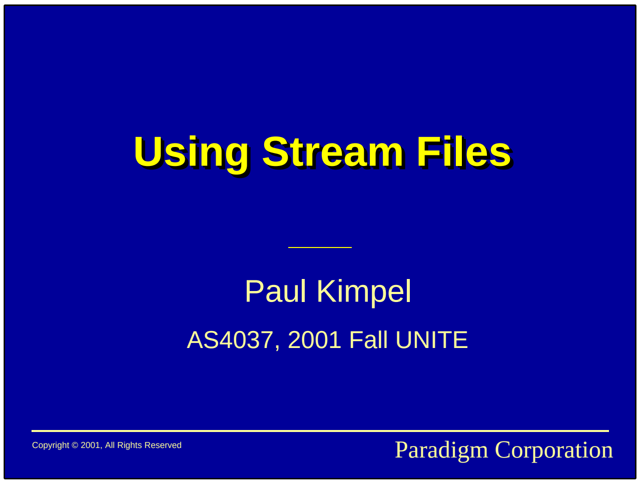


Using Stream Files

Paul Kimpel

AS4037, 2001 Fall UNITE

Copyright © 2001, All Rights Reserved

Paradigm Corporation

Using Stream Files

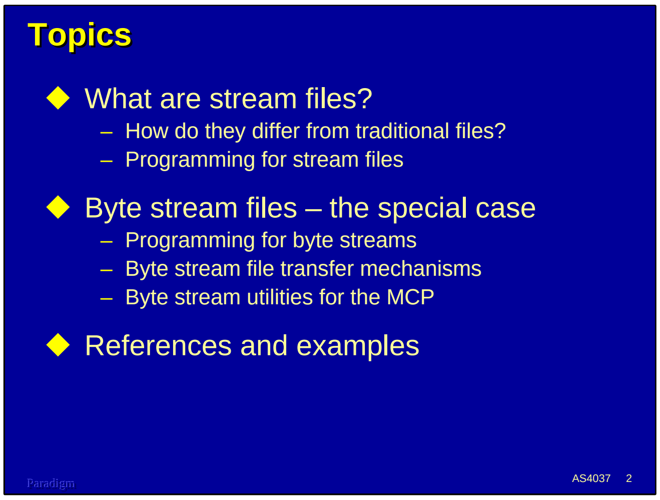
2001 Fall Unite Conference, Phoenix, Arizona.

Paul Kimpel

Paradigm Corporation
San Diego, California

http://www.digm.com

e-mail: paul.kimpel@digm.com



Topics

- What are stream files?
  - How do they differ from traditional files?
  - Programming for stream files
- Byte stream files – the special case
  - Programming for byte streams
  - Byte stream file transfer mechanisms
  - Byte stream utilities for the MCP
- References and examples

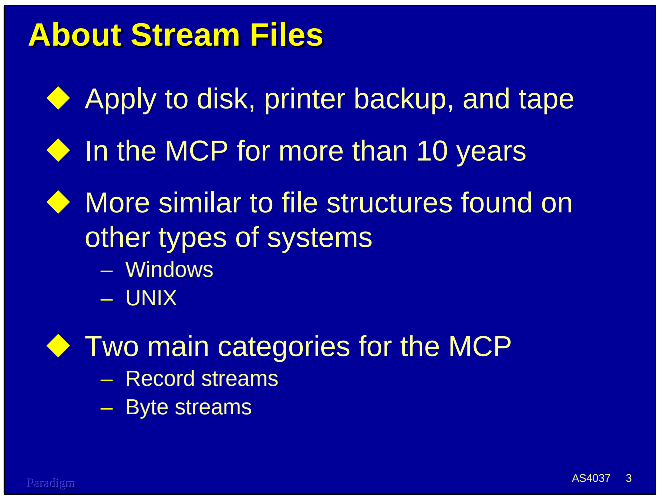
Paradigm AS4037 2

This presentation discusses stream files and their use under the Unisys ClearPath MCP.

We'll talk about how stream files differ from traditional MCP files, and the restrictions that apply to streams that do not apply to other kinds of files. We'll also talk about the file attributes that are relevant to stream files and how you program for streams.

Stream files are interesting and generally applicable to MCP applications, but there is a special case – *byte stream files* – that are the most interesting and useful. We'll spend most of the time taking about the byte stream version, including how you program specifically for byte streams, utilities for them in the MCP, and file transfer mechanisms.

Finally, we'll briefly examine some examples of Algol and COBOL programs that use byte stream files, and point out areas of the Unisys documentation where you can get more information.



About Stream Files

- Apply to disk, printer backup, and tape
- In the MCP for more than 10 years
- More similar to file structures found on other types of systems
  - Windows
  - UNIX
- Two main categories for the MCP
  - Record streams
  - Byte streams

Paradigm AS4037 3

Stream files are a variation on the file structures we have traditionally used with the MCP. They have been around for more than ten years, at least since Mark 3.9.

Stream methods can be applied to files on disk, printer backup, or tape. In this presentation, we'll focus on stream files for disk and, to a lesser degree, for printer backup.

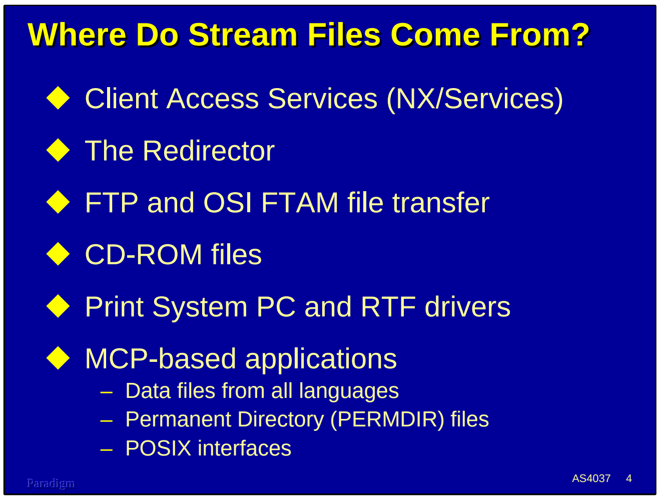
While the ClearPath MCP has a very rich I/O subsystem, the way that files are traditionally structured under the MCP differs quite a bit from the way files are typically structured on other systems. In particular, traditional MCP file structures are different from, and often incompatible with, files from Windows and UNIX systems.

Files on these other systems are often unstructured, without the formal record and block formats we are used to with the MCP. In other words, these unstructured files are stored simply as a "stream" of data.

The MCP supports two categories of stream files that bridge the gap between our traditional file structures and the unstructured approach common to other systems.

- Record streams are essentially traditional MCP files without blocks
- Byte streams are a special case of record streams, and are essentially the same as the unstructured files on other systems.

Since file interchange with other systems (especially using FTP and Client Access Services) are currently such important topics, we will talk about byte stream files in some detail.



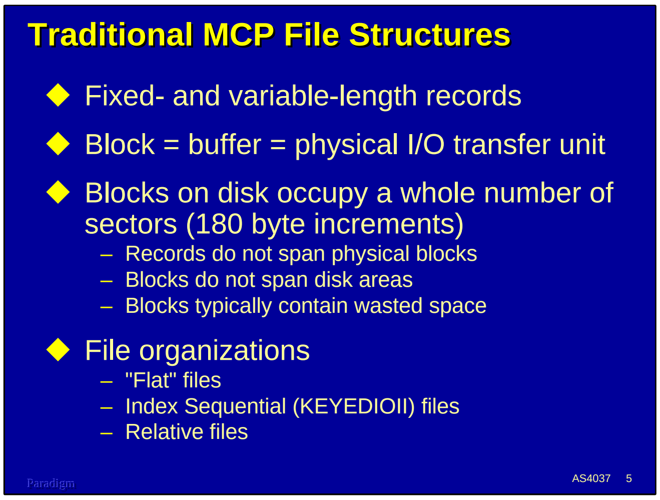
Where Do Stream Files Come From?

- Client Access Services (NX/Services)
- The Redirector
- FTP and OSI FTAM file transfer
- CD-ROM files
- Print System PC and RTF drivers
- MCP-based applications
  - Data files from all languages
  - Permanent Directory (PERMDIR) files
  - POSIX interfaces

Paradigm AS4037 4

The MCP environment can access stream files from a number of sources.

- A common source of stream files is Client Access Services. When you transfer a file to an MCP shared directory using Microsoft Networking, by default you get a byte stream file. There are also named pipes that can create either byte streams or traditional files on an MCP-based share.
- The Redirector is the complement to Client Access Services. It allows you to read and create files from an MCP application on a remote share, say on a Windows file server, or any other system that supports Server Message Block (SMB) protocols. Since you are directly accessing files stored under another operating system, they are not traditional MCP files, and MCP applications must access them as byte streams.
- Byte stream files can also be created by both FTP and OSI FTAM.
  - Files generated by incoming FTP transfers with FTPSTRUCTURE=FTPFILE are stored as byte streams. This includes the FTP mapping styles RAW and FTPDATA.
  - While not as commonly used as FTP, OSI FTAM can also access and transfer byte stream files.
- Files read directly from ISO 9660 and Joliet CD-ROM media are always accessed as byte stream files.
- The Print System can both generate and print byte stream files. You can specify file attributes that will cause the Print System to generate byte stream files directly instead of the standard printer backup file format. Files generated by the PC and RTF printer drivers in the PRINTSUPPORT library are byte stream files. The Print System can also read stream data files generated by other systems and route them for local or remote printing.
- MCP-based applications in all languages can generate and read stream files. We will discuss later how this can be done using the Algol and COBOL-74/85 languages. Files produced by the POSIX interfaces (typically used with C) inherently read and write byte stream files. In addition, permanent directories themselves are considered to be stream files.



Traditional MCP File Structures

- Fixed- and variable-length records
- Block = buffer = physical I/O transfer unit
- Blocks on disk occupy a whole number of sectors (180 byte increments)
  - Records do not span physical blocks
  - Blocks do not span disk areas
  - Blocks typically contain wasted space
- File organizations
  - "Flat" files
  - Index Sequential (KEYEDIOII) files
  - Relative files

Paradigm AS4037 5

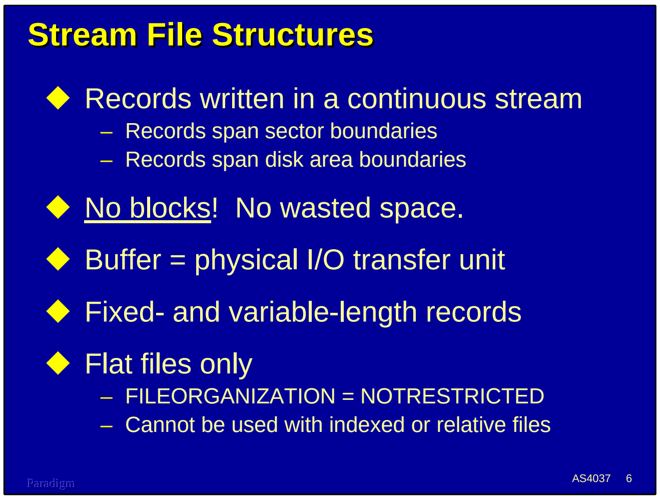
To understand how stream files relate to traditional MCP files, it's helpful to consider how traditional disk files are structured.

Traditional files support both fixed- and variable-length records of various types as determined by the BLOCKSTRUCTURE attribute. All traditional files share the characteristic that records are wholly contained within blocks. A block always contains some whole number of records. The size of the block determines the size of the physical I/O buffer in memory and the size of the physical I/O transfer between memory and the disk device. Thus, there is a relationship in traditional files between logical record sizes and physical I/O sizes – physical I/Os are always at least as large as a record, and at least one record is always transferred in each physical I/O.

Another characteristic of disk files is that blocks always start on a 180-byte sector boundary and occupy a whole number of contiguous sectors. The reason for this is that disk devices can only address to a sector boundary. This leads to a number of consequences:

- While records may be of variable length, blocks for a given file are always of a fixed size.
- There is a resource/performance tradeoff between relatively large and relatively small blocks. Larger blocks reduce the number of I/Os (and often, dramatically reduce the program elapsed time), but require more memory while the file is open.
- Blocks must start on a disk sector boundary, but do not necessarily fill out a whole number of sectors. It is often the case that the block size is not an exact multiple of 180 bytes and there is some amount of space left over in the last sector for a block. This left-over space, or "block slop", is wasted. Good file design practices attempt to minimize this wasted space, but often cannot eliminate it.
- Because blocks are the unit of physical I/O transfer, blocks cannot span disk areas. For this reason, the MCP rounds up, if necessary, the program-specified area size for a file to the next whole multiple of sectors in a block.

In addition to the blocked behavior of disk files, the MCP supports a number of internal file layouts, as determined by the FILEORGANIZATION attribute. This attribute describes the internal organization of the file at a level higher than records and blocks. File organizations break down into three main categories: normal or "flat" files, index sequential files of a couple of varieties, and COBOL-74/85 relative organization files.



Stream File Structures

- Records written in a continuous stream
  - Records span sector boundaries
  - Records span disk area boundaries
- No blocks! No wasted space.
- Buffer = physical I/O transfer unit
- Fixed- and variable-length records
- Flat files only
  - FILEORGANIZATION = NOTRESTRICTED
  - Cannot be used with indexed or relative files

Paradigm AS4037 6

By contrast, stream files have a number of significant differences.

