ANSI/SMPTE 275M-1995

SMPTE STANDARD

for Television and Audio Equipment — ESlan-1 Remote Control System

1 Scope

This standard defines the services and protocols contained within the physical, data link, network, transport, and session layers of ESlan-1, a control and data network for use in television and audio program production, post-production, and distribution equipment. ESlan-1 is intended for application in small- to moderate- sized facilities requiring modest levels of performance. A study to determine limiting parameters on the size of ESlan-1 installations is currently being undertaken by the SMPTE.

This standard is to be read in conjunction with SMPTE EG 29, SMPTE EG 30, and with other documents listed in clause 2 and annex C.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/IEEE 802.3-1993, Information Technology — Local and Metropolitan Area Networks — Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

SMPTE EG 29-1993, Remote Control of Television Equipment

SMPTE EG 30-1995, Implementation of ESlan Standards

RFC 768, User Datagram Protocol (UDP)*

RFC 791 updated by RFC 1349, Internet Protocol (IP)*

RFC 826, Ethernet Address Resolution Protocol (ARP)*

RFC 1349, Type of Service in the Internet Protocol Suite (IPS)*

*For information on obtaining RFC documents, contact the SMPTE Engineering Department.

3 Introduction

In order to simplify as much as possible the interface between audio and television equipment and computer systems used to establish medium- to large-scale remote-control networks, ESlan-1 employs, wherever possible, standard or industry-standard networking services and protocols. Its architecture complies with the model for open systems interconnection (OSI) defined by the International Organization for Standardization (ISO). (See ISO 7498.)

The section ordering of this standard follows that described in the model for open systems interconnection of the ISO, starting at the physical and rising to the session layer. The content of the presentation layer, the virtual machine, is contained within other SMPTE documents (see annex C). The content of the application layer, which is proprietary to users, is outside the scope of the ES hierarchy of network standards.

American National Standard

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4 Structure of the ESlan-1 addressing scheme

4.1 ESlan-1 provides for layered addressing from individual machines to the full wide-area network.

4.2 Each individual node on the network has a specific CSMA/CD address. The CSMA/CD (6-octet, 8-bit byte) destination and (6-octet) source addresses are transmitted first within a message packet.

4.3 The Internet (IP) (4-octet) source address and (4-octet) destination address contained within the IP header follow the CSMA/CD addresses.

4.4 Each individual item of equipment on the network is allocated one of the 8064 (2-octet) device addresses fully compliant with existing ESbus systems.

4.5 A device group addressing scheme is provided. This operates in conjunction with the delegation bitmap (see 8.4).

4.6 The data structure of the ESlan-1 message packet is shown in figure 1.

5 Physical and data link layers and access control

5.1 The physical connection and data link services shall be provided by a 10 Mb/s data communication highway operating under ANSI/IEEE 802.3.

The physical medium and its access shall be in accordance with accepted CSMA/CD practice. It may include AUI, 10Base2, 10BaseT, etc. Any limitation in segment length for a particular medium can be overcome by the use of bridges and repeaters. However, the latency of such devices and multipaths to a

