DTCP Volume 1
Supplement G
Mapping DTCP to WirelessHD
(Informational Version)

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Preface

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Volume 1 Supplement G DTCP Mapping to WirelessHD

V1SG.1 Introduction
This supplement maps DTCP onto WirelessHD. All aspects of IEEE 1394 DTCP functionally except those described in Appendix D are preserved and this supplement only details WirelessHD DTCP specific changes or additions.

V1SG.1.1 Related Documents
This specification shall be used in conjunction with the following publications. When the publications are superseded by an approved revision, the revision shall apply.
- Digital Transmission Content Protection Specification Volume 1 and Volume 2
- WirelessHD Specification

V1SG.1.2 Terms and Abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTB</td>
<td>Channel Time Block</td>
</tr>
<tr>
<td>DTCP-WirelessHD</td>
<td>DTCP volume 1 Supplement G</td>
</tr>
<tr>
<td>RTT</td>
<td>Round Trip Time</td>
</tr>
<tr>
<td>STID</td>
<td>STation IDentifier</td>
</tr>
<tr>
<td>WVAN</td>
<td>Wireless Video Area Network</td>
</tr>
</tbody>
</table>
V1SG.2 Modifications to 4.2.3.2 Extended Format Fields (Optional Components of the Device Certificate)
For WirelessHD, the optional content channel cipher for AES-128 is not used.

V1SG.3 Modifications to Chapter 5 Restricted Authentication
Restricted authentication is not permitted for DTCP-WirelessHD transports.

V1SG.4 Modifications to Chapter 6 Content Channel Management Protection

V1SG.4.1 Modifications to 6.2.1 Exchange Keys
DTCP-WirelessHD requires only a single exchange key for all defined EMI Modes.

V1SG.4.2 Modifications to 6.2.2.2 KC for AES-128
The Content Key (KC) is used as the key for the content encryption engine. KC is computed from the three values shown below:
- Exchange Key KX where only a single exchange key is used for all defined EMI Modes to protect the content.
- Seed for content channel NC generated by the source device which is sent in plain text to all sink devices.
- Constant value Ca, Cb, Cc which corresponds to EMI Mode.

The Content Key is generated as follows:

\[ KC = J-AES(K_X, f[Ext || EMI], NC) \]

\[ f[Ext || EMI] \]

- \( f[Ext || EMI] = C_a \) when (Ext = 02 || EMI = 112) = Mode A
- \( f[Ext || EMI] = C_b \) when (Ext = 02 || EMI = 102) = Mode B
- \( f[Ext || EMI] = C_c \) when (Ext = 02 || EMI = 012) = Mode C

<table>
<thead>
<tr>
<th>EMI Mode</th>
<th>Ext bit Value</th>
<th>EMI bits Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode A</td>
<td>02</td>
<td>112</td>
<td>Copy-never (CN)</td>
</tr>
<tr>
<td>Mode B</td>
<td>02</td>
<td>102</td>
<td>Copy-one-generation (COG)</td>
</tr>
<tr>
<td>Mode C</td>
<td>02</td>
<td>012</td>
<td>No-more-copies (NMC)</td>
</tr>
<tr>
<td>N.A.</td>
<td>02</td>
<td>002</td>
<td>Copy-free (CF)</td>
</tr>
<tr>
<td>Reserved Mode1</td>
<td>12</td>
<td>112</td>
<td>Reserved</td>
</tr>
<tr>
<td>Reserved Mode2</td>
<td>12</td>
<td>102</td>
<td>Reserved</td>
</tr>
<tr>
<td>Reserved Mode3</td>
<td>12</td>
<td>012</td>
<td>Reserved</td>
</tr>
<tr>
<td>Reserved Mode4</td>
<td>12</td>
<td>002</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Table 1 EMI Mode and EMI description

Ca, Cb, and Cc are universal secret constants assigned by the DTLA. The values for these constants are specified in Volume 2 Chapter 10.

