

AFP Consortium

RICOH | **IBM**
InfoPrint Solutions Company

AFP Color Management Architecture (ACMA)

Release 1

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Note:

Before using this information and the product it supports, read the information in "Notices" on page 61.

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Introduction

This document provides an overview of the architecture for Advanced Function Presentation™ (AFP™) color management. The objectives of this architecture are the following:

- Consistent output across different devices
- Accurate output, to the best of the device capability, on a wide variety of inputs, provided the input color information is properly described
- Consistent output across different data streams
- Flexible controls that enable customers to obtain output to their exact specifications
- High-speed color conversions

The architecture overview in this document is defined in the terms of the AFP architectures to support color management in AFP environments, but care has been taken to make the mechanisms applicable to other presentation environments as well.

This document itself is not an architecture document. It provides an overview of the changes that will be made for color management in the various AFP architecture references. The affected documents are:

- *Mixed Object Document Content Architecture (MO:DCA) Reference*, SC31-6802
- *Intelligent Printer Data Stream Reference*, S544-3417
- *Color Management Object Content Architecture (CMOCA) Reference*, S550-0511
- *Image Object Content Architecture Reference*, SC31-6805
- *Bar Code Object Content Architecture Reference*, S544-3766
- *Advanced Function Presentation: Programming Guide and Line Data Reference*, S544-3884

The architecture described in this document requires support not only in AFP applications, AFP print servers, AFP transforms, and AFP printer controllers, but also in related applications such as the installers that are mentioned herein. These applications may process constructs that are formally part of the architecture definitions, such as a Resource Access Table (RAT). Wherever such processing is defined in one of the architecture references, it must be implemented in a manner compliant with that architecture definition.

AFP Consortium

The architecture in this book was developed by the AFP Consortium™ (AFPC™). The AFPC began in 2004 as the AFP Color Consortium™ (AFPCC™), with a goal of adding color management support to AFP. It is an industry-wide collaboration whose members include both AFP application providers and AFP printer manufacturers. The current Members of the AFPC are:

- CDP Communications, Inc.
- Cincom
- Compart Systemhaus
- COPI
- Crawford Technologies

- DocPath Corporation
- DocuCorp International
- Document Sciences
- Elixir Technologies
- Emtex
- Exstream Software
- GMC Software Technology
- IBM®
- InfoPrint® Solutions Company/Ricoh®
- Intermate
- Invaris
- Inventive Designers
- ISIS-Papyrus
- Kodak
- Levi, Ray & Shoup
- Lexmark
- Metavante
- MPI
- Océ
- Pitney Bowes Group 1
- PrintSoft Americas, Inc.
- Punch Graphix
- Solimar Systems, Inc.
- StreamServe
- Xenos Group Inc.
- Xerox

The Members have entered into a separate agreement by which they have identified the Contributing Members.

Chapter 1. Overview

The AFP Color Management Architecture™ (ACMA™) is based on the concept of a color management resource (CMR). A CMR is an architected resource that is used to carry all of the color management information required to render a print file, document, group of pages or sheets, page, or data object with color fidelity. CMRs are defined in a new Advanced Function Presentation (AFP) architecture: the Color Management Object Content Architecture™ (CMOCA™). This architecture is defined in the *Color Management Object Content Architecture (CMOCA) Reference*.

In AFP environments, CMRs can be associated with document components and are processed as AFP resources by print servers and printers so that they can be downloaded once, captured, and used repeatedly without requiring additional downloads. CMRs are also applicable to non-AFP environments such as PostScript®, PDF, and PCL.

CMR names

A CMR is identified with a fixed-length name that is specified in the CMR header and that is generated based on an architected naming scheme to ensure uniqueness. This naming scheme includes fields such as CMR type, manufacturer, device type and device model number, and properties specific to the CMR type.

CMR types

Each CMR carries a single type of color management resource. The type of CMR resource is specified by the CMR type parameter in the CMR header. The following CMR types are defined:

Color conversions (CCs)

International Color Consortium (ICC) profiles that tie a device-specific color to or from the profile connection space (PCS).

The accuracy of color rendering is heavily dependent on the accuracy of the description of the input colors using color conversion CMRs. Therefore, AFP applications, document generators, and resource generators are strongly encouraged to focus on defining the input colors as accurately as possible.

Tone transfer curves (TTCs)

CMRs that are used to modify the values of a particular color component.

Halftones (HTs)

CMRs that are applied to multi-bit data.

Indexed (IX) CMRs

CMRs that map indexed colors in the data to output device colors or colorant combinations.

Indexed (IX) CMRs are used to map a two-byte indexed color value, specified in the data stream using the highlight color space, to device colors on a highlight color, process color, or monochrome device. The device colors can be one of the following:

- A fractional mixture of one or more specific device colorants.

- A device-dependent process color (CMYK for printers, RGB for displays).
- A gray value.
- A CIELAB value. This value is always specified, even in the above cases, to provide a substitute color value if the device cannot generate the requested device color.

Link color conversions (LKs)

CMRS that provide look-up tables (LUTs) that directly convert from an input color space in the presentation data to the output color space of the presentation device. An LK CMR is created by combining the CC CMR that defines an input color space with the CC CMR that defines the output color space.

LK CMRs are resources that are generated and processed internally in AFP systems; they are not exposed to the AFP application or the job submitter, and they cannot be referenced in the data stream. LK CMRs can be important for presentation device performance; therefore a goal of the AFP color management system is to provide LK CMRs for the presentation device whenever it needs to convert from an input color space in the presentation data to its own output color space.

For more information on ICC profiles, see the *International Color Consortium Specification ICC.x, File Format for Color Profiles*, where *x* stands for the current level of the specification.

Processing modes

The attributes that dictate how the CMR is processed by an AFP system are referred to as *processing modes* for CMRs. The following processing modes are defined:

Audit Reflects processing that has been done on a document component.

The accuracy of color rendering is heavily dependent on the accuracy of the description of the input colors using audit color conversion CMRs.

Instruction

Specifies processing that is to be done to a document component.

Link Links an input color space in the presentation data to the output color space of the presentation device. Only Link color conversion (LK) CMRs can be processed as link CMRs.

Because some CMR types, such as a color conversion CMR, can be used in an audit mode or in an instruction mode, the processing mode is not specified in the CMR itself. Instead, it is specified in the context within which the CMR is associated with a document component.

IX CMRs should always be referenced as instruction CMRs. If they are referenced as audit CMRs, the output device ignores them. Because IX CMRs specify a direct mapping from the indexed color value in the data stream to an output color, audit CC CMRs and link CMRs are not used when an IX CMR is processed. Instruction CC CMRs are used with IX CMRs only if the Lab value from the IX CMR is used. In that case, the active CC CMR provides the conversion from the Lab value to the output device color value (CMYK, RGB, or gray). Note that, as with all other CMR types, the output device uses the CMR hierarchy to select a single IX CMR to be

used with the data. If an indexed color value is not found in that IX CMR, no attempt is made to look for that indexed color value in another IX CMR.

Halftone CMRs and tone transfer curve CMRs can be specified in a generic sense and referenced as instruction CMRs to request an intended output appearance. Such CMRs are called *generic* CMRs. They are identified with a fixed character pattern in the version field of the CMR name and with the absence of device-specific fields in the name. The CMR Architecture registers all valid generic CMR names for HT and TTC CMRs. Generic CMRs are never used directly by an output device; they are always replaced by device-specific CMRs that provide the intended appearance. This replacement is done either by the print server based on processing inline CMRs or processing the CMR RAT, or by the output device. The output device ignores generic audit HT and TTC CMRs.

Table 1 shows what processing modes are valid for each CMR type and whether the CMR type can be specified as a generic CMR.

Table 1. CMR type: processing mode and generic capability

CMR type	Non-generic CMR			Generic CMR		
	Processing modes			Processing modes		
	Audit	Instruction	Link	Audit	Instruction	Link
Color conversion (CC)	Valid	Valid	Invalid: error	Invalid: error		Invalid: error
Tone transfer curve (TTC)	Valid	Valid		Valid: ignored	Valid	
Halftone (HT)	Valid: ignored	Valid		Valid: ignored	Valid	
Indexed (IX)	Valid: ignored	Valid		Invalid: error		
Link (LK)	Invalid: error		Valid	Invalid: error		

Server Considerations:

1. Servers should download all valid combinations of CMR type and processing mode, even if the device ignores them. This allows the architecture to define possible future use of such combinations without causing errors on existing devices.
2. Servers should not download invalid combinations of CMR type and processing mode. Instead, they should generate an error.

The InfoPrint AFP Resource Installer

CMRs are installed as resources in an AFP resource library with a workstation-based application called the InfoPrint AFP Resource Installer. This program

- Uploads the CMR into the resource library of a print server
- Builds the CMR resource access table (RAT) entry that maps the CMR name to a file name, to an object OID, and optionally to additional CMRs such as link CMRs

When a color conversion CMR is installed, a flag bit in the CMR RAT entry specifies whether this CMR would normally be used to define input colors in the print file, that is, as an audit CMR. This flag bit is used to trigger the generation of LK CMRs that convert from the input color space defined by that CMR to the output color spaces, defined by other CMRs, of all target presentation devices that

are configured to the Resource Installer and that are to be used on the target print servers. These link CMRs are then mapped to the color conversion CMR in the CMR RAT. For generic CMRs, the Installer automatically builds a CMR RAT entry for each architected generic CMR name that points to a dummy generic CMR object and to an object OID for the dummy generic CMR object. This entry allows users to map device-specific CMRs to the generic CMR in the RAT.

The Resource Installer is also used to install the actual data object resources (color objects such as IOCA objects, TIFFs, JFIFs, GIFs, EPSs, and PDFs) that are to be presented on a page. It allows CMRs to be associated with the object being installed.

CMRs and presentation devices

When a print server accesses the CMR RAT with a reference to an audit CMR in the data stream, it may encounter link color conversion CMRs that are mapped to the referenced audit CMR. If the target device supports downloaded link CMRs, the server uses the current target device type and model to select appropriate link CMRs for converting the input color space defined by the audit CMR to the output color space of the target presentation device. Such link CMRs are downloaded to the target device; if necessary.

Similarly, when a print server accesses the CMR RAT with a reference to a generic CMR in the data stream, it may encounter device-specific CMRs of the same type that are mapped to the referenced CMR. If the device supports downloaded CMRs of that type, the server uses the current device type and model to select appropriate device-specific CMRs that are to be sent to the device *in place of* the generic CMR.

Device support for downloaded CC CMRs and generic HT and TTC CMRs is mandatory. Device support for downloaded device-specific HT and TTC CMRs, for LK CMRs, and for IX CMRs is optional. If a print file refers to an optional CMR that is not supported by the output device, the print server recognizes an exception condition. User-specified fidelity controls determine whether this exception condition is reported and whether print file processing continues.

The CMR engine

CMRs are created by the CMR engine (CMRE), which is an application that runs on a workstation platform and is called by the Resource Installer. A version of the CMRE also runs directly in the presentation device. The purpose of the CMRE is to:

- Generate color conversion CMRs from ICC profiles
- Generate indexed CMRs from input data
- Generate link color conversion CMRs
- Generate halftone CMRs from input data
- Generate tone transfer curve CMRs from input data

Associating CMRs with document components

An audit or instruction CMR can be associated with a Mixed Object Document Content Architecture™ (MO:DCA™) document component and becomes a part of the CMR hierarchy that the presentation device uses to apply color management to presentation data. A link CMR is not tied into the CMR hierarchy used by the

presentation device. Instead, if supported by the presentation device, it is sent to the device by the server and is always used if a color conversion is needed to render presentation data and that conversion is defined precisely by that link CMR.

CMRs are associated with MO:DCA document components in the following manner:

Print file

A CMR can be associated with the print file by referencing it as a resource in the Document Environment Group (DEG) of the form definition that is invoked for the print file by the job submitter.

Document

A CMR can be associated with a specific document in the print file by using a CMR that is referenced for the print file and targeting this CMR at the specific document.

Group of pages or sheets

A CMR can be associated with a group of pages by referencing it as a resource in the medium map that is invoked to process those pages.

Page or overlay

A CMR can be associated with a page or overlay by referencing it as a resource in the Active Environment Group (AEG) for the page or overlay. This reference is identified with scope page or overlay to differentiate it from similar object-level references that can be factored up from the Object Environment Group (OEG) of a data object or from an Include Object (IOB) structured field.

Data object

A CMR can be associated with a data object such as IOCA, EPS, PDF, TIFF, JFIF, GIF in multiple ways:

- The data object can be installed with the Resource Installer. When this Installer builds the RAT entry for the data object, it can also specify one or more CMRs that are to be associated with the object. Each CMR reference indicates the processing mode of the CMR (audit or instruction).
- If the data object is included on a page/overlay with an IOB, or if it is included in a page segment that is included on a page/overlay with an IOB, a CMR can be associated with this object by specifying the name of the CMR on the IOB as an external resource reference and then referencing the CMR with a Map Data Resource (MDR) in the Active Environment Group (AEG) of the page. This method is similar to how a resident SWOP or Euroscale color profile is associated with an EPS or PDF object, and how a PDF resource is associated with a PDF object.
- If the data object is specified directly on the page/overlay, it can reference the CMR in its OEG with a MDR that references the CMR. Note that, for resource management, any CMR reference in the OEG must be factored up to the AEG of the including page or overlay.
- The data object can contain embedded CMR-like information. An example is the inclusion of an audit-like ICC profile in a TIFF object. Such information is used by the presentation device when an object-level CMR is not provided. If the data object is installed using the Resource Installer, an embedded audit-like ICC profile can be copied and converted into an audit CC CMR that is then associated with the data object in the data object RAT. Optionally, the embedded profile can also

be extracted from the object to reduce the object size; this version of the object is referred to as the compacted object. The copy and extract functions are allowed only if the embedded ICC profile can be used independently of the data object, as specified with a flag in the ICC header.

Note that if a data object is to be preprocessed with the Preprocess Presentation Object (PPO) structured field, the same CMRs that are to be associated with the object when rendered need to be associated with the object on the PPO. This is done by specifying the CMRs on the PPO as external resource references and by mapping the CMRs with a MDR in the Resource Environment Group (REG) that contains the PPO.

Rendering intent

The proper use of CC CMRs and LK CMRs in a presentation device involves the concept of rendering intent. Rendering intent is used to modify the appearance of color data. Rendering intents supported in AFP color management are based on the rendering intents defined by the ICC, which are also used in other presentation environments such as PostScript and PDF. The ICC defines four rendering intents:

- Perceptual
- Saturation
- Media-relative colorimetric
- ICC-absolute colorimetric

For more information on rendering intents, see the *International Color Consortium Specification ICC.x, File Format for Color Profiles*.

Rendering intent is specified with the Rendering Intent (X'95') triplet on the Presentation Environment Control (PEC) structured field. For document hierarchy levels other than the object level, rendering intents can be specified independently for each major AFP color object type category, as follows:

- IOCA objects
- Object containers (EPS, PDF, TIFF, etc.)
- PTOCA text
- GOCA graphics objects

This allows one object type, such as text, to be rendered with a different rendering intent than another object type, such as continuous tone IOCA image, with a single specification of the Rendering Intent triplet.

Process colors can also be specified for a Bar Code Object Content Architecture™ (BCOCA™) object with the Color Specification (X'4E') triplet on the Bar Code Data Descriptor (BDD) structured field. However, the rendering intent for BCOCA objects is fixed as media-relative colorimetric.

Rendering intents may be associated with a MO:DCA document component at the same levels of the document hierarchy as CMRs, as follows:

- Print file.
- Document.
- Group of pages or sheets.
- Page or overlay.
- Data object. The rendering intent may be associated with a data object in a number of ways:

- By specifying a PEC with RI triplet in the OEG for the data object
- By specifying the RI triplet on the IOB that includes the data object
- By specifying the RI triplet on the PPO that is used to preprocess the data object
- By specifying the rendering intent in the data object RAT entry for a data object that is installed using the Resource Installer

Normal MO:DCA hierarchy rules apply for processing rendering intents. That is, a rendering intent specified for a document component at a lower level in the hierarchy applies only to that document component and overrides any other rendering intent specified at a higher-level in the hierarchy.

CMRs and print media

Color rendering may also be significantly affected by the characteristics of the print media. CMRs may therefore be tuned to specific media; this is indicated by specifying one or more of the following four media attributes in an instruction CMR:

- Media brightness
- Media color
- Media finish
- Media weight

Each attribute has a valid range of values that is defined in the *Color Management Object Content Architecture (CMOCA) Reference*. An instruction CMR may specify none, some, or all of these attributes. The output device uses these CMR media attributes and the media attributes of the current media to select an optimum CMR using the following algorithm:

- If none of the media attributes are specified in an instruction CMR, the printer uses it
- If one or more of the media attributes in an instruction CMR are invalid, exception processing mode is entered
- If all of the media attributes are specified in an instruction CMR and are valid, the CMR is processed as follows:
 - If all attributes match the current media, the CMR is used.
 - If one or more attributes do not match the current media, the printer searches the hierarchy for a media-specific CMR that matches the current media. Multiple applicable CMRs may exist at each level of the hierarchy and are included in the search, and each level of the hierarchy is searched in the normal order, except for the printer default level, which is not part of the search. If no matching media-specific CMR is found, exception processing mode is entered.
- If some, but not all, of the media attributes are specified in an instruction CMR and are valid, the CMR is processed as follows:
 - If all the specified attributes match the current media, the printer searches the hierarchy for a CMR whose media attributes are a better match with the current media. Multiple applicable CMRs may exist at each level of the hierarchy and are included in the search, and each level of the hierarchy is searched in the normal order, except for the printer default level, which is not part of the search. If a better matching CMR is not found, the original CMR is used.

