

## Experiences from quality testing and the new IHE profiles for image sharing with media

**IHE PDI: Portable Data for Imaging**  
**IHE BIR: Basic Image Review**



Marco Eichelberg, PhD

OFFIS-Institute for Information Technology  
E-Mail: [eichelberg@offis.de](mailto:eichelberg@offis.de)

## 2 Agenda

- ▶ **Image sharing on media: the good, the bad, and the ugly**
- ▶ **A short history of DICOM CDs**
- ▶ **The DRG Media Exchange Certification Project**
- ▶ **The new IHE profiles for image sharing with media**
  - ▶ **Portable Data for Imaging (PDI) Extensions**
  - ▶ **Basic Image Review (BIR)**
- ▶ **Outlook and conclusion**

## Image Sharing on Media: the Good, the Bad, and the Ugly



## ▶ 4 Radiological Image Sharing on CD Media



- ▶ Sharing of radiological images on CD is becoming increasingly popular
  - ▶ Most imaging modalities are digital today
  - ▶ CDs/DVDs are inexpensive media for large data volumes (1200 CT slices per CD)
  - ▶ Hardcopies are expensive and unnecessary for filmless Radiology and unsuitable for Multi-slice CT, cine or color images
  
- ▶ Image sharing on media offers many advantages
  - ▶ Maintains original diagnostic image quality
  - ▶ Enables image processing by recipient: window/level, measurements, 3D, MPR etc.
  - ▶ Images can be imported into PACS at recipient's site
  - ▶ Measurements and reports can be included on same medium
  
- ▶ On-line image transmission or regional EHR not widespread (yet) due to higher technical effort needed

## ▶ 5 Problems with Image Sharing on CD



- ▶ CD Media not popular with many recipients!
  - ▶ Recipient must make available suitable PC
  - ▶ Recipient must handle viewing software
    - ▶ Each CD looks different, works differently
    - ▶ Loading from the CD often very slow
    - ▶ Perceived threat of malware infections
  - ▶ Workflow for handling incoming CDs often not clear
  
- ▶ There are in fact many problems with CDs
  - ▶ CD unreadable
  - ▶ Viewer does not work
  - ▶ Image quality bad
  - ▶ PACS import problems
  
- ▶ Two exemplary statements...

## 6 CD Problems: University Hospital Perspective



- ▶ Radiology department receives more than 10 CDs per day
  - ▶ Referring doctors sometimes come with a CD and want to see images at once
  
- ▶ Problems with ca. 30% of CDs (estimated)
  - ▶ CD not readable with local PACS workstations
  - ▶ 10% of CDs require technical expert
  - ▶ 5% of CDs cannot be read at all
  
- ▶ Viewers on CD difficult to use, different on each CD

Source: Prof. Dr. Peter Mildenerger, Uniklinik Mainz (2006)

## 7 CD Problems: State Medical Chamber Perspective



- ▶ CD sometimes unreadable or only partially readable
- ▶ Images not in diagnostic quality
  - ▶ No DICOM
  - ▶ Unsuitable use of lossy compression
  - ▶ Dynamic range too low
- ▶ Labeling of CD insufficient
- ▶ Incorrect Window/Level defaults
- ▶ Missing or incorrect DICOM header information
  - ▶ Demographics, study data, device, acquisition parameters, detector parameters

Source: PD Dr. Michael Walz, Ärztliche Stelle Hessen (2006)

## 8 Causes of Problems



### ▶ „Bad“ media

- ▶ Not all vendors correctly implement the rules of the DICOM standard
- ▶ Viewing software on CD often problematic
  - ▶ No manual, requires administrator privileges, installs software components
- ▶ CDs not labeled
- ▶ Low-grade CD-R media

### ▶ Unsuitable or unclear workflow at recipient's site

- ▶ Which PCs are suitable?
- ▶ How to avoid malware infections?
- ▶ How to include image import into workflow?
- ▶ How to properly import images into local PACS?