Additional rules for AES-128 Cipher are described in the DTCP Specification available under license from the DTLA.
V1SG.4.3 Exchange Key Expiration
Both source and sink devices shall expire their Exchange Keys when they are detached from the WVAN. For avoidance of doubt, this means that a source device shall expire its Exchange Keys when it is detached from the WVAN, and a sink device shall expire its Exchange Keys when it is detached from the WVAN.

V1SG.4.4 Detached status of WirelessHD devices
A Station shall regard it is detached when it becomes disassociated status with a Coordinator. A Coordinator shall regard it is detached when it detects all Stations in the WVAN become disassociated status with it.

V1SG.4.5 Nc Update Process
WirelessHD provides isochronous data transfer services. For isochronous data transfer, there is no change to the description in Section 6.3.2 of update procedure and timing for Nc.

V1SG.4.6 Modification to 6.3.3 Odd/Even Bit
The Odd/Even bit transferred over WirelessHD is set to the DTCP specified field in CP header defined in “WirelessHD specification” as follows;

<table>
<thead>
<tr>
<th>msb</th>
<th></th>
<th>Isb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ext</td>
<td>EMI</td>
<td>Odd/Even</td>
</tr>
</tbody>
</table>

Figure 1 DTCP specified field Format

V1SG.4.7 Modification to 6.4.2 Encryption Mode Indicator(EMI)
The Ext bit and EMI bits that encode EMI Mode transferred over WirelessHD are set to the DTCP specified field. The locations of the Ext bit and EMI bits are shown by Figure 1 DTCP specified field Format.
The encoding used for the Ext bit and EMI bits is shown by Table1 in V1SG.4.2.

V1SG.4.8 Modifications to 6.6.1 Baseline Cipher
For WirelessHD, the baseline cipher is AES-128 using the Counter mode (CTR). AES-128 is described in FIPS 197 dated November 26, 2001 and the CTR mode is described in NIST SP 800-38A 2001 Edition.

Additional rules for AES-128 Cipher are described in the DTCP Specification available under license from DTLA.
V1SG.4.9 Modification to 6.6.3 Content Encryption Formats
DTCP protected content is transferred via sub-packet defined in “WirelessHD specification”. The sub-packet has a CP sub-packet Header which is 16 bits unencrypted field used for carrying Embedded CCI. Encrypted content in sub-packet is an encrypted frame and it can range from 0 to $2^{20}$ bytes in length.
The format of sub-packet is defined in “WirelessHD specification”.

V1SG.4.10 Embedded CCI
The Embedded CCI (Section 6.4.1 or Section 6.4.5.1) is carried in CP sub-packet Header. The format of CP sub-packet header is defined in “WirelessHD specification”.

V1SG.4.10.1 Embedded CCI for Audio stream
There are four types of Audio stream defined in “WirelessHD specification” and Embedded CCI is defined for each type of Audio stream.
The audio type for Audio component of audiovisual stream is referred as “General Audio”.
Three audio types defined in DTCP specification are also defined. Type 1 audio is referred as “IEC 60958 Identified Audio”, Types 2 audio is referred as “DVD Audio” and Type 3 audio is referred as “Super Audio CD”.

V1SG.5 Modifications to Chapter 8 (AV/C Digital Interface Command Set Extensions)

V1SG.5.1 Modifications to 8.1 Introduction
DTCP-WirelessHD uses AV/C message packet to send/receive DTCP control packets, status command packets, and response packets, which is defined in “WirelessHD AV/C specification”. Devices shall wait at least one second for a response to a command except SRM subfunction and shall wait at least ten seconds for a response to a command with SRM subfunction before timing out.

V1SG.5.2 Modifications to 8.3.1 AKE Control Command
This section maps the AKE control command specified in Section 8.3.1 to the WirelessHD DTCP Control Packet Format. The AKE control command subfields used with WirelessHD have the same values and functions as detailed in Chapter 8.

