Wireless Audio-visual Interface over UWB

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Abstract

Typically internal mobile LCD display modules are connected to the mobile product baseband PCB with flexible printed circuit board equipped with board-to-board connector. This solution has a drawback of limiting the product concept work to certain solutions that are based on connector size, location, flexible PCB length, bending, etc. in the display module. Also flexible printed circuit board based solutions are not completely optimized from reliability point of view, causing flex circuit board breakings. For the external displays in the PC or Home entertainment market, the cable solution is too expensive and resource demanding. The wireless solution has obvious advantages over reliability, low cost and flexibility. This paper describes a wireless audio-visual interface solution.

1. Introduction

The development of the short range, ultra low power, and high-speed radio technologies makes it possible to replace the wired interconnects and remote display cable with a wireless connection. Based on packet data type of communication, the display control data stream and RGB data stream can be multiplexed into a single serial data channel. By further combining the audio packet to the video data stream, a full wireless audio-visual communication system can be established.

Here is a list of the advantages of having a wireless solution on both electronic interface and mechanics aspects for the mobile LCD display.

Interface:
Proprietary solution → most standardized
Control + data channel → radio
Low speed → 480 Mbps
Non-interoperable → standard device family

Mechanics:
Big connector → connector free
Fragile flexi cable connection → cable free
Excessive discrete circuitry → less components
Complex PCB routing → less wires

Wireless solution not only solves the existing problems in the current wired solution, but also adds mobility to the display unit. That results in a new set of the applications around the display technology area. The display becomes intelligent device beyond its traditional function as an attached peripheral device only. New applications such as: display docking station (home-car-office), wearable display, internet tablet, wireless video streaming, wireless visual device etc. can well be realized with the wireless display solution.

A very high speed Wireless Personal Area Network (WPAN) can be established by using Ultra Wide Band (UWB) radio technology developed under IEEE802.15.3a [3]. Due to its low transmit power; the application range is limited to 10 meter at 100 Mbps and less than 3 meter at its peek speed of 480 Mbps. Compared to other WPAN radios, Ultra Wide Band can offer 50 to 500 times greater data rates than current Bluetooth. It is envisioned to replace high-speed cables and audio-video connections in homes and offices.

Many display devices are equipped with either analog or digital audio-visual interfaces for displaying the contents from the storage devices or other image sources. Replacing those ports with a universal wireless plug-and-play radio port would add a new dimension into the user experience.

This paper proposes a standard wireless audio-visual interface over UWB, which would benefit both the display vendor and device manufacturer to have a common interface to interoperate with each other.

The rest of this paper is organized as following: Section 2 describes in detail the traditional way of doing audio-visual interface. The wireless audio-visual interface (WAVI) concept and its packet formation are presented in Section 3. Section 4 gives a proposal for WAVI standardization in connection with the WiMedia standardization committee. Section 5 describes the WAVI use case. Finally, the conclusions are drawn in Section 6.

2. Existing Audio-visual Interfaces

Video devices like TV set, VCR, DVD player, PC monitor, projector etc. are equipped with audio-visual cable connectors. Standard interfaces such as, S-video, SCART, composite AV, DVI and most recently HDMI are used to run the video application between the video source and the display unit. The data type for all above-mentioned interfaces can be categorized into

either Y/C or RGB. In this section, the S-Video and DVI standard are introduced to differentiate the two video data type.

S-Video, short for Super-Video is a technology for transmitting video signals over a cable by dividing the video information into two separate signals: one for color (chrominance), and the other for brightness (luminance). When sent to a television, this produces sharper images than composite video, where the video information is transmitted as a single signal over one wire. This is because televisions are designed to display separate Luminance (Y) and Chrominance (C) signals. (The terms Y/C video and S-Video are the same.)

DVI, short for Digital Visual Interface, is a digital interface standard created by the Digital Display Working Group [2] to convert analog signals into digital signals to accommodate both analog and digital monitors. Data is transmitted using the transition-minimized differential signaling (TMDS) protocol, providing a digital signal from the video source subsystem to the display. The standard specifies a single plug and connector that encompass both the new digital and legacy VGA interfaces, as well as a digital-only plug connector.

RGB interface includes both analog and digital RGB. The conversion from analog RGB to digital RGB is not in the scope of this paper and all the discussions concerning RGB interface here are based on the digital RGB interface.

Figure 1 shows a wireless AVI system connecting both the internal display (Display) and the external display (TV). Here the display interface is replaced by a radio interface or more accurately, the radio interface is added to the previous system.

