

# WaveCAST™ Network Guide

FOR CONSULTANTS AND IT PROFESSIONALS



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## Description

A WaveCAST System is built with any Wi-Fi audio streaming Williams AV product. This includes the WaveCAST, WaveCAST EIGHT, FM + and IR + hardware devices.

A typical WaveCAST system consists of the following segments: Audio Source, WaveCAST Server, Router/DHCP Server, IP Network (including Wi-Fi), and receiving device (end point).

WaveCAST receives live audio from sources such as TVs, cable receivers, satellite receivers, microphones, sound systems, etc. WaveCAST then encodes the audio onto an IP Network so the encoded audio can be sent through the Wi-Fi network to smartphones or tablets, as well as the WaveCAST Receiver.

## Understanding Live Audio Streaming

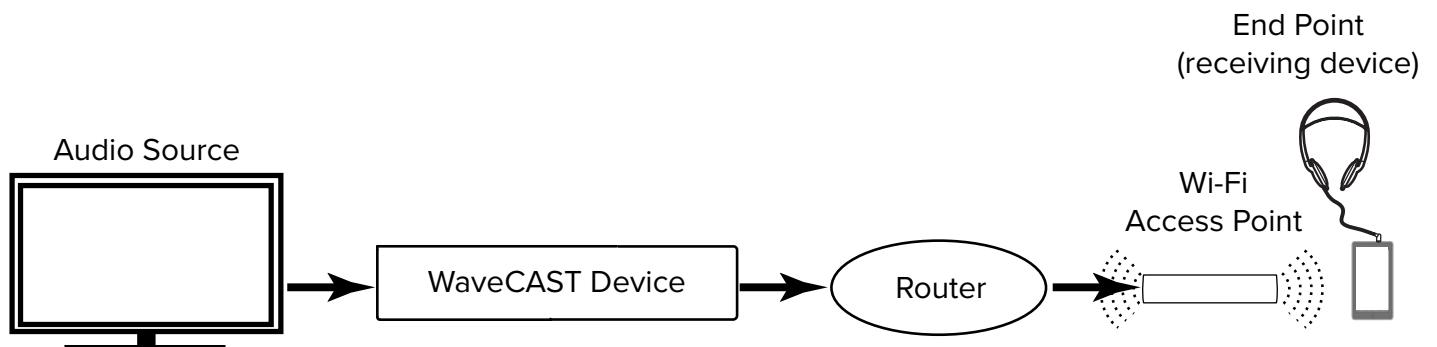
Online streaming services like Netflix, YouTube, Pandora and Spotify work differently than a live streaming system like the WaveCAST.

Both online streaming and live streaming transmit data with packets. Packets are one snippet of a larger piece of information such as an audio file. A streaming system takes the packets it receives and puts them back together into a large piece of content for the user.

In order to optimize the experience, online streaming services buffer hundreds of packets before the user actually sees or hears them. This can be done because the content is stored. If a packet is missed, it is re-requested and inserted back into the stream. This maintains a consistent uninterrupted flow of the data.

Live audio streaming works differently. In order to avoid lip-sync delay, these systems only buffer 2-3 packets ahead of when the audio is heard by the user. A packet that was missed (a “drop-out”) cannot be recovered. There is virtually no storage of packets nor time to re-request the packet. However, with network optimization, the performance can be extremely good. This document covers the necessary parameters to optimize the network for best performance.

## How it Works



Audio is taken from the source (TV’s, cable, satellite, live sound systems, etc.) and brought into the WaveCAST Server via analog or Dante connections. The WaveCAST system encodes and broadcasts the audio over the IP network.

The Wi-Fi Network may consist of Wireless Local Area Network (LAN) Controllers, Router/DHCP Server, and/or Wi-Fi Access Points (APs). Enterprise level Wi-Fi APs are sometimes controlled by WLAN controllers. Ruckus Wireless Networks are preferred based on proven performance but other enterprise level Wi-Fi equipment may also work if properly configured for use with WaveCAST system. The Wi-Fi network also includes the end point devices, smartphones and tablets with the WaveCAST App installed or the WaveCAST Receiver.

## Audio Requirements

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Most WaveCAST systems accept balanced or unbalanced audio via a XLR/ (1/4)" plug combination jack and is optionally either stereo or monaural.

### Dante™ Audio

Dante versions of WaveCAST systems have a dedicated RJ-45 port on the rear panel.

