CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

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TITLE : REPORT OF THE THIRD MEETING IN TORINO (SEPTEMBER 24-27, 1985)

CONTENTS

1. General

The Specialists Group met in Torino from September 24 to 27, 1985, at the kind invitation of CSELT, Italy.

Welcoming address was delivered on behalf of the hosting organization by Mr. Muccini.

The list of participants appears at the end of this report.

At the final session Chairman thanked the inviting organization for the meeting facilities provided and the excellent organization.

2. Documentation for the Meeting

The following documents have been considered during the Torino meeting.

2.1 Normal document

~~#32R: REPORT OF THE SECOND MEETING IN HOLMDEL (CHAIRMAN)~~
Preliminary discussions were carried out on basic parameters, methods of algorithm selection and international field trial.

#33 : EXTRACTS FROM THE REPORT OF THE STUDY GROUP XV MEETING HELD IN GENEVA (CHAIRMAN)
Study Group XV approved the activities of the Specialists Group and gave some guidances on frame structure study and intellectual property related to CCITT standardization.

#34 : PROPOSAL FOR A FRAME STRUCTURE FOR TELECONFERENCING (FRANCE)
Proposes to use 8 kbit/s out of the audio time slot to convey all the end-to-end information and signalling and to superimpose a frame structure to the 384 kbit/s signal.

#35 : SIMULATIONS ON SOURCE CODING WITH A COST-SEQUENCE (THE NETHERLANDS)
Describes the tape format and the pre-processing of the digital data to obtain a uniform picture format. Some general information is given about the COST 211-bis project.

#36 : HYBRID CODEC (SWEDEN, NETHERLANDS, FRANCE, F.R. GERMANY, BT(UK), CSELT(ITALY))
Describes a basic blockdiagram and block specifications for a coding strategy using interframe DPCM and intraframe transform coding.

#37 : EXAMPLE OF SIMULATION WITH HYBRID CODING (SWEDEN)
Presents a simulation result for the coding system described in Document #36 with specific parameters.

#38 : VQ BASED HYBRID CODER (THE NETHERLANDS, BT, FRANCE, CSELT)
Presents simulation results on the intraframe VQ with conditional replenishment coding scheme.

#39 : ANTHROPOMORFIC TRANSFORM CODEC (THE NETHERLANDS, BT)
Describes a coder in the range of 64 kbit/s - 2 Mbit/s using the Anthropomorfic Transform and a motion-speed-based replenishment.

#40 : INTER-REGIONAL CONNECTIONS-THE STANDARDS CONVERSION PROBLEM AND BASIC CODEC PARAMETERS (BT & GEC MCMICHAEL)
Proposes a range of common intermediate coding formats for moving pictures consisting of 288 lines/field, 30 fields/s, 1:1 interlace as fundamental parameter set. An optional graphics facility using 576 lines is also proposed.

#41 : BASIC PARAMETERS OF 384 KBIT/S CODEC (NTT, KDD, NEC AND FUJITSU)
A comparison of the three possible basic parameters (240/25-Single, 288/30-Single and Dual) is presented. 240/25-Single is denied and preference is given to Dual.

#42 : CONSIDERATIONS ON COLOR DIFFERENCE SIGNAL PARAMETERS (NTT, KDD, NEC AND FUJITSU)
Two candidates (60 pels/line-2:1 subline, 90 pels/line-4:1 subline) are compared. Preference is given to the former.

#43 : CANDIDATES FOR SUBRATE CODING ALGORITHM (NTT, KDD, NEC AND FUJITSU)
Describes three different schemes to process motion-compensated interframe prediction errors with some variations. The three schemes are; interpolative/extrapolative prediction, DCT and vector quantization.

#44 : EVALUATION METHODS FOR CODING ALGORITHMS (NTT, KDD, NEC AND FUJITSU)
Proposes to evaluate candidate algorithms in terms of entropy, SNR and picture quality. Some practical methods are also proposed.

#45 : A CONSIDERATION ON TRANSMISSION ERROR PROTECTION FOR 384 KBIT/S (NTT AND KDD)
Describes a transmission error evaluation method and a requirement for error correcting code design when demand refresh is applied.

#46 : EVALUATION OF SINGLE "INTERMEDIATE" APPROACH VERSUS DUAL APPROACH FOR n x 384 KBIT/S CODECS (U.S.A.)
Describes several considerations which led to the conclusion that the dual approach is strongly favored.

#47 : DISCUSSION OF SUBRATE CODING ISSUES (U.S.A.)
Discusses basic picture coding parameters for consideration in the specification of a single worldwide standard for sub-rate codecs based on Dual mode approach.