### ▶ Most problems are avoidable

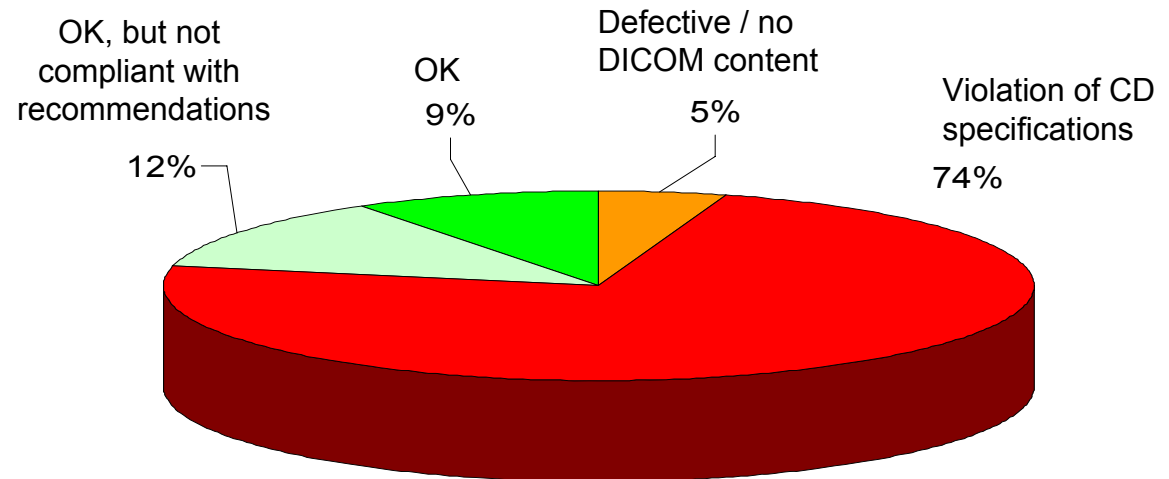
- ▶ Better products creating better CDs
- ▶ Educate users about suitable workflows
- ▶ Some problems remain, however, for example the use of orthopedic templates



## 9 Problems with CD: Exception or Rule?



- ▶ At the German Congress of Radiology 2006, radiologists were invited to bring their CD for a short test against the CD specification published by DRG.



- ▶ Test results
  - ▶ Almost 80% of the tested “real world” CDs failed the test!
  - ▶ Even though not each failure would have cause problems for each recipient, the result clearly shows that some quality assurance is needed

## A Short History of DICOM CDs



## ▶ 11 A Short History of DICOM CDs

- ▶ **1995: DICOM Specification for Image Sharing on CD**
  - ▶ Describes DICOM file format, filenames and directory names permitted on CD
  - ▶ Requires a special index file named „DICOMDIR“ to be included on the CD
    - ▶ Permits a quick look-up of patients, studies and series before images are loaded
  - ▶ No rules for viewing application on the CD, labeling, manual, etc.
  - ▶ Different „application profiles“ describe rules for different scenarios
  - ▶ 1997 Specification for General-Purpose Image Sharing in Radiology added
  
- ▶ **2004: IHE Portable Data for Imaging (PDI) specification**
  - ▶ Based on DICOM General-Purpose CD
  - ▶ Additional rules concerning CD labeling, „web content“, viewer application
  - ▶ Tested at IHE Connect-a-thons
  
- ▶ **2006: DRG Requirements Specification for Exchange Media**
  - ▶ Based on IHE PDI
  - ▶ A few extensions, some strengthened requirements (e.g. on viewer application)
  - ▶ Extensions partly, but not fully adopted in newer IHE PDI releases

## ▶ 12 IHE PDI / DRG Specification: General Requirements

- ▶ CD format
  - ▶ CD-R or CD-RW (prepared for DVD)
  - ▶ ISO 9660 Level 1 (Rockridge, Joliet allowed), no packet writing
  - ▶ Multi-session allowed but may be dangerous
  
- ▶ Three types of content
  - ▶ Medical images in DICOM format **required**
  - ▶ DICOM viewer and IHE web content **allowed**
  - ▶ “Other” (non-DICOM) content **optional** (reports, discharge letters etc.)
  
- ▶ Malicious software
  - ▶ Creator needs to verify that no viruses / trojans are on the CD
  
- ▶ Recommendation for CD labeling
  - ▶ Patient’s name, patient’s birth date, patient ID (e. g. for PACS import)
  - ▶ Creator of CD, date of study, type of content, ...

