The “applied systems analysis impact" of IIASA on the popular ITU (CCITT) JPEG-1 still image standardization (1986-1992)

JPEG = Joint Photographic Expert Group’s still picture standard
JavaScript/ECMAScript = Major Web-Scripting (tele software) standard

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(Ex-ITU CCITT Special Rapporteur on NIC)
Currently Ecma TC39 (ECMAScript) Secretary
Founding Member of the Original JPEG

2022-09

Why this presentation?

- I was fulltime research staff member at IIASA between 1978-1983,
- Then IIASA Visiting Scholar between 1983-1985 while Vising Professor at the Technical University of Graz in Austria,
- Then Chief Engineer and later Director of Standardization at Siemens in Munich, Germany in the Divisions of Telecommunications - between 1985-2006
- Then Secretary General at Ecma International in Geneva, Switzerland – an International ICT Standardization Organization between 2007-2019
- Now Secretary of Ecma TC39 (ECMAScript/JavaScript standardization)
- *Actually those few early years at IIASA (1978-1985) – I would like to reveal a particular story - had significant impact on my later professional and personal life…*

What Science Areas at IIASA did I work with?

- 1978-1980: 50% in the Systems and Decision Science Area (SDS) on Computer Networking ("IIASA-Gateway")
  - The IIASA-Gateway linked for several European IIASA-member Countries the first international computer connections and enabled early computer network usages - about 10 years before the Internet was introduced there.
- 1980- 1983: 50-100% in the Management and Technology Area (MMT) on impact of new ICT technologies on "everything". Later in 1983-1985 as Guest Scholar. I worked in particular on studies about:
  - **"Videotex-like Networks" - as forerunner of Internet and World-Wide-Web – technology, systems, applications, interdisciplinary aspects**
  - Multimedia related studies
  - Interdisciplinary Transborder Data Flow (TDF) aspects of Data Networks

What was “videotex”? – An ITU CCITT defined telecom service & technique (1980-90s), but due to poor standardization work with many different implementations

Some innovative terminals... (e.g. a Siemens product combining phone and videotex)... Black and white screen only…

The most advanced one... The intelligent Austrian Mupid (dedicated 8-bit PC). Combined European + North American videotex + “Extended Basic tele-software”

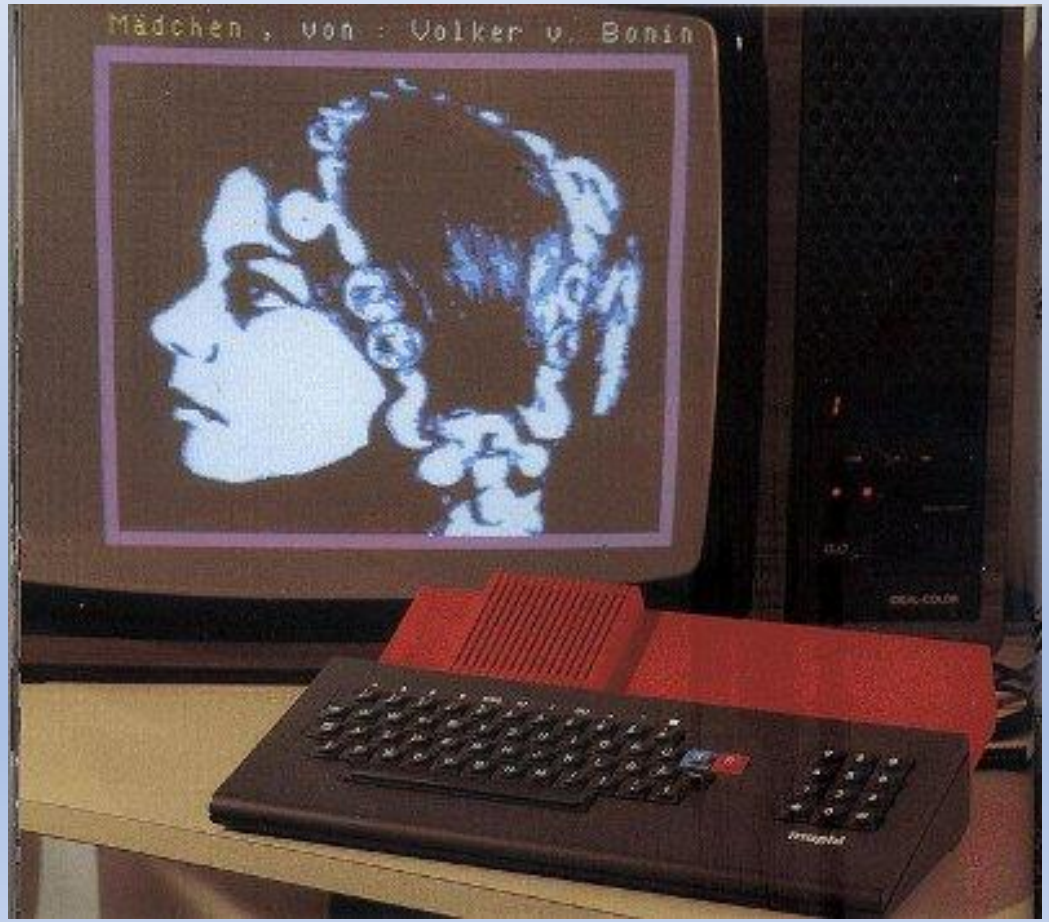
Videotex Studies at IIASA Management and Technology Area (MMT) between 1981-1984 (1)

- Experiences gained through the “B2B” (Business to Business) “IIASA-Gateway” project by the SDS Area and later Computer Communications Services and the rapid spread of Personal Computers in the end of 1970s, early 1980s it was evident that besides “B2B” model we would also see ICT network systems with “B2C” (Business to Customers), “C2B” (Customers to Business) and “C2C” (Customers to Customers”) models **at low costs and at a large worldwide scale not seen before.**
- We called them at IIASA **“Videotex like systems”** as “Videotex” was the **ITU (CCITT) defined term** for that, but we were not sure which “wave” of technology and standards would make market breakthrough.
- We expected in our studies a market breakthrough around **1995-2000 -** which was correct. But it was **not the ITU (CCITT)** defined **“Videotex” (“1st wave”),** but the later developed **(“2nd wave”) “Videotex like” Internet (IETF)** and the **World-Wide-Net (W3C).** Only a few relevant ITU (CCITT) standards survived in that new environment, like **JPEG (ITU-T T.80 Series Still image standards) and Audio-Visual Standards (like ITU-T H.32x Series Audio-Visual Standards – called also as MPEG)**

Videotex Studies at IIASA Management and Technology Area (MMT) between 1981-1984 (2)

- In the IIASA **“Videotex like systems” “tele-software” played a fundamental part** in our studies.
- **Tele-software** (mixing, downloading and executing of running code in information pages) was implemented from 1982 in the Austrian PTT Videotex System (plus in a few countries who brought that technology), but that concept was not part of the **ITU (CCITT) videotex standard (ITU-T T.100 Series), which also turned out as major mistake, because “tele-software” enabled out of dull static information pages the needed dynamic internet applications, like on-line banking, gaming, conferencing, social networking and many more…**
- The Internet and Worldwide Web has realized that deficiency very soon. **On September 18, 1995, Netscape Communications Corporation released the Netscape Navigator 2.0 web browser**. The browser was available for all popular Platforms. The browser contained a wide range of innovations and enhancements. **Among other features, Netscape Navigator 2.0 supported JavaScript, THE SOLUTION for “Tele-software” and also Progressive JPEG.**
- **JavaScript (called also as ECMAScript) has been standardized since 1996 by Ecma International in Geneva as ECMA-262 (Language), ECMA-402 (Internationalization) and ECMA-404 (JSON). It is a standard that is one of the most implemented and used worldwide today.**

But now back to the JPEG story: One of the first photographic images via Videotex – Mupid proprietary telesoftware (TU Graz, Prof. Maurer) in 1982 – about 4 minutes to download this image over a 1200 b/sec POT line...much too slow….



Not good enough for practical use (Prestel, Telidon extended with Photographic telesoftware)

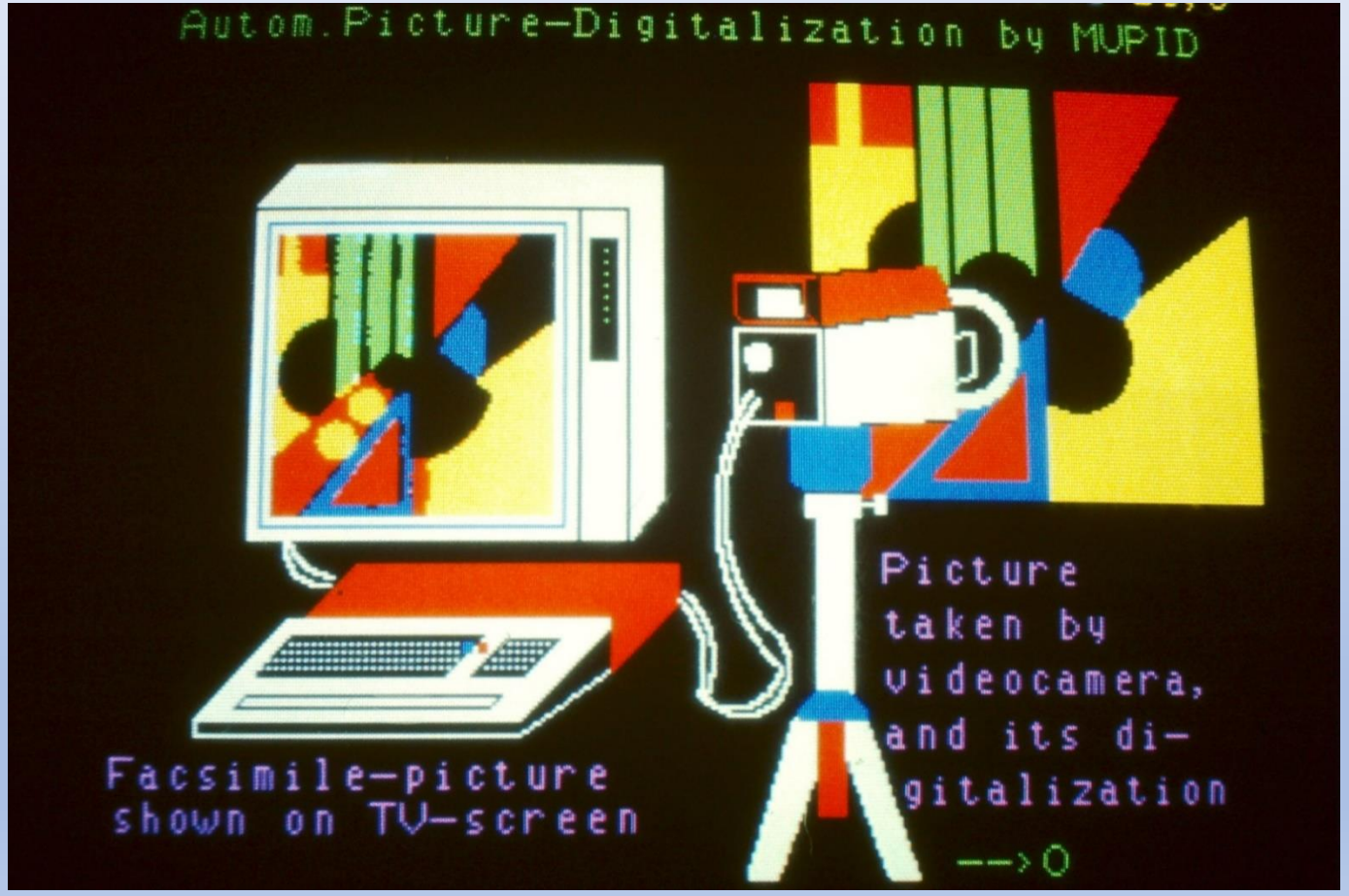
3 Coding modi:

-Color- & runlenght coding linewise (this picture)
-Image Blocs & Huffman coding
-Progressive image coding

Problems:

-Low image compression (50%)
-Slow image build up
-Low quality
-Limited color presentation (not cont. tone colors)

Photo taken by an analogue Video-camera



To improve this….

