SMPTE RECOMMENDED PRACTICE

RP 139-1997
Revision of RP 139-1992

Tributary Interconnection for Digital Control Interface

1 General

1.1 Scope

This practice describes the mechanism for the transfer of control messages between tributaries used within a general-purpose communications channel of an interface system which transports data and digital control signals between equipment utilized in the production, post-production, and/or transmission of visual and aural information.

It is intended that the mechanism described in this practice be utilized when transferring control messages between tributaries used as a part of an overall system. The tributaries may be located either within a local network or on separate local networks which are interconnected by means of gateways and an interconnection bus.

It is further intended that this mechanism, when used as part of an overall system, shall allow the interconnection of programmable and nonprogrammable equipment as required to configure an operational system with defined functions, and will allow rapid reconfiguration of a system to provide more than one defined function utilizing a given group of equipment.

1.1.1 The message transfer mechanism makes use of virtual circuits, linkage directories, and system service messages (defined below).

1.1.2 The primary intent of this practice is to define the mechanism enabling the transfer of messages between tributaries for the purpose of controlling equipment by external means.

1.2 Definitions

For the purposes of this practice, the following definitions shall apply:

1.2.1 virtual machine: A logical device consisting of a single device or a combination of devices that respond in essence or effect as a generic type of equipment; e.g., VTR, video switcher, telecine, etc.

1.2.2 virtual circuit: A transparent, unidirectional, logical communications connection between virtual machines. The communications path, in reality, passes through other levels and is propagated over a physical medium.

2 Normative references

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

CCITT Recommendation X.21, Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Synchronous Operation on Public Data Networks

CCITT Recommendation X.24, List of Definitions for Interchange Circuits Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) on Public Data Networks

CCITT Recommendation X.25, Interface Between Data Terminal Equipment (DTE) and Data Circuit-

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Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit

CCITT Recommendation X.27, Electrical Characteristics for Balanced Double-Current Interchange Circuits for General Use with Integrated Circuit Equipment in the Field of Data Communications

ISO 4903:1989, Information Technology — Data Communication — 15-Pole DTE/DCE Interface Connector and Contact Number Assignments

ISO/IEC 3309:1993, Information Technology — Telecommunications and Information Exchange Between Systems — High-Level Data Link Control (HDLC) Procedures — Frame Structure

ISO 4335:1993, Information Technology — Telecommunications and Information Exchange Between Systems — High-Level Data Link Control (HDLC) Elements of Procedures

3 Interconnection within a local network

3.1 Message transfer

The mechanism for message transfer between tributaries is based broadly on the principles of communications layering and makes use of virtual circuits. This allows for the establishing of, and breaking down of, multiple links between the tributaries. System service messages perform this function.

A linkage directory is established within the bus controller for each working session. The directory is considered to be a system service feature and provides for the establishment of multiple virtual circuits through the network.

3.2 Linkage directory

The linkage directory shall establish a relationship between virtual machines; i.e., a virtual circuit. Establishment of the linkage directory shall be completed as the initial task in each working session. The linkage directory resident within the system service level of the bus controller binds message sources and destinations.

Linkage information may originate in any application level, and shall effect directory construction within the system service level of the bus controller. Linkage messages are reserved messages within the system service subset of all message dialects; they establish and disconnect virtual circuits within the network.

The bus controller, on receipt of a transmission request from the supervisory level of any tributary, will identify the destination tributary by reference to the linkage directory; acting as an intermediary, it will forward the message as directed.

3.3 Multiplexing within tributaries

Tributaries, in general, have a single supervisory level address, and a single physical connection end point to the bus. Alternative multiplexing mechanisms, as described below, enable multiple virtual circuits to pass through any single connection end point.

3.3.1 Multiple, logically independent virtual machines, each with a unique supervisory level address, may be attached to the communications channel through a common connection end point. Multiplexing is then performed by multiple polling of the addressing entity residing within the supervisory level (see figure 1).