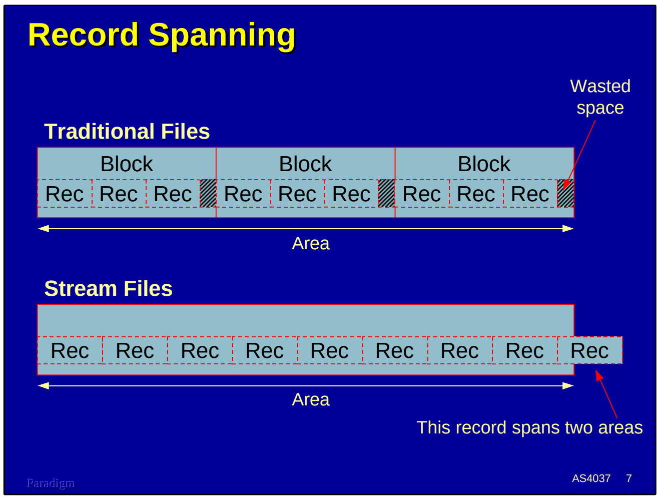
- The most significant difference between stream and traditional files is that stream files *do not have blocks!* In fact, specifying BLOCKSIZE for a stream file results in a non-fatal attribute error. Stream files completely separate the concepts of logical records and physical I/Os. Physical disk I/Os must still start on a sector boundary and cover a whole number of sectors, but logical records are not constrained to a pre-determined block size and can span area boundaries, hence *there is no wasted space*.

- In a stream file, logical records are simply written continuously across the allocated space for a file. There are no delimiter codes between records, just as with traditional files. Individual records span sector boundaries, and can even cross area boundaries. The MCP Logical I/O routines automatically fragment and reassemble records as necessary – application programs simply perform READs and WRITEs the same way they do with traditional files.

- Although stream files do not support the concept of blocks, there is still a memory buffer area and a physical I/O transfer process between memory and the disk device. A logical file still has I/O buffers associated with its File Information Block (FIB), but in the default case, the MCP determines the size of these.

- Stream files support all of the fixed- and variable-length formats except BLOCKSTRUCTURE=LINKED.

- The primary restriction on stream files is that they are for flat file organizations only. NOTRESTRICTED and RELATIVE are the only values of FILEORGANIZATION allowed.



Record Spanning

Wasted space
Traditional Files
Block
Block
Block
Rec Rec Rec Rec Rec Rec Rec Rec Rec
Area
Stream Files
Rec Rec Rec Rec Rec Rec Rec Rec Rec
Area
This record spans two areas
Paradigm
AS4037 7

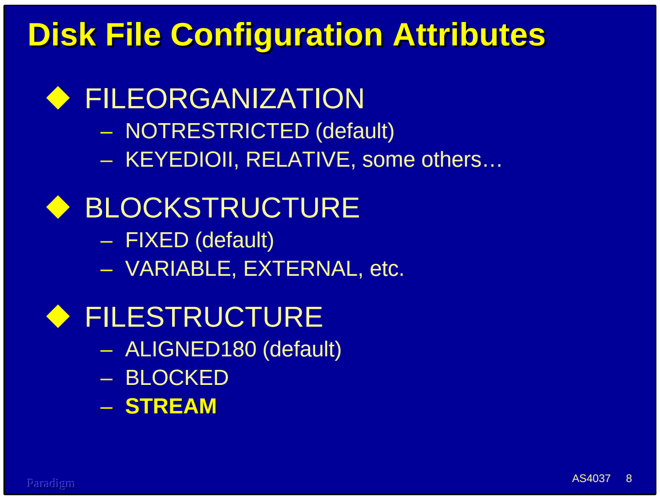
This diagram shows the difference in record and block structures for traditional and stream files.

With traditional files, there is no record spanning. Records fit entirely within blocks, blocks fit entirely within a whole number of sectors and within the space allocated for a disk area. If the block size is not an exact multiple of 180 bytes, there is wasted space on disk at the end of each block.

With stream files, there are no blocks, and the records are simply stored contiguously in the disk area. If the last record in an area does not fit, it is split. The part of the record that will fit in the area is written there; the rest of the record is written to the next area. Records and fragments of records are assembled in memory buffers and written to disk in 180-byte multiples. These buffers are typically a few thousand words long. You can control the size of these with the BUFFERSIZE attribute, but this sizing is normally left to the MCP.

Unlike traditional files, which always read or write whole records with each physical I/O, stream files may perform more than one physical I/O to read or write one logical record.

This example shows fixed-length records, but the behavior is exactly the same with variable-length records for both traditional files and streams.



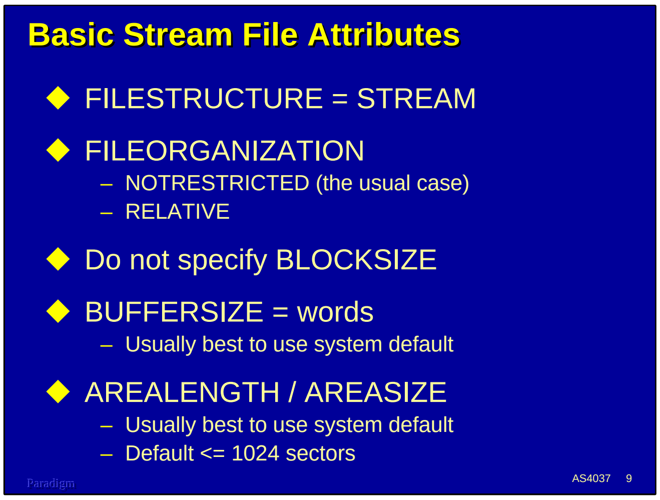
Disk File Configuration Attributes

- FILEORGANIZATION
  - NOTRESTRICTED (default)
  - KEYEDIOII, RELATIVE, some others…
- BLOCKSTRUCTURE
  - FIXED (default)
  - VARIABLE, EXTERNAL, etc.
- FILESTRUCTURE
  - ALIGNED180 (default)
  - BLOCKED
  - **STREAM**

Paradigm AS4037 8

Three file attributes control the general format and nature of disk files: FILEORGANIZATION, BLOCKSTRUCTURE, and FILESTRUCTURE.

- FILEORGANIZATION, as previously mentioned, describes the high-level organization of data within a file. There are three main classes of organization: normal or "flat" files, indexed sequential files, and relative files.
- BLOCKSTRUCTURE determines the format of records within a block. A more intuitive name for this attribute would probably be "recordstructure". It indicates whether the records are fixed length, variable length (and which of several varieties), or externally determined from the physical file medium.
- FILESTRUCTURE determines how the data is physically laid out on the disk. This attribute has three values:
  - `ALIGNED180`. This is the default layout and the one used by traditional files. Records are wholly contained within blocks, blocks are the physical unit of I/O transfer, all blocks start on a sector boundary, sectors are 180 bytes in size, and all blocks occupy a whole number of sectors. These files can be "reblocked" – that is, they can be read with a different block size than the one they were created with, as long as the original and new block sizes are integral multiples of the sector size.
  - `BLOCKED`. This is similar to ALIGNED180, but has some differences. Records are grouped in blocks, and blocks are written on sector boundaries, but the sectors are not required to be 180 bytes in size. Memory buffers and physical I/Os may be in multiples of the block size. FILEORGANIZATION must be NOTRESTRICTED. Reblocking is not allowed.
  - **`STREAM`**. *This is the attribute that makes a file a stream file.* As discussed previously, records are written to the disk in a continuous stream, spanning sector and area boundaries as necessary. Physical I/Os are buffered in memory and typically span multiple records. FILEORGANIZATION must be NOTRESTRICTED or RELATIVE. A feature somewhat like reblocking, using the ANYSIZEIO attribute, is supported.



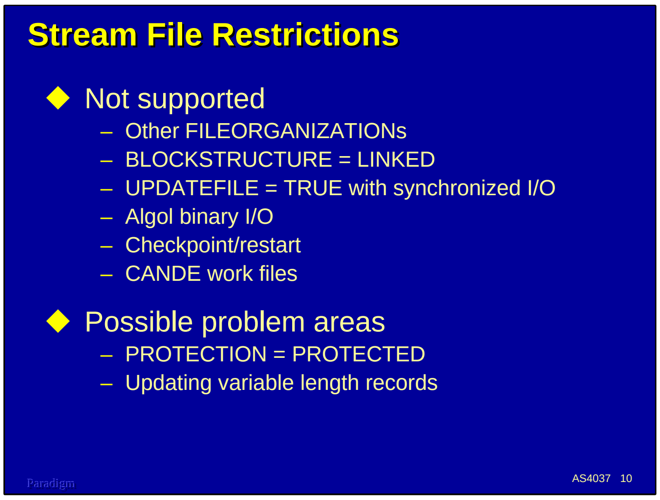
Basic Stream File Attributes

- FILESTRUCTURE = STREAM
- FILEORGANIZATION
  - NOTRESTRICTED (the usual case)
  - RELATIVE
- Do not specify BLOCKSIZE
- BUFFERSIZE = words
  - Usually best to use system default
- AREALENGTH / AREASIZE
  - Usually best to use system default
  - Default <= 1024 sectors

Paradigm AS4037 9

Several attributes deserve special consideration when using stream files.

- The FILESTRUCTURE attribute must have a value of STREAM. Since the default is ALIGNED180, this must be specified explicitly for the file.
- FILEORGANIZATION may be NOTRESTRICTED or RELATIVE. NOTRESTRICTED is the default, and for most applications, is the only value of interest.
- BLOCKSIZE may not be specified for a stream file. Attempting to do so causes a non-fatal attribute error at run time.
- BUFFERSIZE determines the number of *words* in memory buffers for the file and the size of physical I/O transfers to disk. This attribute can be read for any type of file at any time. It can be set when a file is closed for a FILESTRUCTURE of BLOCKED or STREAM. The Unisys documentation recommends that you normally let the MCP determine the buffer size automatically, but some programs may benefit from larger or smaller values. In general, for stream files, do not set this attribute to a value smaller than the size of one record plus two sectors. The default value will be between 2,000 and 5,000 words, depending on the amount of memory configured for your system. For details, see the discussion of BUFFERSIZE in the *File Attributes Programming Reference Manual* and the BUFFERGOAL option of the SF command in the *System Commands Operations Reference Manual*.
- AREALENGTH or AREASIZE. These attributes determine the physical size of disk areas, as for traditional files. AREALENGTH is specified in terms of FRAMESIZE units, while AREASIZE is specified in terms of records. The Unisys documentation recommends that, for stream files, the MCP determine this value. The MCP default will be the largest area size that is a multiple of MAXRECSIZE but not larger than 1,024 sectors. However, for very large files, you will probably want to override that default. For stream files, you will also usually want to set FLEXIBLE=TRUE. Note that AREASIZE is not meaningful for stream files if BLOCKSTRUCTURE is other than FIXED.



Stream File Restrictions

- Not supported
  - Other FILEORGANIZATIONs
  - BLOCKSTRUCTURE = LINKED
  - UPDATEFILE = TRUE with synchronized I/O
  - Algol binary I/O
  - Checkpoint/restart
  - CANDE work files
- Possible problem areas
  - PROTECTION = PROTECTED
  - Updating variable length records

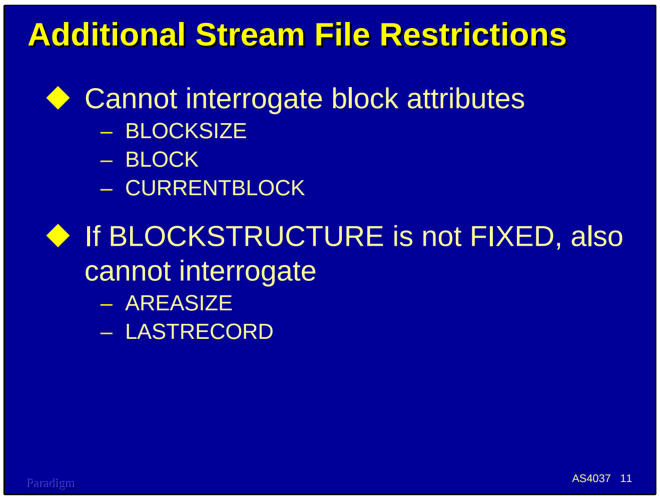
Paradigm AS4037 10

There are some restrictions on other file attributes used with stream files and how such files can be used.

- FILEORGANIZATION values other than NOTRESTRICTED and RELATIVE are not allowed.
- The BLOCKSTRUCTURE value LINKED (normally used only by FORTRAN) is not allowed. All other BLOCKSTRUCTURE values can be used with stream files.
- The combination of update I/O (UPDATEFILE=TRUE) and synchronized I/O (SYNCHRONIZE=OUT or writes with the SYNCHRONIZE option) is not allowed. Attempting to do this turns off synchronization.
- Algol Binary I/O (using a "*" as the format part with a list) is not allowed.
- Programs cannot use checkpoint/restart facilities in the MCP if they have stream files open.
- CANDE does not support stream files. You cannot GET, MAKE, LIST, etc. a stream file from CANDE. You can, however, use Library/Maintenance commands (COPY, CHANGE, REMOVE, ALTER) and the PRINT command with stream files.
- Stream files *can* be listed, copied, etc. with SYSTEM/DUMPALL.