The Videotex Photographic Mode project (CCITT, ISO, ETSI, EU)

Videotex = Viewdata = PRESTEL = Bildschirmtext = NAPLPS = CAPTAIN = Minitel etc...

Great server-network-terminal-service technology from the end of 1970s = prior to the Web

CCITT Plenary Meeting Malaga-Torr. 1984 CCITT SG VIII Terminal equipment for telematic services (facsimile, Teletex, Videotex, etc.) – SG VIII Questions for 1986-1990

Question	Short title
1/VIII	Revision of Recommendations
2/VIII	Definitions
3/VIII	Study of telephone-type circuit dependent problems in facsimile transmission
4/VIII	Group 4 facsimile apparatus
5/VIII	Choice of modulation techniques to be used with Telematic services connected to the PSTN
6/VIII	Technical implications of new facsimile services under study by Study Group I
7/VIII	Digital phototelegraphy equipment
8/VIII	Coding of alphanumeric and pictorial information for Telematic services
9/VIII	Optional repertoires and coded sets for Teletex
10/VIII	Technical charactteristics of Teletex terminals
11/VIII	Standardized options for the Teletex terminals
12/VIII	Terminal requirement for mixed-mode applications
13/VIII	Enhancements of the Teletex terminals for information retrieval applications
14/VIII	Teletex technical requirements for special services and message handling applications
15/VIII	Development of conformance procedures to ensure the international compatibility of Teletex
16/VIII	Interactive Videotex
17/VIII	Terminal equipment for Telewriting
18/VIII	New forms of image formation, communication, storage and presentation
19/VIII	Technical implications for Tele-conference service under study by Study Group I
20/VIII	Terminal characteristics and protocols for Telematic services on ISDN
21/VIII	Use of telephone-type circuits for facsimile telegraphy
22/VIII	Use of Group 4 facsimile apparatus on the public networks
23/VIII	Interworking between different facsimile apparatus groups

NIC

NIC = New image communication

CCITT Q.18/VIII – Study Question on NIC as defined by the CCITT 1984 Plenary Meeting

CCITT defined Q.18/VIII at the Plenary Meeting at Malaga-Torremolinos in 1984 in the following way:

New forms of image formation, communication, storage and presentation

Considering

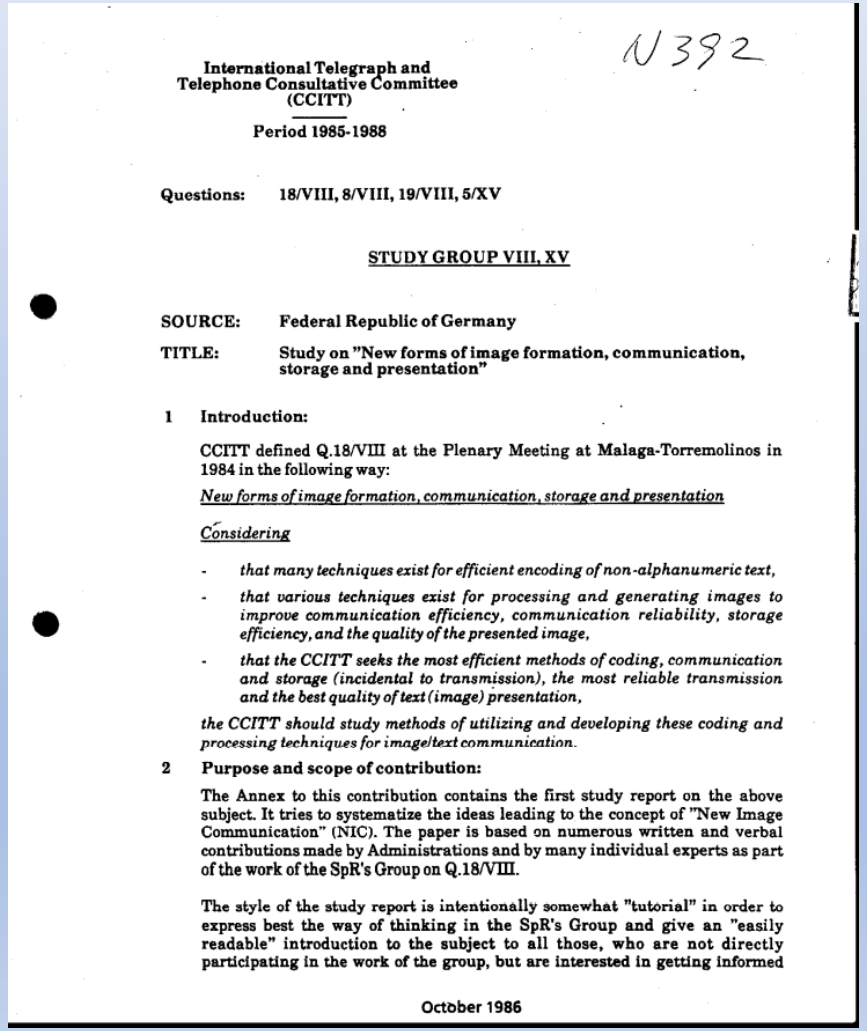
- *that many techniques exist for efficient encoding of non-alphanumeric text,*
- *that various techniques exist for processing and generating images to improve communication efficiency, communication reliability, storage efficiency, and the quality of the presented image,*
- *that the CCITT seeks the most efficient methods of coding, communication and storage (incidental to transmission), the most reliable transmission and the best quality of text (image) presentation,*

the CCITT should study methods of utilizing and developing these coding and processing techniques for image/text communication.

The CCITT „New Image Communication” (NIC) Project

- This was a new „Study Question” approved by the CCITT - VIIIth Plenary Assembly (Málaga-Torremolinos, 1984)
- Had a very general formulation for the work 1985-1988 and nothing happened until 1986....so started to became sort of embarrassing
- No one (including the **Special Rapporteur Mr. Manfred Worlitzer** from the Deutsche Bundespost) had clear idea what it should be... But he was very honest and pragmatic about it ☺
- Mr. Worlitzer was key expert in Videotex terminals (high priority, very busy with that), therefore the Bundespost asked early 1986 Siemens to give him some support in his work. **Mr. Sebestyén** was asigned by Siemens (Mr. Popp) to assist to Mr. Worlitzer.
- Mr. Worlitzer said, if you have a good idea what the question should do, please let me know... So I started to study the topic...
- Mr. Worlitzer left the Videotex- and the NIC group in Summer of 1987, and Mr. Sebestyén became the Special Rapporteur for NIC.

Study on what Q.18/VIII should be doing on “New forms of image formation, communication, storage and presentation



N 392

International Telegraph and Telephone Consultative Committee (CCITT)

Period 1985-1988

Questions: 18/VIII, 8/VIII, 19/VIII, 5/XV

STUDY GROUP VIII, XV

SOURCE: Federal Republic of Germany

TITLE: Study on "New forms of image formation, communication, storage and presentation"

1 Introduction:

CCITT defined Q.18/VIII at the Plenary Meeting at Malaga-Torremolinos in 1984 in the following way:

New forms of image formation, communication, storage and presentation

Considering

- *that many techniques exist for efficient encoding of non-alphanumeric text,*
- *that various techniques exist for processing and generating images to improve communication efficiency, communication reliability, storage efficiency, and the quality of the presented image,*
- *that the CCITT seeks the most efficient methods of coding, communication and storage (incidental to transmission), the most reliable transmission and the best quality of text (image) presentation,*

the CCITT should study methods of utilizing and developing these coding and processing techniques for image/text communication.

2 Purpose and scope of contribution:

The Annex to this contribution contains the first study report on the above subject. It tries to systematize the ideas leading to the concept of "New Image Communication" (NIC). The paper is based on numerous written and verbal contributions made by Administrations and by many individual experts as part of the work of the SpR's Group on Q.18/VIII.

The style of the study report is intentionally somewhat "tutorial" in order to express best the way of thinking in the SpR's Group and give an "easily readable" introduction to the subject to all those, who are not directly participating in the work of the group, but are interested in getting informed

October 1986

The study was done by
Istvàn Sebestyén, Siemens
on a Siemens Office System 5800
(Xerox NS 8000)
using “interdisciplinary,
system analytical IIASA techniques”
on the various existing and possible future (NIC) ITU (CCITT) still image communication applications and services.

List of CCITT Image Communication Applications in 1986

Applications with relationship to "NIC"

1. Low speed applications (up to 9600 b/s):
   - Videotex,
   - Facsimile,
   - Digital Phototelegraphy.
2. High speed applications (64 kbit/s):
   - Videotex in ISDN,
   - Picture transmission in ISDN (Image data bases),
   - Digital Phototelegraphy,
   - Press telegraphy (IPTC),
   - Facsimile,
   - Still image (CCIR),
   - Telematic-Teleconferencing.

Type of Photographic Image Information Formats and Presentation modes in the CCITT 1986 Study

Types of photographic image information formats and presentation modes

a) Moving pictures versus freeze frame images

b) Black/white, multilevel and color images

c) Unified algorithm versus individual algorithm for black/white, multilevel and color images

d) "Soft-" versus "hard-copy" images

e) "Progressive" versus "sequential" (line by line) build-up of pictures

f) "Symmetrical" versus "asymmetrical" encoding/decoding of pictures

g) Information "preserving" versus "non-preserving"

Elementary presentation formats of selected ITU image communication applications / services

Selected telecommunication and telematic services and other data processing applications	Elementary presentation formats						
	Text element characters	Pictorial element characters	Geometric elements	Photographic images			
				Black / white	Multilevel	Color (freeze frame)	Color (moving pictures)
Videotex	●	●	□	□	□	□	
Teletext	●	□	★	★	★	★	
Teletex	●	□					
Telefax				●	★	★	
Mixed mode teletex	●	□		●	★	★	
Telewriting			●				
Video telephone							●
Teleconferencing terminal	□	□	□	□	□	□	□
Still image video (TV)						●	
Motion video (TV)							●
Pressfax (pictures)					●	●	
Newspaper text pages				●			
Office documents	●	●	●	●	★	★	
Computer graphics	●	★	●				
Image processing				●	●	●	□
NIC-capable terminal	□	□	□	●	●	●	★

Basic:● Optional:□ Possible future extention:★

Table 1

Elementary image presentation formats of different services/applications

Types of possible NIC-capable applications and terminals in the CCITT 1986 Study

Characteristics of "New Image Communication" (NIC) applications/services and terminals

a) NIC-capable terminal to NIC-capable terminal connection and image transmission, such as for Teleconferencing, Videotelephony

b) NIC-capable terminal to host connection for image database retrieval, downloading, local processing and display ("hard-" and "soft-copy")

c) NIC-capable terminal access to and interworking with existing telematic services (videotex, telefax, mixed mode teletex)

Was not implemented…. But, in the 1990s on the Internet and WWW this has been widely implemented.