NOTE - It may be noted that any individual tributary address may achieve a higher priority — and hence an improved response time at the expense of that of the remaining tributaries — by being allocated more than one poll within each poll sequence.

3.3.2 Alternatively, a single supervisory level address may be multiplexed to multiple logically independent virtual machines with selection being performed by a logical switch residing within the entity of the destination tributary system service level (see figure 2).

The required virtual machine is selected from those associated with the single supervisory level address, by means of a system service virtual-machine-select message (see 4.4). This is transmitted from the bus controller under the direction of the linkage directory held within its system service level, to the destination tributary system service level, immediately prior to the transmission of any control message, or sequence of control messages, destined for that specific virtual machine.

The selected routing will remain in existence until receipt, by the system service level, of a new virtual-machine-select message thereby minimizing the message traffic on the communications channel.

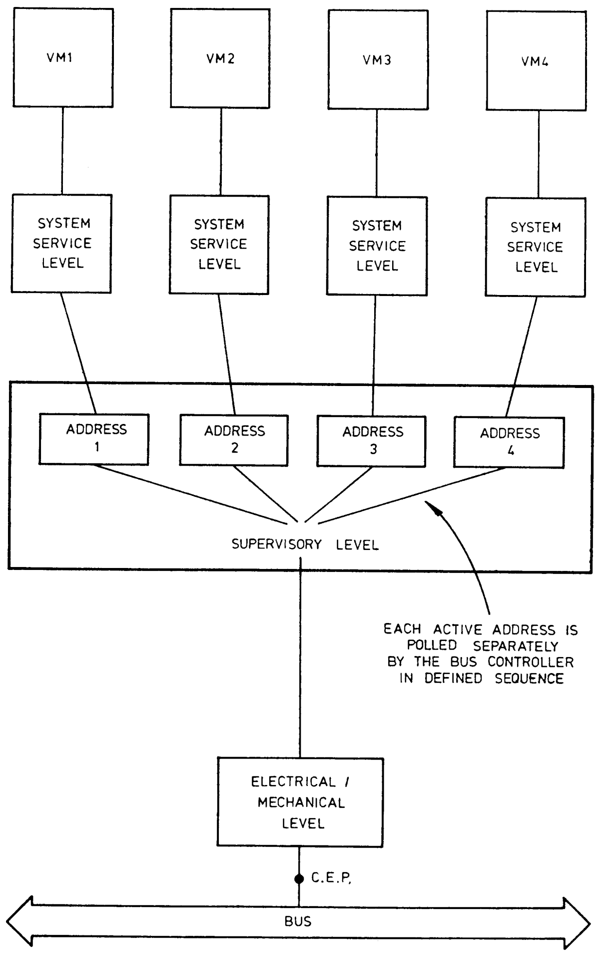

Figure 1 – Multiplexing within supervisory level

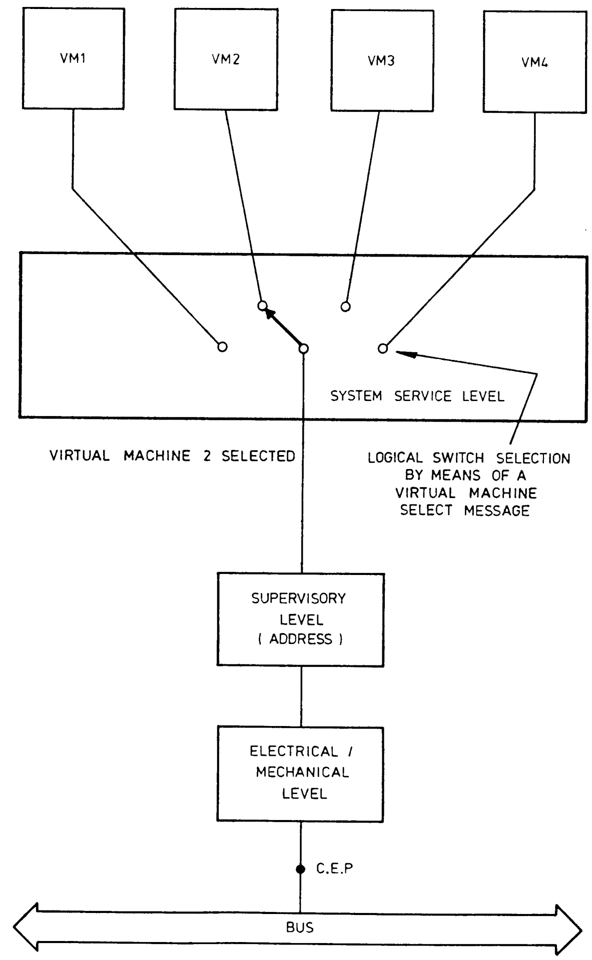

Figure 2 – Multiplexing within system service level

3.3.2.1 The reverse route of each virtual circuit, when required, will be selected similarly by the logical switch resident within the entity of the system service level of the multiplexed tributary. This selection is performed on receipt of a control or response message from any one of the virtual machines attached to the system service level of the tributary. The system service level will then instruct its supervisory level to transmit the appropriate virtual-machine-select message to the supervisory, and hence the system service, level of the bus controller.

3.3.2.2 System service level group assign and deassign commands shall be used to assemble/disassemble groups of virtual machines within the system service level, from those associated with a single supervisory level address, for simultaneous control purposes.

Virtual circuits employing virtual group identifiers shall be recorded as additional entries within the bus controller linkage table.

3.3.3 It should be noted that a bus overhead exists in each method of virtual circuit multiplexing. Where the multiplex is to take place within the supervisory level (3.3.1), the overhead will take the form of additional polls in each cycle.

System service level multiplexing (3.3.2) introduces an additional control message (the virtual-machine-select message) prior to each virtual machine message, or series of virtual machine messages, destined for an alternative virtual machine.