There are some other file uses that are potential problem areas when applied to stream files:

- Setting PROTECTION=PROTECTED will preserve the end-of-file position for open files across a system restart. However, for stream files, the EOF will be recovered to the end of the last sector written, which will typically be after the end of the last record written.
- If you rewrite a variable-length record and the size of the record differs from its original size, the MCP will generate a record length (data size) error.



Additional Stream File Restrictions

- Cannot interrogate block attributes
  - BLOCKSIZE
  - BLOCK
  - CURRENTBLOCK
- If BLOCKSTRUCTURE is not FIXED, also cannot interrogate
  - AREASIZE
  - LASTRECORD

Paradigm

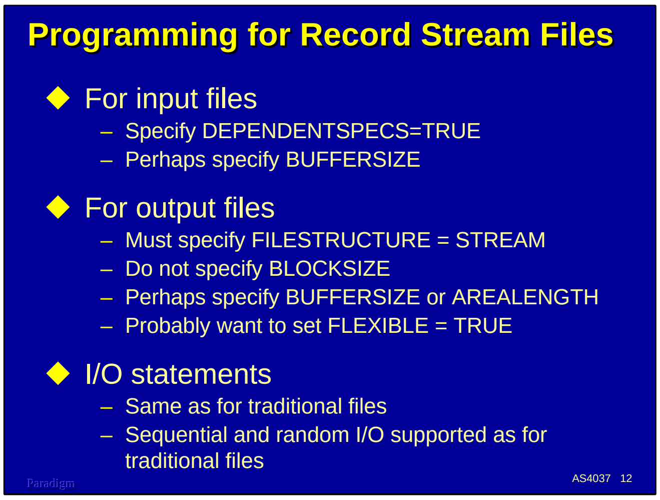
AS4037 11

Because stream files are not blocked like traditional files, attempting to access block-oriented attributes will result in a non-fatal attribute error at run time. These attributes include

- BLOCKSIZE
- BLOCK
- CURRENTBLOCK

If BLOCKSTRUCTURE has a value other than FIXED, access to two additional attributes is not valid, since in that case both attributes are in units of blocks rather than records.

- AREASIZE
- LASTRECORD



Programming for Record Stream Files

- For input files
  - Specify DEPENDENTSPECS=TRUE
  - Perhaps specify BUFFERSIZE
- For output files
  - Must specify FILESTRUCTURE = STREAM
  - Do not specify BLOCKSIZE
  - Perhaps specify BUFFERSIZE or AREALENGTH
  - Probably want to set FLEXIBLE = TRUE
- I/O statements
  - Same as for traditional files
  - Sequential and random I/O supported as for traditional files

Paradigm AS4037 12

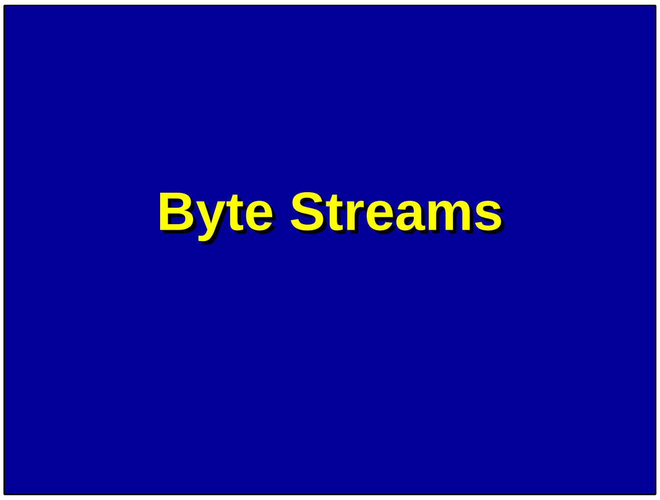
Programming for record-oriented stream files is easy. The major consideration is the value of several attributes when the file is opened.

For input files, the easiest thing to do is specify DEPENDENTSPECS=TRUE. Since FILESTRUCTURE, BLOCKSTRUCTURE, and FILEORGANIZATION are physical file attributes, they will be established automatically from the disk header. You can additionally specify BUFFERSIZE, if desired.

For output files, you must specifically declare the file as a stream file, along with record size and any other attributes you need to control.

- In most cases you can simply replace the BLOCKSIZE specification with FILESTRUCTURE=STREAM.
- Depending on your specific requirements, you may want to specify the number of words for memory buffers using BUFFERSIZE or the length of disk areas with AREALENGTH. In most cases, the MCP defaults for these attributes will suffice.
- If you are creating or extending a stream file, you will probably want to set FLEXIBLE=TRUE, since you do not typically control the area size of stream files.

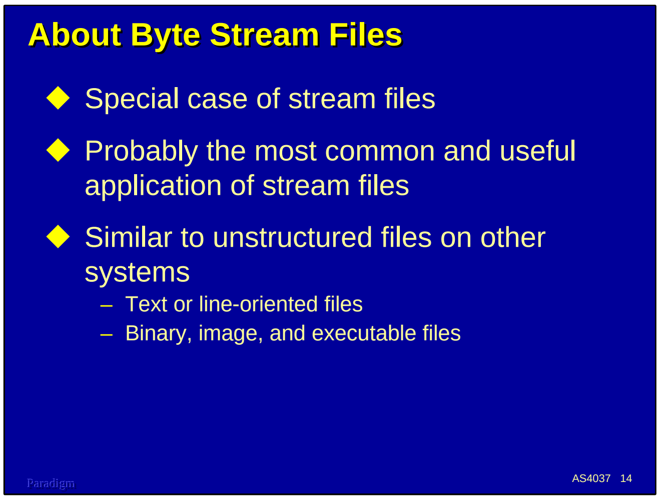
Once stream files are open, there are essentially no differences compared to the way you access traditional files. The syntax and semantics of READ, WRITE, SEEK, etc., are identical for stream files. Both random and sequential I/O are supported for stream files in the same way they are for traditional files.



Byte Streams

All of the foregoing discussion has been about stream files in general, and specifically about record-oriented streams. These record streams are useful and efficient. They avoid wasted space on disk and eliminate the need to perform block sizing calculations when designing files. Because the system determines buffer sizes based on total system memory, physical I/O for stream files is often at least as efficient as for traditional files. Except for some inconveniences (such as the inability to access them with CANDE), streams are arguably a superior file structure for many applications.

Even so, the discussion to this point has primarily been in preparation for a special case of stream files – *byte streams*.



About Byte Stream Files

- Special case of stream files
- Probably the most common and useful application of stream files
- Similar to unstructured files on other systems
  - Text or line-oriented files
  - Binary, image, and executable files

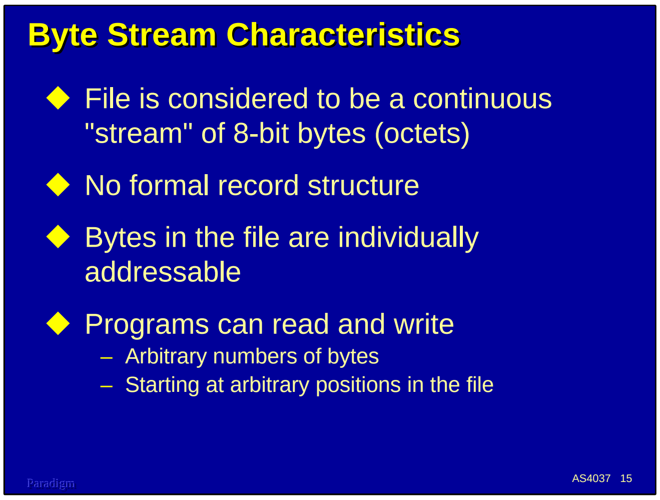
Paradigm AS4037 14

Byte streams are typically the most common and most useful application of stream file structures. They closely resemble the unstructured nature of files for other systems, and are usually compatible with them. Such files include:

- Text or line-oriented files, e.g., those produced by NotePad and other text editors.
- Binary byte streams of all kinds. These include application specific file formats, bitmaps and other image files, and executable files for other systems.

Given the ease and increasing importance of file transfer between the MCP and other operating systems, and the excellent integration with Microsoft Windows that is a hallmark of the ClearPath architecture, the ability to generate and process byte streams directly in MCP applications is extremely useful and often necessary. Byte streams can also be useful in some applications that are solely MCP based.

The remainder of this presentation will focus on these byte streams.



Byte Stream Characteristics

- File is considered to be a continuous "stream" of 8-bit bytes (octets)
- No formal record structure
- Bytes in the file are individually addressable
- Programs can read and write
  - Arbitrary numbers of bytes
  - Starting at arbitrary positions in the file

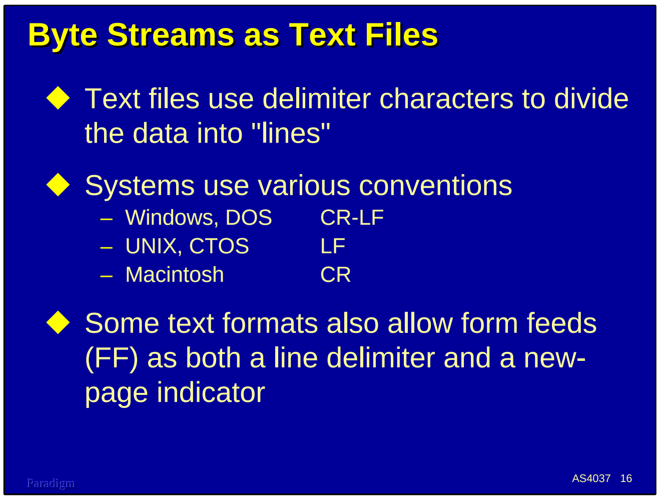
Paradigm

AS4037 15

A byte stream file is simply a stream of contiguous bytes. The operating system assumes no record or block structure. Any structure within the file must be handled by the application programs reading and writing the file.

Another important characteristic of byte streams is that the bytes are individually addressable. Programs can seek to any byte position in the file and read an arbitrary number of bytes from that position. To application programs, byte streams are essentially one long character string that can be accessed either sequentially or randomly.

Note that this is a logical view of the file. Physically, the file must be read and written in units of disk sectors. The logical I/O subsystem must handle buffering of data between the disk and the application programs, and must worry about the details of logical reads and writes starting at other than sector boundaries.



Byte Streams as Text Files

- Text files use delimiter characters to divide the data into "lines"
- Systems use various conventions

– Windows, DOS	CR-LF
– UNIX, CTOS	LF
– Macintosh	CR

- Some text formats also allow form feeds (FF) as both a line delimiter and a new-page indicator

Paradigm AS4037 16

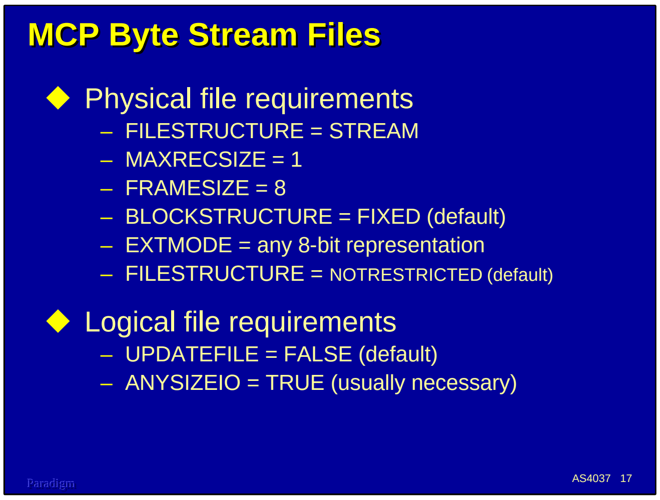
One of the most common uses of byte streams on other systems is for text, or line-oriented files. If you have ever used a text editor on another system, such as NotePad under Windows or *vi* under UNIX, you have been manipulating a text file.

Text files use delimiter characters to divide the file into logical lines. You can think of these lines as "records" of the file, but the concept of a record size for a text file does not exist. A line can be as long or short as necessary, although some applications place a limit on the maximum length they will correctly handle, often 255 or 1023 bytes.

Different systems use different delimiters to divide a file into lines. There are three common conventions:

- Microsoft Windows and DOS operating systems have traditionally used a carriage-return (CR) followed by a line-feed (LF) as the delimiter. Although the delimiter is officially a two-character pair, many text editors and software tools under Windows will accept either a carriage-return, or a line-feed, or the CR-LF pair as a line delimiter.
- UNIX systems have traditionally used the line-feed (LF) character as a line delimiter. This is sometimes referred to as the "new line" (NL) character. CTOS systems also used this convention.
- Apple Macintosh systems use CR as the text delimiter.

A form-feed (FF) in the text typically indicates the start of a new page if the file is sent to a printer. Many applications also treat FF as a line delimiter.



