Implementierung von DICONDE für die Speicherung von Ultraschallwellenformen

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1

Situation in the 1980s

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PACS (Picture Archiving and Communication System)

Samuel Dwyer III, PhD

Dr. André Duerinckx

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3

DICOM

Digital Imaging and Communications in Medicine

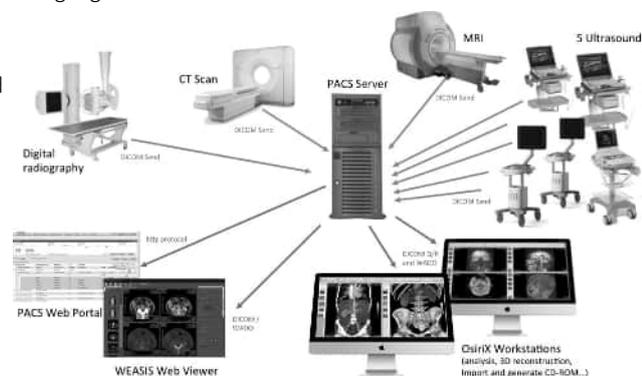© Vrana GmbH 2017-2026 | vrana.net

4

DICOM History

DICOM History

1982: First International Conference and Workshop on Picture Archiving and Communication Systems

1983: The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) form a joint committee to create a universal standard for medical imaging

1985: ACR-NEMA 1.0

1993: The Birth of DICOM and PACS (Version 3.0)

1995: Expansion from Radiology to include Cardiology, Pathology, Dentistry, and Ophthalmology

2004: DICONDE: Digital Imaging and Communication in NDE (ASTM E2339-04)

2009: DICOS: Digital Imaging and Communication in Security

2010: DICOMweb

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5

What is DICOM

DICOM

- Global Vendor-Independent Standard and Universal Language
- Open, Interoperable **File Format**
  - Meeting the Requirements of the EU Data Act
  - Data Encryption and Digital Signatures On-Board
  - Defines the Ontology
- Comprehensive Data Package
  - **Data**
  - **Metadata**
  - **Job Description**
  - **Inspection Report**
- Audit Proof Storage

- **C2C Communication Protocol**
- Long-Term, Centralized Data Management by Integration with PACS (Archiving and Communication Server)

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6

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DICONDE

Digital Imaging and Communications in
NDE

7

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DICONDE History

DICONDE History
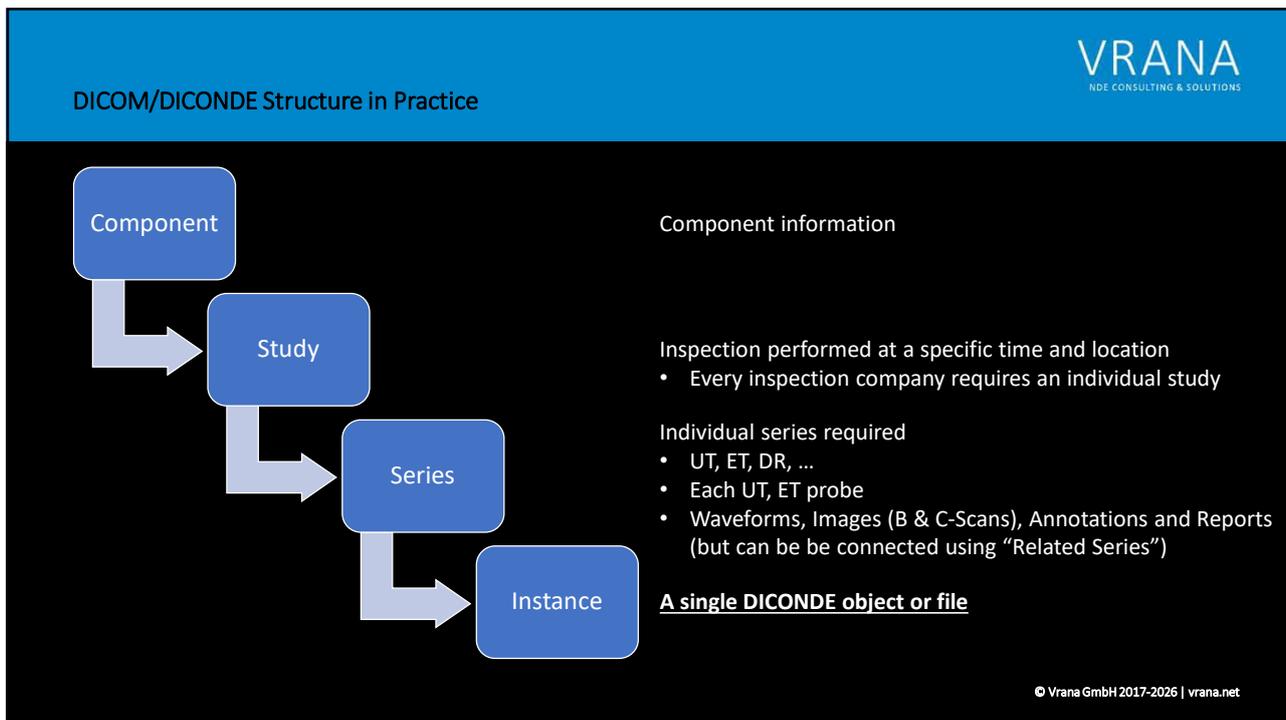
		ASTM Standard
2004:	Start	E2339-04
2006:	Indication Module and NDE Approval Module	E2339-06
2008:	Ultrasonic Testing (no waveform data)	E2663-08
2010:	Digital Radiography	E2699-10
	Computed Radiography	E2738-10
	Computed Tomography	E2767-10
2013:	Eddy Current Testing	E2934-13
2018:	Interoperability Testing	E3147-18
2021:	Building Information Models (BIM)	E3267-21
2024:	Thermography	E3440-24
2025:	Image and Presentation State Display	E3463-25
	Ultrasonic A-Scan	E2663-25

