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SMPTE ENGINEERING GUIDELINE

Remote Control of Television Equipment

1 Introduction

This guideline provides a guide to the architecture of the SMPTE/EBU ESbus digital control interface and related interfaces, which were developed for the purpose of standardizing the control of television equipment. The digital control interface was developed jointly by the SMPTE and the European Broadcasting Union (EBU).

The referenced documents define the technical specification and system characteristics required to allow the control of television production and distribution equipment.

2 Normative references

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

ANSI/SMPTE 207M-1992, Television — Digital Control Interface — Electrical and Mechanical Characteristics

SMPTE RP 113-1992, Supervisory Protocol for Digital Control Interface

SMPTE RP 138-1992, Control Message Architecture

SMPTE RP 139-1992, Tributary Interconnection

SMPTE RP 163-1992, Television — System Service Messages

SMPTE RP 170-1993, Video Tape Recorder Type-Specific Messages for Digital Control Interface

SMPTE RP 171-1993, Type-Specific Messages for Digital Control Interface of Analog Audio Tape Recorders

SMPTE RP 172-1993, Common Messages for Digital Control Interface

3 Application

3.1 Introduction

The ESbus and associated interfaces establish the system characteristics required for the remote control of television equipment, from any location, by the employment of an intelligent processor which should ideally be an integral part of the controlled equipment.

This digital control interface is based on the ESbus developed and documented by the SMPTE and EBU and is, therefore, made available by a multitude of manufacturers.

Both SMPTE and EBU are continuing to develop specifications for additional applications. This guideline will be updated to reference the appropriate documents as they are completed.

3.2 Overview

A function of any remote control system is to establish a connection between operational controlling and controlled devices. The ESbus system is based on the concept of distributed intelligence whereby each device is attached to the system by means of an intelligent interface that will carry out the majority of local calculations and logical operations required by the device. The intelligent equipment will be called a tributary of the remote control system.

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The use of distributed intelligence within the control system offers a number of advantages:

– the ability to modify elements of the configuration without affecting other users;

– high resilience, the majority of failures can be contained within a single tributary;

– the number of time-critical messages needing to be transferred between tributaries is minimized;

– the control system is independent of the type of device.

The basic functional unit of the remote control system is the local network which comprises an interface bus, a bus controller, and a number of tributaries as required by the user. The number of tributaries on any one local network may range from one to a practical maximum of up to 32, although typically the number will probably be in single figures. The configuration may be either multipoint in which one controller and more than one tributary share a common interface bus or, alternatively, point-to-point in which more than one interface bus radiates from the bus controller and only one tributary connects to each bus.

Where larger systems are required, there is provision for local networks to be interconnected via a separate interconnection bus accessed through a gateway. This gateway may be integral with the bus controller.

3.3 System architecture

The system architecture conforms largely to the International Organization for Standardization (ISO) architecture. This is the logical model used by the IEEE 802 Committee in its recommendations on local area networks (LAN). Progress in communications over several years has led to the development of a structured technique to describe communication systems. The systems are viewed as logically composed of layers.

Layering divides the whole service offered by the system in such a way that each layer adds value to the service provided by the lower layers. The layers and service referred to are logical in nature as distinct from a physical entity or software implementation. The logical functions are carried out in software residing in hardware, but the implementation is carried forth using these logical entities to represent the software elements of the final program. This added value contributed by each layer is established by the characteristics of an entity residing in the layer.

Two entities operating in the same layer but in different parts of the network are called peer entities. The aim is to permit communication between peer entities; this communication is governed by a protocol. The route between peer entities using a protocol is only a virtual one; in reality, the communication path passes through lower layers and is completed over a physical medium, such communication being effected transparently.

In software terms, the **interface** is the logical line separating two layers. It is not necessarily a physical reality.

The point where a communication path crosses an interface is called a service access point (SAP). The point within a SAP that provides a real connection is called a connection end point (CEP).

3.4 International Organization for Standardization (ISO) Model OSI

The ISO has established a model consisting of seven layers and specified the function of each. This is called open system interconnection (OSI) architecture.