MCP Byte Stream Files

- Physical file requirements
  - FILESTRUCTURE = STREAM
  - MAXRECSIZE = 1
  - FRAMESIZE = 8
  - BLOCKSTRUCTURE = FIXED (default)
  - EXTMODE = any 8-bit representation
  - FILESTRUCTURE = NOTRESTRICTED (default)
- Logical file requirements
  - UPDATEFILE = FALSE (default)
  - ANYSIZEIO = TRUE (usually necessary)

Paradigm AS4037 17

The MCP supports byte stream files as a special case of record streams. You define a byte stream file the same way you define a record stream file, but a few attributes must have specific values.

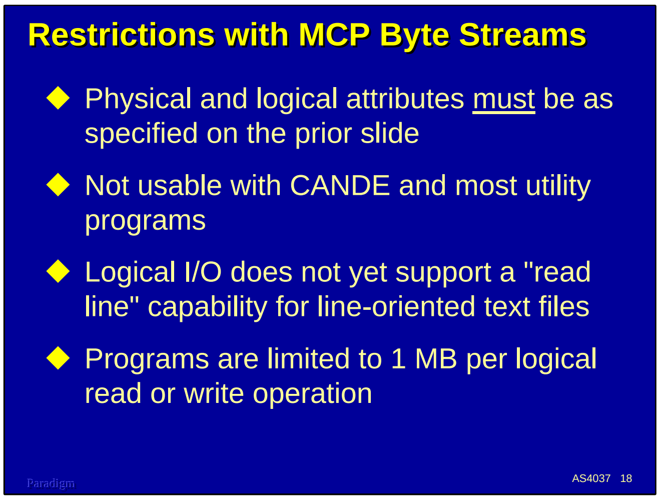
The following physical attributes are associated with byte streams. These are stored the the disk header for permanent files.

- FILESTRUCTURE must, of course, have a value of STREAM.
- MAXRECSIZE must have the value 1. Do not set MINRECSIZE.
- FRAMESIZE must have the value 8, indicating eight-bit character frames.
- BLOCKSTRUCTURE must have the value FIXED. This is the default for this attribute.
- EXTMODE must be one of the values that is consistent with an 8-bit data frame. EBCDIC is the default, but ASCII, OCTETSTRING, and other mnemonics for 8-bit national character sets are also allowed.
- FILESTRUCTURE must be NOTRESTRICTED. This is the default for this attribute. RELATIVE is not permitted for byte stream files.

Some logical attributes also affect byte streams. These are not stored in the disk header, but may be specified at run time before the file is opened.

- Update I/O is not supported for byte streams, so UPDATEFILE must be FALSE. This is the default value for this attribute. You can open a byte stream in input-output mode and perform mixed reads and writes, but the sequential rewrite after read behavior implied by the UPDATEFILE attribute is not supported.
- When using byte stream files, you almost always want to set ANYSIZEIO to TRUE. The reason for this will become clear shortly.

Note that, since MAXRECSIZE=1, record spanning is never an issue with byte stream files. However, a program could issue a logical read or write request that would span an area boundary, and the MCP would perform more than one physical I/O to satisfy the request.



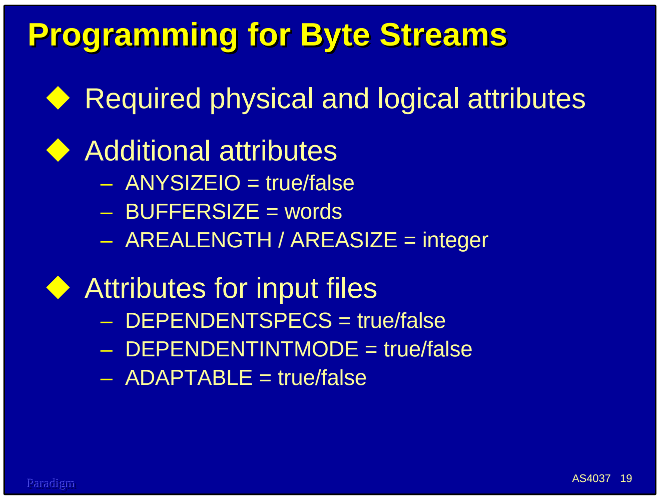
Restrictions with MCP Byte Streams

- Physical and logical attributes must be as specified on the prior slide
- Not usable with CANDE and most utility programs
- Logical I/O does not yet support a "read line" capability for line-oriented text files
- Programs are limited to 1 MB per logical read or write operation

Paradigm AS4037 18

There are a few additional restrictions on byte stream files over those for record streams.

- First, the physical attributes of the file *must* include:
  - FILESTRUCTURE = STREAM
  - MAXRECSIZE = 1
  - FRAMESIZE = 8
  - BLOCKSTRUCTURE = FIXED (default)
  - FILEORGANIZATION = NOTRESTRICTED (default)
  - EXTMODE must specify an 8-bit representation
- Like other stream files, byte streams cannot be used as CANDE files. Library/Maintenance commands and the PRINT command can be used with byte streams, however. Most system utilities do not yet support byte streams.
- Since a very common use of byte streams is for text files, it would be nice if the MCP provided the equivalent of a "read line" function for these files as part of Logical I/O. Alas, at present it doesn't. Unless you are using the C I/O libraries, you will have to parse lines in text files yourself. Some of the example programs discussed at the end of the presentation deal with this issue.
- MCP application programs are limited to transferring 2^{20}-1 (1,048,576) bytes in a single read or write statement. For most applications, this is not much of a limitation.



Programming for Byte Streams

- Required physical and logical attributes
- Additional attributes
  - ANYSIZEIO = true/false
  - BUFFERSIZE = words
  - AREALENGTH / AREASIZE = integer
- Attributes for input files
  - DEPENDENTSPECS = true/false
  - DEPENDENTINTMODE = true/false
  - ADAPTABLE = true/false

Paradigm AS4037 19

To open a byte stream file, it must satisfy at least the minimum physical attributes

- FILESTRUCTURE = STREAM
- MAXRECSIZE = 1
- FRAMESIZE = 8.

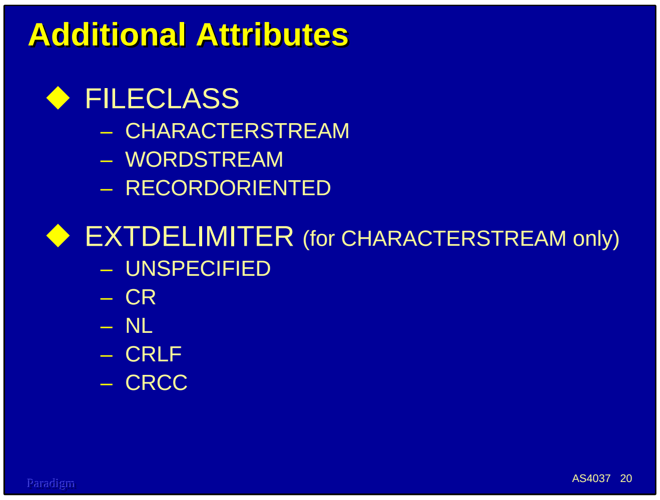
You may also need to specify the following attributes, but their default settings are compatible with byte streams:

- EXTMODE = (any 8-bit character representation)
- BLOCKSTRUCTURE = FIXED
- FILEORGANIZATION = NOTRESTRICTED
- UPDATEFILE = FALSE.

Once again, you almost always want to specify ANYSIZEIO=TRUE with byte stream files, for reasons we will discuss next.

You may also want to specify BUFFERSIZE or AREALENGTH, but the MCP defaults for these attributes are usually adequate.

DEPENDENTSPECS, DEPENDENTINTMODE, and ADAPTABLE are often useful when opening byte streams for input. We will discuss these attributes shortly.



Additional Attributes

- FILECLASS
  - CHARACTERSTREAM
  - WORDSTREAM
  - RECORDORIENTED
- EXTDELIMITER (for CHARACTERSTREAM only)
  - UNSPECIFIED
  - CR
  - NL
  - CRLF
  - CRCC

Paradigm

AS4037 20

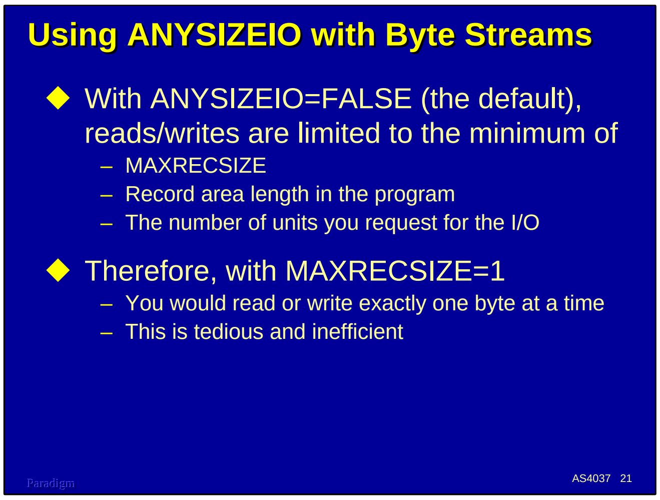
There are two additional attributes which are specifically applicable to byte stream files.

- FILECLASS is a read-only attribute that describes the class of a physical file's structure. It has three values:
  - `CHARACTERSTREAM` – any disk, printer backup, or CD-ROM file with FILESTRUCTURE=STREAM, MAXRECSIZE=1, and EXTMODE other than SINGLE. It is also set for certain TCP/IP port files and POSIX FIFO files.
  - `WORDSTREAM` – Any disk, printer backup, or CD-ROM file with FILESTRUCTURE=STREAM, MAXRECSIZE=1, and EXTMODE=SINGLE, plus certain TCP/IP port files.
  - `RECORDORIENTED` – all other physical files.
- EXTDELIMITER specifies the delimiter characters used to separate records or lines in a file. It presently has meaning only for files with FILECLASS=CHARACTERSTREAM. The possible values are:
  - `UNSPECIFIED` – the default
  - `CR` – carriage-return only
  - `NL` – new-line (line-feed) only
  - `CRLF` – carriage-return followed by line-feed
  - `CRCC` – carriage-return followed by either line-feed or form-feed

  The MCP will automatically set EXTDELIMITER to `CRCC` when a file with the following characteristics is created:
  - KIND = PRINTER
  - BACKUPKIND = DISK
  - FILESTRUCTURE = STREAM

  In addition, the MCP will place the actual delimiter characters in the file, creating a delimited byte stream file.

  You can specify EXTDELIMITER for other types of byte stream files, but the setting is purely advisory. The Print System uses this attribute when printing byte stream files to determine what kind of line delimiters and carriage control to look for.



Using ANYSIZEIO with Byte Streams

- With ANYSIZEIO=FALSE (the default), reads/writes are limited to the minimum of
  - MAXRECSIZE
  - Record area length in the program
  - The number of units you request for the I/O
- Therefore, with MAXRECSIZE=1
  - You would read or write exactly one byte at a time
  - This is tedious and inefficient

Paradigm AS4037 21

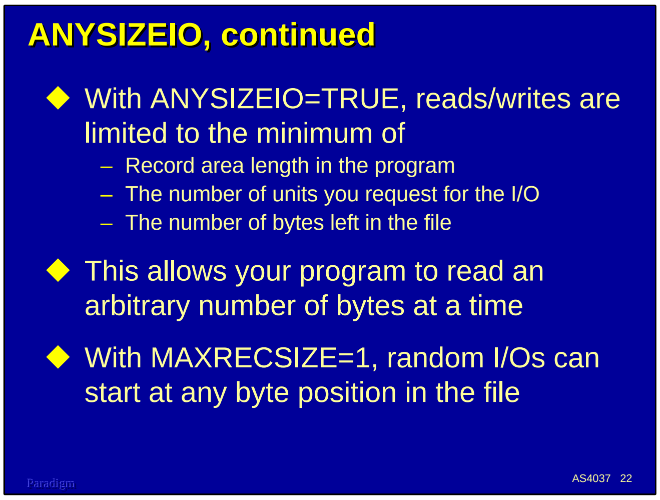
I have mentioned that you will almost always want to set the ANYSIZEIO attribute to TRUE when programming for byte stream files. Here's why.

In the default case, when ANYSIZEIO is FALSE, the number of frames (bytes) transferred between file buffers and your program for reads and writes is limited by the MCP to the minimum of:

- MAXRECSIZE for the file
- The physical length of the record area in your program
- The number of frames you request to be transferred in the read or write statement. Note that in COBOL programs, this value is normally the same as the size of the largest record declared for the file. We'll see shortly how to control this dynamically. In Algol programs using array-row I/O, you specify this value directly in the second parameter of a read or write statement.

Since by definition byte stream files have MAXRECSIZE=1, this default situation will only allow you to read or write one byte at a time. In most cases this results in extremely tedious coding and inefficient execution, due to the overhead of making a separate Logical I/O call for each byte in the file.

The ANYSIZEIO attribute was introduced specifically to address this problem for byte stream files.



