International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

I.733
(03/2009)

SERIES I: INTEGRATED SERVICES DIGITAL NETWORK

B-ISDN equipment aspects – ATM equipment

Voice on ATM circuit multiplication equipment

Recommendation ITU-T I.733

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Recommendation ITU-T I.733

Voice on ATM circuit multiplication equipment

Summary

The purpose of a voice on ATM circuit multiplication equipment (VACME) is to provide a bandwidth efficient means of connecting TDM-based international switching centres (ISCs) and an ATM network. In addition to providing traditional CME functions, the equipment will have additional capabilities such as ATM multiplexing to optimize bandwidth utilization.

VACME is a general switched telephone network (GSTN) trunking equipment using pulse code modulation (PCM) and low rate encoding technique together with digital speech interpolation (DSI) and facsimile demodulation/remodulation. Recommendation ITU-T I.733 addresses key issues, such as interfaces, signal processing functions, ATM adaptation layer mappings, and OAM functions, to be used in VACME in order to ensure the interworking of this equipment.

Source

Recommendation ITU-T I.733 was approved on 16 March 2009 by ITU-T Study Group 16 (2009-2012) under Recommendation ITU-T A.8 procedures. This version also includes Corrigendum 1 approved on 14 December 2009.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Voice on ATM circuit multiplication equipment

1 Scope

The purpose of a voice on ATM circuit multiplication equipment (VACME) is to provide a bandwidth efficient means of connecting TDM-based international switching centres (ISCs) and an ATM network. In addition to providing traditional circuit multiplication equipment (CME) functions, the equipment will have additional capabilities such as ATM multiplexing to optimize bandwidth utilization.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.703] Recommendation ITU-T G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces*.

[ITU-T G.704] Recommendation ITU-T G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.

[ITU-T G.711] Recommendation ITU-T G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

[ITU-T G.723.1] Recommendation ITU-T G.723.1 (2006), *Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s*.

[ITU-T G.726] Recommendation ITU-T G.726 (1990), *40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)*.

[ITU-T G.728] Recommendation ITU-T G.728 (1992), *Coding of speech at 16 kbit/s using low-delay code excited linear prediction*.

[ITU-T G.729] Recommendation ITU-T G.729 (2007), *Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction*.

[ITU-T G.732] Recommendation ITU-T G.732 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*.

[ITU-T G.733] Recommendation ITU-T G.733 (1988), *Characteristics of primary PCM multiplex equipment operating at 1544 kbit/s*.

[ITU-T G.736] Recommendation ITU-T G.736 (1993), *Characteristics of a synchronous digital multiplex equipment operating at 2048 kbit/s*.

[ITU-T G.763] Recommendation ITU-T G.763 (1998), *Digital circuit multiplication equipment using G.726 ADPCM and digital speech interpolation*.

[ITU-T G.767] Recommendation ITU-T G.767 (1998), *Digital circuit multiplication equipment using 16 kbit/s LD-CELP, digital speech interpolation and facsimile demodulation/remodulation*.

[ITU-T G.775] Recommendation ITU-T G.775 (1998), *Loss of Signal (LOS), Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) defect detection and clearance criteria for PDH signals*.

[ITU-T G.803] Recommendation ITU-T G.803 (2000), *Architecture of transport networks based on the synchronous digital hierarchy (SDH)*.

[ITU-T G.804] Recommendation ITU-T G.804 (2004), *ATM cell mapping into plesiochronous digital hierarchy (PDH)*.

[ITU-T I.363.1] Recommendation ITU-T I.363.1 (1996), *B-ISDN ATM Adaptation layer specification: Type 1 AAL*.

[ITU-T I.363.2] Recommendation ITU-T I.363.2 (1997), *B-ISDN ATM Adaptation layer specification: Type 2 AAL*.

[ITU-T I.366.2] Recommendation ITU-T I.366.2 (2000), *AAL type 2 service specific convergence sublayer for narrow-band services*.

[ITU-T Q.50] Recommendation ITU-T Q.50 (2001), *Signalling between Circuit Multiplication Equipment (CME) and International Switching Centres (ISC)*.

3 Definitions

This Recommendation defines the following terms:

3.1 circuit multiplication equipment (CME): A generic type of the equipment, including all these types of equipment such as DCME, PCME, IP-CME, VACME and channel transcoder, having a number of 64 kbit/s PCM encoded input trunks, compressing speech signals on channel basis in various ways and sending them out through various types of bearers including STM type, packetized type, ATM type and IP type.

3.2 circuit multiplication system (CMS): A telecommunications network comprised of two or more interoperating CME terminals where each CME terminal contains a transmit unit and a receive unit.

3.3 comfort noise: Artificially generated noise signal at the receive side to compensate for the silent part of conversation that was removed by the send side and that gives a comfortable feeling to the receiver when silence elimination is introduced. It is desirable for a comfort noise to have the characteristics similar to those of the original background noise signal that was suppressed (e.g., in terms of its level and spectrum).

3.4 digital circuit multiplication equipment (DCME): A general class of equipment which permits concentration of a number of 64 kbit/s PCM encoded trunk circuits on a reduced number of transmission circuits.

3.5 digital speech interpolation (DSI): A process which, when used in the transmit unit of a VACME, causes digital voice signals of a trunk channel to be mapped into ATM cells transferred through an ATM network only when activity is actually present on the trunk channel. This, by exploiting the probability of the speech activity factor of trunk channels being less than 1.0, enables the traffic from a number of trunk channels to be concentrated and carried by a lesser number of ATM cells compared with the number of cells necessary for continuous connections.

NOTE – A similar concept is defined in [ITU-T G.763], [ITU-T G.767], and [b-ITU-T G.768], however, in specific terms as applicable to these Recommendations.

3.6 facsimile demodulation/remodulation: A processing introduced in a VACME where facsimile traffic is discriminated from voiceband data; subsequently demodulated to recover the baseband digital signal; mapped into ATM cells; demultiplexed in the VACME receive unit; and remodulated using the same modulation scheme as used on the original signal received by the VACME transmit unit.

