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Network Job Entry Concepts and Protocols Overview

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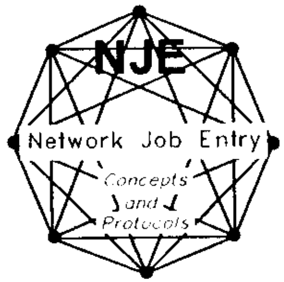
Abstract



Network Job Entry (NJE) provides access to batch computing facilities from other host systems. It enables users to transfer work requests (i.e., jobs) and spooled data through a distributed network of systems.

This document describes some basic NJE concepts and the protocols involved. The information contained herein is from *NJE Formats and Protocols* GG22-9373 which can be referenced for further details.

Acknowledgements

This material originally came from a presentation given by Dave Stamper, from the IBM Data Systems Division Poughkeepsie Programming Center at SHARE 60 in March 1980. It has been updated considerably since then and was given at SHARE 65 in August 1985.

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- Jim Richards Jr., DSD
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1.0 NJE Concepts

1.1 NJE Implementations

NJE Products

MVS — JES2		BSC	CTC	SNA
MVS — JES3		BSC	CTC	
VM — RSCS		BSC	CTC	SNA
VSE — POWER		BSC		SNA
other — TSS, HASP, ASP		BSC	CTC	

Figure 1. IBM NJE Implementations

The protocol used for host peer-to-peer Network Job Entry (NJE) communication is described. The current host products implementing this protocol are JES2, JES3, VSE/POWER and VM/RSCS. Previous products which also supported portions of this protocol are HASP, ASP, TSS and VM Networking.

All implementations support BSC protocols, and all but VSE/POWER support the Channel-to-Channel adapter. JES2, VSE/POWER, and most recently RSCS support SNA.

Channel-to-channel protocols are similar to BSC protocols and will be treated as such in this presentation.

1.2 NJE Evolution

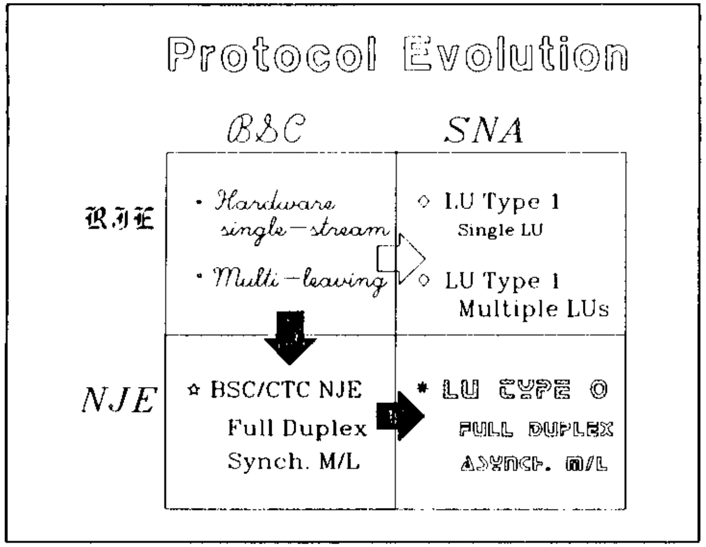


Figure 2. NJE Protocol Evolution

This is an evolved, *de facto* protocol rather than a formally designed protocol used to communicate between like and unlike job networking products. Because of the way in which this protocol evolved, it contains product dependencies, some ambiguities and some currently unused features. Each of the products implementing this protocol contains exceptions to it. This paper will not discuss these exceptions. The presence of unsupported features in the NJE protocol does not imply an IBM commitment to add these features to any of the supporting products.

Together with RJE, NJE is used to create distributed job processing networks. The RJE protocols permit remote work station source and sink (i.e., destination) devices to enter SYSIN jobs and receive SYSOUT jobs from the network of host processors. The RJE protocol has four forms:

1. BSC Hardware (Non-multileaving)
2. BSC Multileaving
3. SNA LU Type 1 Single LU
4. SNA LU Type 1 Multiple LU's

The non-multileaving and single Logical Unit (LU) protocols allow only one stream to flow at a time in any direction, whereas the multileaving and multiple LU forms permit concurrent transfer of several SYSIN or SYSOUT streams.

Also, RJE protocols (except for BSC Multileaving) are Half-Duplex, whereas the NJE protocols are Full-Duplex. (More about that later.)

The NJE protocol evolved from the BSC RJE multileaving protocol. The NJE protocol for SNA connections is more like the BSC multileaving protocol than the RJE protocol for SNA connections.