- If one or more of the specified attributes do not match the current media, the printer searches the hierarchy for a CMR whose media attributes do match the current media. Multiple applicable CMRs may exist at each level of the hierarchy and are included in the search, and each level of the hierarchy is searched in the normal order, except for the printer default level, which is not part of the search. If no CMR is found whose attributes match the current media, exception processing mode is entered.

CMRs in the IPDS data stream

Within the Intelligent Printer Data Stream™ (IPDS™), CMRs are activated and deactivated like all other IPDS resources. A host-assigned ID (HAID) is assigned during activation. For audit and instruction CMRs, the CMR is not used unless it has also been explicitly invoked. Invocation is accomplished either with a new home state IPDS command called Invoke CMR (ICMR) or with a new Invoke CMR (X'92') triplet on a command associated with an object. These controls invoke the CMR by HAID and define the scope for the CMR. A link CMR can be used without invocation.

CMOCA provides a rich set of functions and types of CMR objects; however, not all of these functions are appropriate for all types of IPDS printers. Sense Type & Model command property pairs are defined to allow each printer to identify the optional color management functions that are supported.

CMR scoping rules require that the printer select appropriate CMRs for all print data using a well-defined hierarchy. For example, a form definition may specify that all CMYK colors in the print file that are not otherwise tied to a particular audit color conversion CMR are interpreted using an audit color conversion CMR for the InfoPrint Color 130+. Inside the print file, an IOCA FS45 may specify that its CMYK was generated for Lexmark color printer X, and was tagged with an audit color conversion CMR for that printer. When the FS45 is processed, the printer needs to apply the Lexmark printer X audit CMR for the duration of the FS45 processing. The CMR-usage hierarchy has the following levels:

- Data-object-level CMR; note that when an object-level CMR is not invoked, internal object CMR-like information, such as an embedded ICC profile can be used in its place
- Page-level or overlay-level CMR
- Home-state-level CMR (which corresponds to either a document-level CMR, a CMR associated with a group of pages or sheets, or a print file-level CMR)
- Default CMR (which could be either an architected default or a printer default)

All color conversions from an input color space in the presentation data to the printer's output color space are done using Link color conversion CMRs. These link CMRs do not need to be invoked. If the printer cannot find a link CMR that provides the required color conversion, it calls its internal CMRE to generate a link CMR or a portion of a link CMR. The printer also identifies a current rendering intent, which is based on the rendering intents that may be specified at the different levels of the MO:DCA document hierarchy. This rendering intent is used to select one of the four LUTs in a Link color conversion CMR.

The processing of CMRs described above is intended to provide a basic level of color management support. Additional layers may be added to provide more sophisticated and complete functionality. Such layers may, for example, manipulate CMR entries in a RAT to map a device-specific CMR to a generic CMR. Such

layers operate independently of the MO:DCA and IPDS CMR processing in the print servers and can be added to each platform as required.

Examples of APF color management systems

A complete APF system with color management is shown in Figure 1.

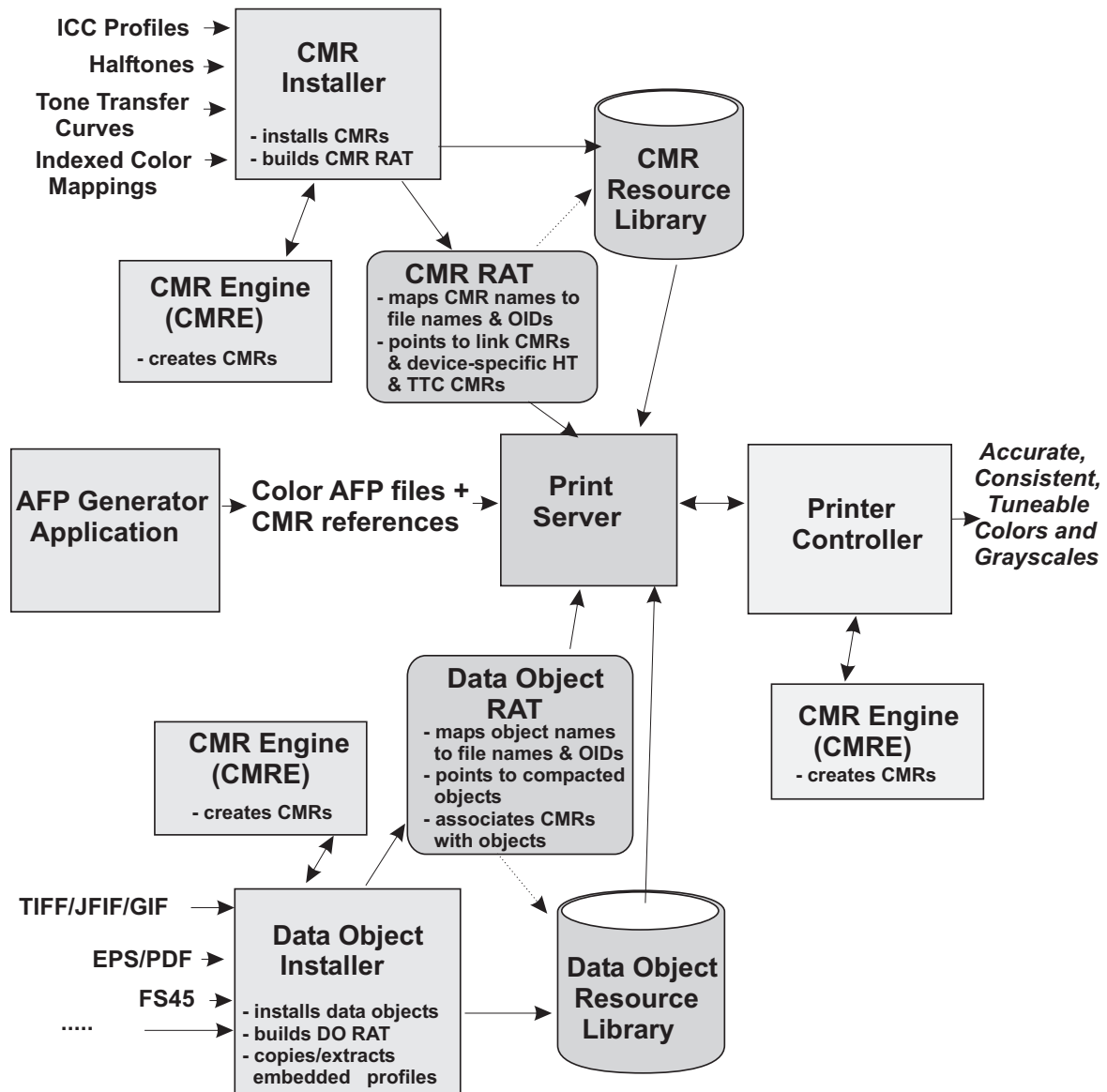


Figure 1. APF Color Management System with resources in libraries

A system where the resources are contained in a resource group at the print-file level is shown in Figure 2 on page 10.

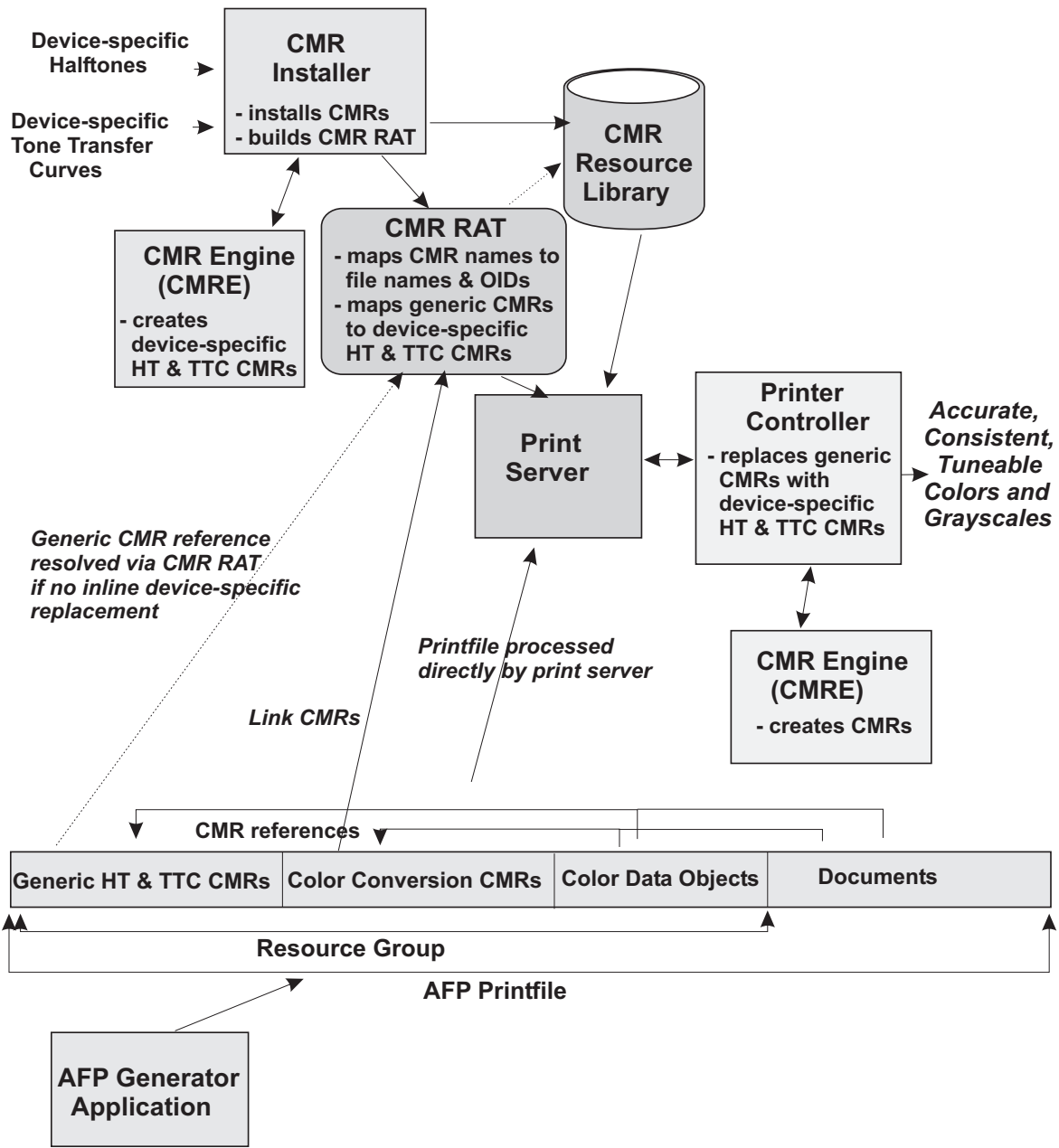


Figure 2. AFP Color Management System with inline resources

Chapter 2. Color management resource (CMR) overview

The CMR consists of a header, followed by the color management data, as follows:

Table 2. CMR header

Length (bytes)	Name	Description
4	Length	CMR length, including length field
4	CMRSig	Signature; an eye-catcher string to identify this as a CMR
2	Reserved	Should be set to zero
16	CMRAlias	Human-readable CMR alias
4	Type	CMR Type
14	CMRVersion	Version number or generic indicator
28	ManufacturerName DeviceType DeviceModel	Device-specific fields
22	MediaBrightness MediaColor MediaFinish MediaWeight	Media-specific fields
46	Prop1 Prop2 Prop3 Prop4 Prop5	CMR-type-specific fields
16	Reserved	Should be set to @. .@
8	Reserved	Should be set to zero
	CMRData	CMR data

All character data in the header is encoded in UTF-16BE. The fields starting with the CMRAlias field and ending with the reserved field consisting of 8 @ characters, concatenated in the sequence defined in the header, form the formal CMR name, which is used to reference the CMR in the data stream. The CMR name therefore has a fixed length of 146 bytes representing 73 characters encoded in UTF-16BE. If the number of characters for a particular field in the CMR name is smaller than the field length, the characters are left-aligned and padded with the @ character, encoded in UTF-16BE (X'0040').

The following CMR types are defined:

- Halftone
- Tone transfer curve
- Color conversion
- Indexed
- Link color conversion

CMR data is carried in CMR tags. Each CMR type defines which tags are required and which are optional. CMR tags also define the exception conditions which can exist when the tags are processed. The tags are loosely based on the TIFF tag syntax, but with significant changes and additions. The tags are carried first, optionally followed by other tag data.

Table 3 shows the syntax of the CMR tags.

Table 3. CMR tags

Length (bytes)	Name	Description
2	TagID	Unique identifier for the tag
1	Reserved	Should be set to zero
1	FieldType	Data format of field
4	Count	Number of values of the indicated FieldType (may be zero)
4	ValueOffset	Either: <ul style="list-style-type: none">• Up to 4 bytes of left-aligned data• Offset to more than 4 bytes of data, counted from the start of the CMRData field

Note that ICC profiles are carried unaltered in color conversion CMRs using the appropriate CMR tags.

For a detailed definition of the CMR syntax and semantics, and for a description of the CMR types, see the *Color Management Object Content Architecture (CMOCA) Reference*.

Chapter 3. Installing CMRs using the AFP Resource Installer

The InfoPrint AFP Resource Installer runs on Microsoft® Windows® and can install CMRs in local and remote print server resource libraries. The component that installs CMRs is called the CMR installer. The CMR installer provides functions to upload the CMRs to the server library and to build and update the resource access table (RAT) so that CMRs can be processed as AFP resources.

The CMR installer takes a list of CMRs and uploads them to server resource libraries. In addition, the CMR installer builds a CMR resource access table (RAT) for the installed CMRs in a given library and adds this RAT to that library. The CMR RAT is identified with TBLtpe = X'03' (CMR RAT) in the RAT header. The CMR RAT contains an entry for each installed CMR. The general RAT syntax and semantics are defined in the *Mixed Object Document Content Architecture (MO:DCA) Reference*. Each RAT entry for a CMR maps the CMR resource name (CMR name) to the file name of the CMR, to the object OID with which the CMR may be captured by a printer, and optionally to other additional CMRs.

For generic CMRs, the CMR installer automatically builds a CMR RAT entry for each architected generic CMR name. This entry contains a pointer to a dummy generic CMR object, and specifies the object OID for the dummy generic CMR object.

The RAT used for CMRs is similar to the TrueType Font RAT, but is a separate table with filename AFP_ColorManagementResource.rat. The RAT entry for a referenced CMR is defined syntactically with a repeating group (RG). Each RG contains a length, a header, and one or more self-identifying table vectors (TVs) that specify processing information. The header specifies the object-type OID for CMRs and a set of flags that are unique to CMR RAT RGs. TVs are similar to MO:DCA triplets and are differentiated by their type. The following TVs are defined:

CMR Name TV

Specifies the CMR name that is used to reference the CMR. This name is used as an index into the RAT.

File Name TV

Specifies the file name with which the CMR is installed.

CMR OID TV

Specifies the CMR object OID with which the CMR can be captured by the printer. This OID is computed using an architected algorithm that includes an MD-5 checksum and that uniquely identifies the CMR. This algorithm is similar to the one used to calculate object OIDs for TrueType and OpenType fonts. The OID is based on the complete CMR, including the header and data field.

Mapped CMR TV

Specifies the CMR name of a CMR that is mapped to the referenced CMR; this TV may be specified multiple times. For CC CMRs, this TV may specify a mapped link CMR. For generic HT and TTC CMRs, this TV may specify a device-specific CMR of the same type that replaces the generic CMR when used for that device type and model. For all other CMRs, this TV is ignored.

The CMR RAT is indexed with a CMR name, which is matched against the table vector in each RG that specifies the CMR name. The RAT RG for a CMR is structured as shown in Table 4 and Table 5.