The choice of multiplexing mechanism, where used, rests with the system designer in recognition of specific design considerations.

3.4 Forbidden configurations

Some virtual circuit configurations may be forbidden due to the function of the particular tributary; i.e., the functions of the tributaries are incompatible. Checking mechanisms should be employed to ensure that illegal virtual circuits cannot be established. Most of the checking would be performed in the system service level according to predefined rules within the particular network. Some rules could be readily derived from the type of tributary (built in) while others may be imposed by the user or system designer.

4 System service messages

System service messages are messages contained in the system service subset of all message dialects and shall be used to command the performance of system functions. These functions include but are not limited to:

4.1 Segmentation and reassembly

These processes enable the transfer of messages which exceed the maximum supervisory level message block length (see figure 3a). The parsing mechanism for segmentation and blocking is described by the state diagram given in figure 4.

4.1.1 A data segment shall take the following form (see figure 3b):

– 1st byte: Keyword SEGMENT.

– 2nd byte: Number of segments remaining; last segment is 0; segment count shall be sent in sequentially descending order.

– Remaining bytes: Segment data. No further message shall follow a data segment message within a single supervisory level block.

4.2 Blocking and deblocking

These processes enable the concatenation of messages within a single supervisory level message block.

4.2.1 A data block shall take the following form (see figure 3c):

– 1st byte: Keyword BLOCK.

– 2nd byte: Byte count (N), where N is the number of bytes in the block data.

– Remaining bytes: Block data.

4.2.2 The supervisory level shall transfer the byte count to the system service level.

4.3 Establishment of virtual circuits

This process is effected through the management of the linkage directory contained within the bus controller.

4.4 Selection of a virtual machine

This process enables the selection of a virtual machine from those previously assigned to a tributary.

4.5 Tributary reset

This command returns the tributary to its power-up default state.

4.6 Group assign/deassign

These commands establish/break down system service level groups of virtual machines for joint control purposes.

4.7 Virtual group assign/deassign

These commands establish/break down supervisory level groups of tributaries for joint control purposes.

5 Interconnection of local networks

5.1 Interconnection bus

Interconnection of individual local networks shall be by means of an interconnection bus (see figure 5). Linking of the local network to the interconnection bus shall be by means of a GATEWAY.