8

DICOM/DICONDE Structure

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Component → Component information

Study → Inspection performed at a specific time and location
- Every inspection company requires an individual study

Series → Same method(modality) and the same equipment

Instance → **A single DICONDE object or file**

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9

DICOM/DICONDE Structure in Practice

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Component → Component information

Study → Inspection performed at a specific time and location
- Every inspection company requires an individual study

Individual series required
- UT, ET, DR, …
- Each UT, ET probe
- Waveforms, Images (B & C-Scans), Annotations and Reports (but can be be connected using "Related Series")

Series

Instance → **A single DICONDE object or file**

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10

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: E2663 – 25

Standard Practice for
Digital Imaging and Communication in Nondestructive
Evaluation (DICONDE) for Ultrasonic Test Methods[1]

This standard is issued under the fixed designation E2663; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. **Scope***

1.1 This practice covers the interoperability of ultrasonic imaging equipment by specifying image data transfer and

1.3.3 The overall set of features and functions to be expected from a system implemented by integrating a group of devices each claiming DICONDE conformance.

11

Prüfung von Bahnkomponenten

Dr. Wolfram Deutsch, Jörn Bolten, Stefan Kierspel, Jacob Rühe

KARL DEUTSCH
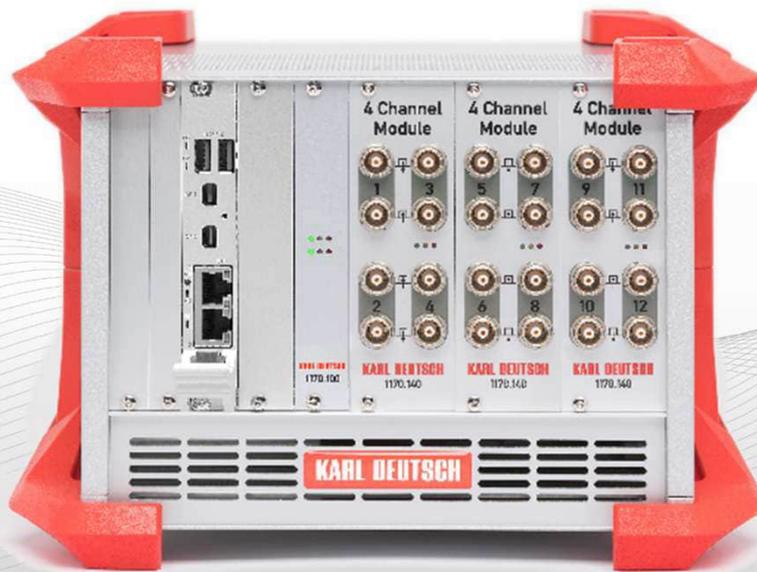Mit Sicherheit geprüft! Definitely Tested!

