



SiBEAM™

wireless beyond boundaries

**Applications for SiBEAM's
WirelessHD Compliant
Products**

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SiBEAM, Inc. Proprietary & Confidential

Usage Case Scenarios

The idea of sending video and audio without wires is easy to understand. From the first land-based analog broadcast towers to modern digital satellite dishes, wireless has been one of the best and most popular ways of distributing media to the home.

Once it enters the home, however, the idea of wireless media goes from being a natural and ubiquitous interface to becoming an expensive and niche technology. All too often, the elegant and high definition pictures flying wirelessly in one's home are constricted to a tangled mix of digital and analog cables.

Consumers want to be able to view their video and hear their music on all of the equipment they own. They don't like the restrictions and actual cost of traditional wired connections, and the advent of high definition video and multi-channel speaker systems is only making the wired mess worse. Meanwhile, the complexity and quality tradeoffs necessary for most wireless home media systems limit their desirability.

WirelessHD technology addresses the challenges of traditional wired and wireless connectivity with a new architecture suited for the unique challenges of high definition consumer electronics products. This technology uses full bandwidth uncompressed HDTV video and audio signals to take advantage of the quality and ease of use and configuration of wired connections. In addition, WirelessHD transports these signals to all of a consumers' equipment without wires to take advantage of the ease of deployment and usability advantages of radio technologies.

WirelessHD is enabling a new type of universal wireless link which interfaces consumer electronics products at full high definition quality with less complexity than traditional cabled connections. This technology enables an A/V network for the connection of flat panel plasma or LCD displays and multimedia projectors, video sources such as digital set-top-boxes (STB), high definition digital video cameras (DVC), Digital Versatile Disc (DVD) players and future successors, and both PC-based and standalone media centers.

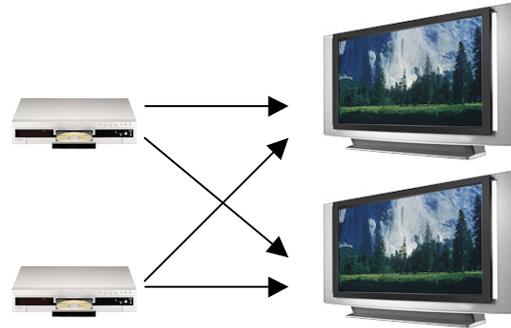
Through an integrated delivery of high definition multi-channel video, audio, and system control functions, WirelessHD supports a broad range of everyday usage scenarios. This technology features the capabilities that make it easier and less costly for consumers to setup, control and store their multimedia components.

Usage Case #1: Direct Audio/Video Streaming

HDTV, HD Projectors, Blu-Ray Disc (BD), Set-Top Box (STB)

Summary Requirements

- 1080p resolutions, 24-bit color, 60 frames per second
- 10^{-9} pixel error rates
- Support all EIA-861 video formats
- Multiple video streams for picture-in-picture (PIP)
- Multiple video streams for single source to multiple displays
- Range of up to 10m near line-of-sight
- Device control



Description

The focal point of almost all home theater systems is the display. Whether it's the latest flat panel display or projector or an earlier generation of rear projection television, one of the most basic and most challenging problems in high definition video is how to get a real-time, low latency signal from source to display within the home.

The display demands of modern high definition video systems are much more rigorous than those of traditional, standard definition systems. With maximum resolutions ranging from 1920x1080p to 1280x720p, HD video delivers 5 to 10 times the fidelity and requires 5 to 10 times the bandwidth of traditional NTSC 480i or PAL 576i video systems. The growing popularity of picture-in-picture and multi-display systems further increases the bandwidth requirements of modern high definition video systems.

Many wireless designs approach the bandwidth challenge of high definition video by either working with a compressed source video stream or transcoding to lower data rates. While this does reduce the performance requirements of the wireless link, it also increases cost and complexity by requiring new hardware rendering, compositing and access control designs while simultaneously reducing image quality and introducing latency. A successful, mass market wireless design must be able to transmit and receive the uncompressed digital baseband video signals used by consumer electronics equipment.