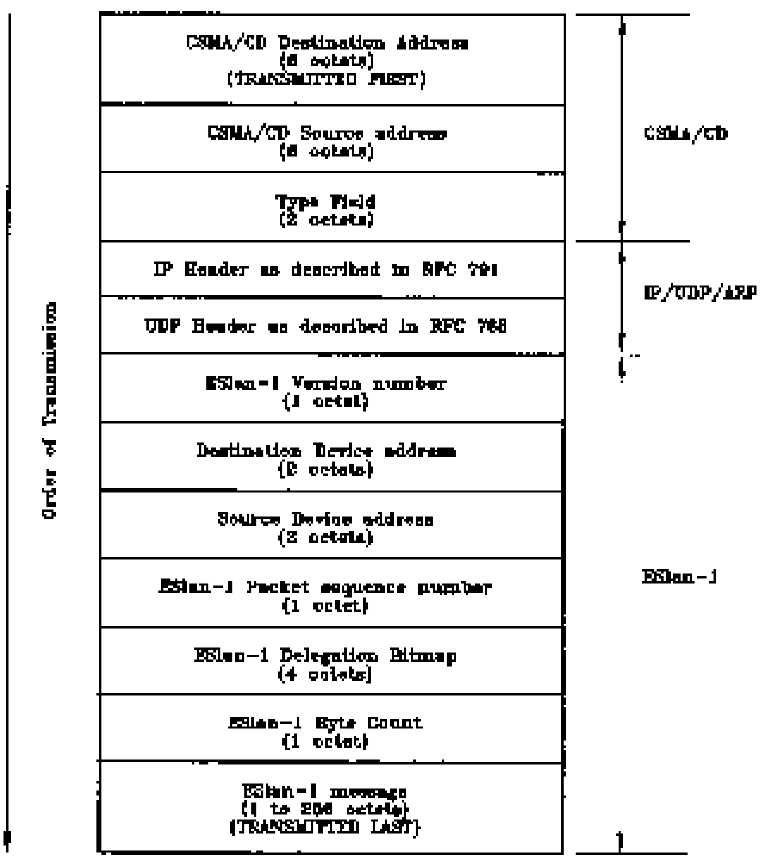

Figure 1 – Data structure of message packet (excluding preamble and postamble)

receiver within large networks must be considered within any network design. In networks extended by the use of such devices, it may prove necessary to use a protocol capable of higher granularity in order to avoid timing errors in the receipt of messages.

5.2 The data packet shall be a CSMA/CD packet, except that the “length” field (as defined in ANSI/IEEE 802.3) shall be replaced by a 2-octet “type” field whose value shall be set to 0800_h, defining it as an Internet packet.

6 Network layer

6.1 The network layer of ESlan-1 shall employ the RFC 791 Internet protocol (IP), as updated by RFC 1349.

6.2 RFC 826 address resolution protocol (ARP) shall be used to determine the CSMA/CD address of a device for which only the IP address is known.

7 Transport layer

The transport layer of ESlan-1 shall employ RFC 768 user datagram protocol (UDP).

8 Session layer

8.1 Version number

A single octet field within each message block is used to determine the ESlan-1 version number in order to allow for future developments. The version described by this standard is version zero (0).

8.2 ESlan-1 addressing

8.2.1 Association directory

By the use of IP/UDP and ARP, it is possible to communicate with any ESlan-1 device by the use of sockets or streams.

The addressing mechanisms provided by the IP and UDP protocols enable peer-to-peer communication sessions between devices. A device specifies the IP address and the port required when seeking connection. For ESlan-1, the UDP port field shall be set to 420 ($1A4_h$).

The IP address identifies the particular node connected to the ANSI/IEEE 802.3 network; the unique UDP port field XXXX (bound to a specific socket) identifies this as ESlan-1 traffic, and the device address identifies the specific machine within the local area network.

To establish a link with an ESlan-1 device, an association between the IP address and the device address is required.

Each network device shall establish and maintain an association directory, in order to map device addresses to IP addresses.

The mapping of device addresses to IP addresses shall be aged. The aging mechanism used in ARP shall be followed. Address mappings older than those specified by the aging period shall be deleted.

System service commands (see clause 9) are provided which enable the association directory to be constructed and modified, and for the association status to be determined.

8.2.2 Individual machine selection

An ESlan-1 device requiring communication with another ESlan-1 device shall first look for an IP address association in its association directory.

If no association information exists, then the device shall issue the system service command ASSOCIATION REQUEST.

This command shall be transmitted as a network broadcast, since the IP address is generally unknown. The UDP ESlan-1 socket shall be specified, and the network destination address set to broadcast format (all bits set to 1). The ESlan-1 destination address shall be used to specify the ESlan-1 device for which the association is required.

Alternatively, the command may be directed to a specific network address to obtain the ESlan-1 device address connected to a known IP address. In this case, the ESlan-1 address field shall be set to zero.