12

ECHOGRAPH Prüfelektronik

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Mit Sicherheit geprüft! Definitely Tested!

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ECHOGRAPH 1170 Mehrkanalige Prüfelektronik

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14

14

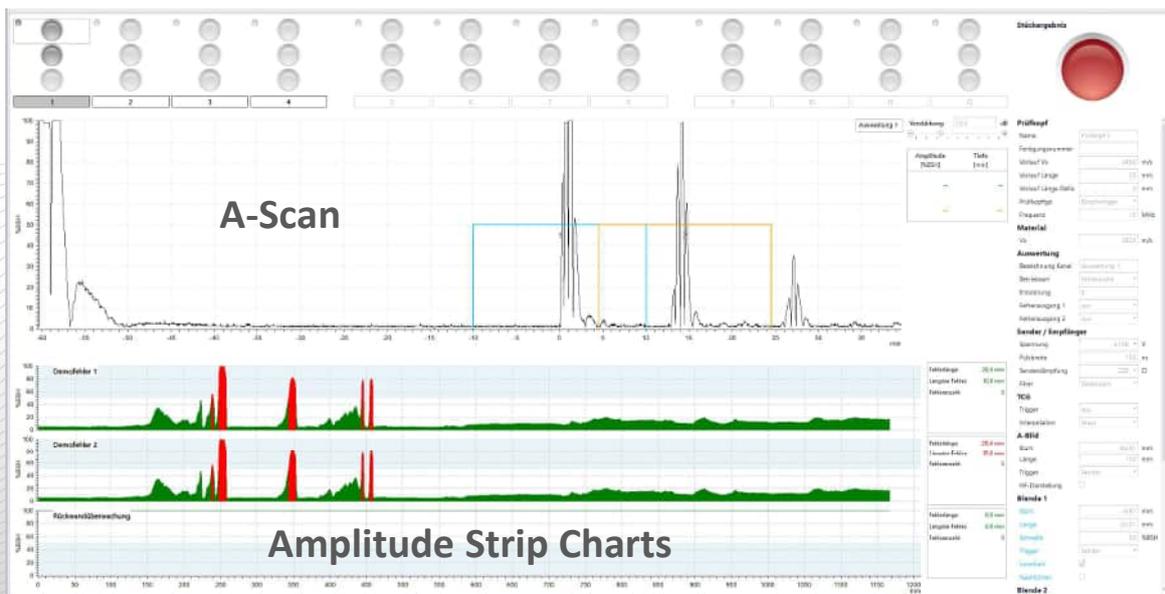ECHOGRAPH PAUT Prüelektronik (Beispiel mit 2 Modulen 32/128)

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15

ECHOVIEW Software zur UT & PAUT Datenauswertung

A-Scan

Amplitude Strip Charts

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16

ECHOGRAPH WEASEL
Prüfung von Hohlwellen

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Mit Sicherheit geprüft! Definitely Tested!

17

Übernahme der Firma BTD in Kirchmöser, Brandenburg (2024)

Gründung im Jahr 2001 durch Wolfgang Spruch
Zahlreiche Referenzen im Sektor Bahn

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18

ECHOGRAPH WEASEL: Prüfmechanik für Radsatzwellen mit Längsbohrung

Antriebseinheit

Prüfkopfhalter

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19

19

ECHOGRAPH WEASEL: Leistungsmerkmale

- ■ Gewicht der Mechanik (inkl. Prüfkopfhalter 30 mm): 5 kg

- ■ Aufbauzeit: 2 Minuten

- ■ Prüfzeit: 8 Minuten

- ■ Längs-Stange: segmentiert

- ■ Durchmesser-Bereich für Prüfkopfhalter: Ø 30 – 90 mm

- ■ Maximaler Verfahrweg der Prüfköpfe: 2,1 m

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20

20

ECHOGRAPH WEASEL: Segmentierte Stange -> Transport-Länge 1,05 m

Nächster Entwicklungsschritt: Phased Array-Version !
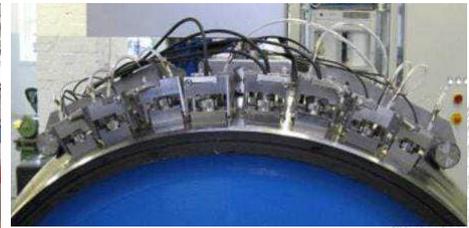

