Integrating A Color Management System With A Unix and X11 Environment

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Agenda

- Color Management Problem Description
- Color Awareness for Solaris
- Xcms
- KCMS - A Color Management Framework
- KCMS API
- X11 Window System and Solaris Integration
- Calibrator Tool
- Conclusion

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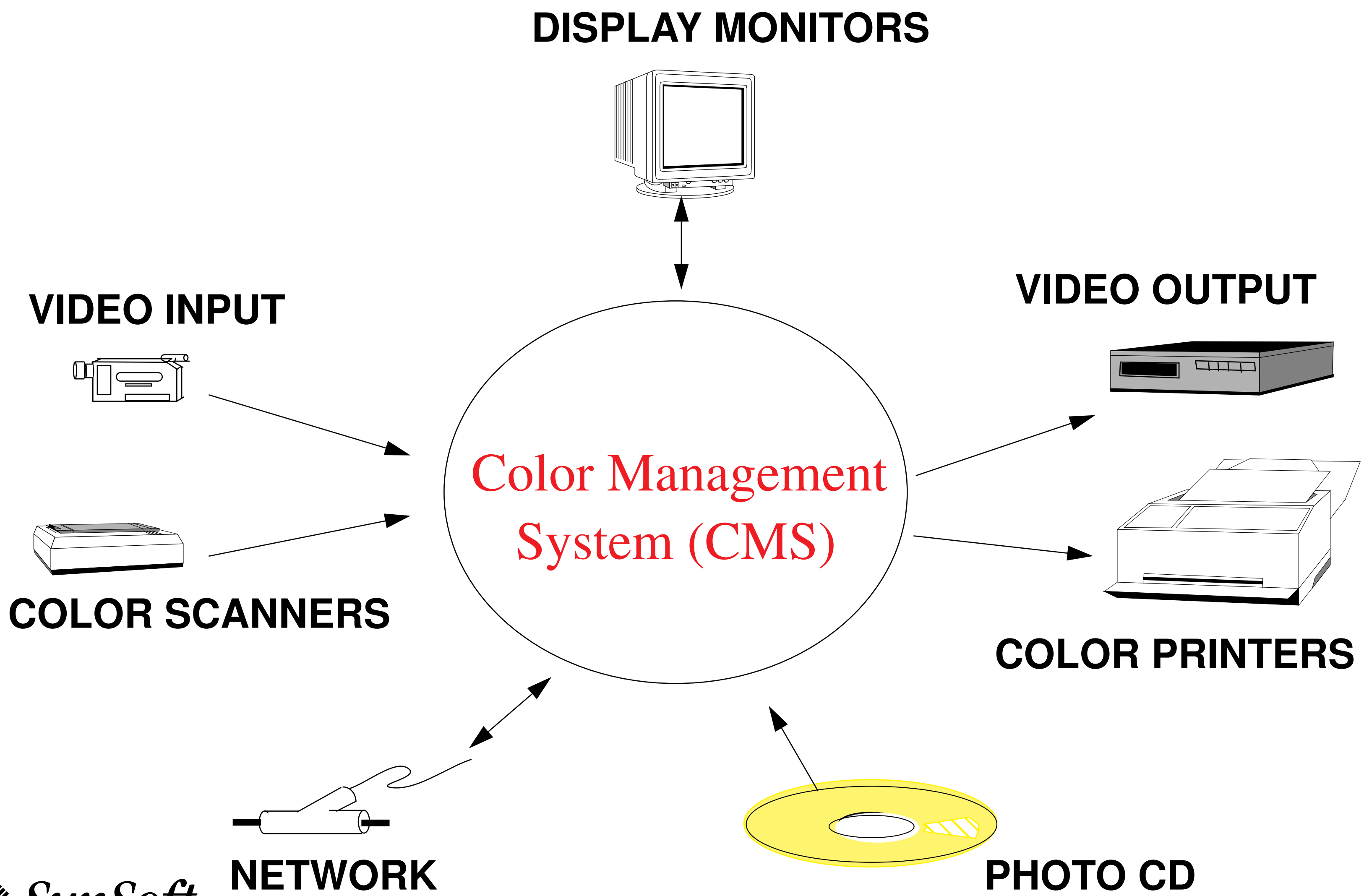
Color Management Problem Description