With the popularity of all sorts of wireless technologies, the problem of radio interference is increasingly worrisome. In both single family or multi-dwelling homes, the growing use and integration of wireless data networks, headsets, baby monitors, cameras, and other devices risks compromising any wireless multimedia designs. A high definition system must be robust and consistent in the face of competing radio technologies.

WirelessHD technology is focused on reducing the cost and complexity of building wireless into consumer electronics products by building upon existing wired AV interfaces ranging from EIA-861 parallel buses to HDMI. This enables source devices ranging from game consoles, DVD players, to STB's to maintain their role in content decompression, user interface composition, and access control. The full 4Gbps uncompressed baseband video signal should be able to be transmitted through the air at a 10^{-7} to 10^{-9} pixel error rate, then recovered fully intact for display and any further compositing by high definition display devices ranging from flat panel televisions to projector units. In the case of picture-in-picture or multi-display applications, products may either simultaneously use multiple radio subsystems or use a single radio in a time division mode to send lower resolution video to the display device.

Smart antenna technologies including beamforming and beam steering address the coexistence and interference challenges of traditional wireless designs. Instead of broadcasting or receiving radio signals from all directions, WirelessHD technology facilitates the intelligent acquisition and rapid adaption of directed wireless beams with less than 5 degrees of arc in less than 1 millisecond. This means that any given video source focuses all of its wireless energy only in the direction of its intended receiver while an intended receiver electronically points its antenna only in the direction of its intended video source. By quickly adapting the electronic characteristics of its antennas, WirelessHD products maintain their reliability in the face of intervening or moving obstructions and also avoid interference from or with neighboring wireless products.

Questions & Answers

- (Q) What are the distances that can be supported from source to display?
- (A) The vast majority of homes worldwide require no more than 5m from device to device, line of sight. Accounting for the non-line-of-sight nature of 60GHz technology, WirelessHD supports 10m distance from source to source or source to display.
- (Q) How many simultaneous video connections are supported?
- (A) Up to three simultaneous high definition video/audio connections are supported to any particular device.
- (Q) How are picture-in-picture (PIP) and content protection handled in a WirelessHD system?
- (A) The high bandwidth of WirelessHD allows the traditional capabilities of consumer electronics products to be supported in the same way they would in a wired system. For example, PIP from multiple sources to a single display is handled as each source wirelessly (or through a wire, it doesn't matter in a WirelessHD system) sends its signal through its standard WirelessHD transmitter to the display device. The PIP-supporting display then accepts each incoming input through any combination of multiple WirelessHD receivers or wired connectors. Likewise, the content protection systems used for wired digital video connections may be used to protect the frames and pixels of an uncompressed, high bandwidth WirelessHD link.

Usage Case #2: Networked A/V Streaming

Home Theater (HT) Systems, Audio/Video Receivers, Speakers

Summary Requirements

- 13.1 channels of 24-bit 192 KHz compressed Dolby TrueHD or DTS-HD audio, 5.1 channels of 24-bit 96 KHz multi-channel LPCM audio, 2 channels of 192 KHz 2 channel LPCM
- Maximum of 15ms latency between multi-channel links, 5 ms typical
- Device control and monitoring of multiple sources and displays or speakers



Description

Home theater systems with a variety of components, and multi-channel audio systems ranging from DTS NEO to Dolby AC3 5.1 and TrueHD place further demands on in-home wireless distribution systems. Many consumers attempt to ignore this problem by deferring to friends familiar with the latest wiring technologies and topologies, but even this will soon not be enough.

Businesses have wiring closets to deal with the grand tangle of cables necessary to bridge every combination of signal source and destination. The consumer equivalent to this situation consists of the scores of inputs or outputs on the back of every digital television device or AV receiver. While the advent of HDMI and S/PDIF have somewhat simplified these connections for high-definition video and multi-channel, the problem of webbing together multiple sources with displays and speakers remaining daunting for the typical consumer. This often leads to a poor media experience as consumers decline to set up side speakers or limit their source options.

The experience is further degraded with the compression or transcoding latencies typical of many wireless systems. If there is more than 15ms of separation between video and audio, the loss of lip synchronization becomes readily apparent. At even lower latencies, the spatial effects of multi-channel audio systems is significantly degraded or lost altogether. These challenges cannot be remedied by “synchronizing” latency, because many consumers may use a mix of both wired front speakers patched through high quality analog amplifiers, and wireless speakers for surround or rear channels.