NOTE – A similar concept is defined in [ITU-T G.763], [ITU-T G.767], and [b-ITU-T G.768], however, in specific terms as applicable to these Recommendations.

3.7 low rate encoding (LRE): A voiceband signal encoding method which results in a bit rate less than 64 kbit/s. Conversion between voiceband signals encoded in PCM at 64 kbit/s and those encoded at the lower rates will be carried out by the means specified in the referred ITU-T Recommendations.

NOTE – In [ITU-T G.763], [ITU-T G.767], and [b-ITU-T G.768], LRE is defined in slightly different terms, as specifically needed in these Recommendations.

3.8 silence elimination: A process that suppresses the transmission of the inactive part of the silent part of conversation to attain efficient transmission of a voice conversation. When silence elimination is introduced, it is necessary to insert comfort noise at the receive side, to compensate for the suppressed silence periods present during listening and pause time intervals. This process is also sometimes called **silence suppression**.

NOTE – A similar concept is used in [ITU-T G.763], [ITU-T G.767], and [b-ITU-T G.768], however, in specific terms as applicable to these Recommendations.

3.9 trunk channel (TC): A unidirectional, digital transmission path (generally short distance) used for carrying traffic and which connects a VACME to other equipment, e.g., an ISC. Two such trunk channels (transmit and receive) are needed by 4-wire telephone circuits and constitute a trunk circuit.

NOTE 1 – Signals carried by a trunk channel are transmitted at a bit rate of 64 kbit/s.

NOTE 2 – A number of trunk channels in each direction of transmission are required between a VACME CME and, for instance, an ISC. These trunk channels may be carried by a number of 2048 or 1544 kbit/s systems for example.

3.10 voice on ATM circuit multiplication equipment (VACME): A class of equipment which allows for the concentration of a number of 64 kbit/s PCM encoded input trunk circuits onto a reduced amount of bandwidth in the ATM domain. ATM cross-connection and multiplexing functions allow for a more efficient use of bandwidth.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
ADPCM	Adaptive Differential Pulse Code Modulation
AIS	Alarm Indication Signal
AMI	Alternate Mask Inversion
ATM	Asynchronous Transfer Mode
BAIS	Backward Alarm Indication Signal
BER	Bit Error Rate
B3ZS	Bipolar with three-Zero Substitution
B8ZS	Bipolar with eight-Zero Substitution
BMAIS	Backward Multiframe Alarm Indication Signal
CID	Channel Identifier
CME	Circuit Multiplication Equipment

CMS	Circuit Multiplication System
CPS	Common Part Sublayer
CS-ACELP	Conjugate-Structure Algebraic-Code-Excited Linear Prediction
DCME	Digital Circuit Multiplication Equipment
DLC	Dynamic Load Control
DSI	Digital Speech Interpolation
GSTN	General Switched Telephone Network
HBER	High BER Condition
HDB3	High Density Bipolar of order 3 code
ISC	International Switching Centre
LD-CELP	Low-Delay Code Excited Linear Prediction
LOF	Loss of Frame
LOMF	Loss of Multiframe
LOS	Loss of Input Signal
LRE	Low Rate Encoding
PCM	Pulse Code Modulation
PDH	Plesiochronous Digital Hierarchy
PLCP	Physical Layer Convergence Protocol
PVC	Permanent Virtual Channel
SAR	Segmentation and Reassembly
SDT	Structured Data Transfer
SID	Silence Insertion Descriptors
SSCS	Service Specific Convergence Sublayer
STM	Synchronous Transfer Mode
Timer_CU	Timer-Combined Use
TS0, TS16	Time Slot 0 or 16 of a 2048 kbit/s G.704 frame
VACME	Voice on ATM Circuit Multiplication Equipment
VBD	VoiceBand Data
VCI	Virtual Channel Identifier
VPI	Virtual Channel Path Identifier

5 VACME functions

The purpose of a voice on ATM circuit multiplication equipment (VACME) is to provide a means of augmenting the traffic capacity of ATM facilities operating between international switching centres (ISCs) and sources of ATM traffic. In addition to providing traditional DCME functions, the equipment will have additional capabilities such as ATM multiplexing to optimize bandwidth utilization.

This Recommendation applies to VACME telecommunication systems and specifies the following major aspects of VACME system:

a) Network interface requirements:
   - PDH facility interfaces;
   - ATM facility interfaces;
   - Signalling systems.

b) Functional requirements:
   - digital speech interpolation (DSI) with associated functions such as activity detection, silence removal and noise measurement and insertion;
   - silence elimination;
   - low rate encoding (LRE);
   - capability to accommodate the following connection types:
     i) speech;
     ii) 3.1 kHz audio;
     iii) facsimile;
     iv) n × 64 kbit/s
     v) 64 kbit/s and 128 kbit/s (the latter is under study) unrestricted;
   - input traffic classification;
   - conversion between A-law and μ-law;
   - a means to accommodate pre-assigned traffic, including n × 64 kbit/s;
   - facsimile and voiceband data demodulation/remodulation;
   - timeslot interchanger;
   - timing and synchronization;
   - dynamic load control (DLC) for PDH and ATM traffic;
   - maintenance and alarm functions (equipment, PDH and ATM facilities);
   - ATM adaptation;
   - ATM cross-connection;
   - ATM multiplexing;
   - PDH echo control;
   - certain types of signalling interpretation.

   Compression is accomplished by actively monitoring the 64 kbit/s trunk circuit traffic and the appropriate assignment of a coding rate through traffic classification, in addition to traffic activity detection and silence removal. The system shall also provide for the interpretation of ISDN requests for 128 kbit/s unrestricted transit and for [ITU-T Q.50] signalling.

c) Performance criteria of VACME system elements such as:
   - speech detector;
   - noise measurement;
   - traffic classifier;
   - signalling detector;
   - facsimile demodulation/remodulation;
   - voiceband data demodulation/remodulation.

