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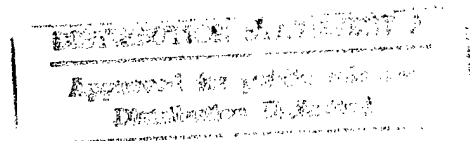


NATIONAL COMMUNICATIONS SYSTEM

TECHNICAL INFORMATION BULLETIN 92-16

"CCITT TEST DOCUMENTS" DIGITIZATION

JUNE 1993



OFFICE OF THE MANAGER
NATIONAL COMMUNICATIONS SYSTEM
701 SOUTH COURT HOUSE ROAD
ARLINGTON, VA 22204-2198

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1. INTRODUCTION

13

This document summarizes work performed by Delta Information Systems, Inc. (DIS) for the National Communications System (NCS), Office of Technology and Standards. This office is responsible for the management of the Federal Telecommunications Standards Program, which develops telecommunications standards, whose use is mandatory for all Federal departments and agencies. The purpose of this project, ~~performed under contract number DCA100-91-C-0031,~~ was to scan the "eight CCITT test documents" at pel densities of 200, 300, 400 and 600 pels per inch, and store them on DOS diskettes.

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The eight documents were originally digitized by the French Administration, and were used in the Group 3 Facsimile algorithm selection process, completed in 1980. These images are often referred to as the "CCITT standard images". Although they were never an official standard, they have been used extensively by experimenters over the years. They were scanned at roughly 200 pels per inch, consistent with the capabilities of facsimile machines at that time.

Recently there has been renewed interest in these images, including a proposal in the CCITT that they be made an official standard (recommendation). Many of the inquiries for these images have been for digitized images on DOS diskette media at pel densities higher than 200 pels per inch. Current Group 3 and Group 4 facsimile machines have up to 400 pel per inch capability, and the next step could easily be 600 pels per inch.

The NCS has been a leader in the development and promulgation of standardized imagery for facsimile. The NCS has sponsored the digitizing of documents at resolutions of 200, 240, 300, 400, and 480 lines per inch. This data has been used by many experimenters in the development of standard compression algorithms for digital facsimile, and has contributed significantly to the development of facsimile recommendations which will be of considerable value to the U.S. Government. In addition, the NCS sponsored the preparation of standard gray scale images, representative of continuous tone pictures to be transmitted through facsimile systems.

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"CCITT TEST DOCUMENTS" DIGITIZATION

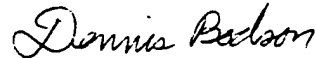
JUNE 1993

PROJECT OFFICER



STEPHEN PERSCHAU
Computer Scientist
Office of Technology
and Standards

APPROVED FOR PUBLICATION:



DENNIS BODSON
Assistant Manager
Office of Technology
and Standards

FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents and overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of facsimile. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

Office of the Manager
National Communications System
Attn: NT
701 S. Court House Road
Arlington, VA 22204-2198

**"CCITT TEST DOCUMENTS"
DIGITIZATION**

JUNE 1993

**SUBMITTED TO:
THE NATIONAL COMMUNICATIONS SYSTEM
701 SOUTH COURT HOUSE ROAD
ARLINGTON, VA 22204-2198**

**DELTA INFORMATION SYSTEMS, INC.
300 WELSH ROAD, BUILDING 3
HORSHAM, PA 19044-2273
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1. INTRODUCTION

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2. TECHNICAL DISCUSSION

Figure 1 through Figure 8 illustrate the test documents that were scanned. The images used in the scanning process were obtained from SEPT¹. They are from a set of original-quality copies made at the time that the Group 3 compression algorithm studies were being conducted. All of the images are A4 size, that is 210 mm wide by 297 mm long.

The resolutions selected for the scanning process (200, 300, 400, and 600 pels per 25.4 mm) were based on those specified in the Group 3 and Group 4 recommendations (200, 300, and 400 pels per 25.4 mm) plus 600 pels per 25.4 mm. The additional higher resolution anticipates the advancing laser printing technology.

