60 GHz Architecture for Wireless Video Display

Lianne Caetano

March 2006

Introduction

SiBEAM's new 60 GHz millimeter wave radio technologies bring the promise of extremely high data rates with increased reliability and better use of wireless spectrum. SiBEAM's design breakthrough draws upon the multiple antenna capabilities of 802.11n and the simple wideband modulations of Ultra Wideband (UWB) along with the capability of manufacturing using standard CMOS technology. The first set of wireless communication systems is a wireless transport solution for wireless video and audio delivery and control, what we call wireless HD. One example of this would be a DVD player, wirelessly sending audio and video to a high-definition television (HDTV), without compromising picture or sound quality.

SiBEAM chipsets for wireless HD are easy to design in, inexpensive to build and offer secure delivery of content. In addition, SiBEAM's advanced intelligent antenna architecture provides solid reliable connections. This paper reviews the architecture and benefits of the SiBEAM wireless communication system for wireless HD video display.

Easy

SiBEAM's technology natively supports the same video formats and encoding mechanisms included in today's HD video devices, such as 1080i and 1080p. This means that SiBEAM solutions do not have to transcode the video. Transcoding involves transforming existing video formats, often through decompression and recompression, and altering them for transport. This process typically reduces picture quality and increases latency and delivery jitter.

When working with compressed video, it's necessary to intercept the data stream at a very unnatural place - either between source and decoder or between the decoder and renderer. This is shown in Figure 1. This means changing the architecture of a traditional wireless product since these compression and decompression capabilities are highly integrated within a source device, such as a DVD player. This makes this type of wireless technology difficult to design in and it results in compromised picture quality.

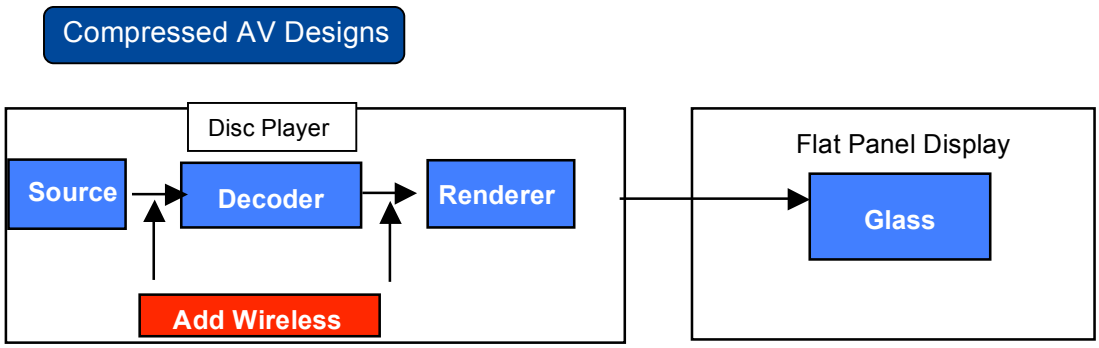

Figure 1

Although the SiBEAM solution can work with compressed data if required, the unique quality about this wireless HD solution is that it allows consumer electronics manufacturers to put the wireless transport where it naturally belongs. In Figure 2, the wireless is dropped in as a substitution for the external cable connection and delivers the video data without the additional overhead and latency of transcoding. In this scenario, SiBEAM does not have to repackage and encapsulate the data in a new format. It takes an existing video connection and directly transcribes it to wireless without compression quality loss or transcoding cycles.

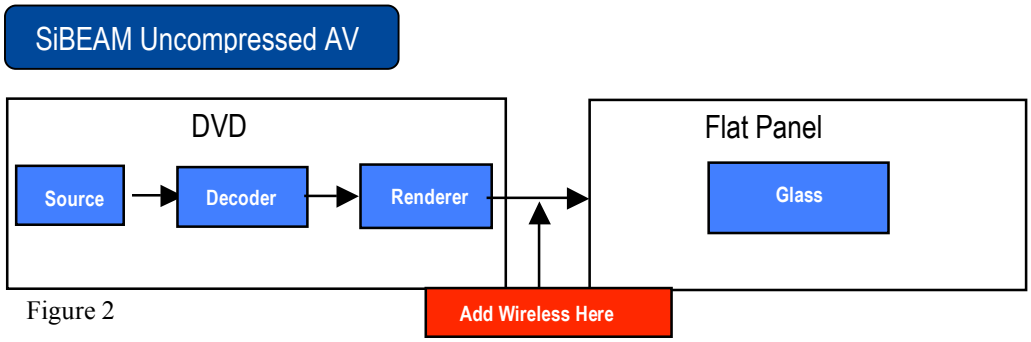

Figure 2

Keeps wireless at the edge of product

Keeps all existing rights management, composition, and video enhancement capabilities, as is

