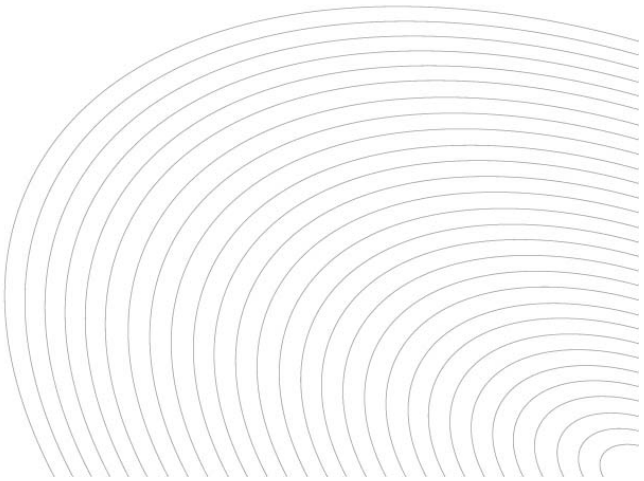
WirelessHD Specification Summary

February 2007



Preface

Notice

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Introduction

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. This dynamic beam forming and beam steering not only optimizes the line-of-sight link, it allows the use of reflections and other indirect paths when the line-of-sight connection is lost.

This summary document generally follows the order of the WirelessHD specification, version 0.6, which is a draft specification. Section headings are the same, however, subsection numbering, is not necessarily the same but does follow the same general order as in the WirelessHD specification.

The following abbreviations are used in the specification and this summary

ACK	acknowledgement
A/V	audio/video
AWV	antenna weight vector
BER	bit error rate/ratio
CE	consumer electronic
CrdID	coordinator identifier
CTB	channel time block
DSC	digital still camera
DVC	digital video camera
EEP	equal error protection

FEC	forward error correction
HR	high rate
HRP	high rate physical layer
LOS	line of sight
LR	low rate
LRP	low rate physical layer
MAC	medium access control
MCS	modulation coding scheme
NLOS	non line of sight
PER	packet error rate/ratio
PHY	physical layer
PMP	personal media player
PVR	personal video recorder
QoS	quality of service
ReBoM	reliable broadcast or multicast
STB	set top box
STID	station identifier
TDD	time division duplex
UEP	unequal error protection
WVAN	wireless video area network
WVNID	wireless video area network identifier

Use cases

Applications

The WirelessHD WVAN supports a variety of applications, but is focused foremost on the delivery of high quality, uncompressed A/V content. The applications supported by the WirelessHD specification are listed in Table 1.

Table 1: Applications supported by WirelessHD

Application	Data rate	Maximum latency
Uncompressed 1080p A/V	3.0 Gb/s	50 ms
Uncompressed 1080i A/V	1.5 Gb/s	50 ms
Uncompressed 720p A/V	1.4 Gb/s	50 ms
Uncompressed 480p A/V	0.5 Gb/s	50 ms
Uncompressed 7.1 surround sound audio	40 Mb/s	20 ms
Compressed 1080p A/V[1]	20-40 Mb/s	50 ms
Uncompressed 5.1 surround sound audio	20 Mb/s	20 ms
Compressed 5.1 surround sound audio	1.5 Mb/s	20 ms
File transfer	> 1.0 Gb/s	N/A

[1] This specification does not preclude the use of any codec for compressing A/V data. At a minimum compressed A/V data can be transported as regular data packet.

The A/V applications are supported with a pixel error ratio of less than 10^{-9} for 24-bit color.

Both stationary and mobile devices are supported by the specification. Advanced power management methods are available to enable mobile devices. In addition, while the WirelessHD radios will typically be embedded, the specification supports the creation of external adapters to enable legacy devices.

