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Profili za izmenjevanje medicinskih slik

Profiles for medical image interchange

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Profiles for medical image interchange

This CEN REPORT has been prepared by EWOS/EG PT024 for Technical Committee CEN/TC 251 "Medical informatics" and has been approved by CEN on 1995-06-28.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 Requirements for Medical Image Interchange

Traditional analogue medical imaging devices are fast being replaced by digital apparatus in hospitals. This, together with the increased use of information systems and communications in the healthcare environment, has led to an upsurge in demand for communication involving medical images. Over recent years technological restrictions have limited the demand for intercommunication but recent developments in both imaging equipment and information technology have to a large degree overcome these.

A wide variety of information technologies are being applied successfully in other industries to reduce cost and increase productivity and quality. Applying those technologies to healthcare services can help alleviate the tremendous pressure on the healthcare system.

In this situation standards are becoming increasingly important. Currently no international standards exist for medical image interchange, but development of standardised formats is underway in Europe, USA and Japan. Once application layer standards for medical image interchange are available, directions are needed on the use of these standards in conjunction with supporting communication standards. Wherever appropriate international standards exist these should be preferred in this connection. As yet, little work has been done on the OSI profiles necessary to allow communication and interworking using these standards.

1.1.2 The Joint EWOS / CEN Work Programme

In 1989, SOGITS issued Mandate BC-IT-SI-05 concerning medical informatics. This Mandate was split into two parts, one being the responsibility of CEN and the other of EWOS. As a result CEN / TC 251 and EWOS / EG MED were set up to undertake work that fell within the remit of CEN and EWOS respectively.

The CEN Work Programme consists of a number of work items and is being undertaken by seven Working Groups. One of these, WG 4, is responsible for medical imaging and multimedia. Elements of this work which involve OSI profiles are, however, being handled by EWOS.

The CEC issued a mandate in respect of work item 4.1, "Profiles for Medical Image Interchange", which is included as an Annex to this document. This mandate caused the formation of EWOS Project Team PTN024 which produced a report on medical image interchange profiles between May 1992 and August 1993. The PTN024 report was approved by EWOS TA in October 1993.

This EWOS Technical Guide is a revised and updated version of the PTN024 Report, rewritten so that it can be used as a guide to the use of communications profiles in the field of medical imaging.

1.1.3 Related Work

CEN/TC 251/WG 4 is in the process of drafting a set of ENVs collectively entitled MEDICOM (MEDical Image COMmunication). Similar work is being done by ACR-NEMA, a joint committee of the American College of Radiology (ACR) and the National Electronic Manufacturers Association. Version 3 of this standard is known as "Digital Image and Communications in Medicine (DICOM)".

1.2 CONTENTS OF THIS ETG

The areas addressed in this ETG are as follows:

- Survey of relevant work in the area of OSI profiles for image interchange
- Recommendations for European profiles

This was done by applying the method defined in the EWOS Technical Guide, "A Method for Defining Profiles for Healthcare" EWOS / ETG 021.

1.3 ORIGINATORS

This ETG has been produced by Martin Whittaker of Touchstone Consultancy Ltd.

The PTN024 Project Team, on whose work this ETG is based, consisted of the following members:

Leader	Rudy Mattheus
Team	Katrine Weisteen Bjerde
	Tony Kerr
	Martin Whittaker
	Norbert Lipszyc
	Louis Schilders
	Andrew Todd-Pokropek
	Marek Rejmer
	Rainer Thieme

Between them, members of the team represent the key parties concerned with the domain of medical image interchange: imaging equipment suppliers, communications specialists, imaging specialists, OSI experts, medical specialists and people with practical experience of implementing medical image communication systems.

2. SCOPE AND METHOD OF WORK

2.1 SCOPE

The purpose of this ETG is to give advice as to what profiles are suitable for applications concerned with multi-disciplinary medical image interchange.

