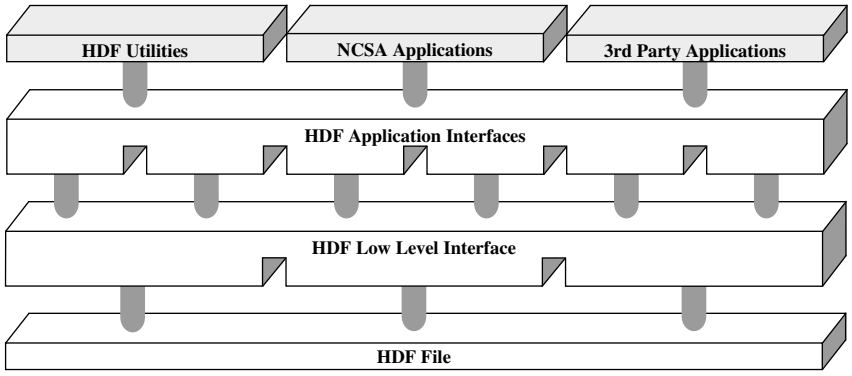
Chapter 4

HDF Utilities and Software Applications

4.0 Chapter Overview

At its highest level of interaction, HDF supports a collection of utilities, applications, and third-party commercial products (See FIGURE 4.0a). Utilities are typically short programs used to perform a single operation on an HDF file or its contents. All HDF utilities are executed through a simple "UNIX-like" command line interface. On a larger scale, NCSA applications and third-party commercial products are multi-purpose programs that provide sophisticated graphical user interfaces (GUIs) for extracting, analyzing, and storing data in HDF files.

FIGURE 4.0a **HDF supports a variety of utilities, applications and third party commercial products.**



Chapter 4 introduces the HDF utilities, demonstrates a few of their many command line options, and concludes with a table of freely available NCSA software and the data models they support.

4.1 Introducing the HDF Utilities

All ***HDF utilities*** are small application programs executed through a command line interface. In general, HDF utilities make it possible for you to perform common operations without requiring you to write your own programs.

There are currently 14 different utilities which, generally speaking, fall into three categories: inquiry utilities, conversion utilities, and compression utilities (See TABLE 4A). ***Inquiry utilities*** are primarily used to examine the contents of an HDF file. For example, the **hdfls** utility lists all the data elements contained in an HDF file. ***Conversion utilities*** include a variety of programs for converting between different HDF formats and raw data formats. Finally, the ***compression utilities*** are useful for compressing HDF files using standard compression algorithms and compacting techniques.

TABLE 4A **Utilities included in the HDF distribution.**

Type		Utility	Purpose
Inquiry		hdfls	Displays the tags and ref numbers for the data elements contained in a file.
		hdfed	Invokes and HDF editor which allows you to browse through HDF files and/ or manipulate the data elements.
		hdfseq	Displays sequences of 8-bit images directly to the screen.
Conversion	**Raw to HDF**	r8tohdf	Converts raw 8-bit images to HDF raster image sets and writes them to a file.
		paltohdf	Converts raw palettes to HDF format and writes them to file.
		r24hdf8	Converts raw 24-bit images to 8-bit raster image sets and writes them to file.
		fp2hdf	Converts 32-bit floating-point data to scientific data or 8-bit raster image sets.
	HDF to Raw	hdftor8	Converts HDF raster image sets to raw format and separates them into image files and palette files.
		hdftopal	Converts palettes in HDF files to raw format and writes them to separate files.
	HDF to HDF	ristosds	Converts several 8-bit raster images to one 3D scientific data set.
		hdf24hdf8	Converts 24-bit HDF images to 8-bit raster image sets.
		fp2hdf	Converts 32-bit floating-point data to scientific data or 8-bit raster image sets.
Compression		hdfpack	Condenses HDF files by removing the empty spaces left by deleted objects.
		hdfcomp	Compresses 8-bit raster image in an HDF file using run-length encoding or IMCOMP compression.

