



**Medical Imaging Display Colour Space (mRGB)
Teleconference**

17 July 2014 • 15:00 (UK) / 10:00 (EST)

The meeting was called to order at 10:00 am (EST) by Craig Revie, acting chair, with the following attendees:

Craig Revie, MIWG chair	FFEI Corporation
Tom Kimpe, Medical Displays chair	Barco
Phil Green, technical secretary	Gjøvik University
Takashi Matsui	Eizo Corporation
Masahiro Yamaguchi	Tokyo Institute of Technology
Debbie Orf	NPES
Bas Hulsken	Philips Healthcare Incubator
Chris Bai	BenQ Corporation
Brian Cote	Eizo Corporation
Michael Flynn	Henry Ford Health System
Efthimia Bilissi	Westminster University
James Chang	Sharp Labs
John Penczek	NIST
Andy Masia	X-Rite
Elizabeth Krupinski	University of Arizona
William Li	Kodak
David Clunie	DICOM
Po-Chieh Hung	Konica Minolta
Wei-Chung Cheng	U.S. Food and Drug Administration
John Sweeney	BenQ Corporation
Yuya Yushuda	Eizo Corporation
Tyler Keay	Omnyx
Tom Lianza	X-Rite
John Dalrymple	Technical Consultant
Jim Martin	

Following a sound check, Mr Revie introduced the meeting, which was a follow-up to the discussion at the recent face-to-face meeting at the FDA in June. He presented a summary of future MIWG meetings [see attached], including three proposed additional meetings on mRGB, skin color and virtual reading of petri plates. He then handed the meeting over to Mr Tom Kimpe.

Mr Kimpe presented a brief summary of the recent meeting at the FDA and the goal of this teleconference [see attached]. Having established the main use cases to support and agreed the main points of the visualization architecture, the next step was to agree a set of validation tests, which was the focus for the current meeting. The validation tests should include both bench tests and simulation model tests.

Two initial tasks were identified, which were to collect test images and define the performance requirements. It was established that test images should include both representative images of relevant modalities and uniform color patches that could be measured on the display.

At this point an emergency at Barco made it impossible for Mr Kimpe to continue on the call, and the meeting continued with some of the discussion in his absence.

Dr Elizabeth Krupinski recommended that test images should be defined for diagnostic purposes and a realistic task, leading to quantitative performance measures relevant to the clinical situation, rather than preference-based. It was noted that this could be difficult given the intrinsic subjectivity in many tasks.

The meeting discussed the use of metrics for evaluating the difference between images. JND metrics were proposed. Mr Revie recommended using the Media-Relative Colorimetric rendering intent with Black Point Compensation. Dr Bas Hulsken noted that images with different source white points would be rendered with a color shift relative to each other when using the Media-relative Colorimetric intent. In WSI there was a need to standardize the white reference to avoid this issue.

Mr Michael Flynn showed a workflow diagram for the use case for primary display radiology workstation [see attached]. Although the source image was encoded in mRGB, he agreed this was not essential in the workflow. An mRGB source encoding would be relevant when displaying a radiology image with a GSDF intent for output, as it would be transformed and presented correctly on a secondary display. Other use cases would depend on whether GSDF was required. The meeting agreed that different profiles would be needed for each output luminance level.

It was agreed to schedule a follow-up meeting in the near future to continue the discussion on the substantive agenda items.

ICC Medical Imaging Working Group

Displays

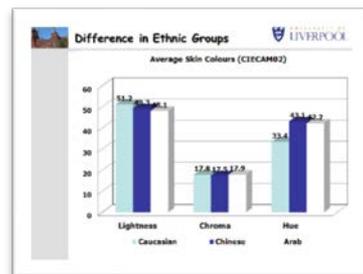
17th July 2014

Future meetings

- **ICC MIWG, IS&T CIC and IADP Congress**
 - Boston (30th October – 7th November)
 - Saturday 1st November: ICC MIWG
 - Monday 3rd November: ICC DevCon
 - 3rd – 7th November: IS&T Color and Imaging Conference (CIC22) and the 2nd International Congress of the International Academy of Digital Pathology (IADP)
 - 3rd and 4th November: IADP / CIC Short Courses
- **Regular monthly teleconferences**
 - 21 Aug 2014 (Ophthalmology)
 - 18 Sep 2014 (Whole Slide Imaging)
 - 18 Oct 2014 (Medical Photography)
 - 11 Dec 2014 (Mobile)
- **Details on http://www.color.org/groups/medical/medical_imaging_wg.xalter**

