IEEE802.11a Based Wireless AV Module (WAVM) with Digital AV Interface

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Outline

• Background
• Key techniques
  – Timing jitter removal function for MPEG2 TS data
  – IR command path-through
  – IIC I/F function
  – Status consistency control
• Block diagram
• Experiment results
• Conclusions
Background

- Enhancement of IEEE802.11 standard is continuing.
  - b, g, a, e, h, i, n and so on...
- WLAN became very popular for PC applications.
- Wireless feature is attractive for non-PC applications.
  - VoWLAN
  - Wireless Audio/Video(AV) transfer
- PC peripheral WLAN equipments are not directly applicable to the non-PC applications.
- AV application requires the AV specific capability.
- WAVM (Wireless Audio / Video Module)
  - Specific LSI equipped with AV I/Fs has been developed.
  - Proprietary protocol is defined for the AV data transmission because the standardization is not finalized yet.

Target Application

- Robust data and low latency transmission.
- Jitter removal caused by WLAN.
- IR command pass-through function.
- Status consistency control between WAVMs.
Key Techniques of WAVM

- Jitter removal function for MPEG2 data.
- IR remote control signal pass-through.
- IIC bus interface.
- Status consistency control.
- Module partitioning.
- WAVM architecture.

Jitter Removal Function

The timing jitter at the WLAN output is inevitable.

Causes of timing jitter
- Transmission retry of WLAN.
- The queue management of the MAC (Medium Access Control).
- Bit rate control according to the radio quality.

The MPEG2 TS decoder requires that the variation of delay time should be suppressed within 500nsec.
Jitter Removal Function (Cont’d)

<Transmitter side>
- MPEG2 TS Data
- Add Timestamp
- Counter value
- Internal counter
- WLAN
- 27MHz

<Receiver side>
- Internal counter
- Counter value
- compare
- Time stamp
- MPEG2 TS Data
- Buffer Memory
- WLAN
- 27MHz
- The received data is stored so as to absorb the timing jitter.
- The MPEG data is output when the time stamp value equals to the internal counter value.

MAC parameters are optimized.

Synchronization

Because of the frequency offset between the transmitter and the receiver, the synchronization function is needed.

The acceleration / deceleration control is performed by controlling the counter value, according to the total amount of the stored MPEG2 packets.
IR Remote Control Signal Pass-through

Broadcast Television

VCR

DVD Player

IR system cable

AM-modulated remote control signal

Non AM-modulated remote control signal

Audio / Video

WAVM

Monitor (LCD, PDP)

IR commands

Over-sampling data of the IR command signal.

Any IR remote controller can be used.

Example of IR Signal Waveform

G-code transmission (TOSHIBA VCR remote controller)

This signal is over-sampled continuously and packetized.

IR original signal

Packetized

WLAN

Received packet

Regenerated signal

Station side

IR signal waveform is reproduced at the station side.
WAVM has two types of IIC bus I/Fs which are designed to be appropriate for each purpose.

IIC Bus I/F 1
- WAVM control
- WAVM status read
- Command write

IIC Bus I/F 2
- Dedicated data path between station / monitor system CPUs

Station
System CPU
IIC I/F1
IIC I/F2
WAVM

Monitor
System CPU
IIC I/F2
IIC I/F1
WAVM

IIC Bus I/F 2
The IIC bus I/F2 is designed so as to fit the packet data transmission.

- By using IIC bus I/F2, the transmission efficiency is improved.
- Large capacity data transmission is possible.
- The packet size is defined by the register of the IIC I/F1.
Even though the command packet is lost, the status of the monitor is synchronized to the status of the station because the status information is periodically transmitted.

### MPEG Rate Setting (Automatic-mode)

1. User selects the mode by OSD menu.
2. CPU sets the automatic-mode (by the command).
3. Adaptive control based on radio quality starts.
4. Rate change request message
5. TC35672 sets MPEG encoding rate.

WAVM always shows the status by the register.
Key Techniques of WAVM

- Jitter removal function for MPEG2 data.
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- IIC bus interface.
- Status consistency control.
- Module partitioning.
- WAVM architecture.

Module Partitioning

The appropriate I/Fs are selected to apply a wireless function into the existing TV set.
Embedded CPU controls all the function of WAVM

AV specific functions

SDRAM

TC6405 (AV Specified I/F LSI)

TC35672 (BB LSI)

Flash ROM

PA

TB32152 (RF IC)

TA32151 (IF IC)

RF Out

SW

Video

ITU-R BT.656

Audio

PCM Audio (IIS Available)

IIC Bus

IR Remote Control

AV specific digital I/Fs

Embedded CPU controls all the function of WAVM

Video

ITU-R BT.656

Audio

PCM Audio (IIS Available)

IIC Bus

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AV specific digital I/Fs

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Block Diagram of WLAN BB LSI

Chip Features

WLAN LSI(TC35672)
- Process: 0.18um CMOS 6layer metal
  (Random: 1.27Mgates, Memory: 4.29Mbits)
- Chip Size: 10.9 x 10.9 mm
- Package: 361pin PFBGA (Plastic Fine pitch Ball Grid Array)
- Supply Voltage: Core: 1.5V, Analog: 2.5V, I/O: 3.3V
- Frequency: 20/40/80MHz

AV I/F LSI(TC6405)
- Process: 0.18um CMOS 5layer
  (Random: 251Kgates, Memory: 1.63Mbits)
- Chip Size: 7.1 x 7.1 mm
- Package: 217pin PFBGA (0.8mm pitch)
- Supply Voltage: Core: 1.5V, I/O: 3.3V
- Frequency: 27/33MHz
WAVM Features

- Wireless audio/video transmission
  - Timing jitter removal to satisfy MPEG2-TS delay spread
  - WLAN parameters are optimized for AV data transmission.
  - Using clear 5GHz band WLAN (suitable to the home application)
  - Packet by packet selection antenna diversity.
  - High performance super heterodyne radio architecture.
- Easy-add-on to an existing TV system.
- All-in-one module including an MPEG2 encoder/decoder LSI
  - Embedded CPU in BB LSI controls all the function of WAVM.
    - No additional CPU is used in WAVM.
  - AV I/F LSI equipped with the AV specific function and I/Fs.
  - Status consistency control.
- Small size
  - 70 x 100 x 11 mm

Air-transmission Examples

- Measurement Condition (closed meeting room)
  - Station
  - Monitor
  - Through four steel boards
  - Tx power is reduced for severe condition (set to 0dBm).

<table>
<thead>
<tr>
<th>Radio PHY Rate</th>
<th>MPEG Encoding Rate</th>
<th>Normal condition</th>
<th>Severe condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Mbps</td>
<td>14.4 Mbps</td>
<td>○</td>
<td>×</td>
</tr>
<tr>
<td>12 Mbps</td>
<td>6.0 Mbps</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6 Mbps</td>
<td>2.7 Mbps</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Even the 24Mbps result under severe condition, the result may be improved if antenna arrangement is optimized.
Conclusions

- WAVM achieved all the necessary features for home AV application.
  - Simplest wireless function extension into the conventional TV set.
  - All-in-One module including an MPEG2 Encoder/Decoder LSI.
  - Provides AV specific function.
  - Rapid wake up.
  - Short latency control (Ex. tuner ch. change time).

- Future plan
  - Digital HD (High Definition) stream transmission with secure content protection.
  - AV transmission protocol standardization.

Pier5 LSI