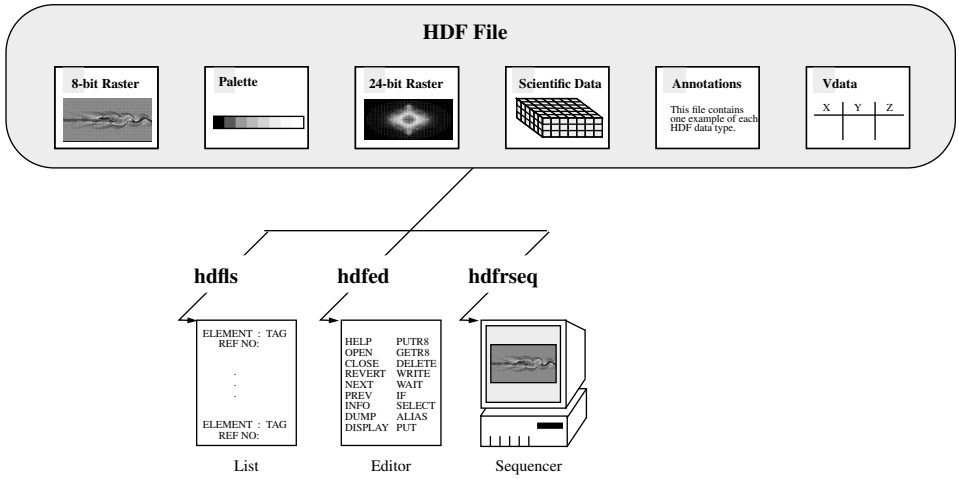
Each HDF utility supports a number of command line options. These options are exercised in a similar manner to UNIX commands, i.e. they are specified by a letter proceeded by a dash. For example, the **hdfls** utility will list the contents of an HDF file in ascending order if a −o is included on the command line. By default, hdfls lists information in descending numerical order.

In the following sections, you will explore each utility and its command line options. After reading this chapter, you will know enough about the HDF utilities to perform common operations on simple HDF files, convert data to and from the HDF format, and execute rudimentary compression operations. If, after becoming familiar with the information presented here, you need to access more information for a particular utility, consult the HDF User's Guide.

4.2 The HDF Inquiry Utilities

HDF supports three inquiry utilities (See FIGURE 4.2a). The “HDF list” utility or **hdfls** displays the contents of an HDF file by listing its tag and reference pairs. The “HDF editor” or **hdfed** provides an edit mode for examining or in some cases, modifying HDF data elements. Finally, the “HDF sequencer” or **hdfseq** extracts 8-bit images from HDF files and prints them to the local screen.

FIGURE 4.2a **HDF supports three command line inquiry utilities.**



hdfls

The **hdfls** utility lists the tag and reference number for every data element stored in the named file. A ***tag*** identifies the type of data element, and the ***reference number*** distinguishes a specific data element from the other elements with a similar tag. For example, HDF tags will differentiate raster data from Vdata, but only reference numbers can differentiate one raster element from another.

Consider a 64-bit floating point array stored as a scientific data set in a file called `example.hdf`. To display the contents of this file, enter the following command line:

```
hdfls example.hdf
```

The information printed to the screen would appear something like this:

```
example.hdf:
Version Descriptor    : (tag 30)
        Ref nos: 1
Number type           : (tag 106)
        Ref nos: 2
SciData description   : (tag 701)
        Ref nos: 2
Scientific Data       : (tag 702)
        Ref nos: 2
Numeric Data Group    : (tag 720)
        Ref nos: 2
```

At this point it is not necessary to identify the purpose of each data element in this file. Notice however, that each element is given a different tag and that reference numbers are often repeated for data elements with different tags. It is also important when retrieving data to note that reference numbers are not necessarily assigned in any order. For a more information on the form and function of data elements, their tags, and using reference numbers to retrieve data elements, see the HDF User's Guide.

hdfed

The HDF edit utility **hdfed** is an editor loosely modeled after "ed," the Unix line editor. After invoking the **hdfed** utility, the terminal screen functions as a window into an HDF file. Through this window, you can access the same information provided by **hdfls** or perform rudimentary operations on the data itself. These operations include browsing among elements in a file, displaying images, and dumping, deleting, copying or annotating data.

The **hdfed** utility is designed for users who need to manipulate HDF files at the data element level. It is not designed to provide a high-level view of HDF files. To use **hdfed** effectively requires a high level of familiarity with the format of HDF files, therefore it is not recommended for users who are unfamiliar with low level HDF components. See the HDF User's Guide for more complete instructions.