Requirements of NIC Image Communication Properties in 1986

Properties of soft- and hard-copy image communications

1. Quick look-up

A crude version of a soft copy image can be obtained within a small percentage of total transmission time and then a receiver can quickly recognize the contents of the image. If necessary, the quality of the image can be improved by receiving supplementary information.

2. Adaptive selection of image quality

The quality of the image can be improved by adding supplementary information. Therefore, the user should select the quality of the receiving image and should always get images having the appropriate resolution.

3. High coding efficiency (compression rate)

The coding efficiency of proposed coding schemes should preferably be high for the final image on an average.

Requirements of NIC Image Communication Properties in 1986 (cont.)

4. Unified algorithm for black and white, grey scale and colour images

It is preferable that the coding scheme is applicable to:

- black and white;
- grey scale;
- colour images,

by using the unified algorithm.

5. Applications

These coding schemes should be especially effective for soft-copy image communications. Therefore it should be applicable to image communication in Telematic services such as Teleconference and Image data base retrieval, Videotex and so on as well as hard-copy image communications.

6. Range of resolution

The resolution should be flexible and should allow for a range of 400 pixels/inch (16p/mm and 18p/mm).

Note - For press telegraphy there is an extreme resolution of up to 2000 pixels/inch necessary.

Requirements of NIC Image Communication Properties in 1986 (cont.)

7. Range of speed

It should be possible to transmit and process up to 64 kbit/sec.

Note - For press telegraphy there are extreme transmission speeds up to 2 Mbit/sec necessary.

8. Information preserving

This is useful for soft-copy application particularly under low speed conditions. Some applications require information preserving techniques in the final stage of transmission (e.g. when an image is transmitted for later processing).

Note - Information preserving in this context means that the final state of a copy of a transmitted image contains exactly the same pixel and colour information as the original. This is not the case for some coding techniques particularly based on prediction and interpolation methods for redundancy reduction.

9. Error sensitivity

Generally the error rate should be low. The better the error correction procedure of special applications the less important are the requirements for error sensitivity.

11. Switching capability between copy modes

In some applications capabilities to switch from soft copy to hard copy (and vice versa) is necessary. The coding technique should be compatible for both soft- and hard-copy display.

Typical application areas of JPEG and JBIG according to ITU-T T.80

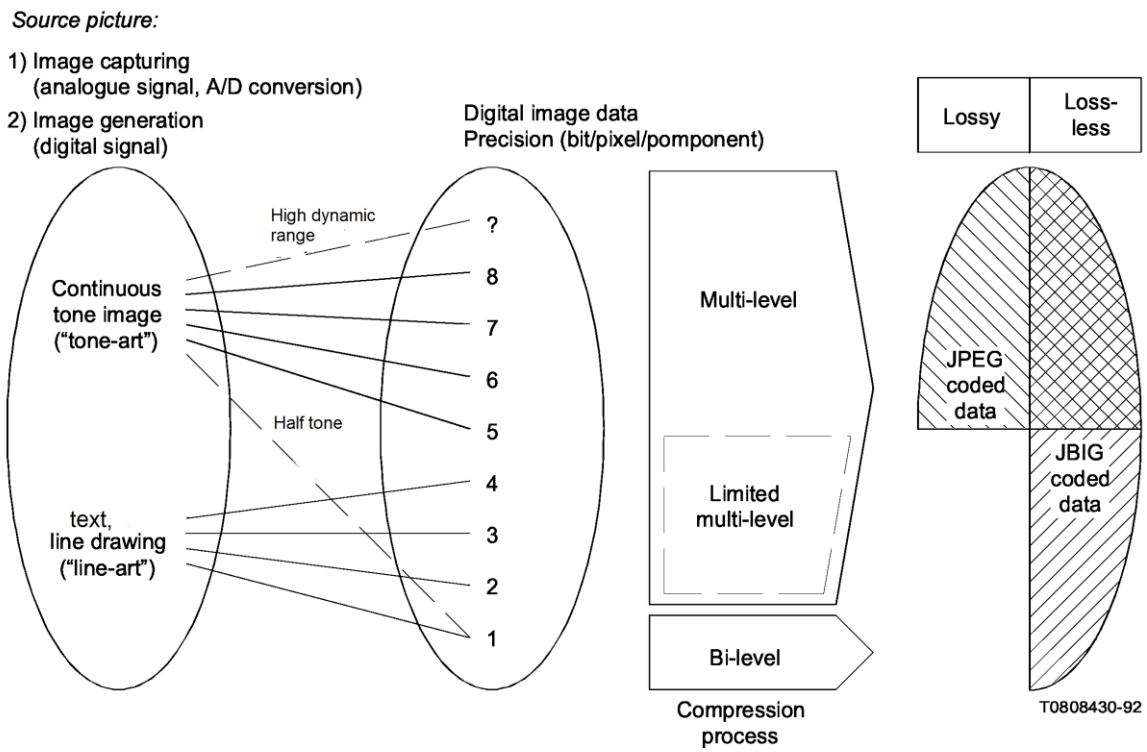
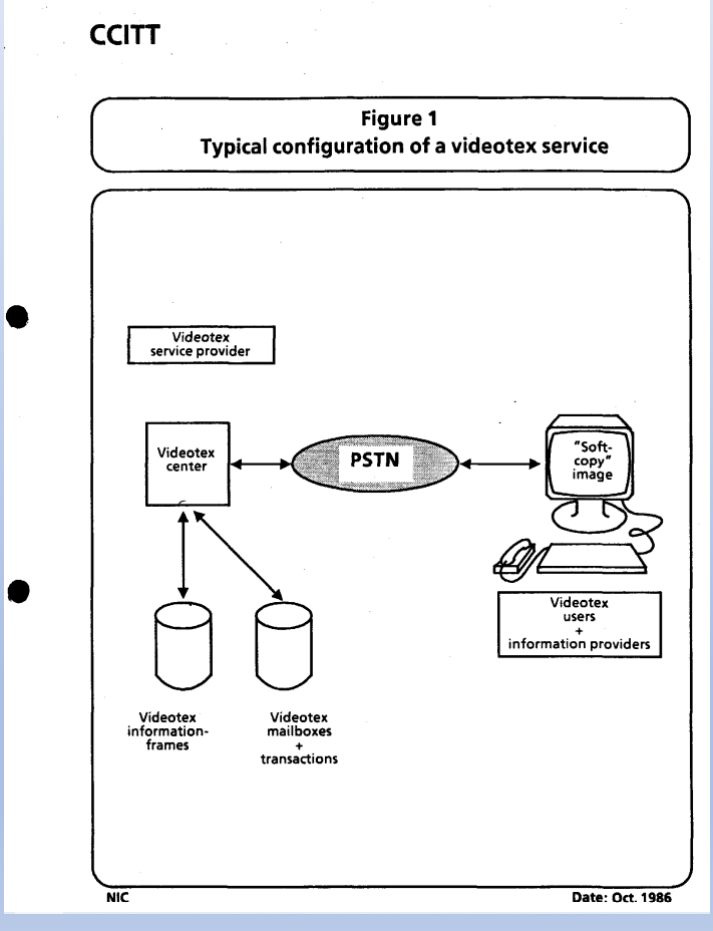
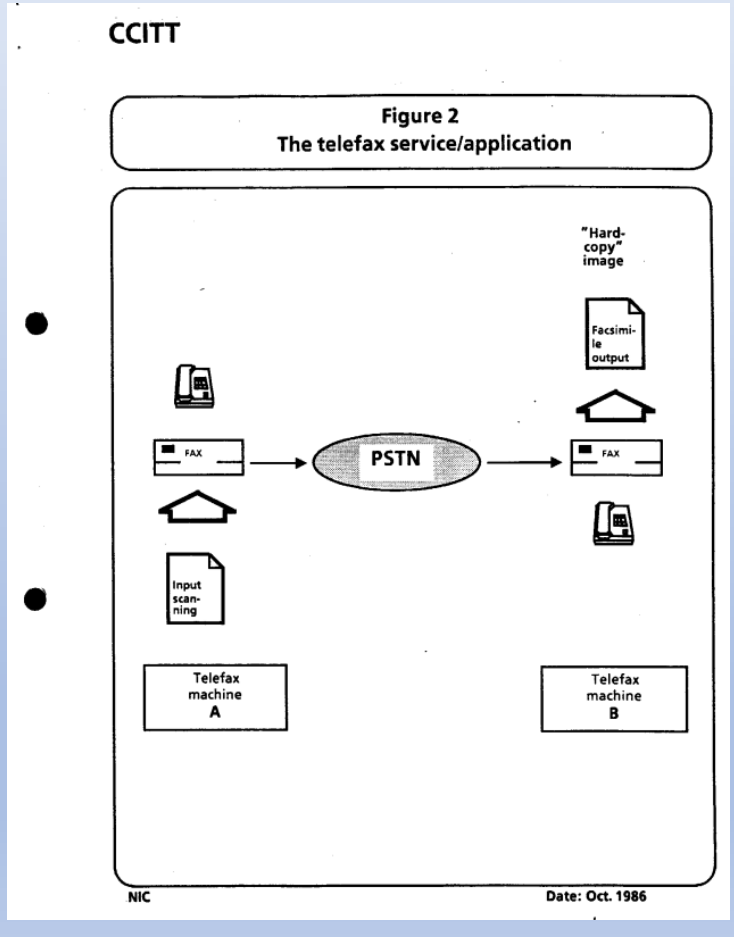