Specific use cases

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

- HD A/V source: set top box (STB), Blue-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.
- Audio sink: Speakers, audio receiver/amplifier
- Data source/sink: PMP, DVCs, digital still cameras (DSCs), digital audio players

A summary of the uses cases is listed in Table 2. In the use cases listed, the destination of the audio or video is not necessarily the display or the Coordinator of the WVAN. Many of the use cases involve multiple destinations of the isochronous data.

Table 2: Use cases for WirelessHD

UseCase #	Source(s)	Sink(s)	Data rate(s)	Number of streams
1	HD A/V	HD A/V	3.0 Gb/s	1
2	HD A/V	HD video Audio	3.0 Gb/s 40 Mb/s	2
3	HD A/V Compressed A/V	HD A/V Compressed A/V	3.0 Gb/s 24 Mb/s	2
4	HD A/V HD A/V	HD A/V HD A/V	1.5 Gb/s 1.5 Gb/s	2
5	HD A/V Compressed A/V	HD video Compressed A/V Audio	1.5 Gb/s 24 Mb/s 40 Mb/s	3
6	Audio	Audio	30 Mb/s	1
7	HD A/V	HD A/V HD A/V	1.5 Gb/s 1.5 Gb/s	2
8	Data source	Data sink	1.0 Gb/s	1
9	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

UseCase #	Source(s)	Sink(s)	Data rate(s)	Number of streams
10	HD A/V HD A/V	HD A/V Audio Audio	1.5 Gb/s 40 Mb/s 40 Mb/s	3
11	HD A/V Audio	HD A/V Audio	3.0 Gb/s 40 Mb/s	2

For all of the use cases listed in Table 2, with the exception of use case #6, 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. If no other data transfer is taking place in the network, as in use case #6, the LRP mode may be used for low-rate data streaming of audio. This allows a Station like an FPD that does not have a HRP transmitter to stream audio it receives from over-the air broadcast to remote speakers.

WirelessHD Architecture

Overview

The WVAN consists of one Coordinator and zero or more Stations. The Coordinator is usually the display, but any other device in the WVAN could be the Coordinator as well. 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. An example of a WVAN is illustrated in

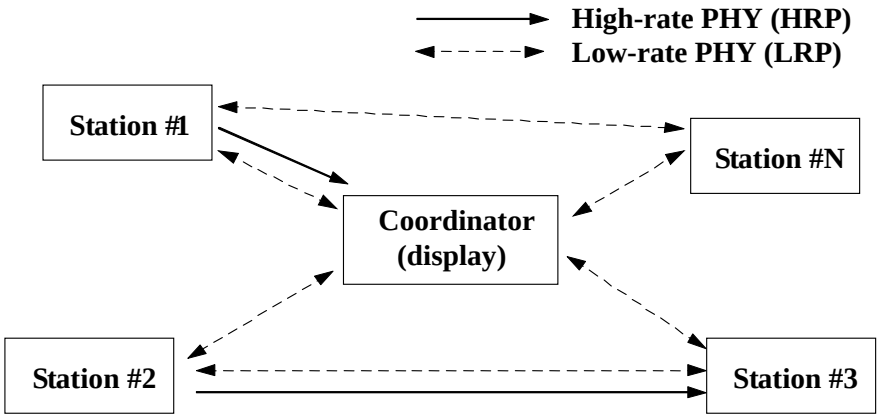

Figure 1: Example of a WVAN

There are two types of physical layers (PHYs) defined in the WirelessHD specification; the high-rate PHY (HRP) and the low-rate PHY (LRP). The HRP is optimized to efficiently carry A/V data at very high data rates, up to 4 Gb/s using directional links. The HRP is typically used to carry:

- Isochronous data such as audio and video,
- Asynchronous data

- MAC commands,
- Antenna steering information, and
- Higher layer control data for A/V devices

To enable the transmission of broadcast data and to support beam forming and beam steering, the LRP is also provided. The LRP supports data rates from 2.5-10 Mb/s with near omni-directional coverage and 20-40 Mb/s by using beam steering and beam forming. The LRP is typically used to carry the following:

- 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 channels with the LRP using a much narrower bandwidth. Except in the contention period, all transmissions are coordinated in a TDMA manner. In addition, three LRP frequency channels are defined for each of the four HRP frequency channels. This allows nearby WVANs to share the same HRP frequency with beam steering and beam forming by using different LRP channels in the same HRP frequency.