1.3 RJE and NJE

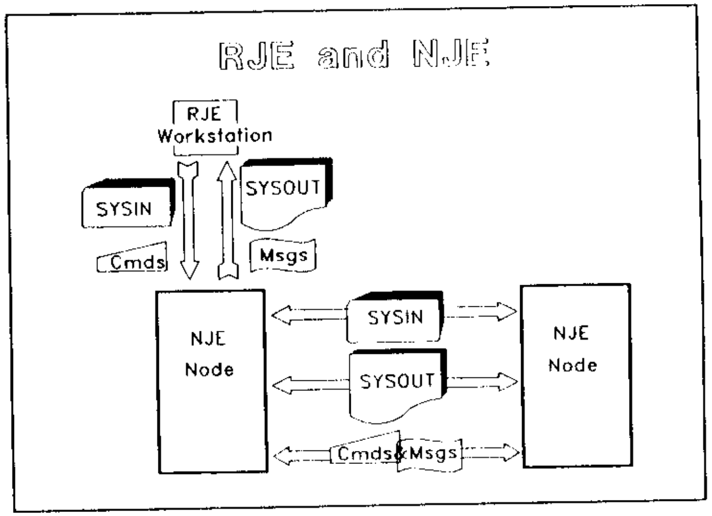


Figure 3. RJE and NJE

The RJE protocols are non-symmetric protocols permitting only inbound SYSIN and commands from the work station to the host, and only outbound SYSOUT and messages from the host to the work station.

On the other hand, the NJE protocols are symmetric, peer-to-peer protocols allowing job (both SYSIN, SYSOUT), command and message flow in both directions. In NJE terminology, a JOB refers to either a SYSIN job before its execution, or a SYSOUT job which is a collection of SYSOUT data set produced by the execution of a (SYSIN) job.

The RJE protocols were designed for remote unit record devices (readers, printers and punches) and are therefore device-oriented protocols, enabling the host to control the work station devices as if they were local (channel attached) devices. The NJE protocol, in contrast, is a spool transfer protocol where a spool is considered to contain a SYSIN queue and a SYSOUT queue.

SYSIN may be forwarded to remote SYSIN (job) queues. SYSOUT may be transferred from a spool queue to a remote spool queue with a final destination of a channel attached or remote "sink" device, an interactive user (memory) or a program using the external writer interface.

1.3.1.1 NJE Network Nodes

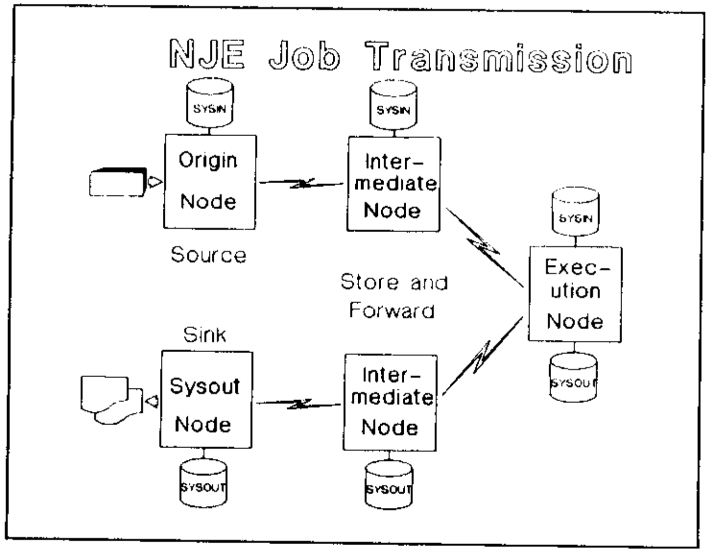


Figure 4. NJE Network

In an NJE network, all participating systems are host nodes, each served by an NJE Product and each able to assume a number of different roles:

1. SYSIN (job) Submission, Origin or Source
2. SYSIN (job) Execution
3. SYSOUT Processing or "Sink"
4. Intermediate Node (Store and Forward)

The above diagram is just an example. In fact, there may be many more nodes involved as intermediate or SYSOUT processing nodes. Conversely, many of the roles may be played by the same node, so you could have no intermediate nodes, or the SYSIN job could execute on the origin node, for example.