Cost optimized

The opportunity from using CMOS technology to manufacture the chipset provides the highest level of integration, yielding the lowest cost solution. SiBEAM has developed and offers to provide a unique advantage, having rigorously vetted our 60 GHz wireless communications building blocks over five years, thereby eliminating development risks.

While 130 nm CMOS is more common, 90 nm processes are expected to take over by late 2007 to early 2008. At that time, 90 nm would become the lowest-cost process on the market since less chip area and die size drive down price given that less space per wafer is required.

SiBEAM has designed chip scale antennas, which means they are part of the chip itself. We have been able to accomplish this, in large part, because of Friis' Law (see SiBEAM white paper, "Making 60 GHz Work"). Since 60 GHz is such a high frequency, we can achieve sufficient gain with very small antennas. This enables SiBEAM to integrate dozens of antennas as well as the power amplifiers (PAs), low noise amplifiers (LNAs) and baluns. By placing antennas and other components onto the chipsets, SiBEAM reduces board space. In addition, fewer components off of the chip make it easier and cheaper to manufacture.

Another factor that leads to an affordable design is the fact that due to the large channel bandwidth of 60 GHz, SiBEAM can employ simpler modulation techniques. Simpler modulation techniques require a less complex radio design. The reason is that with all of

that bandwidth, fewer bits per hertz (bits/Hz) are required to achieve gigabit speeds. For example, 802.11n, with 40 MHz of channel bandwidth, would require a radio design that delivers 25 bits/Hz in order to achieve a one gigabit data rate, while a 60 GHz millimeter wave system, with 2,500 MHz of channel bandwidth, would require modulation that reaches 0.4 bits/Hz in order to achieve the same. Note that the current 802.11n design goal is able to only achieve 16 bits/Hz resulting in only 630 Mbps of raw data rate. Since SiBEAM does not have to use high density coding mechanisms, we can use less costly components since the silicon does not have to be as precise as in other radios with complex modulation.

Secure Content Delivery

Short for ***h****igh-bandwidth* ***d****igital-****c****ontent* ***p****rotection*, a specification developed by Intel for protecting digital entertainment content that uses the DVI or HDMI interface, HDCP encrypts the transmission of digital content between the video source, or transmitter – such as a computer, DVD player or set-top box, and the digital display, or receiver – such as a monitor, television or projector. HDCP is designed to protect the integrity of content as it is being transmitted.

Implementation of HDCP requires a license obtainable from the Digital Content Protection, LLC, which then issues a set of unique secret device keys to all authorized devices. During authentication, the transmitter will only transmit content once the receiver demonstrates knowledge of the keys. Furthermore, to make eavesdropping and stealing of the data more difficult, the transmitter and receiver will generate a shared secret value that is consistently checked throughout the transmission. Once authentication is established, the transmitter encrypts the data and sends it to the receiver for decryption.

Since SiBEAM chipsets deliver uncompressed video, we preserve the integrity of the existing HDCP system, which is an extremely important quality concern for content providers as well as consumer electronic equipment manufacturers. The fact that HDCP is already approved by Hollywood and is already in use today in HDMI systems makes it even easier for consumer electronics manufacturers to incorporate the SiBEAM wireless solution. In addition, SiBEAM realizes costs advantages relative to more costly content protection solutions, like DTCP, which compressed video solutions are required to use.

Another security feature of SiBEAM's 60 GHz system has to do with the fact that we have pioneered electronic steering of highly directional antennas, which prevents eavesdropping. It is extremely difficult to intercept a directional signal versus an omni-directional wireless connection.

