iccMAX for Display Applications

Max Derhak

Principal Scientist – Onyx Graphics
Co-Chair – ICC

Taipei, Taiwan

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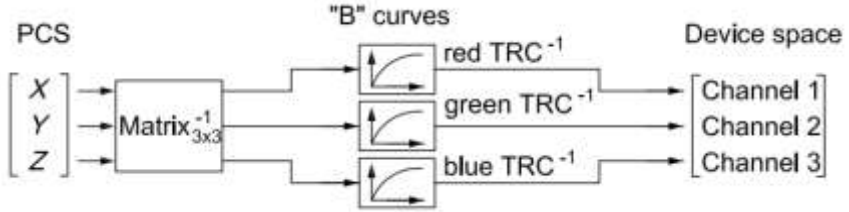
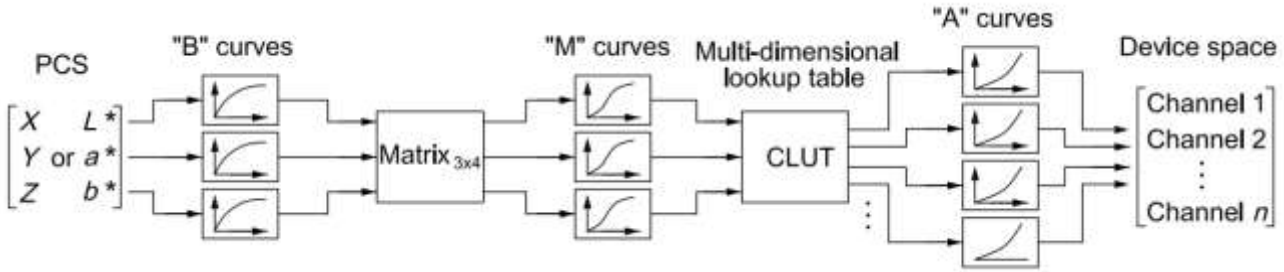
Agenda

- **Displays and ICC.1**
- **Introduction to iccMAX & iccMAX workflows**
- **iccMAX and Displays**
- **Examples**
- **Wrap-up**

Displays and ICC.1

- **Limited transform options for displays**





- **Color management is based on Profile Connection Space (PCS) colorimetry expressed only in terms of D50 illuminant for Standard 2-degree observer**
  - Adaptation required for other observing conditions

Introducing iccMAX

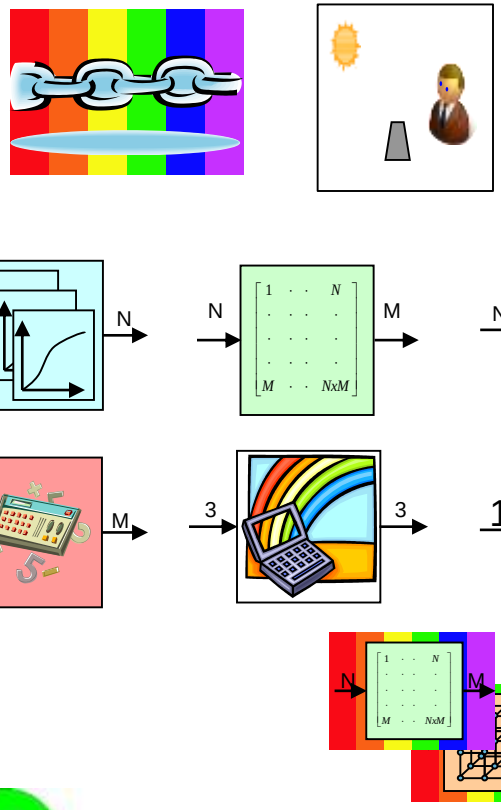
- **iccMAX represents an extension of the general approach provided by ICC.1**
  - Profiles have same basic header + tag structure as v4 profiles
    - Some different values in header, and some retained tag types from v4
  - New extended color space and connection types
    - Named, Colorimetric, Spectral, Material connection options
    - Colorimetry for arbitrary illuminant and observer
  - Wider range of transform elements
    - Complete flexibility with multiProcessElement
    - Static and programmable transforms
  - Wider range of tag types
    - BRDF, CxF measurement data, Gamut boundary, Named Color using extended hierarchical data types

iccMAX Workflows and Compatibility

- **iccMAX workflows are defined by iccMAX Interoperability Conformance Specification (ICS) documents separate from the iccMAX specification**
  - —ICS documents define workflow specific requirements utilizing features of iccMAX specification
  - —Not every feature of iccMAX specification needs to be implemented to support an iccMAX based workflow
- **iccMAX CMMs generally intended to use v2 & v4 profiles, but earlier CMMs will not need to be compatible with iccMAX profiles**

iccMAX building blocks for displays

- **Connection Space Extensions**
  - Spectral profile header extensions
  - Profile Connection Condition tags
  - PCS Transforms
- **multiProcessElements**
  - 1-D Look Up Tables (LUTs)
  - Matrices
  - N-dimensional LUTs
  - Calculator element
  - ICC Color Appearance Model
  - Tint Array element
  - Spectrally defined Colorimetric elements
- **Color Space Encoding profiles**