1.3.1.2 NJE Addressing

An RJE workstation can be considered a sub-node, associated with one of the NJE nodes. A useful model to show the two-level addressing scheme in NJE is:

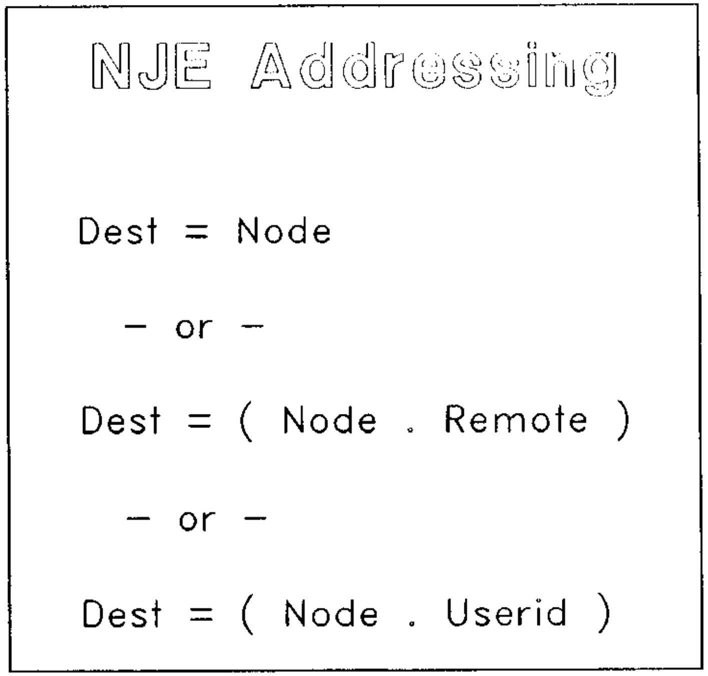


Figure 5. NJE Addressing

NJE is concerned with routing a file or work-request to the NODE portion of the specified destination, while preserving the REMOTE (or USERID) identification in the second portion. It is then up to the destination node to route the job (i.e., work request) to the REMOTE or USERID on the destination node, using RJE or some other mechanism.

1.4 Multileaving

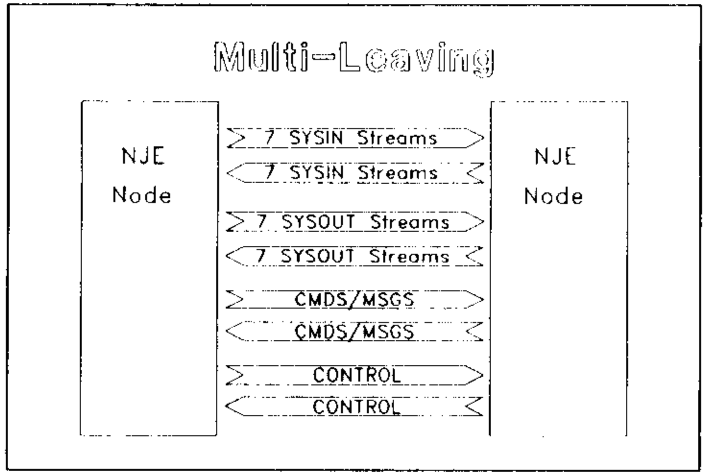


Figure 6. Multileaving

Multileaving is the term used to describe the capability to concurrently transfer multiple SYSIN and SYSOUT streams on the same BSC connection or SNA session. The protocol permits the identification of 7 SYSIN streams, 7 SYSOUT streams, a command/message stream and a control stream in both directions. The BSC protocol permits the concurrent use of 8 of the 14 possible SYSIN and SYSOUT streams in both directions. The version using SNA permits concurrent use of all 14 streams in both directions.

1.5 Full Duplex

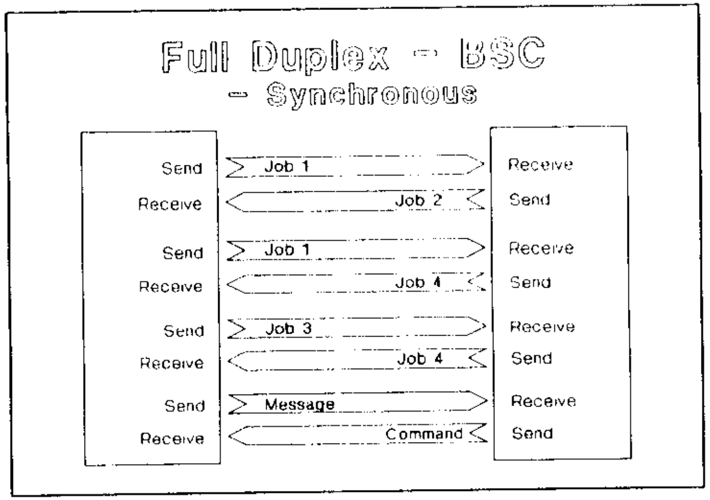


Figure 7. BSC Multileaving

Full duplex refers to the capability to send data in one direction while receiving unrelated data in the other direction. The BSC protocol is pseudo full duplex since each end must flip-flop between the send and receive states. Both ends are synchronized.