FIGURE 1/T.80

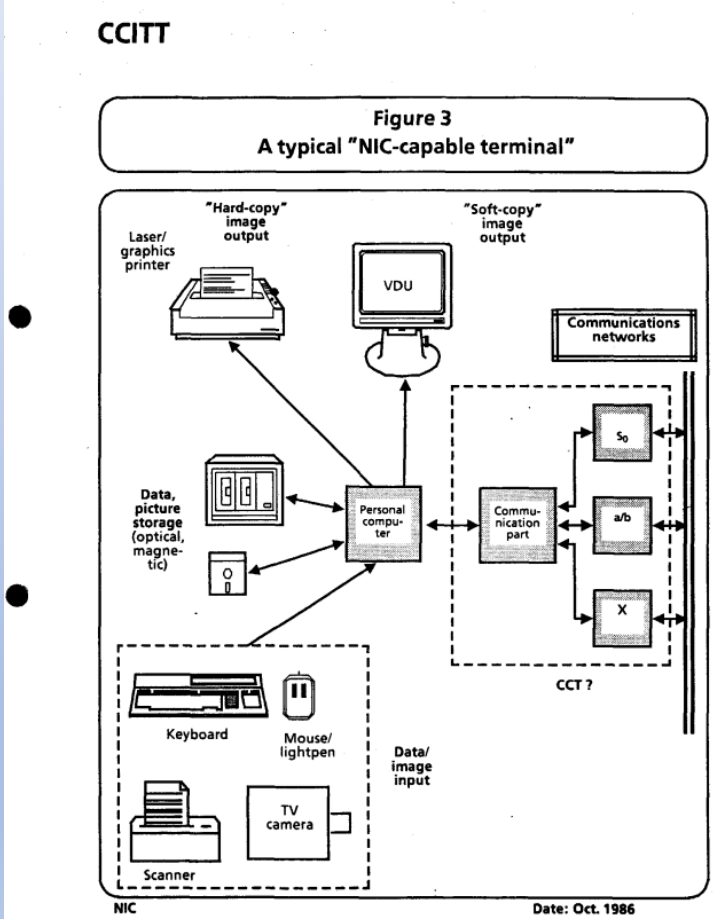
Typical application areas of T.81 and T.82 techniques with regard to the digital quantization/precision of data

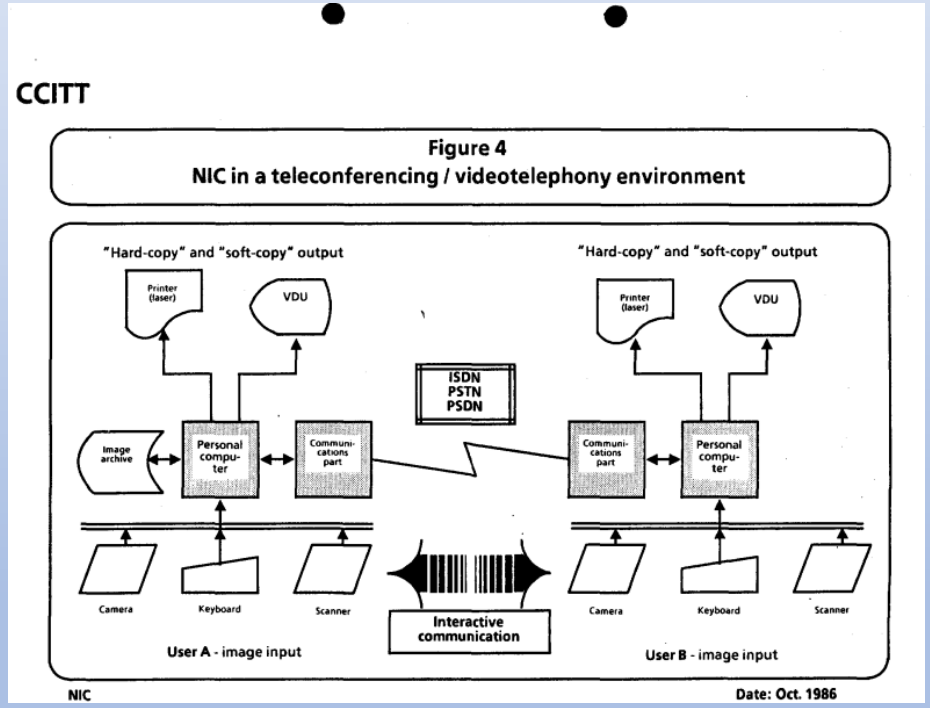
Typical configuration of existing CCITT services / applications



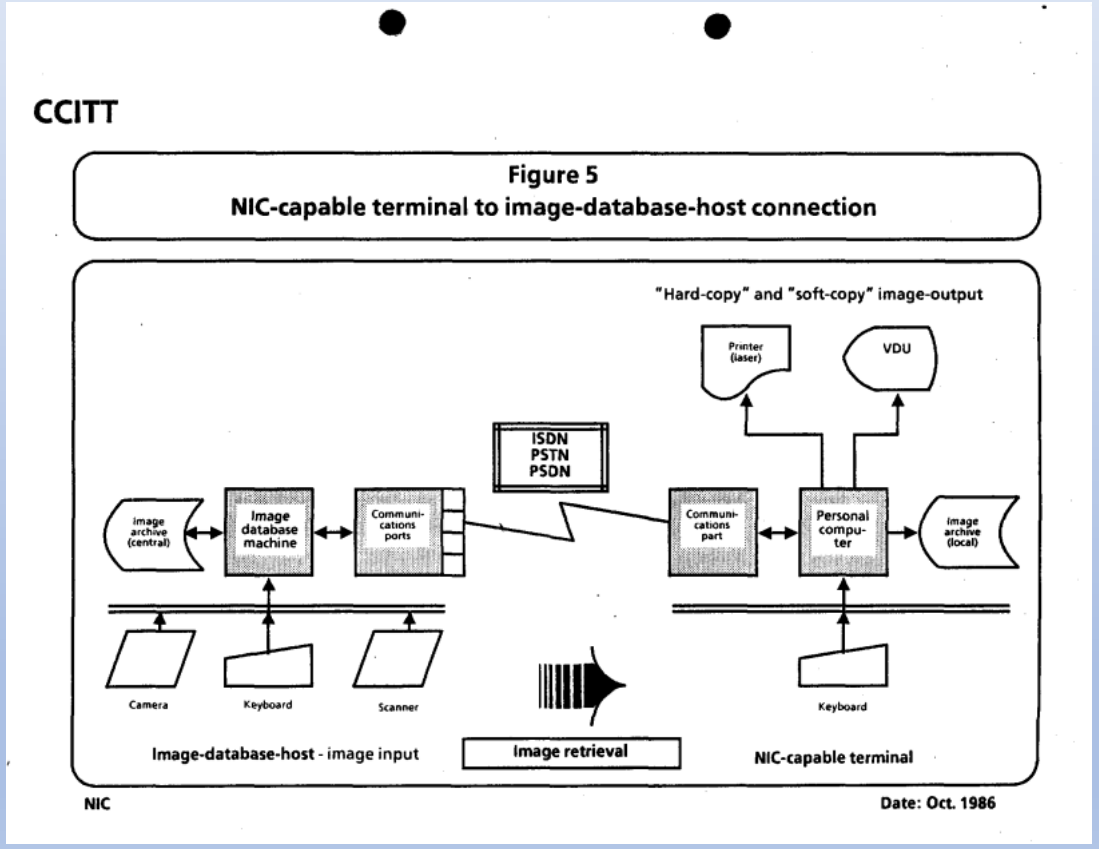


Typical future “NIC-capable” image communication application / services (1)





Typical future “NIC-capable” image communication application / services (2)



- It was recognized:
- Existing CCITT applications / services / protocols can also be enhanced with NIC features
- Thus, no separate NIC service is needed for the time being

Consequences: Answer to the Question 18/VIII

- “No NIC is needed for the time being” – Also no request from CCITT SGI (responsible for CCITT Services)
- Rather existing CCITT applications / services have to be enhanced with NIC features built on similar, compatible components
- For that a set of “Common Image Communication Components” are needed. This is analog to the “LEGO” Bricks…
- In the Study Period 1989-1993 the following CCITT SGVIII Applications / services have been enhanced with JPEG:
  - Videotex
  - Color Facsimile Gr3. and Gr.4
  - Teletex Mixed Mode
  - Audiographic Conferencing
  - Office Document Architecture

CCITT Plenary Meeting Sydney – 1988
CCITT SG VIII Terminals for telematic services
SG VIII Questions for 1990-1993

Question	Short title
1/VIII	Revision of Recommendations
2/VIII	Definitions
3/VIII	Study of telephone-type circuit dependent problems in facsimile transmission
4/VIII	Group 4 facsimile apparatus
5/VIII	Choice of modulation techniques to be used with Telematic services connected to the PSTN
6/VIII	Terminal characteristics for Mixed Mode and Processable Mode
7/VIII	Digital phototelegraphy equipment
8/VIII	Coding of alphanumeric characters and associated control functions for Telematic services
9/VIII	Protocols for Interactive audiovisual services
10/VIII	Terminal characteristics and standardized options for the Teletex terminals
11/VIII	Conversion
12/VIII	Telematic interworking
13/VIII	Development of conformance procedures to ensure the international compatibility of Teletex
14/VIII	Syntax aspects of interactive Videotex
15/VIII	Protocol aspects of interactive Videotex
16/VIII	Common components for image communications
17/VIII	Terminal characteristics and protocols for Telematic services on ISDN
18/VIII	Group 3 facsimile apparatus

CCIC

CCIC = Common components for image communication

One can build from the “Common Components for Image Communication” many different applications – also outside of the ITU/ISO World

Some Disadvantages:

- JPEG was “color blind” – as color model was expected from the app.
- JPEG had at the 1992 approval no standard “File Format” defined (Remedy for PC applications “JFIF” by Eric Hamilton)

Now about the standardization process…..
IIASA was never formally involved…

Different Projects by different standardization groups lead to the creation of JPEG (Joint Photographic Experts Group)

- **The ISO/TC97/SC2/WG8 project on picture coding identification**
- **The "Videotex Photographic Mode" project (CCITT, ISO, ETSI)**
- **The CCITT Q.18/VIII „New Image Communication" (NIC) Project**

All were driven first by the same type of people, namely primerily by telecommunication folks (FT, BT, AT&T, DBP, NTT, KDD,…) and Telecom Industry (Siemens, ANT,…).

Most IT folks (e.g. IBM, DEC, Kodak,….) joined later.