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Color Awareness for Solaris

- Move “color aware” applications from a niche market to the mainstream
  - Provide color solutions for all users
  - Employ standards where possible

- Solaris integration
  - with the X11 window system
  - with Solaris imaging and graphics libraries
  - make the software network aware, e.g. remote printers and display

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Xcms

- Primarily intended for use with the window system.
  - Desktop publishing requires a color management solution to address display, input (scanning) and output (printing).
  - Printers are usually modelled using large (~100K) tri-linear interpolation tables.
  - A similar problem hurt the adoption of the ColorSync 1.0 profile format on the Macintosh.

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KCMS - A Color Management Framework

- Flexible Framework
  - One Independent Software Vendor (ISV)API
  - Color Management Module (CMM) Plug and Play
  - Color science encapsulated in CMM and profiles

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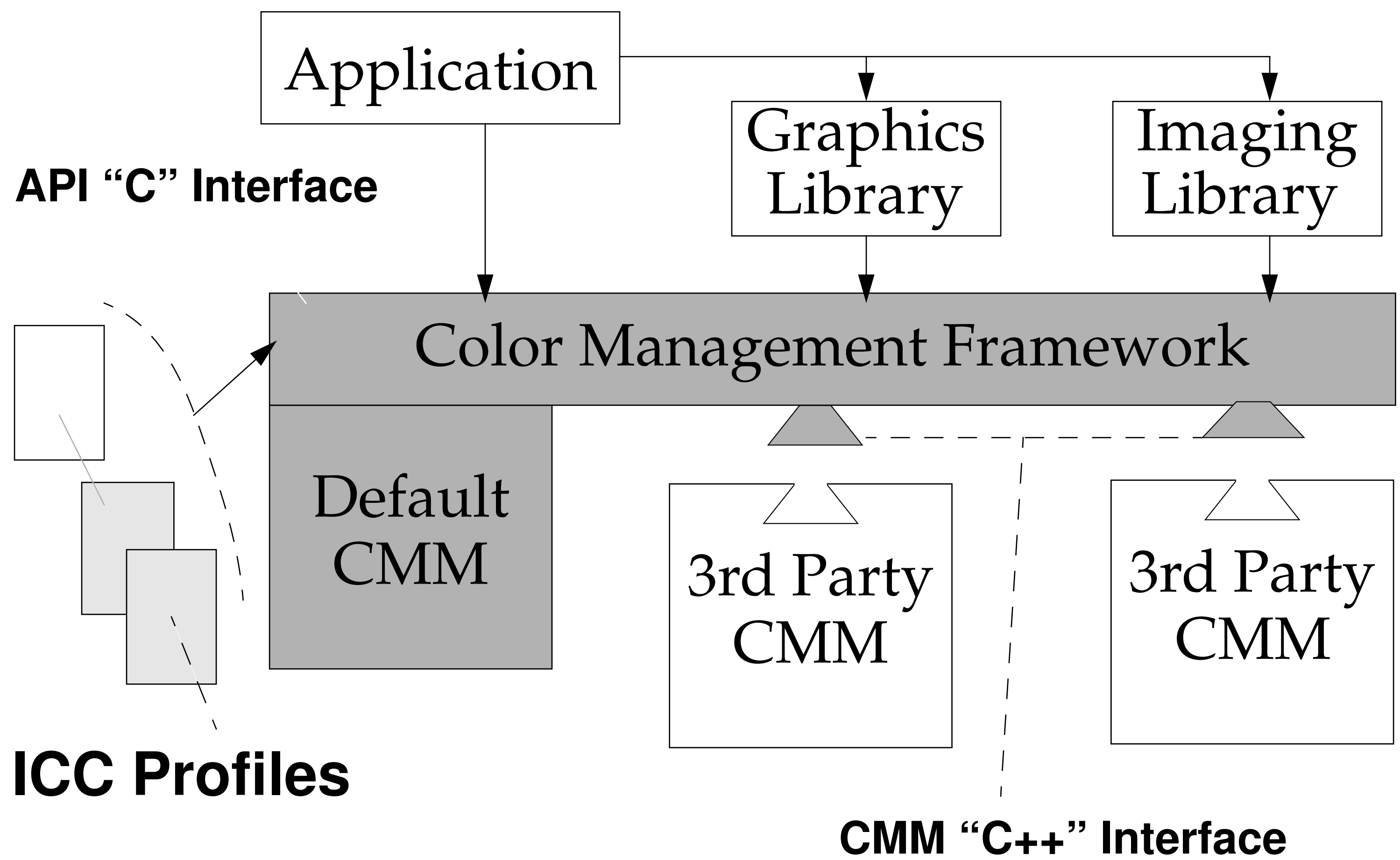
KCMS - A Color Management Framework