Proposed additional meetings

- **Details of mRGB / dRGB (to be chaired by Mike Flynn)**
 - Po-Chieh Hung's presentation from FDA meeting
 - colour gamut requirements
 - white point chromaticity and luminance
- **Follow up on topic of skin colour database**
 - topic introduced by Kaida Xiao
- **New topic: virtual reading of Petri plates**
 - Jérémie Pescatore, FMLA System Design Architect, bioMérieux



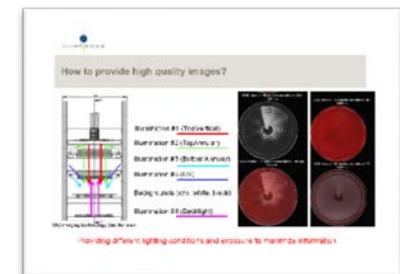

Petri dish keeps a great future thanks to Microbiology Laboratory Automation

- Wave of lab automation
 - probably limited machine based replacement time scaled still high quality required.
- No breakthrough technology culture-based microbiology will always be a fundamental part of diagnosis

Path forward is stain imaging associated to automated incubation step

bioMérieux IFA 5000 series

bioMérieux IFA 5000 series



How to provide high quality images?

Microscope A1 (Dialux 100)

Microscope A2 (Dialux 100)

Microscope A3 (Dialux 100)

Microscope A4 (Dialux 100)

Microscope A5 (Dialux 100)

Microscope A6 (Dialux 100)

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Today's meeting

**follow-up from 19-20 June
face-to-face meeting**

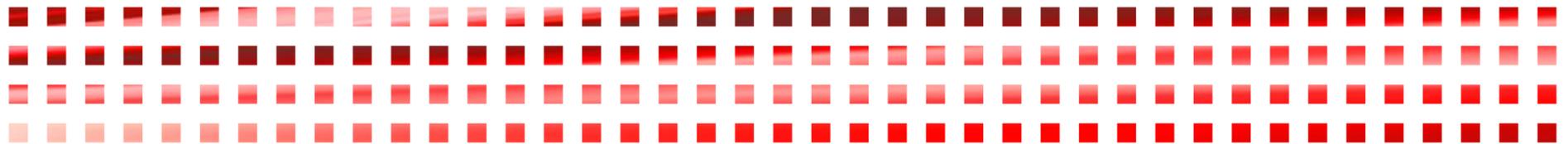
Tom Kimpe (Barco)

International Color Consortium



MIWG - Displays

Teleconference July 17th 2014



Summary of the decisions taken at the face-to-face meeting on June 19-20th 2014

(see also: http://www.color.org/groups/medical/Minutes_Jun2014_mRGB.pdf)

1. The use cases have been fixed
2. Visualization architecture
 - We should aim for one architecture that can support all use cases (until proven that this does not work)
 - We should try the standard ICC framework first before making extensions
 - We need to practically validate/challenge the proposed framework against the use cases

Goal of this telephone conference

3. A series of validation tests need to be defined and agreed upon

Plain grey or color medical image

Use case 1
Use case 2

8 or 10-bit greyscale or color medical images

Grey or color medical image with ICC profile

Use case 3

CMM

8 or 10-bit greyscale or color medical images

The standard operating system CMM may not be appropriate for this application

(eg. handling dynamic ICC profiles)

Display calibrated to be perceptually linear

- using DICOM GSDF for neutral (R=G=B) scale
- and optionally being also perceptually linear in its color behavior
- Calibration LUT of at least 12 bits depth

The tone scale changes when the white point or black point (including ambient illumination) changes

ICC profile

A set of example/default profiles could be developed for different white/black range and could be posted on the ICC web site

Your input and support is highly desired

- The next slides contain some suggestions to facilitate the discussion on which tests need to be performed
- Intention is to fully share all testing results within the MIWG Displays
- Feel free to:
 - Suggest changes
 - Propose alternative approaches for validation
 - Volunteer to do specific tasks

Proposed validation tests

- Bench testing

- Making a (reference) implementation
- Showing that the architecture can work
- Measuring/quantifying performance



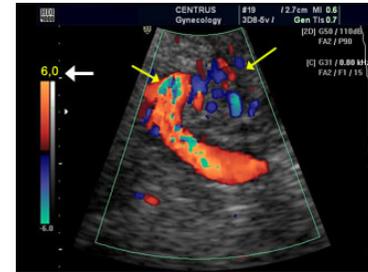
- Simulation/theoretical

- Making theoretical calculations about performance
- Developing simulation software/pipeline to simulate behaviour in various configurations

