By Fanny Mlinarsky
octoScope Inc.

It is difficult to imagine a wireless technology with more innovation and dynamism at work than UWB, particularly for the delivery of HD video. After a period of relative quiet in the UWB arena, new products are now emerging to raise the throughput bar.

Testing by octoScope verified that Radiospire's AirHook technology achieved throughput of 1.6Gbit/s—fast enough for uncompressed HD video distribution over distances of 15 feet.

This article will first review the promise and technical challenges facing UWB, report on the most recent test results, and analyze Radiospire's approach to UWB. It will also discuss the throughput and encryption considerations for high-definition (HD) video distribution.

Recent developments

It was less than a year ago that the industry eagerly anticipated the arrival of Certified Wireless USB (CW-USB) and wondered how close real-world systems would come to the advertised 480Mbit/s PHY rate quoted by the technology's trade association, the WiMedia Alliance. Some WiMedia companies were promoting their technologies for video distribution with the help of data compression.

In independent testing conducted by octoScope and published by *EE Times* and *Wireless Net DesignLine*, however, performance of CW-USB chips and systems proved to be disappointing. But the same testbed confirmed that Pulse-Link's CWave technology achieved a 675Mbit/s PHY rate and 500Mbit/s of application layer throughput.

This is where Radiospire took the lead. It remains to be seen how WiMedia and Pulse-Link will respond, not to mention the UWB technology community, which has already taken initial steps toward standardizing a 60GHz technology.

UWB video challenges

UWB operates in the noise floor of traditional wireless applications and is able to share the already allocated spectrum with other services while only negligibly raising their noise floor.

The low transmit power limit of -41.3dBm/MHz Effective Isotropic Radiated Power curtails the range of UWB to about 10m, but the wide available spectrum of 3.1- to 10.6GHz, enables high throughput applications, making

UWB technology well suited for short range HD video transport, connecting devices such as the DVD players, STBs and displays.

After the Federal Communications Commission approved the UWB spectrum allocation in February 2002, the IEEE 802.15 committee attempted to standardize the MAC and PHY layers to operate in the UWB band, but abandoned this effort in January of 2006 for lack of consensus. Many of the companies originally working on the IEEE 802.15 standard joined the WiMedia Alliance and focused on the CW-UWB technology that was evaluated in octoScope's recent EE Times test.

In that test the WiMedia-based products exhibited an order of magnitude lower throughout than Pulse-LINK (675Mbit/s), the only non-WiMedia product tested. Radiospire, another player outside the WiMedia camp, has set a new record of 1.6Gbit/s.

Although WiMedia is regarded as the UWB standard, companies such as Pulse-LINK and Radiospire point out that other MAC and transport standards, such as the IEEE 802.15.3b, TCP/IP and HDMI can also bridge the gap between UWB PHY technologies.

The original goal of UWB was short range HD video distribution. HDMI, in particular, is an uncompressed video interface, requiring more throughput (**Table 1**) than was achievable in the UWB band until Radiospire came along.

Format	Resolution	Bits/pixel	Frames/second	Total uncompressed throughput*
720p	1280 x 720	24	60	1.3 Gbps + audio
1080i	1920 x (1080/2)	24	60	1.5 Gbps + audio
1080p (YCrCb)	1920 x 1080	12	60	1.5 Gbps + audio
1080p (RGB)	1920 x 1080	24	60	3.0 Gbps + audio

***Table 1**: Audio bandwidth varies with the number of channels. 8-channel audo requires 74 additional Mbit/s of transport bandwidth.*

Results

Radiospire's AirHook UWB chipset has demonstrated the highest airlink throughput in the UWB industry of about 1.6Gbit/s. The top device in our recent *EE Times* test, Pulse-LINK's CWave, performed at 675Mbit/s PHY data rate and delivered approximately 500Mbit/s TCP throughput.

WiMedia devices, comprising most of the UWB market, reached around 50Mbit/s application layer throughput. We were unable to verify whether the WiMedia PHY data rate reached the advertised 480 Mbit/s.