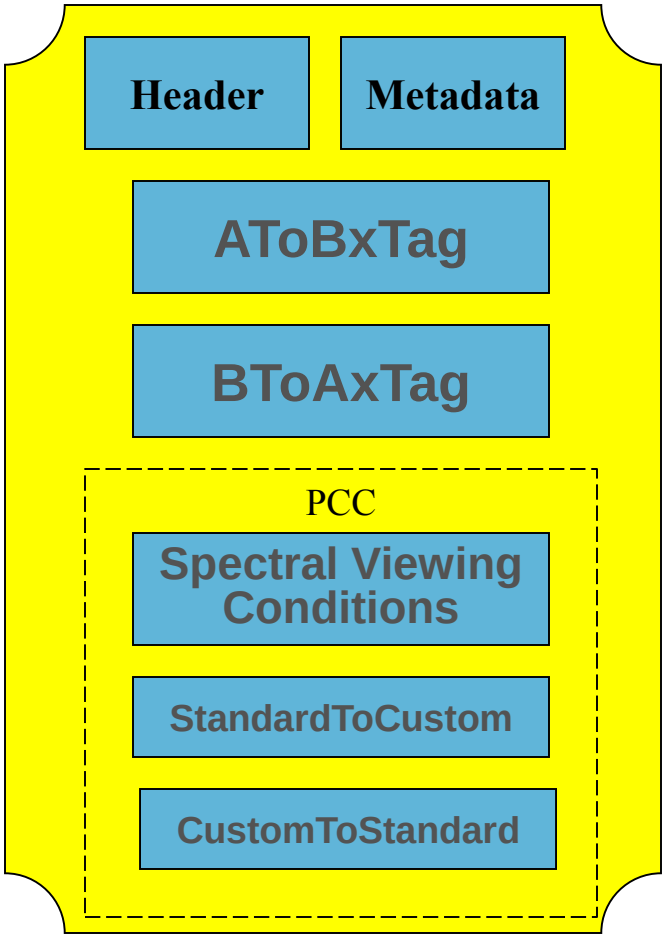
Examples

iccMAX Color Encoding Space profiles

- **Color Encoding Space profiles define what the "device" color space is (not the transform)**
- **Intentionally simple files with minimal header information and one tag describing color space**
- **Can optionally supply encoding overrides or fully define ISO 22028-1 color encoding**
  - Represents logical successor to ICC.1 Matrix/TRC profiles
- **CMM responsible for establishing actual transform**

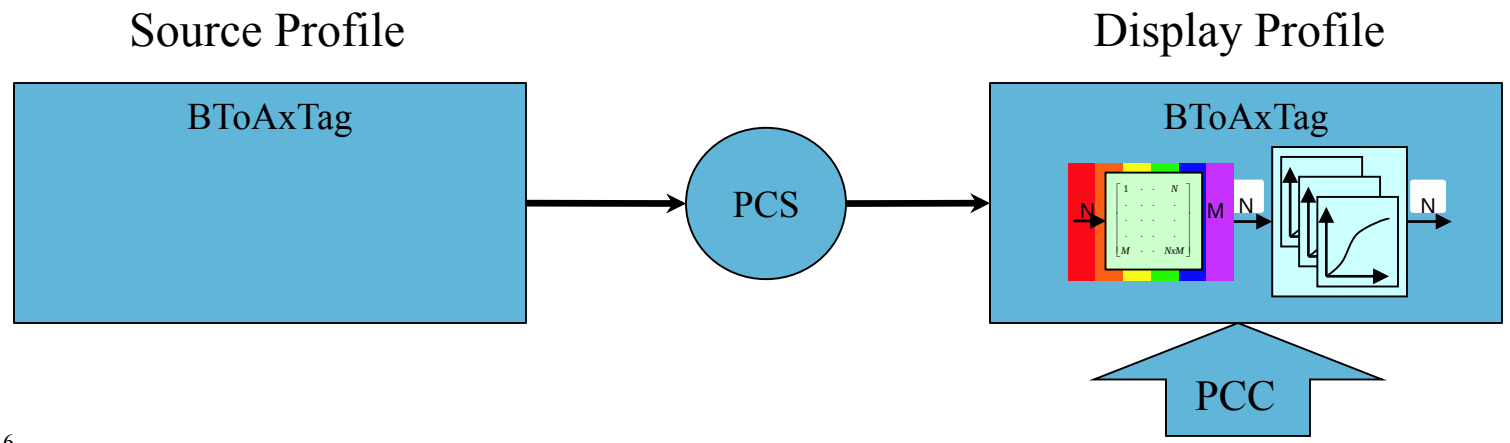
iccMAX display profiles using alternate colorimetry