A network device that receives the ASSOCIATION REQUEST command at its ESlan-1 UDP port connection shall check the ESlan-1 destination address field.

If the specified ESlan-1 address is not a controlled device at that network connection, no response shall be given.

If the specified ESlan-1 address is a device controlled at that network connection or the ESlan-1 address is 0, then an ASSOCIATION STATUS response shall be returned.

Note that the network design requires that the ASSOCIATION REQUEST shall reach all nodes.

8.2.3 Group machine selection

This mechanism enables a number of ESlan-1 devices to respond to a single group address. Potentially, any network device may make a group assignment.

Group assignment shall operate in conjunction with the delegation bitmap in order to avoid conflict between different devices each attempting to assign group addresses. Therefore:

– Network devices capable of group assignment shall be given unique bitmap values (i.e., no bit-setting shall be repeated on another device that may assign group addresses);

– An ESlan-1 device given a new bitmap setting shall clear any previous group address assignment(s).

8.2.4 Group mode communication

A command to be actioned by a group of devices shall be sent as a network broadcast, and with the ESlan-1 destination address field set to the previously assigned group address.

No acknowledge or error messages shall be returned by any device in response to a group mode or broadcast message, with the exception of ASSOCIATION REQUEST.

8.3 Packet sequence number

In order to confirm the correct sequence of packets in an ordered sequence of commands, each packet shall contain a sequence number field.

Transmitting devices shall increment the packet sequence number by 1 modulo 256 for each packet transmitted in the stream to each destination address. A receiving device shall compare the sequence number of each newly received, correctly addressed packet from the same ESlan-1 source address with that of the previously addressed packet using modulo 256 arithmetic. If an out-of-sequence packet is received, other than NOOP, it shall be discarded and a system service error message <08_h> with exec code <06_h> returned.

8.4 Delegation bitmap

It is possible that a command may be sent to a destination by a source not authorized to control that destination; for example, an edit command to the wrong VTR. To minimize the possibility of responding to an unauthorized command, a delegation bitmap (32-bit) field is provided.

A bitmap field value shall be assigned to each operational device within an operational session, and this value shall be attached to each message from that device. When a destination device receives a source message, it shall perform a logical AND on the source delegation bitmap field and its own internal delegation bitmap field.

Initial session values shall be set such that if the result is NON-ZERO, the message shall be accepted and if the result is ZERO, the message shall be ignored and the session management error message <08_h>, with exec code <05_h>, returned. (A detailed description of this mechanism is given in annex A.)

8.5 Byte count

The byte count field shall contain a byte count of the message to follow. Byte count is an unsigned 8-bit value.

8.6 Message block field

This field shall contain any ESlan-1 message, such as a system service, common, or dialect type-specific message.

9 System service commands and responses

9.1 Keywords

<00$_h$> SYSTEM SERVICE NO OPERATION (SNOP) System service no-operation.

Format: <SYSTEM SERVICE NO OPERATION>

<01$_h$> Reserved for BEGIN (RBGN)
<02$_h$> Reserved for END (REND)

In Eslan-1 operations, these two keywords shall be used for two purposes: firstly as BEGIN and END delimiters

Format: <BEGIN>
<Command or information field (I/F) list>
<END>

and secondly for flow control.

If a device, receiving many messages from another device, is unable to receive more data for a short period, it shall issue the <END> keyword. This shall cause the sending device to stop sending until the receiving device issues the <BEGIN> keyword reenabling transmission.

On receipt of the <BEGIN> keyword, a device shall either continue with its interrupted transmission or, if its transmission has been completed, shall send a <SNOP> keyword (<00$_h$>).

A device employing this flow control shall incorporate a timer. On receipt of the <END> keyword, the timer shall be started. If the <BEGIN> keyword is not received before the timer expires, the <BEGIN> keyword shall be deemed to have been lost, and transmission shall be resumed. The duration of the timer is not specified. It is left to the system designer to determine the optimum duration for each system.

The receipt of multiple <BEGIN> or <END> keywords shall be treated as if a single command only had been received.