<table>
<thead>
<tr>
<th>msb</th>
<th>reserved (zero)</th>
<th>ctype/response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte [0]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte [1]</td>
<td>category = 0000₂ (AKE)</td>
<td>AKE_ID</td>
</tr>
<tr>
<td>Byte [2]</td>
<td></td>
<td>AKE_ID dependent field</td>
</tr>
<tr>
<td>Byte [3]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte [4]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte [5]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte [6]</td>
<td>AKE_label</td>
<td></td>
</tr>
<tr>
<td>Byte [7]</td>
<td>number(option)</td>
<td>status</td>
</tr>
<tr>
<td>Byte [8]</td>
<td></td>
<td>AKE_Info</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Byte [7+m]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2 WirelessHD DTCP Control Packet Format

- ctype/response has the same values as referenced in chapter 8 of DTCP Volume 1 specification and specified by the AV/C Digital Interface Command Set. The possible values for DTCP-WirelessHD are specified in V1SG.5.4.
- The Reserved bits are reserved for future definition and are currently defined to have a value of zero.
- The AKE_Info field is identical to the data field specified in section 8.3.1.
- The AKE_label and source STID of each control command should be checked to ensure that it is from the appropriate controller.
- Unless otherwise noted in the description of each subfunction, if a given command frame includes an AKE_Info field, the corresponding response frame does not have an AKE_Info field.
- For WirelessHD DTCP Control packet, fragmentation is not defined.

The data length of WirelessHD DTCP Control Packet is exchanged via a Length field defined in “WirelessHD specification”.

(Informational Version)
V1SG.5.3 Modification to 8.3.2 AKE Status Command

This section maps the AKE status command specified in Section 8.3.2 to the WirelessHD DTCP Status Packet Format. The AKE status command subfields used with WirelessHD have the same values and functions as detailed in Chapter 8.

| Byte [0] | reserved (zero) | ctype/response |
| Byte [1] | category = 0000₂ (AKE) | AKE_ID = 0000₂ |
| Byte [2] | | |
| Byte [3] | | AKE_ID dependent field |
| Byte [4] | | |
| Byte [5] | | |
| Byte [6] | AKE_label=FF₁₆ | |
| Byte [7] | F₁₆ | status |

Figure 3 WirelessHD DTCP Status Packet Format

- ctype/response has the same values as referenced in chapter 8 of DTCP Volume 1 specification and specified by the AV/C Digital Interface Command Set. The possible values for DTCP-WirelessHD are specified in V1SG.5.4.
- The Reserved bits are reserved for future definition and are currently defined to have a value of zero.
- Byte[1]..Byte[7] are identical to Operand[0]..Operand[6] as specified in Section 8.3.2.

V1SG.5.3.1 Modifications to AKE status command status field

<table>
<thead>
<tr>
<th>Value</th>
<th>Status</th>
<th>Response code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000₂</td>
<td>No error</td>
<td>STABLE</td>
</tr>
<tr>
<td>0001₂</td>
<td>Support for no more authentication procedures is currently available</td>
<td>STABLE</td>
</tr>
<tr>
<td>0111₂</td>
<td>Any other error</td>
<td>STABLE</td>
</tr>
<tr>
<td>1111₂</td>
<td>No information¹</td>
<td>REJECTED</td>
</tr>
</tbody>
</table>

Table 2 AKE Status Command Status Field

¹ It is recommended that implementers not use the “No information” response.
V1SG.5.4 ctype/response values (informative)

<table>
<thead>
<tr>
<th>Value</th>
<th>Command type / Response type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0₁₆</td>
<td>CONTROL</td>
</tr>
<tr>
<td>1₁₆</td>
<td>STATUS</td>
</tr>
<tr>
<td>2₁₆</td>
<td>SPECIFIC INQUIRY</td>
</tr>
<tr>
<td>3₁₆</td>
<td>Not used</td>
</tr>
<tr>
<td>4₁₆</td>
<td>Not used</td>
</tr>
<tr>
<td>5₁₆ – 7₁₆</td>
<td>Reserved for future extension</td>
</tr>
<tr>
<td>8₁₆</td>
<td>NOT IMPLEMENTED</td>
</tr>
<tr>
<td>9₁₆</td>
<td>ACCEPTED</td>
</tr>
<tr>
<td>A₁₆</td>
<td>REJECTED</td>
</tr>
<tr>
<td>B₁₆</td>
<td>Not used</td>
</tr>
<tr>
<td>C₁₆</td>
<td>IMPLEMENTED/STABLE</td>
</tr>
<tr>
<td>D₁₆</td>
<td>Not used</td>
</tr>
<tr>
<td>E₁₆</td>
<td>Reserved for future extension</td>
</tr>
<tr>
<td>F₁₆</td>
<td>Not used</td>
</tr>
</tbody>
</table>