- **Colorimetric PCS can be for any observer or illuminant**
  - —No PCS operations are performed when profiles connected using same observer and illuminant
- **Profile Connection Conditions (PCC) header/tags**
  - —Provide definition of observer and illuminant
  - —Define transforms into out of Standard D50/2-degree observer PCS using multiProcessElement



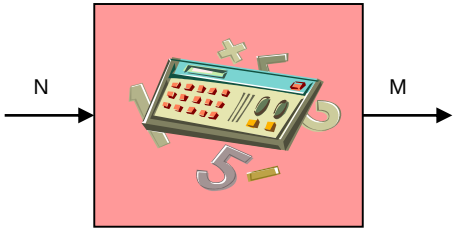
iccMAX spectrally defined display profiles

- **Special processing elements allow spectral information to be defined**
- **Just before transforms are applied the PCC information provided by profile or CMM is used to determine actual colorimetry**
- **Transform processing performed based on derived colorimetry**
- **Allows spectral definition of display with custom observer color matching**
  - Especially important when displays have narrow emission spectra



iccMAX model based display profiles

- **More complex display models are made possible by use of calculator processing element**
  - Uses stack based script to transform input values to output values
  - Allows for lossless inversion of non-linear transforms
  - Useful when more than 3 display channels are involved
  - CMM environment values can be passed in to control behavior

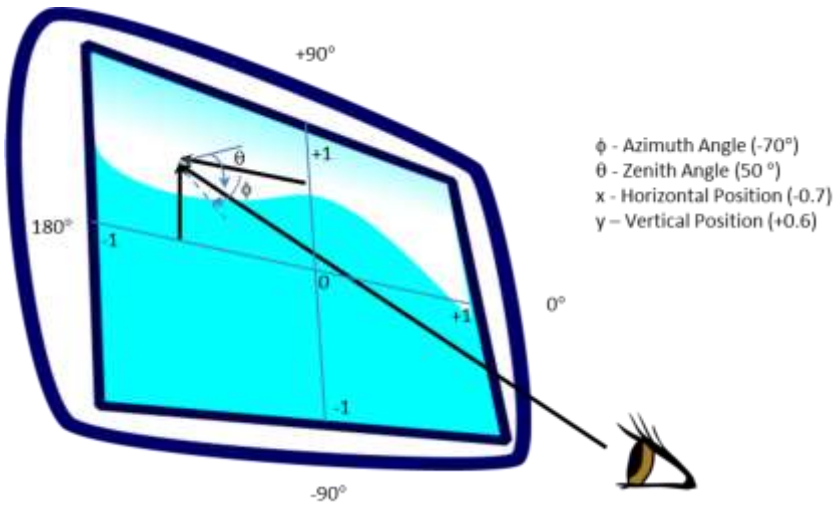



```
{
  in[0,3]
  XdisplayWhite YdisplayWhite ZdisplayWhite mul[3]
  0.9642 1.000 0.8249 div[3]

  XdisplayBlack YdisplayBlack ZdisplayBlack sub[3]
  copy(3) tput[3,3]  %requested normalized XYZ

  mtx(0) copy(3) tput[0,3]  %theoretical RGB values

  max(3) 1.0 gt if {
    tget[0,3] min(3)
    copy tget[0] eq if {
      curv(2)
    } else {
      copy tget[1] eq if {
        curv(3)
      } else {
       curv(4)
      }
    }
    neg copy(1,2)
    (XdisplayWhite - XdisplayBlack)
    (YdisplayWhite - YdisplayBlack)
    (ZdisplayWhite - ZdisplayBlack)
    mul[3]
    tget[3,3] add[3]
    mtx(1)
  }
  curv(5) out[0,3]
}
```

Script for RGBW projector

iccMAX directional Profiles

- **A directionalAToBxTag provides PCS information for viewing of relative position on display at a given viewing angle**
- **A directionalBToAxTag provides device information for viewing of relative position on display at a given viewing angle**



Wrap-Up

Going Forward with iccMAX

- **Now available on the ICC Web Site**
  - Nearly final iccMAX specification document
  - Link to open source reference implementation source code on GitHub
  - Binary command line executables to compile, apply, and interact with iccMAX profiles
  - Example profiles and images for various uses
  - Link: http://www.color.org/iccmax/index.xalter
- **Various implementations are in development**
- **Standardization Progress**
  - Nearing final vote of iccMAX document within ICC
  - In process of ISO standardization

- **iccMAX encompasses the complexities of color in the Real World**

Thank You

Questions?