Multi-disciplinary medical image interchange includes applications in radiology, nuclear medicine, pathology, internal medicine, dermatology, ophthalmology, etc. dealing with different types of images (e.g. static greyscale, colour, volumetric, time sequences etc.) all with dedicated user requirements.

The audience of the ETG includes users of medical imaging applications, standards bodies and implementors.

2.2 METHOD OF WORK

The ETG team applies the method defined in the EWOS Technical Guide 021 to the field of medical image interchange ("the Method"). It is strongly suggested that readers of this ETG familiarise themselves with this method before reading this report.

The steps taken to apply the Method were as follows:

- Review of the field of medical image interchange and derive the attributes and attribute values that affect the transmission of medical images
- Creation of a series of User Scenarios describing real-world medical imaging requirements
- Derivation of technical characteristics of these scenarios to enable each to be described exactly in terms of their communication requirements
- Selection of Transport Profiles, Application Profiles and Format Profiles relevant to medical imaging. Only these profiles which were candidates to support image interchange were considered, "Candidate Profiles".
- Establishment of taxonomies of Candidate Profiles and User Scenarios so as to allow them to be mapped on to each other in a rigorous manner.
- Derivation of the Profile Functional Characteristics (PFCs) for each communications profile
- Definition of the quality criteria to be used for the evaluation of the usefulness and appropriateness of each profile, known as Goodness Of Fit Factors (GOFFs).
- Production of a matrix of User Scenarios and Candidate Profiles, where each intersection in the matrix is a GOFF, i.e. an indicator of the suitability that Candidate Profile in the circumstances described in the User Scenario.
- Whenever the GOFF indicated that a no Candidate Profile would satisfy the user need, recommendations for the enhancement of the base profile were made.
- As a result of the mapping activities, a set of usable profiles could be defined. These profiles have been included in a summary sheet per scenario.

The recommendations at the end of this ETG give wherever possible the ideal set of profiles for a given user scenario. There may however be other sets of profiles which could be used to satisfy that scenario. There may also be other sets of profiles which do not completely satisfy the user requirements by, for

example, not allowing the image transfer within the time required by the user. This does not mean that the image cannot be transferred, only that it cannot be transferred in such a way as to satisfy completely the user requirement. This situation is common in case where the user scenario requires a very high bandwidth for which no profiles are currently available.

3. REFERENCES

1 Method for Defining Functional Profiles for Healthcare, EWOS Technical Guide 021.

2 Directory of the European Standardisation Requirements for Healthcare Informatics and Programme for the Development of Standards, Adopted on 1991-02-28 by CEN TC 251; Approved by CEN / BT, version 1.3.

3 First working document CEN TC 251 PT 006, " MEDICOM - Medical Image and Related Data Structure - overview and framework" version 1.0 - 1 June 93.