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Kodak Color Management Framework

- Application Programming Interface (API)
  - One interface for ISVs

  - ISVs manipulate profiles, need not be Color Science aware

  - Characterization/Calibration interface

  - Integration with Graphics and Imaging Libraries
    Provide access to KCMS functionality without directly calling KCMS
    Provide access to hardware acceleration

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Kodak Color Management Framework

- Color Management Module (CMM) Interface
  - Framework supplies general functionality e.g. File access, network access.
  - Direct link from profile to CMM module
  - Derivation from C++ Classes
  - Dynamic Loading of CMMs

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Kodak Color Management Framework

- ICC (I* C* C*) Profile Format
  - Is a *major* step forward for Color Management
  - Solaris will use the ICC profile format
  - Founding members are Adobe, Agfa, Apple, Kodak, Microsoft, SGI, Sun, and Taligent
  - Open cross-platform specification
  - Movement of the specification to a standards organization is a goal of the Consortium.
  - Copies of the specification are available via anonymous ftp from sgigate.sgi.com:/pub/icc/InterColor3.0.ps

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Creating, Updating Profiles

- Characterization
  - Establishes a norm for a particular device across a range of samples of a device.
  - Information about the device is generated by measuring known color patches displayed/printed/scanned on that device.
- Calibration
  - Makes measurements of an individual device and applies them to a characterization, to obtain an accurate profile for the particular version of the device.

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Color Management Framework Example

Color photo

Displayed image

Data in scanner's color space

Data in monitor's color space

Complete Color Profile

Scanner DCP + Monitor DCP

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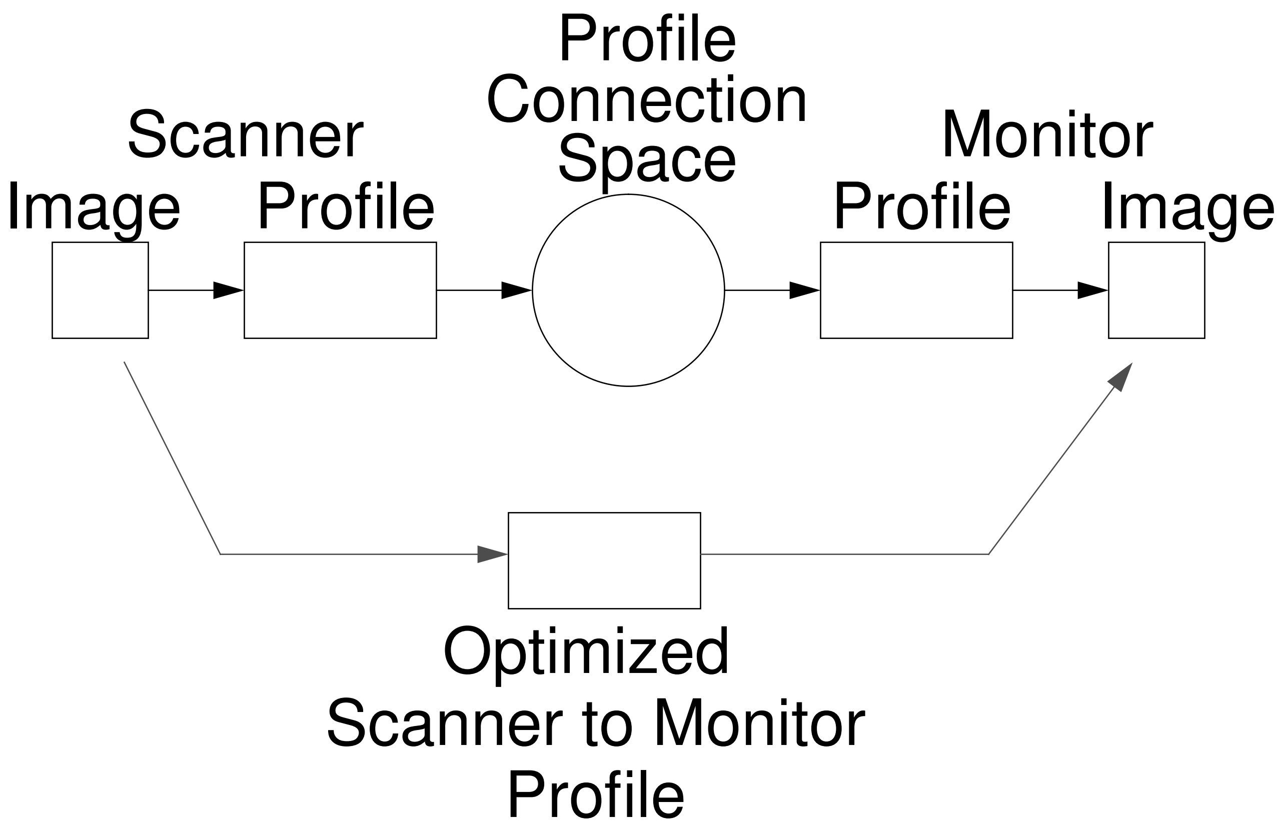
Color Management Framework Example