## ▶ 13 IHE PDI / DRG Specification: DICOM and Viewer Requirements

- ▶ Strict DICOM conformance required
  - ▶ All medical images have to be stored in DICOM format
  - ▶ DICOMDIR required, DICOM directory and file naming rules apply
  
- ▶ CDs may contain data for one or more patients
  - ▶ Multi-patient CDs only useful for very specific purposes (QA, clinical studies)
  
- ▶ PDI only permits uncompressed images, DRG also supports compression
  
- ▶ DICOM viewer
  - ▶ Must run without administrator privileges and without additional installations
  - ▶ Must be able to display all DICOM objects on the CD
  - ▶ PDF manual and short printed manual recommended
  - ▶ Recommends not to use “auto-run” feature

## The DRG Media Exchange Certification Project



## ▶ 15 DRG Media Exchange Certification Project: Overview

- ▶ The project is a collaboration between the German Society of Radiology (DRG) and the (non-profit) OFFIS Institute for Information Technology
  - ▶ Started in 2005 to address DICOM CD problems voiced by many doctors
  
- ▶ The project has defined three building blocks:
  - ▶ Requirements specification for DICOM CDs based on IHE PDI
  - ▶ Guideline document (“cookbook”) for recipients of DICOM CDs
  - ▶ Technical test and certification procedure for products creating DICOM CDs
  
- ▶ All documents available in German and English language from website
  - ▶ <http://www.dicom-cd.de/>

## ▶ 16 DRG Guidelines for Handling DICOM Media

- ▶ A smooth image sharing with DICOM CDs requires not only suitable CDs, but also suitable handling by the recipient.
- ▶ The guidelines describe
  - ▶ Minimum hardware requirements for image review (based on DIN 6868-57)
  - ▶ Recommendations on lighting conditions and display adjustment / calibration
  - ▶ General preparation of the PC
    - ▶ Install, update and activate firewall and virus scanner
    - ▶ Keep operating system updated
    - ▶ Disable auto-run for CDs
    - ▶ Install web browser and PDF reader
    - ▶ Work from a user account without administrator privileges
    - ▶ If possible use locally installed DICOM viewer instead of software on CD
- ▶ Two „scenarios“ covered in the guideline:
  - ▶ Image review without PACS import
  - ▶ PACS import with reconciliation of DICOM identifiers  
(use of the IHE Import Reconciliation Workflow profile recommended)