Having selected the resolutions and given the width of the image, the number of pels per line can be determined. For the A4 page width of 210 mm, a 200 pels per 25.4 mm scan gives 1654 pels per line. The 1654 pel width is not a convenient number for computers (not divisible by 8). One way to correct this condition is to extend the right margin to make an even number of bytes, as the French PTT did when they originally scanned the images. A better approach would be to produce a digital image that closely approximates the image produced by a Group 3 or Group 4 facsimile scanner. The latter approach was chosen for this project; that is, the charts were scanned to produce the nominal pels per line and lines per image shown in the Group 3 and Group 4 Recommendations. This means that the documents were centered and overscanned. (The chart itself is 210 mm wide, but the scan line is 219.46 mm wide.) Figure 9 illustrates the scanning geometry for the four sampling densities. A reference point is defined that is just inside the top left corner of the image, 0.5 pels from the corner. The coordinates of the reference point, shown in pels, define the position of the A4-size image within the total digitized image. The blanking margin is white.

The images are scanned left-to-right and top-to-bottom, just as in facsimile.

¹ Mr. Grimault of Service d'Etudes communes de La Poste et de France Telecom graciously provided the images.

The scanning process was performed by the Image Electronics Center of Eastman Kodak on a microdensitometer. The microdensitometer samples each pel at 12 bits. The data is processed to produce one bit per pel, stored in the following way. The left-most (first) pel of the first scan line is stored in the most significant bit of the first byte. Proceeding from left to right, pels are stored in successive bytes, 8 pels to a byte, from most significant to least significant. A black pel is a "1" and a white pel is a "0".

THE SLEREXE COMPANY LIMITED

SAPORS LANE . BOOLE . DORSET . BH 25 8 ER

TELEPHONE BOOLE (945 13) 51617 . TELEX 123456

Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

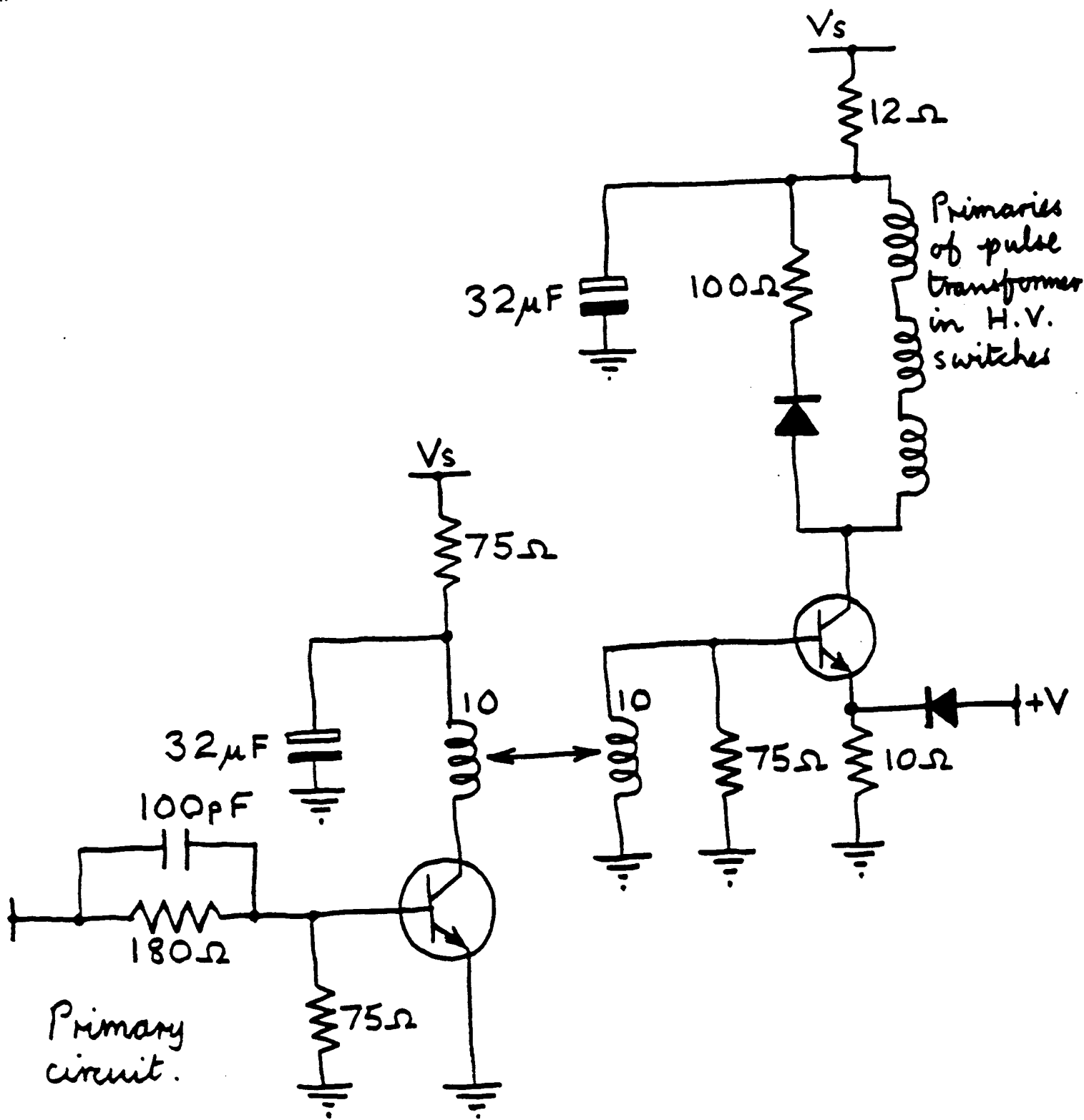
Probably you have uses for this facility in your organisation.