Table 4. CMR RAT repeating group header

Length (bytes)	Name	Description
2	RGLngth	Length of repeating group
1	Reserved	Should be set to zero
1	RGTpe	X'10' (RAT repeating group)
2	RGFlgs	Repeating group flags: <ul style="list-style-type: none"> • Bit 1: RG contains device-specific CMRs that are mapped to the CMR • Bit 2: indicates whether the CMR is private or public • Bit 3: indicates whether the CMR may be embedded in a print file level resource group • Bit 4: indicates whether the CMR may be captured or not • Bit 5: indicates whether the CMR was copied or extracted from an ICC profile embedded in a data object. This is only done if the profile flags indicate that the profile can be used independently of its parent data object. • Bit 7: indicates whether the CMR is normally used in audit mode; if yes, and if this is a CC CMR, causes generation and mapping of link CMRs to this CMR. This bit does <i>not</i> specify the processing mode for this CMR. • All other bits reserved
16	ObjTpe	Object-type OID that identifies resource as a CMR: X'06072B120004010139'

Table 5. CMR RAT repeating group table vectors (TVs)

TV Type	TV Content
CMR Name TV	CMR name
File Name TV	File name for CMR
CMR OID TV	Object ID for CMR
Mapped CMR TV	CMR name for mapped CMR; may be repeated

When the print server encounters a reference to a CMR that has been installed in a resource library, it accesses the RAT entry with the CMR name, the processing mode (audit or instruction), and the device type and model of the target output device, and processes the CMR. For information on processing CMRs using the CMR RAT, see “CMRs in a resource library” on page 35.

Notes:

1. The processing mode is specified in the context within which the CMR is associated with a document component. If a CMR is referenced for a document component in the data stream, the processing mode is specified in the data stream. If it is referenced for a data object in a data object RAT, it is specified in the RAT entry.
2. All color conversion CMRs, all indexed CMRs, and all link color conversion CMRs, are normally device-specific and their device type and model are specified as part of the CMR name. The only CMR types that can be specified as generic CMRs, identified with a fixed character pattern in the version field of the CMR name and with the absence of device-specific fields in the name, are tone transfer curves and halftones.

Chapter 4. Installing data objects using the AFP Resource Installer

The InfoPrint AFP Resource Installer also installs the actual data object resources, that is, color objects such as IOCA FS45s, TIFFs, and PDFs, that are to be presented on a page. This component of the Resource Installer is called the data object installer. From a color management perspective, this Installer also allows CMRs and rendering intents to be associated with the object being installed. *This association allows color management to be specified for, and applied to, data objects without changing the application that references the objects and without changing the objects.*

As part of the installation a data object RAT is built, which is identified with `TBLtpe = X'04'` (data object RAT) in the RAT header. The data object RAT contains an entry for each installed data object. The general RAT syntax and semantics are defined in the *Mixed Object Document Content Architecture (MO:DCA) Reference*. Each entry in this RAT maps the name of the object (which is also the name that is used to reference the object in the MO:DCA data stream) to the file name with which the object is stored and to the object OID with which the object may be captured in a printer.

This RAT entry may also optionally associate CMRs with the object and indicate how each CMR is to be processed: in audit mode or instruction mode. For example, a TIFF image may be associated with an audit CC CMR that ties the RGB colors in the TIFF to the ICC profile of the scanner that was used to create the TIFF. The RAT entry may also specify instruction CMRs, such as a tone transfer curve and a halftone, that are to be applied in the rendering process to optimize the output appearance of the TIFF. The corresponding CMR names are used by the print server to access the CMR RAT, and to process the CMRs in accordance with the rules for CMR RAT processing. Lastly, the RAT entry may specify a rendering intent that is to be used when the object is presented on an output device. This rendering intent selects the link CMR LUT that is used to render colors in the object.

CMRs that are mapped to a data object in the RAT become *secondary resources* of that data object. In order for these secondary resources to be processed, the data object must itself be mapped as a resource in the AEG of the page or overlay that includes the data object. This allows the print server to process the data object RAT entry while processing the AEG and thereby ensure that secondary resources, such as mapped CMRs, are downloaded to the presentation device before the device enters the page-build state. Data objects that are mapped as resources before being included on a page or overlay are sometimes called *hard* objects. Data objects that are not mapped as resources before being included on a page or overlay are sometimes called *soft* objects. Therefore, using that terminology, CMRs that are mapped to a data object in the RAT will only be processed for *hard* objects.

Note: Not all data objects can be mapped as a resource and processed as a hard object. IOCA objects and non-OCA objects such as EPS, PDF, TIFF, GIF, JFIF, PCL, and JP2 can be processed in this manner, but PTOCA, BCOCA, and AFP GOCA objects cannot.

The RAT used for data object resources is similar to the CMR RAT and the TrueType Font RAT but is a separate table with filename AFP_DataObjectResource.rat.

Some data object types support embedded ICC profiles. These object types are TIFF, JFIF, GIF, and EPS. When an object with embedded ICC profile is installed, the Installer can copy the ICC profile information into a CC CMR that is then associated with the object as an audit CC CMR. However, use of this function requires that the Use Profile Independently flag in the ICC header of the embedded profile be set to B'0', indicating that the profile may be used independently of the data object. Another option of the Installer, for the case where the profile may be used independently of the data object, is to actually extract the embedded profile from the object to generate a compacted version of the data object. This is controlled by the end-user, who also specifies whether to:

- Install only the original object
- Install only the compacted object, in which case the compacted object completely replaces the original object
- Install both the original object and the compacted object

If both are installed, the RAT entry for the original object points to the files for both the original object and the compacted object. It is recommended that for the compacted object, the file name is formed by prepending `iccr_` to the file name of the original object. If the compacted object has been installed, it is always used by the print server for performance reasons, because it can be significantly smaller in size than the original object. Note that when both are installed, the compacted object is only available for use in AFP systems because its file name is only specified in the RAT.

The RAT entry for a given data object is defined syntactically with a repeating group (RG). Each RG contains a length, a header, and one or more self-identifying table vectors (TVs) that specify processing information. The header specifies the object-type OID for the data object being installed and a set of flags that are unique to data object RAT RGs. The following TVs are defined:

Object Name TV

Specifies the object name with which the object is referenced in the data stream. This name is used as an index into the data object RAT.

File Name TV

Specifies the file name with which the data object is installed.

Object OID TV

Specifies the OID with which the object can be captured by a printer.

Compacted Object File Name TV

Specifies the file name with which the compacted object is installed.

Compacted Object OID TV

Specifies the OID with which the compacted object can be captured by a printer.

Rendering Intent TV

Specifies the rendering intent that is to be used to present the object or the compacted object.

CMR Name TV

Specifies a CMR that is to be associated with the object or the compacted object.

CMR Descriptor TV

Specifies whether the preceding CMR is to be processed as an audit or instruction CMR.

The data object RAT is indexed with an object name, which is matched against the table vector in each RG that specifies an object name. The RG for a data object is structured as shown in Table 6, Table 7, and Table 8 on page 20.

Table 6. Data object RAT repeating group header

Length (bytes)	Name	Description
2	RGLngth	Length of repeating group
1	Reserved	Should be set to zero
1	RGTpe	X'10' (RAT repeating group)
2	RGFlgs	Repeating group flags: <ul style="list-style-type: none">• Bit 1: RG contains CMRs that are to be associated with the data object• Bit 2: indicates whether data object is private or public• Bit 3: indicates whether data object may be embedded in a printfile-level resource group• Bit 4: indicates whether data object may be captured or not• Bit 5: indicates whether a compacted object has been generated• All other bits reserved
16	ObjTpe	Object-type OID that identifies the type of data object; see Table 7.

Table 7. Data object types for RAT repeating group

Object type	Object-type OID
IOCA FS10	X'06072B120004010105'
IOCA FS11	X'06072B12000401010B'
IOCA FS45	X'06072B12000401010C'
EPS	X'06072B12000401010D'
TIFF	X'06072B12000401010E'
GIF	X'06072B120004010116'
JFIF	X'06072B120004010117'
PDF single page	X'06072B120004010119'
PCL single page	X'06072B120004010122'
IOCA FS42	X'06072B12000401012D'
EPS with transparency	X'06072B120004010130'

Table 7. Data object types for RAT repeating group (continued)

Object type	Object-type OID
PDF with transparency	X'06072B120004010131'
IOCA FS40	X'06072B120004010137'
JPEG2000 (JP2)	X'06072B12000401013A'

Table 8. Data object RAT repeating group table vectors (TVs)

TV Type	TV Content
Object Name TV	Name of the data object
File Name TV	File name for data object
Object OID TV	Object ID for data object
Compacted Object File Name TV	File name for compacted data object
Compacted Object OID TV	Object OID for compacted data object
Rendering Intent TV	Rendering intent for data object
CMR Name TV	CMR name for CMR to be associated with this object; may be repeated
CMR Descriptor TV	Specifies the processing mode (audit or instruction) for the preceding CMR; may be repeated

The CMR Name TV and the CMR Descriptor TV must occur in pairs; multiple pairs are allowed in a RG. The CMR Descriptor TV specifies whether the preceding CMR is to be processed as an audit or instruction CMR. Similar information is carried in the CMR Descriptor (X'91') triplet when a CMR is referenced in the MO:DCA data stream. Note that, in order for the mapped CMRs to be processed with the data object, the object must be mapped as a resource in the AEG of the page or overlay that includes it.

Data objects can be installed without the data object installer. In that case, color management information can be specified for an object using a number of alternate methods:

- CMRs can be referenced in the OEG of the data object.
- CMRs can be referenced on the IOB that includes a data object. Such CMRs completely replace all CMRs that are referenced in the OEG of the data object; They also override any conflicting CMRs that are associated with the data object in the RAT.
- CMRs can be inherited by a data object in accordance with the architected hierarchy for CMR processing.
- Color management information may be embedded directly in the data object using syntax and semantics defined by the object. See the *Color Management Object Content Architecture (CMOCA) Reference*, S550-0511 for a description of how conflicts between embedded color management information and object-level CMRs are resolved.

Chapter 5. CMR engine (CMRE)

The CMR engine (CMRE) is an application that is called by the AFP Resource Installer and is used to generate CMRs. A version of the CMRE also runs directly in the presentation device.

The CMR installer can be configured to recognize a set of input devices, such as scanners and digital cameras, and a set of output devices such as printers. Part of the configuration information are ICC profiles for these devices, which can be entered from media such as CDs. Based on this configuration information, the CMR installer calls the CMRE to generate the following CMRs:

Color conversion (CC) CMRs

For input devices such as scanners and digital cameras, these CMRs define the conversion from the input color space to the ICC Profile Connection Space (PCS). For output devices such as printers, these CMRs define the conversion from PCS to the output color space (CMYK for printers, RGB for displays).

Link color conversion (LK) CMRs

For each CC CMR that has been assigned a Normally Used as Audit attribute, link color conversion CMRs are generated to tie this CC CMR to the CC CMRs of all output devices configured to the CMR installer.

The CMR installer also calls the CMRE to generate the following CMRs based on user input data:

- Halftone (HT) CMRs
- Tone transfer curve (TTC) CMRs
- Indexed (IX) CMRs

Note that the CMR installer does not call the CMRE to generate generic CMRs. The valid set of generic CMRs, as defined by and registered in CMOCA, are automatically installed by the installer.

Chapter 6. Link color conversion CMRs

The basis for color management is the use of ICC profiles in color conversion CMRs to define device-specific colors, or, more precisely to tie device-specific colors to the ICC profile connection space (PCS), which is CIELAB or CIEXYZ. An audit color conversion CMR defines how the input color, such as the RGB in a scanned TIFF, is related to the PCS. An instruction color conversion CMR defines how the output color, such as the CMYK rendered on an InfoPrint Color 130+, is related to the PCS. Therefore, for example, to convert from TIFF RGB to the InfoPrint Color 130+ CMYK one

1. Converts the RGB to the PCS using the scanner's ICC profile
2. Converts the PCS to CMYK using the InfoPrint Color 130+ ICC profile

Both operations are processing-intensive and can adversely affect performance in a high-speed printing system, especially when they need to be applied to every image point in a raster image. A goal of AFP color management is to avoid these two operations by generating and using a link color conversion CMR that links the input and output color spaces directly using look-up tables (LUTs), and by managing these link CMRs using AFP resource management to avoid unnecessary repetitive downloading. Each LK CMR effectively contains four LUTs corresponding to the four possible rendering intents. Using standard AFP resource management processing, both the color conversion CMRs and the link color conversion CMRs can be captured by the presentation device to avoid repeated downloading of these resources.

Link color conversion structure

Link color conversion CMRs link two color spaces by linking their corresponding CC CMRs. More specifically, LK CMRs tie together two CC CMRs, an audit CC CMR that defines the input color space, and an instruction CC CMR that defines the output color space, using their respective identifiers. These identifiers can be specified in two ways:

- Using a CMR name, which is used in the MO:DCA data stream and in the CMR RAT and data object RAT to reference the CMR
- Using an object OID, which is used by the server and presentation device to manage CMR capture

While the CMR name *should* be unique, the object OID *is* unique because of the algorithm with which it is constructed, which includes an MD-5 checksum of the complete CMR. The likelihood of two CMRs that differ by as little as one bit having the same MD-5 checksum is extremely small.

Both identifiers, name and OID, for each color conversion CMR are specified in the link CMR, but only the object OIDs are used to process a LK CMR. The names are only used for informational purposes. Therefore, when a presentation device is ready to render a color in the presentation data, it uses the object OID of the current audit CMR and the object OID of the current instruction CMR to search for a LK CMR that specifies matching CMR object OIDs.

Generating link color conversion CMRs during CMR installation

When a color conversion CMR is installed or generated using the CMR installer, a flag bit in the CMR RAT RG specifies whether this CMR is normally used as an audit CMR. For example, if the CMR defines the relationship between an input color space, such as RGB, and the profile connection space (PCS), it can and probably will be referenced as an audit CMR. This flag bit signals the CMR installer to call the CMRE to generate link color conversions that tie the new CC CMR to the CC CMRs of all target output devices that are configured to the installer and that are to be used on the target print servers.

For example, assume that the CMR installer installs a CC CMR for an RGB scanner in a z/OS[®] resource library. Note that the installer can generate this CMR based on the ICC profile of the scanner or based on an audit-like ICC profile embedded in a data object. The installer now searches a list of target output devices configured to the installer for use on the z/OS system. As part of the configuration process, a CC CMR based on the ICC profile of the device has already been installed for each output device. Next, the installer calls the CMRE to generate LK CMRs that convert the scanner RGB to each target output device color space (CMYK if it is a printer). These link CMRs are then mapped to the scanner CC CMR in the CMR RAT RG. Note that each target device can have multiple CC CMRs for different media.

Example

The following example illustrates in more detail how link color conversions are generated and used by the presentation system:

1. A color printer in the system is configured to the CMR installer as an output device using its ICC profile, which is read from a product CD, as well as other device information. The CMRE that runs on the installer is called to generate a CC CMR, with object OID (o), for the printer. This CMR is then installed in the server resource library and an entry is created in the CMR RAT. This same CC CMR, with the same object OID, is shipped with the printer as its default instruction CC CMR.
2. A scanner in the system is used to generate TIFF images with RGB color. This scanner is configured to the CMR installer as an input device using its ICC profile, which is read from its product CD, as well as other device information. The CMRE that runs on the installer is called to generate a CC CMR, with object OID (i) for the scanner; this CMR is then installed in the server resource library and an entry is created in the CMR RAT. Because the CMR relates the scanner's RGB to PCS, the installer sets the flag bit in the CMR RAT RG that indicates that this CMR is normally used as an audit CMR.
3. When the scanner's CC CMR is installed, the CMRE is called to generate a LK CMR that ties the scanner's CC CMR with object OID (i) to the printer's CC CMR with object OID (o). The installer then maps this link CMR to the scanner's CC CMR in the CMR RAT.
4. An AFP print file is now generated with many TIFFs created by the same scanner. (Assume that the only RGB colors in the print file are specified in these TIFFs.) The CMR for that scanner, with object OID (i), is associated with the print file as an audit CMR in the form definition by the job submitter. This tells the system that all device RGB for the print file is defined by that scanner CC CMR (unless overridden by other CC CMRs in the hierarchy). The form definition also specifies a rendering intent for the print file, for example, *perceptual*. The print file is submitted to the color printer that has a default instruction CMR with object OID (o).

5. When the server starts to process the print file, it resolves the form definition reference to the scanner CC CMR by locating this CMR in the CMR RAT. It sends this CMR to the printer, if necessary, and invokes the CMR. Because the RAT also specifies a mapped link CMR, it also sends the link CMR, if necessary, and activates it.
6. When the printer encounters the RGB in the TIFF, it looks in its hierarchy for an audit CC CMR that defines the RGB, and finds the CC CMR with object OID (i). It then looks in its hierarchy for an instruction CC CMR that defines the CMYK. Because no instruction CC CMR was specified (the normal case), the printer finds its default CC CMR with object OID (o). The printer then examines its storage of link CMRs to see if there is a LK CMR that ties an audit CC CMR with object OID (i) to an instruction CC CMR with object OID (o). Because the link CMR that ties together these two CMRs, based on their object OIDs, was previously sent by the server, it is used for the color conversion from RGB to CMYK. Finally, the rendering intent from the form definition is used to select one of the four LUTs in the link CMR for the actual color conversion.

Generating link color conversion CMRs in the presentation device

When the presentation device needs to convert from an input color space in the presentation data, identified by an audit color conversion CMR, to its output color space, identified by an instruction color conversion CMR, it searches its storage of link color conversion CMRs for a link CMR that maps the object OID of the audit color conversion CMR to the object OID of the instruction color conversion CMR. If no such link CMR is found, the presentation device calls its CMRE to generate the appropriate link CMR, activates it and, along with the current rendering intent, uses it to perform the color conversion. Note that the device can also capture this link CMR using the object OID of the link CMR. Because support of downloaded link CMRs is optional, some output devices might always generate link CMRs in this fashion.