Table 3 ctype/response values (informative)

V1SG.5.5 Modifications to 8.3.3

V1SG.5.5.1 AKE_ID dependent field

DTCP-WirelessHD implementations only require a single exchange key, specifically Bit 4 of exchange_key field will be used for transporting all DTCP Protected content over WirelessHD for all defined EMI.

For DTCP-WirelessHD, both Source and Sink shall support only Full Authentication. Therefore Restricted Authentication procedure (rest_auth) and Enhanced Restricted Authentication procedure (en_rest_auth) are prohibited. Extended Full Authentication procedure (ex_full_auth) is optional

<table>
<thead>
<tr>
<th>Bit</th>
<th>AKE_procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (lsb)</td>
<td>Prohibited</td>
</tr>
<tr>
<td>1</td>
<td>Prohibited</td>
</tr>
<tr>
<td>2</td>
<td>Full Authentication procedure (full_auth)</td>
</tr>
<tr>
<td>3</td>
<td>Extended Full Authentication procedure³ (ex_full_auth, optional)⁴</td>
</tr>
<tr>
<td>4 – 7 (msb)</td>
<td>Reserved for future extension and shall be zero</td>
</tr>
</tbody>
</table>

Table 4 AKE_procedure values

² Features of this specification that are labeled as “optional” describe capabilities whose usage has not yet been established by DTLA.
³ Devices that support extended device certificates use the Extended Full Authentication procedure described in this chapter.
⁴ Features of this specification that are labeled as “optional” describe capabilities whose usage has not yet been established by DTLA.
V1SG.5.5.2 Modifications to Authentication selection

<table>
<thead>
<tr>
<th>Source supported authentication Procedures</th>
<th>Sink supported authentication procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full_auth</td>
<td>Full auth</td>
</tr>
<tr>
<td>Full_auth and Ex_full_auth</td>
<td>Full Authentication</td>
</tr>
<tr>
<td></td>
<td>Extended Full Authentication</td>
</tr>
</tbody>
</table>

Table 5 Authentication selection

V1SG.5.5.3 Modification to Exchange_key values

DTCP-WirelessHD uses a single exchange key defined in the following table.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Exchange_key</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (lsb)</td>
<td>Prohibited</td>
</tr>
<tr>
<td>1</td>
<td>Prohibited</td>
</tr>
<tr>
<td>2</td>
<td>Prohibited</td>
</tr>
<tr>
<td>3</td>
<td>Prohibited</td>
</tr>
<tr>
<td>4</td>
<td>Exchange Key for AES-128 CTR mode</td>
</tr>
<tr>
<td>5 – 7 (msb)</td>
<td>Reserved for future extension and shall be zero</td>
</tr>
</tbody>
</table>

Table 6 Exchange_key values

V1SG.5.6 Modifications to AKE Subfunctions

Subfunction modified for DTCP-WirelessHD are described in the DTCP specification available under license from the DTLA.

V1SG.5.7 Modifications to 8.4 Bus Reset Behavior

Source device and sink device shall immediately stop authentication procedure between the devices if each device detects either device is detached from the WVAN during authentication procedure.
V1SG.6 Additional Localization via RTT

This section specifies Additional Localization for the WirelessHD.

V1SG.6.1 Purpose and Scope

Source devices and Sink devices must implement Additional Localization (AL) as specified in this section.

Source devices with AL when conducting an AKE with a Sink device with AL, the source devices must perform a RTT test if the sink device's Device ID is not on the source device's RTT registry.

Source devices will add a Sink device’s Device ID to the Source device’s RTT registry, will set the content transmission counter for the sink device to 40 hours, and will provide an exchange key only if the source device measures a RTT value of 1 millisecond or less during RTT test.