## ► 17 Certification Procedure

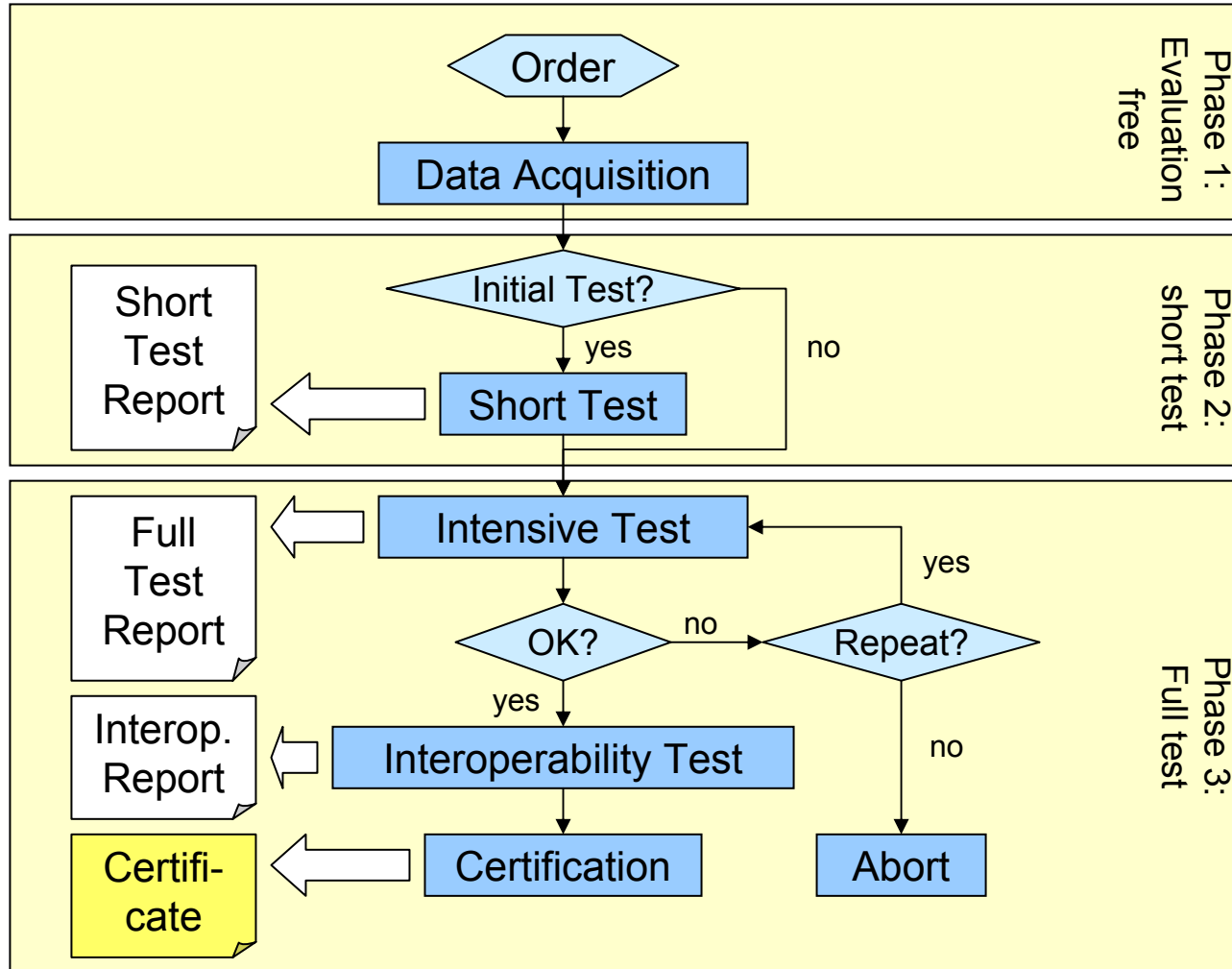
- ▶ Vendors of products producing DICOM CDs can have their product tested and certified for conformance with the DRG requirements specification
  - ▶ The test involves a both a conformance test and a practical interoperability test with well-established PACS workstations.
  - ▶ After successful completion of the tests, a certificate is awarded and details are published on the website <http://www.dicom-cd.de/>
  - ▶ A specific logo can be printed on the product and the CDs created
  - ▶ Vendor liable to pay costs for this process
- ▶ Radiologists using a certified system can be certain that their DICOM media are state of the art and will not unnecessarily annoy their customers
- ▶ Recipients of CDs produced by a certified system can be certain that the CDs can be read and processed.



## ▶ 18 Conformance Testing Process

- ▶ After receiving comprehensive information about the test procedure, rules and costs, vendors signs contract and provides detailed product info
  - ▶ Conformance statement, manual
  
- ▶ OFFIS assembles a set of DICOM objects matching product characteristics
  - ▶ Matching application profiles, SOP classes (image types) and transfer syntaxes (encodings) supported by the product
  - ▶ Detailed instructions how to configure the system for CD creation, based on vendor documentation
  
- ▶ Vendor burns DICOM objects onto CDs, labels them and sends them to OFFIS
  
- ▶ OFFIS performs in-depth check of the CDs produced
  - ▶ First round: “short test” results sent to company (“homework” to do)
  - ▶ After receiving a new set of CDs from company, full test is performed
  - ▶ Semi-automated tool chain, lots of manual testing
  - ▶ If successful, interoperability test is done and certificate is awarded
  - ▶ Company can repeat full test (add. cost) or drop out from process at any time

# 19 Conformance Testing Process



## ► 20 Certificate Validity

- ▶ Certificates are awarded to a specific product in a specific release version
  - ▶ Identical products with different names (OEM products) are also covered upon request of the vendor
  - ▶ New versions with modified software require a new test
- ▶ Certificates are valid for two full calendar years following the year of issue
  - ▶ This ensures that the requirements specification can evolve and vendors cannot indefinitely advertise „very old“ products as being certified.



