeline of planned deliverables*

## 5.2 Consolidated Schedule

Table 04 below shows the planned schedule for the submission and processing of requests for the temporary use of spectrum.

Client / Body Responsible	Action	Means	Period
OBS and RHBs	Delivery of requests to Rio 2016	Spreadsheet	March 1 <sup>st</sup> 2015 to July 31 <sup>st</sup> 2015
Users in general	Delivery of requests to Rio 2016 - Period 1	Portal	March 1 <sup>st</sup> 2015 to July 31 <sup>st</sup> 2015
Rio 2016 / ANATEL	Processing of requests	Spreadsheet, Portal and Mosaico	Until December 30 <sup>th</sup> 2015
OBS, RHBs and users in general	Delivery of late requests to Rio 2016	Portal	From August 1 <sup>st</sup> 2015 to Games Time
Rio 2016 / ANATEL	Processing of late requests	Portal and Mosaico	Up to 2 month from January 2 <sup>nd</sup> 2016

*Table 04 - Schedule for the delivery of spectrum usage requests*

## 6. Information and Communication with Users

### 6.1 Information

Relevant information of general nature about subjects related to radiofrequency spectrum for the Rio 2016 Olympic and Paralympic Games will be provided to those interested in using radiofrequencies and the general public through a “Spectrum Newsletter”, to be divulged by Rio 2016. ANATEL may reproduce sections of this newsletter on its website.

The publication of the newsletters will be Rio 2016’s responsibility, in order to communicate subjects of shared nature and interest related to frequency spectrum for the 2016 Games. The newsletters will be published whenever a significant fact or important update occurs.

Appendix II provides more detailed clarification of the procedures for issuing newsletters.

### 6.2 Communication

Those interested in submitting comments or suggestions concerning the Rio 2016 Olympic Games spectrum management plan may do so by emailing ***spectrum@Rio 2016.com*** or in person, by scheduling a meeting in advance with the Rio 2016 telecommunications area.

Requests for specific clarifications from users, sent to the above email address, will be processed by Rio 2016 and, if appropriate, forwarded to the responsible entities (ANATEL, APO and MINICOM) for a response.

ANATEL will also provide a channel for international demands of regulatory nature on its website for major events(<http://grandeseventos.anatel.gov.br>). If demands for which Rio 2016 is responsible are received through this channel, they will be forwarded for handling by this entity.

## **7. Appendices**

- 7.1 Appendix 1 - Games Venues
- 7.2 Appendix 2 - Communication Channels
- 7.3 Appendix 3 - London 2012 Olympic Games Spectrum Usage Reference



## Appendix 1 - Games Venues (September 2013 version)

**Venues:** Sites operated by Rio 2016, where the Olympic and Paralympic Games and various other activities connected to the Games take place. The official document specifying the venues involved in the Games is the Venue List, which is published and updated regularly.

**Facilities:** Sites operated by external entities, affiliated to Rio 2016 or otherwise. In the case of Rio 2016's partners' facilities, they are managed under rights and guarantees given by Rio 2016. In other cases, the Organising Committee has no responsibilities.

Venues	
Competition (COV)	36
Non-Competition (NCV)	25
Training (TRV)	20
Support (SUP)	63
Facilities	
Precincts (PRE)	4
Affiliates (AFL)	21
Partners (PRT)	6
Other (OTH)	2
<b>Total</b>	<b>177</b>

As of this date, 177 sites with some relation to the 2016 Olympic and Paralympic Games are planned under the following concepts:

**ZONE:** Division of an area by proximity, in order to facilitate the overall vision of it. In Rio, there are the Barra, Copacabana, Maracanã and Deodoro zones, and there are also the football cities.

**PRECINCT:** A given number of venues and/or facilities (more than one) in a confined geographical area with a shared security perimeter. Venues' and/or facilities' operations impact each other and consequently they are integrated as necessary. In the case of Rio, the Olympic Park, Riocentro and Maracanã are precincts.