ANYSIZEIO, continued

- With ANYSIZEIO=TRUE, reads/writes are limited to the minimum of
  - Record area length in the program
  - The number of units you request for the I/O
  - The number of bytes left in the file
- This allows your program to read an arbitrary number of bytes at a time
- With MAXRECSIZE=1, random I/Os can start at any byte position in the file

Paradigm AS4037 22

By setting ANYSIZEIO to TRUE, you remove the restriction imposed by MAXRECSIZE on the number of frames that can be transferred to and from your record area by a read or write. Instead, the size of the transfer is limited by the minimum of:

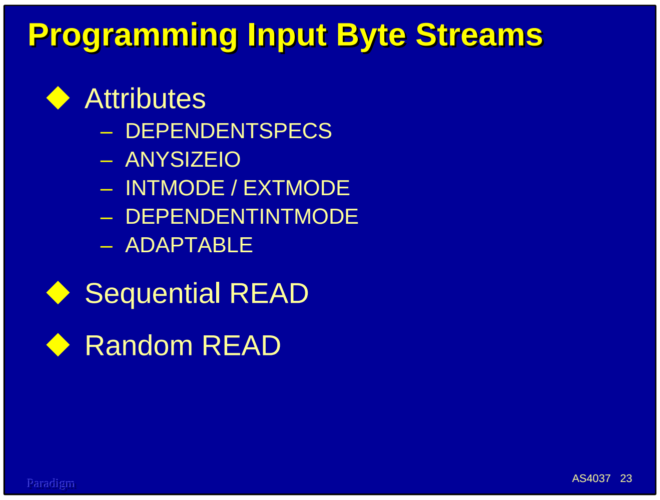
- The physical length of the record area in your program
- The number of frames you request to be transferred in the read or write statement
- The number of frames left in the file.

This means that the transfer will span record boundaries as necessary to satisfy the minimized length requested.

Therefore, setting ANYSIZEIO=TRUE allows your program to read an arbitrary number of frames (up to 2^{20}-1) from the byte stream with one I/O statement. In addition, since the MCP considers the file to have a record length of one frame (one byte), random I/Os can start at any byte position in the file. This allows MCP applications to read and write arbitrary amounts at arbitrary locations in the file, just as for byte streams on other systems.

While ANYSIZEIO is particularly useful for byte stream files, it can be used for any file with FILESTRUCTURE=STREAM, BLOCKSTRUCTURE=FIXED, FILEORGANIZATION=NOTRESTRICTED, and UPDATEFILE=FALSE. If these restrictions are not adhered to, you will get an open error.

When ANYSIZEIO is used with record stream files, data transfer always starts at a record boundary and continues for the number of frames requested, spanning records as necessary. If the transfer does not cover a whole number of records, the remaining frames in the last record will be skipped, since the next I/O will start at the next record boundary.



Programming Input Byte Streams

- Attributes
  - DEPENDENTSPECS
  - ANYSIZEIO
  - INTMODE / EXTMODE
  - DEPENDENTINTMODE
  - ADAPTABLE
- Sequential READ
- Random READ

Paradigm AS4037 23

When reading byte stream files, it's usually best to open them using DEPENDENTSPECS=TRUE. This will set a number of attributes from settings in the physical file, including FILESTRUCTURE, MAXRECSIZE, FRAMESIZE, BLOCKSTRUCTURE, FILEORGANIZATION, EXTMODE, FILECLASS, and EXTDELIMITER. You will probably also want to specify ANYSIZEIO=TRUE.

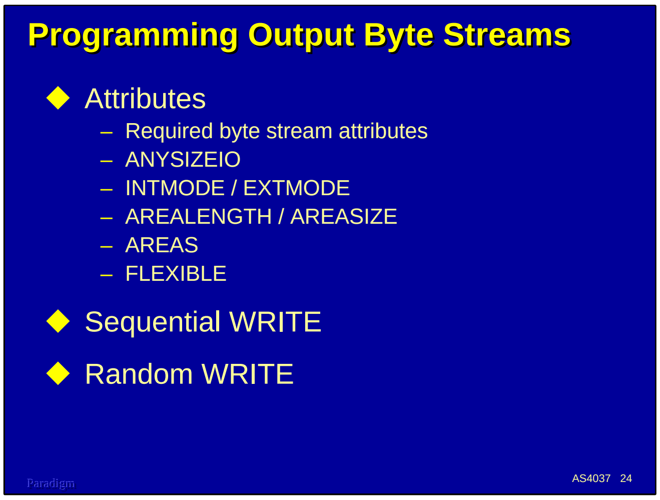
You can use the INTMODE and EXTMODE attributes to control character translation. Most MCP applications are written to process EBCDIC internally. DEPENDENTSPECS sets EXTMODE from the physical file attributes, but does not affect the INTMODE setting, which defaults to EBCDIC. If INTMODE and EXTMODE are different, translation can occur.

If you are processing image data, or data with mixed text and binary content, you normally do not want translation to take place. By setting DEPENDENTINTMODE=TRUE, you force the MCP to automatically set the INTMODE for the logical file to the EXTMODE of the physical file. This will suppress character translation.

If you need to have a general-purpose application that can handle any kind of file (traditional, record stream, or byte stream), the restrictions on ANYSIZEIO can cause a problem. If you set ANYSIZEIO=TRUE and try to open a file that does not meet the restrictions for ANYSIZEIO, you will get an open error. By setting ADAPTABLE=TRUE, you tell the MCP to check the compatibility of the file with ANYSIZEIO. If the file *is* compatible, the setting of ANYSIZEIO is not altered; if the file *is not* compatible, ANYSIZEIO is set to FALSE. This allows the open to succeed, after which your program can interrogate the other attributes to determine how to process the file.

There are no differences in the syntax of read statements for byte stream files. You can perform both sequential I/O and random I/O using relative record numbers – just keep in mind that for byte stream files, "record number" means "byte offset into the file".

Random I/O in COBOL is accomplished using the ACTUAL KEY clause of the SELECT statement. You also need to declare the record size in a special way to allow ANYSIZEIO to work in a useful manner, as we will see shortly.



Programming Output Byte Streams

- Attributes
  - Required byte stream attributes
  - ANYSIZEIO
  - INTMODE / EXTMODE
  - AREALENGTH / AREASIZE
  - AREAS
  - FLEXIBLE
- Sequential WRITE
- Random WRITE

Paradigm AS4037 24

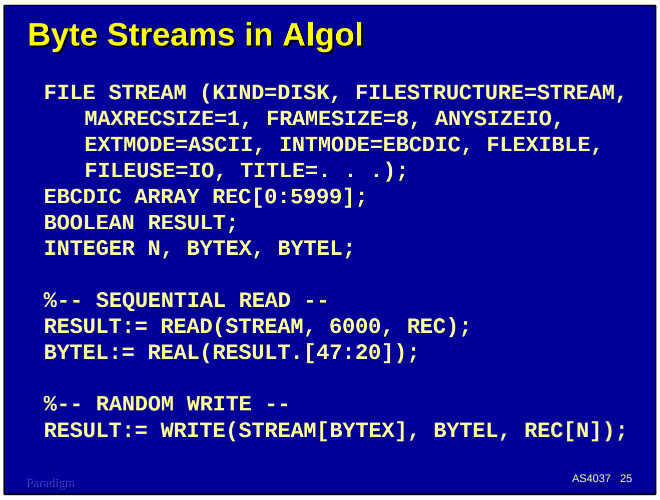
When creating a byte stream file, you must explicitly set the FILESTRUCTURE attribute to STREAM, since default attribute settings result in a traditional MCP file. You should also explicitly specify MAXRECSIZE=1 and FRAMESIZE=8 as attributes for the file, even if you are programming in COBOL. The required values for the other attributes are the defaults.

As with input files, you probably want to set ANYSIZEIO=TRUE. You may also want to specify INTMODE and/or EXTMODE. Setting INTMODE to EBCDIC (the default) and EXTMODE to ASCII will allow your program to write EBCDIC text, but the text will be translated and physically stored in ASCII. If you are writing binary or image data, it is usually best to set INTMODE and EXTMODE both to OCTETSTRING.

You can set AREALENGTH or AREASIZE when creating a byte stream file, but in most cases the MCP default of 1,024 sectors will probably be adequate. You should also set a value for AREAS.

If you are using the MCP default for AREALENGTH, you will also probably want to set FLEXIBLE=TRUE, so the number of areas will automatically expand as the file grows.

There are no differences in the syntax of write statements for byte stream files. You can perform both sequential I/O and random I/O using relative record numbers – as with reads, keep in mind that "record number" means "byte offset into the file".



Byte Streams in Algol

```
FILE STREAM (KIND=DISK, FILESTRUCTURE=STREAM,
   MAXRECSIZE=1, FRAMESIZE=8, ANYSIZEIO,
   EXTMODE=ASCII, INTMODE=EBCDIC, FLEXIBLE,
   FILEUSE=IO, TITLE=. . .);
EBCDIC ARRAY REC[0:5999];
BOOLEAN RESULT;
INTEGER N, BYTEX, BYTEL;

%-- SEQUENTIAL READ --
RESULT:= READ(STREAM, 6000, REC);
BYTEL:= REAL(RESULT.[47:20]);

%-- RANDOM WRITE --
RESULT:= WRITE(STREAM[BYTEX], BYTEL, REC[N]);
```

Paradigm AS4037 25

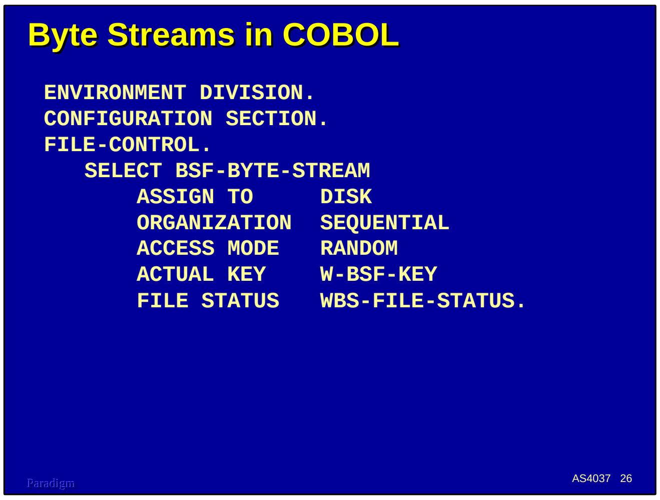
Access to byte streams is Algol is very straightforward. You specify the attributes you need directly in the file declaration or through file attribute assignments in WFL, CANDE, or MARC.

Sequential reads and writes are done in the same way as for traditional files. With ANYSIZEIO=TRUE, the record length parameter always specifies the number of 8-bit frames to read or write in the file.

Algol read and write statements return a Boolean result value that has the same format as the STATE attribute. Some useful fields in this word result are:

- Bits [47:20] = the number of frames (bytes) actually read or written
- Bit [7:1] = parity or data transfer error
- Bit [9:1] = end of file encountered
- Bit [4:1] = length or size error (sometimes called "data error")
- Bit [0:1] = some exception occurred (this bit determines the word's true or false value).

To perform random I/O, you specify an arithmetic expression in square brackets after the file identifier. For byte stream files, this will be the *zero-relative* byte offset into the file where the read or write will begin transferring data. Algol also allows you to transfer data into the middle of the record area by using a pointer expression or an indexed array identifier.



Byte Streams in COBOL

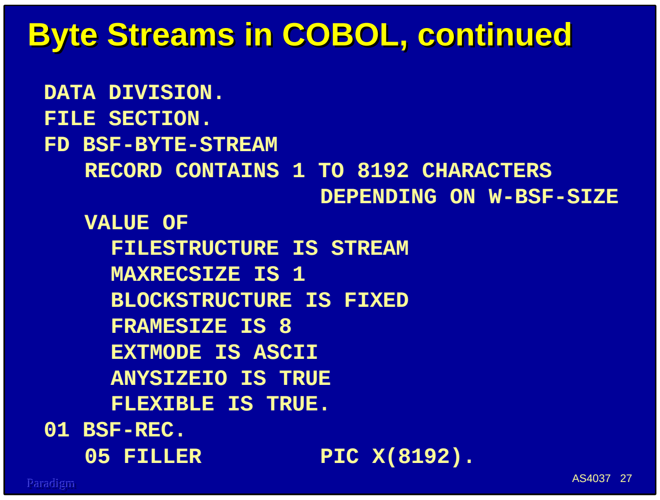
```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
FILE-CONTROL.
   SELECT BSF-BYTE-STREAM
       ASSIGN TO      DISK
       ORGANIZATION   SEQUENTIAL
       ACCESS MODE    RANDOM
       ACTUAL KEY     W-BSF-KEY
       FILE STATUS    WBS-FILE-STATUS.
```

Paradigm AS4037 26

Programming for byte stream files in COBOL-74 or -85 is somewhat more cumbersome, but all of the facilities are available. The coding in both languages is identical.

In the SELECT statement, the file should have ORGANIZATION SEQUENTIAL (the default) and an ACCESS MODE of either SEQUENTIAL (again, the default) or RANDOM. If you will be doing random I/O or using SEEK statements, you need to include an ACTUAL KEY clause referencing a numeric data item in WORKING-STORAGE. Keys defined as USAGE BINARY or REAL are more efficient than DISPLAY or COMP.

The FILE STATUS clause is not necessary, but it is a useful and convenient way to get detailed I/O results in a COBOL program.