Source devices when transmitting content will update content transmission counters of all RTT registered sink devices and are required to remove the Device ID of a sink device from the RTT registry after counting 40 hours of content transmission.

Background RTT testing is not supported for WirelessHD because the method of measuring RTT in “WirelessHD Specification” is specified only for RTT-AKE case.

When RESPONSE2 subfunction is received, ID_U shall be used instead of Device ID in above processes.

V1SG.6.2 Protected RTT Protocol

V1SG.6.2.1 Protocol

Protected RTT protocol is described in Figure 4 and is used in RTT-AKE procedure. The RTT protocol is executed after the Challenge-Response portion of the AKE is completed. SHA-1 is used to construct following messages that are exchanged during RTT testing protocol to ensure that source and sink which completed Challenge-Response portion of AKE are only ones involved in RTT testing.

- MAC1A = MAC1B = \([\text{SHA-1(MK+N)}]_{\text{msb80}}\)
- MAC2A = MAC2B = \([\text{SHA-1(MK+N)}]_{\text{lsb80}}\)
- OKMSG = \([\text{SHA-1(MK+N+1)}]_{\text{msb80}}\)

Where MK is 160 bits and equal to SHA-1(Kauth||Kauth), N is 16 bit number that ranges from 0 to 1023, and “+” used in RTT Protocol means mod \(2^{160}\) addition.
The RTT READY command is used to indicate that authentication computation is complete and that source and sink devices are ready to execute the RTT test procedure. The RTT procedure begins by first establishing value of N using the RTT SETUP command. N is initially set to zero and can range from 0 to 1023 as maximum permitted RTT trials per AKE is 1024. After preparation of MAC values corresponding to N, source device will then measure RTT which is the time interval starting after source transmits RTT TEST command and terminates upon reception of RTT TEST accepted response.

If the RTT is greater than 1 millisecond and the value of N is less than 1023 the source will repeat RTT procedure by incrementing N by 1 and reissue RTT SETUP and RTT TEST commands. If the measured RTT is less than or equal to 1 millisecond:

Figure 4 RTT Protocol Diagram
The source device compares most recently computed MAC2A to most recently received MAC2B and if not equal the source device aborts RTT procedure else if equal it sends RTT_VERIFY command to sink device. The sink device will after receipt of RTT_VERIFY command compare the most recently received MAC1A and most recently computed MAC1B and if not equal aborts RTT procedure else if equal it will send OKMSG in RTT_VERIFY accepted response. The source device will verify OKMSG and if it is not correct the source device aborts RTT procedure else it will add sink device’s Device ID to RTT registry and set content transmission counter to 40 hours. When RESPONSE2 subfunction is received, IDU shall be used instead of Device ID in above process.

If RTT procedure is aborted the source shall not provide an exchange key.

**V1SG.6.2.2 RTT-AKE**

The RTT-AKE procedure starts exactly the same as normal AKE but a source device that has DTCP certificate with AL flag set to one must check AL flag value of a sink device and if the AL flag value is also set to one then:

The sink device after completing Challenge-Response portion of AKE will wait and the sink device will abort if it receives any other command than the RTT_READY command, EXCHANGE_KEY command, or AKE_CANCEL command.

The source device then examines the RTT registry and if the sink device’s Device ID is on its RTT registry, the source device proceeds to exchange key portion of AKE otherwise the source device initiates a RTT test procedure and if during test it obtains a RTT measurement of 1 millisecond or less it will add the sink device’s Device ID to its RTT registry, set content transmission counter to 40 hours, and then proceed to exchange key portion of AKE. When RESPONSE2 subfunction is received, IDU shall be used instead of Device ID in above process.
Figure 5 RTT-AKE Informative Flow Diagrams
V1SG.7 Additional Commands and Sequences
Commands for Additional Localization are described in the DTCP specification available under license from the DTLA.

V1SG.8 WirelessHD DTCP Protocols
This section describes the exchange of DTCP AKE commands, responses, and status frames by WirelessHD DTCP Function.

WirelessHD support for RTT is defined in Round Trip Time Verification section of the WirelessHD specification.

Additional rules for WirelessHD DTCP Protocols are described in the DTCP Specification available under license from the DTLA.