Working Group 32
Neurophysiology Data

ORGANIZATION AND PURPOSE
Working Group 32

Chaired by:

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  Medical University of South Carolina (MUSC)
- vacant

Secretary:

- The International Federation of Clinical Neurophysiology (IFCN)
  Catherine Lamoureux
Working Group 32

Ultimate goal is

- A comprehensive, standard-based digital platform for neurophysiology in the patient care setting

New specification should

- Leverage the existing and growing ecosystem of DICOM-capable systems in use in healthcare institutions
- Leverage standards already in use in the neurophysiology industry
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Short-term objectives:

- New IOD(s) for storing neurophysiology data in PACS or VNA
  - Direct association with the patient
  - Together with related objects such as video or ECG
  - Keeping data synchronized
- Gap analysis of existing DICOM Standard with respect to potential neurophysiology requirements (e.g. waveform compression)
- Identify and establish relationship to other DICOM Working Groups currently responsible for related features
- Priorities for the identified gaps
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Milestones so far:

- In Vienna 2016 some research projects were initiated:
  - Using DICOM Waveforms for EEG and Sleep Studies
  - proofed EHR integration, EEG analysis algorithms running on DICOM Waveforms
- IFCN Task Force in 2018
  - “Common Standard Format for Neurophysiology Data Exchange”
  - Clear vote of the IFCN Task Force for DICOM
- Kickoff for Working Group 32 in 12/2018
- First Read of Sup217 in 06/2019
- Public Comment ended in 01/2020
Neurophysiology Waveforms

EXTENDING DICOM WAVEFORMS TO NEW DOMAINS
Supplement 217 addresses

Exchange and storage of neurophysiology data like

- Electroencephalography (EEG)
- Electromyography (EMG)
- Electrooculography (EOG)
- Polysomnography (PSG)

and

- Continuous recording of the patient’s position
DICOM Waveforms

DICOM Support since 2000

- Audio: 2 SOP Classes
- ECG: 3 SOP Classes
  - 12-lead, General ECG, Ambulatory
- Arterial Pulse Waveform
- Respiratory Waveform
- Basic Cardiac Electrophysiology
- Hemodynamic

DICOM PS3.17 Fig. C.4-1.
DICOM Waveforms

SCP-ECG

VITAL

MIB

ASTM E31.16

DICOM Waveform

HL7 v2.x

HL7 v3 aECG
DICOM Waveforms

- Waveform Attributes
  - Acquisition Time
  - Acquisition Context
  - Annotations

- Channel Multiplexing

- Channel Attributes
  - Channel Source
  - Scaling
  - Callibration
  - Filter

- Sample Values

DICOM Waveform Information Model PS3.17 Fig. C.5-1
## Clinical Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Recording</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routine EEG</td>
<td>Scalp EEG</td>
<td>Encephalography, epilepsy</td>
</tr>
<tr>
<td>EEG-Video-Monitoring</td>
<td>Scalp EEG</td>
<td>Seizure characterization, presurgical epilepsy evaluation</td>
</tr>
<tr>
<td>EEG-Video Monitoring – intracranial</td>
<td>Implanted electrodes</td>
<td>presurgical epilepsy evaluation</td>
</tr>
<tr>
<td>Longterm EEG Monitoring</td>
<td>Scalp EEG</td>
<td>Encephalographyh, epilepsy, ICU</td>
</tr>
<tr>
<td>Polysomnography</td>
<td>Scalp EEG, EMG, EOG + additional</td>
<td>Sleep disorders</td>
</tr>
<tr>
<td>High-density EEG</td>
<td>More Electrodes, req. 3D localization</td>
<td></td>
</tr>
<tr>
<td>EEG-fMRI</td>
<td>Sync. Acquisition of EEG and MRI</td>
<td></td>
</tr>
</tbody>
</table>
Routine Scalp EEG

Properties

- Electrode positions according the international 10/20 or 10/10 system
- Maybe alternative setting using a cap instead of single electrodes
- Up to 32 channels, sampling frequency up to 1024 Hz
- Additionally recorded: single ECG channel

Nomenclature: ISO IEEE 11073 10101

- Leads
  A.8.4 Sites for EEG-electrode placement on the head
- Annotations
Polysomnography

Multimodal recording:

- EEG is essential, additionally required:
  - EMG (activity of skeletal muscles)
  - EOG (eye activity)
- Reuse of existing DICOM objects:
  - ECG
  - Pulse oximetry
  - Sound recordings
  - Video

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Multi-channel Respiratory Waveform

- Existing IOD is limited to a single channel
- Existing Context Group for respiratory channel sources (CID 3005) contains only a single value
- PSG respiration monitoring needs more channels and distinguishable channel sources
DICOM has no IOD to monitor the patient’s position continuously

[WG-07 Sup.160 – worked on patient position monitoring]

Tracking the patient’s movement is essential for PSG

- Video
- Sensor(s) applied to the patient’s body
  >> Patient Position IOD
Proprietary PSG systems often store 5 discrete values:

- supine (the patient's face being in an upward direction)
- lateral decubitus left (patient's left side being in downward direction)
- prone (the patient's face being in a downward direction)
- lateral decubitus right (patient's right side being in downward direction)
- upright (the patient's chest is elevated from the bed)
To meet this requirement an IOD was defined as follows:

- A single multiplex group
- not limiting the number of channels
- A defined CID with different types of channel sources
  - Single channel monitoring just storing 5 discrete values
  - Two channel monitoring storing two rotation angles:
    - Channel I (head-feet-axis rotation: supine, lat. decubitus left, prone, lat. decubitus right)
    - Channel II (laying down versus sitting/standing upright)

By amending CID 30ww further position monitoring methods can be added easily.
<table>
<thead>
<tr>
<th>Position Value</th>
<th>Channel I</th>
<th>Channel II</th>
</tr>
</thead>
<tbody>
<tr>
<td>supine</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>lateral decubitus left</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>prone</td>
<td>180</td>
<td>0</td>
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<tr>
<td>lateral decubitus right</td>
<td>270</td>
<td>0</td>
</tr>
<tr>
<td>head up (sitting or standing)</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>feet up</td>
<td>0</td>
<td>-90</td>
</tr>
</tbody>
</table>
Work Items Defered to Later

- Waveform compression
- Long term monitoring
- High density EEG Intracranial EEG
- Evoked Potentials
- Magnetoencephalography (MEG)
- Amend body position to sensor data