WirelessHD Technology figuratively cuts the knot of cables hiding behind every consumer’s home theater system. By logically switching between any combination of source and display device and selecting appropriate signals in mid-air, no additional complexity is introduced as consumers add the latest electronics devices. Furthermore, the inclusion of a wireless audio video control signal with universal translation to and from existing wired protocols enables consumers to readily control one device from another and automatically initiate formerly complex functions such as copying from one device to another by simultaneously playing one and recording another.

The use of a multi-megabit backchannel for both uncompressed and compressed audio, control, and low rate video functions facilitates modern multi-channel designs by supporting the ready synchronization of any combination of wired and wireless speakers with high definition multi-gigabit video.

Questions & Answers

(Q) Which audio formats are natively supported by WirelessHD?

(A) Supported formats include Dolby TrueHD, Dolby Digital Plus, Dolby Digital, Dolby Digital Surround EX, DTS-HD, DTS-D, DTS, DVD-Audio, SACD, and Linear PCM

(Q) Which control methods are supported by WirelessHD?

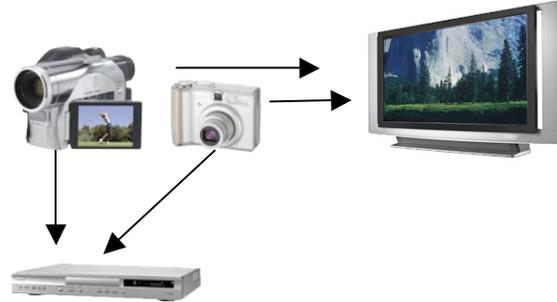
(A) All WirelessHD devices are required to support a standard control protocol for powering on, controlling, and monitoring consumer electronics devices. This protocol is compatible with existing control protocols including Viera Link™, CECBus, and Universal Plug-and-Play. Devices automatically bridge and translate between these wired and WirelessHD's wireless commands.

Usage Case #3: Multimedia Streaming and File Transfer

Digital Still Camera (DSC), Digital Video Camera (DVC), Digital Video Recorder (DVR), Blu-ray Disc Recorder (BD-R)

Summary Requirements

- Multi-way copy-managed communication in both compressed (MPEG2, MPEG4, H.264, et. al.) and uncompressed (EIA-861) formats
- Low power and short range modes with less than 300mW average power consumption
- Multi-device video recording and editing control capability
- On-the-fly resolution and frame rate adjustment



Description

The hassle of cabling up or transferring pictures or video means that people often view their content on the 2.5 inch or smaller displays on their digital still or video cameras. This situation is not optimal now, and will be even less optimal as consumer's recorded content moves to high definition formats.

While it's much better to view or transfer high definition content on a suitable screen, any wireless technology must also mind the low power and small battery requirements of portable source devices.

With WirelessHD technology embedded into digital still and video cameras or any other recording device, one can easily and readily view all recorded content on any nearby high definition display device. In addition, one can seamlessly play audio tracks, background music, or narration on a home stereo while doing so. Consumers seeking a way to store, replay and share access to the growing amount of available digital content may also do so in the form of a WirelessHD-connected media server. With these wireless solutions, consumers can wirelessly record, store and playback their stored video content to any wireless-enabled display device in the home.

Since the underlying technology operates at multi-gigabit speeds, even the largest files transfer in a fraction of the time required by traditional wireless systems. This enables wireless modules to quickly revert to a sleep state, minimizes radio duty cycle, and reduces the impact of wireless on any portable device's battery life.

Questions & Answers

(Q) How does WirelessHD compare to other technologies for wireless communication?

(A) WirelessHD devices operate at data rates up to several gigabits per second. This

can mean longer battery device for many devices as WirelessHD products are able to transfer recorded content such as home DV tapes, and DVR recordings much more quickly than older wireless protocols. This means the radios stay on less often and save more battery life. WirelessHD technology also includes support for transmit power control, and other methods for adapting performance and power for actual range and application requirements.