The WiMedia vendors claim that the low throughput is due to early driver implementations. The top performing new generation WiMedia chipset from Alereon is expected to reach 160Mbit/s, but this is still an order of magnitude lower than Radiospire's 1.6Gbit/s.

octoScope has verified the 1.6Gbit/s performance of the Radiospire AirHook chipset both on the bench and working as an HDMI cable replacement. The airlink transport of uncompressed 1080p HD video and 8 channel audio worked at 15 feet of range, through obstructions and at any antenna orientation.

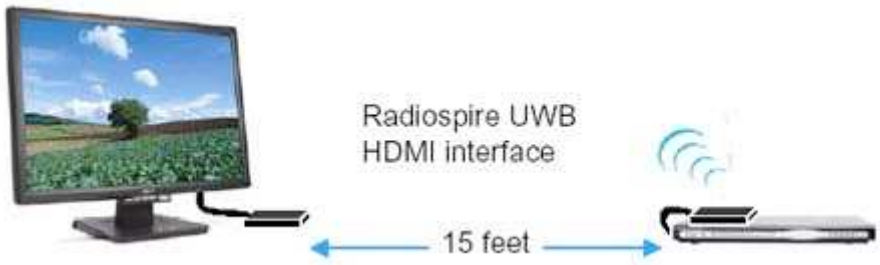

***Figure 1**: Testing verified studio grade performance of the Radiospire wireless UWB based HDMI cable replacement reference design.*

The data converters worked at 1.92GSps with 5.5bit effective resolution. The Radiospire device handled 1.7GHz of bandwidth from 3.1- to 4.8GHz, per design.

The system test setup included two displays placed side by side for a visual comparison of signal quality on the airlink vs. the ideal cabled signal. One of the displays was connected to the video source through an HDMI cable and the other display was connected through the AirHook airlink (**Figure 2**).

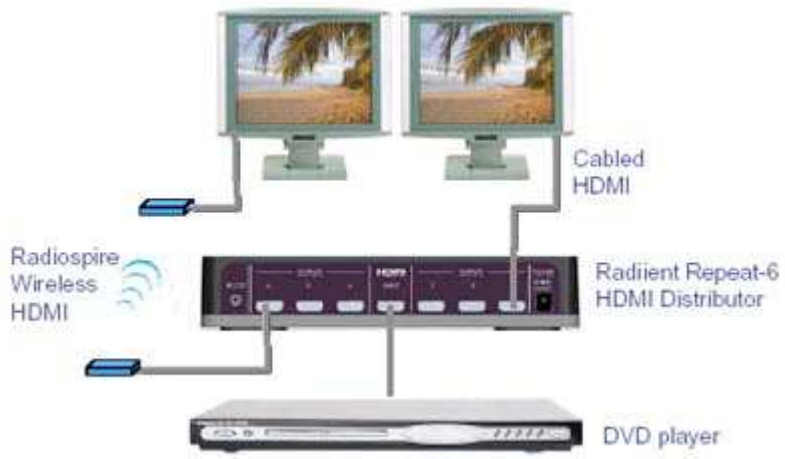

***Figure 2**: Radiospire system test setup—Two displays side by side with one connected through an HDMI cable and the other via the Radiospire UWB link. The Radiient repeater was used to split the HDMI signal into two identical synchronized streams.*

The airlink delivered approximately 1.6Gbit/s at all antenna and device orientations and with humans and furniture blocking the beam. The display quality on the wired and wireless HDMI links was indistinguishable to the naked eye under all test conditions (**Figure 3**). The audio on both displays was synchronized with no perceptible delay indicating low latency on the UWB link.

***Figure 3**: Comparison of the video quality between the wired and wireless links revealed no visible differences under any of the test conditions, for any antenna orientation and with obstructions in the beam.*

The video quality was tested with 2.4GHz Wi-Fi interference (streaming video from a website to a laptop) right next to the Radiospire device and with 900MHz interference from a nearby baby monitor. We have observed no degradation in video quality due to this interference.

We also verified the transmit power at the antenna port of the transmitter for FCC compliance (**Figure 4**). This was intended to be an informal verification.