Scanner to Monitor Correction

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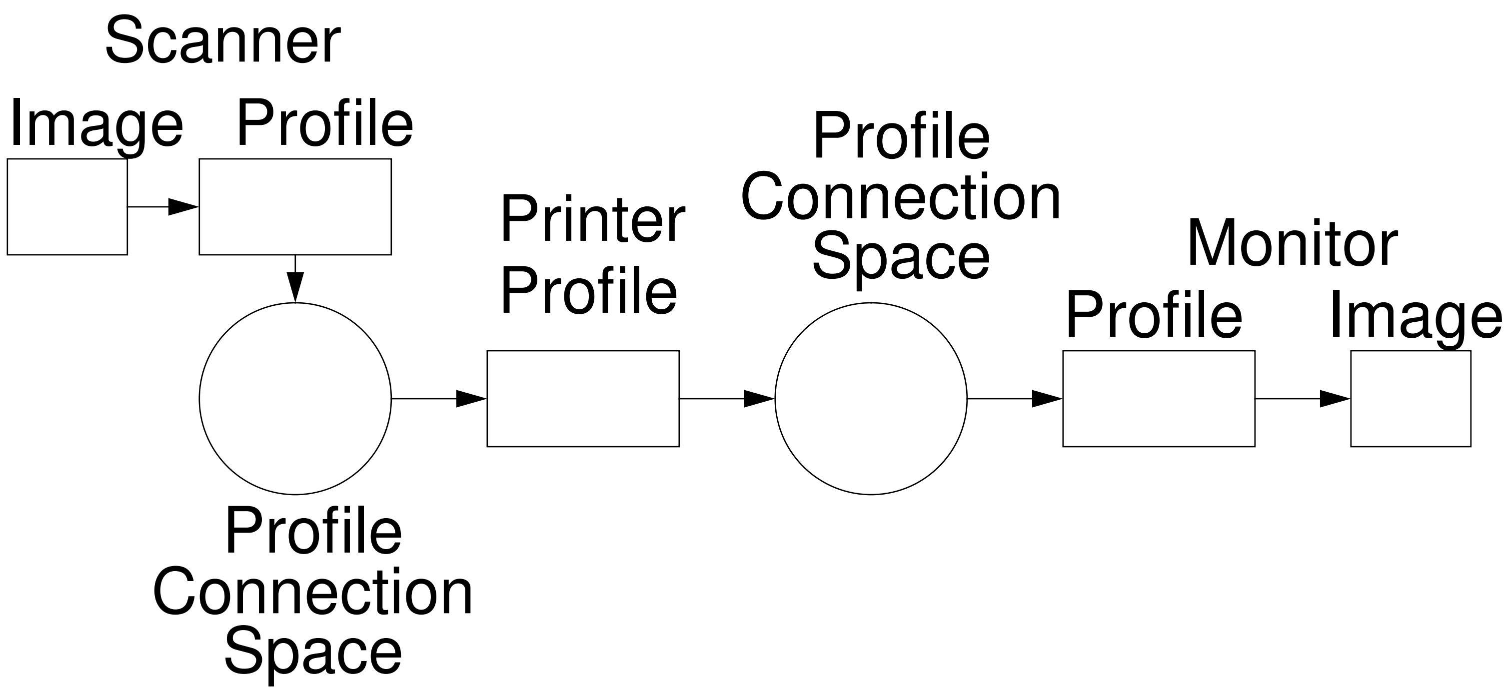