ISO/IEC 3309 and 4335 (HDLC), in accordance with CCITT Recommendation X.25 — LAPB, shall be used for the data link layer protocol between the gateway and the interconnection bus coupler; the physical interface shall employ the connector and pin assignment as specified by CCITT Recommendation X.21 (ISO 4903); using balanced signalling as specified by CCITT Recommendation X.27; and with interface signals as specified by CCITT Recommendation X.24.

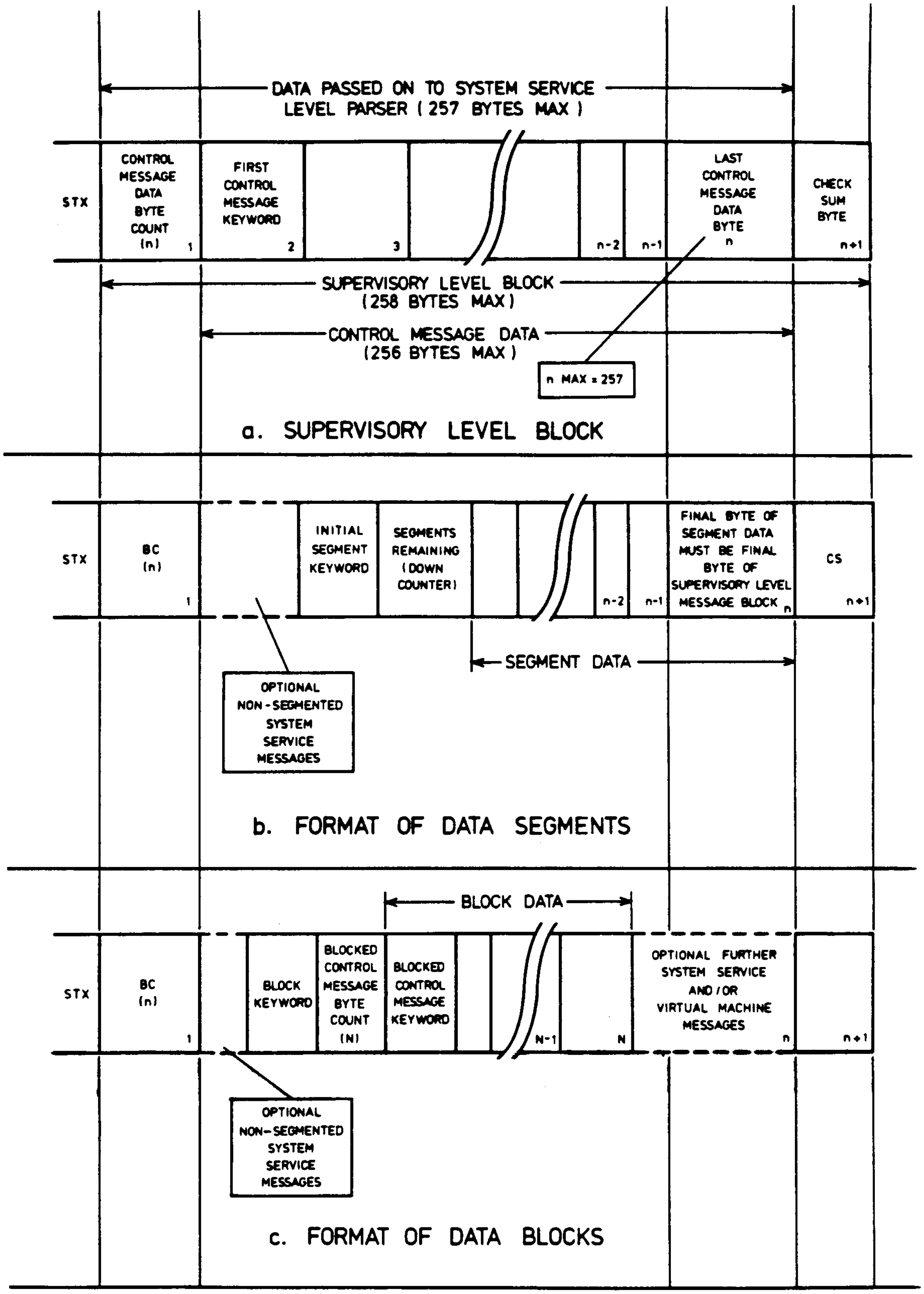

Figure 3 – Data segments and blocks

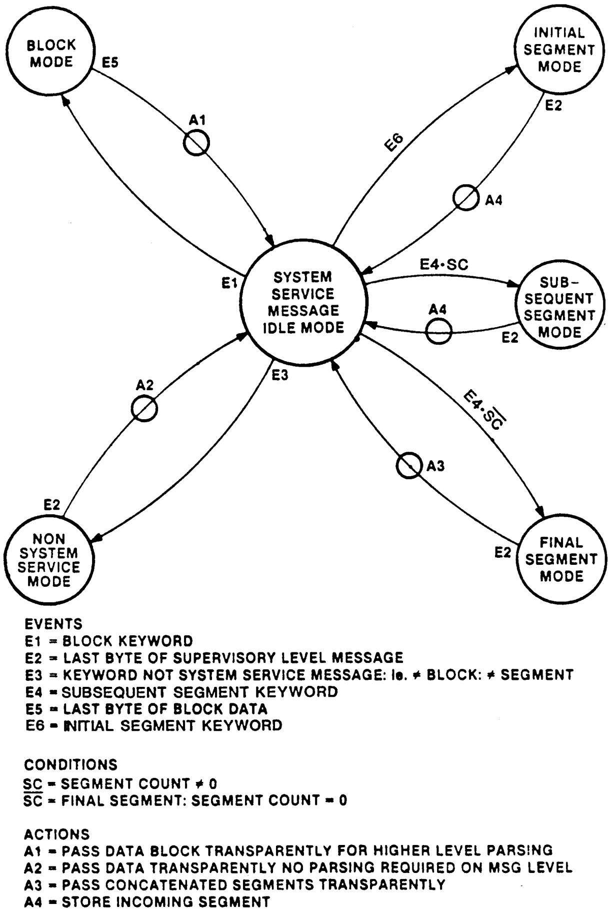

Figure 4 – Segmentation/blocking state diagram

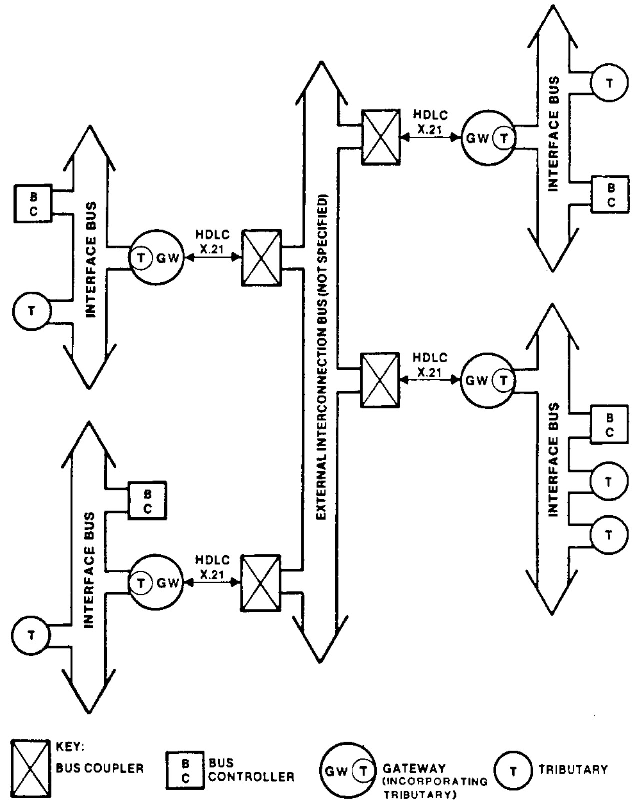

Figure 5 – Local network interconnection

5.2 Gateway

The gateway is a logical device whose task is to transfer messages between a local network and an external interconnection bus coupler. The gateway provides for the interchange of messages between multiple local networks.

