Extending Network Domain for IEEE1394

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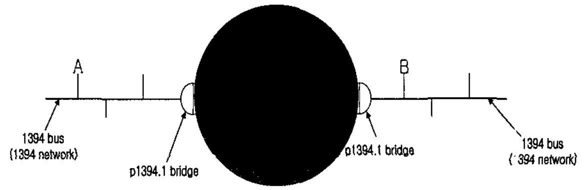
***Abstract*—Wireless 1394 over IEEE802.15.3 must allow a data reserved for delivery over a wired 1394 network to be delivered over an IEEE802.15.3 wireless network through bridging IEEE 1394 to IEEE802.15.3. Isochronous transfers on the 1394 bus guarantee timely delivery of data. Specifically, isochronous transfers are scheduled by the bus so that they occur once every 125 µs and require clock time synchronization to complete the real-time data transfer. IEEE1394.1 and Protocol Adaptation Layer for IEEE1394 over IEEE802.15.3 specify clock time synchronization for a wired 1394 bus network to a wired 1394 bus network and wireless 1394 nodes, which are IEEE802.15.3 nodes handling 1394 applications, over IEEE802.15.3. Thus, the clock time synchronizations are just defined within a homogeneous network environment like IEEE1394 or IEEE802.15.3 until now. This paper proposes new clock time synchronization method for wireless 1394 heterogeneous networks between 1394 and 802.15.3. If new method is adopted for various wireless 1394 products, consumer electronics devices such as DTV and Set-top Box or PC devices on a 1394 bus network can transmit real time data to the AV devices on the other 1394 bus in a different place via IEEE 802.15.3.**

Index Terms - 1394.1, Protocol Adaptation Layer, Synchronization,Cycle Time, IEEE1394, IEEE802.15.3

I. Introduction

Wireless communication technologies have led to a significant interest in future home networking due to its advantages such as simplicity for networking and low cost for maintenance. The introduction of an audio and a video promises to create a new market for multimedia home networking technology with the large number of multimedia home network households. IEEE802.15.3 is designed to enable wireless connectivity of high-speed, low-power, low-cost multimedia-capable portable consumer electronic devices. While most home networks today can carry audio with little difficulty, a video requires more bandwidth and Quality-of-Service(QoS) guarantees. IEEE1394 is the most viable standard for making multimedia home networking providing high bandwidth and isochronous, or real-time, data transfer in a peer to peer network. Thus, IEEE1394 and IEEE802.15.3 can be two standard technologies for a future wireless multimedia home network. In order to combine the two network technologies for an isochronous data transfer, clock time synchronization is the most important issue that needs to be solved. The draft IEEE1394.1 bridge specification just defines clock time synchronization method for two or more wired 1394 bus networks and the wireless PAL specification defines clock time synchronization for nodes using 1394 applications within IEEE802.15.3 network. However, since the wireless 1394 specification may support real time data transfer between the two different logical networks, we also need clock time synchronization method between them; IEEE1394 and IEEE 802.15.3. In this paper, we propose clock time synchronization method for wireless 1394 heterogeneous network scenario like **Figure 1** to complete an isochronous data transfer.



II. Overview of Clcok Synchronization

A net is a collection of 1394 buses interconnected by bridges. Each bus has a single cycle master that provides uniform cycle time to that bus, a net requires a single cycle master to provide cycle offset for the entire net. This singular cycle master is called as the Net Cycle Master. Net cycle offset originates at the net cycle master and is distributed throughout the net by bridges. It is the way to synchronize entire 1394 buses. In IEEE802.15.3 network, PNC(piconet coordinator) provides the basic timing for the piconet, which is a wireless ad hoc data communication system, and the PNC also acts as a net cycle master for wireless 1394. Wireless1394 has a logical bus called virtual 1394 instead of a physical 1394 bus. Wireless 1394 coordinator is a device that administers the virtual 1394 bus within a piconet. One wireless 1394 device within a piconet becomes the wireless 1394 coordinator and instantiates a virtual 1394 bus; the wireless 1394 coordinator is co-located with a PNC. Thus, the wireless 1394 coordinator is responsible to broadcast bus and cycle time periodically with beacons to maintain network synchronization. The beacons contain network information elements including piconet synchronization parameters. Each node in the piconet is controlled by the network information of the beacons. Wireless1394 nodes have their own cycle timers and they adjust their cycle time to that of wireless 1394 coordinator through a beacon frame. Wireless 1394 nodes are in a piconet, even though they use applications developed for wired 1394. So it is reasonable for using synchronization method of IEEE802.15.3. Normally wireless1394 will let consumers easily connect 802.15.3 wireless electronics components using 1394 applications to each other and to the wired 1394 home entertainment network. However, wireless1394 does not specify a specific synchronization method between IEEE1394 bus network and IEEE802.15.3

network. In other words, there is no way to inform IEEE802.15.3 network of the network cycle time of entire wired 1394 buses. Therefore we need a new clock time synchronization method to combine the two different networks for a multimedia data transfer.