<03$_h$> SYSTEM SERVICE RESET (SRST) Resets all system service level functions to the power-up default state.

Format: <SYSTEM SERVICE RESET>

<04$_h$> INITIAL SEGMENT (ISGT) Directs the session (system service) layer to commence message segment assembly.

Format: <INITIAL SEGMENT>

<SEGMENT COUNT> — 8-bit binary unsigned number; count zero shall be the final segment.

<SEGMENT DATA...>

NOTE -- The final octet of a data segment shall be the final octet of the block.

<05_h> SUBSEQUENT SEGMENT (SSGT) — Directs the session (system service) layer to continue segment assembly.

Format: <SUBSEQUENT SEGMENT>

<SEGMENT COUNT> — 8-bit binary unsigned number; count zero shall be the final segment.

<SEGMENT DATA...>

<06_h> BLOCK (BLCK) — Directs the session (system service) layer to disassemble virtual machine messages which have been concatenated within a single supervisory level frame. The BLOCK command shall be employed to delimit messages on every occasion where message concatenation is employed.

Format: <BLOCK>

<BYTE COUNT> — 8-bit binary unsigned number, specifies the length of the individual blocked message, in octets, not including the byte count.

<BLOCK DATA...>

<08_h> SYSTEM SERVICE ERROR (SERR) — Advises that the system service command in the last frame received had not been understood, or could not be performed. Following receipt of a SYSTEM SERVICE ERROR, no further processing shall take place on the frame, although any virtual machine messages encountered up to that point shall be forwarded.

Format: <SYSTEM SERVICE ERROR>

<EXEC CODE> — 8-bits:
- 00 -- parse error
- 01 -- unrecognized command
- 02 -- insufficiently equipped
- 03 -- buffer overflow
- 04 -- invalid keyword argument
- 05 -- destination device unavailable
- 06 -- out-of-sequence packet number

<BYTE COUNT> — 8 bits, not including the byte count.

<OFFENDING COMMAND>

<0B$_h$> ASSOCIATION REQUEST (ASRQ) — This command shall be used to determine the association between an ESlan-1 address and its Internet (IP) address. The command shall be issued either as a broadcast message or may be directed to a specific user address.

Format: <ASSOCIATION REQUEST>

<xxxx$_h$>	The device address.

<0C$_h$> ASSOCIATION STATUS (ASST) — This command shall be returned by a network device in response to an ESlan-1 <ASSOCIATION REQUEST> command from another network device.

A network device that receives an ASSOCIATION STATUS command shall read the IP address from the IP field and shall update its association directory, as required, with the returned IP address.

Format: <ASSOCIATION STATUS>

<xxxx$_h$>	The number of ESlan-1 devices attached at that network connection.
<BEGIN>	
<yyyy$_h$>	The first device address.
|	
|	
|	
<yyyy$_h$>	The last device address.
<END>	

<10$_h$> ASSIGN LINKAGE (ALNK)
<11$_h$> DEASSIGN LINKAGE (DLNK) — These two commands shall direct an ESlan-1 device to establish/clear a logical control link to another specified ESlan-1 device address. Any ESlan-1 device can receive this command.

Format: <ASSIGN/DEASSIGN LINKAGE>

<xxxx$_h$>	Source device address.
<yyyy$_h$>	Destination device address.

<12$_h$> ASSIGN GROUP ADDRESS (AGAD) — This command assigns an ESlan-1 device (specified by the ESlan-1 destination fields) to a logical group address. The group addresses available are:

8082$_h$ – 80FF$_h$ Group select – groups 1 to 63
8180$_h$ – 81FF$_h$ Group select – groups 64 to 127
(These are the same as those specified as ESbus group select addresses in SMPTE RP 113.)

The addresses in which the least significant bit of the least significant octet equals binary one (1) shall not be used as ESlan-1 group addresses. The most significant octet shall be transmitted first.

Format: <ASSIGN GROUP ADDRESS>
<xxxx$_h$> — The specified group address in the range 8082$_h$/8083$_h$ -- 81FE$_h$/81FF$_h$. (This accommodates ESbus practice.)