The gateway will maintain a linkage directory in its system service level. The linkage table will allow the gateway to be seen by the bus controller as a set of virtual tributaries linked by virtual circuits.

The gateway will provide for all protocol conversions required to convert from the interface bus supervisory and electrical/mechanical level standards as specified in SMPTE RP 113 and ANSI/SMPTE 207M, respectively, to the HDLC data link and X.21 physical link layers.

The gateway will provide decoding of group addresses provided for in the supervisory level (SMPTE RP 113) and will forward messages addressed to these groups over the interconnection bus as discrete individual select addresses. Where more than one external tributary is addressed by a group message, the individual messages to all such tributaries shall be dispatched sequentially as individual messages from the gateway. Translation takes place in the system service level of the gateway. The functional structure of the gateway is shown in figure 6.

6 Guidelines

This clause gives a typical example of virtual machine selection when using the multiplexing technique detailed in 3.3.2. It encompasses operations in both the system service and supervisory levels and thus includes features described in SMPTE RP 113.

In 6.1, the procedure is described in broad outline; in 6.2, the same example is dealt with in more rigorous detail.

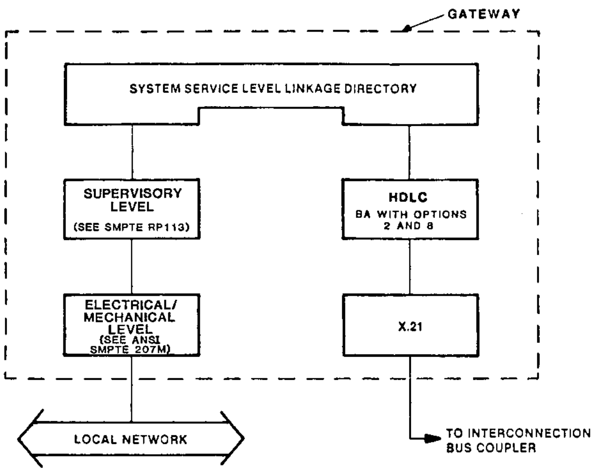

Figure 6 – Gateway functional structure

6.1 In this broad outline, the form of the messages is not defined precisely, but is given only as an illustration of the function to be performed.

(A) Assume that three control panels are linked to the local network through a single tributary address and connection end point as shown in figure 7.

During the assignment process, the control panels CP1, CP2, and CP3 have been associated with VTR, telecine, and still store, respectively, via virtual circuits (1), (2), and (3).

(B) Assume further that a VTR command has just been issued by CP1 and a telecine PLAY command is now required.