**CLUSTER:** A given number of venues and/or facilities (more than one) that do not require a shared security perimeter. Within a cluster, venues' and/or facilities' operations impact each other and consequently they are integrated as necessary. In the case of Rio, there are the Copacabana, Maracanã, Barra and Deodoro clusters.

**STAND-ALONE VENUE:** Venue whose location is geographically independent of all others, so that it must have its own security perimeter and its operations do not impact other venues. In the case of Rio, the João Havelange Stadium, Lagoa Rodrigo de Freitas and Marapendi Golf Course are stand-alone venues.

## **Appendix 2 - Communication Channels**

In addition to this Radiofrequency Spectrum Management Plan, which may be revised, two other communication and information channels will be used in spectrum management for the 2016 Games, namely:

### **1. SPECTRUM Newsletter**

#### **a. How often will the SPECTRUM Newsletter be published?**

It will be published whenever there is significant information to disclose.

#### **b. Who is the SPECTRUM Newsletter aimed at?**

Users of radiofrequency spectrum for the 2016 Games, above all the Olympic and Paralympic Families.

#### **c. What type of information will be disclosed in the Newsletter?**

It will feature information about the 2016 Games Radiofrequency Spectrum Management Plan. The focus will be on important information such as the process of requesting temporary use of radiofrequency spectrum, updated radiofrequency maps, test and tagging procedures, enforcement and monitoring, test events for spectrum, Private WIFI deployment in venues coordination and other related topics will be the focus of the Newsletter.

#### **d. What language will the Newsletter be published in?**

Like the Spectrum Management Plan, the Newsletter will be published in Portuguese and English.

The newsletter will be called “Boletim Informativo - ESPECTRO” in Portuguese and “SPECTRUM Newsletter” in English.

#### **e. What channel will be used to distribute the newsletter?**

The newsletter will be distributed by email, on Rio 2016’s website, and on the websites of ANATEL and other official entities.

To receive the newsletter, interested parties will need to request their registration on the channel to be divulged on Rio 2016’s website.

Questions about how to register should be emailed to [spectrum@Rio 2016.com](mailto:spectrum@Rio 2016.com).

#### **f. When will the bulletins start going out?**

As of the second quarter of 2014.

## **2. Email: spectrum@Rio 2016.com**

### **a. What is the objective of this email account?**

To create a channel to answer questions and receive suggestions and criticism about the Games Radiofrequency Management Plan. Interested parties' questions may be replied to through this channel and also through the newsletter in the case of recurring questions (FAQs).

### **b. How will requests sent to this email account be treated?**

Topics submitted to this email account may be analysed and replied to by Rio 2016 directly, and also by teams from ANATEL, the APO and MINICOM if the subject concerns these entities. If appropriate, they may respond directly to the interested party through their own channel or via spectrum@Rio 2016.com.

### Appendix 3 - London 2012 Olympic Games Spectrum Usage Reference

Table 1 below presents information obtained from the report produced by OFCOM about spectrum use during the 2012 Olympics in London. These figures merely serve to guide spectrum management planning for the Rio 2016 Games. The table presents statistics from London that served as a benchmark for the 2016 Games' demands.

Product	Licences	Frequencies	Licences rejected
Wireless cameras	452	631	53
Wireless microphones	1,958	6,052	337
Talkback devices	946	3,037	38
Trunked radio communication networks	1,412	3,026	98
Telemetry and telecommand	331	444	1
In-Ear Monitors (IEM)	496	1,468	36
Mobile Maritime Radio (MMR)	18	44	2
Mobile microwave links	116	134	3
Fixed links	76	90	2
Fixed earth stations	20	n/a	0
Transportable earth stations	24	1,439	0
WCCTV (OBS)	4	5	n/a
LOCOG's PMR network	1	206	n/a
<b>TOTAL</b>	<b>5,858</b>	<b>16,576</b>	<b>570</b>

*Table 1: Statistical reference about requested and issued frequency requirements*