hdfseq/hdfrseq

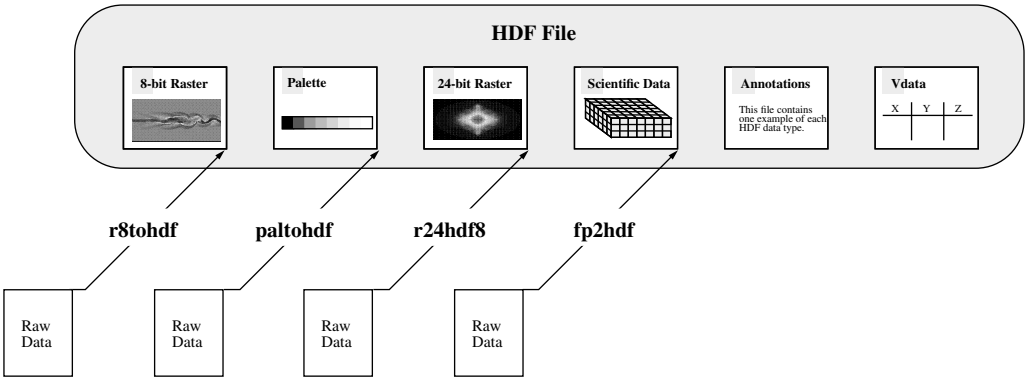
The HDF 8-bit image sequencer, otherwise known as **hdfseq**, displays one or more 8-bit images in a specified sequence. This sequencer is limited to Sun consoles and SGI's with access to the gllib library. Furthermore, all files must reside on the local machine and if more than one file is listed, **hdfseq** prints the images in the order in which their files are specified. Each new image will overwrite the preceding image on the screen.

Although **hdfseq** and **hdfrseq** perform essentially the same function, **hdfrseq** displays remote files on local Macintosh displays. The **hdfrseq** utility uses ICR, a protocol supported by NCSA MacTelnet, to transport data between machines. For more information on **hdfseq** or **hdfrseq**, consult the HDF User's Guide.

4.3 The Raw Data to HDF Conversion Utilities

HDF provides four utilities for converting data between raw data format and HDF files (See FIGURE 4.3a). The "raster 8 to HDF" utility or **r8tohdf** will convert raw two-dimensional 8-bit data into an 8-bit raster image set. The "palette to HDF" or **paltohdf** provides a similar feature for converting a raw 8-bit palette into HDF format. The "raster 24 to HDF 8" utility or **r24tohdf**8 converts raw 24-bit image data into 8-bit raster image sets. Finally, the "floating point to HDF" or **fptohdf** converts raw 32-bit floating point data into raster images and/or scientific data sets.

FIGURE 4.3a **HDF supports four Raw Data to HDF conversion utilities.**



Although each of the raw data to HDF conversion utilities are introduced here, for more detailed information on a particular utility, consult the HDF User's Guide.

r8tohdf

The r8tohdf utility converts raw 8-bit raster images into HDF raster image sets. To convert a raw raster file to an HDF file requires a command line operation similar to the following:

```
r8tohdf rows cols raster_set.hdf [-p palette_file.raw] raster_file.raw
```

Note that r8tohdf can add a palette to a raster image set if one is specified on the command line. Consider a 256 row x 512 column raw raster image stored in a file called raster.raw. Assume its palette is stored in raw form in a file called palette.raw. To create a single raster image set by including data from both files, use the following command line operation:

```
r8tohdf 256 512 raster_set.hdf -p palette.raw raster.raw
```

paltohdf

The **paltohdf** utility converts raw palette files to HDF format. The incoming palette is assumed to have 768 bytes organized in the following order: 256 red values, 256 green values, and 256 blue values. Once the palette is converted to HDF format, the palette data is interlaced as follows: RGB, RGB, ...RGB. To convert a raw palette into an HDF palette using **paltohdf**, execute a command line similar to:

```
paltohdf palette_file.raw palette_file.hdf
```

r24hdf8

The **r24hdf8** utility is useful for converting 24-bit images into 8-bit raster image sets containing palettes. The raw raster file is assumed to contain 8-bit color component values ordered in the following manner: RGB, RGB, ...RGB. To quantize a 24-bit image, execute a command line similar to the following:

```
r24hdf8 cols rows raster24_file.raw raster8_file.hdf
```

fp2hdf

The floating-point to HDF conversion utility, or **fp2hdf**, converts raw 32-bit or 64-bit floating-point data into an HDF file containing an 8-bit raster image set, a 32-bit floating point scientific data set, or both. The input data may originate from a text file, binary file or HDF file. To convert text files containing 2-dimensional data, the data must appear in the following format:

Format	Planes	Rows	Columns	Row Location	Column Location	Data
TEXT	1	10	20	row_1 row_2 . . . row_10	col_1 col_2 . . . col_20	data_1 data_2 . . . data_200