Intelligent Antenna Technology

SiBEAM technology is able to exploit the propagation characteristics and directionality of 60 GHz to overcome any perceived range and line-of-sight limitations. In 60 GHz, when using traditional antenna signals, direct from source to target, the signal *is* significantly attenuated by certain obstructions, such as furniture, but with intelligent beam steering technology, it is possible to dramatically reduce signal losses that would typically be experienced.

When people traditionally look at range and the effects of materials, they usually assume materials weaken, absorb and/or completely block radio waves. When operating at high

frequencies, we observe something else; instead of just blocking radio waves, they actually reflect and/or bounce off of some very dense materials. Those reflections get scattered all over the environment.

SiBEAM is using directionality to its advantage by manipulating the direction of the signal *and* intelligently taking advantage of reflections. This means that the system electronically steers the signal in such a way that the intended receiver can obtain it. When a SiBEAM antenna encounters obstructions in a direct path, between the transmitter and receiver, SiBEAM antennas respond by reflecting the signal off of nearby objects to get to the intended receiver. Much like a game of billiards, when the path directly into the pocket is blocked, players use the pool table borders and possibly other balls to reach the pocket.

Another critical element of SiBEAM technology that overcomes directionality is that it can aim the signal at the intended target, even if the direct path is not the best path. Much like a radar guided missile that can be directed in flight to automatically adjust its flight path to reach the intended target, SiBEAM's electronic beam steering technology accordingly aims at the target and adjusts its path on the fly.

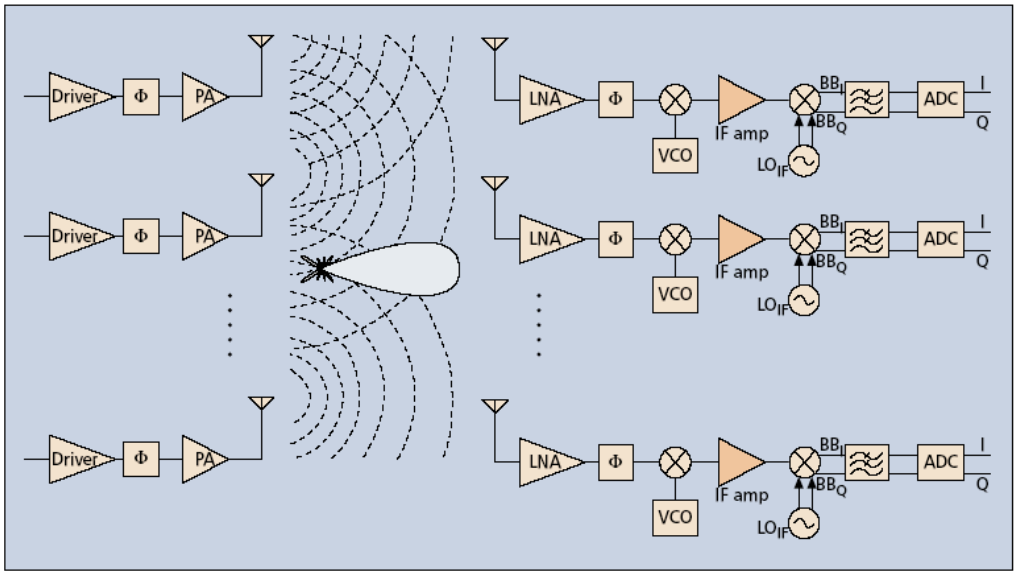

Figure 3: A generic multi-antenna transceiver architecture employing beam steering

SiBEAM antenna beam steering technology continuously sends signals in many directions, captures information about the RF environment and quickly uses the information to send data in the optimal direction. SiBEAM's intelligent beam steering aims the signal and looks for the path that results in the least loss, thereby using both direct and reflected signals to reach the intended recipient with a strong, stable signal.

Conclusion

SiBEAM's technology breakthroughs combine to deliver the optimal technology for wireless HD. SiBEAM's wireless communication system is cost optimized with the use

of standard CMOS technology, chip scale integration and the fact that simpler modulation techniques are required to achieve gigabit-plus data rates. The fact that the majority of components are on one chip makes it more reliable and manufacturable. The 60 GHz frequency brings reliable gigabit-plus signals while complying with the Hollywood-endorsed industry standard for content protection, HDCP. Most importantly, SiBEAM's pioneering intelligent antenna technology delivers strong reliable signals that are able to navigate around obstructions to bring the intended recipient high quality, high definition video.