Yours sincerely,

Phil.

P.J. CROSS
Group Leader - Facsimile Research

FIGURE 1



This is current driver circuit.

Phil.

FIGURE 2

22-9-71

ETABLISSEMENTS ABCDEFG
SOCIÉTÉ ANONYME AU CAPITAL DE 300 000 F
20, RUE DU XYUTRSTBSL F 00000 NTBCLAG
Tél. : (35) 24.46.32 Adr. Tg. : NRVUJROLM
Télex : 31596 F IN : 718490070257
Transporteur (ou Transitaire)
M. M. DUPONT Frères
8 quai des bleds F 0000 NTBCLAG

Mot directeur

CLASSEMENT

FACTURE
INVOICE

Exemplaire 15

CODE CLIENT
2-04399

DATE
7-7-74

NUMERO
06

FEUILLET
01

Votre commande

du 74-2-Numéro 438

Notre offre AZ/B7

du 74-1-Numéro 12

LIVRAISON

5, rue XYZ

99000 VILLE

FACTURATION

12, rue ABCD BP 15

99000 VILLE

DOMICILIATION BANCAIRE DU VENDEUR

PAYS D'ORIGINE

PAYS DE DESTINATION

CODE BANQUE

CODE GUICHET

COMPTE CLIENT

CONDITIONS DE LIVRAISON

DATE 74-03-03

ORIGINE

TRANSPORTS
DESTINATION

MODE

LICENCE D'EXPORTATION

NATURE DU CONTRAT (monnaie)

Pays 1

Etat 2

Air

CONDITIONS DE PAIEMENT

FAB
(échéance, %...)

MARQUES ET NUMEROS MARKS AND NUMBERS		NOMBRE ET NATURE DES COLIS : DENOMINATION DE LA MARCHANDISE NUMBER AND KING OF PACKAGES: DESCRIPTION OF GOODS		NOMEN- CLATURE STATISTICAL No.	MASSE NETTE NET WEIGHT MASSE BRUTE GROSS WEIGHT	VALEUR VALUE DIMENSIONS MEASURE- MENTS
74.21.456.44.2 A		1 Composants		U 123/4	5 kg 8 kg	1400 X 13x10x6
QUANTITE COMMANDEE ET UNITE QUANTITY ORDERED AND UNIT	N° ET REF. DE L'ARTICLE	DESIGNATION		QUANTITE LIVREE ET UNITE QUANTITY DELIVERED AND UNIT	PRIX UNITAIRE UNIT PRICE	MONTANT TOTAL TOTAL AMOUNT
2	AF-809	Circuit intégré		2	104,33 F	208,66 F
10	S8-T4	Connecteur		10	83,10 F	831,00 F
25	ZIO7	Composant indéterminé		20	15,00 F	300,00 F