As an example of how to use fp2hdf, consider a text file containing raw 32-bit floating point data. To convert the raw file into an HDF file containing both an 8-bit raster image set and a scientific data set, the command line operation should appears as follows:

```
fp2hdf float32.raw –o float32.hdf [–r] [–f]
```

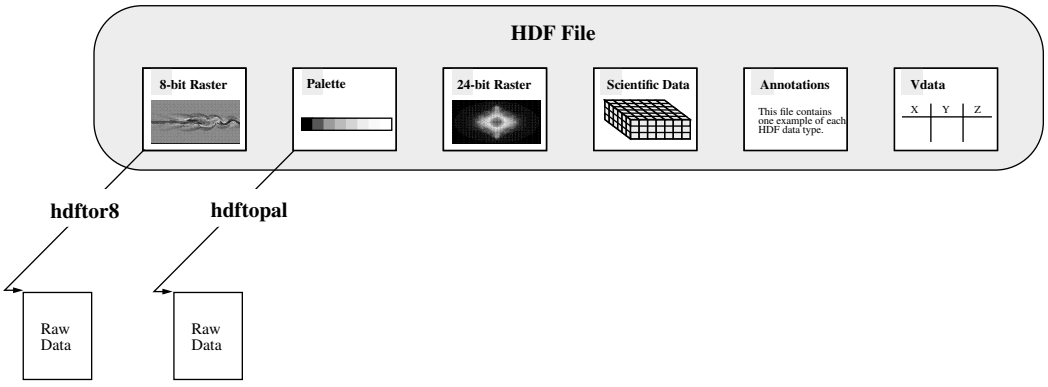
where the -r specifies the creation of a raster data set, and the -f specifies the creation of a scientific data set.

The **fp2hdf** utility also provides additional options for converting raw float-point data to HDF format. To learn more about these options, consult the HDF User's Guide or execute the command line: `fp2hdf –help`. To learn more about converting floating point data from scientific data sets to raster image sets, see Section 5.5, HDF to HDF Conversion Utilities.

4.4 The HDF to Raw Data Conversion Utilities

HDF supports two HDF to raw data conversion utilities, **hdftor8** and **hdftopal** (See FIGURE 4.4a). The **hdftor8** utility converts 8-bit raster image sets into raw data by writing the image and palette data to separate files. The **hdftopal** utility converts palettes stored in HDF files to palettes stored in raw data files. Both utilities are more completely described in the HDF User's Guide.

FIGURE 4.4a **HDF supports two HDF to Raw Data conversion utilities**



hdftor8

The **hdftor8** utility extracts raster image sets from HDF files, separates them into image data and palette data, and saves them to separate raw data files. To convert a single raster image set stored in an HDF file, execute a command line similar to the follows:

```
hdftor8 raster8_set.hdf [-r image_file.raw][-p palette_file.raw]
```

Keep in mind that when converting from HDF to raw data files the dimension record is not stored with the image data. As a result, it's best to make a note (mental or otherwise) of the image dimensions before deleting any HDF files.

hdftopal

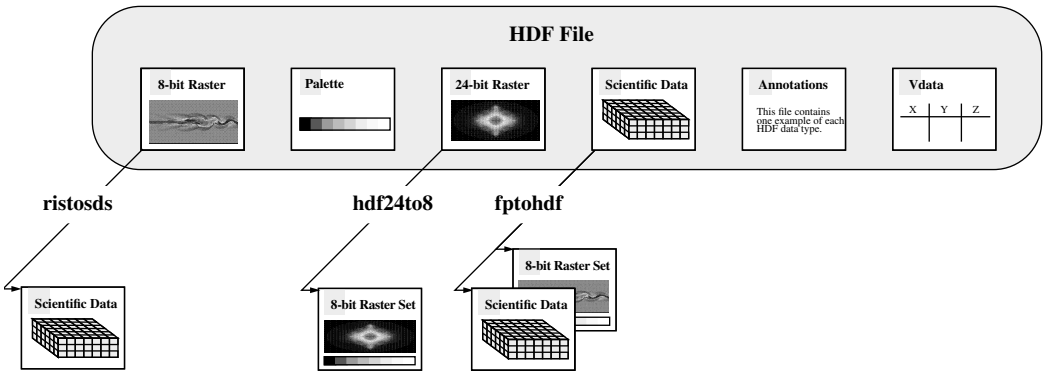
The **hdftopal** utility is used to convert palettes stored in HDF files to palettes stored in raw data files. Although HDF stores palettes by interlacing their color components, the raw file will contain a palette stored as 256 red components, followed by 256 green components, and finally 256 blue components. A typical **hdftopal** command line operation appears as follows:

```
hdftopal palette_file.hdf palette_file.raw
```