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21

21

ECHOGRAPH TRAINTECH
Ultraschallprüfung von Radsätzen

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Mit Sicherheit geprüft! Definitely Tested!
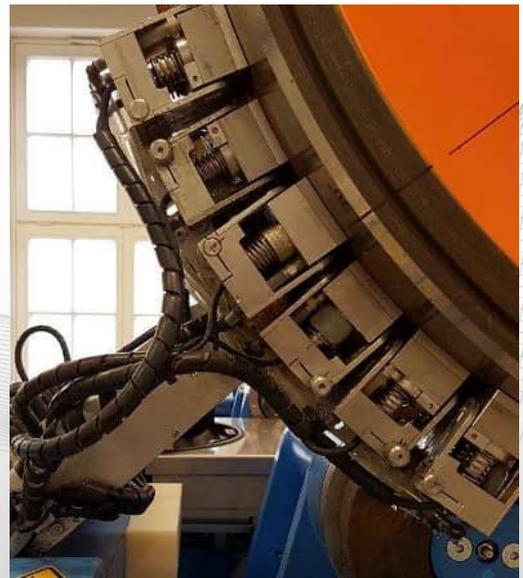
22

Radsatzprüfung im ausgebauten Zustand
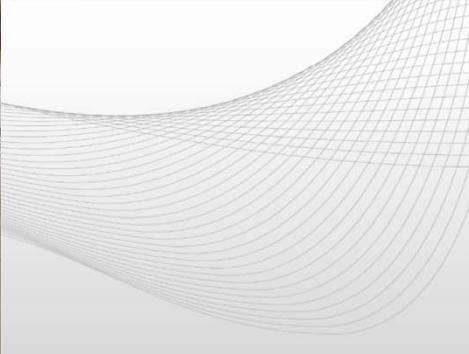
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23

23

Radsatzprüfung im eingebauten Zustand

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24

24

25

DICONDE Waveform

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NDE Wavform Modules Information Object Definition (IOD)		
• Component	M	E2339, 7.4
• Component Study	M	E2339, 7.6
• Component Series	M	E2339, 7.7
• Acquisition Context	M*	DICOM Part 3 Section C.7.6.14
• SOP Common	M*	DICOM Part 3 Section C.12.1

```
// Component Study Module (M: Mandatory)
StudyModule Study = new StudyModule(
    //Type 1
    StudyInstanceUID,
    DateTime.UtcNow,
    //Type 2
    ID: "Study ID",
    AccessionNumber: "Accession Number",
    ComponentOwnerName: "Component Owner Name",
    string[]["Inspecting Company Name 1", "Inspecting C
    string[]["Certifying Inspector Name 1", "Certifying
    Description: "Study Description",
    ExaminationNotes: "Examination Notes",
    DateTime.MaxValue);

// Component Series Module (M: Mandatory)
SeriesModule Series = new SeriesModule(
    // Type 1
    SeriesInstanceUID,
    // Type 2
    Number: 1,
    // Type 3
    DateTime.UtcNow,
    Description: "Series Description",
    string[]["Inspector Name 1", "Inspector Name 2"],
    string[]["Operator Name 1", "Operator Name 2"],
    new SeriesModule.RelatedSeries[] { new SeriesModule
    EnvironmentalConditions: "Environmental Conditions",
    ActualEnvironmentalConditions: "Actual Environmental Condi
```

M: Mandatory; U: User Optional; C: Conditional; N: Not mentioned in IOD Table
* Included for DICOM compatibility; + Required only if annotation is present

