



RoboCup 2019 v1.1

Radio Policy

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See <http://intelligentrobots.org/files/RoboCup/2019/RadioPolicy.pdf> for the latest version of this document.

1. Overview:

Radios are vital for most leagues within RoboCup. Robots need to communicate with each other, with base stations and with league management networks. To reduce the probability of interference, these transmissions need to be co-ordinated.

This year we are making a particular effort to ensure that the radio environment is well known and managed. In the past, leagues have operated under various formal and informal radio policies. This document aims to bring all of these policies together.

While the laws of Australia, and of physics, may prevent us from fully satisfying every league's desires when it comes to radio spectrum, we endeavour to do our best to make sure that each league has what it needs to run an effective competition.

This document has been developed with feedback from Local Organising Committee representatives of each League (in communication with their associated Technical Committees). Individuals and teams with questions or concerns should raise them with the League Technical Committee and Local Organising Committee representatives in the first instance.

2. Radio Channel/Frequency Assignment:

The following channel assignment is based on the current available floorplan, using directional antennas to reduce league-to-league interference. It is subject to change, particularly if the floorplan changes. It assumes that (apart from Rescue Robot League) the higher powered transmitter will be on the access point, not the robot.

The Local Organising Committee, through our networking partner Aruba Networks, will be providing the wireless LAN access points, antennas and configuration. Apart from Rescue Robot League, no leagues or teams should run their own access points on these channels.

The Local Organising Committee reserves the right to shut down any access point, not provided or managed by Aruba Networks, that is found to be broadcasting on these channels.

In addition to the channels listed below, teams may freely use 802.11ac UNII2 channels 100, 104, 108, 112, 116, 132, 136 and 140 but equipment must be set to automatically frequency hop among these channels. No guarantee is made as to how clear these channels will be.

NOTE: Not all channels assigned to a league may be used across all fields. See radio frequency map for details.

League	802.11bg (2.4 GHz)	802.11ac (5 GHz)	Other
Junior Leagues	(None)	(None)	Zigbee, Bluetooth
Humanoid League	1, 6 (alternating)	36, 44, 48	(None)
Standard Platform League	1, 6 (alternating)	36, 44, 153, 161	(None)
Mid Sized League	11,	40, 48	(None)
Small Sized League	11-13 (overlapping)	40	nRF24/XBee @ 2.451–2.483 GHz
Logistics/Industrial League	(None)	40	(None)
@Work	(None)	44	(None)
@Home	(None)	36, 44, 153, 161	(None)
Rescue	(None)	48, 149, 157, 165 (Omni antennas)	(None)



3. Radio Policy:

1. During competition time, teams should not use their own access points (be they hardware, "hotspot", mobile/cell phone or similar) or ad-hoc networks anywhere in the venue (with the exception of Rescue Robot and Junior Leagues, who must follow league policy). All teams must use league-assigned ESSIDs (or if there is no league-assigned ESSID, <Leaguename>_<Teamname>).
2. Between 8pm and venue close, all areas of the spectrum legal in Australia are free to use *but* teams/leagues must declare on the venue radio board (details TBD) which frequencies they will be using so that if there are issues, teams know who to talk to. If a league is still running competition games after 8pm, they can declare this on the whiteboard, at which point other leagues close enough to interfere with them must avoid their part of the spectrum until they're done.
 - a. This formalises informal practice in past years. It enables leagues to perform demonstrations and collaborations with other groups (eg. local responder

- groups) using equipment that otherwise does not fall within this policy without interfering with games.
- b. "Close enough to interfere" is a malleable term. Please use your common sense (and the judgement of those in your league with RF experience). If in doubt, there will be at least one spectrum analyser available for leagues to test how far their radios can be "seen" across the hall.
 - c. Please use this facility considerately. Do not use up spectrum during after-hours time "just because you can". If as a league you're running competitions after-hours, please declare an accurate end time. Likewise, if you're doing demonstrations please only declare the part of spectrum that you're using and the time that you're going to use it.
3. Each league should nominate a point of contact for radio issues. This should be someone who understands radios and, ideally, how to use and read the output of a spectrum analyser. They should also be in a position to compel teams in their league to change their equipment configuration should they be found to be interfering with another team or league and to switch off unattended equipment found to be transmitting.
 4. Any unattended equipment found transmitting in a way that interferes with the operation of any league will be shut down without warning. This includes routers/switches that also happen to act as access points. It is highly recommended that all teams that bring transmitting equipment label it with a contact name and phone number.