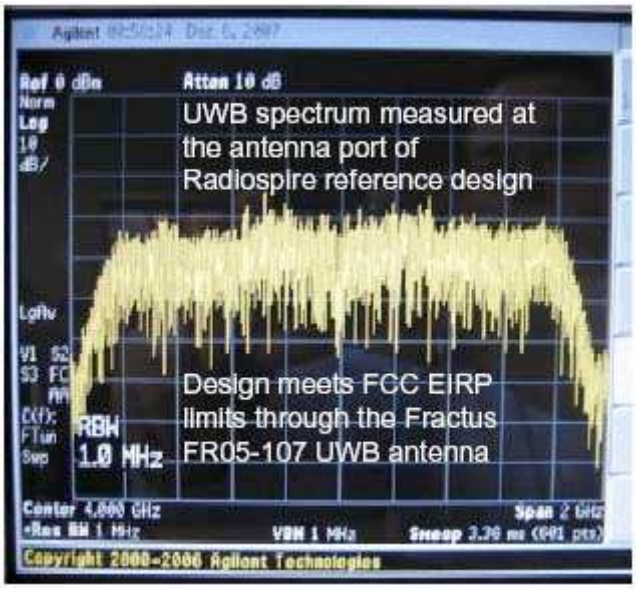

***Figure 4**: Informal FCC compliance verification—Conducted spectrum measurement at the antenna port of the transmitter. The average power at the antenna port is below -40 dBm/MHz and with some isotropic losses through the antenna meets the FCC limit.*

Tables 2 and 3 summarize the tests we have performed and the test results.

Bench-top Tests	
ADC and DAC operation at 1.92 Gsps	√
1.7 GHz of bandwidth	√
Operation at 1.6 Gbps	√
FCC compliance conducted power informal verification	√

***Table 2**: Benchtop verification of the AirHook chipset*

System Tests	With obstructions in the beam	With 802.11 interference	With 900 Mbps interference	At variety of antenna orientations
System operation at 12 ft, 720p, 1.6 Gbps (video quality)	Flawless	Flawless	Flawless	Flawless
System operation at 15 ft, 720p (video quality)	Flawless	Flawless	Flawless	Flawless
System operation at 12 ft, 1080p, 1.6 Gbps (video quality)	Flawless	Flawless	Flawless	Flawless
System operation at 15 ft, 1080p, 1.6 Gbps (video quality)	Excellent	Excellent	Excellent	Excellent
Audio synchronization on both displays	No detectable asynch	No detectable asynch	No detectable asynch	No detectable asynch

Table 3: System verification of the Radiospire AirHook chipset

AirHook review

The Radiospire AirHook chipset implements a UWB point to point airlink with a transmitter on one end and a receiver on the other end. The chipset is composed of three devices on the TX end of the link and three counterpart devices on the RX end of the link (Table 4, Figure 5).

System Tests	With obstructions in the beam	With 802.11 interference	With 900 Mbps interference	At an or
System operation at 12 ft, 720p, 1.6 Gbps (video quality)	Flawless	Flawless	Flawless	Fl
System operation at 15 ft, 720p (video quality)	Flawless	Flawless	Flawless	Fl
System operation at 12 ft, 1080p, 1.6 Gbps (video quality)	Flawless	Flawless	Flawless	Fl
System operation at 15 ft, 1080p, 1.6 Gbps (video quality)	Excellent	Excellent	Excellent	Ex
Audio synchronization on both displays	No detectable asynch	No detectable asynch	No detectable asynch	No det asy

***Table 4**: Table 4: Radiospire AirHook chipset*

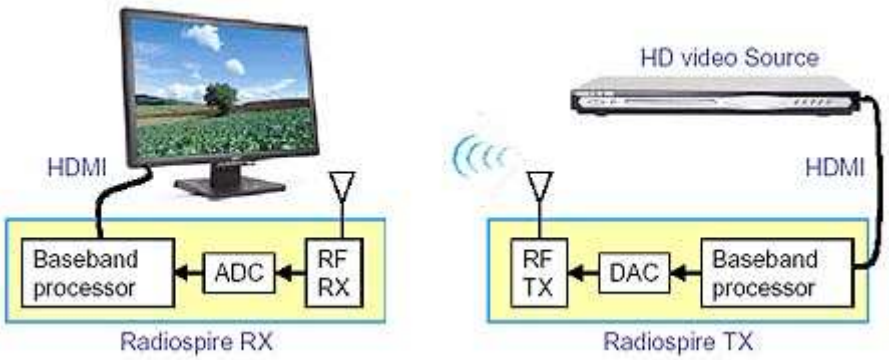

***Figure 5**: Radiospire wireless HDMI solution—UWB TX and RX. The video interface supports almost any standard format including HDMI, DVI, XGA and analog video such as NTSC, composite and S-video.*