Scanner to Printer Simulation

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Kodak Color Management API

- KcsLoadProfile, KcsSaveProfile
  - Load/Save a profile from storage.
- KcsSetAttribute, KcsGetAttribute
  - Set/Get attributes on a profile, e.g. white point.
- KcsConnectProfiles
  - Connect a sequence of profiles together.
- KcsOptimizeProfile
  - Optimize a sequence of profiles.

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- KcsEvaluate
  - Pass color data through a sequence of profiles

- KcsCreateProfile, KcsUpdateProfile
  - Create a blank profile, update it with characterization or calibration data.

- Miscellaneous utility functions.

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X11 Window System and Solaris Integration

- API Additions, required on Load/Save of a profile.

```
/* KcsProfileDescription */
typedef struct KcsProfileDesc_s {
  KcsProfileType   type;
  union {
     /* Existing KCMS types */
     struct file_f {
        long           offset;
        KcsFileId      openFileId;
     } file;
     struct memPtr_f {
        void           *memPtr;
        long           offset;
        long           size;
     } memPtr;
```

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```
      /* Extensions for Solaris */
      struct solarisFile_f {
         char           *fileName;
         char           *hostName;
         int            oflag;
         mode_t         mode;
      } solarisFile;
      struct xWindow_f {
         Display        *dpy;
         int            screen;
         Visual         *visual;
         long           reserved;
      } xwin;
      long pad[4];/* Max size */
   } desc;
} KcsProfileDesc;
```

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- Loading a profile

```
KcsStatus
KcsLoadProfile(
  KcsProfileId        *profileId,
  KcsProfileDesc      *desc,
  KcsLoadHints        loadHints)
```

- Saving a profile,