Generating link color conversion CMRs based on embedded color management information

Some data objects contain embedded color management information that is specified using syntax defined by the object. An example is an embedded audit-like ICC profile in a TIFF object that ties the TIFF RGB to the ICC profile connection space (PCS). Such information is used by the presentation device when the object is rendered if there is no audit CC CMR associated with the object.

Using an embedded ICC profile can reduce performance if there is no pre-built LK CMR that converts the input color space in the object to the output color space of the target presentation device. A link CMR can be pre-built for such objects if they are installed using the new data object installer and if the embedded profile has been copied or extracted into a CC CMR that is associated with the object as an audit CC CMR. For more information, see Chapter 4, “Installing data objects using the AFP Resource Installer,” on page 17. When this CC CMR is installed, the CMRE is called to generate LK CMRs that convert the input color space defined by this CMR to the output color spaces of the target devices on that system, and to map these link CMRs to the installed CC CMR, as described in “Generating link color conversion CMRs during CMR installation” on page 24.

Based on this processing, when the object with embedded profile is referenced in the data stream, the server sees the associated CMR in the data object RAT and

downloads, if necessary, both the audit color conversion CMR and the link color conversion CMRs. When the presentation device processes the object with this audit CC CMR, it searches for and finds the correct link CMR.

Chapter 7. Color management resources in the MO:DCA-P (AFP) data stream

This chapter describes:

- How Mixed Object Document Content Architecture (MO:DCA) document components can be associated with CMRs or contain embedded color management information
- The structured fields used to reference CMRs in the MO:DCA data stream
- How the print server locates and processes CMR resources in a resource library or a print file level resource group

Associating a CMR with a MO:DCA document component

A CMR can be associated with a MO:DCA document component at the following levels of the document hierarchy:

- Print file (highest level).
- Document.
- Group of pages or sheets.
- Page or overlay.
- Data object (lowest level). At this level, color management information may be specified in two ways:
 - With CMRs associated with the object.
 - With color management information that is embedded in the object. Conflicts between embedded color management information and object-level CMRs are resolved based on rules defined in the *Color Management Object Content Architecture (CMOCA) Reference*.

Normal MO:DCA hierarchy rules apply. That is, CMRs specified for a document component at a low level of the hierarchy override, for that level only, conflicting CMRs specified for a document component at a higher level. For example, CMRs specified at the data-object level override CMRs specified at the page or overlay level.

CMRs at the print-file level

A CMR can be associated with a print file using the form definition that is specified for the print file by the job submitter. This is done by referencing the CMR in the form definition's Document Environment Group (DEG) using a Map Data Resource (MDR) structured field. The CMR Descriptor (X'91') triplet specifies that the scope of the CMR is a print file. Multiple CMR types can be associated with a print file. They are processed in a manner dictated by the CMR type and the processing mode (audit or instruction), which is specified with a CMR Descriptor triplet on the MDR. For example, if a CC CMR for the InfoPrint Color 130+ is associated as an audit CC CMR with a print file, all CMYK colors specified in the print file should be interpreted as InfoPrint Color 130+ CMYK, unless overridden by other audit CC CMRs lower in the hierarchy. Rendering such colors on a different device requires converting the InfoPrint Color 130+ CMYK to the target device CMYK.

CMRs at the document level

A CMR can be associated with a specific document in the print file in the same manner that it is associated with the print file: using a MDR in the DEG of the form definition that is specified for the print file. In this case, the MDR also points to the specific document in the print file. This is done in a manner that is similar to how finishing is specified for a specific document in the print file. That is, an Object Offset (X'5A') triplet is specified on the MDR that references the CMR. This triplet, using ObjTpe = X'A8' (document), specifies the offset of the selected document, in documents, from the beginning of the print file. For example, to associate the CMR with the third document, the triplet should specify an offset of 2. The CMR Descriptor (X'91') triplet specifies that the scope of the CMR is a document. Multiple CMR types can be associated with a document. They are processed in a manner dictated by the CMR type and the processing mode (audit or instruction), which is specified with a CMR Descriptor triplet on the MDR. In case of a conflict with CMRs specified at the print-file level, the document CMRs override for that specific document.

CMRs at the page-group or sheet-group level

A CMR can be associated with a group of pages or sheets in a document using the medium map that is invoked for that group of pages. This is done by referencing the CMR with a MDR in the medium map. Multiple CMRs can be associated with a group of pages or sheets. They are processed in a manner dictated by the CMR type and the processing mode (audit or instruction), which is specified with a CMR Descriptor triplet on the MDR. The CMR Descriptor (X'91') triplet also specifies that the scope of the CMR is a group of pages or sheets. In case of a conflict with CMRs specified at the document or print file level, the page or sheet group level CMRs override for that specific group of pages or sheets.

CMRs at the page or overlay level

A CMR can be associated with a page or overlay by referencing it with a MDR in the Active Environment Group (AEG) for the page or overlay. Multiple CMR types can be associated with a page or overlay. They are processed in a manner dictated by the CMR type and the processing mode (audit or instruction), which is specified with a CMR Descriptor triplet on the MDR. The CMR Descriptor (X'91') triplet also specifies that the scope of the CMR is the page or overlay, to differentiate this CMR reference from a CMR reference that is factored up from the OEG of a data object or from an IOB. In case of a conflict with CMRs specified at the page-group, sheet-group, document, or print-file level, the page or overlay CMRs override for that specific page or overlay.

CMRs at the data-object level

A CMR can be associated with a data object such as an IOCA, EPS, PDF, TIFF, GIF, or JFIF object in multiple ways:

- If the data object is installed with the data object installer, CMRs can be associated with the data object using the data object RAT entry that is built for the object. In this case the data object itself is not changed and can be installed in its native, unaltered format. Each CMR is associated with the data object by a CMR name Table Vector (TV) and CMR Descriptor TV pair. The CMR name TV points to the CMR, and the CMR Descriptor TV specifies whether the CMR is to be processed as an audit or instruction CMR. Note that, in order for the mapped CMRs to be processed with the data object, the object must be mapped as a resource in the AEG of the page or overlay that includes it.

- If the data object is included on a page with an IOB, a CMR may be associated with the object to be included in a manner similar to the manner in which resident SWOP or Euroscale color profiles can be associated with an EPS or PDF or that PDF resources can be associated with a PDF. That is, the CMR must first be referenced with an MDR in the AEG for the page. Then on the IOB, the CMR is referenced with an FQN type X'DE' triplet, followed immediately by a CMR Descriptor triplet that specifies the processing mode and indicates that the CMR scope is the data object. Note that CMRs specified on the IOB completely replace all CMRs specified in the OEG of the included data object; the CMR references in the OEG are ignored when the object is included with an IOB. A CMR specified on an IOB also overrides any conflicting CMR that is associated with the object, for example, a CMR specified in the data object RAT.
- If the data object is included directly on a page, the object may reference a CMR with an MDR in its OEG. The MDR must also specify a CMR Descriptor (X'91') triplet that specifies the processing mode (audit or instruction) and indicates that the CMR scope is the data object. Note that when a CMR is referenced in the OEG, the same CMR must also be referenced with an MDR in the AEG of the page or overlay for resource management.
- The data object itself may contain embedded color management information. An example is an embedded audit-like ICC profile in a TIFF object. Such information is used in conjunction with CMRs that may also be applicable to the data object. Conflicts between embedded color management information and object-level CMRs are resolved based on rules defined in the *Color Management Object Content Architecture (CMOCA) Reference*. Note that such an embedded profile may be copied into a CC CMR that is associated with the object; see Chapter 6, "Link color conversion CMRs," on page 23.

In case of a conflict with CMRs specified at the page, overlay, page-group, sheet-group, document, or print-file level, the object-level CMRs override for that specific data object.

Note that there is no method to explicitly associate a CMR with a page segment object. However, CMRs can be associated with the data objects in a page segment, or they can be associated with the page/overlay that contains the page segment.

CMR association and scope

CMRs are associated with a document component *implicitly*. That is, that document component does not call out the associated CMRs directly.

- At the print-file level, a CMR is associated by referencing the CMR in a MDR in the DEG for the form definition. The CMR applies to all documents in the print file.
- At the document level, the CMR is associated by referencing the CMR in a MDR in the DEG for the form definition, and by pointing to the specific document in the print file. The CMR then applies only to that document.
- At the page-group or sheet-group group level, the CMR is associated by referencing the CMR with a MDR in the invoked medium map. The CMR applies to all pages or sheets processed with that medium map.
- At the page or overlay level, the CMR is associated by referencing the CMR in a MDR in the AEG for that page or overlay. The CMR applies only to that page or overlay.
- At the data-object level, the CMR is associated with a data object in any of the following ways:
 - By referencing the CMR in the RAT entry for the object in a data object RAT

- By referencing the CMR on the IOB that is used to include the data object
- By referencing the CMR on the PPO that is used to preprocess the data object
- By referencing the CMR with a MDR in the Object Environment Group (OEG) of the data object

In general, when a CMR is associated implicitly with a document component, the scope of the CMR is the complete document component, unless noted otherwise.

Resident SWOP or Euroscale color profiles are examples of color management resources that are associated implicitly with an EPS or PDF object. They are not called out directly within the object. Their scope is the complete EPS or PDF object with which they are associated.

CMR processing mode

The processing mode determines how a CMR is used in the presentation system. The *audit* processing mode indicates that the CMR defines an operation that has been done on a document component. For example, an audit CC CMR defines the device color that was used to generate the presentation data. It does that by defining the relationship between the input device color space (often called the *input* color space) and PCS. An audit HT CMR defines the halftone that was used to create the data. An audit TTC CMR defines a tone adjustment that was applied to a color component before the halftone was applied to that component.

The *instruction* processing mode indicates, in a similar manner, that the CMR defines an operation that is to be done on a document component. For example, an instruction CC CMR defines the relationship between PCS and the output device color space (often called the *output* color space). An instruction TTC CMR defines a tone adjustment that is to be applied to a color component before it is halftoned. An instruction HT CMR defines the halftone that is to be applied to the color component. An instruction IX CMR defines the mapping of indexed colors in a document component to output device colors.

Audit and instruction processing modes are specified when a CMR is associated with a document component. For print files, documents, page or sheet groups, pages, and overlays, the processing mode is specified with the CMR Descriptor triplet on the MDR. For data objects, the processing mode can be specified in multiple ways:

- With a CMR Descriptor triplet on the MDR in the OEG for the object
- With a CMR Descriptor triplet on the IOB that includes the object
- With a CMR Descriptor triplet on the PPO that is used to preprocess the object
- With a CMR Descriptor table vector (TV) in the data object RAT entry for the object

IX CMRs should be processed as instruction CMRs. IX CMRs that are to be processed as audit CMRs are ignored by the output device.

The *link* processing mode is valid only with LK CMRs. Such CMRs are not associated directly with a document component. Instead, link CMRs are associated with, or mapped to, CC CMRs either in the CMR RAT entry, or, for CC CMRs in print file level resource groups, on the Begin Resource (BRS) structured field that wraps the container of the CMR.

CMR inheritance rules

The interaction of CMRs at different levels of the document hierarchy follows MO:DCA hierarchy and state rules. When a CMR is associated with a document component at a given level, it replaces (for that level or state only) any conflicting CMR that is associated with a document component at a higher level. For example, if audit color conversion CMR (x) is associated with the print file, and audit color conversion CMR (y) is associated with a data object on a page in a document in that print file, audit color conversion CMR (y) is used as the active audit color conversion CMR for the duration of the data object processing, or the duration of the object state. When the object state is terminated, audit color conversion CMR (x) again becomes the active audit color conversion CMR.

Note that this CMR replacement rule applies only to conflicts. In the above example, if CMR (x) converts device RGB to PCS and CMR (y) converts device CMYK to PCS, the CMRs do not conflict. Both can be used to process RGB and CMYK colors in the data object.

Generic CMR processing

Halftone CMRs and tone transfer curve CMRs can be specified in a generic sense to request an intended output appearance. Such CMRs are called *generic* CMRs. They are identified with a fixed character pattern of *generic* (encoded in UTF-16BE) in the version field of the CMR name. Generic HT and TTC CMRs should be referenced as instruction CMRs. Generic HT and TTC audit CMRs are ignored by the output device. Generic CMRs are processed as follows:

- A server processes a reference to a generic instruction CMR in the same manner that it processes a reference to a device-specific CMR, with one exception. Because the CMR is generic, the server checks whether device-specific CMRs that match the device type and model of the target printer have been mapped to the generic CMR in the CMR RAT. If yes, the device-specific CMRs are used instead. Note that this mapping could occur inline as well by placing the generic CMR in an inline resource group and referencing device-specific CMR replacements that match the device type and model of the target printer on the BRS of the container. If no matching device-specific CMR is mapped to the generic CMR either inline or in the CMR RAT, the server downloads (if necessary), activates, and invokes the generic CMR.
- The printer processes the CMR hierarchy in the normal manner, with one exception. If the active instruction halftone CMR or TTC CMR is a generic CMR, the printer substitutes an appropriate version of a device-specific default CMR.

Default CMRs

When the presentation device requires color management information to render presentation data but no CMRs have been associated with the data, default CMRs are used. For a definition of these defaults, see the *Color Management Object Content Architecture (CMOCA) Reference*, S550-0511.

CMR exception processing

A CMR exception is detected when a CMR that has been referenced in the data stream (which includes FormDefs and Medium Maps) or a data object RAT cannot be processed as specified. For example, a FormDef may reference a device-specific instruction TTC CMR, but the output device does not support downloaded TTC CMRs. The processing of such exceptions is controlled by the Color Fidelity (X'75') triplet.

The above does not apply to CMRs that are *mapped* to referenced CMRs but that are themselves not directly referenced in the data stream or a data object RAT. This includes:

- Link CMRs that are mapped to color conversion CMRs in a CMR RAT or on the BRS of an inline CMR
- Device-specific halftone and tone transfer curve CMRs that are mapped to generic CMRs in a CMR RAT or on the BRS of an inline CMR

The processing of such mapped CMRs is not governed by the Color Fidelity triplet. If a device does not support the download of such a mapped CMR, it does not cause a CMR exception and the mapped CMR is ignored.

A CMR *tag* exception is detected when an unsupported CMR tag is encountered in a CMR. The processing of such exceptions is controlled by the CMR Tag Fidelity (X'96') triplet.

CMR references in the MO:DCA-P data stream

A CMR is referenced in the MO:DCA-P data stream using the FQN type X'DE' (Data Object External Resource Reference) triplet on the MDR, IOB, and PPO structured fields. The triplet must be specified using FQNFmt X'00' (character string). The name must match the CMR name that is specified in the CMR header. The encoding of the name is specified in the Coded Graphic Character Set Global Identifier (X'01') triplet, which must precede the FQN type X'DE' triplet. The CMR name has a fixed length of 73 characters. Therefore, the length of the encoded string is fixed to 73 characters (146 bytes if encoded in UTF-16BE).

The CMR reference always requires a CMR Descriptor (X'91') triplet. This triplet specifies the processing mode for the CMR (audit or instruction), and the scope of the CMR. Table 9 shows the format of the CMR Descriptor triplet.

Table 9. CMR Descriptor (X'91') triplet

Length (bytes)	Name	Description
1	Tlength	Length of triplet
1	Tid	Triplet ID
1	Reserved	Should be set to zero
1	ProcMode	Specifies CMR processing mode: <ul style="list-style-type: none"> • X'01' = audit • X'02' = instruction
1	CMRScpe	Scope of CMR: <ul style="list-style-type: none"> • X'01' = data object • X'02' = page or overlay • X'03' = document • X'04' = print file • X'05' = page or sheet group

CMR reference using the MDR structured field

Table 10 on page 33 shows the CMR-related triplets that can be specified on a Map Data Resource (MDR) repeating group for a CMR reference in the Document Environment Group (DEG) of a form definition, a medium map, the Active

Environment Group (AEG) of a page or overlay, or the Object Environment Group (OEG) of a data object.

Table 10. MDR triplets

Parameter	Triplet
CMR name	Fully Qualified Name (X'02') type X'DE' (Data Object External Resource Reference) triplet; mandatory, must be specified once
Encoding of CMR name	Coded Graphic Character Set Global Identifier (X'01') triplet; optional and may be specified more than once, but must occur before triplets that use the encoding, such as the FQN type X'DE' triplet
Characterization of the object being referenced	Object Classification (X'10') triplet; mandatory, must be specified once and must specify object-type OID = X'06072B120004010139' (Color Management Resource)
CMR descriptive information	Color Management Resource Descriptor (X'91') triplet; mandatory and must be specified once.
For a CMR that is to be associated with a specific document in the print file, the offset of the document in the print file	Object Offset (X'5A') triplet, with ObjTpe = X'A8' (offset counted in number of documents); allowed only on MDRs that are specified in the DEG of a form definition

CMR reference using the IOB structured field

Table 11 shows the CMR-related triplets that can be specified for a CMR reference on the Include Object (IOB) structured field that includes a data object on a page or overlay.