This Recommendation specifies these elements to achieve interworking.

6 Reference model

The reference model of VACME is shown in Figure 1. The VACME is positioned between the STM and ATM networks. In this position, it provides compression for voiceband services and transport for digital services such as 64 kbit/s, 128 kbit/s (this latter is under study) and n × 64 kbit/s. It is also positioned within the ATM network to provide cross-connection and add-drop function for the different STM and ATM traffic.

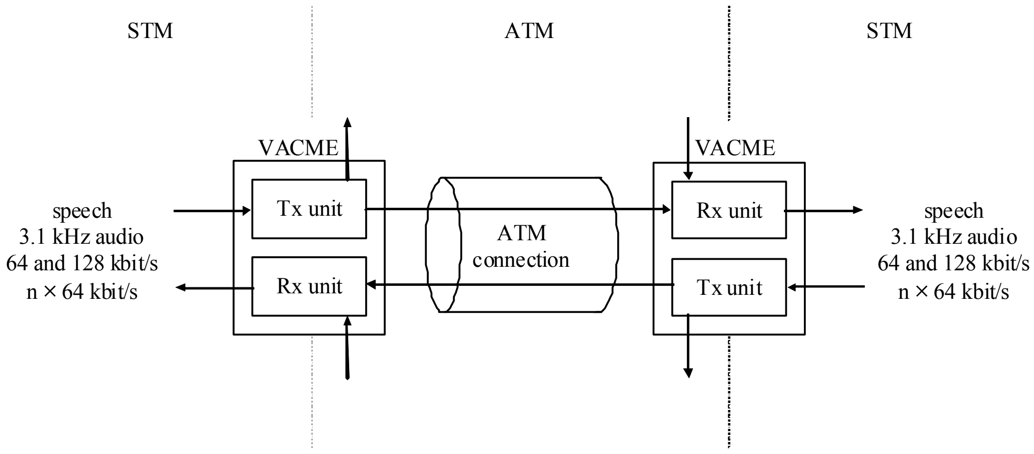

Figure 1 – Reference model of VACME

7 VACME functional description

7.1 VACME functional model

VACME is composed of the following general functional blocks: facility interface, signal processing function, ATM adaptation function, ATM cross-connect and multiplexing and control function. The functional block diagram of VACME is shown in Figure 2.

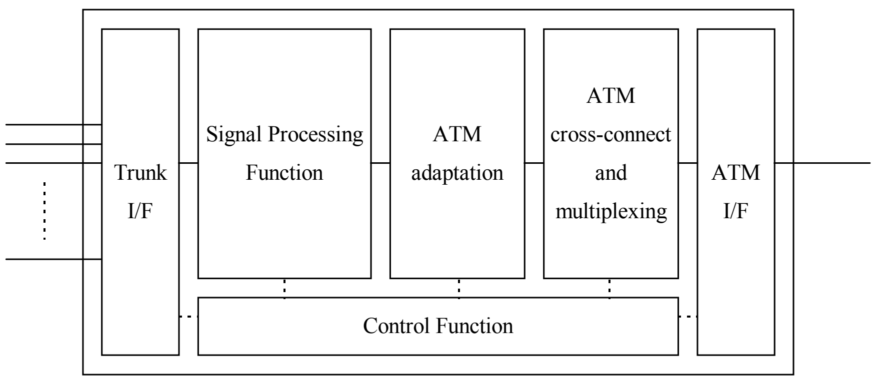

Figure 2 – Functional model of VACME

8 Interfaces

8.1 Transmission interface – Trunk side

8.1.1 Trunk side interface at 1544 kbit/s

a) The electrical characteristics shall comply with [ITU-T G.703]. The line code adopted shall be either AMI or B8ZS, depending on the user's selection.

b) The frame structure shall comply with [ITU-T G.704]. The multiframe size shall be either 24 frames or 12 frames, depending on the user's selection.

c) The encoding law for voice frequency signals shall conform to the μ-law system described in [ITU-T G.711].

8.1.2 Trunk side interface at 2048 kbit/s

a) The electrical characteristics shall comply with [ITU-T G.703]. The test load impedance shall be either 75 Ω unbalanced or 120 Ω balanced, depending on the user's requirement. The line code adopted shall be HDB3.

b) The frame structure shall comply with [ITU-T G.704]. The multiframe size shall be 16 frames.

c) The encoding law for voice frequency signals shall conform to the A-law system described in [ITU-T G.711].

8.2 ATM interface

8.2.1 Physical layer interface

1) The electrical characteristics shall comply with [ITU-T G.703]. The line code adopted shall be B3ZS.

2) The frame and multiframe structures shall comply with [ITU-T G.704].

8.3 Local alarms interface

The VACME must present alarms to the local entity according to the user's requirement. The choice of the physical/electrical interface is to be decided by the individual administration. In the case of individual voltage-free loop alarms, the categories of alarm in [ITU-T G.803] should be included. In the case of a serial alarm interface, it is recommended to provide, as a minimum, the following signals:

a) initial occurrence of an alarm in the monitored VACME;

b) initial occurrence of a clear in the monitored VACME;

c) receipt of a data request from the local entity;

d) initial system power-on.

8.3.1 Fault conditions (see Note)

The VACME unit shall detect the following fault conditions:

1) Failure of the incoming trunk primary group – The fault conditions are loss of incoming signal, loss of frame alignment or BER detected in frame alignment signal greater than 1 in 10^3 as defined in [ITU-T G.736], for 2048 kbit/s links. Primary group alarm indication signal (AIS) is not included.

2) Primary group AIS – AIS detected on trunk primary group.

3) Loss of 2048 kbit/s multiframe alignment as defined in clause 4.1 of [ITU-T G.732].

4) Alarm indication from the remote end (bit 3 of TS0) received from the local switch.