4.5 The HDF to HDF Conversion Utilities

There are three HDF to HDF conversion utilities, **ristosds**, **hdf24hdf8** and **fp2hdf** (See FIGURE 4.5a). The **ristosds** utility converts a group of raster images into a 3-dimensional scientific data set. The **hdf24hdf8** utility converts 24-bit raster image sets into 8-bit raster images using 8-bit palettes. Finally, the **fptohdf** utility converts 32-bit scientific data sets into files containing 8-bit raster image sets, scientific data sets, or both. This utility is the same utility outlined in the raw data to HDF conversion section, except that the data originates from an HDF file instead of a raw data file.

FIGURE 4.5a **HDF supports three HDF to HDF data conversion utilities.**



ristosds

The **ristosds** utility converts a series of HDF raster image files into a single HDF scientific data set. The resulting scientific data set is a 3-dimensional array whose width and height are equal to the dimensions of the raster images. Consequently, all raster images in a series must have the same dimensions. The third dimension of the array, or its length, is determined by the total number of images included in the conversion.

If the conversion is also to include a palette in the operation, the palette must appear in the first HDF file. All subsequent palettes are ignored. The command line for ristosds takes the following form:

```
ristosds raster_file.hdf {...raster_file.hdf} -o sds_file.hdf
```

Consider a directory containing twenty HDF files named storm001, storm002,... storm020. Assume each file contains a single raster image set with a 100x200 image. To combine this series of images into one scientific data set, execute the following command line:

```
ristosds storm*.hdf -o storm.hdf
```

hdf24to8

The **hdf24to8** utility quantizes a 24-bit raster image set into an 8-bit raster image set containing an 8-bit palette. All **hdf24to8** operations take the following form:

```
hdf24to8 raster24_file.hdf raster8_file.hdf
```

fp2hdf

The **fp2hdf** utility previously described in Section 4.3, can also convert 32-bit floating-point data sets into HDF files containing 8-bit raster image sets, 32-bit floating point scientific data set, or both.

As an example, consider an HDF file containing 32-bit floating point data. To convert the data into a raster image set with a palette, the command line operation appears as follows:

```
fp2hdf float32.hdf -o raster8.hdf [-r] [-p palette.hdf]
```

Notice that in order to add a palette to the raster image set, the palette data must also originate from an HDF file.

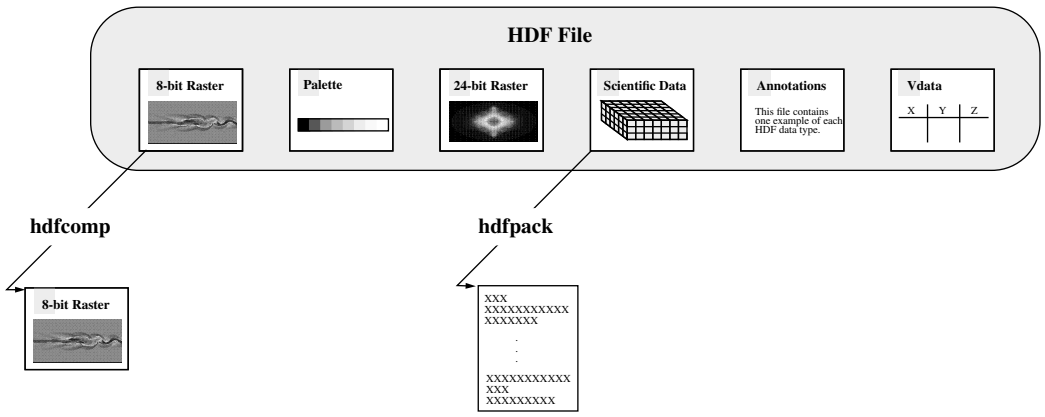
The **fp2hdf** utility provides a number of additional options for converting from float-point data to raster images. To learn more about converting HDF floating point data, see the HDF User's Guide.

4.6 The HDF Compression Utilities

There are two HDF compression utilities, **hdfpack** and **hdfcomp** (See FIGURE 4.5a). The **hdfpack** utility condenses the size of an HDF file by removing the spaces left behind by deleted data elements. The **hdfcomp** utility also condenses HDF file, but only those containing 8-bit raster image

sets. The **hdfcomp** utility compresses 8-bit raster image data using IMCOMP compression or run-length encoding.