Table 11. IOB triplets

Parameter	Triplet
CMR name	Fully Qualified Name (X'02') type X'DE' (Data Object External Resource Reference) triplet; optional, may be specified more than once
Encoding of CMR name	Coded Graphic Character Set Global Identifier (X'01') triplet; optional and may be specified multiple times, but must occur before triplets that use the encoding, such as the FQN type X'DE' triplet
CMR descriptive information	Color Management Resource Descriptor (X'91') triplet; mandatory and must be specified directly after the FQN type X'DE' triplet.

CMR reference using the PPO structured field

Table 12 on page 34 shows the CMR-related triplets that can be specified for a CMR reference on the Preprocess Presentation Object (PPO) structured field that specifies parameters used to preprocess a data object.

Table 12. PPO triplets

Parameter	Triplet
CMR name	Fully Qualified Name (X'02') type X'DE' (Data Object External Resource Reference) triplet; optional, may be specified more than once
Encoding of CMR name	Coded Graphic Character Set Global Identifier (X'01') triplet; optional and may be specified multiple times, but must occur before triplets that use the encoding, such as the FQN type X'DE' triplet
CMR descriptive information	Color Management Resource Descriptor (X'91') triplet; mandatory and must be specified directly after the FQN type X'DE' triplet

CMR reference in a Resource Environment Group (REG)

The Resource Environment Group (REG) is used to identify large, recurring resources that are to be preloaded to the presentation device before the pages that require these resources are processed. A CMR can be preloaded by referencing it with a MDR structured field in the REG. Such a MDR must also specify the CMR Descriptor (X'91') triplet. In that case the processing mode, as specified in the CMR Descriptor, is downloaded along with the CMR and is used by the presentation device. However, the CMR scope, which is also specified in the CMR Descriptor, is ignored and must be established in an ensuing mapping of the same CMR with the same processing mode at the group of pages/sheets (medium-map) level, page or overlay level, or data-object level.

CMR reference by data object in a resource group

A data object such as an IOCA object or a TIFF object may be carried as a resource object in a print file-level resource group. Such objects are said to be *inline*. These objects are always enveloped by Begin Resource (BRS) and End Resource (ERS) structured fields. In the case of an IOCA object, the BRS is followed by Begin Image Object (BIM) and an OEG, followed by the object data. In the case of a non-OCA object like TIFF, the BRS is followed by Begin Object Container (BOC), which is normally followed directly by the Object Container Data (OCD) structured fields that carry the actual object data. The only way to include these data objects directly on a page or overlay is with an IOB. *All CMRs that are to be associated with these data objects must be specified on the IOB with the triplets described in "CMR reference using the IOB structured field" on page 33.* The IOB CMR references (or lack thereof) override any CMR references that are specified on MDRs in the OEG for the data object. Another way to state this is that all CMR references on MDRs in the OEGs of inline data objects are ignored and are replaced by the CMR invocations (or lack thereof) on the IOB that includes the data object on a page or overlay.

CMR location and processing

CMRs can be located either in resource libraries or in resource groups at the print-file level. In the latter case they are said to be *inline*. CMRs in resource libraries are installed without any MO:DCA wrappers using the CMR installer, and must be processed using the CMR RAT for the library. CMRs in resource groups must be wrapped in accordance with MO:DCA rules for inline resources: the CMR

is wrapped with BOC/EOC, and this container in turn is wrapped with BRS/ERS. When a CMR reference is processed in the data stream, the resource group is always searched first by looking for a match on the resource name on the BRS.

CMRs in a resource library

When CMRs are located in a resource library, they must be accessed using the CMR RAT for that library. The CMR name is used to index the RAT, and the RAT repeating group (RG) for that CMR name provides all of the information required by the server to find and process the CMR as shown in Table 13. The RAT RG maps the CMR name directly to a file name and an object OID, and it may also optionally map the CMR name to additional CMRs.

Notes:

1. The processing mode is specified in the context within which the CMR is associated with a document component. If a CMR is referenced for a document component in the data stream, the processing mode is specified in the data stream. If it is referenced for a data object in a data object RAT, it is specified in the RAT entry.
2. All color conversion CMRs, all indexed CMRs, and all link color conversion CMRs, are normally device-specific and their device type and model are specified as part of the CMR name. The only CMR types that can be specified as generic CMRs, identified with a fixed character pattern in the version field of the CMR name and with the absence of device-specific fields in the name, are tone transfer curves and halftones.

Table 13. How the print server processes CMRs in resource libraries

CMR type	Processing mode	Device-specific or generic	Processing
Color conversion	Audit or instruction	Device-specific	The referenced CMR is downloaded, if necessary, and activated. If the target device supports downloaded link CMRs, all LK CMRs that are mapped to the referenced CMR and that match the target device type and model are downloaded, if necessary, and activated. All other mapped CMRs are ignored.
Halftone	Audit	Device-specific	If the target device supports downloaded HT CMRs, the referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Halftone	Audit	Generic	The referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Halftone	Instruction	Device-specific	If the target device supports downloaded HT CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.

Table 13. How the print server processes CMRs in resource libraries (continued)

CMR type	Processing mode	Device-specific or generic	Processing
Halftone	Instruction	Generic	If the target device supports downloaded HT CMRs, all mapped device-specific HT CMRs that match the device type and model of the target output device are downloaded, if necessary, and activated. These CMRs replace the referenced generic CMR. Otherwise, the generic CMR is downloaded, if necessary, activated, and replaced by the output device with a device-specific HT CMR.
Tone transfer curve	Audit	Device-specific	If the target device supports downloaded TTC CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.
Tone transfer curve	Audit	Generic	The referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Tone transfer curve	Instruction	Device-specific	If the target device supports downloaded TTC CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.
Tone transfer curve	Instruction	Generic	If the target device supports downloaded TTC CMRs, all mapped device-specific TTC CMRs that match the device type and model of the target output device are downloaded, if necessary, and activated. These CMRs replace the referenced generic CMR. Otherwise, the generic CMR is downloaded, if necessary, activated, and replaced by the output device with a device-specific TTC CMR.
Indexed	Audit	Device-specific	If the target device supports downloaded IX CMRs, the referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Indexed	Instruction	Device-specific	If the target device supports downloaded IX CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.

CMRs in a resource group at the print-file level

CMRs may also be carried in the resource group for a print file, in which case they are called *inline* CMRs. The CMR must first be wrapped in a BOC/EOC object container, which in turn must be wrapped in a BRS/ERS resource envelope. The BRS specifies the CMR name, encoded in UTF-16BE, with a FQN type X'01' triplet. If the CMR in the container is a color conversion (CC) CMR, the BRS may also specify the names of link color conversion CMRs, also encoded in UTF-16BE, that are mapped to the CMR using FQN type X'41' (CMR Reference) triplets. If the CMR in the container is a generic HT or TTC CMR, the BRS may also specify device-specific CMR replacements for the generic CMR using the FQN type X'41' triplets. When resolving a CMR reference in the data stream, the print server must always search the print-file resource group, if one exists, first. The CMR name is matched against the CMR name that is specified on the BRS of the resource container. If no match is found, the search continues with the CMR RAT.

If a match is found, the inline CMR is processed as shown in Table 14.

Table 14. How the print server processes inline CMRs

CMR type	Processing mode	Device-specific or generic	Processing
Color conversion	Audit or instruction	Device-specific	The inline CMR is downloaded, if necessary, and activated. If the target device supports downloaded link CMRs, all LK CMRs that are mapped to the referenced CMR with a FQN type X'41' triplet on the BRS and that match the target device type and model are downloaded, if necessary, and activated. All other mapped CMRs are ignored.
Halftone	Audit	Device-specific	If the target device supports downloaded HT CMRs, the inline CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Halftone	Audit	Generic	The inline CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Halftone	Instruction	Device-specific	If the target device supports downloaded HT CMRs, the inline CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.

Table 14. How the print server processes inline CMRs (continued)

CMR type	Processing mode	Device-specific or generic	Processing
Halftone	Instruction	Generic	<p>If the target device supports downloaded HT CMRs, and if the BRS references device-specific HT CMRs that match the device type and model of the target device, these CMRs are downloaded, if necessary, and activated. These CMRs replace the inline generic CMR. Otherwise, the search continues with the CMR RAT.</p> <p>If a matching generic CMR RAT entry is found, and if the target device supports downloaded HT CMRs, all mapped device-specific CMRs that match the device type and model of the target device are downloaded, if necessary, and activated. These CMRs replace the inline generic CMR. Otherwise, the inline generic CMR is downloaded, if necessary, activated, and replaced by the output device with a device-specific HT CMR.</p>
Tone transfer curve	Audit	Device-specific	If the target device supports downloaded TTC CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.
Tone transfer curve	Audit	Generic	The referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Tone transfer curve	Instruction	Device-specific	If the target device supports downloaded TTC CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.

Table 14. How the print server processes inline CMRs (continued)

CMR type	Processing mode	Device-specific or generic	Processing
Tone transfer curve	Instruction	Generic	<p>If the target device supports downloaded TTC CMRs, and if the BRS references device-specific TTC CMRs that match the device type and model of the target device, these CMRs are downloaded, if necessary, and activated. These CMRs replace the inline generic CMR. Otherwise, the search continues with the CMR RAT.</p> <p>If a matching generic CMR RAT entry is found, and if the target device supports downloaded TTC CMRs, all mapped device-specific CMRs that match the device type and model of the target device are downloaded, if necessary, and activated. These CMRs replace the inline generic CMR. Otherwise, the inline generic CMR is downloaded, if necessary, activated, and replaced by the output device with a device-specific TTC CMR.</p>
Indexed	Audit	Device-specific	If the target device supports downloaded IX CMRs, the referenced CMR can be downloaded and activated, but the target device ignores it. All mapped CMRs are also ignored.
Indexed	Instruction	Device-specific	If the target device supports downloaded IX CMRs, the referenced CMR is downloaded, if necessary, and activated. All mapped CMRs are ignored.

Table 15 shows the triplets that can be specified on the BRS for an inline CMR.

Table 15. BRS triplets

Parameter	Triplet
CMR name	Fully Qualified Name (X'02') type X'01' (Replace First GID Name) triplet; mandatory, must be specified once with FQNFmt = X'00' (character string). This triplet carries the name of the CMR and is used by the server to match the CMR reference in the data stream. The encoding is fixed as UTF-16BE, to match the encoding when the target of the data stream reference is the CMR RAT.
Characterization of the resource enveloped by the BRS/ERS	Retired Resource Object Type (X'21') triplet; mandatory, must be specified once with ObjType = X'92' (object container).

Table 15. BRS triplets (continued)

Parameter	Triplet
Characterization of the object in the BOC/EOC container	Object Classification (X'10') triplet; mandatory, must be specified once and must specify object-type OID = X'06072B120004010139' (color management resource)
Encoding of character data on the BRS	Coded Graphic Character Set Global Identifier (X'01') triplet; optional because the encoding for the CMR name is fixed as UTF-16BE.
Name of CMR that is mapped to the inline CMR in the container	Fully Qualified Name (X'02') type X'41' (Color Management Resource Reference) triplet; optional, may be specified more than once if the CMR in the container is a CC CMR or a generic HT or TTC CMR. Must be specified using FQNFmt = X'00' (character string). The encoding is fixed as UTF-16BE.

The BOC/EOC container carries the actual CMR that is used to satisfy the CMR reference in the data stream. Table 16 shows the triplets that can be specified on the BOC for an inline CMR.

Table 16. BOC triplets

Parameter	Triplet
CMR identifier	Fully Qualified Name (X'02') type X'01' (Replace First GID Name) triplet; optional, may be specified once in one of the following formats: <ul style="list-style-type: none"> • With FQNFmt = X'00', to specify the CMR name, encoded in UTF-16BE. This is not really needed on the BOC because the print server uses the BRS triplet to identify the CMR. • With FQNFmt = X'10' (OID), to specify the object OID of the CMR. This allows the server to use a device-captured version of the CMR and to search for a link CMR.
Characterization of the object in the BOC/EOC container	Object Classification (X'10') triplet; mandatory, must be specified once and must specify object-type OID = X'06072B120004010139' (Color Management Resource).
Encoding of character data on the BOC	Coded Graphic Character Set Global Identifier (X'01') triplet; optional because the encoding for the CMR name is fixed as UTF-16BE.

Table 16. BOC triplets (continued)

Parameter	Triplet
Name of CMR that is mapped to the inline CMR in the container	Fully Qualified Name (X'02') type X'41' (Color Management Resource Reference) triplet; optional, may be specified more than once if the CMR in the container is a CC CMR or a generic HT or TTC CMR. Must be specified using FQNFmt = X'00' (character string). The encoding is fixed as UTF-16BE. This triplet is not really needed on the BOC because the print server uses the BRS triplets to identify mapped CMRs.

Chapter 8. Rendering intent in the MO:DCA-P (AFP) data stream

Rendering intent is an output attribute used to modify the final appearance of color data. The rendering intents supported in AFP color management are based on the rendering intents defined by the ICC, which are also used in other presentation environments such as PostScript and PDF. Rendering intent can be specified by the job submitter, the document creator, or the data object installer. It provides the presentation device with information on how to process out-of-gamut colors, differences in white points, and appearance preferences.

ICC rendering intents

The following four rendering intents are defined by the ICC and supported for AFP color management:

Perceptual

Gamut mapping is vendor-specific, and colors are adjusted to give a pleasing appearance. This intent is typically used to render continuous-tone images.

Saturation

Gamut mapping is vendor-specific, and colors are adjusted to emphasize saturation. This intent results in vivid colors and is typically used for business graphics.

Media-relative colorimetric

In-gamut colors are rendered accurately, and out-of-gamut colors are mapped to the nearest value within the gamut. Colors are rendered with respect to the source white point and are adjusted for the media white point. Therefore colors printed on two different media with different white points won't match colorimetrically, but may match visually. This intent is typically used for vector graphics.

ICC-absolute colorimetric

In-gamut colors are rendered accurately, and out-of-gamut colors are mapped to the nearest value within the gamut. Colors are rendered only with respect to the source white point, and are not adjusted for the media white point. Therefore colors printed on two different media with different white points should match colorimetrically, but may not match visually. This intent is typically used for logos.

For more information on ICC rendering intents, see the *International Color Consortium Specification ICC.x, File Format for Color Profiles*, where *x* stands for the current level of the specification.

As implied by the above definitions, rendering intents are often tied to a specific object type. For example, perceptual rendering intent is normally used with continuous tone images.

Rendering Intent (X'95') triplet

In MO:DCA data streams, the rendering intent is specified with a Rendering Intent (X'95') triplet. This triplet is defined as follows:

Table 17. Rendering Intent (X'95') triplet

Length (bytes)	Name	Description
1	Tlength	Length of triplet
1	Tid	Triplet ID
2	Reserved	Should be set to zero
1	IOCARI	Specifies the rendering intent for IOCA objects: <ul style="list-style-type: none"> • X'00' = perceptual • X'01' = media-relative colorimetric • X'02' = saturation • X'03' = ICC-absolute colorimetric • X'FF' = not specified
1	OCRI	Specifies the rendering intent for objects carried in a container or referenced as a container, for example, TIFF, EPS: <ul style="list-style-type: none"> • X'00' = perceptual • X'01' = media-relative colorimetric • X'02' = saturation • X'03' = ICC-absolute colorimetric • X'FF' = not specified
1	PTOCARI	Specifies the rendering intent for PTOCA text: <ul style="list-style-type: none"> • X'00' = perceptual • X'01' = media-relative colorimetric • X'02' = saturation • X'03' = ICC-absolute colorimetric • X'FF' = not specified
1	GOCARI	Specifies the rendering intent for AFP GOCA objects: <ul style="list-style-type: none"> • X'00' = perceptual • X'01' = media-relative colorimetric • X'02' = saturation • X'03' = ICC-absolute colorimetric • X'FF' = not specified
2	Reserved	Should be set to zero

Associating rendering intent with a MO:DCA document component

A rendering intent can be associated with a MO:DCA document component at any level of the document hierarchy. The rendering intent provides instructions to a presentation device for rendering the document component. The presentation device identifies a current rendering intent and uses this to select one of the four LUTs in a link color conversion CMR. The presentation device uses the LUT to convert the input color space to the output color space.

To associate a rendering intent with a document component, specify the Rendering Intent (X'95') triplet as follows:

Print file

On the Presentation Environment Control (PEC) structured field in the DEG of the form definition. If you do not specify the Object Offset (X'5A') triplet on the PEC structured field, the rendering intent applies to all the documents in the print file.

Document

On the PEC structured field in the DEG of the form definition for the print file that contains the document. To target a specific document in the print file, specify the Object Offset (X'5A') triplet on the PEC structured field.

Group of pages or sheets

On the PEC structured field in the medium map that is used to process the group of pages or sheets.