Tasks – General (1)

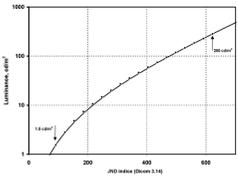
- Collect a set of representative test images for each use case

- Greyscale radiology images
- Fused multimodality images
- Dermatology images



- Specify minimum performance requirements for each use case

- Eg. DICOM GSDF compliance with max 10% error
- Eg. Absolute colour accuracy with max error 5 deltaE2000 units



Tasks – General (2)

- Select a number of colour displays to be included in the testing
 - At least one medical colour display which uses internal luminance & color stabilization
 - At least one consumer sRGB display
 - Mobile display?

- Characterize these colour displays
 - Neutral grey luminance curve
 - Full colour gamut characteristics
 - ...

Tasks – Bench testing

- Define the specific setups to be evaluated
(combinations of viewing application, use case, display)
 - ...
 - Include multi-monitor setup
 - Include variable ambient light conditions
- Create a reference implementation
 - ICC profile generation
 - Medical viewing application with CMM

Tasks – simulation

- Develop a simulation framework such that the effect of (parameter) choices in the visualization chain can be tested. Eg.
 - What is the effect of positioning the calibration LUT inside the display or inside the CMM (/PC/GPU)?
 - What accuracy can be achieved (DICOM GSDF, PLCB, deltaE2000 absolute color rendering) when the display is natively sRGB vs DICOM GSDF vs PLCB?
 - What is the minimal bit depth needed in the calibration LUT in order to reach sufficient performance for the different use cases?
 - ...



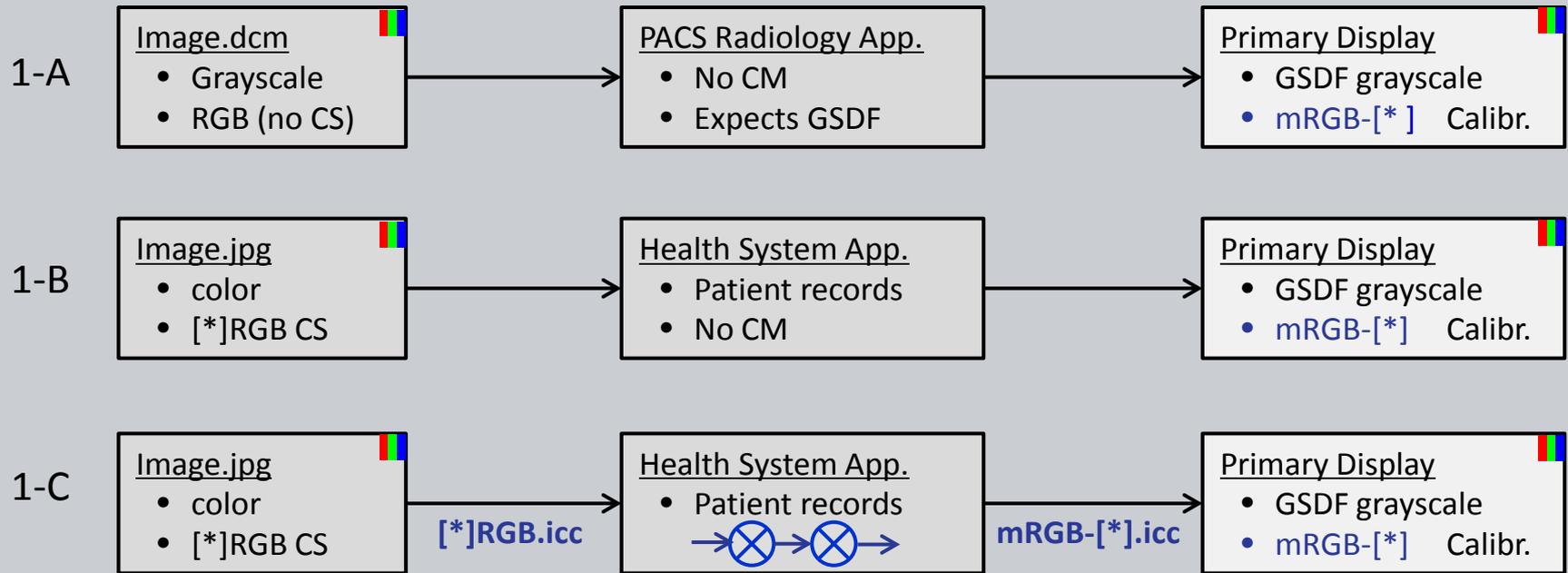
It would be really nice if people participating in the MIWG Displays would volunteer to take care of some of the validation tasks to be performed

Thank you!