26

DICONDE Waveform

NDE Wavform Modules Information Object Definition (IOD)		
• Component	M	E2339, 7.4
• Component Study	M	E2339, 7.6
• Component Series	M	E2339, 7.7
• NDE Equipment	M	E2339, 7.8
• Acquisition Context	M*	DICOM Part 3 Section C.7.6.14
• SOP Common	M*	DICOM Part 3 Section C.12.1
• NDE US Equipment	N	E2663, 7.3
• NDE US Equipment Settings	N	E2663, 7.4

M: Mandatory; U: User Optional; C: Conditional; N: Not mentioned in IOD Table
* Included for DICOM compatibility; + Required only if annotation is present

```
// NDE Equipment Module (M: Mandatory)
NDEEquipmentModule NDEEquipment = new NDEEquipmentModul
    // Type 2
    Manufacturer: "Equipment Manufacturer",
    // Type 3
    ManufacturerModelName: "Manufacturer's Model Name",
    DeviceSerialNumber: "Serial Number",
    DateTime[]DateTime.MinValue, DateTime.UtcNow],
    SystemName: "System/Station Name",
    SystemID: "System/Scanner ID",
    SpatialResolution: (float)0.3,
    CompanyName: "Company Name",
    CompanyAddress: "Company Address",
    DepartmentName: "Department Name"
);
```

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27

Equipment Modules

NDE Equipment	NDE US Equipments	NDE US Equipment Settings
High level definitions/properties, like, • Software Version • Manufacturer • Model Name • System Name and ID	Information/Properties of • Pulser • Reciever • PreAmplifier • Transmit Transducer • Recieve Transducer • Wedges Including: • Manufacturer • Calibration • Serial Number • Type • Physical Transducer Properties • Wedge Properties	Settings of • Pulser • Reciever • PreAmplifier • Transmit Transducer • Recieve Transducer • Gate • Wedges Including: • Pulse, PRF, Modulation, Filter • Gain, DAC, Soundpath, Rectifier • Coupling • Gate Settings, Velocity of Sound • Procedures

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28

DICONDE Waveform

NDE Wavform Modules Information Object Definition (IOD)

• Component	M	E2339, 7.4
• Component Study	M	E2339, 7.6
• Component Series	M	E2339, 7.7
• NDE Equipment	M	E2339, 7.8
• NDE Waveform Identification	M	E2663, 7.2 (based on C.10.8)
• **NDE Waveform**	M	E2663, 7.2 (based on C.10.9)
• Acquisition Context	M*	DICOM Part 3 Section C.7.6.14
• SOP Common	M*	DICOM Part 3 Section C.12.1
• NDE US Equipment	N	E2663, 7.3
• NDE US Equipment Settings	N	E2663, 7.4

M: Mandatory; U: User Optional; C: Conditional; N: Not mentioned in IOD Table
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29

1. Define Dimensions

Dimensions Struktur

Dimension
- Number
- Description
- Unit
- CodeValueType
  - Numeric (Signed Int32)
  - Shortnumeric (Signed Int16)
  - Byte (Unsigned Int8)
  - Singlefloat
  - Doublefloat

Dimensions Example

Number	Description	Unit	CodeValueType	
1	X-Axis	cm	Numeric	(SInt32)
2	Y-Axis	cm	Shortnumeric	(SInt16)
3	Angle	degrees	Singlefloat	(single)

30

15

2. Wavefrom Sequence

Wavefrom Sequence

	VR	VM	
Waveform Data	OB or OW	1	Sample 1 Sample 2 Sample 3 Sample 4 ... Sample N

31

2. Wavefrom Sequence

Wavefrom Sequence

	VR	VM	
#Samples	UL	1	N
Sampl. Freq.	DS	1	
Bits Allocated	US	1	8, 16, 32, 64
Sample Interpr.	CS	1	Signed or Unsigned Ints from 8 – 64 bit
Waveform Data	OB or OW	1	Sample 1 Sample 2 Sample 3 Sample 4 ... Sample N

32

2. Wavefrom Sequence

Wavefrom Sequence	VR	VM	
... Offset	DS	1	
Trigger Position	UL	1	
Originality	CS	1	
#Samples	UL	1	N
Sampl. Freq.	DS	1	
Bits Allocated	US	1	8, 16, 32, 64
Sample Interpr.	CS	1	Signed or Unsigned Ints from 8 – 64 bit
Waveform Data	OB or OW	1	Sample 1 Sample 2 Sample 3 Sample 4 ... Sample N