Page or overlay

On the PEC structured field in the AEG.

Data object

In any of these places:

- On the PEC structured field in the OEG for the data object.
- On the IOB structured field for an object to be included. This rendering intent overrides any rendering intent specified elsewhere for the data object, such as a rendering intent specified in the data object's OEG or in a data object RAT entry for the object.
- If the data object installer is used to install the data object, in the RAT entry for the data object.
- On the PPO structured field for an object to be preprocessed.

Note: In all these cases, the rendering intent applies only to the data object for which it is specified.

Normal MO:DCA hierarchy rules apply. That is, a rendering intent specified for a document component at a lower level in the hierarchy applies only to that document component and overrides any other rendering intent specified at a higher-level in the hierarchy. If no rendering intent is specified in the hierarchy, the preferred rendering intent specified in the active instruction CC CMR is used. The preferred rendering intent is the same as the default rendering intent specified in the corresponding link CMR.

Notes:

1. The rendering intent for BCOCA objects and IM-image objects is fixed as media-relative colorimetric.
2. The rendering intent for object area fills and page and overlay presentation space fills is the same as the rendering intent of the corresponding object. For

example, when an overlay presentation space is filled with color, the rendering intent that is used for rendering the overlay is also used for generating the fill.

Chapter 9. Device appearance—monochrome output

It is sometimes desirable to have a color printer generate output in the same way that a monochrome printer generates output. That is, given a print file with process colors, to generate monochrome output. One reason to do this is to improve printer performance by generating only one color plane instead of four. Another reason is to save on consumables. For example, it might be desirable to proof a color application with monochrome output to check content as well as line and page breaks. Other types of device output appearance may be desirable as well. Therefore, the architecture includes a general mechanism for specifying a device output appearance.

You can use the Device Appearance (X'97') triplet to instruct a color printer to generate monochrome output or another type of output appearance. Table 18 shows the format of the Device Appearance triplet.

Table 18. Device Appearance (X'97') triplet

Length (bytes)	Name	Description
1	Tlength	Length of triplet
1	Tid	Triplet ID (X'97')
1	Reserved	Should be set to zero
2	DevApp	Specifies the desired device output appearance: <ul style="list-style-type: none">• X'0000' = device default appearance• X'0001' = device default monochrome appearance• All others: reserved
2	Reserved	Should be set to zero

Note: The IPDS architecture defines the functions that a printer must support for AFP color management. Support for the Device Appearance (X'97') triplet with DevAPP=X'0000' (device default appearance) is required. Support for other device appearances is optional and therefore depends on the device implementation.

The Device Appearance triplet is specified on the new Presentation Environment Control (PEC) structured field, which can also specify the Rendering Intent (X'95') triplet. Table 19 shows the format of the PEC structured field.

Table 19. Presentation Environment Control (PEC) structured field

Length (bytes)	Name	Description
2	SFLength	Length of structured field
3	SFTypeID	Structured field ID (X'D3A7A8')
1	FlagByte	Structured field flags
2	Reserved	Should be set to zero
2	Reserved	Should be set to zero

Table 19. Presentation Environment Control (PEC) structured field (continued)

Length (bytes)	Name	Description
0– <i>n</i>	Triplets:	<ul style="list-style-type: none"> • Rendering Intent (X'95') triplet; optional; may be specified once • Device Appearance (X'97') triplet; optional; may be specified once • Object Offset (X'5A') triplet, with ObjTpe = X'A8' (offset counted in number of documents); optional; may be specified once

The PEC structured field can be used to specify either the rendering intent, or the device appearance, or both, as follows:

- The PEC can be used to specify a rendering intent with the X'95' triplet as follows:
 - In the form definition DEG after the PFC
 - In a medium map after the MFC
 - In the page or overlay AEG before the MCF
 - In the GOCA, IOCA, or Container OEG before the OBD
- The PEC can be used to specify device appearance with the X'97' triplet as follows:
 - In the form definition DEG after the PFC
 - In a medium map after the MFC

Note that when it is specified in a medium map, the PEC is considered a medium-level control. This means that in N-up mode, as in non-N-up mode, invoking a new medium map to change printer appearance always causes a sheet eject.

Chapter 10. Color management resources in the IPDS data stream

The IPDS architecture handles color management resources (CMRs) as non-presentation, object-container resources. CMRs can be downloaded in home state using a WOCC/WOC/End command sequence. Audit and instruction CMRs must also be invoked by other IPDS commands before they can be used.

CMRs can also be resident in the printer or captured by the printer. In this case, they are activated by the Activate Resource (AR) command; but, just as in the download case, another IPDS command is required to invoke an audit or instruction CMR. A resident or captured CMR is identified by an object OID. The object OID is generated using an architected algorithm, such as the generic-OID algorithm described in “ACMA object OID algorithm,” on page 59.

When a CMR is activated, by either an AR command or a download command sequence, a processing mode is specified in a Color Management Resource Descriptor (X'91') triplet. An OID can be specified to uniquely identify the CMR object. The OIDs specified with audit and instruction color conversion CMRs are later used to locate an appropriate link color conversion CMR.

CMRs are deactivated using the Deactivate Data Object Resource (DDOR) or Execute Order Home State (XOH) Erase Residual Print Data (ERPD) command. When a CMR is deactivated, all invocations of that CMR are also removed.

The printer also provides default audit and instruction CMRs for most CMR types and many color spaces. Default CMRs provide a default level of color management when no host-invoked CMR of a needed type is provided. Default CMRs do not require activation.

In many cases, the printer can use a prebuilt link color conversion CMR that performs the same function as a selected pair of audit and instruction color conversion CMRs, but provides for more efficient processing. Link color conversion CMRs can either be built by the printer as needed or be activated as link CMRs. Link CMRs do not need to be invoked.

CMR usage hierarchy

A CMR-enabled IPDS printer uses the CMR usage hierarchy shown in Figure 3 on page 50 to determine which CMRs to use when processing print data. All print data has color information associated with it (often in an implicit manner). When an explicit color is not specified, the data is assigned the printer-default color (normally black). CMRs can be supported by single-color printers, highlight color printers, and full-process color printers. It is important to know which color space is used for the current print data before searching the hierarchy for the appropriate CMRs. Refer to the *Color Management Object Content Architecture (CMOCA) Reference* for a definition of the relationship between each color space and each CMR type.

When a highlight color space is used with indexed color values (X'0100–X'FFFF'), the printer uses an indexed CMR for color conversion (instead of using color conversion CMRs). For all other color spaces, color conversion CMRs (audit,

instruction, and link) are used for converting specified colors to device colors. Tone transfer curve CMRs and halftone CMRs can be used with all color spaces.

For each halftone CMR, tone transfer curve CMR, and color conversion CMR that applies to the rendering of non-highlight-color data, exactly one instruction CMR, exactly one audit CMR, and (for color conversion) exactly one rendering intent is selected for that color space using the hierarchy. For example, when the printer is processing a presentation data object, it uses the instruction color conversion CMR specified for the data object, if there is one. Otherwise, the printer looks at the next level in the hierarchy for an instruction CMR of that type. (The same search is done for an audit CMR). The printer searches each level of the hierarchy until an appropriate pair of CMRs is found for each required CMR type. When an appropriate CMR is found at a particular level, the printer does not search any farther in the hierarchy. If the data stream does not invoke an instruction CMR or audit CMR for each appropriate CMR type, the printer uses a default CMR (the last level of the hierarchy).

There can be multiple CMRs invoked at each level in the hierarchy. The printer keeps track of the order in which the CMRs are invoked. When more than one CMR is found at a particular hierarchy level that meets the selection criteria, the printer uses the most recently invoked CMR. For example, if three CMRs are invoked at the home-state level (CMR1, CMR2, and CMR3 in that order) and both CMR1 and CMR3 are appropriate for use with RGB data, CMR3 is selected. The printer searches, at each hierarchy level, from last invoked to first invoked.

The start of the hierarchy depends on where the data is specified in the data stream;
start at ①

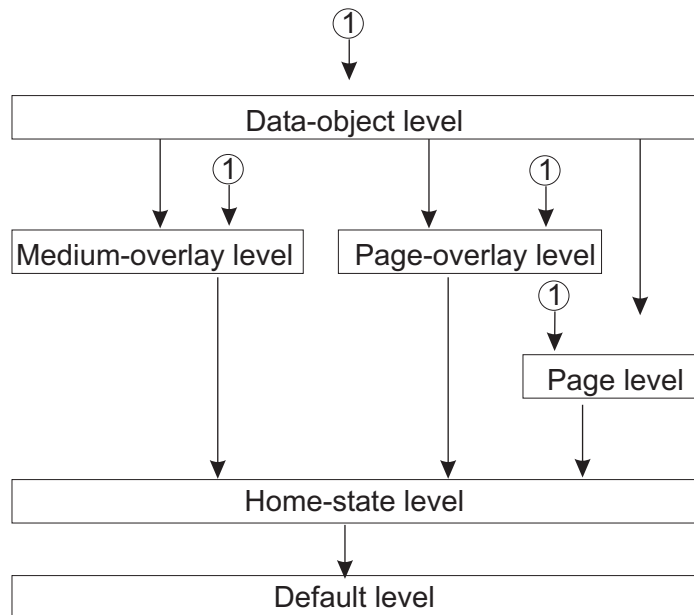


Figure 3. Printer hierarchy for CMR processing

Data-object-level CMRs

Data-object-level CMRs are invoked with an Invoke CMR (X'92') triplet on the command that begins a data object; for example, WIC2 for an IOCA image object, WGC for a graphics object, WBCC for a bar code object, and WOCC for an object-container object. Note that CMRs cannot be directly invoked for an

IM-image or for a page segment; but IM-image data and page-segment data can be processed with CMRs from another level of the hierarchy.

A data-object-level CMR can also be overridden by specifying an Invoke CMR triplet on an Include Data Object (IDO) command.

The scope of a data-object-level CMR is the data object. When an End command is processed, the scope ends for all data-object-level CMRs.

Notes:

1. Some presentation data objects contain internal color management information. An object-level audit CMR can override this internal information, but if an object-level audit CMR is not selected for this object, the internal information is used in place of an audit CMR and a link CMR is not necessarily used with this object. All internal “instruction-like” color management information is ignored. Refer to the *Color Management Object Content Architecture (CMOCA) Reference* for processing rules.
2. For EPS and PDF-page objects only, when there is no object-level audit color conversion CMR invoked, the printer uses a resident color profile (if an appropriate one has been established as a secondary resource for the EPS or PDF-page object by a DORE command). Currently, resident color profiles are defined only for CMYK data. For these objects, internal color management information is used only when no resident color profile is defined and no object-level audit color conversion CMR has been selected.

To establish a rendering intent (perceptual, media-relative colorimetric, saturation, or ICC-absolute colorimetric) for the object, a Rendering Intent (X'95') triplet can also be specified on the command that begins the object (WGC, WIC2, or WOCC). The rendering intent specified within the triplet for this object type is used and the rendering intents for all other object types are ignored.

Medium-overlay-level CMRs

Medium-overlay-level CMRs are invoked when an LPD command for the overlay is processed. This level of the hierarchy is used only for medium overlays and does not apply when processing page data. When the overlay is downloaded, overlay-level CMRs are specified by an Invoke CMR (X'92') triplet on the overlay's Logical Page Descriptor (LPD) command.

When traversing the hierarchy, the next level after the medium-overlay level is the home-state level.

The scope of a medium-overlay-level CMR is the overlay; when the overlay's End Page command is processed, the scope ends for that overlay.

To establish rendering intents for the medium overlay, a Rendering Intent (X'95') triplet can also be specified on the LPD command.

Page-overlay-level CMRs

Page-overlay-level CMRs are invoked when an LPD command for the overlay is processed. When the overlay is downloaded, overlay-level CMRs are specified by an Invoke CMR (X'92') triplet on the overlay's Logical Page Descriptor (LPD) command.

When traversing the hierarchy, the next level after the page-overlay level is the home-state level; CMRs for the including page (or overlay) are not used. The original page overlay uses the same CMRs regardless of where it appears in a print file.

The scope of a page-overlay-level CMR is the overlay. When the overlay's End Page command is processed, the scope ends for that overlay.

To establish rendering intents for the page overlay, a Rendering Intent (X'95') triplet can also be specified on the LPD command.

Page-level CMRs

Page-level CMRs are invoked by an Invoke CMR (X'92') triplet on the page's Logical Page Descriptor (LPD) command.

The scope of a page-level CMR is the page. When the page's End Page command is processed, the scope ends for that page.

To establish rendering intents for the page, a Rendering Intent (X'95') triplet can also be specified on the LPD command.

Home-state-level CMRs

Home-state-level CMRs are invoked or reset by an Invoke CMR (ICMR) command. CMRs invoked with the ICMR command are used whenever there are no data-object level, page level, or overlay level CMRs in effect.

Home-state-level CMRs remain invoked until they are reset by another ICMR command or until the printer is reinitialized (which returns an IML NACK).

To establish rendering intents for multiple pages, a Rendering Intent (X'95') triplet can be specified on a Set Presentation Environment (SPE) command.

Default CMRs

Default CMRs are provided by the printer for all CMR types supported by that printer. Some of these defaults are defined in CMOCA. Default CMRs provide a default level of color management when no host-invoked CMR of a needed type is provided. Default CMRs do not require activation.

CMR hierarchy processing

Instruction CMRs can be made media-specific by including media information within the CMR header. Refer to the Color Management Resource architecture for a description of media-specific CMR processing. If an applicable instruction CMR is not found in the hierarchy, the printer selects an appropriate printer default CMR whose media information matches the currently selected media. If such a match is not found, the printer selects one of the existing printer defaults and no exception ID is reported. If an invoked, media-specific instruction CMR is selected but does not match the currently selected media, exception ID X'025E..03' exists. The Color Fidelity triplet can be used to control whether printing stops or continues and whether this exception is reported.

Instruction halftone and tone transfer curve CMRs can also be generic. (This is indicated in the CMR Version field in the CMR header). When the printer selects a generic instruction CMR, it substitutes an appropriate version of a device-specific default CMR. All generic CMRs are defined in the *Color Management Object Content*

Architecture (CMOCA) Reference. Exception ID X'025E..04' exists if a generic CMR is selected, but the printer does not have an appropriate device-specific CMR to use in place of the generic CMR.

In many cases, a prebuilt link color conversion CMR is available to the printer that performs the same function as the selected audit color conversion CMR and instruction color conversion CMR, but provides for more efficient processing. Link color conversion CMRs can either be built by the printer as needed or can be activated as link CMRs; link CMRs do not need to be invoked. Printers indicate using STM property pair X'E001' whether host-activated link color conversion CMRs are used; link color conversion CMRs should not be downloaded to a printer that does not use them. Printers also indicate using STM property pair X'E000' whether capture is supported for CMRs. Refer to the *Color Management Object Content Architecture (CMOCA) Reference* for a description of link color conversion CMRs.

Link color conversion CMRs provide four lookup tables, one for each possible rendering intent. The Rendering Intent (X'95') triplet allows for rendering-intent selection at each level of the hierarchy. If a X'95' triplet is found while searching the hierarchy for audit and instruction CMRs, that rendering intent is used to select the appropriate lookup table in the link color conversion CMR. If no rendering intent is found, the printer defaults to the preferred rendering intent specified in the instruction color conversion CMR (which is the same as the default rendering intent in the selected link color conversion CMR).

CMR hierarchy summary

In summary, before color data can be presented, the printer must select an appropriate set of color-management controls using the CMR usage hierarchy. An appropriate set must be selected each time a color space is used or the presentation of a new object is begun. Table 20 shows the required color-management controls.

Table 20. CMRs selected by IPDS printers

Purpose	Color values	Color-management controls
Color conversion	Indexed color values (X'0100'-X'FFFF')	An indexed CMR. If the printer cannot handle the color value specified in the indexed CMR, the substitution LAB value is converted into a color that the printer can present. This is not an exception condition.
Color conversion	All other color values	<ul style="list-style-type: none"> • One audit color conversion CMR that identifies the input color space; note that audit color conversion CMRs do not apply to standard OCA color values. • One instruction color conversion CMR that identifies the output color space • A rendering intent • An optional link color conversion CMR
Halftoning	All	<ul style="list-style-type: none"> • One audit halftone CMR to identify halftoning that has been done to the data. This is the device default, which indicates that halftoning is not to be undone. • One instruction halftone CMR to halftone the output color data.

Table 20. CMRs selected by IPDS printers (continued)

Purpose	Color values	Color-management controls
Color calibration	All	<ul style="list-style-type: none"> • One audit tone transfer curve CMR to identify calibration that was done to the input color before halftoning. This is normally the device default, which indicates that no color calibration has been applied. • One instruction tone transfer curve CMR to identify calibration to be done to the output color before halftoning

Color-resource relationships

In addition to CMRs, some printers support color mapping tables and resident color profiles. Most IPDS printers also support the standard OCA color-value table.

