



## WirelessHD

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## WirelessHD

WirelessHD is an effort to define a specification for the next generation wireless digital network interface for wireless high-definition signal transmission for consumer electronics products. The consortium currently has over 40 adopters. Key members behind the specification include Broadcom, Intel, LG, Panasonic, NEC, Samsung, SiBEAM, Sony, Philips and Toshiba. It was finalized in January 2008.

The WirelessHD specification will serve as the first and only wireless digital interface to combine uncompressed high-definition video, multi-channel audio, intelligent format and control data, and Hollywood approved standard content protection techniques. For end-users, elimination of cables for audio and video dramatically simplifies home theater system installation and eliminates the traditional need to locate source devices in the proximity of the display. The WirelessHD specification is based on the 7GHz of continuous bandwidth around the 60GHz radio frequency and allows for uncompressed, digital transmission of full HD video and audio and data signals, essentially making it equivalent, in theory, to wireless HDMI. The specification has been designed and optimized for wireless display connectivity, achieving in its first generation implementation high-speed rates from 4 Gbit/s for portable device segments. Its core technology promotes theoretical data rates as high as 25 Gbit/s (compared to 10.2-Gbit/s for HDMI 1.3), permitting it to scale to higher resolutions, color depth, and range.

The WirelessHD specification defines a wireless protocol that enables consumer devices to create a wireless video area network (WVAN) with the following characteristics:

- Stream uncompressed audio and video at up to 1080p resolution, 24 bit color at 60 Hz refresh rates
- Deliver compressed A/V streams and data
- Advanced A/V and device control protocol
- Unlicensed operation at 60 GHz with a typical range of at least 10 m for highest resolution HD A/V
- Smart antenna technology to enable non line of sight (NLOS) operation
- Data privacy for user generated content

The requirement for high data throughput at distances of 10 m necessitates a large allocated frequency spectrum. A large amount of spectrum is available on an unlicensed basis in many regulatory domains in the 60 GHz band. In North America, South Korea and Japan, a total of 7 GHz is allocated for use, 5 GHz of which is overlapping. The band 57-64 GHz is allocated in North America and South Korea while 59-66 GHz is allocated in Japan. In addition, the European Union is in the process of creating similar allocations. The regulations allow very high effective transmit power (the combination of transmitter power and antenna gain), greater than 10 W of effective isotropic radiated power (EIRP). High EIRP and wide allocated bandwidth will allow high throughput connections that, however, are very directional.

The WirelessHD specification defines a novel wireless protocol that enables directional connections that adapt very rapidly to changes in the environment. This is accomplished by dynamically steering the antenna beam at the transmitter while at the same time focusing the receiver antenna in the direction of the incoming power from the transmitter.

## Applications

The WirelessHD WVAN (wireless video area network) supports a variety of applications, but is focused foremost on the delivery of high quality, uncompressed audio/video (A/V) content. The applications supported by the WirelessHD specification are listed in Table

Application	Data rate	Target latency
Uncompressed 1080p A/V	3.0 Gb/s	2 ms
Uncompressed 1080i A/V	1.5 Gb/s	2 ms
Uncompressed 720p A/V	1.4 Gb/s	2 ms
Uncompressed 480p A/V	0.5 Gb/s	2 ms
Uncompressed 7.1 surround sound audio	40 Mb/s	2 ms
Compressed 1080p A/V2	20-40 Mb/s	2 ms
Uncompressed 5.1 surround sound audio	20 Mb/s	2 ms
Compressed 5.1 surround sound audio	1.5 Mb/s	2 ms
File transfer	> 1.0 Gb/s	N/A

Using the applications previously defined, a variety of use cases can be defined. The potential sources and sinks are grouped as follows:

- HD A/V source: set top box (STB), Blu-ray disc (BD) player, BD recorder, HD DVD player, HD DVD recorder, personal video recorder (PVR), broadcast HD receiver, etc.
- Audio source/server: Any of the HD video sources, stereo tuner, broadcast radio receiver.
- HD A/V sink: flat panel display (including LCD, plasma and projection), BD recorder, HD DVD recorder, PVR, etc.
- HD video sink: Same as HD A/V sink, except in the uses case, the audio is delivered to a different location.
- Compressed A/V sink: PVR, BD recorder, HD DVD recorder.
- Compressed A/V source: Personal media players (PMPs), digital video cameras (DVCs), digital audio players, etc.
- Audio sink: Speakers, audio receiver/amplifier