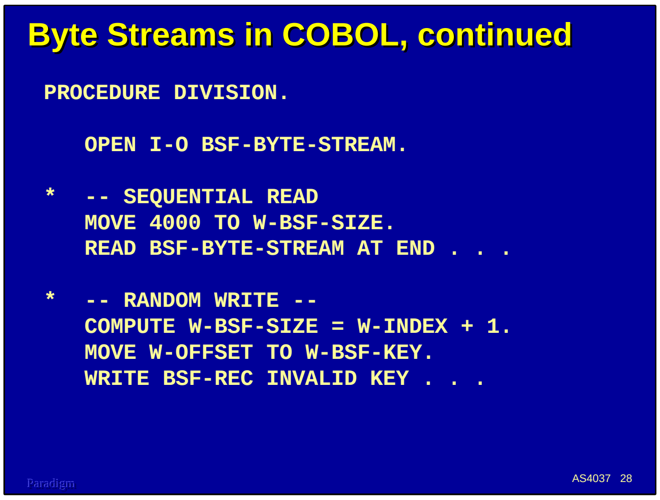
Byte Streams in COBOL, continued

```
DATA DIVISION.
FILE SECTION.
FD BSF-BYTE-STREAM
   RECORD CONTAINS 1 TO 8192 CHARACTERS
                     DEPENDING ON W-BSF-SIZE
   VALUE OF
     FILESTRUCTURE IS STREAM
     MAXRECSIZE IS 1
     BLOCKSTRUCTURE IS FIXED
     FRAMESIZE IS 8
     EXTMODE IS ASCII
     ANYSIZEIO IS TRUE
     FLEXIBLE IS TRUE.
01 BSF-REC.
   05 FILLER         PIC X(8192).
```

Paradigm AS4037 27

When working with byte stream files, you frequently need to be able to read and write variable length strings of data and control the length programmatically. In order to do that, you must declare the COBOL FD in particular way:

- Specify a RECORD CONTAINS clause with a range of 1 TO *n*, where *n* is the maximum size of the string you need to read or write. The clause must also have a DEPENDING ON phrase, naming a numeric data item in WORKING-STORAGE. The value of this item will control the number of frames (bytes) read or written by each I/O statement for the file. As for ACTUAL KEY items, it is more efficient to declare this length item as USAGE BINARY or REAL.
- Specify the stream-related attributes using VALUE OF clauses in the FD. Alternatively, you can specify these externally using file attribute assignment. When reading existing files, you can usually specify just DEPENDENTSPECS=TRUE and ANYSIZEIO=TRUE.
- Declare at least one record area for the file that is as large or larger than the maximum size specified in the RECORD CONTAINS clause. COBOL will allocate the record area in your program based on the longest record you define for the file.



Byte Streams in COBOL, continued

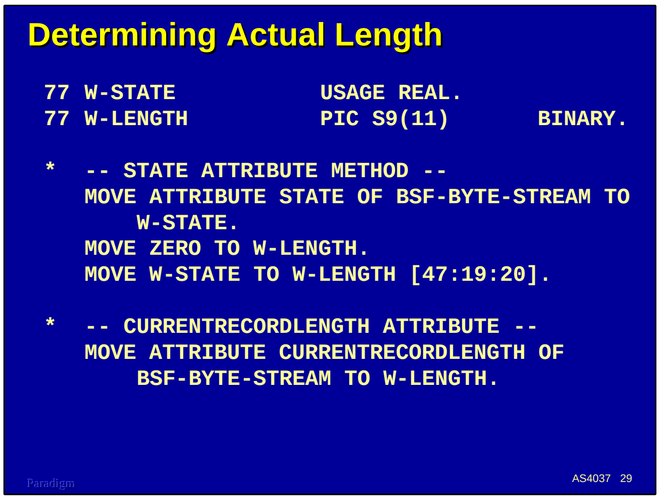
```
PROCEDURE DIVISION.

   OPEN I-O BSF-BYTE-STREAM.

*  -- SEQUENTIAL READ
   MOVE 4000 TO W-BSF-SIZE.
   READ BSF-BYTE-STREAM AT END . . .

*  -- RANDOM WRITE --
   COMPUTE W-BSF-SIZE = W-INDEX + 1.
   MOVE W-OFFSET TO W-BSF-KEY.
   WRITE BSF-REC INVALID KEY . . .
```

Paradigm AS4037 28

To read or write a string of bytes in COBOL, you first move the length of the string you want to transfer to the data item specified in the DEPENDING ON phrase of the RECORD CONTAINS clause for the file.

It's a good practice to reestablish this length value before each I/O statement, even if you are always reading strings of the same size. The reason for this is that the DEPENDING ON data item is updated after each I/O with the actual length of data that was transferred between your record area and the file buffers.

If you are reading or writing randomly, you may also need to place the relative record number (byte offset) where the data is to be read or written into the data item specified in the ACTUAL KEY clause. Note that for COBOL this is a *one-relative* byte offset into the file, since COBOL numbers records starting at 1.



Determining Actual Length

```
77 W-STATE            USAGE REAL.
77 W-LENGTH           PIC S9(11)       BINARY.

*   -- STATE ATTRIBUTE METHOD --
    MOVE ATTRIBUTE STATE OF BSF-BYTE-STREAM TO
        W-STATE.
    MOVE ZERO TO W-LENGTH.
    MOVE W-STATE TO W-LENGTH [47:19:20].

*   -- CURRENTRECORDLENGTH ATTRIBUTE --
    MOVE ATTRIBUTE CURRENTRECORDLENGTH OF
        BSF-BYTE-STREAM TO W-LENGTH.
```

Paradigm AS4037 29

One thing to keep in mind when working with byte stream files is that you may not get all the bytes you asked for. This happens when you read the last chunk of data at the end of the file. You may have asked for, say, 3000 bytes, but perhaps there were only 1255 left in the file before the EOF. The MCP will not read beyond the current end of file, and will only transfer data to your program up to that point.

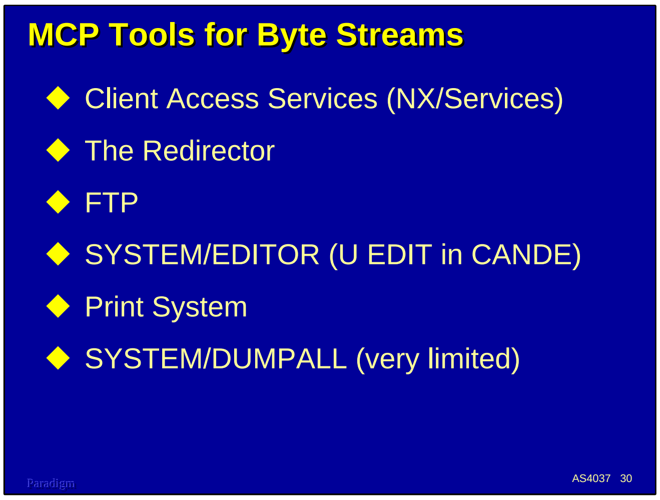
There are several ways to determine how may bytes were actually transferred between the file buffer and your program's record area.

- If you declared the file with a RECORDS CONTAINS … DEPENDING ON clause, the data item referenced by the clause will be updated after each read or write with the actual number of frames transferred. This is usually the most convenient method.
- As mentioned earlier, the STATE attribute holds the result of the last I/O operation in the form of a bit-packed word. Bits [47:20] in that word indicate the actual number of frames transferred. The first example on the slide shows how you can extract these bits into a COBOL data item. Note that the partial word notation in square brackets works only with word-oriented data items, such as USAGE REAL and BINARY.
- The CURRENTRECORDLENGTH attribute indicates directly how many frames were transferred by the last I/O operation.

The last two methods have the disadvantage that you must get their value from an attribute at run time. This involves making a procedure call to the MCP each time. While this is an efficient operation, there is some overhead to it, especially if you are doing it thousands of times. Algol provides a more efficient mechanism by returning a copy of the STATE attribute as the result of each read or write statement.

In COBOL-85, an equivalent mechanism is provided by the MCPRESULTVALUE special register. After each I/O statement, the COBOL-85 run time stores a copy of the STATE attribute in this register, much the same way it stores DMSII results in the DMSTATUS special register. Accessing MCPRESULTVALUE is many times more efficient than obtaining an attribute value. The actual length read or written can be obtained from this register in the same way as for the state attribute:

```
MOVE ZERO TO W-LENGTH.
MOVE MCPRESULTVALUE TO W-LENGTH [47:19:20].
```



MCP Tools for Byte Streams

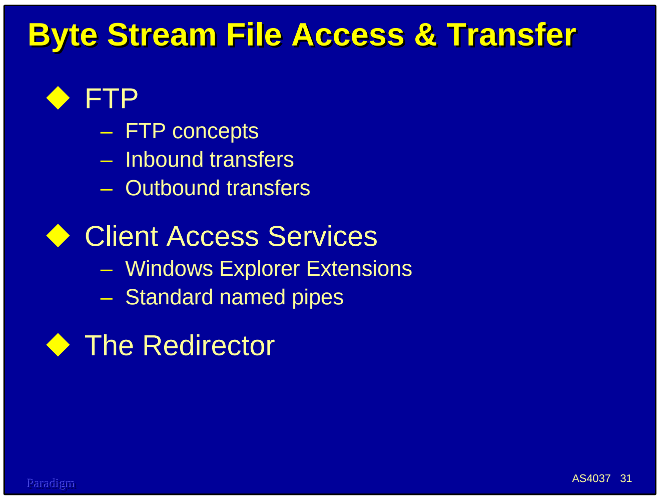
- Client Access Services (NX/Services)
- The Redirector
- FTP
- SYSTEM/EDITOR (U EDIT in CANDE)
- Print System
- SYSTEM/DUMPALL (very limited)

Paradigm

AS4037 30

While MCP support for byte streams is not universal, and most of the utility programs from Unisys do not currently support them, there are a number of facilities and tools for the MCP besides Logical I/O that you can use to generate and access byte stream files.

- Client Access Services can access and transfer both traditional and byte stream files between MCP shares and Microsoft Networking clients. The Windows Explorer Extensions add-in, the MCPCOPY command line utility, and several types of named pipes can convert byte stream files to and from traditional MCP file formats.
- MCP applications can use the Redirector to access files on external Microsoft Networking shares. These files appear as byte streams in the MCP environment.
- The File Transfer Protocol (FTP) component of TCP/IP can transfer byte stream files to and from MCP systems. FTP also has the ability to map both incoming byte streams to traditional MCP file formats and outgoing traditional files to byte streams.
- SYSTEM/EDITOR can read, edit, and convert byte stream files.
- The Print System can generate printer backup files in byte stream format as well as standard backup file format. It can also print byte stream files from other systems, obeying line delimiter conventions and form feeds.
- SYSTEM/DUMPALL can read and write byte stream files, but the functionality is limited. DUMPALL is driven largely by file attributes. Since MAXRECSIZE=1 for byte stream files, listing such a file with DUMPALL results in a tabulation of one-character records, which is not very useful. Copying byte streams with DUMPALL is not very efficient, since each byte in the file is treated as a separate logical record.



Byte Stream File Access & Transfer

- FTP
  - FTP concepts
  - Inbound transfers
  - Outbound transfers
- Client Access Services
  - Windows Explorer Extensions
  - Standard named pipes
- The Redirector

Paradigm

AS4037 31

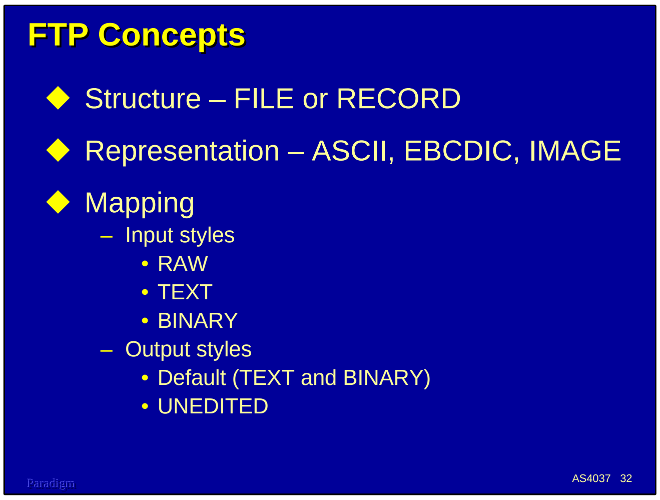
There are three principal methods of transferring or accessing byte stream files to and from the MCP.

The FTP component of TCP/IP can transfer files into and out of the MCP environment. These transfers can be initiated either from the MCP environment or from a remote system.

Client Access Services can be used both to transfer files into and out of the MCP environment, and to access MCP files directly from a remote system through a directory share. Both mechanisms are initiated from the remote system. You can use either Windows Explorer (with or without the Unisys Extensions add-in) or a number of types of named pipes to access the MCP shares.

Finally, the Redirector can be used to access files on remote system shares from MCP applications.

We will discuss each of these in turn in a little more detail.