5) Failure of incoming ATM signal – The fault conditions are loss of incoming signal, loss of frame alignment, as defined in [ITU-T G.775].

6) Loss of multiframe alignment, clause 5.2 of [ITU-T G.732]

7) Alarm indication from the remote end received on ATM interface.

8) VACME failure or VACME power failure.

NOTE – Optionally, a time delay selectable up to 3 s maximum shall be provided before alarms are initiated or indications are transmitted in fault conditions 1), 4), 5) and/or 6).

8.3.2 Explanation of consequent actions

Following the detection of a fault condition, appropriate actions shall be taken as specified in Table 5.

The consequent actions are listed below:

a) Backward alarm indication to the remote end (towards local switches) generated – For 2048 kbit/s primary multiplex trunks, this is done by changing bit 3 of channel time slot 0 from state 0 to state 1 in frames not containing the trunk frame alignment signal (BAIS: clause 4.2.3 of [ITU-T G.732]) or bit 6, TS16 in frame 0 in the case of loss of multiframe alignment (BMAIS: clause 5.3.2.3 of [ITU-T G.732]). For 1544 kbit/s primary multiplex trunks, this is done by forcing bit 2 in every channel time slot to the value 0 or by modifying the S-bit for the 12-frame multiframe or by sending a frame alignment alarm sequence for the 24-frame multiframe (see [ITU-T G.733]). This consequent action shall be effected as soon as possible.

b) Alarm indication signal applied on relevant trunk circuits towards local switch(s), e.g., by AIS on relevant time slots and by means of the out-of-service message through the ISC.

c) AIS on primary trunk groups (all time slots).

d) Maintenance visual alarm indication generated to signify that performance is below acceptable standards and maintenance attention is required locally. When the AIS (see Note below) is detected, the maintenance visual alarm indication, associated with loss of frame alignment and excessive error rate in the frame alignment signal shall be inhibited, while the rest of the consequent actions associated with these four fault conditions shall be followed in accordance with Table 5.

   NOTE – The equivalent binary content of AIS on the trunk groups or time slots is a continuous stream of binary 1s. The strategy for detecting the presence of AIS will be such that with a high probability AIS is detectable even in the presence of random errors having a mean error rate of 1 in 10^3. Nevertheless, a signal in which all the binary elements, with the exception of the frame alignment signal, are in state 1, will not be taken as an AIS.

e) Backward alarm indication to the remote end generated – For 2048 kbit/s, structured bearers, this is done by changing bit 3 of time slot 0 from the state 0 to the state 1 in those frames not containing the bearer frame alignment signal (see [ITU-T G.732]). For 1544 kbit/s, structured bearers, this is done by forcing bit 2 in every channel time slot to the value 0, or by modifying the S-bit for the 12-frame multiframe, or by sending a frame alignment alarm sequence for the 24-frame multiframe (see [ITU-T G.733]). This consequent action shall be effected as soon as possible.

9 Signal processing functions

9.1 Trunk channels

The trunk channels may be either A or μ-law at 64 kbit/s.

9.2 Low rate encoding (LRE)

LRE is used to accommodate voiceband signals (speech, tones, voiceband data) at bit rates less than their original bit rate of 64 kbit/s. The VACME shall provide the capability of selecting from the set of codecs described in the following subclauses.

9.2.1 Low rate coding schemes

Speech codecs

- [ITU-T G.728] and its Annex H at the coding rate of 16 kbit/s, 12.8 kbit/s and 9.6 kbit/s
- [ITU-T G.729] at the coding rate of 8 kbit/s and 6.4 kbit/s

Voiceband data codecs

- [ITU-T G.728] Annex J at the coding rate of 40 kbit/s (for [b-ITU-T V.17] and below);
- [ITU-T G.711] 64 kbit/s (for [b-ITU-T V.34] and above)

For tone signals

- any of the above codecs may be assigned

Codec for supporting Signalling System No. 5 Tone signals

- [ITU-T G.728] 16 kbit/s ADPCM

9.2.2 Synchronous reset

To obtain better speech quality using low rate codecs, synchronous reset between the encoder and corresponding decoder shall take place to synchronize the internal variables and realize quicker convergence of the codecs, as employed in [ITU-T G.763] DCME.

Synchronous reset is required for CS-ACELP codecs, LD-CELP codecs and ADPCM codecs. When the codec pair gets the new assignment after the silence period, a synchronous reset shall be performed. A synchronous reset shall also take place when the input signal is reclassified and a different type of codec pair is to be used.

9.2.3 Frame alignment between different types of codecs

[ITU-T G.729] CS-ACELP codec, [ITU-T G.728] LD-CELP codec have different coding frame intervals, i.e., 10 ms, 2.5 ms. [ITU-T G.726] ADPCM codec and [ITU-T G.711] PCM codec have sampling periods of 125 μs. In I.733 VACME operation, LD-CELP coding frame boundary, ADPCM sample timing and PCM sample timing for a specific trunk channel shall be aligned with that of CS-ACELP coding frame boundary allocated to the trunk channel. No LD-CELP coding frame shall be split into two adjacent CS-ACELP frames for the trunk channel.

9.2.4 Processing delay adjustment

The theoretical processing delays of these three types of codecs are as follows.

Theoretical processing delay in encoders:

- 8 kbit/s and 6.4 kbit/s CS-ACELP: 15 ms (5 ms look-ahead delay plus 10 ms coding frame)
- 40 kbit/s LD-CELP: 0.625 ms (0.625 ms coding sub-frame)
- 16 kbit/s ADPCM: 125 μs (125 μs coding frame)

Processing delay in decoders will depend on the hardware and/or software design.

Should switchover of the codec types occur (e.g., due to the signal classification from voice to data) during the active part of input signal, the switchover from 8/6.4 kbit/s CS-ACELP codec to 40 kbit/s LD-CELP should follow. Without absorbing the difference of processing delays, not only a click noise will be heard, but also the duplication (or cut-off) of signal can occur. It should also be noticed that such kind of switchover may occur, although not desired and not often, when the input signal is misclassified.