Actors of the JPEG-1 standardization (1986-1994)

1. Original JPEG Committee (1986-1993) – independent expert group until the formal ITU-ISO/IEC JTC1 Cooperation was concluded (1993)
2. CCITT SGVIII (from 1992 ITU-T SG8) (1986-1994) – “New Image Communication Group” / “Common Components for Image Communication” – Informal Founders of JPEG from the CCITT side
3. ISO/TC97/SC2/WG8 (1986-1987) – Informal Founders of JPEG from ISO side
4. ISO/TC97 became ISO/IEC JTC1 in 1987:
   ISO/IEC JTC1/SC2/WG8 (from 1987-1990) later due to reorg in SC2:
   ISO/IEC JTC1/SC2/WG10 (from 1990-1994) – as successor of ISO/TC97/SC2/WG8 for “JPEG-1” as ISO/IEC “parent”
   (and ISO/IEC JTC1/SC2/WG9 (from 1990-1994) – as successor of ISO/TC97/SC2/WG8 for “JBIG-1” as ISO/IEC “parent”
5. Independent JPEG Group – Open Source Software implementation of JPEG-1 (1990-1994)

Process of the JPEG-1 standardization (1986-1994)

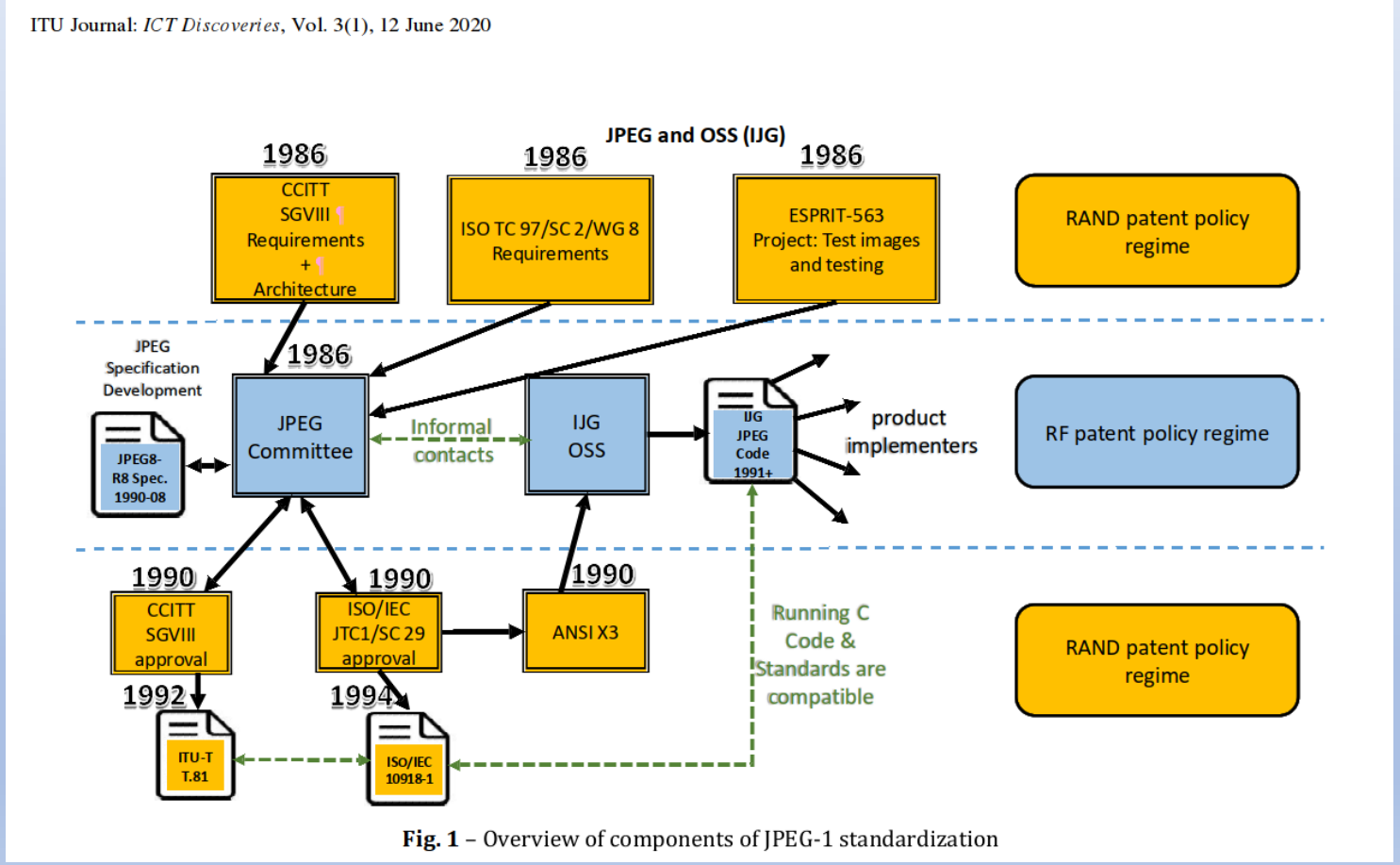


Fig. 1 – Overview of components of JPEG-1 standardization

First generation of T.80 Series of Recommendations (Standards) in the ITU
30 Years Anniversary in 2022

- CCITT T.80 (later ITU-T T.80) : Common components for image compression and communication - **Basic principles**
  (Approved in 1992-09-18)
- **“JPEG-1” standard for multicolor pixel-images :**
  CCITT T.81 (after 1993 : ITU-T T.81¦ISO/IEC 10918-1) Information technology - Coded representation of picture and audio information - Progressive bi-level image compression
  (Approved on 1992-09-18)
- **“JBIG-1” standard for bi-level (limited level) pixel-images:**
  ITU-T T.82 (after 1993 : ITU-T T.82¦ISO/IEC 11544) Information technology - Coded representation of picture and audio information - Progressive bi-level image compression
  (Approved on 1993-03-12)

Comparison: informal JPEG versus formal ITU/CCITT SGVIII "NIC" and ISO/TC97/SC2/WG8 groups (1)

JPEG was an informal group created in November 1986 from some individual members of CCITT SGVIII and ISO/TC97/SC2/WG8

- Members: Individual Photographic Coding Experts
- Documentation: "Relaxed" separate JPEG Documentation from JPEG Members, from external partners. Only JPEG had the full set of documentation.
- Decision process: At all times "Consensus" among JPEG experts on all matters
- IPR Policy: "RF Baseline and RAND Options"
- Meetings: Alternate "piggy back" between ISO and CCITT meetings

CCITT SGVIII and ISO/TC97/SC2 were the informal "parents" of JPEG. They defined JPEG requirements and took the finished JPEG specifications for formal CCITT/ITU and ISO/IEC approval

- Members: ITU State- and Sector Members (industry); respective ISO/TC97 National Bodies
- Documentation: Formal documentation procedures of both bodies. The documentation was selected, not complete.
- Decision process: Formal staged and separate decision process by ITU and ISO Members (organizations)
- IPR Policy: Strict "RAND" on everything, no "RF" supported, only so called "RAND 0"
- Meetings: Formal procedures according to respective ITU and ISO rules

Comparison: informal JPEG versus formal ITU/CCITT SGVIII "NIC" and ISO/TC97/SC2/WG8 groups (2)

JPEG was an informal group created in November 1986 from some individual members of CCITT SGVIII and ISO/TC97/SC2/WG8

- Conclusions:

1. Flexible, fast decision making and specification writing.
2. "Killer application" Bodies (W3C and IJG) could pick up and implement JPEG 8 Spec. very early in 1990.
3. Incompatible IPR policy created significant problems in 2000 and beyond. Due to the early closing of JPEG in 1994 IPR support in litigation cases only by individual members. Loss of some documents, no formal JPEG archive.

CCITT SGVIII and ISO/TC97/SC2 were the informal "parents" of JPEG. They defined JPEG requirements and took the finished JPEG specifications for formal CCITT/ITU and ISO/IEC approval

- Conclusions:

1. The decision making was separate for both CCITT and ISO. Synchronization difficult and time-consuming. Result: CCITT Approval of JPEG was 9/1992 and JTC1 Approval in 02/1994.
2. ITU and ISO/IEC JTC1 has only incomplete documentation.
3. Very limited IPR support to those in need because of litigations due to difference in IPR policy. Due to the "Fast Track"-type of submission process the formal SDOs do not have strict control over the standardization
4. Insufficient formal recognition of JPEG experts who did the actual technical work on JPEG. The value of the formal approval process is overrated.

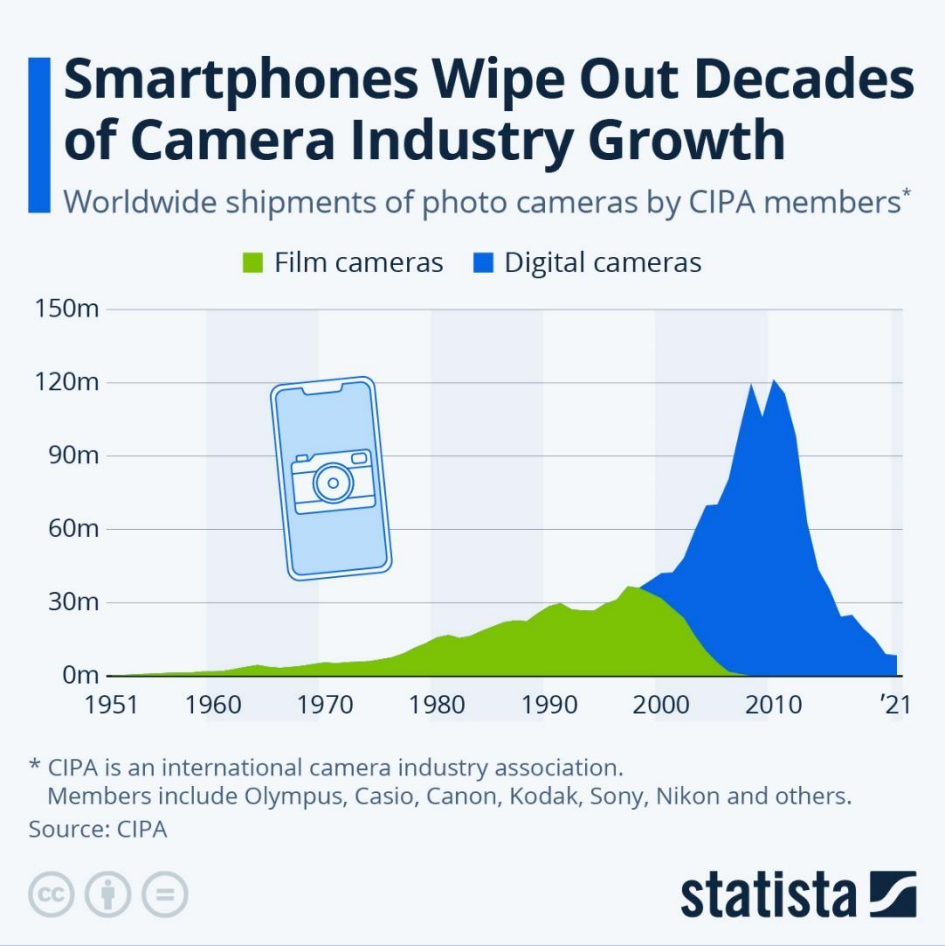
What were the “killer applications” for JPEG? (1)

- Unfortunately, the ITU/CCITT Applications /services looked at the initial NIC study were not successful:
  - ITU/CCITT Videotex (the “1st wave”) standards exist today, but no one uses them. The entire Videotex technology, the way of standardization did not materialize in a significant market breakthrough.
  - The “2nd wave” with Internet and WWW is one of the “killer apps”. Early implementation of the progressive JPEG in early 1995 was a key factor in the success. Also the RF Open Source code of the Independent JPEG Group (IJG) that implemented only the RF Components of JPEG. The IJG has picked up an early version of the JPEG-8 Specification and started to implement. They came out with the first code in 9/1991. So, they celebrated their 30th Anniversary already a year ago.
  - Color (JPEG) Facsimile Gr3. came too late. It is implemented in most current machine, but Facsimile on an outdated POT network is out of date. This use has been replaced by the Internet and Email.
  - ITU-T T.417 “Office Document Architecture” – Raster Image Graphic. It is a standard, but a dead one. The WWW with html and JavaScript has killed it.