FTP Concepts

- Structure – FILE or RECORD
- Representation – ASCII, EBCDIC, IMAGE
- Mapping
  - Input styles
    - RAW
    - TEXT
    - BINARY
  - Output styles
    - Default (TEXT and BINARY)
    - UNEDITED

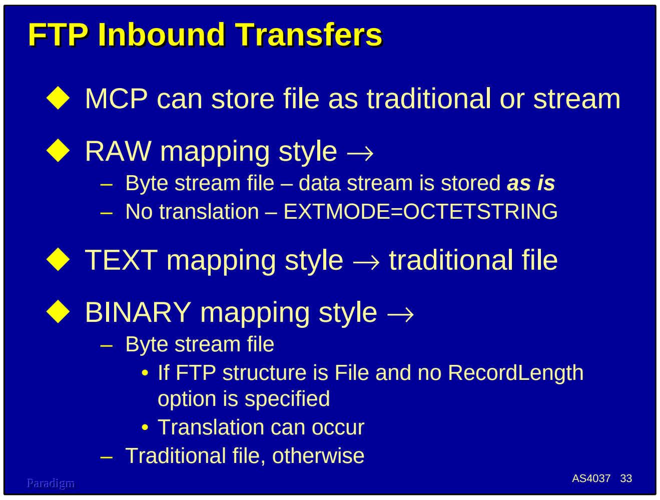
Paradigm AS4037 32

FTP can be used to transfer files between the MCP environment and virtually any other system which supports a minimal implementation of FTP. Since the capabilities of file systems vary widely among systems, FTP accomplishes this nearly universal interchange by reducing the files to a simple set of common characteristics. It leaves each end of the transfer to convert this simple representation of files to a form that is meaningful for that system.

FTP characterizes file transfers in three ways:

- Structure – the file can be transferred as a single entity or a record at a time.
- Representation – the data transferred can be encoded in ASCII or EBCDIC, or it can be unencoded. In the unencoded, or IMAGE form, the data is considered simply to be a stream of 8-bit bytes (octets).
- Transfer Mode – the FTP standard defines this as a third characteristic, but the MCP currently supports only one mode, Stream.

To convert the standard FTP parameters to the Logical I/O subsystem, the MCP implementation of FTP supports a mapping process during the transfer. Mapping can translate the simplified characteristics of FTP data to a wide variety of the richer file structures available under the MCP. Specifically, the mapping process can convert byte stream files from other systems to either traditional or byte stream formats under the MCP.



FTP Inbound Transfers

- MCP can store file as traditional or stream
- RAW mapping style →
  - Byte stream file – data stream is stored ***as is***
  - No translation – EXTMODE=OCTETSTRING
- TEXT mapping style → traditional file
- BINARY mapping style →
  - Byte stream file
    - If FTP structure is File and no RecordLength option is specified
    - Translation can occur
  - Traditional file, otherwise

Paradigm AS4037 33

When you transfer files to the MCP environment, you want to receive the files in either traditional or byte stream format. If byte streams are what you want, you essentially bypass FTP's mapping process, except possibly for character translation.

By specifying the RAW mapping style for an inbound transfer, you are guaranteed of getting a byte stream file stored in the MCP environment. The bytes are stored exactly as sent by the remote system. No character translation is available with RAW. The file is stored with an EXTMODE of OCTETSTRING.

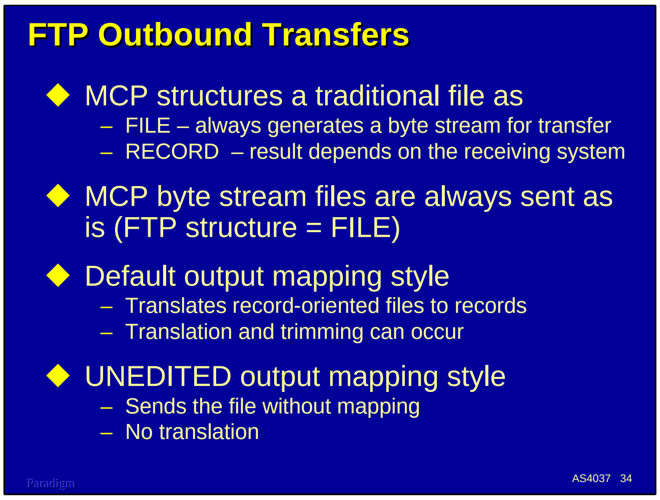
The TEXT mapping style will always store a traditional MCP file.

The BINARY mapping style may or may not store a byte stream file in the MCP, depending on the parameters specified for the transfer.

- If the Structure for the FTP transfer is specified as File and no RecordLength option was specified in the mapping parameters, you will get a byte stream file. With this type of inbound transfer, character translation can occur.
- If the Structure is Record or a RecordLength parameter is specified, FTP will store a file in the traditional (blocked) format.

Note that the characteristics of an FTP transfer can be affected by two external sources:

- If the transfer is remotely initiated, the originator has control over the Structure and Representation characteristics of the transfer.
- FTP supports default settings through a hierarchy of configuration files. You may need to override these defaults on a case-by-case basis.



FTP Outbound Transfers

- MCP structures a traditional file as
  - FILE – always generates a byte stream for transfer
  - RECORD – result depends on the receiving system
- MCP byte stream files are always sent as is (FTP structure = FILE)
- Default output mapping style
  - Translates record-oriented files to records
  - Translation and trimming can occur
- UNEDITED output mapping style
  - Sends the file without mapping
  - No translation

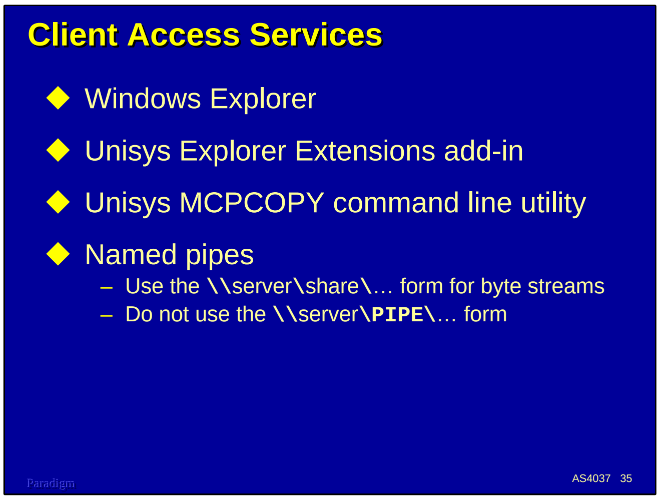
Paradigm AS4037 34

For outbound transfers, FTP can send the file with either the FILE or RECORD structure. If you are starting with an MCP byte stream file, it will always be sent with a structure of FILE, since the file is not record oriented.

Output mapping supports two modes: a default mapping style and the UNEDITED style.

The default style is typically used with traditional or record oriented files, and is usually the one to use if you want to transfer text. With this style, character translation can occur, as well as selected trimming of trailing blanks, sequence numbers, and identification (patchmark) fields.

The UNEDITED style for output is the complement of the RAW style for input. It causes the file to be transferred as is, without mapping or character translation. This is the style to use if you need to transfer a traditional MCP file as a binary data stream without record delimiters.



Client Access Services

- Windows Explorer
- Unisys Explorer Extensions add-in
- Unisys MCPCOPY command line utility
- Named pipes
  - Use the `\\server\share\`… form for byte streams
  - Do not use the `\\server\`**`PIPE`**`\`… form

Paradigm AS4037 35

With Client Access Services, you can both transfer and directly access files on MCP shares. Since Windows does not support record-oriented files, the MCP files will appear to Windows applications as byte streams having carriage-return/line-feed record delimiters.

When transferring a file to the MCP environment, you can use either Windows Explorer, the MCPCOPY command line utility, or a Windows-based application that supports named pipes. If what you want to store in the MCP environment is a byte stream file, *do not* use the Unisys Explorer Extensions add-in that is activated by right-click-dragging a file to an MCP share. Instead, use a left-click-drag.

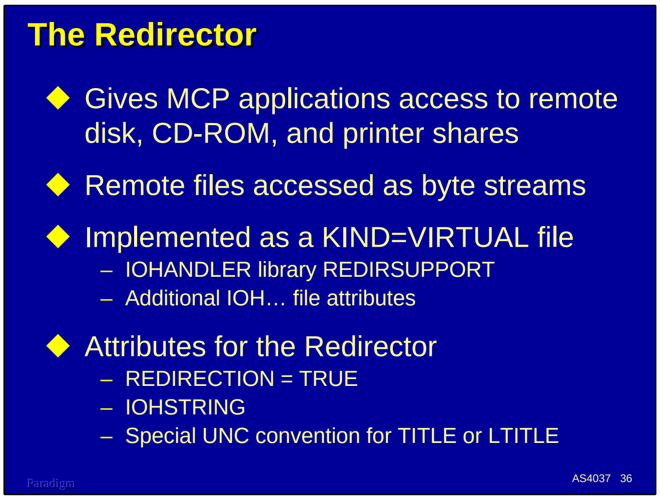
The Unisys MCPCOPY utility can transfer files to the MCP as byte streams or as record-oriented files based on command line switches. In general, to get a byte stream file stored in the MCP environment, do not specify the `/Z:SR`, `/R`, `/D`, `/B`, `/U`, `/T`, `/W`, or `/F` switches for MCPCOPY.

There are several Windows APIs and tools that support reading and writing to disk shares as well as Windows-resident files, including the TYPE and MORE commands, and NotePad. To access shares using these tools, use the named pipe form of file name,

```
\\server\share\pathname
```

instead of the "drive-letter : pathname" form.

Note that there are a number of named pipes supported by Client Access Services that start with `\\`server`\PIPE\`… These pipes either convert between Windows byte streams and MCP traditional files or connect to port files in MCP application. Do not use these if you want to transfer byte stream files to the MCP and have them stored as byte streams.



The Redirector

- Gives MCP applications access to remote disk, CD-ROM, and printer shares
- Remote files accessed as byte streams
- Implemented as a KIND=VIRTUAL file
  - IOHANDLER library REDIRSUPPORT
  - Additional IOH… file attributes
- Attributes for the Redirector
  - REDIRECTION = TRUE
  - IOHSTRING
  - Special UNC convention for TITLE or LTITLE

Paradigm AS4037 36

The Redirector, which was first introduced in HMP 5.0, is a complement to Client Access Services. It allows MCP applications to access disk, CD-ROM, and printer shares on a remote system using Microsoft Networking. Using the Redirector you can directly read and write files on these shares – no separate file transfer process is necessary. You program these files in your MCP application as byte stream files.

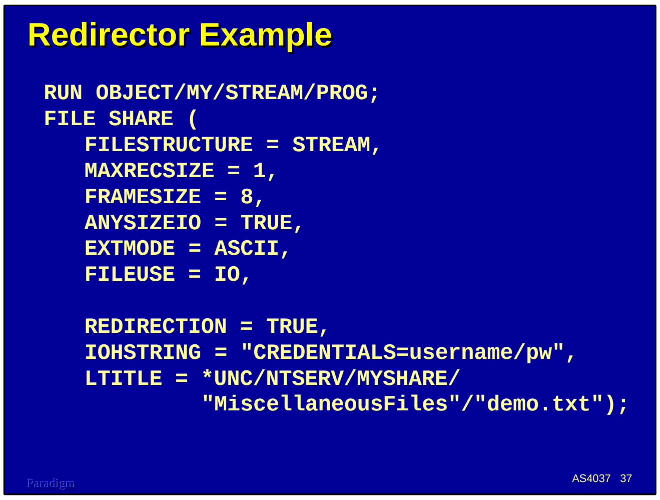
The Redirector is implemented as an instance of a new kind of file, KIND=VIRTUAL. The semantics of virtual files are not implemented within the Logical I/O subsystem of the MCP. Instead, the semantics are implemented by a library program, called an IOHANDLER, that Logical I/O calls in response to standard open/close, read/write statements in an application. The interface for an IOHANDLER is documented in the *I/O Subsystem Programming Guide*. You can even write your own IOHANDLER if you have a unique input/output processing need.

There are a number of new attributes that support the use of virtual files. Most of these (e.g., IOHLIBACCESS, IOHTITLE, IOHFUNCTIONNAME) are used to establish the library linkage between Logical I/O and the appropriate IOHANDLER when a file is opened. There is also a string parameter, IOHSTRING, that is used to pass file-specific options from an application program to the IOHANDLER library.

The Redirector is implemented by a Unisys-supplied IOHANDLER library, SYSTEM/REDIRSUPPORT. There is a new Boolean file attribute, REDIRECTION, that can be used as a shorthand to configure the IOH library linkage attributes for REDIRESUPPORT. Therefore, to use the Redirector, you have to specify the attributes you would normally need to read or write a byte stream file, plus

- REDIRECTION = TRUE
- Some redirection-specific options in IOHSTRING
- A specially formatted TITLE or LTITLE string that represents the Uniform Naming Convention (UNC) name for the file on the remote system.

The Redirector is also documented in the *I/O Subsystem Programming Guide*.



Redirector Example

```
RUN OBJECT/MY/STREAM/PROG;
FILE SHARE (
   FILESTRUCTURE = STREAM,
   MAXRECSIZE = 1,
   FRAMESIZE = 8,
   ANYSIZEIO = TRUE,
   EXTMODE = ASCII,
   FILEUSE = IO,

   REDIRECTION = TRUE,
   IOHSTRING = "CREDENTIALS=username/pw",
   LTITLE = *UNC/NTSERV/MYSHARE/
            "MiscellaneousFiles"/"demo.txt");
```

Paradigm AS4037 37

One of the nice things about the Redirector is that if your program already understands how to read or write byte stream files, you can simply use file attribute assignments to have it work with files on remote shares.