III. NEW CLOCK SYNCHRONIZATION

The procedure of proposed clock synchronization is shown in **Figure 2** below. The cycle master of a 1394 bus generates the periodic cycle start packet and adjusts bus network cycle time. Wireless 1394 bridge consists of two portals for wired and wireless connection and is a member of both wired 1394 bus and 802.15.3. One portal of wireless 1394 bridge notifies wireless 1394 coordinator of time adjustment made by the other portal. The time adjustment is dependent on the cycle start packet from the cycle master of a 1394 bus. Cycle start packet indicates the start of an isochronous period for a real time data on the 1394 bus. In 802.15.3, time adjustment with a wireless 1394 bridge shall be transmitted as an application specific information element(ASIE) within each beacon. Wireless 1394 coordinator broadcast the beacon periodically. Now we can maintain single clock time between first wired 1394 bus and IEEE802.15.3. At the last step, the second wireless 1394 bridge just does the same thing as the first wireless 1394 bridge does. One important thing for this new method is that as least one of the portals of each wireless bridge has to be a cycles master to ensure network wide clock time synchronization. Therefore, one portal of the first wireless 1394 bridge provides wireless 1394 coordinator with a network cycle time for 802.15.3 and one portal of the second wireless

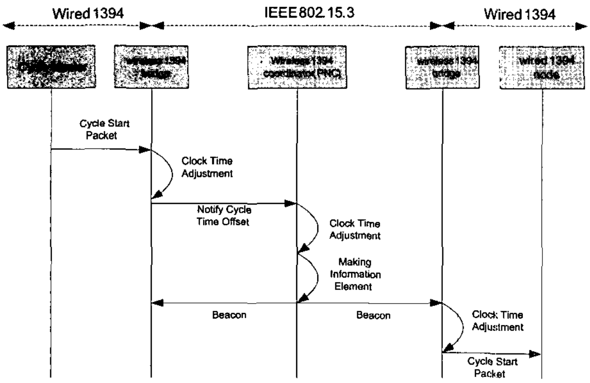


Figure2. Procedure of a clock synchronization for IEEE 1394 and IEEE802.15.3

1394 bridge provides the second wired 1394 bus with entire bus cycle time. Each procedure showed in **Figure 2** deploys propagation delay of a proper frame for a clock time adjustment.

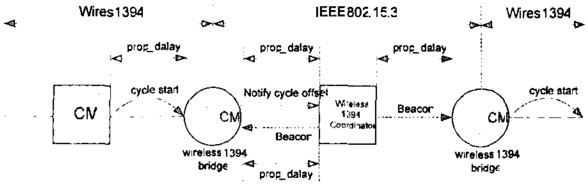


Figure3. Clcok time adjustment

Figure 3 above shows clock time adjustment. Cycle masters for each network are marked CM. Entire clock time between the two networks may be calculated by the following formula:

(1) first wired 1394 bus time = Cycle offset of first cycle start + propagation delay of first cycle start packet

(2) 802.15.3 network time = **(1)** + propagation delay of notification packet + coordinator internal processing time(generate information element) + propagation delay of beacon.

(3) second wired 1394 bus time = **(2)** + propagation delay of second cycle start packet

Thus, entire synchronized time is obtained by three formulas above. Each bridge portal and wireless coordinator measure the propagation delay between themselves and the cycle masters by means of packet size and network speed. Once all procedure have been done, Source nodes on the first wired 1394 bus can transmit real time data to destination nodes on the second 1394 bus via IEEE 802.15.3 network.

IV. CONCLUSION

We described a specific method for clock time synchronization between IEEE1394 and IEEE802.15.3. New synchronization method may allow home network domain to be extended to multi-cluster domain in different places for a real time data transfer. Thus, PC cluster using 1394 applications can communicate with AV cluster for 1394 in other space over 802.15.3. Many AV vendors may adapt this new synchronization method to their products to improve device interoperability for a real time data in a future wireless multimedia home network.

REFERENCES

[1] IEEE Std. 1394-1995, "IEEE Standard for a High Performance Serial Bus" 1995

[2] IEEE P1394.1/D2.0 Draft Standard for High Performance Serial Bus Bridges. February 2004.

[3] Working Draft for Protocol Adaptation Layer(PAL) for IEEE 1394 over IEEE 802.15.3 April 2004.

[4] Javier del Prado, Sai Shankar N and Sunghyun Choi, "Multemedia Clock Synchronization over IEEE 802.11 WLAN" Philips Research USA and Seoul National University, Seoul, Korea 2003.

[5] IEEE Std. 802.15.3, "IEEE Standard for Wireless Medium Access Control(MAC) and Physical Layer(PHY) Specifications for High Rate Wireless Personal Area Networks(WPNs)" 2003.