33

2. Wavefrom Sequence

Wavefrom Sequence	VR	VM	
> Position			**In the M-dimensional coordinate system defined in step 1**
> ... Offset	DS	1	
> Trigger Position	UL	1	
> Originality	CS	1	
> #Samples	UL	1	N
> Sampl. Freq.	DS	1	
> Bits Allocated	US	1	8, 16, 32, 64
> Sample Interpr.	CS	1	Signed or Unsigned Ints from 8 – 64 bit
> Waveform Data	OB/OW	1	Sample 1 Sample 2 Sample 3 Sample 4 ... Sample N

34

DICONDE Waveform

NDE Wavform Modules Information Object Definition (IOD)

• Component	M	E2339, 7.4
• Component Study	M	E2339, 7.6
• Component Series	M	E2339, 7.7
• NDE Equipment	M	E2339, 7.8
• NDE Waveform Identification	M	E2663, 7.2 (based on C.10.8)
• **NDE Waveform**	M	E2663, 7.2 (based on C.10.9)
• Acquisition Context	M*	DICOM Part 3 Section C.7.6.14
• Waveform Annotation	C+	DICOM Part 3 Section C10.10
• SOP Common	M*	DICOM Part 3 Section C.12.1
• NDE US Equipment	N	E2663, 7.3
• NDE US Equipment Settings	N	E2663, 7.4
• NDE Indication	U	E2339, 7.9
• NDE Geometry	U	E2339, 7.10
• NDE Approval Module	N	E2339, 7.11
• NDE Data Element Label Dictionary	U	E2339, 7.12
• NDE Geolocation	U	E2339, 7.13

M: Mandatory; U: User Optional; C: Conditional; N: Not mentioned in IOD Table
* Included for DICOM compatibility; + Required only if annotation is present

```
// NDE Indication Module => Completely Type 3
NDEIndicationModule NDEIndications = new NDEIn
    new NDEIndicationModule.Evaluator[] {
        new NDEIndicationModule.Evaluator(
            Number: 0,
            Attempt: 1,
            Name: "Evaluator Name",
            new NDEIndicationModule.Evaluator.
            {
                new NDEIndicationModule.Evalua
                    SOPInstanceUID,
                    IndicationNumber: 2,
                    IndicationROIGeometricType
                    IndicationROIValueTypes.SC
                    IndicationROIContourPoints: 3,
                    float[][(float)0.1, (float)
                    IndicationLabel: "Indication L
                    IndicationDescription: "Indicat
                    IndicationTypes[] [IndicationT
                    IndicationDispositionTypes:
                new NDEIndicationModule.Ev
                new NDEIndicationModule.Ev
                ...
            })
    });
```

35
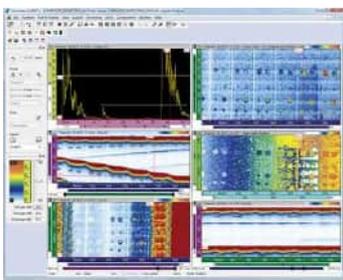
Soon to come …

TomoView/OmniScan to DCM

Soon to be released:

Program for the conversion of Olympus/Evident
  • OmniScan (.opd or .oud)
  • TomoView (.rdt)
into DICONDE
and storage on your PACS Server

36

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Digital Transformation Consulting

NDE Consulting

Research & Development
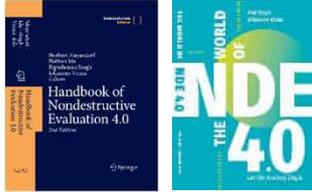
Customers
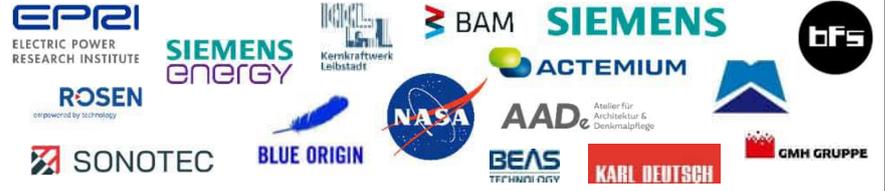
Strategic Partners

37

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38