- Data source/sink: PMP, DVCs, digital still cameras (DSCs), digital audio players

Source	Sink	Data rate	Number of streams
HD A/V	HD A/V	3.0 Gb/s	1
HD A/V	HD video Audio	3.0 Gb/s 40 Mb/s	2
HD A/V Compressed A/V	HD A/V Compressed A/V	3.0 Gb/s 24 Mb/s	2
HD A/V HD A/V	HD A/V HD A/V	1.5 Gb/s 1.5 Gb/s	2
HD A/V Compressed A/V	HD video Compressed A/V Audio	1.5 Gb/s 24 Mb/s 40 Mb/s	3
Audio	Audio	30 Mb/s	1
HD A/V	HD A/V HD A/V	1.5 Gb/s 1.5 Gb/s	2
Data source	Data sink	1.0 Gb/s	1
HD A/V HD A/V	HD A/V HD A/V Audio	0.5 Gb/s 0.5 Gb/s 40 Mb/s	3
HD A/V HD A/V	HD A/V Audio Audio	1.5 Gb/s 40 Mb/s 40 Mb/s	3
HD A/V Audio	HD A/V Audio	3.0 Gb/s 40 Mb/s	2

## WirelessHD Architecture

The WirelessHD specification has been architected and optimized for wireless display connectivity, achieving in its first generation implementation high-speed rates up to 4 Gbps for the consumer electronic, personal computing and portable device segments. Its core technology promotes theoretical data rates as high as 25 Gbps, permitting it to scale to higher resolutions, color depth, and range. Coexisting with other wireless services, the WirelessHD platform is designed to operate cooperatively with existing, wire line technologies. Recent availability of several new technologies make it possible to achieve the multi-gigabit data rates required for uncompressed video streaming. Such breakthroughs enable low cost, better image quality, and higher performance wireless A/V systems. The key characteristics and technologies include:

- High interoperability supported by major device manufacturers
- Uncompressed HD video, audio and data transmission, scalable to future high-definition A/V formats

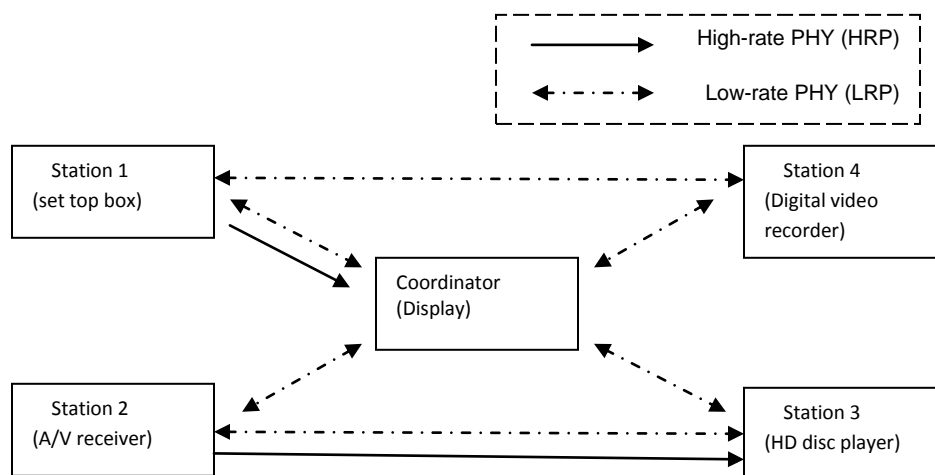
- High-speed wireless, multi-gigabit technology in the unlicensed 60 GHz band
- Smart antenna technology to overcome line-of-sight constraints of 60 GHz
- Secure communications with Digital Transmission Content Protection (DTCP) over WirelessHD technology
- Device control for simple operation of consumer electronics products
- Error protection, framing and timing control techniques for a quality consumer experience

The WirelessHD specification defines a wireless video area network (WVAN) for the connection of consumer electronic (CE) audio and video devices. A key attribute of the WirelessHD system is its ability to support the wireless transport of an uncompressed 1080p A/V stream with a high quality of service (QoS) within a room at distances of ten meters.

The WirelessHD specification defines a novel wireless protocol that enables directional connections that adapt very rapidly to changes in the environment. This is accomplished by dynamically steering the antenna beam at the transmitter while at the same time focusing the receiver antenna in the direction of the incoming power from the transmitter. This dynamic beam forming and beam steering utilizes not only the direct path, but allows the use of reflections and other indirect paths when the line-of-sight connection is obstructed. This dynamic adjustment of the antenna energy is completed in less than one millisecond.