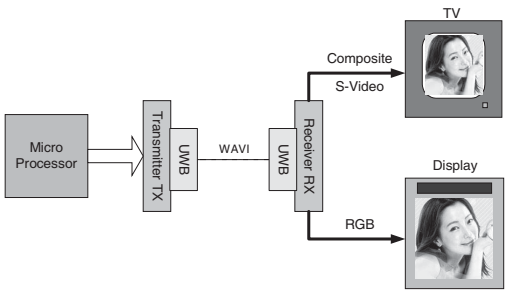

Figure 1 Wireless AVI for internal and external display

In the wireless AVI approach, the glue protocol between the UWB and audio-visual interface is a key fact for the success and smooth communication throughout the entire system. A well-defined link layer protocol inside the audio-visual interface is necessary to guarantee the smooth transition to the wireless interface.

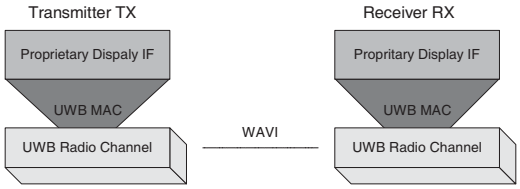

Figure 2 WAVI proprietary protocol architecture

Figure 2 shows a proprietary wireless audio-visual interface protocol solution where the audio-visual interface sits on top of the UWB MAC layer; it transmits and receives data to/from UWB MAC layers. The detailed data packet formation methods of this proprietary solution will be discussed in section 3 and further development of WAVI solution to the standardization will be discussed in section 4.

3. Wireless AVI Packet Formation

The Packet formation is very important for a wireless communication. As mentioned earlier, a well-defined set of packets would enable the smooth transmission in between different layer of protocols. In WAVI case, there is a link protocol in wired interface standard and MAC protocol in the radio system. The question is how to glue these two protocols into one sophisticated solution that would sever the purpose of a wireless audio-visual interface concept. It is not the intention of this paper to give a full solution of a WAVI protocol, rather to give some thoughts and references concerning the construction of a WAVI system. Here MDDI link layer is used as an example of wired audio-visual protocol and UWB is used as a radio interface.

In MDDI [1] specification, the link layer defines following packet type: link control packets, basic media stream packets, client status and control packets and advanced graphic and display packets.

The UWB MAC layer service function includes: networking, control algorithms, channel selection, synchronization, data communication, security, power management, range measurement and application-specific command management.

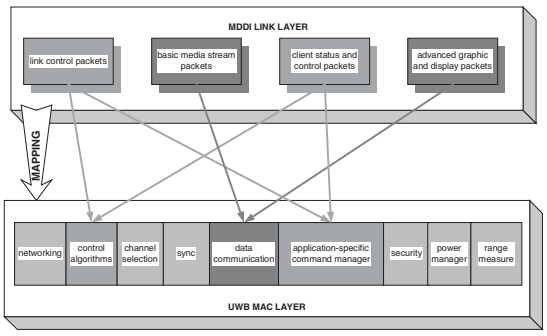

Figure 3 MDDI link layer to UWB MAC layer mapping

Figure 3 shows a packet mapping mechanism from MDDI link layer to UWB MAC layer. Since MDDI is originally designed for the wired connection, some of the link layer functions are obviously not fit to the wireless communication. Functions reside in particular to the "link control" and "client status and control" area need to be either merged into the UWB functionality or modified to fit in a wireless communication.

Synchronization is probably the most difficult field that requires careful plan during the protocol mapping. The channel synchronization in a wireless system is much more complicated and its latency is far more significant compare to a wired system due to its clock recovery process. The video frame synchronization is even more difficult to realize through the air interface if the same synchronization profile as in the wired connection would be used. So there is a need to develop an advanced algorithm, which could handle both the channel synchronization and frame synchronization. The channel synchronization in the WAVI case is handled by UWB radio interface. Since it is difficult to do the frame synchronization based on the transmitted synchronization profile, one way to solve this problem is to use independent synchronization scheme.

The independent synchronization doesn't rely on the transmitter to send the entire synchronization bits; instead it receives only the information of the frame size and its data. With its own device profile, it accomplishes the task of frame synchronization by generating the synchronization profile by itself. Once there is need to scale the image size, for example in the remote display case, it will handle the scaling also by itself. This approach gives the transmitter lots of freedom to form a video frame, it can either request the receive display profile before the formatting of the video frame or independently send the video frame whatever the size it can offer. On the other hand, the receiver has all the intelligence and resources to form an optimized display unit.