(Q) How many WirelessHD devices are supported in a single A/V network?

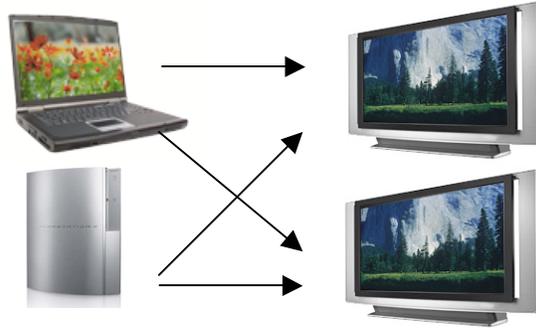
(A) Up to a total of 64 sources, display, and speaker devices are supported in each network. For auditorium, digital cinema, and other industrial applications, multiple A/V networks may be bridged together.

Usage Case #4: Rendered Streaming

Gaming Consoles, Personal Computers

Summary Requirements

- Scalable video/audio capability support, including compatibility with 30-, and 36-bit video, and frame rates up to 100fps
- Extremely low latency mode with direct communication links of less than 1ms
- Multiple color management and gamma control profiles linked to individual source/display pairs



Description

Gaming consoles and personal computers produce some of the greatest demands on any video system. Gamers want play their favorite games on any wireless-enabled TV without unhooking and hooking up any game equipment. Likewise, game consoles can be used on anything from the children's room television to the family's home theater without disturbing any existing equipment. Just designate the source destination and gaming will be available for the entire family to enjoy. Low latency is very important in a video game application. Any latency or mis-synchronization between movement, action or weapons, and the broadband network can be fatal (to the game character, anyway).

Furthermore, game systems are driving the cutting edge with respect to video frame rates and color quality. Third generation systems expect to push the standards from 60 frames per second (fps) to 100 fps or more. These latest systems are also behind the drive beyond 24-bit color to 30-, 36-bits, and beyond.

While compressed wireless has had limited success with existing video designs, they hampered by their ability to scale to the state-of-the-art in high definition video. Their latency and lossiness also hamper or nullify the advances in rendered gaming video.

WirelessHD's firm basis in simple, wideband transmissions and scalable orthogonal frequency division multiplexing (OFDM) enable forward compatibility to the newest high definition video and audio designs.

Questions & Answers

(Q) What are the color depths and frame rate supported by WirelessHD?

(A) The WirelessHD protocol includes support for 24- and 30- bit color initially, and 36-bit color soon after, and frame rates including 15-, 24-, 30-, 50-, 60-, 100-, and 120-Hz. Many current source and display device implementations, however, are limited to 24-bit, 60-Hz support.

(Q) How does WirelessHD scale to future video technologies?

(A) WirelessHD uses a combination of advanced radio signaling and bandwidth management techniques and a unique learning protocol that enables forward compatibility to future requirements including Digital Cinema, 4K, & 5K resolutions.

Conclusion

High definition flat panel displays represent a growing market expected to reach over 40 million units by 2008, driven by the high quality of these displays and their distinct space-saving designs. The aesthetics of these wall-hanging displays are diminished by the need to run audio and video cables across the room to the often numerous A/V sources. Practical and reliable wireless solutions address the installation and usage problems of the new, high definition, multi-channel, multi-device home.

The availability of high definition wireless connections eliminates the morass of switches, HD-capable stereo receivers and other complexities traditionally needed to support the wide variety of devices consumers have and will continue to buy. With high definition wireless links, connecting any source to any display or recorder is dramatically simplified by removing the need for a hard-wired connection.

Consumers no longer have to guess about which cables to buy or plan for a particular physical relationship between their consumer electronics devices. Just place one's source and display device wherever it's convenient and aesthetic. Then, use one's existing remote controls to select which source is shown on the display or heard on the speakers. That's all.

Such a basic idea of simple and reliable high definition connectivity is facilitated by the many technologies that are part of WirelessHD. By bringing together the latest advances in millimeter wave technology, audio/video control protocols, and smart antenna technology, this consumer electronics industry standard is focused on doing all of the hard work necessary to make high quality, high definition multimedia wireless in the home very simple and very affordable.