4. Policy Explanation:

1. We're starting with the RoboCup 2017 (Nagoya) regulations, available from https://www.robocup2017.org/file/RoboCup2017_WirelessGuideline_0714.pdf .
2. In Australia, we have the following 20 MHz non-overlapping channels:
 - a. 3 at 802.11b/g/n (2.4 GHz) that can be set: 1, 6 and 11 (or 2, 7, 12 or 3, 8, 13).
 - b. 4 at 802.11a/c (5 GHz) UNII1 band that can be set: 36, 40, 44 and 48.
 - c. 8 at 802.11a/c (5 GHz) UNII2 band that *must* frequency hop to a free channel: 100, 104, 108, 112, 116, 132, 136 and 140.
 - d. 5 at 802.11a/c (5 GHz) UNII3 band that can be set: 149, 153, 157, 161 and 165. Not all equipment can operate on these channels. As of writing, only Rescue Robot League, @Home League and Standard Platform League have declared that their robots can operate on these channels, thus only these leagues have been assigned channels in this band.

3. 802.11 Channel Bonding (using more than one 20 MHz channel for increased bandwidth) is forbidden. We simply don't have enough radio spectrum. Note that many "channels" in 802.11a are actually channel bonded versions of other channels. For example, 802.11a channel 42 (80 MHz) covers the same frequencies as channels 36, 40, 44 and 48 (20 MHz each) and thus can't be used in RoboCup. If you set your equipment to 20 MHz (or single channel), it will automatically avoid these "bonded" channels.
4. RoboCup Junior teams (separate area) can keep using Bluetooth and Zigbee. Being lower bandwidth and hopping more quickly through more frequencies, these can generally avoid trouble among themselves. En-masse, they will cause trouble for 802.11b/g/n so are not allowed in the Major venue.
5. Small-sized League uses low bandwidth, narrow fixed-frequency transmitters. These have been assigned a part of the spectrum equivalent to 802.11b/g/n channels 11 to 13. They must be operated within this band and in accordance with Australian law (see Section 5 for details). If possible, keep high powered transmissions to 2.473-2.483 GHz to avoid interfering with MSL which shares channel 11 at the other end of the hall.
6. 20 MHz channels 100, 104, 108, 112, 116, 132, 136 and 140 are permitted but under Australian law they must channel hop. These may be used for practice and backup (eg. if another channel is needed for congestion) but no guarantees are made that they will stay clear.
7. All other channels are forbidden, either because they're wider than 20 MHz (ie. channel bond) or because they fall outside the Australian class license.
8. All other radio transmissions are forbidden. This includes RC units (analog, "Spektrum", "FrSky" or similar), analog video senders (regardless of frequency), "DJI Lightbridge" or similar video senders, "Garage door opener" style remotes (even for e-stop), wireless keyboards/mice/gamepads, wireless microphones/headphones, and (for Major teams) Bluetooth. Yes we know these are supposed to be low interference (particularly spread spectrum devices). The "low interference" bit breaks down when you have a lot of devices in the one space, such as at RoboCup.

5. Laws and Regulations of Australia:

The following is an abstracted summary of our understanding of the relevant legislation and regulations. We are not lawyers and make no guarantee that this is a valid interpretation.

Note: Please be aware that Australian regulations governing LIPD use had a major update in 2015 and a minor update in mid-2018. When comparing this list against resources you may find online or in drivers, please make sure that they reference the most recent regulations.

Unless a team has a specific license from the [Australian Communications and Media Authority](#) (ACMA), teams must operate under a class license, typically the [Radiocommunications \(Low Interference Potential Devices \(LIPD\)\) Class License 2015](#) (most recently amended in June 2018) under Section 132 of the Radiocommunications Act 1992. See <https://www.legislation.gov.au/Details/F2018C00500> for details.