```
KcsStatus
KcsSaveProfile(
  KcsProfileId        *profileId,
  KcsProfileDesc      *desc)
```

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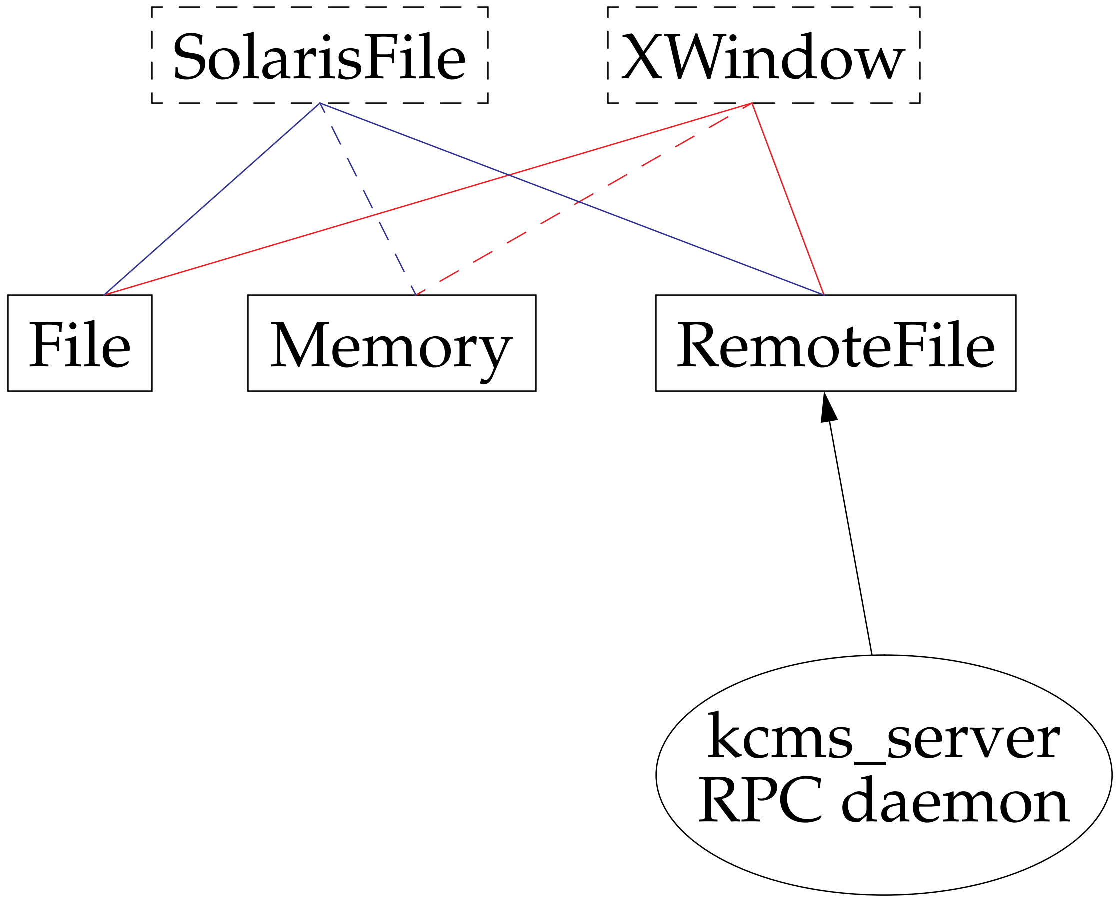
X11 Window System and Solaris Integration



KcsIO Class Hierarchy

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X11 Window System and Solaris Integration

- Input and Output is handled via the KcsIO class
  - KcsIO provides a storage and OS independent mechanism for accessing profile data.
  - The framework supplies three sub-classes to access local files, remote files and memory.

- XWindow and SolarisFile KcsIO sub-classes
  - Dynamically loaded at run time
  - implemented as separate C++ sub-classes
  - each contains a pointer to a File or RemoteFile KcsIO class.
  - KcsIO type is determined from the KcsProfileDesc structure.

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- SolarisFile KcsIO sub-class
  - searches for files in known locations, and with known endings.
  - Locks files, allows read only files to be shared and provides exclusive access for writing.
  - Provides access to profiles on remote machines.
  - Provides a toolkit-like layer for applications accessing profiles.
  - This permits future enhancements without changing the API interface.

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- Profile location
  - Per network group
    allows the window system to be NFS mounted

  - Per machine
    e.g local calibrated monitor profiles

  - Per person
    KCMS_PROFILES environment variable is a colon separated list of directories

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- XWindow KcsIO sub-class
  - Handles access to local and remote window system profiles.
  - Provides a programming abstraction.
  - Locks files, only super-user can write to these profiles, others share them.