4. WAVI Standardization Proposal

WiMedia [4] is a leading industry alliance in UWB development. It specifies convergence architecture to provide coexistence and fairness including support for multiple applications that covers both high speed and low speed short range communications.

WAVI has a good potential to become a member of the WiMedia legacy connectivity platform as shown in Figure 4. It provides a multimedia contents delivering and sharing methodology and it offers great potential to develop new applications in the multimedia communication area.

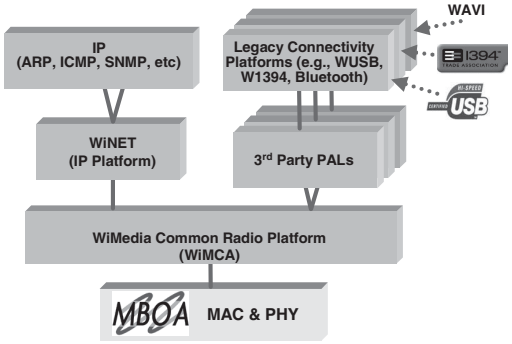

Figure 4 WiMCA standard protocol architecture

5. Wireless AVI Use Case

In this section, we provide two use case scenarios .

A. Wireless Home Theater

Digital home is a hot topic these days; it changes the way people live in their ordinary life. Home theater is one concept representing the change of entertainment style of many people.

With more and more electronic devices coming into people's life, connecting those devices to make best use of them becomes a challenge task for the electronics industry. Wireless connection has its obvious advantage over the cable connection and yet it gives more possibilities to launch new applications of the digital home concept.

Table 1 shows a bit rate requirement for a very basic home theater system. The video consumes most of the bandwidth and the 3-channel audio consumes only 0.1% of the whole bandwidth. By placing a WAVI enabled AV receiver, DVD player or a mobile phone as a video server, through an S-Video/WAVI or DVI/WAVI Dongle the video can be streamed to the

HDTV or the projector. The speaker is usually connected with composite audio video connector, so the composite AV/WAVI dongle can be used to make the voice connection to the speaker.

	Interface	Rate (Mbps)
HDTV/Projector	S-Video-DVI/WAVI	98.304
3D speaker	Composite AV/WAVI	0.1344
Total Rate		98.4384

Table 1 Typical video bandwidth requirements

B. GPS Navigation System

The GPS (Global Positioning System) is already implemented in mobile phones nowadays. The most popular application of the GPS is the car navigation system. Since most mobile phones have small displays, the phone navigation system may not offer great help to the car driver visually. A big external display must be used in order to make the best use of the system.

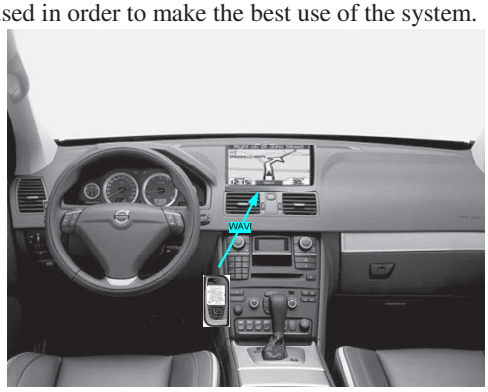

Figure 5 WAVI/GPS navigation system

Figure 5 shows an example of a GPS car navigation system. The phone has a GPS navigator. Its navigation contents are further delivered to a bigger screen in front of the driving seat over the UWB WAVI link. All the contents are synchronized in real time from the phone to the display.

6. Summary

In this paper, a wireless audio-visual interface was introduced. It uses UWB radio technology to achieve high bit rate video application. WAVI provides in-room video connectivity; remove the barrier of cabling and offers customer greater flexibility. It is revolutionary technology that will play important role in both the display industry and mobile industry. Multimedia contents sharing and delivering will ever be easier by using the WAVI technology. The display vendors, device manufacturers and users should all be able to benefit from the WAVI industrial standard once it becomes reality.

It is worth to mention, although the security and privacy issue is not discussed in this paper, the author is aware of the importance of the issue and believes it will be solved with the further development of the technology. The existing encryption technology in varies wireless communication systems can well be applied to the WAVI concept.

7. References

[1] VESA Mobile Digital Interface Standard. © Copyright 2002-2004 Video Electronics Standards Association, www.vesa.org
[2] Digital Display Working Group, www.ddwg.org
[3] IEEE Standard 802.15.3a, www.ieee.org
[4] WiMedia Alliance. © Copyright 2005 WiMedia Alliance, www.wimedia.org
[5] Robert L. Myers, “Display Interface Fundamentals and Standards” Copyright © 2002 John Wiley & Sons Ltd.