If Dante audio is being used, a 48 KHz sample rate is the only one supported. A 44.1 sample rate is not supported.

## Standard WaveCAST System Network Requirements

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A WaveCAST System is configured to receive a DHCP address from a DHCP server on the existing network. A DHCP server is required for managing traffic for users using mobile phones.

A separate or isolated LAN, subnet, etc. for audio streaming is recommended.

If no mobile users will be present, (for example, only WaveCAST Receivers will be used), the system can be configured to use a static IP address in the device settings (see full user manual for details).

Both unicast and multicast modes are available. The mode must be selected by the user in the WaveCAST system settings (see full user manual for details). Approximately 30kBS of bandwidth are used (depending on audio source and frequency response) per device. This bandwidth measurement is per stream in Unicast mode and per channel in Multicast mode.

Unicast mode made for 45 users or less.

For multicast mode, up to 1,500 users can be supported. The maximum amount of users may be limited by network hardware, configuration and/or DHCP server. For Multicast, consumer-grade routers do not work well, enterprise-grade routers and access points are recommended.

The network must pass more than 45 users from the WaveCAST system to the access points (AP)s. The APs must be able to deliver multicast to multiple end points simultaneously.

End points must be able to communicate with the WaveCAST system. We recommend that the WaveCAST system and the end points are on the same subnet.

The TTL is selectable in the WaveCAST system settings (see the full user manual for details). In most cases, Williams AV recommend keeping the default TTL value of 1. However, if the endpoint resides on a different VLAN than the WaveCAST system, or access to the network requires switch hopping, it may be necessary to adjust the TTL to a higher value.

Likewise, the end points must not be isolated from the WaveCAST. In a guest Wi-Fi environment, it is usual to have the SSID connections "isolated" from the LAN. The Wi-Fi connections will need to have access to the WaveCAST and vice versa. This can be accomplished either by creating acceptable routes from the Wi-Fi to the WaveCAST, or by making the SSID non isolated from the LAN that the WaveCAST is located on.

UDP protocol and UDP Broadcast are used for device discovery and for multiple Wavecast server sync/communication.

### Port Information

The following ports are required to be open for the WaveCAST system to work: 80, 3300, 3301, 3302 and 3303.

The server control commands on the mobile app are received by the WaveCAST system on UDP port 3300 and replies are sent back to UDP port 3301. These are used for UDP discovery.

The server transmits audio from UDP port 3302 to UDP port 3303 in both Unicast and Multicast mode. The WaveCAST App checks in on these ports.

The web control interface is accessed on port 80 and will need to be available for setting adjustments.

### Other Required Features

The network equipment selected is also required to support:

- Internet Group Management Protocol (IGMP) support
- IGMP Snooping enabled
- Quality of Service (QoS) set to voice or higher (as is typically done in VOIP systems)
- Multicast (if being used)

## Considerations for an Interference-Free Network

Since the WaveCAST system uses Wi-Fi as its medium for transmission, care should be taken to minimize obstructions between the access point and user devices. The more numerous or significant the obstructions, the less consistent the performance will be.

Access points are critical to optimal performance of the user experience. There must be adequate Wi-Fi coverage to accommodate the space where users are expected to utilize the WaveCAST App.

Network security settings, including firewalls and switch configurations, must be configured to pass audio streams.

User density must also be considered as different access points will allow different amounts of maximum client connections. The Wi-Fi network must be able to accommodate all users within the space with adequate bandwidth.

Signal strength should be kept strong in all areas required, no less than -60 dBm. Signal strength is also impacted a great deal by frequency and co-channel interference. Interference mitigation is critical. A site survey may be useful in diagnosing or discovering interference issues.

Channel hopping by the access points can cause quick audio interruptions. It is advisable to use manually configured and stationary channels within the Wi-Fi network.

It is also recommended to increase the minimum allowed connection rate. Using the 5 GHz band only may improve performance due to less network interference, but this will also eliminate devices that are only capable of utilizing the 2.4 GHz band or devices unable to recognize the higher channel frequencies within the 5 GHz band.

Keep in mind, encryption uses bandwidth and reduces the number of successful connections substantially in a Wi-Fi environment and must be taken into account.

If any of network parameters cannot be configured on the enterprise network, an independent or segregated network may be an option.