Color mapping tables

Color mapping tables are used to map color values specified in a source color space to color values specified in a target color space. This allows colors specified in print data to be mapped (at print time) to colors more suitable to the specific printer and allows, for example, a highlight color value or a standard OCA color value (specified in the print data) to be mapped to a target color space (such as RGB, CMYK, or CIELAB). Refer to the *Mixed Object Document Content Architecture (MO:DCA) Reference* for a description of the color mapping table resource.

When color data is encountered, the printer first applies the mapping from the current color mapping table (if any). The CMR usage hierarchy is then used to select appropriate CMRs based on the target color space from the color mapping table.

Resident color profiles

Resident color profiles are used to identify a specific predefined type of CMYK data (such as CMYK SWOP and CMYK Euroscale). Device-specific CMYK data can also be identified using a Color Management Resource (CMR). If an audit, object-level, color conversion CMR is invoked for an object, it takes precedence over the resident color profile.

Resident color profiles are only used with certain presentation objects, such as EPS and PDF page objects.

Standard OCA color-value table

The standard OCA color-value table describes named colors that are inherently device-dependent. Named colors should not be used when an exact color is required. In the standard OCA color-value table, an RGB value is provided for each named color. It is recommended that IPDS printers interpret these RGB values as SMPTE-C values and map the SMPTE-C RGB values to the printer's CMYK.

Note that audit color conversion CMRs do not apply to named colors.

New and changed triplets for color management

The following triplets are new for color management:

- CMR Descriptor (X'91')
- CMR Tag Fidelity (X'96')
- Device Appearance (X'97')
- Invoke CMR (X'92')
- Rendering Intent (X'95')

A new type has been added to the FQN (X'02') triplet.

Color Management Resource Descriptor (X'91') triplet

This triplet specifies the processing mode for a CMR and is specified in the AR or WOCC command that activates the CMR. In particular, it identifies whether the CMR is to be processed as an audit CMR, as an instruction CMR, or as a link CMR. The printer must use the CMR in the manner indicated by this triplet.

CMR Tag Fidelity (X'96') triplet

This triplet specifies the exception continuation and reporting rules for Color Management Resource (CMR) tag exceptions. A CMR tag exception is detected when an unsupported CMR tag is encountered in a Color Management Resource. The applicable exception ID is X'025D..04'.

Device Appearance (X'97') triplet

This triplet selects one of a set of architected appearances (such as, monochrome) for the device to temporarily assume. The assumed appearance stays in effect until another Set Presentation Environment (SPE) command is received that changes the appearance or until the printer issues an IML NACK.

The presentation environment default if a Device Appearance triplet has not been received by the printer or if the printer issues an IML NACK is to assume the printer default appearance, which is normally to assume the full presentation capabilities of the printer.

Note: This triplet can request a device appearance change whenever the printer is in home state (that is, between pages). Some appearance changes can be assumed in the middle of a sheet and others require a sheet boundary; if a sheet boundary is required but an appearance change was requested within a sheet, the appearance change will occur after the current sheet is completed. An appearance change might also temporarily degrade performance or cause paper to be wasted.

Fully Qualified Name (X'02') triplet

This triplet is specified on a Write Object Container Control (WOCC) command to provide the object OID for a downloaded CMR. The FQN Type is X'41' (Color Management Resource reference) and the FQN Format is X'10' (OID).

The OIDs specified with audit and instruction color conversion CMRs are later used to locate an appropriate link color conversion CMR.

Invoke CMR (X'92') triplet

This triplet identifies a color management resource to be invoked.

For pages and overlays, the triplet is specified on the LPD command. For data objects, the triplet is specified on the WBCC, WGC, WIC2, or WOCC command. When a presentation data object resource is included in a page or overlay, data-object-level CMRs are specified with this triplet on the Include Data Object (IDO) command.

This triplet is used to invoke audit and instruction CMRs. Link CMRs must be activated, but do not need to be invoked. Invoking a link CMR is not an error, but it performs no function.

Rendering Intent (X'95') triplet

This triplet specifies up to four rendering intents to be used with a link color conversion CMR when processing presentation data. A different rendering intent can be specified for PTOCA, GOCA, IOCA, and object container data. The rendering intent for BCOCA and IM-Image data is fixed as media-relative colorimetric.

For pages and overlays, the triplet is specified on the LPD command. For data objects, the triplet is specified on the WGC, WIC2, or WOCC command. When a presentation data object resource is included in a page or overlay, data-object-level rendering intent can be overridden by specifying this triplet on the Include Data Object (IDO) command. To establish a rendering intent for multiple pages (such as for a MO:DCA document or print file) a Rendering Intent (X'95') triplet can be specified on a Set Presentation Environment (SPE) command.

New commands for color management

The following commands are new for color management:

- Invoke CMR
- Set Presentation Environment

Invoke CMR command

Invoke CMR (ICMR) is a home state command used to invoke (or reset) one or more CMRs at the home-state level of the CMR usage hierarchy.

A CMR invoked with the ICMR command is used whenever there is no applicable data-object level CMR, internal color management information, resident color profile (for EPS and PDF-Page objects), page level CMR, or overlay level CMR in effect. Home-state-level CMRs remain invoked until they are reset by another ICMR command or until the printer is reinitialized. Reinitializing the printer causes an IML NACK.

When an IPDS printer processes an ICMR command, it first performs the reset (if any) specified in the invocation flags. Then each ICMR entry is processed in sequence; an entry identifies a specific CMR for a specific CMR type. There can be any number of CMRs invoked at the home-state level, but when the printer is processing specific print data, the printer selects for use only one instruction CMR and one audit CMR of each required CMR type that is appropriate for the specific print data. For example, there can be an audit color conversion CMR for CMYK data and an audit color conversion CMR for RGB data invoked at the home-state level (both have the same CMR type). If processing the hierarchy results in the first encountered color conversion CMR being at the home-state level, the printer will select the first CMR when processing CMYK data and the second CMR when processing RGB data.

This command is used to invoke audit and instruction CMRs. Link CMRs must be activated, but do not need to be invoked. Invoking a link CMR is not an error, but it performs no function.

Set Presentation Environment command

Set Presentation Environment (SPE) is a home-state command used to set the following presentation attributes for use on the pages that follow the command:

- Rendering intent at the home-state level
- Device appearance

The presentation attributes, which are specified within triplets, completely replace all previously set presentation attributes.

Exception reporting

Several new IPDS exception IDs have been defined for color management. This section lists those exception IDs and describes the format of one of them.

New IPDS exception IDs

- X'025D..*ee*' (CMR object error) is added as described in "CMR object exception ID."
- New exception IDs are defined for syntax and semantic errors in the new ICMR and SPE commands and in the new triplets.
- A new exception ID is defined to report that an invoked, media-specific instruction CMR does not match selected media.
- A new asynchronous exception ID is added for color-related errors.
- A new exception ID is defined for an invoked and selected CMR that was not used and for which a printer substitution was made.
- A new exception ID is defined to allow colorant changes at the printer to be reported to the host.

CMR object exception ID

In IPDS architecture, errors are identified by a three-byte exception ID, with the first byte predefined for an error class. For errors found within a CMR object:

- The first byte must be X'02' to indicate a specification check.
- The second byte is error-specific. It indicates, with a value of X'5D', that this is a CMR-object error.
- The third byte is error-specific. It contains the CMR exception code, which is defined in the Color Management Resource Architecture.
- For this type of exception ID, there is a special two-byte field (sense bytes 16–17) that contains the CMR TagID value.

Therefore, CMR object errors reported in IPDS NACKs are of the form X'025D..*ee*' with *ee* being the CMR exception code. The TagID value is in bytes 16–17. Here are some examples:

- EC-001105 is reported as X'025D..*05*' with X'0011' in sense bytes 16–17.
- EC-FFFF0E is reported as X'025D..*0E*' with X'FFFF' in sense bytes 16–17.

Appendix. ACMA object OID algorithm

This algorithm can be used to generate an essentially unique object ID (OID) for CMR objects and for presentation objects. This algorithm is owned and managed by the AFP Consortium. All components that follow the first four components (that is, those after 1.2.208.171) are managed by the AFP Consortium.

Pattern

The OID consists of a seed followed by object-unique components.

Seed The seed is a predefined constant that has five components defined as follows:

1. **ISO**, value = 1
2. **Member body**, value = 2
3. **Denmark**, value = 208
4. **AFP Color Consortium**, value = 171
5. **OID algorithm**, value = 1

Therefore, a seed for a data stream object OID takes the following form:

1.2.208.171.1

Object-unique components

Two object-unique components are predefined, as follows:

1. **MD5 fingerprint**, a 16-byte hexadecimal value in the human-readable form of the OID. This is a checksum calculated from the entire object (in stream format; that is, after any environment-specific encapsulation or blocking has been removed). The algorithm is the RSA Data Security, Inc. MD5 Message-Digest Algorithm described in RFC 1321. This algorithm claims to be unique to a 1 in 2^{64} probability, given two different byte strings of independent size.
2. **Size of the object**, the number of bytes in the object. This is the actual size of the object after any environment-specific encapsulation or blocking has been removed. This is a variable-length value.

Component growth

Because all components except the last component are of fixed size, component growth is minimal. An OID computed using this algorithm is approximately 30 bytes long in ASN.1 definite short form. The minimum length of an OID in this form is calculated to be 10 bytes.

Example

This example shows an OID in two useful forms:

- Human-readable OID:
1.2.208.171.1.X'FFEEDCCBBAA99887766554433221100'.X'0F4240'
- ASN.1 definite short form OID (see the *Mixed Object Document Content Architecture (MO:DCA) Reference* for the OID encoding):
X'061C2A8150812B0183FFEEEF397BAD4E690F7B395A8C39988A200BD8440'

Notices

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Glossary

This glossary contains terms that apply to the AFP architecture and also terms that apply to other related presentation architectures.

If you do not find the term that you are looking for, please refer to the *IBM Dictionary of Computing*, document number ZC20-1699 or the *IBM Dictionary of Printing*, document number G544-3973.

The following definitions are provided as supporting information only, and are not intended to be used as a substitute for the semantics described in the body of this reference.

A

ACMA. AFP Color Management Architecture.

additive primary colors. Red, green, and blue light, transmitted in video monitors and televisions. When used in various degrees of intensity and variation, they create all other colors of light; when superimposed equally, they create white. Contrast with *subtractive primary colors*.

addressable position. A position in a presentation space or on a physical medium that can be identified by a coordinate from the coordinate system of the presentation space or physical medium.

Advanced Function Presentation (AFP). An open architecture for the management of presentable information that is developed by the AFP Consortium (AFPC). AFP comprises a number of data stream and data object architectures:

- Mixed Object Document Content Architecture (MO:DCA), formerly referred to as AFP Data Stream (AFPDS)
- Intelligent Printer Data Stream (IPDS) Architecture
- AFP Line Data Architecture
- Bar Code Object Content Architecture (BCOCA)
- Color Management Object Content Architecture (CMOCA)
- Font Object Content Architecture (FOCA)
- Graphics Object Content Architecture for AFP (AFP GOCA)
- Image Object Content Architecture (IOCA)
- Presentation Text Object Content Architecture (PTOCA)

AFP. Advanced Function Presentation.

AFPC. AFP Consortium.

AFPCC. AFP Color Consortium.

ASCII. American Standard Code for Information Interchange.

application. (1) The use to which an information system is put. (2) A collection of software components used to perform specific types of work on a computer.

architected. Defined and controlled by an architecture.

American Standard Code for Information Interchange (ASCII). A standard code used for information exchange among data processing systems, data communication systems, and associated equipment. ASCII uses a coded character set consisting of 7-bit coded characters.

attribute. A property or characteristic of one or more constructs.

audit CMR. A CMR that reflects processing that has been done on an object.

B

base level. In the base-and-towers concept, the smallest portion of architected function that is allowed to be implemented.

big-endian. Relating to a format for storage or transmission of binary data in which the most significant bit (or byte) is placed first. Contrast with *little-endian*.

bilevel. Allowing every point in an image to take only the values 0 or 1, that is, black or not black. The scanner then reads one bit per pixel. Contrast with *multilevel*.

BITS. A data type for architecture syntax, indicating one or more bytes to be interpreted as bit string information.

brightness. Attribute of a visual sensation according to which an area appears to exhibit more or less light.

C

calibration. Adjusting the correct value of a reading by comparison to a standard.

Cartesian coordinate system. An image coordinate system that uses the fourth quadrant with positive values for the Y axis. The origin is the upper left-hand corner of the fourth quadrant. A pair of (x,y) values

corresponds to one image point. Each image point is described by an image data element.

character. A member of a set of elements used for the organization, control, or representation of data. A character can be either a graphic character or a control character.

CIE. Commission Internationale d’Eclairage

CIELAB color space. Internationally accepted color space model used as a standard to define color within the graphic arts industry, as well as other industries. L^* , a^* and b^* are plotted at right angles to one another. Equal distances in the space represent approximately equal color difference.

CIEXYZ color space. The fundamental CIE-based color space that allows colors to be expressed as a mixture of the three tristimulus values X, Y, and Z.

CMOCA. Color Management Object Content Architecture.

CMR. Color management resource.

CMY. Cyan, magenta, and yellow, the subtractive primary colors.

CMYK. Cyan, magenta, yellow, and black.

CMYK color space. The color model used in four-color printing. Cyan, magenta, and yellow, the subtractive primary colors, are used with black to effectively create a multitude of other colors.

CODE. A data type for architecture syntax that indicates an architected constant to be interpreted as defined by the architecture.

color. A visual attribute of things that results from the light they emit, transmit, or reflect.

colorants. Colors (pigments, dyes, inks) used by a device, primarily a printer, to reproduce colors.

colorimetric intent. A gamut mapping method that is intended to preserve the relationships between in-gamut colors at the expense of out-of-gamut colors.

colorimetry. The science of measuring color and color appearance. Classical colorimetry deals primarily with color matches rather than with color appearance as such. The main focus of colorimetry has been the development of methods for predicting perceptual matches on the basis of physical measurements.

color calibration. The process of altering the behavior of an input or output device to make it conform to an established state, specified by a manufacturer, user, or industry-wide specification or standard.

color component. A dimension of a color value expressed as a numeric value. A color value may consist of one, two, three, four, or eight components, also referred to as channels.

color conversion. The process of converting colors from one color space to another.

color management. The technology to calibrate the color of input devices (such as scanners or digital cameras), display devices and output devices (such as printers or offset presses). Parts of this technology are implemented in the operating system, the API, or directly in the application.

color management resource. An object that provides color management in presentation environments.

color management system. A set of software designed to increase the accuracy and consistency of color between color devices like a scanner, display and printer.

color palette. A system of designated colors that are used in conjunction with each other to achieve visual consistency.

color rendering dictionary. PostScript language for converting colors from the XYZ color space to a device color space. It is analogous to the “from PCS” part of an ICC printer profile with one rendering intent: the part used when the profile is a destination profile.

color space. A model for representing color in terms of intensity values; a color space specifies how color information is represented. It defines a multidimensional space whose dimensions, or components, represent intensity values.

Commission Internationale d’Eclairage (CIE). An association of international color scientists who produced the standards that are used as the basis of the description of color.

coordinate system. See *Cartesian coordinate system*.

Coordinated Universal Time (UTC). The standard time reference for Earth and the human race. Knowing the UTC time and one’s time-zone offset from it, it is possible to calculate the local time. For example, 1:00 PM UTC corresponds to 3:00 AM Pacific Standard Time (on the same day). UTC is almost the same thing as Greenwich Mean Time (GMT), which was originally used as the standard time reference.

D

data object . An object that conveys information, such as text, graphics, audio, or video.

data stream. A continuous stream of data that has a defined format. An example of a defined format is a structured field.

default. A value, attribute, or option that is assumed when none has been specified and one is needed to continue processing.

device attribute . A property or characteristic of a device.

device-dependent. Dependent upon one or more device characteristics.

device-independent color space. A CIE-based color space that allows color to be expressed in a device-independent way. It ensures colors to be predictably and accurately matched among various color devices.

device profile. A structure that provides a means of defining the color characteristics of a given device in a particular state.

dimension. The attribute of size given to arrays and tables.

document. (1) A machine-readable collection of one or more objects that represents a composition, a work, or a collection of data. (2) A publication or other written material.

document component. An architected part of a document data stream. Examples of document components are documents, pages, page groups, indexes, resource groups, objects, and process elements.

dpi. Dots per inch.

dots per inch (dpi). (1) The number of dots that will fit in an inch. (2) The unit of measure for output resolution. (3) The unit of measure of the quality of input when using a scanner. In this case, the dpi becomes a square function measuring the dots both vertically as well as horizontally. Consequently, when an image is scanned in at 300 dpi, there are 90,000 dots or bits of electronic data (300 × 300) in every square inch.

E

Encapsulated PostScript (EPS). A standard file format for importing and exporting PostScript language files among applications in a variety of heterogeneous environments.

embedded ICC profile. An ICC profile that is embedded within a graphic document or image. It allow users to transparently move color data between different computers, networks and even operating systems without having to worry if the necessary profiles are present on the destination systems.

EPS. Encapsulated PostScript.

exception condition. The condition that exists when a product finds an invalid or unsupported construct.