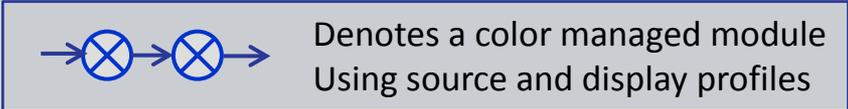


Case – Primary display, radiologist workstation

1. Medical image presentation on a workstation with DICOM calibrated primary monitors used for medical interpretations

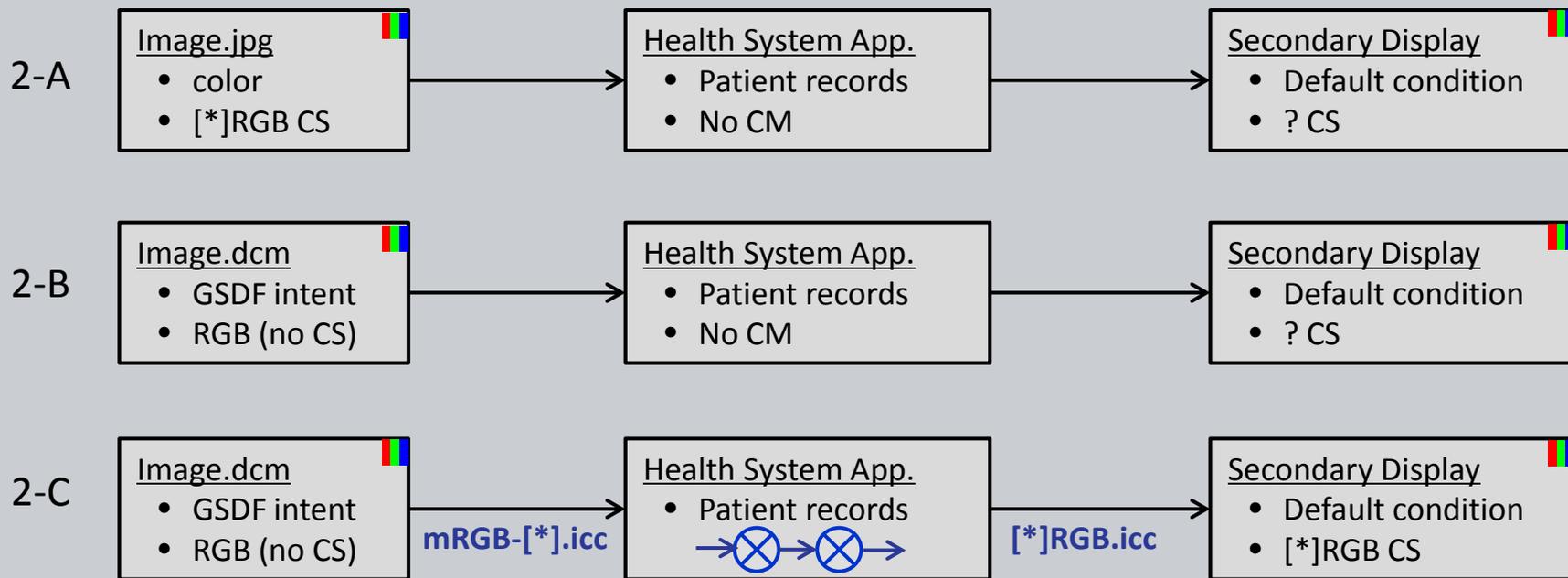


- Case A: Correct Grayscale & pseudo-color DICOM images with GSDF neutral tones.
- Case B: Incorrect Color photograph is presented with GSDF neutral tones.
- Case C: Correct Color photograph is presented with the intended color space.

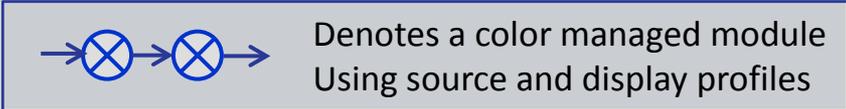


CS – Color Space
CMS – ICC Color Management (full)

2. Medical image presentation on a workstation with secondary monitors used for reviewing patient information.



- Case A: Uncertain Color photograph is presented with the default configuration .
- Case B: Incorrect Grayscale & pseudo-color DICOM images not presented with GSDF.
- Case C: Correct Grayscale & pseudo-color DICOM images are mapped to GSDF



CS – Color Space
CMS – ICC Color Management (full)