FIGURE 4.6a **HDF supports two compression utilities.**



hdfpack

The **hdfpack** utility condenses HDF files by removing the spaces left behind by deleted data elements. It works by reading the existing data elements from the unpacked file and writing them out to a new or "packed" file. All hdfpack operations take the following form:

```
hdfpack unpacked_file.hdf packed_file.hdf
```

The **hdfpack** utility also provides a number of additional options for customizing the way HDF files are compacted. To learn more about these options, consult the HDF User's Guide.

hdfcomp

The **hdfcomp** utility reads encompassed 8-bit raster images from HDF files and writes compressed 8-bit raster images to HDF files. Compressed images are appended to the output file, if the output file exists. All **hdfcomp** command line operations take the following form:

```
hdfcomp uncompress_raster.hdf [-c | -i] compress_raster.hdf
```

where -c compresses the image using run-length encoding and -i compresses the image using IMCOMP compression. To use IMCOMP compression the file containing the uncompressed data must also contain a palette. For more information on **hdfcomp**, see the HDF User's Guide.

4.7 Introducing Applications that Support HDF

Generally speaking, there are two categories of applications that support HDF; those that are freely available through NCSA, and those that are available through commercial vendors. Of those applications available from NCSA, there are supported and unsupported applications. Supported applications are full-scale programs typically released with source code and full documentation (See TABLE). Unsupported NCSA applications are applications developed outside

NCSA. These applications are not official NCSA releases and are therefore not rigorously tested or documented. They are, however, made available through the HDF/contrib directory via the NCSA ftp server. Finally, as HDF improves, so does the outlook for more sophisticated commercial applications. Check with your software distributor for more details.

TABLE 4B **NCSA supported applications.**

Platform	Utility	Purpose	Supported Data Models	Version
Unix	**X-Image**	Displays and analyzes raster images using common color manipulation operations.	8-bit Raster Palette Scientific Data (2D only)	HDF 3.2 (or greater)
	X-DataSlice	Displays and analyzes rasters images created by slicing and scaling 3-dimensional floating point arrays..	8-bit Raster Palette Scientific Data	HDF 3.2 (or greater)
	Reformat	Converts non-HDF files (FITS, TIFF, GIF, raw raster, ASCII, SUN, and X-Windows dumps) into HDF files.	8-bit Raster Scientific Data	HDF 3.1 (or greater)
	Collage	Permits multiple platform synchronized viewing and analysis of raster images, animations, and floating-point data via a TCP/IP network connection.	8-bit Raster Palette Scientific Data (2D only) Annotation	HDF 3.2 (or greater)
SGI	**Polyview**	Creates and renders 3-dimensional objects using polygonal data.	Palette Scientific Data Vdata	HDF 3.1 (or greater)
	AlVis	Uses the alpha-shapes algorithm to create hulls from potentially unconnected points.	Palette Vdata	HDF 3.1 (or greater)
Macintosh	**Image**	Displays and analyzes of raster images using common color manipulation operations.	8-bit Raster Palette Scientific Data (2D only) Annotation	HDF 3.1 (or greater)
	DataScope	Analyzes and operates upon 2-dimensional arrays of floating-point numbers.	8-bit Raster Palette Scientific Data (2D only) Annotation	HDF 3.1 (or greater)
	PalEdit	Customizes 8-bit palettes.	Palette	HDF 3.2 (or greater)
	Layout	Arranges the screen display for photographing related images, spreadsheets, and palettes on a single canvas.	8-bit Raster Palette	HDF 3.1 (or greater)
	Import2HDF	Converts non-HDF files (FITS, TIFF, GIF, raw raster, and ASCII) into HDF files.	8-bit Raster Palette Scientific Data	HDF 3.1 (or greater)
	Collage	Synchronizes the viewing and analysis of raster images, animations, and floating-point data via a TCP/IP network connection.	8-bit Raster Palette Scientific Data (2D only) Annotation	HDF 3.2 (or greater)
IBM PC	**PC Show**	DOS application that displays 8-bit raster images using EGA, VGA or Rev512.	8-bit Raster Palette	HDF 3.2 (or greater)
	Audible Image	Displays and animates images using palettes and sound.	8-bit Raster Palette Scientific Data (2D only)	HDF 3.2 (or greater)
	Collage	MSWindows app that synchronizes the viewing and analysis of raster images, animations, and floating-point data via a TCP/IP network.	8-bit Raster Palette Scientific Data (2D only) Annotation	HDF 3.2 (or greater)