<13$_h$> DEASSIGN GROUP ADDRESS (DGAD) — This command deassigns an ESlan-1 device (specified by the ESlan-1 destination fields) from a logical group address. When the group address is set to <8080$_h$>, the receiving system service level shall deassign all groups established at that physical connection.

Format: <DEASSIGN GROUP ADDRESS>
<xxxx$_h$> — The specified group address in the range 8082$_h$/8083$_h$ -- 81FE$_h$/81FF$_h$. The group address <8080$_h$> shall deassign all groups established at that physical connection.

<16$_h$> SYSTEM SERVICE READ (SSRD) — This command shall be used to direct an ESlan-1 device to read the content of the specified information field (I/F). Its main use is to read the content of the DELEGATION BITMAP I/F <1A$_h$>.

Format: <SYSTEM SERVICE READ>
<I/F FIELD NAME>

NOTE -- The I/F NAME may be replaced by several names wrapped in a BEGIN/END construct.

<17$_h$> SYSTEM SERVICE I/F ITEM RESPONSE (SSIR) — Contains the I/F data in response to a <SYSTEM SERVICE READ> command.

Format: <SYSTEM SERVICE I/F ITEM RESPONSE>
<I/F NAME>
<I/F VALUE>

NOTE -- Several I/F NAMES/VALUES may be wrapped in a BEGIN/END construct.

<1A$_h$> SET DELEGATION BITMAP (SDBM) — This command directs the receiving device to set its delegation bitmap to the value specified. The receipt of this command shall override the value of any bitmap setting established prior to its receipt.

Format: <SET DELEGATION BITMAP>
<BITMAP VALUE> — 4-octet special code

<1F00$_h$> SET LINKAGE LOCK (SLLK)

This command shall provide exclusive control between a controlling and a controlled device. It enables a session to be established between two devices which cannot be interrupted by any other controlling device (other than any user-nominated master control station).

The command shall set, conditionally, the value of the LINKAGE LOCK DEVICE ADDRESS (LLDA) information field to the specified ESlan-1 address. If the ESlan-1 address of the sending device does not correspond with the correct value of the LLDA information field, and the current value of the LLDA information field is not zero (0), the command shall be ignored by the receiving device. This message shall not be transmitted in the broadcast mode.

Format: <SET LINKAGE LOCK>
<xxxx$_h$> The device address.

<1F01$_h$> FORCE SET LINKAGE LOCK (FSLL)

This command shall set, conditionally, the value of the LLDA information field to the value specified in the address. This message shall not be transmitted in the broadcast mode. This message shall be accepted only from a designated master control station whose address appears in a receiving station's LLMA interconnection field.

Format: <FORCE SET LINKAGE LOCK>
<xxxx$_h$> The device address.

<1F02$_h$> SET MASTER LINKAGE LOCK (SMLL)

This command shall set the LINKAGE LOCK MASTER ADDRESS (LLMA) list. SMLL shall be accepted only from a station whose address is established in the LLMA list. If the LLMA list is empty or zero, the SMLL command shall be accepted from any station.

Format: <SET MASTER LINKAGE LOCK>
<BEGIN>
<List of nominated master control station addresses>
<END>

9.2 Information fields

<1A$_h$> DELEGATION BITMAP (DGBM)

This information field contains the current value of the delegation bitmap.

Format: <DELEGATION BITMAP>
<BITMAP> 4-octet special code.

<$1B_h$> LINKAGE LOCK DEVICE ADDRESS (LLDA) When the content of the LLDA information field is set to zero (0), the virtual machine shall accept commands from any device which passes the DELEGATION BITMAP test. If the content of this information field is set to any other value, the virtual machine shall accept commands only from the single device whose address is contained within the information field.

A device whose LLDA information field is set to one specific address shall return a <SYSTEM SERVICE ERROR> message <08_h> with exec code <05_h> to any other ESlan-1 address issuing a command.

Format: <LINKAGE LOCK DEVICE ADDRESS>
<$xxxx_h$> The specified device address.