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- Current implementation
  - Profiles are stored per machine
  - Profile names are generated from window system information.
  - Naming convention is
    <Visual Class name><Visual Id>:<Display #>.<Screen #>
    e.g., PseudoColor0x22:0.0, TrueColor0x26:0.0
  - Abstraction of this file interface permits implementation changes without API changes.

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- RemoteFile KcsIO class
  - Client side for an RPC daemon.
  - Daemon reads data from profiles located on remote machines.
  - Allows X11 window system clients to display color corrected data on a remote host.
  - Writing of data is disabled for security reasons.

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X11 Window System and Solaris Integration

- Xcms integration
  - ICC profiles for monitors match the root window property information for Xcms.
  - xcmsdb has been modified to read KCMS window system profiles and install the appropriate root window properties for Xcms.
  - xcms2kcms utility generates ICC profiles from root window properties.

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Calibrator Tool (kcms_calibrate)

- Motif based application designed to configure and calibrate a system for use with KCMS.

- Operation,
  - User selects a generic monitor profile
  - Tool creates window system profiles through the API interface
  - Measures the response of the different window system visuals present.
  - Updates the window system profiles.

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- Calibrator/Colorimeter hardware module
  - is dynamically loaded.

  - interface exists for new calibrator hardware

- Calibrator/Colorimeter interface is extensible for
  - monitor characterization

  - scanner calibration, characterization