F

format. The arrangement or layout of data on a physical medium or in a presentation space.

G

gamma. A measure of contrast in photographic images. More precisely, a parameter that describes the shape of the transfer function for one or more stages in an imaging pipeline. The transfer function is given by the expression $output = input ^ \gamma$ where both input and output are scaled to the range 0 to 1.

generic. Relating to, or characteristic of, a whole group or class.

GIF. Graphic Interchange Format.

GOCA. Graphics Object Content Architecture.

Graphic Interchange Format (GIF). An image format type generated specifically for computer use. Its resolution is usually very low (72 dpi, or that of your computer screen), making it undesirable for printing purposes.

Graphics Object Content Architecture (GOCA). An architected collection of constructs used to interchange and present graphics data.

grayscale. (1) A file created by scanning a continuous tone original and saving the information as shades of gray. (2) An image containing a series of tones stepped from white to black.

H

halftone. A method of generating on press or on a laser printer an image that requires varying densities or shades to accurately render the image. This is achieved by representing the image as a pattern of dots of varying size. Larger dots represent darker areas, and smaller dots represent lighter areas of an image.

hexadecimal. A number system with a base of sixteen. The decimal digits 0 through 9 and characters A through F are used to represent hexadecimal digits. The hexadecimal digits A through F correspond to the decimal numbers 10 through 15, respectively. An example of a hexadecimal number is X'1B', which is equal to the decimal number 27.

hierarchy. A series of elements that have been graded or ranked in some useful manner.

highlight color. A spot color that is used to accentuate or contrast monochromatic areas.

host. (1) In the IPDS architecture, a computer that drives a printer. (2) In IOCA, the controlling environment.

I

ICC. International Color Consortium.

ICC-absolute colorimetric. This rendering intent in which the chromatically adapted tristimulus values of the in-gamut colors are unchanged. It is useful for spot colors and when simulating one medium on another (proofing). Note that this definition of ICC-absolute colorimetry is actually called *relative colorimetry* in CIE terminology, because the data has been normalized relative to the perfect diffuser viewed under the same illumination source as the sample.

ICC profile. A file in the International sortium profile format, containing information about the color reproduction capabilities of a device such as a scanner, a digital camera, a monitor or a printer. An ICC profile includes three elements: 128-byte file header, tag table, and tagged element data. The intent of this format is to provide a cross-platform device profile format. Such device profiles can be used to translate color data created on one device into another device's native color space. The acceptance of this format by operating system vendors allows end users to transparently move profiles and images with embedded profiles between different operating systems.

illuminant. Something that can serve as a source of light.

image. An electronic representation of a picture produced by means of sensing light, sound, electron radiation, or other emanations coming from the picture or reflected by the picture. An image can also be generated directly by software without reference to an existing picture.

Image Object Content Architecture (IOCA). An architected collection of constructs used for the interchange and presentation of images.

indexed color. A color image format that contains a palette of colors to define the image. Indexed color can reduce file size while maintaining visual quality. The reduction in file size makes it an ideal format for multimedia or web graphics. It is not used for high-end printing.

input device profile. The ICC profile that is associated with the image and describes the characteristics of the device on which the image was created.

instruction CMR. A CMR that reflects processing that is to be done to an object.

Intelligent Printer Data Stream (IPDS). An architected host-to-printer data stream that contains both data and controls defining how the data is to be presented.

intensity. The extreme strength, degree, or amount of ink.

interchange. The predictable interpretation of shared information in an environment where the characteristics of each process need not be known to all other processes.

International Color Consortium (ICC). A group of companies chartered to develop, use, and promote cross-platform standards so that applications and devices can exchange color data without ambiguity.

International Organization for Standardization (ISO). An organization of national standards bodies from various countries established to promote development of standards to facilitate international exchange of goods and services, and develop cooperation in intellectual, scientific, technological, and economic activity.

IOCA. Image Object Content Architecture.

ISO. International Organization for Standardization.

J

JFIF. JPEG File Interchange Format.

Joint Photographic Experts Group (JPEG). A standards committee that designed an image compression format. The compression format they designed is known as a lossy compression, in that it deletes information from an image that it considers unnecessary. JPEG files can range from small amounts of lossless compression to large amounts of lossy compression.

JPEG. Joint Photographic Experts Group.

JPEG File Interchange Format (JFIF). The most common file format for JPEG images. (TIFF is another file format that can be used to store JPEG images, and JNG is a third.) JFIF is not a formal standard. It was designed by a group of companies (though it is most often associated with C-Cube Microsystems, one of whose employees published it) and became a de facto industry standard.

L

L*a*b* color space. CIELAB color space.

LID. Local identifier.

local identifier (LID). An identifier that is mapped by the environment to a named resource.

little-endian. Relating to a format for storage or transmission of binary data in which the most significant bit (or byte) is placed last. Contrast with *big-endian*.

lookup table (LUT). A database table used to map one or more input values to one or more output values.

LUT. Lookup table.

M

media-relative colorimetric. This rendering intent rescales the in-gamut, chromatically adapted tristimulus values such that the white point of the actual medium is mapped to the PCS white point (for either input or output). It is useful for colors that have already been mapped to a medium with a smaller gamut than the reference medium (and therefore need no further compression).

medium. A physical entity on which information is presented. Examples of physical media are a sheet of paper, a roll of paper, an envelope, and a display screen.

Mixed Object Document Content Architecture (MO:DCA). An architected, device-independent data stream for interchanging documents.

Mixed Object Document Content Architecture Presentation (MO:DCA-P). The AFP interchange data stream.

MO:DCA. Mixed Object Document Content Architecture.

MO:DCA-P. Mixed Object Document Content Architecture Presentation.

monochrome. Of a single color. Monochrome usually refers to a black-and-white image.

multilevel . Allowing every point in an image to have values from 0 to n , where n is greater than 1. Contrast with *bilevel*.

multilevel device. A device that is used in a manner that permits it to simultaneously process data of two or more levels.

N

NACK. Negative acknowledge reply.

name. A table heading for architecture syntax. The entries under this heading are short names that give a general indication of the contents of the construct.

named color. A color that is specified with a descriptive name. An example of a named color is **green**.

negative acknowledge reply (NACK). In the IPDS architecture, a reply from a printer to a host, indicating that an exception has occurred.

O

object. (1) A collection of structured fields. The first structured field provides a begin-object function, and the last structured field provides an end-object function. The object can contain one or more other structured fields whose content consists of one or more data elements of a particular data type. An object can be assigned a name, which can be used to reference the object. Examples of objects are text, fonts, graphics, image, and formatted data objects. (2) Something that a user works with to perform a task.

offset. A table heading for architecture syntax. The entries under this heading indicate the numeric displacement into a construct. The offset is measured in bytes and starts with byte zero. Individual bits can be expressed as displacements within bytes.

object identifier (OID). A notation that assigns a globally unambiguous name to an object or a document component. The notation is defined in international standard ISO/IEC 8824(E).

OID. Object identifier.

orientation. The angular distance a presentation space or object area is rotated in a specified coordinate system, expressed in degrees and minutes. For example, the orientation of printing on a physical medium, relative to the X_m axis of the X_m, Y_m coordinate system. See also *presentation space orientation* and *text orientation*.

origin. The point in a coordinate system where the axes intersect. Examples of origins are the addressable position in an X_m, Y_m coordinate system where both coordinate values are zero and the character reference point in a character coordinate system.

output profile. An ICC profile that describes the characteristics of the output device for which the image is destined. The profile is used to color match the image to the device's gamut.

overlay. (1) A resource object that contains presentation data such as, text, image, graphics, and bar code data. Overlays define their own environment and are often used as predefined pages or electronic forms. Overlays are classified according to how they are presented with other presentation data: a medium overlay is positioned at the origin of the medium presentation space before any pages are presented, and a page overlay is positioned at a specified point in a page's logical page. A Page Modification Control (PMC) overlay is a special type of page overlay used in

MO:DCA environments. (2) The final representation of such an object on a physical medium. Contrast with *page segment*.

P

page. (1) A data stream object delimited by a Begin Page structured field and an End Page structured field. A page can contain presentation data such as text, image, graphics, and bar code data. (2) The final representation of a page object on a physical medium.

page segment. (1) A resource object that can contain any mixture of bar code objects, graphics objects, and IOCA image objects. A page segment does not contain an active environment group. The environment for a page segment is defined by the active environment group of the including page or overlay. (2) The final representation of such an object on a physical medium. Contrast with *overlay*.

palette. The collection of colors or shades available to a graphics system or program.

Pantone. The proprietary Pantone color matching system is the most popular method of specifying extra colors (not out of the CMYK four-color process) for print. Pantone colors are numbered and are made up out of a base set of colors. By specifying a specific Pantone color, a designer knows that there is little chance of color variance on the presses.

parameter. (1) A variable that is given a constant value for a specified application. (2) A variable used in conjunction with a command to affect its result.

PCS. Profile connection space.

PDF. Portable Document Format.

perceptual rendering intent. The exact gamut mapping of the perceptual intent is vendor specific and involves compromises such as trading off preservation of contrast in order to preserve detail throughout the tonal range. It is useful for general reproduction of images, particularly pictorial or photographic-type images.

pixel. The smallest printable or displayable unit on a physical medium. In computer graphics, the smallest element of a physical medium that can be independently assigned color and intensity. Picture elements per inch is often used as a measurement of presentation granularity.

Portable Document Format (PDF). A standard file format developed by Adobe® Systems Inc. PDF files are cross-platform and contain all of the image and font data. Design attributes are retained in a compressed single package.

PostScript. A page description programming language created by Adobe Systems Inc. that is a device-independent industry standard for outputting documents and graphics. It describes pages to any output device with a PostScript interpreter.

presentation data stream. A data stream that is processed in AFP environments. MO:DCA-P is the AFP interchange data stream. IPDS is the AFP printer data stream.

presentation device. A device that produces character shapes, graphics pictures, images, or bar code symbols on a physical medium. Examples of a physical medium are a display screen and a sheet of paper.

presentation space. A conceptual address space with a specified coordinate system and a set of addressable positions. The coordinate system and addressable positions can coincide with those of a physical medium. Examples of presentation spaces are medium, logical page, and object area.

presentation space orientation. The number of degrees and minutes a presentation space is rotated in a specified coordinate system. For example, the orientation of printing on a physical medium, relative to the X_m axis of the X_m, Y_m coordinate system. See also *orientation* and *text orientation*.

print file. A file that is created for the purpose of printing data. A print file includes information to be printed and, optionally, some of the data.

process color. A color that is specified as a combination of the components, or primaries, of a color space. A process color is rendered by mixing the specified amounts of the primaries. An example of a process color is C=.1, M=.8, Y=.2, K=.1 in the CMYK color space. Contrast with *spot color*.

profile. See *ICC profile, output profile*.

Profile Connection Space (PCS). The reference color space defined by ICC, in which, colors are encoded in order to provide an interface for connecting source and destination transforms. The PCS is based on the CIE 1931 standard colorimetric observer.

R

raster image processor (RIP). A hardware or software tool that processes a digital PostScript file and converts it to a printable format (*rasterizes* it).

rendering intent. A particular gamut mapping style or method of converting colors in one gamut to colors in another gamut. ICC profiles support four different rendering intents: perceptual, media-relative colorimetric, saturation, and ICC-absolute colorimetric.

reserved. Having no assigned meaning and put aside for future use. The content of reserved fields is not used by receivers, and should be set by generators to a specified value, if given, or to binary zeros. A reserved field or value can be assigned a meaning by an architecture at any time.

resolution. The sharpness of text and graphics provided by any output device. On printed media, it is the number of dots per inch; on a video monitor, it is the number of pixels per unit of measurement. In general, the higher the dpi, the sharper the image.

resource. An object that is referenced by a data stream or by another object to provide data or information. Resource objects can be stored in libraries. In MO:DCA, resource objects can be contained within a resource group. Examples of resources are fonts, overlays, and page segments.

RGB. Red, green and blue, the additive primary colors.

RGB color space. The basic additive color model used for color video display, as on a computer monitor.

RIP. Raster image processor.

rotation. The orientation of a presentation space with respect to the coordinate system of a containing presentation space. Rotation is measured in degrees in a clockwise direction. Zero-degree rotation exists when the angle between a presentation space's positive X axis and the containing presentation space's positive X axis is zero degrees. Contrast with *character rotation*.

S

saturation rendering intent. The exact gamut mapping of the saturation intent is vendor-specific and involves compromises such as trading off preservation of hue in order to preserve the vividness of pure colors. It is useful for images which contain objects such as charts or diagrams.

SBIN. A data type for architecture syntax, that indicates that one or more bytes be interpreted as a signed binary number, with the sign bit in the high-order position of the leftmost byte. Positive numbers are represented in true binary notation with the sign bit set to B'0'. Negative numbers are represented in twos-complement binary notation with a B'1' in the sign-bit position.

semantics. The meaning of the parameters of a construct. See also *syntax*.

server. In a network, hardware or software that provides facilities to other stations. Examples of a server are a file server, a printer server, or a mail server.

sheet. A division of the physical medium; multiple sheets can exist on a physical medium. For example, a roll of paper might be divided by a printer into rectangular pieces of paper, each representing a sheet. Envelopes are an example of a physical medium that comprises only one sheet. The IPDS architecture defines four types of sheets: cut-sheets, continuous forms, envelopes, and computer output on microfilm. Each type of sheet has a top edge. A sheet has two sides, a front side and a back side.

Specifications for Web Offset (SWOP). A standard set of specifications for color separations, proofs, and printing to ensure consistency of color printing.

spot color. A color that is specified with a unique identifier such as a number. A spot color is normally rendered with a custom colorant instead of with a combination of process color primaries. See also *highlight color*. Contrast with *process color*.

sRGB. One of the standard RGB color spaces, a means of specifying precisely how any given RGB value should appear on a monitor or printed paper or any other output device. sRGB was promoted by the ICC and submitted for standardization by the IEC.

stochastic. Using a pseudo-random dot size, frequency, or both to create halftoned images, but without the visible regularity in the dot patterns found in traditional screening.

structured field. A self-identifying, variable-length, bounded record, which can have a content portion that provides control information, data, or both. See also *document element*.

subtractive primary colors. Cyan, magenta, and yellow colorants used to subtract a portion of the white light that is illuminating an object. Subtractive colors are reflective on paper and printed media. When used together with various degrees of coverage and variation, they have the ability to create billions of other colors. Contrast with *additive primary colors*.

SWOP. Specifications for Web Offset.

syntax. The rules governing the structure of a construct. See also *semantics*.

T

tag. A data structure that is used within the data portion of the CMR. A CMR tag consists of TagID, FieldType, Count, and ValueOffset.

Tagged Image File Format (TIFF). A graphics file format using bitmaps.

text. A graphic representation of information. Text can consist of alphanumeric characters and symbols

arranged in paragraphs, tables, columns, and other shapes. An example of text is the data sent in an IPDS Write Text command.

text orientation. A description of the appearance of text as a combination of inline direction and baseline direction. See also *orientation* and *presentation space orientation*.

TIFF. Tagged Image File Format.

triplet. A three-part self-defining variable-length parameter consisting of a length byte, an identifier byte, and one or more parameter-value bytes.

tone transfer curve (TTC). A mathematical representation of the relationship between the input and output of a system, subsystem, or equipment. The function is normally one-dimensional: a single channel of input corresponds to a single channel of output. In imaging systems, it is mainly used for contrast adjustments. In printing, the tone transfer curve is also used to modify images to compensate for dot gain.

TTC. Tone transfer curve.

U

UBIN. A data type for architecture syntax, indicating one or more bytes to be interpreted as an unsigned binary number.

UTC. Coordinated Universal Time.

UTF-16. Unicode Transformation Format, 16-bit encoding form, which is designed to provide code values for over a million characters

UTF-16BE. UTF-16 that uses big-endian byte order; this is the byte order for all multibyte data within AFP data streams. The byte order mark is not necessary when the data is externally identified as UTF-16BE (or UTF-16LE).

UTF-16LE. UTF-16 that uses little-endian byte order. The byte order mark is not necessary when the data is externally identified as UTF-16LE (or UTF-16BE).

V

vector graphics. A vector has a defined starting point, a designated direction and a specified distance. Vector graphics are line-based graphics where, vectors determine how straight and curved lines are shaped between specific points. The lines and the colors fill the areas enclosed by the lines make up the picture.

W

white point. One of a number of reference illuminants used in colorimetry to define the color white.

Depending on the application, different definitions of white are needed to give acceptable results. For example, photographs taken indoors may be lit by incandescent lights, which are relatively orange compared to daylight. Defining white as daylight gives unacceptable results when attempting to color-correct a photograph taken with incandescent lighting.

X

XYZ color space. CIEXYZ color space.

Y

YCbCr. A color space that approximately models how color is interpreted by the human visual system, with an intensity value and two color values. Color JPEG images almost always use the YCbCr color space.

Yxy color space. A color space belonging to the XYZ base family that expresses the XYZ values in terms of x and y chromaticity coordinates, somewhat analogous to the hue and saturation coordinates of HSV space.

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