It is important to avoid generating such unnecessary noises. To ensure the interoperability between the CME of different manufacturers, the absorption of delay difference shall be independently executed within the transmit unit and the receive unit. The real implementation of delay difference absorption will depend on the design, and the details are left to the manufacturers.

The equipment design is requested to take notice of the existence of processing delay difference between the different types of speech codecs used in a single equipment, and to absorb the difference of processing delay independently within the transmit unit and the receive unit.

9.2.5 Profiles for audio services

The default profiles of the codecs for voice and voiceband data transmission in I.733 VACME Audio service is as shown in Table 1. Optional example profiles for the case supporting [ITU-T G.729] codec with Generic SID and for the case supporting [ITU-T G.729] Annex B codec are indicated in Tables 2 and 3, respectively.

Table 1 – Default profile of the codecs for voice and voiceband data transmission

UUI codepoint range	Packet length (octets)	Description of algorithm	M	Packet time (ms)	Sequence number interval (ms)
0-7	40	[ITU-T G.711]-64 A-law	1	5	5
0-7	35	[ITU-T G.711]-56 A-law	1	5	5
0-7	1	Generic SID	1	5	5
8-15	40	[ITU-T G.711]-64 μ-law	1	5	5
8-15	35	[ITU-T G.711]-56 μ-law	1	5	5
8-15	1	Generic SID	1	5	5

Table 2 – Optional example profile of the codecs for voice and voiceband data transmission (for the support of [ITU-T G.729] with Generic SID)

UUI codepoint range	Packet length (octets)	Description of algorithm	Packet time (ms)	Sequence number interval (ms)
0-15	40	PCM, [ITU-T G.711]-64, generic	5	5
0-15	25	LD-CELP, [ITU-T G.728]-40	5	5
0-15	10	LD-CELP, [ITU-T G.728]-16	5	5
0-15	8	LD-CELP, [ITU-T G.728]-12.8	5	5
0-15	6	LD-CELP, [ITU-T G.728]-9.6	5	5
0-15	20	CS-ACELP, [ITU-T G.729]-8	20	5
0-15	16	CS-ACELP, [ITU-T G.729]-6.4	20	5
0-15	30	ADPCM, [ITU-T G.726]-16	15	5
0-15	1	Generic SID	10	5
NOTE – Generic SID is applied to all speech coding algorithms.				

Table 3 – Optional example profile of the codecs for voice and voiceband data transmission (for the support of [ITU-T G.729] Annex B)

UUI codepoint range	Packet length (octets)	Description of algorithm	Packet time (ms)	Sequence number interval (ms)
0-15	40	PCM, [ITU-T G.711]-64, generic	5	5
0-15	25	LD-CELP, [ITU-T G.728]-40	5	5
0-15	10	LD-CELP, [ITU-T G.728]-16	5	5
0-15	8	LD-CELP, [ITU-T G.728]-12.8	5	5
0-15	6	LD-CELP, [ITU-T G.728]-9.6	5	5
0-15	20	CS-ACELP, [ITU-T G.729]-8	20	5
0-15	16	CS-ACELP, [ITU-T G.729]-6.4	20	5
0-15	30	ADPCM, [ITU-T G.726]-16	15	5
0-15	2	[ITU-T G.729] SID	10	5
0-15	1	Generic SID	10	5
NOTE – Generic SID is applied only to [ITU-T G.711] and [ITU-T G.728] coding algorithms. [ITU-T G.729] SID is applied only to [ITU-T G.729] coding algorithms.				

9.3 Digital speech interpolation

Digital speech interpolation is a process which, when used in the transmit unit of a VACME, causes a speech signal data existing in the trunk channel to be mapped to the bearer transport cell only when activity is actually present on the trunk channel. This, by exploiting the probability of the speech activity factor of trunk channels being less than 1.0, enables the traffic from a number of trunk channels to be concentrated and carried using less capacity of shared bearer transport cells. The signals carried by the bearer transport cells therefore represent interleaved bursts of speech signals derived from a number of different trunk channels.

NOTE – A process complementary to DSI is required in the receive unit of a VACME, i.e., re-mapping of the interleaved burst data to their appropriate trunk channels.

9.4 Facsimile remodulation

The supported fax remodulation schemes are as follows:

- [b-ITU-T V.21] (300 bit/s)
- [b-ITU-T V.27] (4800 and 2400 bit/s)
- [b-ITU-T V.29] (9600 and 7200 bit/s)
- [b-ITU-T V.17] (14400 bit/s)
- [b-ITU-T V.34] (for further study)

9.5 Comfort noise insertion

The detection of noise (at the transmit unit) is as specified in [ITU-T G.767]. The insertion level and spectrum of the comfort noise is left up to the manufacturer.

When generic SID is used, the comfort noise insertion shall be the same as in [ITU-T G.767]. If the [ITU-T G.729] SID is introduced for 8 kbit/s coding algorithm, the VAD/DTX scheme shall comply with Annex B of [ITU-T G.729] (see also Tables 2 and 3).

9.6 Packet loss concealment

It is preferable to introduce a packet loss concealment technique in VACME operation in case cell-loss is expected. The packet loss concealment procedure has been incorporated in the decoding process to reduce the degradation in the reconstructed speech because of frame erasures in the bitstream. This procedure can be applied to avoid speech quality degradation in case the ATM cell losses occur due to ATM traffic congestion.

Some codecs, such as [ITU-T G.729] or [ITU-T G.723.1], have inherent frame loss concealment capabilities in the main body, and some have it as an annex (Annex I of [ITU-T G.728] for example). In case a speech codec without packet loss concealment capability is used, the frame loss concealment technique after the reconstruction of the PCM signal as specified in Appendix I of [ITU-T G.711] can also used.

10 Signalling support

Support of CAS signalling shall be compliant with [ITU-T I.366.2].