## ► 21 Certification: Current Status

- ▶ Three products have been certified so far
  - ▶ IMAGE Information Systems Ltd. (London) for “iQ-VIEW / iQ-LITE 2.5”
  - ▶ CERNER Deutschland GmbH (Herzogenrath) for “ProVision PACS 6.0”
  - ▶ CHILI GmbH (Heidelberg) for “CHILI CD/DVD Burn Gateway 3.0”
  
- ▶ Five more products are in the certification process at the moment
  - ▶ Details confidential until certificate awarded
  
- ▶ Interest has been voiced by about 12 more vendors
  
- ▶ Current list of certificate available from the project’s website <http://www.dicom-cd.de/>



First certificates awarded at ECR 2008

# The new IHE Profiles for Image Sharing with Media

Portable Data for Imaging (PDI) Extensions



## ▶ 23 Portable Data for Imaging (PDI) Extensions



- ▶ Currently, the IHE Radiology Technical Committee is working on a revised and extended version of the PDI specification to address the shortcomings of the current version:
  - ▶ Uncompressed CDs are too small and too slow for some cases
    - ▶ Very large cross-sectional datasets (CT/PET, fMRI)
    - ▶ Very large images (e.g. mammography)
  - ▶ PDI offers no means of privacy protection – just like a hardcopy
  - ▶ Viewers on the CD are not standardized at all
  - ▶ Divergence between PDI and national specifications (Germany, Australia, UK)
- ▶ In order to maintain backward compatibility, all extensions are defined as options that a PDI compliant system – reader or writer – may (or may not) support
  - ▶ New media types: DVD and USB memory
  - ▶ Privacy protection
  - ▶ Sending software option

## ▶ 24 PDI Extensions: New Media Types and Compression



### ▶ New media types

- ▶ Recordable DVD media (DVD±R, DVD±RW)
  - ▶ Higher capacity (4.7 GB)
  - ▶ A multi-vendor test at the 2008 IHE Connectathon has shown that basic interoperability between writers and reads is sufficient.
- ▶ USB media (USB sticks, SD cards, MMC cards etc.)
  - ▶ Physical interface identical (USB 1.1 or 2.0), simple adapters sufficient
  - ▶ High capacity (up to 128 GB!), high speed

### ▶ Compression

- ▶ Lossless and lossy (if and only if original image is lossy compressed)
- ▶ JPEG and JPEG 2000 (readers must support both!)
- ▶ Linked to DVD and USB options, but can be used on CD-R media since all DVD readers will read CDs.



## ▶ 25 PDI Extensions: Privacy Protection and Sending Software

### ▶ Privacy protection option

- ▶ All DICOM files on the medium are encrypted (DICOM secure file format)
- ▶ Other files must be encrypted as well if they contain patient information
- ▶ Encryption key is password based (no public key infrastructure needed)
- ▶ State-of-the-art AES encryption (128 or 256 bit key)
- ▶ Requires „sending software option“ (see below), so recipients can utilize the medium even if they have no specific software that supports encrypted DICOM CDs

### ▶ Sending software option

- ▶ Software running from CD, no installation, no admin privileges needed
- ▶ Software can perform DICOM send of all DICOM objects on media, e.g. to PACS
- ▶ Supports decryption and decompression
- ▶ Supports conversion of unsupported SOP classes to fallback defaults
- ▶ Supports reconciliation of identifiers (Patient ID, Accession No. etc.)
  - ▶ May support DICOM worklist or HL7-based PDQ, but this is not a requirement

## ▶ 26 PDI Extensions: Limitations

- ▶ **Reports on CD**
  - ▶ PDI recommends but does not mandate presence of a report
  - ▶ PDI does not restrict the file format of a report (DRG recommends DICOM)
- ▶ Different options exist
  - ▶ DICOM reports (SR or Encapsulated PDF) → requires support in DICOM viewer
  - ▶ IHE XDM (Cross-enterprise Document Sharing on Media) with CDA documents → requires XDM “Portable Media Importer” software
  - ▶ Report as Web page using the “Web content” option → requires Browser
  - ▶ Just a file somewhere on the CD → requires your attention and the right software
- ▶ No perfect solution for everyone...
  