Costs	Débours	Inclus	Non inclus
Packing	Emballages		92,14
Freight	Transport		
Insurance	Assurances		
Invoice amount	Montant total de la facture		1431,80
Installment	Acomptes		7
NET TO BE PAID	NET A REGLER		1431,80

FIGURE 3

FIGURE 3

L'ordre de lancement et de réalisation des applications fait l'objet de décisions au plus haut niveau de la Direction Générale des Télécommunications. Il n'est certes pas question de construire ce système intégré "en bloc" mais bien au contraire de procéder par étapes, par paliers successifs. Certaines applications, dont la rentabilité ne pourra être assurée, ne seront pas entreprises. Actuellement, sur trente applications qui ont pu être globalement définies, six en sont au stade de l'exploitation, six autres se sont vu donner la priorité pour leur réalisation.

Chaque application est confiée à un "chef de projet", responsable successivement de sa conception, de son analyse-programmation et de sa mise en oeuvre dans une région-pilote. La généralisation ultérieure de l'application réalisée dans cette région-pilote dépend des résultats obtenus et fait l'objet d'une décision de la Direction Générale. Néanmoins, le chef de projet doit dès le départ considérer que son activité a une vocation nationale donc refuser tout particularisme régional. Il est aidé d'une équipe d'analystes-programmeurs et entouré d'un "groupe de conception" chargé de rédiger le document de "définition des objectifs globaux" puis le "cahier des charges" de l'application, qui sont adressés pour avis à tous les services utilisateurs potentiels et aux chefs de projet des autres applications. Le groupe de conception comprend 6 à 10 personnes représentant les services les plus divers concernés par le projet, et comporte obligatoirement un bon analyste attaché à l'application.

II - L'IMPLANTATION GEOGRAPHIQUE D'UN RESEAU INFORMATIQUE PERFORMANT

L'organisation de l'entreprise française des télécommunications repose sur l'existence de 20 régions. Des calculateurs ont été implantés dans le passé au moins dans toutes les plus importantes. On trouve ainsi des machines Bull Gamma 30 à Lyon et Marseille, des GE 425 à Lille, Bordeaux, Toulouse et Montpellier, un GE 437 à Massy, enfin quelques machines Bull 300 TI à programmes câblés étaient récemment ou sont encore en service dans les régions de Nancy, Nantes, Limoges, Poitiers et Rouen ; ce parc est essentiellement utilisé pour la comptabilité téléphonique.

A l'avenir, si la plupart des fichiers nécessaires aux applications décrites plus haut peuvent être gérés en temps différé, un certain nombre d'entre eux devront nécessairement être accessibles, voire mis à jour en temps réel : parmi ces derniers le fichier commercial des abonnés, le fichier des renseignements, le fichier des circuits, le fichier technique des abonnés contiendront des quantités considérables d'informations.

Le volume total de caractères à gérer en phase finale sur un ordinateur ayant en charge quelques 500 000 abonnés a été estimé à un milliard de caractères au moins. Au moins le tiers des données seront concernées par des traitements en temps réel.

Aucun des calculateurs énumérés plus haut ne permettait d'envisager de tels traitements. L'intégration progressive de toutes les applications suppose la création d'un support commun pour toutes les informations, une véritable "Banque de données", répartie sur des moyens de traitement nationaux et régionaux, et qui devra rester alimentée, mise à jour en permanence, à partir de la base de l'entreprise, c'est-à-dire les chantiers, les magasins, les guichets des services d'abonnement, les services de personnel etc.

L'étude des différents fichiers à constituer a donc permis de définir les principales caractéristiques du réseau d'ordinateurs nouveaux à mettre en place pour aborder la réalisation du système informatif. L'obligation de faire appel à des ordinateurs de troisième génération, très puissants et dotés de volumineuses mémoires de masse, a conduit à en réduire substantiellement le nombre.

L'implantation de sept centres de calcul interrégionaux constituera un compromis entre : d'une part le désir de réduire le coût économique de l'ensemble, de faciliter la coordination des équipes d'informaticiens ; et d'autre part le refus de créer des centres trop importants difficiles à gérer et à diriger, et posant des problèmes délicats de sécurité. Le regroupement des traitements relatifs à plusieurs régions sur chacun de ces sept centres permettra de leur donner une taille relativement homogène. Chaque centre "gèrera" environ un million d'abonnés à la fin du VIème Plan.