Support of No.7 signalling shall use 64 kbit/s clear channel.

11 ATM adaptation layers

This function maps user data into ATM cells to be transferred through an ATM network. The VACME performs this function in the ATM adaptation function block. The adaptation layers available at the VACME include AAL type 1 and AAL type 2.

A VPI/VCI for an AAL type 1 connection may be associated with one or several trunk channels. In the first case, the ATM connection is used to transfer a single 64 kbit/s unrestricted channel if one trunk channel is associated with that connection. In the second case, the ATM connection is used to transfer n × 64 kbit/s if several trunk channels are associated with it. Such association between VPI/VCI and the trunk channel is done beforehand. To ensure connectivity, the association should be similar between the sending and receiving VACME.

One or up to four VPI/VCI/CID(s) are assigned to a trunk channel when an AAL type 2 connection is made. If more than one VPI/VCI/CIDs are assigned to a trunk channel, the specific VPI/VCI/CID number to be used within that set is chosen on demand by the VACME, depending on the traffic type given by the traffic classifier (i.e., "speech", "voiceband data", "facsimile" or "pass-through"; see also clause 11.2).

There is a possibility that a VPI/VCI for an AAL type 1 connection and a VPI/VCI/CID for an AAL type 2 connection are assigned to the same single trunk channel. In such a case, whether to use AAL type 1 or type 2 is determined on demand by the traffic classifier. An example of the AAL type selection procedure is shown in Figure 3. In all cases, such channel assignments should be similar between the sending and receiving VACME to ensure connectivity.

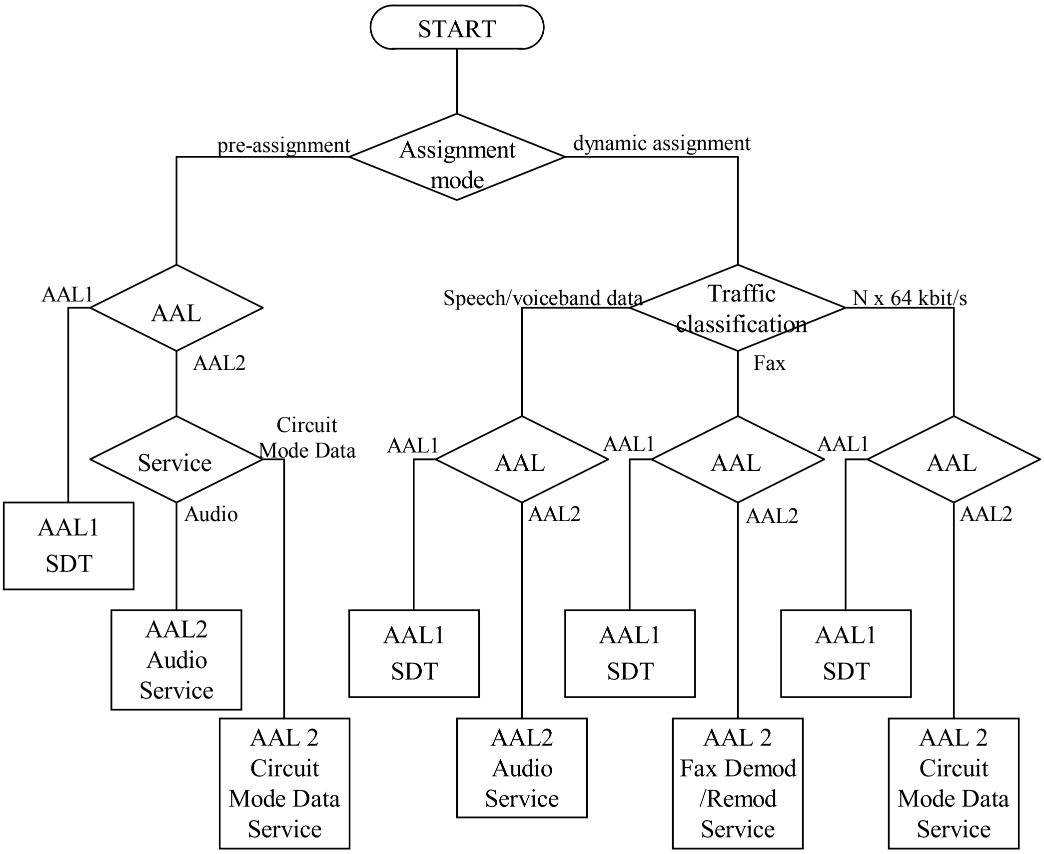

Figure 3 – Example of selection of AAL type

11.1 AAL type 1 mapping

AAL type 1 mapping is used to transfer signals transparently through the VACME regardless of traffic type. More than one trunk channel can be assigned to one AAL type 1 connection in order to transmit n × 64 kbit/s unrestricted traffic (see Figure 4).

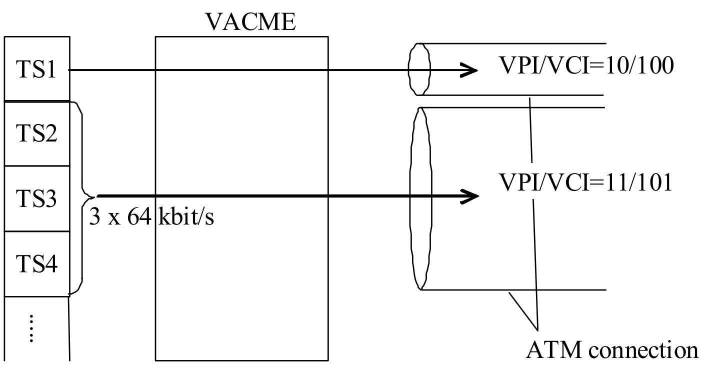

Figure 4 – Example of AAL type 1 mapping

VACME shall be compliant with [ITU-T I.363.1] as the specification of AAL type 1 segmentation and reassembly (SAR) sublayer and convergence sublayer (CS), and the structured data transfer (SDT) method will be used for this purpose. The mapping between trunk channels and associated ATM connections need to be determined beforehand so that the sender and receiver can establish connectivity. The use of AAL type 1 mapping for n × 64 kbit/s dynamic assignment is for further study.