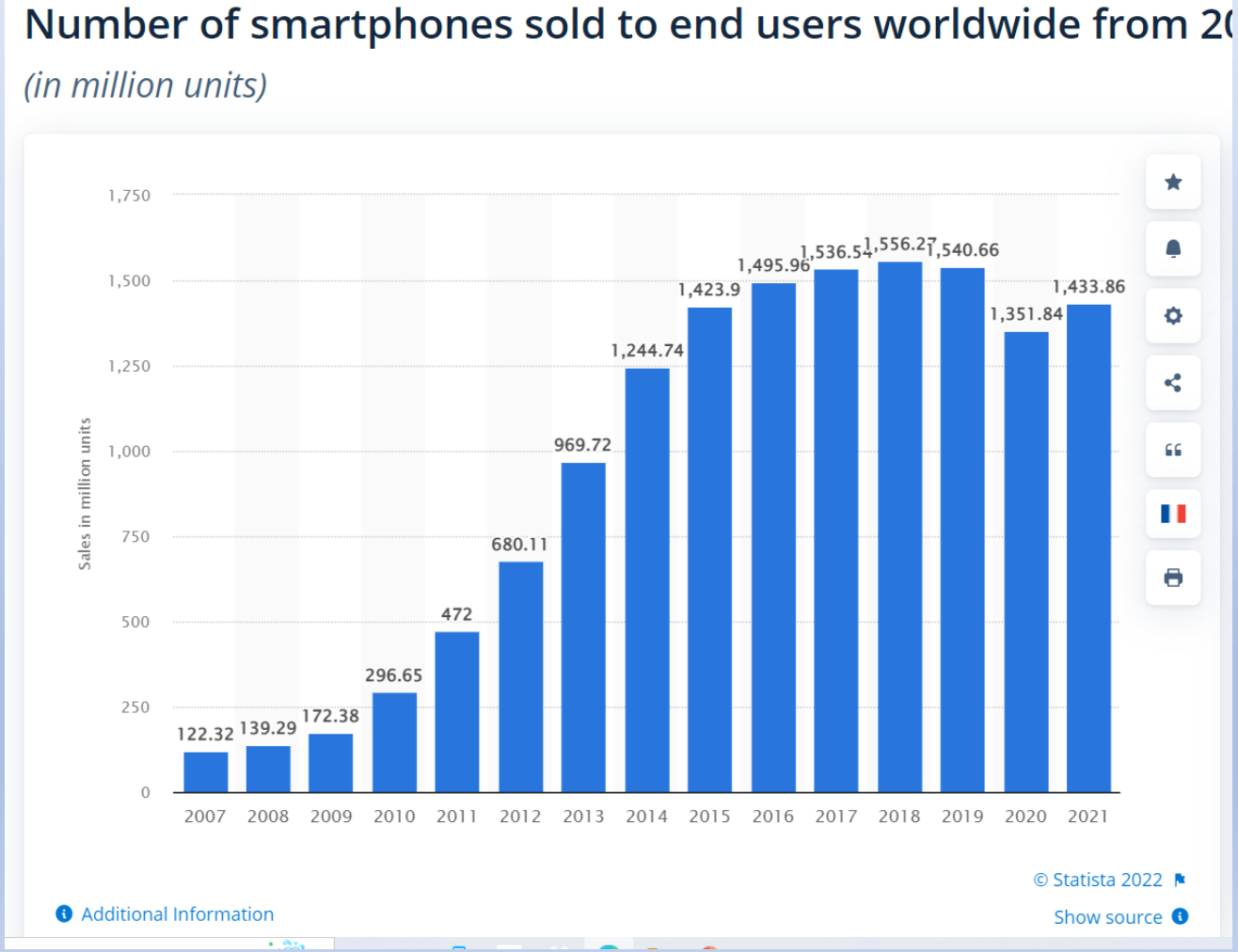
What were the “killer applications” for JPEG? (2)

- Unfortunately, the ITU/CCITT Applications /services looked at the initial NIC study were not successful:
  - ITU-T T.120 Series of Recommendation. After a good start around the year of 2000, the ITU SG16 Standards around ITU-T H.323 and T.120 got fragmented by the market. Currently there exist many video conferencing applications, such as Skype, Zoom, Google Meets, Webex, etc… all with incompatible solutions basically doing the same thing. JPEG is always included, but compatibility with ITU Audio-Visual and Conferencing Standard is not given.
- Other JPEG Applications are successful:
  - Medical imaging (Dicom) is very successful since the early days. JPEG always had liaisons with them
  - Military JPEG standards are also successful. As soon as 1993 JPEG was taken over as such
  - Digital Photography is another “killer application”: see some figures next…

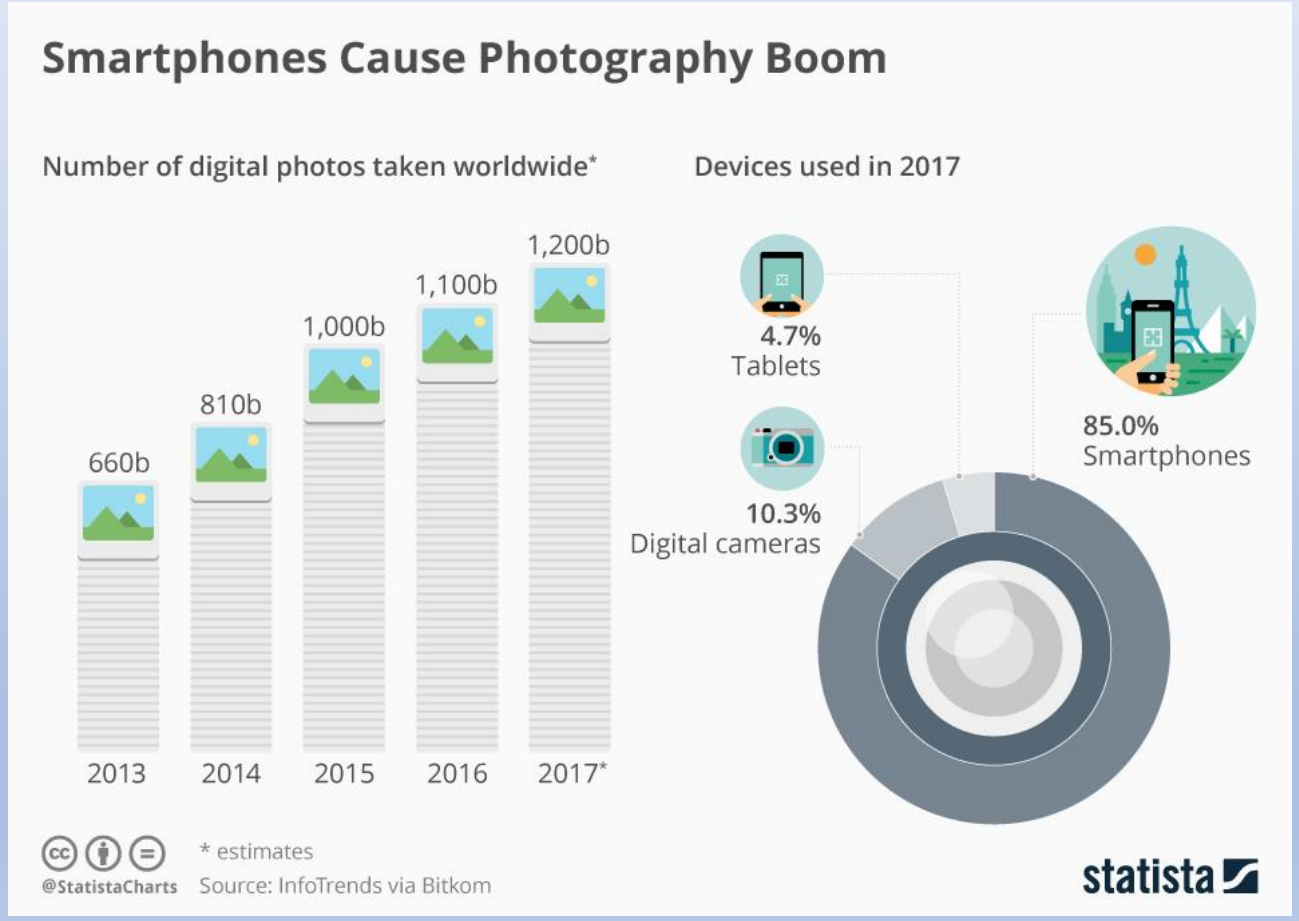
Digital Photography has killed the classical film based photography but also digital camera based photography is greatly suffering…



Number of smartphone sold worldwide to end users (2007-2021)



Smartphones taken still images (de facto all JPEG-1 pictures) dominate. About 1.2 trillion images in 2017…



What is left for the future?

- Unfortunately the long-term (min. 50 years until “forever”) archival is not solved yet. Therefore a large number of taken JPEG images are in danger one day to disappear.
- Also the JPEG standard has to be protected as a “Human Heritage Standard”. This new category of standard means that this standard will never become obsolete, because of a strong society interest that a very large number of surviving images should never disappear. What “Human Heritage Standards” means need to be yet worked out yet (e.g. they must be an IPR of RF, including Normative References, it needs more explanation on all components etc.), also who can take care of them (e.g. UNESCO).
- All these might become an interesting interdisciplinary study subject for future IIASA work.

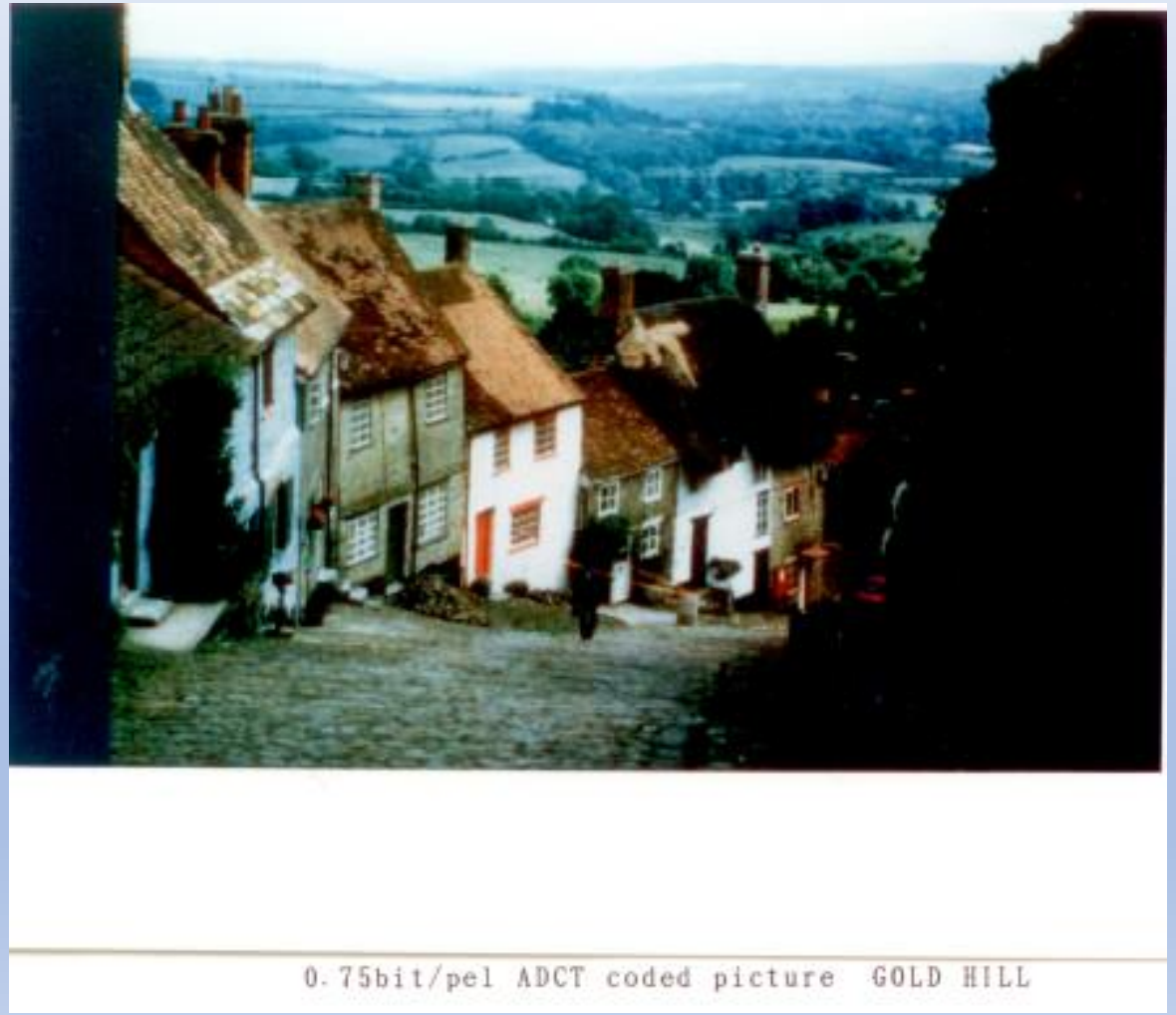
So far what was discussed about the JPEG standardization was only the begining...
It took a long way from there to get JPEG approved and published in 1992 (ITU-T) / 1994 (ISO/IEC JTC1)...