The WVAN consists of one Coordinator and zero or more Stations. The Coordinator schedules time in the channel to ensure that the wireless resources are prioritized for the support of A/V streams. The other devices that are a part of the WVAN are referred to as Stations. A station may be the source and/or sink of data in the network. The device that is the Coordinator also acts as a Station in the WVAN and may act as a source and/or sink of data.

The high rate physical layer (HRP) is used for data transfer because it is capable of a throughput well in excess of 3 Gb/s. While the low rate physical layer (LRP) is capable of carrying data, its throughput is less than 40 Mb/s.



The high-rate PHY (HRP) is a PHY that supports multi-Gb/s throughput at distance of 10 m through adaptive antenna technology. Because of this, the HRP is highly directional and can only be used for unicast connections. The HRP is optimized for the delivery of uncompressed high definition video, other data can be communicated using the HRP. To support multiple video resolutions, the HRP has more than one data rate defined. The HRP carries:

- isochronous data such as audio and video,
- asynchronous data,
- MAC commands,
- antenna steering information, and
- higher layer control data for A/V devices.

The low-rate PHY (LRP) is a multi-Mb/s bidirectional link that also provides a range of 10 m. Multiple data rates are defined for the LRP, with the lower data rates having near omnidirectional coverage while the highest data rates are directional. Because the LRP has near omnidirectional modes, it can be used for both unicast and broadcast connections. Furthermore, because all Stations support the LRP, it can be used for Station-to-Station links. The LRP supports multiple data rates, including directional modes, and is used to carry:

- low-rate isochronous data such as audio,
- low-rate asynchronous data,
- MAC commands including the beacon,
- acknowledgements for HRP packets,
- antenna beam forming information,
- capabilities information, and
- higher layer control data for A/V devices.

The HRP and LRP operate in overlapping frequency bands and so they are coordinated in a TDMA manner by the MAC.

## Device capabilities

There are two types of devices, based on MAC capabilities, in WirelessHD specification; Coordinator and Station.

The Coordinator:

- controls the timing in the piconet,
- keeps track of the members of the WVAN,
- is able to transmit and receive using the LRP,
- may be able to transmit data using the HRP, and
- may be able to receive data using the HRP.

A Station:

- is able to transmit and receive using the LRP,
- may initiate stream connections,
- may be able to transmit data using the HRP, and
- may be able to receive data using the HRP.

In addition to the two MAC personalities of Coordinator and Station, each device in the WVAN will have one of four different PHY capabilities:

- HR0 - a device that is not able to either receive or transmit using the HRP,
- HRRX - a device that is able to receive in the HRP, but is not able to transmit using the HRP,
- HRTX - a device that is able to transmit in the HRP, but is not able to receive using the HRP, and
- HRTR - a device that is able to both transmit and receive using the HRP.

All compliant WirelessHD devices are able to transmit and receive using the LRP. The major functions supported by the host/higher layer, MAC and PHY are

#### **Host/higher layer functionality**

- Video format selection (resolution, color depth, etc.)
- bus encode and decode
- Video and audio encode and decode
- Clock synchronization
- Service discovery

#### **MAC sub layer functionality**

- Cryptographic authentication and key generation
- PHY channel selection
- Send and receive data
- Check for errors in data delivery
- Bandwidth reservation and scheduling
- Connection start and stop
- Monitor channel characteristics and inform higher layer
- Schedule beam forming
- Device discovery
- Shutdown and sleep
- bus data delivery

## PHY layer functionality

- Antenna control
- Analog link quality assessment
- Verify header information
- Send and receive data
- Detect high data rate option from received packets
- FEC (Forward Error Correction), modulation, etc.

## Competition

WirelessHD competes with the Wireless Gigabit Alliance, an organization promoting a different specification for multi-gigabit-speed wireless communications technology operating over the same unlicensed 60 GHz spectrum used by WirelessHD. WirelessHD is competing somewhat with the upcoming Wireless USB specification, which operates on the 3.1 to 10.6 GHz band and delivers 480 Mbit/s throughput.

WirelessHD also competes with the (WHDI) Wireless Home Digital Interface specification, with key technology provided by AMIMON. The WHDI Special Interest Group was formed by Amimon, Hitachi, Motorola, Samsung, Sharp, Sony, and LG Electronics. WHDI uses 20/40 MHz of bandwidth in the 5 GHz unlicensed band, offering lossless video and achieving equivalent video data rates of up to 3Gbit/s.