The OSI reference model defines the following seven layers:

Layer 7 serves the user directly by defining his **application** tasks in abstract terms. An application process performs a function such as playing a tape. Each applications entity serves a physical device and is device-specific, varying according to the characteristics of the device.

Layer 6 gives a **presentation** of those abstract terms in coded and strictly formatted forms. The presentation layer contains the **virtual machine** which responds to defined data, the control language in a defined manner using a distinct **dialect** within the control language.

Layer 5 is concerned only with **session** involving more than one participant. It associates the coded and formatted data with a particular participant of those available in the session. It connects two presentation entities providing housekeeping services (remapping, dialect identification, error recovery, etc.).

Layer 4 provides facilities for safe **transport** of data from end to end of a system.

Layer 3 dismembers and reassembles transported data into packages for sequential transfer via a **network** system.

Layer 2 establishes a **data link** providing reliable error-free transmission in the presence of line disturbances. Where applicable, the association achieved in layer 5 is converted to an absolute system address. Layer 2 establishes a communication between physical units and is defined for the ESbus in SMPTE RP 113.

Layer 1 defines the hardware properties needed to set up a **physical link** for the logically linked data and is defined for the ESbus in ANSI/SMPTE 207M.

The above description shows:

– how data generated by each layer is handed on from layer to layer; and

– how the quality of service increases from bottom to top.

It should be noted that layers 7, 6, and 5 are concerned with the specific application service; layers 4 to 1 relate to a general transport service. The logical tributary encompasses layers 1 to 5 inclusive.

3.5 OSI model applied to a television control system

It is very helpful to define a remote control system for television equipment using a layered technique.

Because of the protection properties within the supervisory protocol SMPTE RP 113, (2), there is little need for additional end-to-end control facilities normally incorporated in entity (4).

The remaining layers 7, 6, 5, 3, 2, and 1 are of particular importance for ESbus digital control interface application.

The **applications** layer (7) — An applications process performs a specified system function such as playing a video tape. Each applications entity consists of a physical device and the necessary hardware and software interface to connect the entity to lower network layers. The interface is device specific and will vary according to the characteristics of the equipment being controlled. The **applications** layer is not within the scope of the ESbus documentation.

The **presentation** layer (6) contains the **virtual machine**, which responds to defined data — the **control language** in a defined manner regardless of the characteristics of the physical machine used at the applications level. Each type of virtual machine utilizes a distinct **dialect** within the overall control language. **Common** and **virtual machine** (type specific) messages are **presentation** layer constructs.

The **session** layer (5) connects two presentation entities and controls communications between them. It provides such services as mapping logical addresses to physical addresses, identification of the dialect required for the type of machine used, error recovery, etc. **System service** control messages relating to linkage and grouping are considered **session** layer activities.

The **transport** layer (4) normally manages data to and from the session layer, isolating it from potential changes in hardware technology. To do this, this layer may break up messages into smaller packets, and provide the means for them to be received correctly at the other end. It provides for safe transport of system data. There are arguably no true transport layer functions required by the ESbus structure; thus, it is considered that this layer's function is encompassed by the **system service** control structure.

The **network** layer (3) provides message blocking (concatenation) and segmentation such as to allow more effective use of the message block. **System service** control messages relating to blocking and segmentation are considered **network** layer activities.

The **data link** layer (2) establishes communication between physical units connected to the network and provides data synchronization, data transfer, and error recovery services. Local networks include an **access** sublevel within the data link which apportions use of the network between several connected entities. The access method used in this guideline is polling initiated by the bus controller. SMPTE RP 113 **supervisory** protocol provides datalink layer functions.

The **physical** layer (1) consists of the electrical and mechanical specifications which define the actual communication channel. ANSI/SMPTE 207M provides these specifications.

Figure 1 illustrates the functional distribution of ESbus functions within the OSI model layers.