The AirHook chipset employs OFDM signaling with 512 carriers using 16-QAM modulation. The spectrum of the RF signal is 1.7MHz wide, from 3.1- to 4.8GHz. The 6bit ADCs and DACs operate at 1.92GSps on an 850MHz baseband signal.

The Radiospire Baseband processor (**Figure 6**) incorporates low density parity check coding (LDPC) FEC functionality—a powerful FEC technology

that significantly reduces bit error rate. While the raw airlink data rate reaches 2.2Gbit/s, the LDPC corrected data rate is 1.6Gbit/s, the throughput required for 1080p HD A/V transport.

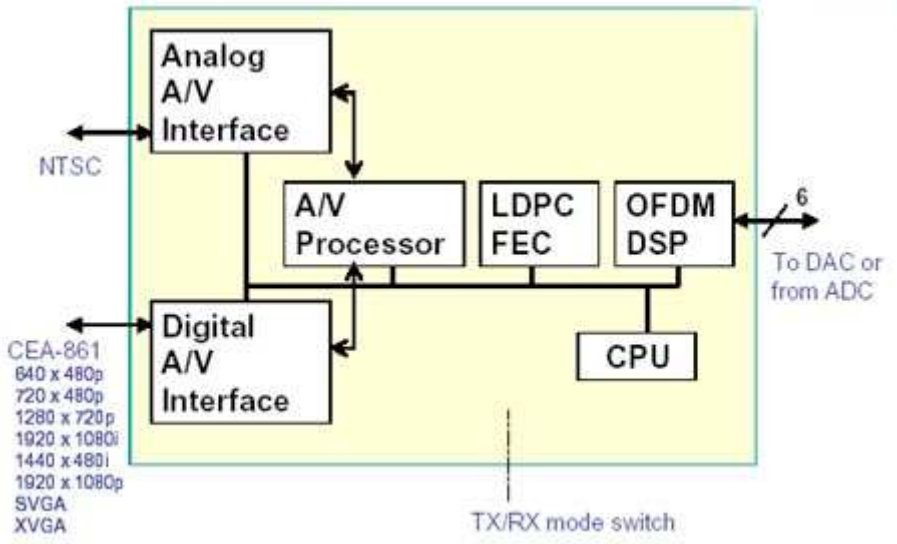

Figure 6: Radiospire baseband processor was able to operate in either transmit or receive mode and interfacing between the video interface, such as the HDMI or the SVGA, and ADC or DAC chips.

The Radiospire ADC and DAC (**Figure 7**) have been segregated into their own 0.35µm SiGe BiCMOS ICs for optimum performance.

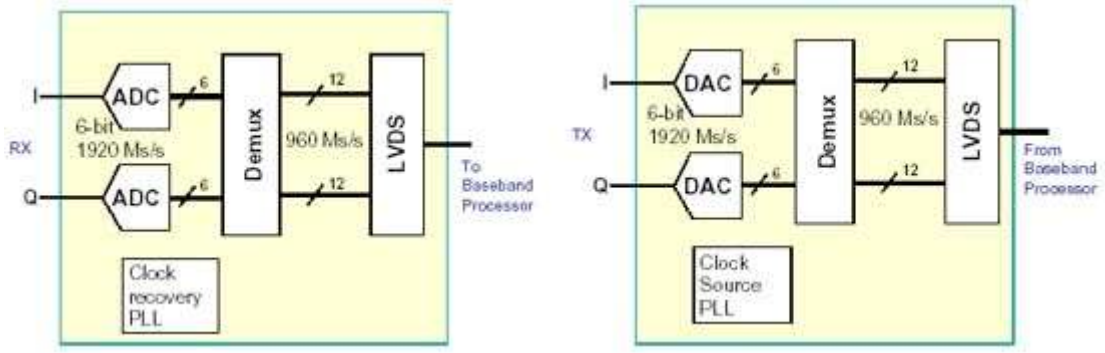

Figure 7: Radiospire ADC and DAC devices interfacing between the RF front end and the baseband processor

The Radiospire RF receiver and transmitter (**Figures 8 and 9**) have also been segregated into their own 0.35µm SiGe BiCMOS ICs to optimize signal integrity and bit error rate performance.