## Checklist of Network Requirements

- A DHCP server (*required to manage traffic for mobile devices*)
- Unicast support (up to 45 users) or Multicast support (up to 1500 users; *maximum users may be limited by network hardware, configuration and/or DHCP server. The FM + (FM T55) and WaveCAST (WF T5) support Unicast or Multicast; The WaveCAST EIGHT (WF T8) and IR + (IR M1) are Multicast Only.*)
- UDP Protocol, UDP Broadcast, and UDP Discovery allowed.
- IGMP support
- IGMP Snooping enabled
- QoS set to voice or higher (*as is typically done in VOIP systems*)
- Port 80, 3300, 3301, 3302, 3303 open
- Network Security/Firewalls/Switch configured to pass audio streams
- Optimize environmental conditions for Wavecast Wi-Fi
- Reduce 2.4 GHz interference with Wavecast Access Points (APs) (*check the environment with Wi-Fi Analyzer or similar App*)
- Reduce AP channel hopping (*fixed channels recommended*)
- Wi-Fi site survey (2.4 GHz) recommended prior to new installs
- For Multicast, enterprise-grade routers and APs are recommended
- Minimize switch hops if possible. If switch hops are required, TTL can be set in the web interface.
- Separate or isolated LAN, subnet, etc. for audio streaming is recommended
- 5 GHz APs recommended. 2.4 GHz often suffers from interference depending on the environment.
- Access Points (APs) should have access to internet. If internet is not present, some devices will attempt to switch to cell data and disconnect from Wi-Fi. If internet cannot be made available, users may need to switch to Airplane mode or disable cell data on their mobile device to use Wavecast.
- If Dante audio is needed, 48 KHz sample rate is the only one supported (not 44.1).
- Bandwidth requirements are approximately 30kBS (*depending on audio source and frequency response*) per device, per stream in Unicast, per channel in Multicast.

## Android Devices

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Android devices are programmed to drop Wi-Fi connections that do not connect to the internet. While the WaveCAST system will work without an internet connection, Android devices will see there is no internet connection, disconnect from the network and switch to using a data network. The audio from the WaveCAST network will then be unavailable.

Putting the Android device in Airplane Mode or disabling cell data can resolve this issue if an internet connection cannot be provided over the same network as the WaveCAST Audio.

## Multicast Details

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The WaveCAST App (the end point) discovers if there is a WaveCAST system on the network by sending a broadcast packet and listening for response on multicast address.

The broadcast uses the broadcast IP Address of the subnet that the endpoints (receiving device) are on. For example, if the subnet has the address range of 192.168.128.XXX, the broadcast address is 192.168.128.255.

The multicast group range must be kept available and allowed on the network. The default Multicast address range is 239.168.0.12 - 239.168.0.127. The user may set a custom Multicast address for each channel in the web interface.

When the WaveCAST App selects a channel, the server begins to stream the audio on that channel to the device (if not already doing so). The access point should be configured to support multicast. Refer to the AP/Wi-Fi manufacturer's documentation.

The network should support: IGMP, IGMP Snooping, and Multicast.

The network and SSID should also be configured for Voice or Premium QoS, (or other priority QoS depending on Manufacturer). The WaveCAST system uses similar settings as most VOIP configurations, and DSCP .46 or EF for QoS classification.

## Multicast Configuration Examples

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*These are intended as an example only; settings may be different on your hardware.*

### Example 1: General Cisco Multicast Network Settings

Configuration for a Wireless LAN Controller from the Settings GUI:



WLANs > [select WLAN] > QoS Tab > Multicast Direct: Enabled

WLANs > [select WLAN] > QoS Tab > Quality of Service: platinum

Wireless > Media Stream > General > Multicast Direct: Enable

#### Optional settings:

Controller > Multicast > Enable Global Multicast Mode

Controller > Multicast > Enable IGMP Snooping

**Streams groups can be created:** Wireless > Media Stream > Streams

**Example 2: Detailed Multicast Network Settings**

- Configure multicast routing on all L3 devices
- Configure one L3 devices as the PIM RP
- Enable PIM on all routed interfaces and SVI
- Enable IGMP snooping on all L2/L3 switches
- Configure the WLC for Multicast Between AP and WLC
- Enable IGMP on the WLC