#48 : TEST SEQUENCES FOR VIDEOCONFERENCE IMAGE CODING SIMULATIONS (U.S.A.)
Provides seven sequences of six second duration obtained by digitizing NTSC analog test tapes described in Document #28.

#49 : PYRAMID TRANSFORM/CONDITIONAL REPLENISHMENT VIDEO CODEC SOURCE CODING METHOD (U.S.A.)
Describes an example of coding methods used in the United States which utilizes pyramid transform as intra-frame coding and conditional replenishment as inter-frame coding.

#50 : PRE- AND POST-PROCESSING IN LOW BITRATE VIDEO-CODECS (F.R.G.)
Discusses spatial diagonal filtering and sampling-rate decimation with a line-quincunx pattern and resulting quality for natural pictures.

#51 : CONCEPT OF A PREDICTIVE VIDEOCONFERENCE CODEC FOR TRANSMISSION RATES BETWEEN 64 KBIT/S AND 2 MBIT/S (F.R.G.)
Describes the concept of a predictive coding algorithm which uses an adaptive three-dimensional predictor and adaptive spatial resolution reduction by subsampling and interpolation.

#52 : INTEGRATION OF STANDARDS CONVERSION WITH SOURCE CODING (CSELT)
Presents a possible architecture operable with any video standard and on a wide bitrate range.

#53 : A COMMENT ON ENTROPY ESTIMATION (SWEDEN)
Describes a bitrate estimation method based on the event occurrence.

2.2 Temporary document

No. 1 Agenda (Chairman)
No. 2 Draft Agreements on basic parameter issue (Canada)
No. 3 Draft Agreements on basic parameter issue (Coordination Group)
No. 4 Agreements on basic parameters issue (Chairman)
No. 5 Agreements on further study on coding algorithm (Chairman)
No. 6 Draft report of the third meeting in Torino (Sep. 24-27, 1985) (Chairman)

3. Basic Parameters

3.1 Field frequency, line number and interlace (#40, 41, 46, 47, 50, 52; TD No. 2, 3, 4)

Dual and single approaches to ensure direct connectivity between 625/50 and 525/60 regions have been compared based on the documents and video tape demonstrations of television standards conversion through intermediate formats. After extensive discussion, the following agreements were reached to adopt single mode approach, where the active picture area obtained by a camera with local television standards is covered by the single intermediate format. Note was taken of Document #52 as an information for the possible third generation codec architecture.

The Specialists Group agrees on the following single intermediate picture format:

- Number of active pels per line : 360 (Note 1)
- Number of fields per second : 29.97
- Number of active lines per field : 288 (Note 2)
- Interlace : 1:1

Pre- and post-processing to/from 360 x 288 intermediate format is carried out in such a way that a 4:3 aspect ratio is maintained throughout.

Note 1: Active line duration is approximately 53 μs.

Note 2: Active field duration is approximately 18.4 ms (for 625/50 systems) and approximately 15.2 ms (for 525/60 systems).

Note 3: The U.S.A. is of the opinion that the dual mode approach is more practical, however in the interests of proceeding with an international agreement the single intermediate format is acceptable.

Note 4: Italy agreed to the decision but expressed concern over the service degradation caused by an unpreventable interregional connection in which two compatible though non-standard codecs are employed each using the nominal 288 lines but one with 240 active lines 29.97 fields/s and the other with 288 lines 29.97 fields/s.

3.3 Color difference signal parameters (#42, 47, 50)

Horizontal and vertical resolutions corresponding to those of luminance signals defined in 3.1 were discussed. Proposed candidates for the number of pels per line and the number of lines per field are shown in Table 1. Tape demonstrations related to Document #42 and #50 showed that all of the pictures in this range have no significant difference.

Further study is required taking into account the picture quality and implications of TDM format for hardware implementation.

Table 1. Proposed candidates for color difference signal parameters

Candidate	Pels/line		Lines/field
	R-Y	B-Y	
No. 1/#42	60	60	144
No. 2/#42	90	90	72
VI/#50, #47	90	90	144
V/#50	180	180	144

3.3 Sampling structure (#40, 47, 50)

Orthogonal structure and quincunx structure are the possible two alternatives. For the selection, impact to coding efficiency for any coding algorithm should be taken into account. Contributions are requested.

BNR (Canada) and Bell CORE (U.S.A.) expressed their readiness to submit contributions on this matter in predictive coding and transform coding environments, respectively.