- ▶ **Viewing applications on CD**
  - ▶ PDI neither mandates nor prohibits the presence of a viewer on the medium
  - ▶ No requirements for viewer features are specified
  - ▶ A viewer may not even be able to display all images on the medium
  - ▶ A viewer may require admin privileges or software installation
- ▶ Viewer issues are addressed in a separate profile named “Basic Image Review” (BIR)
  - ▶ What you (probably) want is a PDI CD supporting the “Basic Image Review Option”

# The new IHE Profiles for Image Sharing with Media

## Basic Image Review



## ► 28 Basic Image Review

- ▶ Goal: “to provide sufficient display functionality to allow adequate review of images for the purpose of clinical decision-making by ordering physicians.”
- ▶ BIR defines requirements for a “basic viewer application” that may be locally installed or contained on a CD:
  - ▶ Well-defined screen layout, icons (IEC 60878) and corresponding actions
  - ▶ Side-by-side series comparison
  - ▶ Window/level adjustment (including non-linear LUT and specific rules for NM/PET)
  - ▶ Synchronized scrolling (stack and tile view), zooming and panning
  - ▶ Detailed list of data to be displayed in viewport corners, incl. laterality and orientation
  - ▶ Cine display of multi-frame images must be supported
  - ▶ Tool to measure distances in an image must be supported
  - ▶ Localizers must be displayed when multiple CT/MR series with different orientations are displayed

## ▶ 29 PDI with Basic Image Review Option

- ▶ When a BIR viewer is included on a storage medium, additional rules apply
  - ▶ Viewer running from CD, no installation, no admin privileges needed
  - ▶ Must work on standard Windows XP/Vista PC with 512/1024 MB RAM
    - ▶ Other operating systems may be supported as well, but this is what most people use
  - ▶ Starts automatically or by click on VIEWER.EXE / VIEWER.BAT
  - ▶ Starts by displaying list of media contents (patients, studies and series)
  - ▶ Supports all DICOM SOP classes actually contained on the medium
  - ▶ Supports localization (national language and character set)
  - ▶ No "not for diagnostic use" disclaimer
  - ▶ Well-defined criteria for minimum performance (waiting times for the user)

## ▶ 30 Public Comment

- ▶ Both the PDI Extensions and Basic Image Review will be published as “Draft for Public Comment” very soon (this month!)
  - ▶ If you have an opinion in this topic, that is the right time to voice it!
  - ▶ Check out [http://www.ihe.net/Technical\\_Framework/index.cfm#radiology](http://www.ihe.net/Technical_Framework/index.cfm#radiology)
  - ▶ Working documents and background information at [http://wiki.ihe.net/index.php?title=Radiology\\_Technical\\_Committee](http://wiki.ihe.net/index.php?title=Radiology_Technical_Committee)
  - ▶ Submit comments at <http://forums.rsna.org/forumdisplay.php?f=11>
  
- ▶ If everything proceeds as planned, the new profiles will be published in Summer 2009 and first implementations can be tested in early 2010:
  - ▶ February 2010: North American IHE Connectathon
  - ▶ April 2010: European IHE Connectathon