La mise en place de ces centres a débuté au début de l'année 1971 : un ordinateur IRIS 50 de la Compagnie Internationale pour l'Informatique a été installé à Toulouse en février, la même machine vient d'être mise en service au centre de calcul interrégional de Bordeaux.

FIGURE 4

Cela est d'autant plus valable que $T \Delta f$ est plus grand. A cet égard la figure 2 représente la vraie courbe donnant $|\phi(f)|$ en fonction de f pour les valeurs numériques indiquées page précédente.

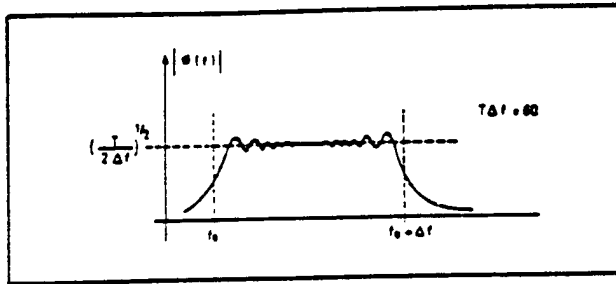


FIG. 2

Dans ce cas, le filtre adapté pourra être constitué, conformément à la figure 3, par la cascade :

— d'un filtre passe-bande de transfert unité pour $f_0 \leq f \leq f_0 + \Delta f$ et de transfert quasi nul pour $f < f_0$ et $f > f_0 + \Delta f$, filtre ne modifiant pas la phase des composants le traversant ;

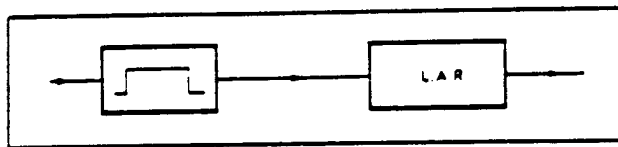


FIG. 3

— filtre suivi d'une ligne à retard (LAR) dispersive ayant un temps de propagation de groupe T_R décroissant linéairement avec la fréquence f suivant l'expression :

$$T_R = T_0 + (f_0 - f) \frac{T}{\Delta f} \quad (\text{avec } T_0 > T)$$

(voir fig. 4).

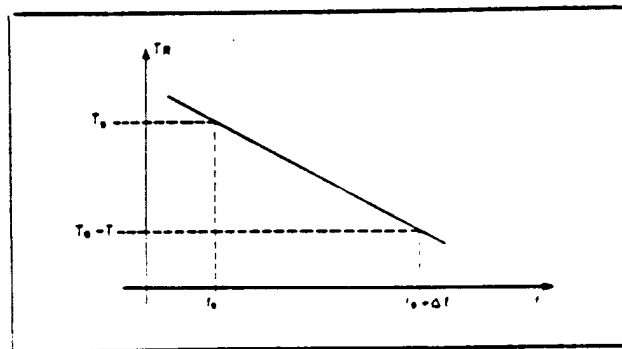


FIG. 4

telle ligne à retard est donnée par :

$$\varphi = -2\pi \int_0^f T_R df$$

$$\varphi = -2\pi \left[T_0 + \frac{f_0 T}{\Delta f} \right] f + \pi \frac{T}{\Delta f} f^2$$

Et cette phase est bien l'opposé de $\phi(f)$,

à un déphasage constant près (sans importance) et à un retard T_0 près (inévitables).

Un signal utile $S(t)$ traversant un tel filtre adapté donne à la sortie (à un retard T_0 près et à un déphasage près de la porteuse) un signal dont la transformée de Fourier est réelle, constante entre f_0 et $f_0 + \Delta f$, et nulle de part et d'autre de f_0 et de $f_0 + \Delta f$, c'est-à-dire un signal de fréquence porteuse $f_0 + \Delta f/2$ et dont l'enveloppe a la forme indiquée à la figure 5, où l'on a représenté simultanément le signal $S(t)$ et le signal $S_1(t)$ correspondant obtenu à la sortie du filtre adapté. On comprend le nom de récepteur à compression d'impulsion donné à ce genre de filtre adapté : la « largeur » (à 3 dB) du signal comprimé étant égale à $1/\Delta f$, le rapport de compression est de $\frac{T}{1/\Delta f} = T \Delta f$