3.4 Graphics (#40)

As for the graphics facility (Note), the following opinions were expressed in the meeting in addition to the proposal of dealing with it as option by Document #40.

- Graphics could be incorporated into the new generation codec as a mandatory function. The resolution is required to be that full resolution of existing television standards.
- Graphic information could be transmitted through a separate channel because there will be a variety of user requirements.

Considerations should be given to the abovementioned points as well as those described in 4.2/#32R.

In case that this graphics is necessary, it is agreed to define its parameters as a simple super-set of the intermediate format agreed for moving pictures.

Each participating country is requested to express its position concerning graphics facility and any proposals for the parameter in the next meeting.

Note: 'Graphics' is defined here as still picture in the form of a normal television signal.

3.5 Summary

Basic parameters for the new generation 384 x n kbit/s codec are summarized in Table 2.

Table 2. Basic parameters for the new generation 384 x n kbit/s CODEC

MOVING PICTURES		
1.	Reference point	Point B in Fig. 1/#32R (Note 1)
2.	Baseband signals	Y, R-Y, B-Y as defined in CCIR Rec. 601 (Note 2)
3.	Number of pels per line	Y: 360 (Note 3) R-Y: * B-Y: *
4.	Number of lines per field	Y: 288 R-Y: * B-Y: *
5.	Field frequency	Y, R-Y, B-Y: 29.97 Hz
6.	Interlace	Y, R-Y, B-Y: 1:1
7.	Sampling structure	Y: * R-Y: * B-Y: *
		* for further study
GRAPHICS		
1.	Reference point	for further study
2.	Baseband signals	
3.	Number of pels per line	
4.	Number of lines per field	
5.	Field frequency	
6.	Interlace	
7.	Sampling structure	

Notes: 1. See 4.2/#32R.
2. See 4.3/#32R.
3. See 4.4/#32R.

4. Coding Algorithm

4.1 Candidate algorithms (#36, 37, 38, 39, 43, 49, 51; TD No. 5)

Various algorithms were presented with documents and video tape demonstrations. These gave the participants better understanding on the present state of the art. It was felt that some more time is necessary to get performance improvement for each candidate. After some discussion, the followings were agreed.

(1) Various coding algorithms proposed as candidates for the new generation codec in this meeting are classified into the following two categories;

Category 1: Interframe prediction + further processing
- Prediction/interpolation A/#43, #51
- DCT #36, B/#43
- Vector quantization #38, C/#43

Category 2: Sub-band coding
- Anthropomorfic transform #39
- Pyramid transform/conditional replenishment #49

(2) General view of the Group is that future study should be focused on Category 1 with the generic structure shown in Fig. 1/#43. It is noted however that in sub-band coding, 'further processing' blackbox may appear before the subtractor.

(3) Since the Group is planning to carry out international field trials early 1987 to get a recommendation during this study period, we are required to specify the new generation codec early 1986. Hence contributions on coding schemes different from those of Category 1 should be presented not after the next meeting.

4.2 Evaluation Methods (#35, 44, 48, 53)

The Specialists Group agreed on a number of topics which should guarantee an appropriate comparison and evaluation of source coding results.

(1) Picture material
These sequences have been selected:

Name	Source	Format	Length
1. "Splitscreen-Trevor"	Europe	4:2:2	5.5 sec
2. "Miss America"	U.S.A.	Intermediate format	5 sec
3. "Checked jacket"	Japan	4:2:2	2 sec

Notes:
1. The Splitscreen-Trevor sequence includes a scene-change. No a priori information should be used as far as the scene-change concerns.

2. NTT/BT will provide a document which describes a method for the conversion to/from the intermediate format.

3. U.S.A. (AT&T Bell Lab.) will send a copy of the "Miss America" sequence to France and Japan. Japan (KDD) will send the "Checked jacket" sequence to France and U.S.A.

4. Intermediate format tape includes 360 luminance pels and 180 x 2 color difference pels for each line.

(2) Initial conditions
Frame No. 0 is mid-gray (127), where applicable the buffer is empty for frame No. 0. Simulation is started from frame No. 1. After simulation the first 8 frames of intermediate format are discarded to avoid initial transients.

(3) The Specialists Group agreed to allow around 200 msec for the total delay (encoder-decoder). The size of the buffer is still open for further consideration.

(4) Assuming that some overhead is necessary, the bitrate for simulations will be 300 kbit/s. Bitrate should be determined based on the number of bits at the output of variable length coder, but not based on entropy estimation.

(5) The signal to noise ratio (S/N) is for reference information, where S has to be defiend as 255 and N as the difference between coder input signal and decoder output signal respectively.