Have a look on some test images and the team who did the final selection in 1988

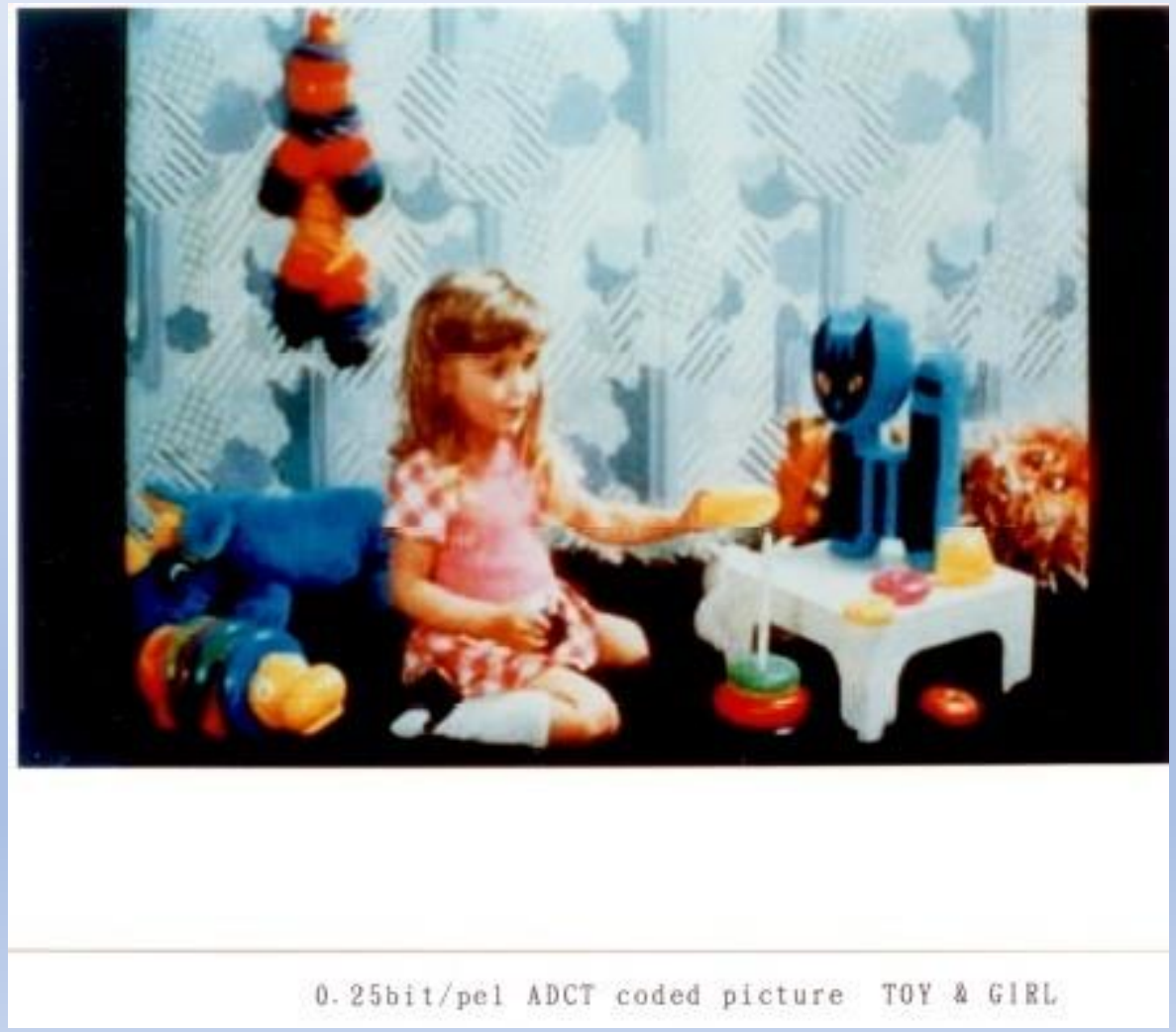
Press Release picture about the winning technique (January 1988)

0.25bit/pel ADCT coded picture GOLD HILL

Press Release picture about the winning technique (January 1988)



Press Release picture about the winning technique (January 1988)



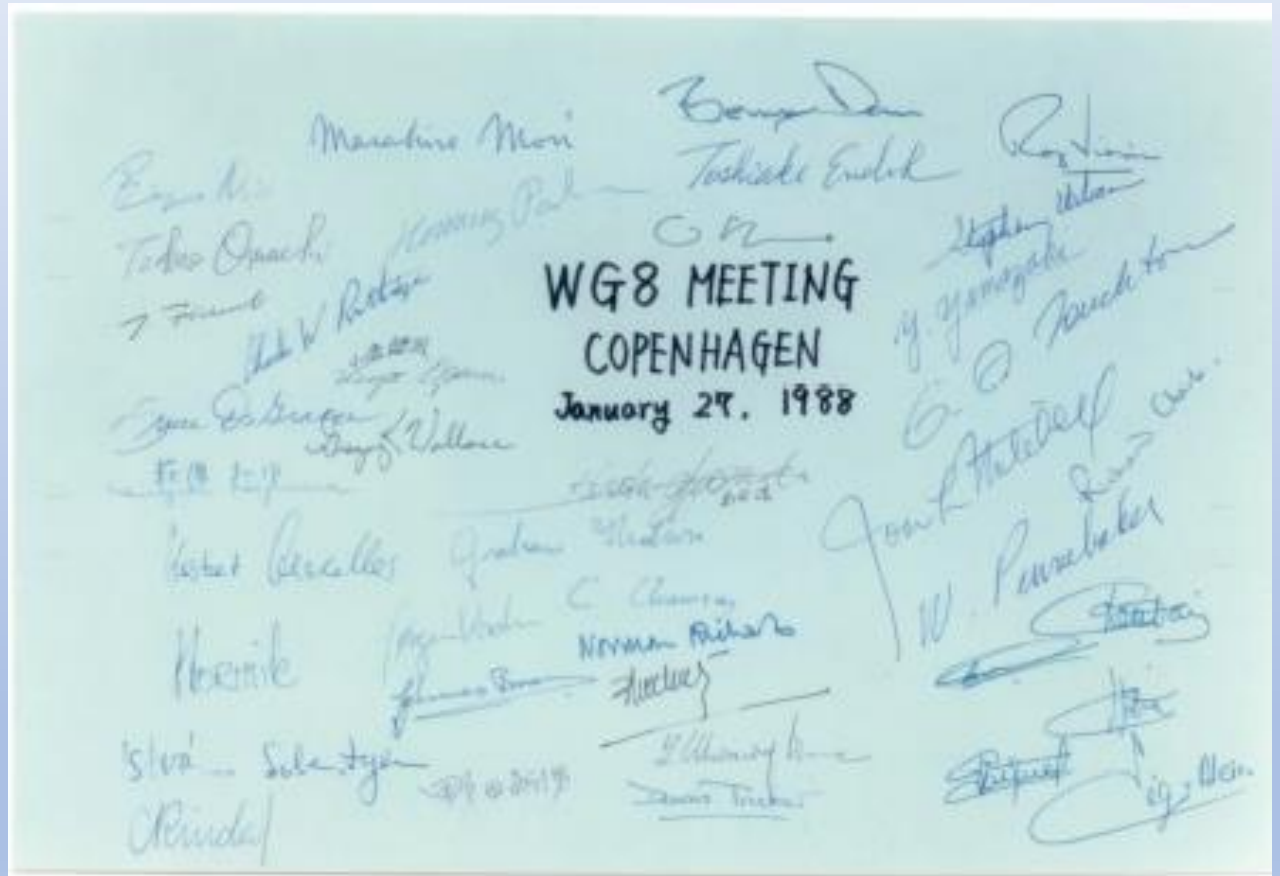
Press Release picture about the winning technique (January 1988)

0.75bit/pel ADCT coded picture TOY & GIRL

Here test image “Barbara 2” with the for the evaluation chosen four progressive stages...