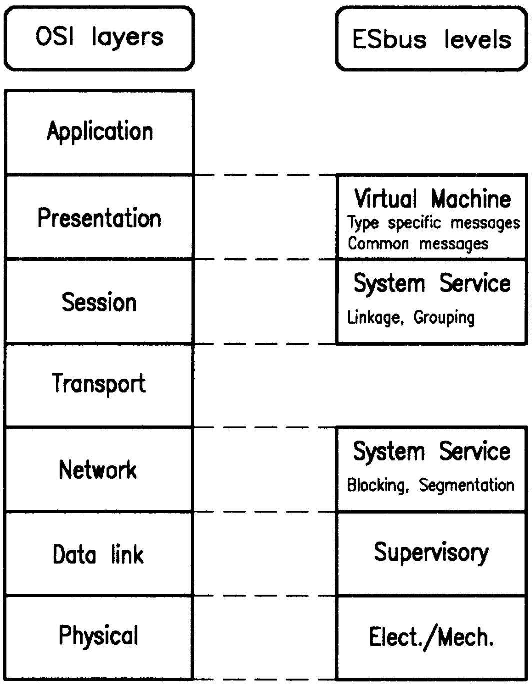

Figure 1 – Functional distribution of ESbus functions

4 Specifications

4.1 General

The specification set out in the following sections conforms to the interpretation of the OSI model.

The presentation layer (6), the virtual machine, for a broadcast equipment control standard is defined by the individual equipment type-specific message. The relevant protocol is commonly referred to as the message language. Each generic equipment type (e.g., video tape recorder, audio tape recorder, telecine, vision mixer, etc.) is allocated a specific subset of messages, a dialect, which takes account of all necessary controllable functions.

Clause 4.2 describes the supervisory protocol for the interface bus in the basic local network, a function of the data link layer. Clause 4.3 deals with tributary interconnections both within the local network and through an interconnection bus.

Clause 4.4 describes the electrical and mechanical characteristics physical link (OSI layer 1) of the interface bus.

4.2 Bus controller

A bus controller is associated with each local network. It supervises communications between all other devices which are connected to the network through the use of a supervisory protocol. The bus controller may be incorporated into a device which performs additional functions, such as an operational control panel, but it is a distinct system entity whose function is delivery of control messages and the management of the control network. The supervisory protocol is specified in SMPTE RP 113.

4.3 Tributaries

Each operational device in a system connects to the network through a tributary. A tributary transfers the messages to and from an operational device as specified by the system supervisory protocol. The tributary may be a distinct unit of equipment, or incorporated into an operational device. In any event, it is a distinct logical entity with the function of managing the network interface, synchronizing with network data flow, detecting errors, and delivering control messages to and from the controlled equipment. The tributary interconnection is specified in SMPTE RP 139.

4.4 Interface bus

The interface bus is the communication channel which carries the messages between tributaries and the bus controller. Its electrical and mechanical specifications are provided in ANSI/SMPTE 207M.

4.5 Control message architecture

Control message language is composed of vocabulary, syntax, and semantics expressed in terms of tokens, rules, and actions, respectively.

The control message architecture is described in SMPTE RP 138. The primary intent of this practice is to define the architecture of the messages to be transmitted within the supervisory protocol of the communications channel for the purpose of controlling equipment by external means. Syntax is the set of rules which shall be applied to the vocabulary (tokens) to construct control messages.

4.6 System service messages

System service messages can affect all participants on the bus, tributaries as well as the bus controller; their effect, however, differs as between tributaries and the bus controller.

Some system service messages address the bus controller only. These originate in a tributary and cause the bus controller to set up a new internal condition, or to originate further messages.

Other system service messages are sent by the bus controller to accomplish linkage tasks in tributaries. The content of the system service messages is described in SMPTE RP 163.

4.7 Common messages

Common messages are used to perform certain functions common to all equipment types within a general-purpose communications channel of an interface system.

The content of the common messages is described in SMPTE RP 172.

4.8 Type-specific machine messages

The documents listed in this section define the type-specific virtual machine messages which are applicable to specific types of machines. Type-specific messages applicable to various categories of equipment shall be as follows:

– Audio tape recorders: SMPTE RP 171;
– Video tape recorders: SMPTE RP 170.