(6) The simulation will be carried out in closed loop mode.

(7) For simulations on 'Splitscreen-Trevor", 48 pels are to be added before and after the 624 pels for each line. The levels for these pels are assumed as Y=127, B-Y=127 and R-Y=127 (mid gray without color).

(8) To ensure that all research organizations are carrying out computer simulations on the same basis, a reference simulation is made for simple interframe encoding without quantization (See Figure 1/#43). The first ten luminance (Y) signal frames of the "Miss America" sequence have to be used. Root mean square value of prediction error for each of ten frames should be reported.
Mr. Okubo will collect the data one month after the date the research organizations received the source material and describe the results afterwards.

(9) Pre- and post-processing may be included in the demonstrations of simulation results provided they are described in detail.

(10) It is strongly suggested to make U-matic tapes available after each meeting. They can be used for evaluation (restricted to internal research purposes only).

(11) Demonstration of simulation results should include the 3 agreed sequences in color.

(12) As a device to display results, U-matic will be used (the tape with a format in NTSC, PAL or SECAM according to the region where the tape has been produced).

(13) Evaluation methods: Contributions on this subject are requested for the next meeting.

5. Frame Structure (#34)

To the presentation of Document #34, the following points were suggested for further study.

a. Affects of introducing error correction and encryption should be examined.
b. In pre-ISDN environments, time slot integrity of six 64 kbit/s channels might not be preserved.
c. Whether "one's density restriction" in North American network is applied to 384 kbit/s channel or not has a great impact to the new generation codec.
d. In some audiographic teleconferencing systems, whole of the 64 kbit/s channel can be used for telematic signals. So the switching between 8+56 kbit/s and 64 kbit/s should be included as a frame structure capability.
e. WP XV/1 plans to collect information on control signals for video-conferencing systems from concerned organizations toward the next meeting to be held in Feb. 1986. This collected information will facilitate defining requirements for the frame structure.

It was also pointed out that since the items b. and c. are urgent problems, Chairman should contact SGXVIII formally as well as informally. U.S.A. was also requested to submit relevant information on these items.

6. Transmission Coding (#45)

To the presentation of the Document #45, a possibility of reducing bitrate required for cyclic refresh by using more elaborate schemes was suggested.

Study on this transmission coding aspect will be continued for future complete specification.

7. International Field Trial

As suggested in the Holmdel meeting, a volunteer Signatory to delegate this Group for acting as liaison to INTELSAT was solicited. Mr. Nicol (BT) expressed his readiness to accept the role of contacting Mr. Lasher (INTELSAT) for future transponder use.

8. Next Meetings

4th Meeting

a. Time : January 21 (Tu) - 24 (Fr), 1986
Tuesday morning will be for technical visit.
b. Place : BTRL (Ipswich, U.K.)
c. Topics:
- Color difference signal parameters
- Sampling structure
- Graphics
- Coding algorithm
- Evaluation method for coding algorithms
- Frame structure
- Transmission coding
- International field trial

5th Meeting
Tokyo; late March or early April, 1986

6th Meeting
Montreal

7th Meeting
Nürnberg

LIST OF PARTICIPANTS
(Torino, September 24 - 27, 1985)

Chairman	S. Okubo	- NTT
Core Members		
F. R. of Germany	J. Speidel	- PKI/TEKADE
	G. Zedler	- FTZ
Canada	S. Sabri	- BNR
U.S.A.	D. Crawford	- Bell CORE
	B. G. Haskell	- AT&T Bell Lab.
	R. A. Schaphorst	- DIS
Italy	L. Chariglione	- CSELT
	G. Ferreti	- SIP (acting for A. D'Ottavio)
France	J. Guichard	- CNET
	J. P. Temime	- CNET
Japan	Y. Hatori	- KDD
	N. Mukawa	- NTT
Netherlands	F. Booman	- DNL
United Kingdom	D. Bonnie	- GEC McMichael
	R. Nicol	- BT
Sweden	H. Brusewitz	- EVA (acting for R. V. Campenhausen)
	P. Weiss	- Swedish Telecom
INTELSAT	R. Lei (acting for K. Kinuhata)	
Assisting Experts		
U.S.A.	J. A. Bellisio	- Bell CORE
	G. Pearson	- CLI
Italy	S. Fontolan	- CSELT
	M. Guglielmo	- CSELT (acting as secretary)
	F. Tommasi	- CSELT
France	J. C. Jolivet	- SAT
Japan	M. Hiraoka	- FUJITSU
	K. Niwa	- NEC