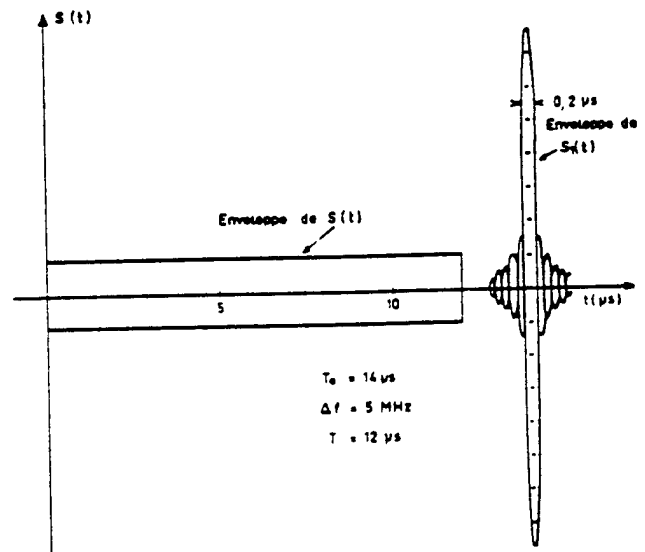


FIG. 5

On saisit physiquement le phénomène de compression en réalisant que lorsque le signal $S(t)$ entre dans la ligne à retard (LAR) la fréquence qui entre la première à l'instant 0 est la fréquence basse f_0 , qui met un temps T_0 pour traverser. La fréquence f entre à l'instant $t = (f - f_0) \frac{T}{\Delta f}$ et elle met un temps

$\frac{T}{\Delta f}$ pour traverser, ce qui la fait ressortir T_0 également. Ainsi donc, le signal $S(t)$