11.2 AAL type 2 mapping

VACME shall have AAL type 2 mapping capabilities and shall be able to select the appropriate mapping method from traffic classifier input for more efficient network transport. AAL 2 capabilities allow for bandwidth savings when compared to AAL type 1 connections.

VACME shall be compliant with [ITU-T I.363.2] and [ITU-T I.366.2], the specifications for AAL type 2 common part sublayer (CPS) and service specific convergence sublayer (SSCS), respectively. Regarding AAL type 2 SSCS, two service categories and eight services are defined in [ITU-T I.366.2]. The services to be supported by VACME are specified in Table 4.

Table 4 – Services to be supported in AAL type 2 SSCS

Service category	Services
Audio service category	Audio Circuit mode data for 64 kbit/s only Facsimile demodulation/remodulation Alarms State control
Multirate service category	Circuit mode data for n × 64 kbit/s, n ≥ 1 Alarms

The user may select from one of the profiles predefined in Annex P of [ITU-T I.366.2] or may create a new profile, depending on the audio algorithms that the VACME supports.

The mapping between trunk channels and associated AAL type 2 connections must be determined beforehand so that the sender and receiver can achieve connectivity over the appropriate AAL type 2 service (see Figure 5).

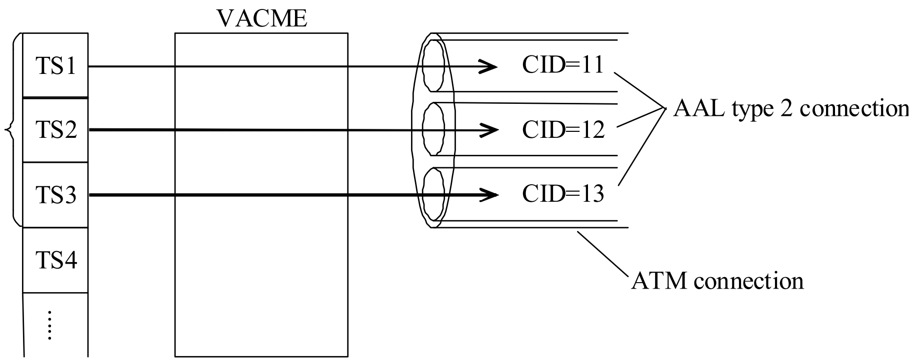

Figure 5 – Example of AAL type 2 mapping

12 ATM multiplexing and cross-connect

12.1 ATM multiplexing

ATM multiplexing for VACME is for further study.

12.2 ATM cross-connect (optional)

The VACME, optionally, has the capability of providing an ATM cross-connection function. A VPC (or VCC) will be routed to another VPC (or VCC) from a separate or the same interface facility, as shown in Figure 6. This function will enhance the bandwidth efficiency of ATM links by multiplexing different ATM sources into a single ATM link.

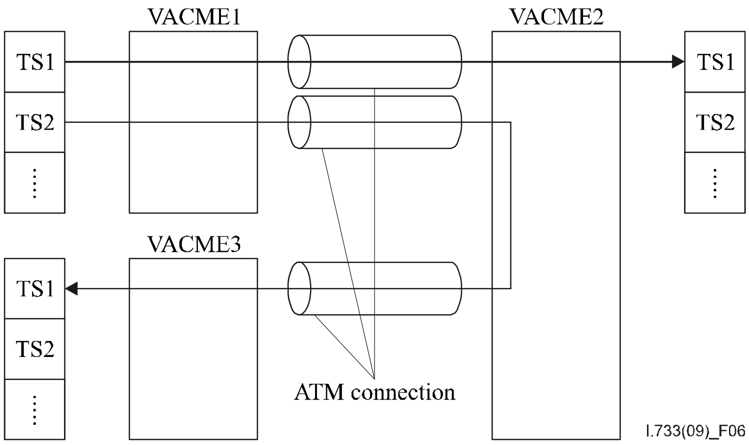

Figure 6 – Example of cross-connection in VACME

13 Traffic load control (for further study)

Traffic load control for VACME is for further study.

13.1 Dynamic load control (for further study)

Dynamic load control for VACME is for further study.

14 Operations and maintenance functions

14.1 Facility alarm handling

Facility alarm detection and consequent actions are specified in the following subclauses.

14.1.1 Facility alarm detection at the trunk side

14.1.1.1 For 2048 kbit/s facilities

The facility interface alarms to be detected for the 2048 kbit/s bit rate, as specified in [ITU-T G.704], are:

- Loss of input signal (LOS)
- Loss of frame (LOF)
- Loss of multiframe (LOMF)
- High BER condition (HBER)
- Alarm indication signal (AIS)
- Remote alarm indication (BAIS and BMAIS)

14.1.1.2 For 1544 kbit/s facilities

The facility interface alarms to be detected for the 1544 kbit/s bit rate, as specified in [ITU-T G.704], are:

- Loss of input signal (LOS)
- Loss of frame (LOF)
- High BER condition (HBER)
- Alarm indication signal (AIS)
- Remote alarm indication (BAIS and BMAIS)

14.1.2 Facility alarm detection at the ATM side

14.1.2.1 Physical layer for ATM interfaces at 44736 kbit/s

The facility interface alarms to be detected for the 44736 kbit/s bit rate, as specified in [ITU-T G.704], are:

- Loss of input signal (LOS)
- Loss of frame (LOF)
- Alarm indication signal (AIS)
- Remote alarm indication

14.1.2.2 Physical layer convergence protocol (PLCP)

The following physical layer convergence protocol alarms shall be detected for the 44736 kbit/s bit rate, as specified in [ITU-T G.804], with reference to [ITU-T G.704];