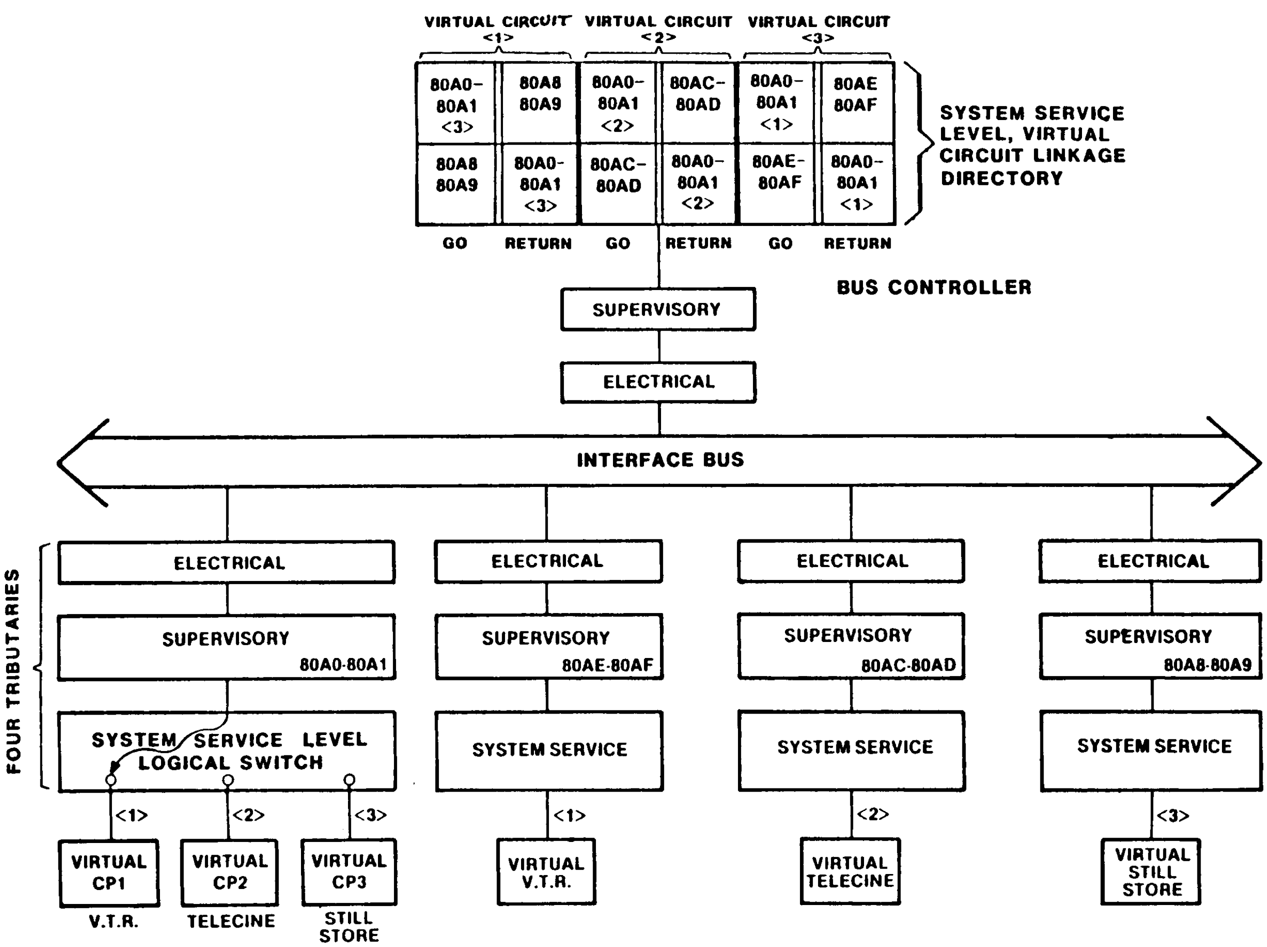

Figure 7 – Example of virtual circuit select mechanism

(C) The following linkage message must be issued by the system service level of the control panel tributary:

[Virtual-machine-select] [2]

This changes the virtual machine selection from virtual machine [1], (VTR), to virtual machine [2], (telecine).

(D) The control panel virtual machine then issues the control message:

[PLAY]

This causes the telecine virtual machine to change to the play state.

Any subsequent messages from the control panel to the telecine will be transferred without any further linkage; e.g., the control message [STOP].

A [NEXT SLIDE] command for the still store virtual machine would, however, require:

1. [Virtual-machine-select] [3] and
2. [NEXT SLIDE]

in order to reselect the virtual machine CP3.

6.2 In this more rigorous treatment of the example given in 6.1, it is assumed that the three control panel virtual machines, CP1, CP2, and CP3, are linked to the interface bus through the single tributary address [82A0/82A1] and connection end point.

6.2.1 A [START] command from the telecine control panel virtual machine CP2 attached to tributary 82A0/82A1 is to be sent by virtual circuit [2] to the telecine virtual machine connected to tributary 82AC/82AD. A possible message exchange might be:

(A) Telecine control panel virtual machine, (CP2), passes [START] command to system service level of tributary 82A0/82A1.