FIGURE 5

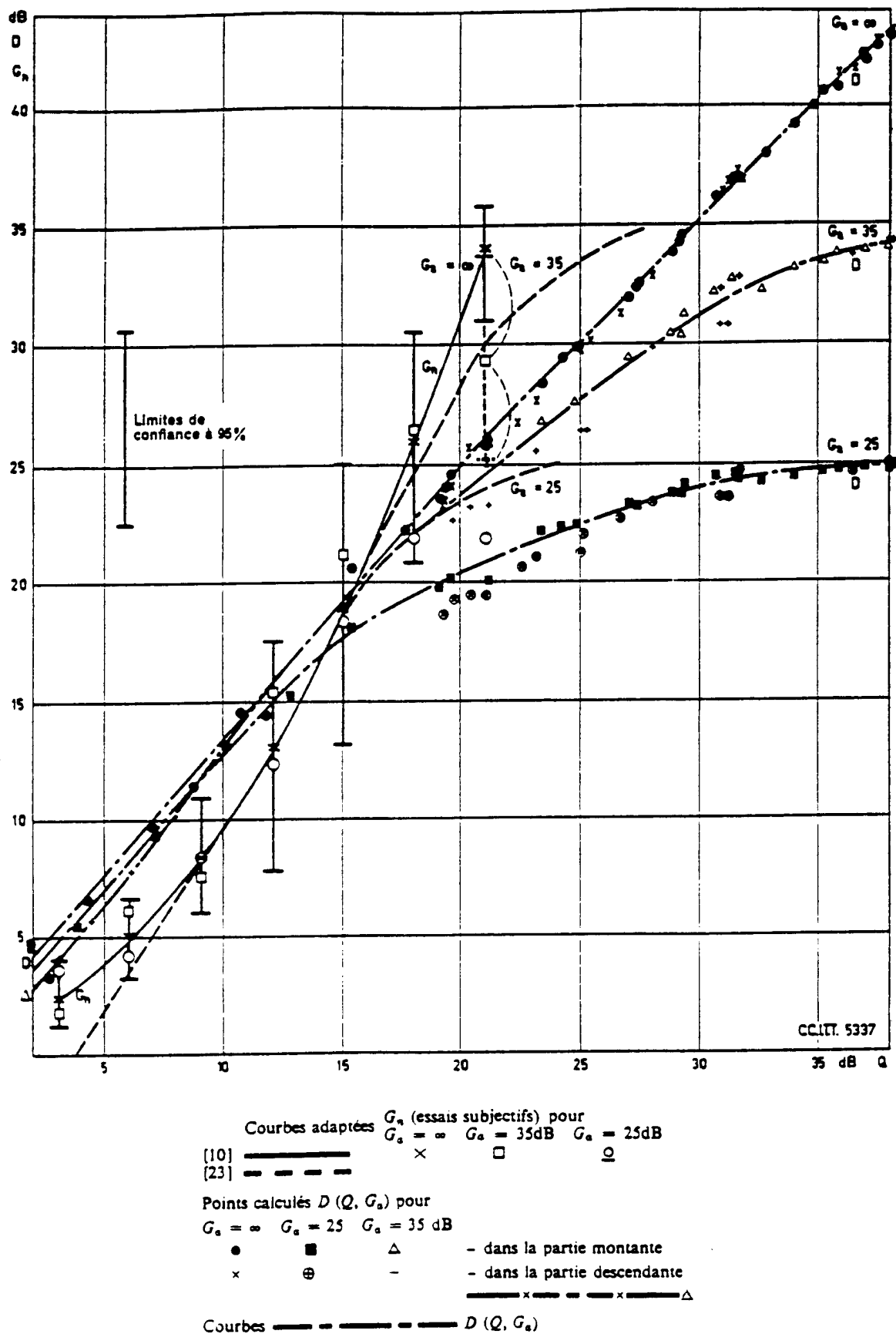


FIGURE 3

memorandum

FROM: A.P. Spriggs Research	TO: E.V. Smith Project Planning
TEL: EXTN. 204-1	DATE: 1-9-71

We know that, where possible, data is reduced to alphanumeric form for transmission by communication systems. However, this can be expensive, and also some data must remain in graphic form. For example, we cannot key-unch an engineering drawing or weather map.

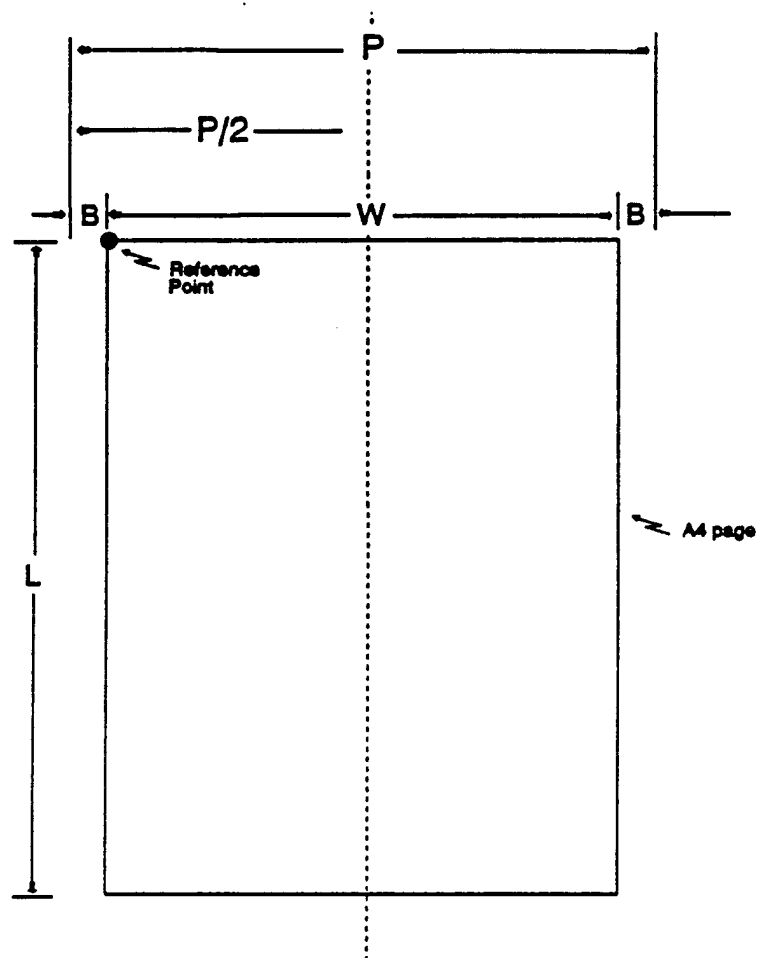
I think we should realise that high speed facsimile transmissions are needed to overcome our problems in efficient graphic data communication. We need research into graphics data compression.