**Step 1: Configure Multicast Routing on all L3 Devices**

## Default Router Configuration

- » **R1#sh ip multicast**
  - ◇ Multicast Routing: disabled
  - ◇ Multicast Multipath: disabled
  - ◇ Multicast Route limit: No limit
  - ◇ Multicast Fallback group mode: Sparse
  - ◇ Number of multicast boundaries configured with filter-autorp option: 0
- Enable on Layer 3 Switches
  - » **mls ip multicast**
- Enable on Routers
  - » **ip multicast-routing**
- Check to make sure it is enabled
  - » **R1#sh ip multicast**
    - ◇ Multicast Routing: enabled
    - ◇ Multicast Multipath: disabled
    - ◇ Multicast Route limit: No limit
    - ◇ Multicast Fallback group mode: Sparse
    - ◇ Number of multicast boundaries configured with filter-autorp option: 0

**Step 2: Configure PIM RP (rendezvous point)**

- Best Practice: configure RP on a Loopback Interface
  - » **interface Loopback1**
    - » **ip address 10.10.10.1 255.255.255.255**
- Configure the RP address on all Routers and L3 switches
  - » **R1(config)#ip pim rp-address 10.10.10.1**

*Note – don't forget to include this on the L3 devices where you have configured the RP address*

- Check the RP status
  - » **R1#sh ip pim rp**
    - » Group: 224.0.1.40, RP: 10.10.10.1, next RP-reachable in 00:00:03

**Step 3: Enable PIM on all Routed and SVI interfaces**

- Enable Sparse Mode on all interfaces
  - » **R1(config)#int g1/0**
  - » **R1(config-if)#ip pim sparse-mode**
    - » \*May 11 21:45:33.703: %PIM-5-DRCHG: DR change from neighbor 0.0.0.0 to 192.168.1.1 on interface GigabitEthernet1/0

- Check PIM neighbors
  - » R1#sh ip pim neighbor
    - » PIM Neighbor Table
    - » Mode: B - Bidir Capable, DR - Designated Router, N - Default DR Priority,P - Proxy Capable, S - State Refresh Capable, G - GenID Capable
    - » Neighbor Interface Uptime/Expires Ver DR
    - » Address Prio/Mode
    - » 192.168.1.3 GigabitEthernet1/0 00:00:33/00:01:40 v2 1 / DR S P G
    - » 192.168.1.2 GigabitEthernet1/0 00:00:50/00:01:40 v2 1 / S P G
- Check to see if other devices can see Multicast
  - » R2#sh ip mrouteIP
    - » Multicast Routing Table
    - » Flags: D - Dense, S - Sparse, B - Bidir Group, s - SSM Group, C -Connected,L - Local, P - Pruned, R - RP-bit set, F - Register flag,T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,U - URD, I - Received Source Specific Host Report,Z - Multicast Tunnel, z - MDT-group sender,Y - Joined MDT-data group, group,V - RD & Vector, v - VectorOutgoing interface flags: H - Hardware A- Assert winner
    - » Timers:Uptime/Expires
    - » Interface state: Interface, Next-Hop or VCD, State/Mode
    - » (\*, 224.0.1.40), 00:05:09/00:02:20

(You should be able to see the \*,Grp for PIM Join and the RP Address)

- » RP 10.10.10.1
- » flags: SJPL
- » Incoming interface: GigabitEthernet1/0, RPF nbr 192.168.1.1
- » Outgoing interface list: Null

#### Step 4: Enable IGMP Snooping on all L2/L3 Switches

- Make sure that all devices are using the same IGMP version:Three different versions of IGMP v1, v2, v3Default is IGMPv2 – use IGMPv2 unless specified
- Enable IGMP snooping
  - » ip igmp snooping

## Specifications

Router	Ports	Information
Operating System	End Point (receiving device)	Apple iOS 9.1 or newer Android 6.0 or newer Blackberry/Windows currently not supported
Bandwidth	Initial App Connect(i)	Background = 128 Kb per device
	Audio	Wired Bandwidth = 30 Kbs/S per configured channel Wi-Fi Bandwidth = 30 Kbs/S per connected channel (ii)

<sup>i</sup>After connecting to the WaveCAST network, when the WaveCAST App is launched there is an initial connection that will download background content to the device. This initial connection happens once per device per session.

<sup>ii</sup>Connected channels are any channel that has at least one device actively playing the channel, (joined to the Multicast Group). It does not matter how many devices are joined to a particular channel, it is connected if one or many devices are joined.



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