(B) 82A0/82A1 system service level instructs supervisory level to raise the service request flag (SVC).

(C) The bus controller, as part of its normal poll sequence, polls 82A1; and receives [SVC].

(D) The bus controller issues select address 82A0; it then sends [TEN] to 82A0/82A1 supervisory level.

(E) 82A0/82A1 supervisory level sends:

[STX] [byte count (BC)] [virtual-machine-select] [2] block check (B.CK)]

to the bus controller (see note 1).

(F) The bus controller responds with [ACK] and a further [TEN].

(Since the last message was a virtual-machine-select message, a further virtual machine control message is expected by the bus controller) (see note 1).

(G) The supervisory level of the tributary 82A0/82A1 sends:

[STX] [BG] [START] [B.CK]

to the bus controller (see note 1).

(H) The bus controller system service level identifies the destination of [82A0/82A1 — virtual-machine 2] from its linkage directory. The address is found to be 82AC/82AD.

(I) The bus controller issues [BREAK] followed by the select address 82AC.

(J) 82AC/82AD tributary supervisory level responds with [ACK].

(K) The bus controller then sends:

[STX] [BC] [START] [B.CK]

to tributary 82AC/82AD.

(L) The supervisory level of tributary 82AC/82AD responds with [ACK] and passes the control message to the system service level parser.

(M) The system service level parser passes the [START] command to the telecine virtual machine.

NOTE 1 - The messages in (E) and (G) might be concatenated into the single hybrid command:

[STX] [BC] [virtual-machine-select] [2] [BLOCK] [START] [B.CK]

in order to limit protocol overhead. In this case, the message contained in (F) would not be necessary.

6.2.2 A tally response [STARTED] from the telecine virtual machine tributary 82AC/82AD is to be sent to telecine control panel virtual machine CP2 attached to the interface bus through tributary 82A0/82A1.

(A) The telecine virtual machine passes the [STARTED] tally to the system service level of tributary 82AC/82AD.

(B) The system service level instructs the supervisory level of 82AC/82AD to raise the service request flag (SVC).

(C) The bus controller, as part of its normal poll sequence, polls 82AD and receives [SVC].

(D) The bus controller issues the select address 82AC, followed by [TEN] to the supervisory level of 82AC/82AD.

(E) The bus controller receives the tally:

[STX] [BC] [STARTED] [B.CK]

from 82AC/82AD.

(F) The bus controller system service level determines the destination (82A0/82A1 — virtual machine 2) from its system service level linkage directory.

(G) The bus controller issues [BREAK] and the select address 82A0.

(H) 82A0/82A1 supervisory level responds with [ACK].

(I) The bus controller sends:

[STX] [BC] [virtual-machine-select] [2] [B.CK]

to tributary 82A0/82A1 (see note 2).

(J) The tributary 82A0/82A1 responds with [ACK], and sets the logical switch in its system service level to select telecine control panel virtual machine CP2.

(K) The bus controller sends tally:

[STX] [BC] [STARTED] [B.CK]

to tributary 82A0/82A1 supervisory level (see note 2).

(L) The supervisory level of tributary 82A0/82A1 responds with [ACK] and passes the control message to the system service level parser.

(M) The system service level parser passes [STARTED] tally to the telecine control panel virtual machine CP2.

NOTE 2 - The messages in (I) and (K) might be concatenated into a single hybrid command thus:

[STX] [BC] [virtual-machine-select] [2] [BLOCK] [STARTED] [B.CK]

in order to limit protocol overhead.

6.2.3 It should be noted that further commands to the same virtual machine, and which follow immediately on the sequences detailed in 6.2.1, will omit steps (E) and (F) since no further changes are needed in the virtual machine selection.

Similarly, 6.2.2 steps (I) and (J) will be omitted under the same circumstances.

Annex A (informative)
Bibliography

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

SMPTE RP 113-1996, Supervisory Protocol for Digital Control Interface