Wireless LAN

This license covers wireless LAN and other spread-spectrum devices such as “Spektrum” RC units, Zigbee and Bluetooth. There are frequency, power and frequency hopping restrictions in Australia that may not match teams’ home countries. In general, if you tell your software/driver/operating system that you are in Australia (and it has been updated recently), it should automatically select the correct frequencies.

802.11b/g/n (2.4GHz):

- Item 55 of the class license (2,400 - 2,483.5 up to 500 mW) permits channels 1-13 with or without automatic channel hopping. Channel 14 is NOT permitted in Australia.

802.11a/c/n (5GHz):

- Item 61 of the class license (radio LAN transmitters, 5,150 - 5,250 MHz up to 200 mW) permits the following channels (UNII1) with or without automatic channel hopping:
 - 20 MHz channels 35, 40, 44 and 48 .
 - 40 MHz channels 34, 38 and 46.
 - 80 MHz channel 42.
- Item 62 of the class license (radio LAN transmitters, 5,250 - 5,350 MHz up to 200 mW) permits the following channels (UNII2A) but, by law, *MUST* automatically hop to a free channel to avoid other (non-802.11) licenseholders who also overlap this part of the spectrum.
 - 20 MHz channels 52, 56, 60, 64 and 68.
 - 40 MHz channels 54 and 62.
 - 80 MHz channel 58.
 - 160 MHz channel 50.
- Item 63 of the class license (radio LAN transmitters, 5,470 - 5,600 and 5,650 - 5,725 MHz up to 1 W) permits the following channels (UNII2C) but, by law, *MUST* automatically hop to a free channel.
 - 20 MHz channels 100, 104, 108, 112, 116, 132, 136 and 140.
 - 40 MHz channels 102, 110 and 134.
 - 80 MHz channel 106.

- Items 40 and 41 of the class license (Telecommand or telemetry transmitters, 2400 - 2450, 5725 - 5795 and 5915 - 5875 up to 1 W, 5795 - 5815 up to 2 W) permits the following channels (UNII3) with or without automatic channel hopping.
 - 20 MHz channels 149, 153, 157 and 165 (at 1 W)
 - 20 MHz channel 161 (at 2 W)
 - 40 MHz channels 151 and 159 (at 1 W)
 - 80 MHz channel 155 (at 1 W)

Note that 40, 80 and 160 MHz channels use channel bonding and are thus not allowed in RoboCup.

Remaining 802.11 channels (96, 114, 118, 120, 122, 124, 126, 128, 138, 142-149 and 169-196) are not covered by a “radio LAN” or “General telemetry and telecommand transmitters” specific item in the class license and thus may only be used under item 22, which restricts them to 25 mW (very short range transmissions). These are not likely to be useful to RoboCup teams.

Note: The permitted channels are not consecutive because they denote different bandwidth ranges as well as different starting frequencies. For example, channel 140 runs from 5,690 to 5,710 MHz and is permitted but channel 138 runs from 5,650 to 5,730 MHz, which starts lower and ends higher than channel 140 and is, thus, not permitted.

Analog Video Senders and Other Radio Transmitters

This class license also covers analog and fixed-frequency transmitters (such as those used to transmit video from model aircraft), placing limits on power and bandwidth (generally 25mW at 433.05 - 434.79 MHz, 3mW at 915 - 928 MHz, 10mW at 2,400 - 2,483.5 MHz and 25mW at 5,725 - 5,875 MHz, see items 19 to 22 of the class license).

The class license also covers “Telecommand or telemetry transmitters”, typically operating at 2,400 - 2,483.5 MHz (eg. “Spektrum” type RC units) up to 4W as long as they hop among at least 75 frequencies (item 56 of the class license).

6. Version History:

2018-12-24: First Version.

2019-05-13, V1.1:

- Added UNII3 802.11ac channels (149, 153, 157, 161, 165).
- Added LOC networking partner, Aruba Networks, for supply and management of access points and directional antennas.
- Updated channel assignments and radio map based on discussions with league TCs, the changed floorplan, the availability of directional antennas and the addition of UNII3 frequencies.