As evident from **Figures 6 through 9**, the clean segregation of the AirHook architecture and focused implementation of each functional block may

explain why Radiospire has been able to reach 1.6 Gbit/s on their UWB interface.

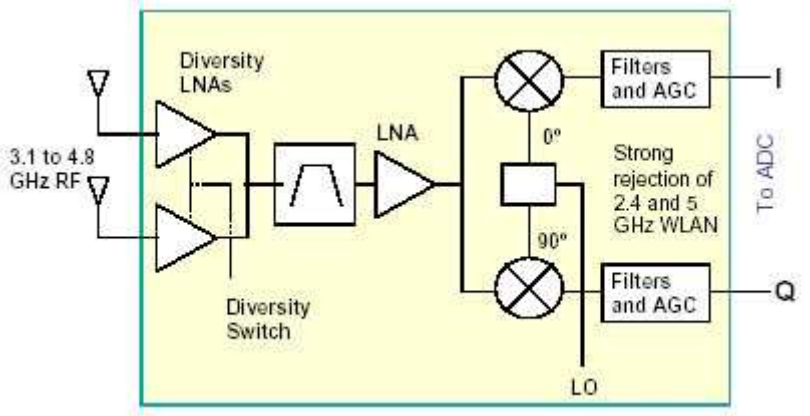

Figure 8: Radiospire RF receiver device interfacing to the ADC

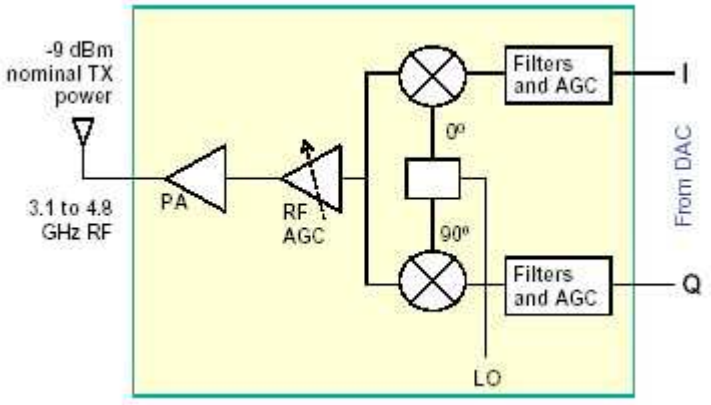

Figure 9: Radiospire RF transmitter device interfacing to the DAC

Conclusion

Following our recent *EE Times* UWB test, we were glad to discover that the throughput performance of UWB now has a new record of 1.6 Gbit/s—performance verified for the Radiospire AirHook chipset.

This is a significant step up from the 675Mbit/s PHY rate of Pulse-LINK's CWave, the winner of our last test and much higher than WiMedia, which delivered around 50 Mbit/s at the CW-USB application layer and now promises around 160Mbit/s with the next generation products.

It is notable that the two highest performing UWB chipsets available today are not based on the WiMedia standard and exceed the verified and expected WiMedia performance by an order of magnitude.

Radiospire is the first to enable uncompressed 1080p HD video transport in the UWB band at a level of throughput that seemed unreachable just a short while ago. While Radiospire's technology can be adapted to the emerging standards based 60GHz band, the UWB solution is the only working solution on the market today.

Radiospire's robust performance at a variety of antenna orientations, in the presence of interference and through obstructions will enable solid and successful UWB based products.

About the author
Fanny Mlinarsky is the president of octoScope, a consulting firm focusing on architecture and performance of wireless data communications systems.