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.

Note that a Station may be capable of acting as a Coordinator in the WVAN. Such a Station is referred to as being Coordinator capable.
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 illustrated in Figure 2.

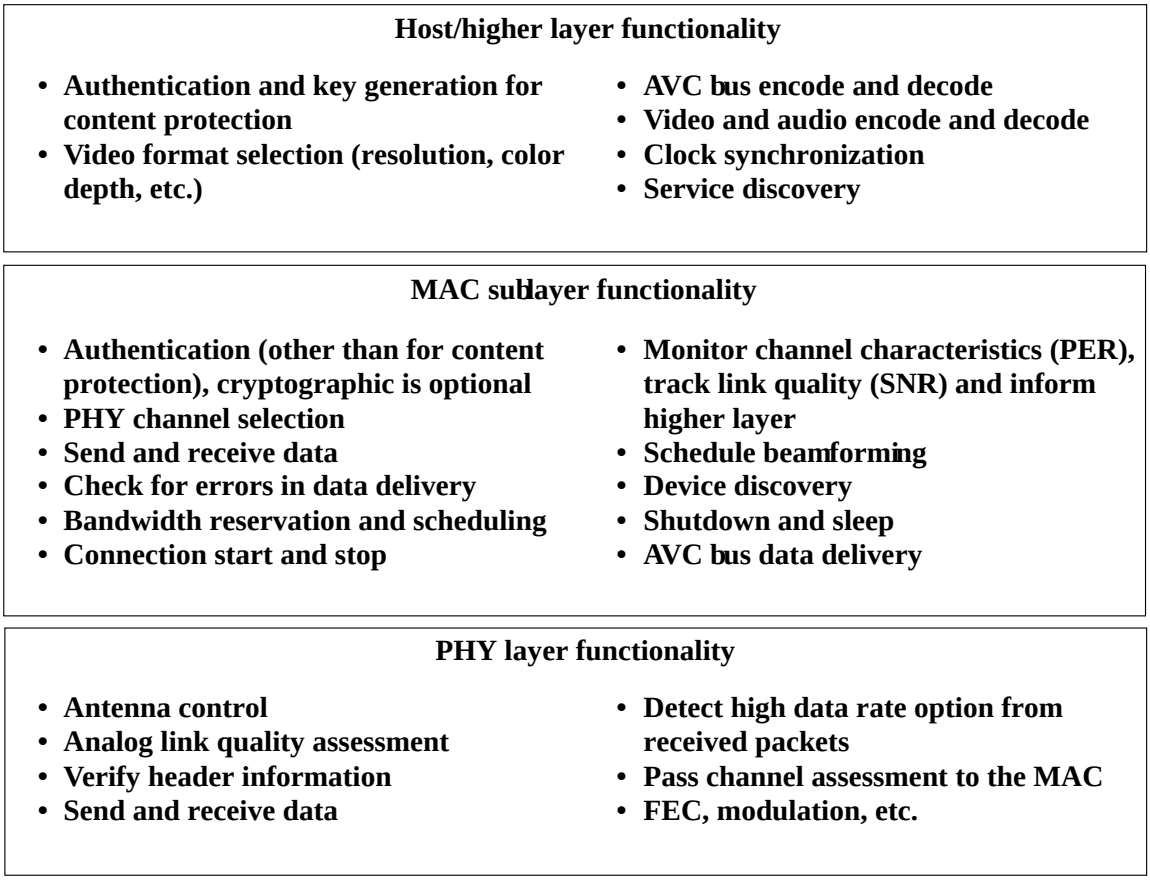

Figure 2: Functional breakdown of the characteristics of a WirelessHD device.