Any comments?

Albert.

WELL, WE ASKED FOR IT!

FIGURE 8



NOTES:

R = Sampling density (pels per 25.4 mm)
 P = Total scan line length (pels) = 219.46 mm
 W = A4 paper width (pels) = 210 mm
 B = Blanking margin (pels)
 L = Nominal number of scan lines

R	P	W	B	L	Reference Point
200	1728	1654	37	2339	(38,1)
300	2592	2480	56	3508	(57,1)
400	3456	3308	74	4677	(75,1)
600	5184	4960	112	7016	(113,1)

Figure 9. Scanning geometry

3. IMAGE STORAGE AND RETRIEVAL

The total number of bytes required to store each of the images, as a function of resolution (or sampling density), is shown in Table 1. Note that at 200 pels per 25.4 mm about 0.5 megabytes are required, while at 600 pels per 25.4 mm about 4.5 megabytes are needed. In order to reduce the storage requirements and make DOS diskettes a practical storage media, the data must be compressed.

Table 2 is a list of the 32 compressed files produced by scanning 8 documents at 4 resolutions. The files are stored on 8 DOS diskettes, one document per diskette, with a decompression program stored on each of the diskettes. To retrieve an image from a compressed file, first copy the compressed file to a hard disk and type:

```
pkunzip <filename> [enter]
```

The compressed file will be expanded and the result written to the hard disk. Make sure that the hard disk has enough space to contain the expanded image.

Table 1. Image storage requirements

pel density (pels per 25.4mm)	pels per line	scan lines	pels per page	bytes per page
200	1728	2339	4041792	505224
300	2592	3508	9092736	1136592
400	3456	4677	16163712	2020464
600	5184	7016	36370944	4546368

Table 2. Compressed files

DOCUMENT	PEL DENSITY	FILE NAME	UNCOMPRESSED BYTES	COMPRESSED BYTES
Document #1	200	DOC1_200.ZIP	505224	33981
	300	DOC1_300.ZIP	1136592	61770
	400	DOC1_400.ZIP	2020464	96736
	600	DOC1_600.ZIP	4546368	193956
Document #2	200	DOC2_200.ZIP	505224	31166
	300	DOC2_300.ZIP	1136592	53431
	400	DOC2_400.ZIP	2020464	82740
	600	DOC2_600.ZIP	4546368	150728
Document #3	200	DOC3_200.ZIP	505224	48828
	300	DOC3_300.ZIP	1136592	87117
	400	DOC3_400.ZIP	2020464	134523
	600	DOC3_600.ZIP	4546368	254890
Document #4	200	DOC4_200.ZIP	505224	105163
	300	DOC4_300.ZIP	1136592	186133
	400	DOC4_400.ZIP	2020464	283570
	600	DOC4_600.ZIP	4546368	541148
Document #5	200	DOC5_200.ZIP	505224	57283
	300	DOC5_300.ZIP	1136592	100292
	400	DOC5_400.ZIP	2020464	153352
	600	DOC5_600.ZIP	4546368	288427
Document #6	200	DOC6_200.ZIP	505224	35213
	300	DOC6_300.ZIP	1136592	62364
	400	DOC6_400.ZIP	2020464	99982
	600	DOC6_600.ZIP	4546368	197443
Document #7	200	DOC7_200.ZIP	505224	119462
	300	DOC7_300.ZIP	1136592	209547
	400	DOC7_400.ZIP	2020464	316710
	600	DOC7_600.ZIP	4546368	242113
Document #8	200	DOC8_200.ZIP	505224	47752
	300	DOC8_300.ZIP	1136592	83438
	400	DOC8_400.ZIP	2020464	126685
	600	DOC8_600.ZIP	4546368	234532