<$1C_h$> LINKAGE LOCK MASTER ADDRESS (LLMA) This I/F contains a list of nominated master control stations. A station denied access to a device may query the information field in the device to determine to whom to address a request to break an existing linkage lock. If the LLMA list is empty or zero, any station may change the linkage lock device address.

Format: <LINKAGE LOCK MASTER ADDRESS>
<BEGIN>
<List of nominated master control station addresses>
<END>

NOTE -- The default content of LLMA is user specifiable, either locally at the device or remotely by use of the command SET MASTER LINKAGE LOCK (SMLL).

<$1D_h$> GROUP ADDRESSES (GADD) This information field contains the group address of each group assigned at that single physical ESlan-1 connection.

Format: <GROUP ADDRESS>
<aaaah> The number of group addresses assigned at that single physical ESlan-1 connection.

<$xxxx_h$> The first assigned group address.
|
|
<$yyyy_h$> The last assigned group address.

Annex A (informative)
Operation of the delegation bitmap

The delegation bitmap provides the system designer with an easy and flexible means of limiting the control of devices to authorized controllers only. When any device receives a message, it performs a logical AND of its own internal bitmap field with the bitmap field of the incoming message. If the result is ZERO, it ignores the message; if it is NON-ZERO, the command is accepted.

In typical use, each bit of the bitmap corresponds to a studio or other control location. Each automation controller, editor, or control panel in the studio would have its bitmap set to a value unique within the installation.

The use of the bitmap may more readily be understood by consideration of the following example:

Consider a studio center comprising three studios A, B, and C, and using ESlan-1 for machine control. There is a central pool of 10 VTRs which are used as required by the three studios.

Without the delegation scheme, it would be possible for studio A, performing an edit with VTRs 1, 2, and 3, to have its work corrupted by a command sent to one of the machines, say VTR 2, in error, from studio B.

The delegation bitmap is provided in order to minimize this danger.

In the example, the editor and control panels in studio A would have their bitmap fields set permanently to 0x0001 (0001 binary). Studio B's machines would be set to 0x0002 (0010 binary), and C's to 0x0004 (0100 binary). Each VTR would be provided with a method, either through a central assignment position or through an indiviaual switch at the machine, to specify its bitmap field value. In the example, the VTR operator would have set the bitmap fields of VTRs 1, 2, and 3 to 0x0001 (0001) for studo A. Whenever studio A issues a command, it includes the bitmap field value of 0x0001 in the message frame.

On receipt of a studio A command by a VTR assigned to studio A, the command's bitmap value (0001) is ANDed with the (0001) in the machine — resulting in (0001), and the command would be accepted. If the command had originated from studio B, it would have included a bitmap field value of (0010) which, when ANDed with the (0001) in the machine, would result in (0000), and would therefore be ignored. Similarly, a command from studio C (bitmap value 0100) would also result in 0000.

If the operator wishes to make a machine accessible from studios A, B, and C, he would set the bitmap field to 0x0007 (0111), thus setting the lower three bits. If the bitmap field value is set to FFFF (i.e., all 1s), the machine would be accessible from everywhere.

The system is, therefore, very flexible, and can be tailored to the needs of the studio center.

Annex B (informative)
Collision avoidance

The synchronous nature of some network applications is likely to increase the risk of network access collisions; for example, in the video environment or where time code is used. In such cases, the preprocessing of access attempts may be considered.

For instance, the quasi-randomizing of messages, by pre-assigning each individual machine within the synchronous group into one of a number of access-time-slots or by providing a 'token passing' procedure between nodes, may minimize the risk of collisions following television vertical interval.

As such mechanisms modify only the time when a node requests access and do not affect the access mode, they do not affect the compatibility of the node with the network, and it remains a fully compliant CSMA/CD partner.

It is emphasized that only those devices which transmit synchronously to a timing reference can gain any potential benefit from such mechanisms. In all other cases, their use is likely to degrade the operation of the network.

Annex C (informative)
Bibliography

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