  - printers

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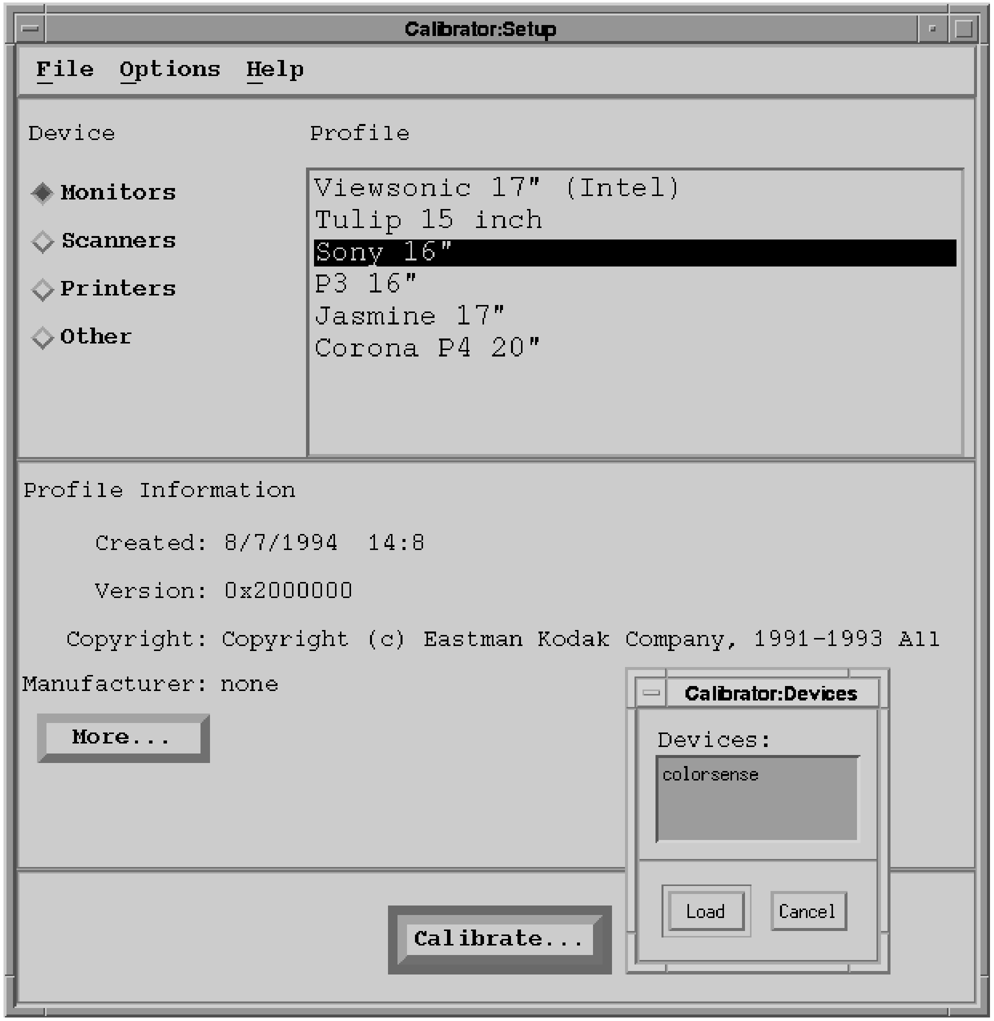

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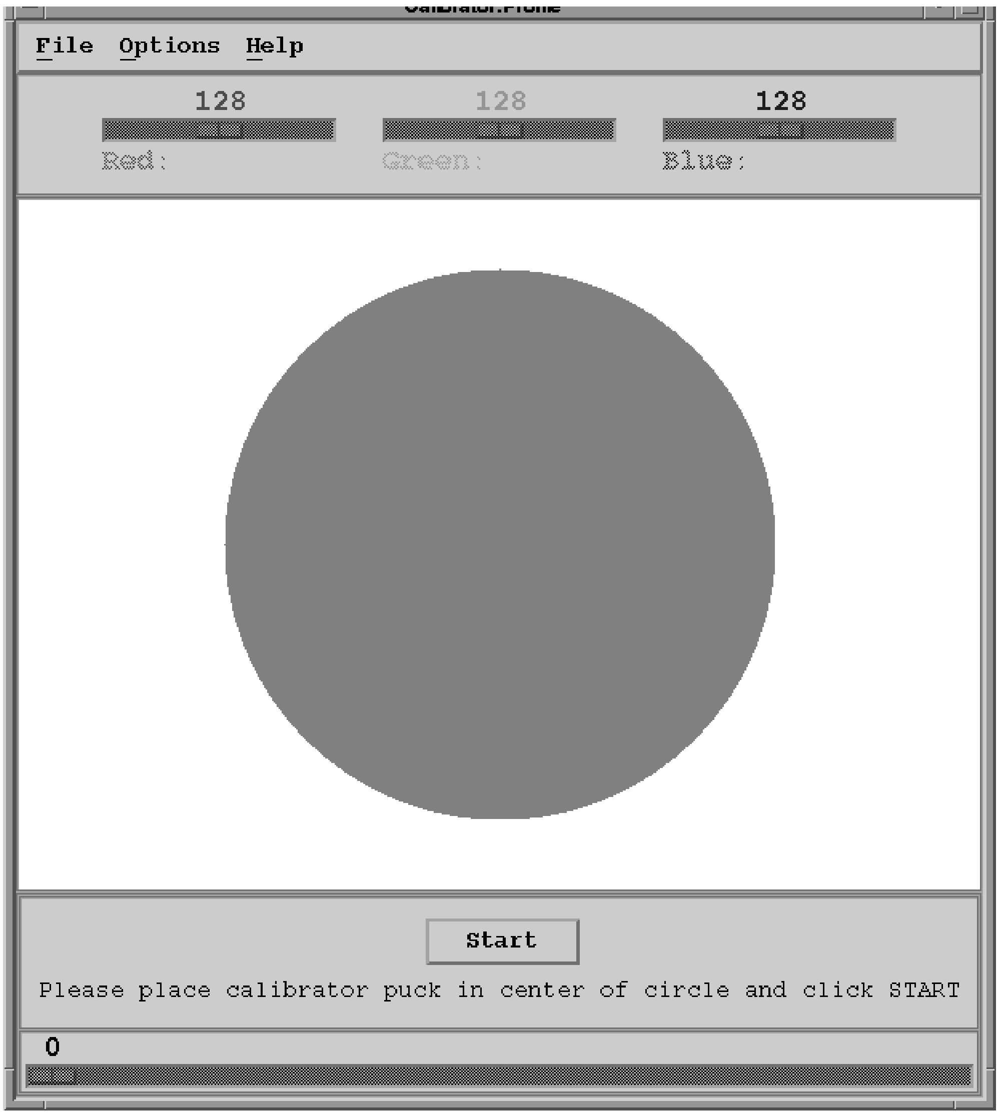

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Interfacing with other Libraries

- KcsEvaluate call accepts pointers to pixel data.
  - i.e the calling application owns the pixel data.

- Operation,
  - set up KCMS pixel layout structures
  - call KcsEvaluate.
  - set up is cheap compared to color processing.

- PostScript, the ICC profile format supports
  - PSL2 color rendering dictionaries
  - PSL2 color space arrays
  - PSL2 rendering intents

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- KCMS has been successfully used with
  - Xlib
  - XIL (Solaris imaging library)
  - Adobe PhotoShop plug-in

- Tighter integration is planned for future Solaris releases.

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Conclusion

• KCMS provides a system wide environment for consistent color.

- from scanner to monitor to print
- use of the ICC profile format.
- extensions added to support distributed (Unix, X11) environments.
- Easy to use with existing libraries and applications.

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- Color managament is and will become a check off item for OS vendors.
  - These four companies all intend to, or are shipping, color management systems with their OS's : *Apple*, *Microsoft*, *SGI* and *Sun*.

- Color management is interesting to if you
  - use *desktop publishing*.
  - *view color data*, e.g. images, computer graphics
  - *print color data*, color management provides *consistent first time* results.
  - color prints can cost $5-10 per sheet getting good first time results *saves money*.

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