4 ACR-NEMA - Digital Imaging and Communications in Medicine (DICOM). ACR-NEMA Working group VI. 1992

5 Final Report of EWOS /EG MED/PT N 024, Profiles for Medical Image Interchange, 1993

4. ABBREVIATIONS AND DEFINITIONS

4.1 ABBREVIATIONS

ACR	American College of Radiology
ACSE	Association Control Service Element
ANSI	American National Standards Institute
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
AV	Attribute Value
CAI	Common Architecture for Imaging
CCITT	Comité Consultatif International Télégraphique et Téléphonique
CCR	Commitment, Concurrency and Recovery
CEC	Commission of the European Communities
CEN	Comité Européen de Normalisation
CEN TC 251	Technical Committee for Medical Informatics
CLNS	Connectionless Mode Transport Service
COTS	Connection Oriented Transport Service
CT	Computed Tomography
DF	Digital Fluoroscopy
DIS(1)	ISO Status (Draft International Standard)
ECG	Electrocardiogram
ED	EWOS Document
EDI	Electronic Data Interchange
EG MED	Expert Group Healthcare (EWOS)
ETG	EWOS Technical Guide
EWOS	European Workshop for Open Systems
GOFF	Goodness of Fit Factor
GP	General Practitioner (in medicine)
HIS	Hospital Information System
IA5	International Alphabet 5
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers (USA)
IIF	Image Interchange Facility
IMACS	Image Management and Communication System
IPM	Interpersonal Messaging
ISDN	Integrated Services Digital Network
ISO	International Organisation for Standardisation
ISP	International Standardised Profile
JPACS	Japanese PACS Society
MHS	Message Handling System
MRI	Magnetic Resonance Imaging
NEMA	National Electrical Manufacturers Association (USA)
OSI	Open Systems Interconnection
PACS	Picture Archive and Communication System
PC	Personal Computer
PET	Positron Emission Tomography
PFC	Profile Functional Characteristic
PIKS	Programmer's Imaging Kernel System
ppi	Pixels Per Inch
PSDN	Packet Switched Data Network
PSTN	Public Switched Telephone Network
PT	Project Team
RGB	Red, Green, Blue
RIS	Radiology Information System

ROI	Region of Interest
SAV	Set of Attribute Values
SC	Sub-Committee
SOGITS	Senior Officials Group - Information Technologies Standardisation
SPECT	Single Photon Emission Computer Tomography
TC 251	CEN Technical Committee on medical informatics
TR	Technical Report (ISO)
US	Ultrasound
WG	Working Group

4.2 DEFINITIONS

A-profile	Application profiles define the use of protocol standards from OSI layers 5 to 7, to provide for the structured transfer of information between end systems [ISO/IEC TR 10000-2]. A-profiles require connection-mode transport services.
Acquisition Unit	Particular device required for performing an imaging procedure.
Application service element	That part of an application entity which provides an OSI environment capability, using underlying services when appropriate [ISO 7498 : 1992] A set of functions that provide a capability for the interworking of application entity invocations for a specific purpose on a single application association.
Archive System	Archive is the process of long-term storage and organisation of data and documents.
Association control service element	An ISO defined application service element that handles the establishment and the termination of associations between peer application entities.
Attribute	A property of an instance of communication. An attribute has a value.
B- profile	As A-profile, but requiring connectionless-mode transport service.
Conformance	Static conformance: A statement of the requirement for support by an implementation of a valid set of features from among those defined by a standard. Dynamic conformance: A statement of the requirement for an implementation to adhere to the behaviour prescribed by a standard in an instance of communication.
Data unit	Information to be exchanged consisting of a structured set of attribute values directly or indirectly related to information objects. The value of each attribute in a data set is expressed as a data element.
Digitiser	A device that codes images or shapes into digital data

DIS	Departmental Information System
Examination	A procedure performed on a patient or on a sample taken from a patient for diagnostic or therapeutic purposes in response to a request
F-Profile	Interchange formats and character repertoires are defined as F-profiles and are in principle capable of being carried over any of the transfer services.
File	An ordered set of computer data (including programs), of arbitrary length, uniquely identified by a pathname.
Folder	A folder associates data objects that are related to a specific type of examination or to another grouping criterion.
GP	General medical Practitioner.
H-profile	Hybrid profile: a combination of F and A profiles
HIS	An system which in a hospital handles the data processing needs, including functions such as medical records storage and access, admissions/discharges/transfers, order communications etc. Parts of the Hospital Information System that are capable of handling images are also considered to be part of the IMACS.
IMACS	An system used in a healthcare centre for the storage and processing of images, for controlling access to stored and/or processed images, and for distributing these images to the users. Image Management And Communication System encompasses the entire PACS plus all image handling devices which are part of the HIS.
Image data	Data which is used to render a digital image. It includes pixel or voxel data and may include overlays, annotation and regions of interest.
Image related data	Data related to an image such as descriptive data, image associated data, examination related data etc.
Imaging department	A department producing images, either digital or analogue.
Interoperability	The ability of two or more systems to exchange information and mutually to use the information that has been exchanged.
Medical image	An image used for medical or healthcare purposes, either for treatment of a patient or research.
Message	An information object which contains address information and content [ISO 2382-27] Another source: (General) An ordered series of characters intended to convey information. (At the data level) The ordered sequence of data elements representing the information to be exchanged as one unit between an environment and an information system.