Photo of the testing team taken at the January 1988 JPEG selection meeting in Copenhagen

Signatures of JPEG experts at the January 1988 JPEG selection meeting



A photo of Attendants' Signiture

Key contributors to the JPEG standard

Many people from around the world participated during the years 1986-1992 in the development, drafting, testing and finishing of the JPEG standard. The key contributors are listed below - in alphabetical order - together with their affiliation at the time.

http://www.original-jpeg.org/

- Dr. Aharon Gill - Zoran Corporation, Israel
- Eric Hamilton - C-Cube Microsystems, USA
- Graham Hudson - British Telecom Research Laboratories (BTRL), UK
- Dr. Alain Léger - Centre Commun d'Études de Télévision et de Télécommunications (CCETT), France
- Dr. Adriaan Ligtenberg - Storm Technology, USA
- Dr. Herbert Lohscheller - ANT Nachrichtentechnik GmbH, Germany
- Dr. Joan Mitchell † - International Business Machines (IBM), USA
- Birger Niss - Kjøbenhavns Telefon Aktie Selskab (KTAS), Autograph International (AGI), Denmark
- Dr. Takao Omachi - NEC Corporation (NEC), Japan
- Dr. William Pennebaker - International Business Machines (IBM), USA
- Henning Poulsen - Kjøbenhavns Telefon Aktie Selskab (KTAS), Denmark
- Dr. István Sebestyén - Siemens AG, Germany
- Dr. Jørgen Vaaben - Kjøbenhavns Telefon Aktie Selskab (KTAS), Autograph International (AGI), Denmark
- Gregory Wallace - Digital Equipment Corporation (DEC), USA

Where to find out more? – On relevant JPEG history literature

- https://www.researchgate.net/profile/Istvan-Sebestyen-3/publication/363800929_wg8n0392_Sebestyen_BRD_NIC_Study_1986-10_-_The_Study_submitted_to_the_CCITT_SGVIII_and_SGXV_on_New_Image_Communication_-_Preparation_suggesting_the_principles_ITU-T_T80_of_the_JPEG-1_ITU-T_T81_and_JBI/links/632ee404165ca227876bc7d6/wg8n0392-Sebestyen-BRD-NIC-Study-1986-10-The-Study-submitted-to-the-CCITT-SGVIII-and-SGXV-on-New-Image-Communication-Preparation-suggesting-the-principles-ITU-T-T80-of-the-JPEG-1-ITU-T-T81-and-JBI.pdf
- https://www.researchgate.net/publication/342765604_SOME_LITTLE-KNOWN_ASPECTS_OF_THE_HISTORY_OF_THE_JPEG_STILL_PICTURE-CODING
- https://www.researchgate.net/publication/316899532_JPEG_at_25_Still_Going_Strong
- https://www.researchgate.net/publication/327357375_JPEG-1_standard_25_years_Past_present_and_future_reasons_for_a_success

Where to find out more? – On relevant Videotex /ICT IIASA publications (1)

- Maurer, H.A., Rauch, W. & Sebestyen, I. (1981). Alphabetic Searching in Videotex Systems. IIASA Research Report (Reprint). IIASA, Laxenburg, Austria: RR-82-011. Reprinted from Electronic Publishing Review, 1(3) [1981].
- Maurer, H.A., Rauch, W. & Sebestyen, I. (1981). On Alphabetic Searching in Videotex Systems. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-81-111
- Maurer, H.A., Rauch, W. & Sebestyen, I. (1981). Videotex Message Service Systems. IIASA Research Report (Reprint). IIASA, Laxenburg, Austria: RR-82-010. Reprinted from Electronic Publishing Review, 1(4) [1981].
- Maurer, H.A., Rauch, W. & Sebestyen, I. (1981). Videotex Message Service Systems. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-81-113
- Maurer, H.A. & Sebestyen, I. (1981). "Unorthodox" Videotex Applications: Teleplaying, Telegambling, Telesoftware and Telecomputing. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-81-161
- Labadi, A. & Sebestyen, I. (1982). The IIASA TPA/70 - X.25 Gateway Network Promotes International Flow of Scientific Information. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-088

Where to find out more? – On relevant Videotex /ICT IIASA publications (2)

- Sebestyen, I. (1981). Computerized Message Sending and Teleconferencing in an International Environment - Present and Future. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-81-084
- Sebestyen, I. (1981). Computerized Message Sending and Teleconferencing in an International Environment: Present and Future. IIASA Research Report (Reprint). IIASA, Laxenburg, Austria: RR-82-012. Reprinted from Electronic Publishing Review, 1(3) [1981].
- Sebestyen, I. (1981). The Videodisc Revolution. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-81-160
- Maurer, H.A., Rauch, W. & Sebestyen, I. (1982). Some Remarks on Energy and Resource Consumption of New Information Technologies. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-013
- Maurer, H.A. & Sebestyen, I. (1982). Inhouse versus Public Videotex Systems. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-073
- Maurer, H.A. & Sebestyen, I. (1982). One-Way Versus Two-Way Videotex. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-030

Where to find out more? – On relevant Videotex /ICT IIASA publications (3)

- Maurer, H.A. & Sebestyen, I. (1982). Public-Key Cryptosystems, Telesoftware and Other Novel Applications of Videotex. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-071
- Maurer, H.A., Sebestyen, I. & Charles, C. (1982). Printing without Paper? IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-016
- Sebestyen, I. (1982). Perspective of Policy Development in the Field of Informatics: The Example of Videotex Technology. IIASA Working Paper. IIASA, Laxenburg, Austria: WP-82-052
- Sebestyen, I. (1982). The Videodisc Revolution. IIASA Research Report (Reprint). IIASA, Laxenburg, Austria: RR-82-027. Reprinted from Electronic Publishing Review, 2(1) [1982].
- Maurer, H.A. & Sebestyen, I. (1983). Inhouse versus public videotex systems. Computer Networks (1976) 7 (5), 329-342. 10.1016/0376-5075(83)90044-2.
- Labadi, A. & Sebestyen, I. (1983). The IIASA TPA/70-X.25 gateway-network promotes international flow of scientific information. Computer Networks (1976) 7 (2), 113-121. 10.1016/0376-5075(83)90063-6.

Where to find out more? – On relevant ITU-T Recommendations - Terminals for telematic services (1) https://www.itu.int/rec/T-REC-T/en

- T.80 - Common components for image compression and communication - Basic principles
- T.81 - Information technology - Digital compression and coding of continuous-tone still images - Requirements and guidelines
- T.82 - Information technology - Coded representation of picture and audio information - Progressive bi-level image compression
- T.83 - Information technology - Digital compression and coding of continuous-tone still images: Compliance testing
- This Recommendation includes 3 diskettes containing compliance test data for the generic encoder and decoder compliance tests.
- T.84 - Information technology - Digital compression and coding of continuous-tone still images: Extensions
- T.85 - Application profile for Recommendation T.82 - Progressive bi-level image compression (JBIG coding scheme) for facsimile apparatus
- T.86 - Information technology - Digital compression and coding of continuous-tone still images: Registration of JPEG Profiles, SPIFF Profiles, SPIFF Tags, SPIFF colour Spaces, APPn Markers, SPIFF Compression types and Registration authorities (REGAUT)

Where to find out more? – On relevant ITU-T Recommendations - Terminals for telematic services (2)

- T.87 - Information technology - Lossless and near-lossless compression of continuous-tone still images - Baseline
- T.88 - Information technology - Lossy/lossless coding of bi-level images
- T.89 - Application profiles for Recommendation T.88 - Lossy/lossless coding of bi-level images (JBIG2) for facsimile
- T.800 - Information technology - JPEG 2000 image coding system: Core coding system
- T.801 - Information technology-JPEG 2000 image coding system - Extensions
- T.802 - Information technology - JPEG 2000 image coding system: Motion JPEG 2000
- T.803 - Information technology-JPEG 2000 image coding system: Conformance testing
- T.804 - Information technology-JPEG 2000 image coding system: Reference software

Where to find out more? – On relevant ITU-T Recommendations - Terminals for telematic services (3)

- T.805 - Information technology - JPEG 2000 image coding system: Compound image file format
- T.807 - Information technology - JPEG 2000 image coding system: Secure JPEG 2000
- T.808 - Information technology - JPEG 2000 image coding system: Interactivity tools, APIs and protocols
- T.809 - Information technology - JPEG 2000 image coding system: Extensions for three-dimensional data
- T.810 - Information technology - JPEG 2000 image coding system: Wireless
- T.812 - Information technology - JPEG 2000 image coding system: An entry level JPEG 2000 encoder
- T.851 - ITU-T T.81 (JPEG-1)-based still-image coding using an alternative arithmetic coder
- T.870 - Information technology - Lossless and near-lossless compression of continuous-tone still images: Extensions
- T.871 - Information technology - Digital compression and coding of continuous-tone still images: JPEG File Interchange Format (JFIF)
- T.872 - Information technology - Digital compression and coding of continuous-tone still images: Application to printing systems
- T.873 - Information technology - Digital compression and coding of continuous-tone still images: Reference software

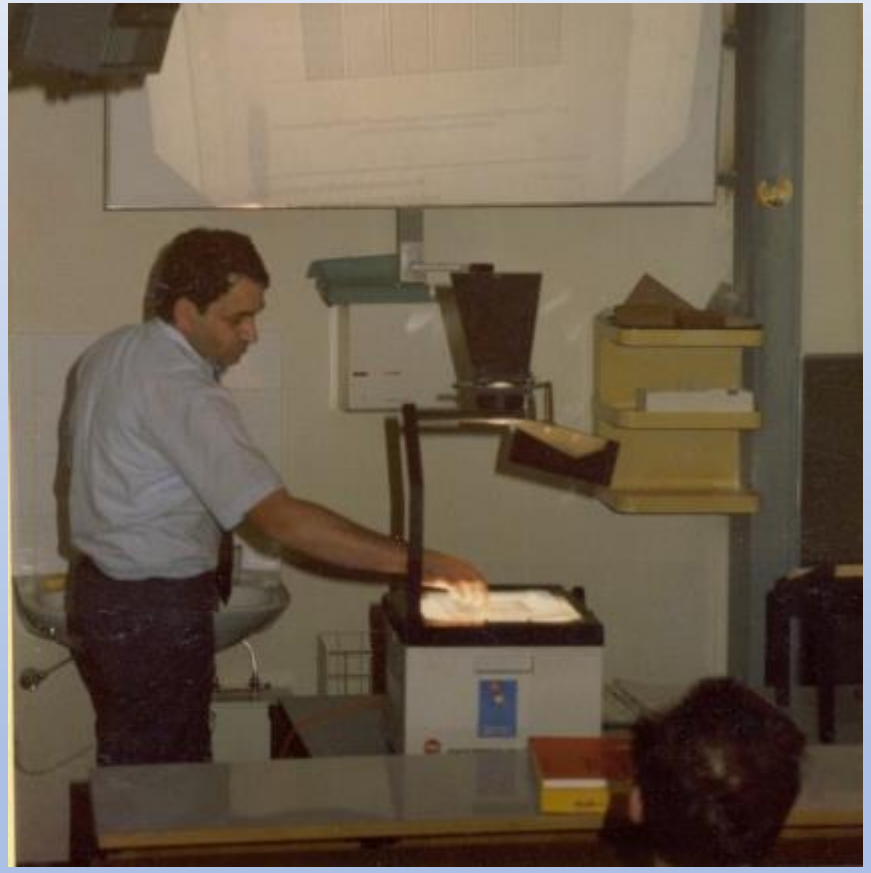
Where to find out more? – On relevant ITU-T Recommendations - Terminals for telematic services (4) – Videotex Standards

- T.100 - International information exchange for interactive Videotex
- T.101 - International interworking for Videotex services
- T.102 - Syntax-based Videotex end-to-end protocols for the circuit mode ISDN
- T.103 - Syntax-based Videotex end-to-end protocols for the packet mode ISDN
- T.104 - Packet mode access for syntax-based Videotex via PSTN
- T.105 - Syntax-based Videotex application layer protocol
- T.106 - Framework of videotex terminal protocols
- T.107 - Enhanced man machine interface for videotex and other retrieval services (VEMMI)

Where to find out more? – On relevant Ecma International Standards on JavaScript / ECMAScript Standards - Ecma International (ecma-international.org)

- ECMA-414 ECMAScript® specification suite
- ECMA-404 The JSON data interchange syntax
- ECMA-402 ECMAScript® 2022 internationalization API specification
- ECMA-262 ECMAScript® 2022 language specification

Thanks…. Questions?



This is me in 1988 as CCITT „NIC” evangelist in Graz, Austria