This slide shows a straightforward example of the attributes needed to access a file called "MiscellaneousFiles\demo.txt" from the share "MYSHARE" on the server "NTSERV". The first set of attributes are standard byte stream attributes. The second set invoke the Redirector. Note that the long filename attribute LTITLE is used instead of TITLE because one of the nodes of the name contains more than 17 characters.

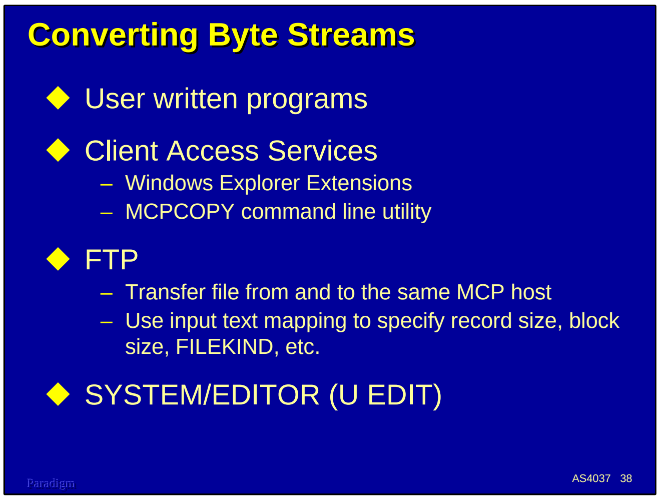
The *UNC prefix on the file name is a special node recognized by the Redirector. It indicates, in place of the standard double backslash (\\), that the rest of the name is in UNC format. Note that forward slashes are used instead of backslashes in these MCP title strings.

The IOHSTRING attribute can specify a number of options for the connection to the remote server and share. In addition to `CREDENTIALS`, keywords which can be specified in this string include:

- `DOMAINNAME` – DNS name for the remote server
- `IPADDRESS` – IP address for the remote server
- `SERVERNAME` – Microsoft Networking host name for the remote server
- `SHARENAME` – name of the share on the remote server
- `USERDOMAIN` – domain under which user credentials will be authenticated
- `TIMEOUT` – timeout value (seconds) for remote server connections to complete
- `SMBTRACE` – invokes SMB diagnostics (true/false).

Instead of using the *UNC form of TITLE attribute, you can identify the server by DOMAINNAME, IPADDRESS, or SERVERNAME, and the share by the SHARENAME options in IOHSTRING. The TITLE or LTITLE attribute would then specify just the path after the share name.

Since specifying CREDENTIALS in the IOHSTRING potentially exposes passwords, the Redirector can use credentials files created by *SYSTEM/NXSERVICES/MAKECREDENTIALS. This utility will create an encrypted file from a host name (which can be a domain name, IP address or server name), a username, a password, and an optional user domain name. The file is stored under your usercode as NXSERVICES/CREDENTIALS/*hostname*. The Redirector will automatically access this credentials file under your usercode if CREDENTIALS is not specified in the IOHSTRING.



Converting Byte Streams

- User written programs
- Client Access Services
  - Windows Explorer Extensions
  - MCPCOPY command line utility
- FTP
  - Transfer file from and to the same MCP host
  - Use input text mapping to specify record size, block size, FILEKIND, etc.
- SYSTEM/EDITOR (U EDIT)

Paradigm

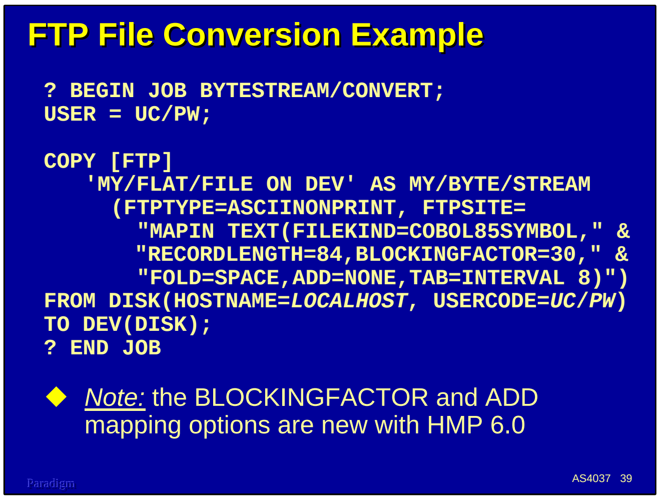
AS4037 38

Sometimes you have a byte stream file in the MCP environment and need to process it using tools that only support traditional files. In these cases you have two choices: write a program yourself to process the data, or convert the byte stream to a traditional file format.

By writing your own program, you can accomplish any kind of conversion you want, and the process will generally be quite efficient in the MCP environment. The problem with this approach, of course, is the time and effort you need to spend designing and coding an appropriate program.

There are also a number of ways to convert byte streams using standard MCP facilities.

- Client Access Services (NX/Services) offers a number byte stream conversion capabilities, but only when transferring files to or from an MCP disk share. To use these to convert a file that is already in the MCP environment, you would have to first copy the file to an external system, then copy it back to the MCP, or copy it between two MCP shares. In either case, all of the data being converted must travel to an external system and back to the MCP over your network. There is a fair amount of overhead in doing this, but it's fine for a quick-and-dirty solution. The two tools you can use are:
  - Windows Explorer Extensions is a Unisys add-in you install in your Windows environment. It is activated when you right-click-drag files to an MCP share in Windows Explorer. A pop-up menu gives you a number of choices for source file formats, data file record sizes, and file names.
  - MCPCOPY is a command line utility that also runs in the Windows environment. It is installed automatically in your WINDOWS or WINNT directory when you install the Explorer Extensions add-in. You can run this program directly, or use it in ".bat" files and Windows Scripting Host scripts. Conversion formatting is controlled by a number of parameter switches, which are documented in the help file for the Explorer Extensions. This help file is also on the documentation CD-ROM.
- FTP has extensive file conversion facilities, and can map byte stream files into a wide variety of traditional MCP file formats, including symbol files, fixed length data files, and variable length data files. The next slide shows an example using FTP to convert files locally.
- Finally, the SYSTEM/EDITOR utility can read and write byte stream files and convert to and from traditional symbol file formats. When using EDITOR from CANDE with byte streams, you need to initiate it using a shell program (U EDIT <file name>).



FTP File Conversion Example

```
? BEGIN JOB BYTESTREAM/CONVERT;
USER = UC/PW;

COPY [FTP]
   'MY/FLAT/FILE ON DEV' AS MY/BYTE/STREAM
     (FTPTYPE=ASCIINONPRINT, FTPSITE=
       "MAPIN TEXT(FILEKIND=COBOL85SYMBOL," &
       "RECORDLENGTH=84,BLOCKINGFACTOR=30," &
       "FOLD=SPACE,ADD=NONE,TAB=INTERVAL 8)")
FROM DISK(HOSTNAME=LOCALHOST, USERCODE=UC/PW)
TO DEV(DISK);
? END JOB
```

- *Note:* the BLOCKINGFACTOR and ADD mapping options are new with HMP 6.0

Paradigm AS4037 39

This slide shows how you can convert a byte stream to a traditional file locally on the host using FTP. You don't even have to be connected to a network in order to use FTP this way, but both the TCP/IP network provider and the FTP DSS must be running.

The trick here is that you are using FTP to transfer the file to and from the same host. That's a pretty inefficient way to copy a file, but in doing so we can take advantage of FTP's extensive input data mapping capability. Input mapping allows FTP to convert byte streams into a number of traditional MCP file formats, including all of the symbol file formats supported by CANDE, and most common data file formats.

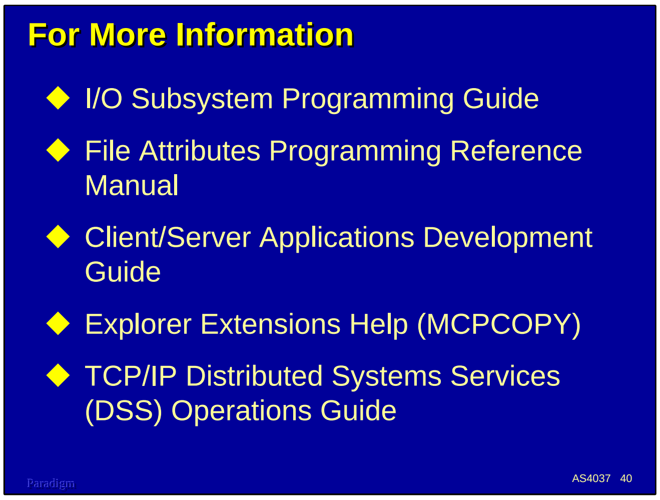
This example shows how to import a COBOL-85 source file in byte stream format and convert it to FILEKIND=COBOL85SYMBOL with the correct record size and blocking. The RECORDLENGTH and BLOCKINGFACTOR options are not really needed here, since FTP will use the correct sizes by default when a FILEKIND for a symbol file is used.

In addition, specifying

- `FOLD=SPACE` folds lines at a space (i.e., between words) if a line is too long for a standard COBOL record.
- `ADD=NONE` assumes the byte stream already has sequence numbers in columns 1-6. Without this option, FTP would insert sequence numbers in front of the text.
- `TAB=INTERVAL 8` expands tabs to increments of eight spaces.

To adapt this example to your own use, you need to change the source and destination file names, replace "LOCALHOST" by the host name of your MCP system, supply an appropriate usercode and password in place of "UC/PW", and change the destination family name ("DEV") to one for your system. You do not need a REMOTEUSER specification in the USERDATAFILE to use FTP locally in this way.

There are a number of options for FTP input mapping other than those shown here. For more information on FTP input and output mapping, see the *TCP/IP Distributed Systems Services Operations Guide*.



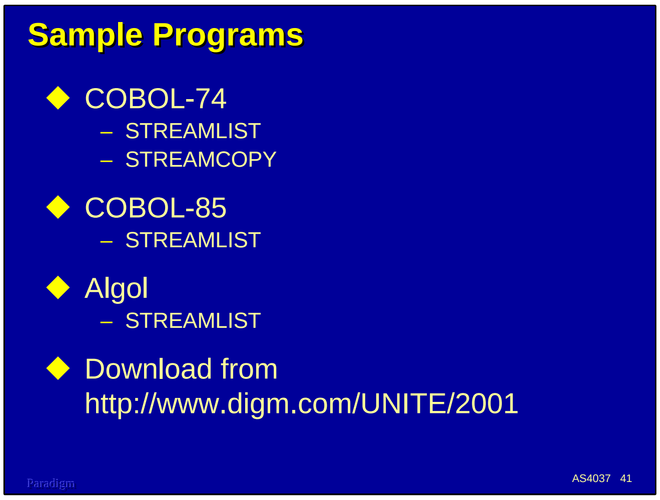
For More Information

- I/O Subsystem Programming Guide
- File Attributes Programming Reference Manual
- Client/Server Applications Development Guide
- Explorer Extensions Help (MCPCOPY)
- TCP/IP Distributed Systems Services (DSS) Operations Guide

Paradigm AS4037 40

A number of Unisys documents contain information relevant to byte stream files in the MCP environment. All of these references are relative to the HMP 6.0 release, and all are on the Product Information CD-ROM.

- The *I/O Subsystem Programming Guide* has a wealth of information on programming for various types of files. See Sections 1 and 2 for general information on byte stream files, Section 29 for a discussion of Virtual files, and Section 30 for information on the Redirector.
- The *File Attributes Programming Reference Manual* is a dictionary of file attributes and their permissible settings. This is the best source if you know the attribute you need to use but need detailed information on its values and effects.
- The *Client/Server Applications Development Guide* is a standard Windows help file. It is the primary resource for information on MCP named pipes.
- The Unisys Explorer Extensions add-in comes with another Windows help file which describes how to use the extensions. It also contains documentation for the MCPCOPY command line utility. This file is installed automatically when you install the extensions.
- The *TCP/IP Distributed Systems Services Operations Guide* contains complete information on several TCP/IP components, including FTP. Sections 2 through 8 are the best resource for information on FTP and its input and output mapping capabilities.



Sample Programs

- COBOL-74
  - STREAMLIST
  - STREAMCOPY
- COBOL-85
  - STREAMLIST
- Algol
  - STREAMLIST
- Download from http://www.digm.com/UNITE/2001

Paradigm AS4037 41

I have written a few example programs that illustrate the basic techniques for reading and writing sequential byte stream files.

There two COBOL-74 examples. STREAMLIST reads a byte stream as a text file and lists it to a standard printer file, adding page headings and line numbers, and folding lines that are too long to fit on a single print line. STREAMCOPY copies a traditional MCP file as a byte stream file, trimming trailing blanks and appending CR-LF delimiters after each record. Both of these programs will also compile with COBOL-85.

There is also a COBOL-85 version of STREAMLIST. It is functionally equivalent to the COBOL-74 version, but uses some of the nicer control structures available in the 1985 standard.

Finally, there is an Algol version of STREAMLIST as well. It is also functionally equivalent to the COBOL-74 version.

You can download the source for all of these examples, along with a copy of this presentation in PowerPoint format, from our web site at:

```
http://www.digm.com/UNITE/2001
```