## ▶ Outlook and Conclusion

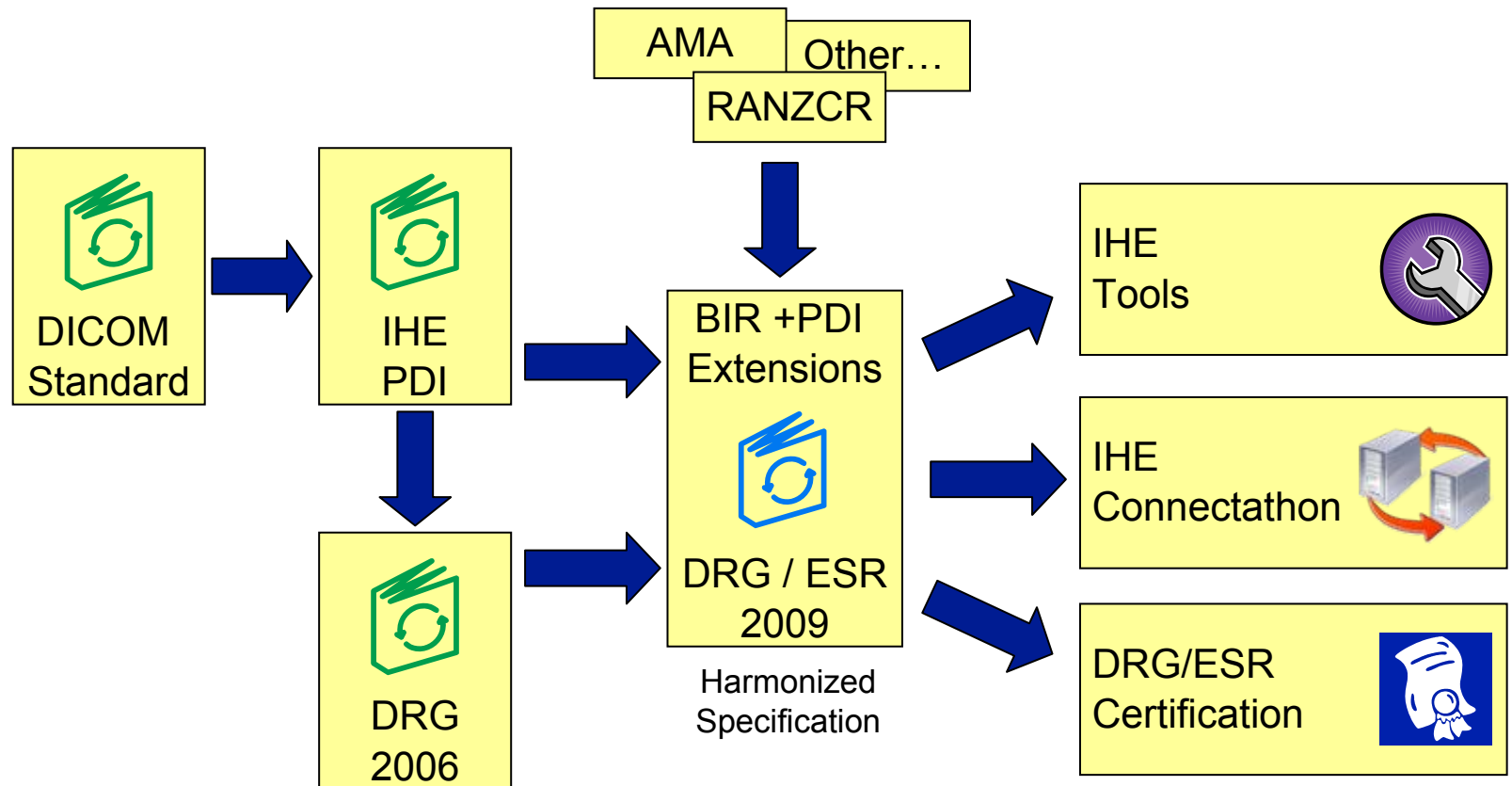


## ▶ 32 Outlook: IHE / DRG Harmonization

- ▶ It is the declared wish of both IHE and the DRG certification project to fully harmonize both specifications as part of the work on PDI/BIR
  - ▶ A new version of the DRG requirements specification will either only “point” to IHE PDI and BIR, or be fully compatible (equivalent).
  - ▶ The current PDI/BIR drafts already include most requirements that lead to the creation of the DRG spec originally.
  - ▶ The IHE work also includes input from
    - ▶ American Medical Association (AMA)
    - ▶ Royal Australian and New Zealand College of Radiologists (RANZCR)
    - ▶ Various vendors and clinical experts
  
- ▶ There are also discussions about “moving” the Certification Project from a national level under sponsorship of the DRG to a European level under ESR sponsorship
  - ▶ European-wide recognition of the certificate would significantly raise this topic on the vendors’ agenda!



## 33 Outlook: IHE / DRG Harmonization



## ▶ 34 Conclusion: Why all of this is good news

- ▶ Harmonized work between IHE and DRG/ESR is good news, because the activities of both groups complement each other
  - ▶ IHE has a strong focus on developing test tools vendors can use to test their products
  - ▶ IHE offers the annual “Connectathon” where implementations can be tested against each other
  - ▶ IHE defines not only the media structure (rules for the creator), but also requirements for a media reader – if you want to buy a workstation that can read PDI CDs, ask for IHE PDI compliance as Image Display or Media Importer.
  - ▶ The certification project, on the other hand, offers an in-depth control of a specific product, while IHE tests are much more cursory and are often performed on prototypes, not products.
  
- ▶ A combined PDI+/BIR medium will be very close to what users really expect
  - ▶ Keep your customers happy!
  - ▶ Certainly a few issues will remain – but at least we’re actively working on it.

► **Thank you for your attention!**

<http://www.dicom-cd.de/>