Object	A entity which has a state and a defined set of operations to access and modify that state. Objects can interact with one another. [ISO 7498]
Object class	A formal description of a set of objects possessing the same logical and properties. [ISO 7498-4] It includes a description of its purpose and the attributes its possesses. It does not include the values of these attributes.
PACS	A system is used for the storage and processing of images in an imaging department, enabling radiologists and imaging specialists to perform diagnostic tasks and select which images are needed by other non-specialist doctors.
Pixel	An area of defined shape, size and position within a two-dimensional image with which a measured value or values are associated.
Profile	A set of one or more base standards, and, where applicable, the identification of chosen classes, subsets, options and parameters of those standards, necessary for accomplishing a certain function. [ISO TR 10000-1]
Protocol	A set of rules and formats defining actions and responses exchanged between systems in order to provide services.
RIS	A Radiology Information System handles the data processing needs of a radiology department
Scenario	A scenario sets the scene in which some action is to take place. It is a formal description of a class of activities including the semantics of agreements, conventions and information content. [ISO/IEC JTC 1 N 1384]
Service class	A structured description of a service which is supported by co-operating application entities using specific commands acting on a specific class of objects.
T-profile	Transport profiles define the use of protocol standards from OSI layers 1 to 4, to provide the OSI Transport Service [ISO/IEC TR 10000-2]. T-profiles provide connection-mode transport services.
U-profile	As T-profile, but providing connectionless-mode transport service.
Voxel	A volume of defined shape, size and position within a three-dimensional space with which a measured value or values are associated.

5. CHARACTERISTICS OF MEDICAL IMAGING

Most imaging disciplines have special characteristics that make them different from other imaging disciplines. This section contains an overview of characteristics of medical imaging. Seen in isolation, most of these characteristics apply to more imaging disciplines than the medical one.

Characteristics of medical imaging may be divided into the following three main areas:

- Legal and regulatory aspects
- Kinds of data handled
- Technical aspects of the environment in which the images are used

Compression of medical images is treated in a separate section.

Finally an overview is given of the amount of data produced using the different imaging modalities currently used.

5.1 LEGAL AND REGULATORY ASPECTS

One of the most important characteristics of medical imaging is that the images are used in a context where people's health or even lives are at stake. As a consequence of this, a number of laws and regulations concerning the use of medical images exist. Legislation differs from country to country, but some of the main aspects are :

- Ownership / responsibility
  In many countries legislation dictates that all medical images be preserved for a certain period of time (typically 5-10 years) before they can be deleted. In such cases it should be clear who is responsible for images not getting lost.

- Access rights
  Who is allowed to look at, modify or delete an image? In some hospitals, only senior doctors are allowed to delete images. Others may be allowed to look at or copy them and yet others may not be allowed to access them at all.

- Identification
  In clinical applications the ability to associate an image with the right patient is vital. For research purposes the opposite is often the case, i.e. anonymity is required.

5.2 KINDS OF DATA HANDLED

Some typical characteristics are :

- Amount of data
  As is the case in most imaging disciplines, medical imaging involves large amounts of data. The size of individual images is not too big (current maximum 2 - 4 MByte), but sets of related images will normally be stored rather than individual images.

- Multi-dimensional data
  The image data will often consist of more than two dimensions. Examples of multi-dimensional image data are :

  - Time series. Many medical imaging modalities produce time series of images rather than just single images
  - Multi-band images. An image in which more than one value is stored for each pixel is called a multi-band image. Examples of such images are :