- PLCP far-end block error (PLCP FEBE): clause 7.2.5.5 of [ITU-T G.804]
- PLCP bit-interleaved parity-8 (PLCP BIP-8): clause 7.2.5.3 of [ITU-T G.804]
- PLCP frame error: clause 7.2.5.2 of [ITU-T G.804]
- PLCP remote alarm indication (PLCP RAI): clause 7.2.5.5 of [ITU-T G.804]
- PLCP loss of frame (PLCP LOF): clause 7.2.5.2 of [ITU-T G.804]
- PLCP out of frame (PLCP OOF): clause 7.2.5.2 of [ITU-T G.804]

14.1.3 Equipment failure detection

14.1.3.1 Equipment failures required to be detected

The detection of the following equipment failures is required in VACME:

- Power failure
- Clock failure
- Hung state of the processor handling traffic data management (protocol handling, data handling)

14.1.3.2 Equipment failures recommended to be detected

The detection of the following equipment failures, among others, is recommended in VACME:

- Parity-check error or check-sum error for traffic data storages
- Hung state of the processor(s) handling OAM functions

14.1.3.3 Fault conditions and consequent actions for VACME

The philosophy of fault conditions and consequent actions from the point of view of maintenance of digital networks is consistent with that contained in the ITU-T G.700-series Recommendations.

Table 5 – Fault conditions and consequent actions for the VACME (Note 1)

Interface side or equipment	Fault conditions	Consequent actions				
		Generated on selected trunks			Local	Generated on ATM interface
	(see clause 8.3.1 1) through 8)	a) Backward alarm indication to remote end	b) Alarm indication on relevant circuits	c) AIS on all trunk groups	d) Maintenance visual alarm indication (recommended) (Note 4)	e) Backward alarm indication to remote end (For further study)
Trunk interface	1) Failure of incoming primary group (Note 2)	Yes (Note 5)			Yes (major)	
	2) Primary group AIS	Yes (Note 5)			Yes (user selectable)	
	3) Loss of multiframe alignment	Yes (Note 3)			Yes (user selectable)	
	4) Remote alarm indication received from local ISC (see clause 8.3.2 a))				Yes (user selectable)	
ATM interface	5) Failure of incoming signal (Note 2)	Yes			Yes (major)	
	6) Loss of multiframe alignment				Yes (user selectable)	
	7) Remote alarm indication received on ATM interface				Yes (user selectable)	
VACME equipment	8) Functional or power supply failure			Yes if practical	Yes if practical (then major)	

NOTE 1 – A Yes in the table signifies that an action shall be taken as a consequence of the relevant fault condition. An open space in the table signifies that the relevant action shall not be taken as a consequence of the relevant fault condition, if the condition is the only one present. If more than one fault condition is simultaneously present, the relevant action shall be taken if, for at least one of the conditions, a Yes is defined in relation to this action.

NOTE 2 – Primary group AIS is excluded from this failure.

NOTE 3 – Bit 6, TS16 frame 0.

NOTE 4 – Maintenance visual alarm indications is recommended to be regrouped as major and minor alarms. For the user-selectable feature, the user may choose the classification of such an alarm as major, minor, or no action.

NOTE 5 – The activity detector shall be disabled for the voice channel which is associated with the faulty trunk interface and shall set the associated activity indication to inactive.

14.1.4 Configuration parameters

In a VACME, any trunk channels will be bundled as a channel group, and the channel group will be associated with an ATM connection (PVC). The following are the configuration parameters to be specified.

14.1.4.1 Channel

1) Trunk interface
2) Timeslot number
3) Corresponding channel group

In case of AAL type 2, the following parameters are added:

4) CID
5) Codec
6) Silence suppression (enabled or disabled)

14.1.4.2 Channel group

A channel group bundles trunk channels which are applied at the same AAL type. Any trunk channel can be bundled into a single channel group. When a channel group is associated with a single PVC, the PVC used is independent of traffic classification. VACME shall also have the capability to associate a channel group with up to four PVCs, i.e., PVCs for speech, voiceband data, facsimile, and 64 kbit/s unrestricted. The following information is associated with a channel group:

1) Corresponding channel(s)
2) Corresponding PVC(s)
3) Corresponding traffic classification(s) to the associated PVC(s)

14.1.4.3 PVC

1) Corresponding channel group
2) AAL type (type 1 or type 2)
3) ATM interface
4) VPI/VCI

In case of AAL type 2, the following parameter is added:

5) Timer_CU

14.1.5 Traffic data measurement

VACME shall have the capability to provide traffic measurements for monitoring purposes. Both the incoming traffic and the outgoing traffic shall be measured. Each statistics shall be calculated once every one-minute interval. The measurements shall be made over an operator settable statistics time interval, with a range from 5 minutes to 60 minutes in 5-minute steps.

1) The number of ATM cells per ATM interface or VPI/VCI
2) The number of AAL type 2 CPS packets per VPI/VCI, CID or the traffic class
3) The number of sequence count errors (AAL type 1) per PVC
4) The number of sequence number errors (AAL type 2) per PVC and CID

Bibliography

[b-ITU-T G.766] Recommendation ITU-T G.766 (1996), *Facsimile demodulation/remodulation for digital circuit multiplication equipment*.

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[b-ITU-T V.17] Recommendation ITU-T V.17 (1991), *A 2-wire modem for facsimile applications with rates up to 14 400 bits*.

[b-ITU-T V.21] Recommendation ITU-T V.21 (1988), *300 bits per second duplex modem standardized for use in the general switched telephone network*.

[b-ITU-T V.27] Recommendation ITU-T V.27 (1988), *4800 bits per second modem with manual equalizer standardized for use on leased telephone-type circuits.*

[b-ITU-T V.29] Recommendation ITU-T V.29 (1988), *9600 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits*.

[b-ITU-T V.34] Recommendation ITU-T V.34 (1998), *A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone-type circuits*.

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Printed in Switzerland
Geneva, 2010