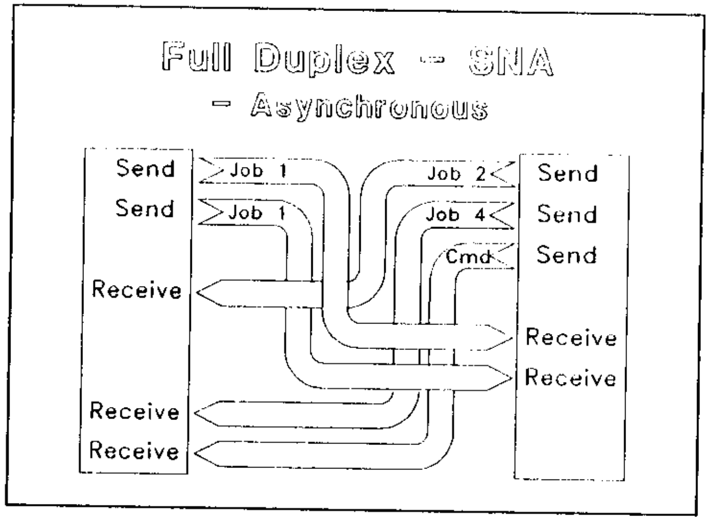


Figure 8. SNA Multileaving

The NJE protocols used in an SNA environment are true full duplex, with each end concurrently in both send and receive state. The session ends are operating independently.

The BSC synchronized full duplex protocol allows the receiver to tell the sender to 'hold' one or more streams, allowing the remaining streams to continue. This individual 'stream flow control' is not possible using the SNA asynchronous, full duplex protocol. The SNA flow control must be handled by VTAM pacing at the session level.

The BSC full duplex protocol requires the receiving application to notify the sender of temporary link failures so that transmission can be retried. This is unnecessary when using SNA since the transmission subsystem takes care of all link errors.

The SNA asynchronous protocol is more efficient and less error-prone on full duplex links and on long delay links or satellite links.

1.6 Applications using NJE Networks

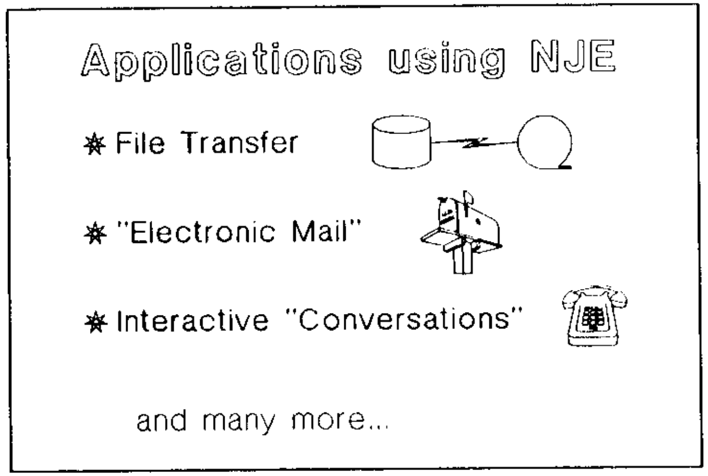


Figure 9. Applications using NJE

In addition to the use of NJE networks to transfer SYSIN and SYSOUT to remote host processors, there are many other uses of NJE networks, such as:

- File Transfer
- "Electronic Mail"
- Interactive "Conversations"

... and many more.

The data elements for these applications are not defined in the NJE protocols, but use NJE networks for the transmission and distribution of the data.

1.6.1.1 File Transfer

There are many types of file transfer mechanisms, several which use NJE networks. When using NJE for bulk data transfer of user files, an additional step is required at the sending node to place the source data set on spool reformatted into a SYSIN or SYSOUT data set. Another step is required at the receiving node to unload the SYSIN or SYSOUT data set from spool, recreate the original format and write it to the target data set. If the data structure or the target file have special attributes, such as keyed records, these attributes must be passed from sender to receiver embedded within the sysin or SYSOUT data. These additional steps and special attributes are not included in the NJE protocol definition.

1.6.1.2 "Electronic Mail"

Several implementations have taken advantage of the distribution and transfer facilities of NJE to send notes between interactive users on NJE-connected systems. Two examples are the TSO/Extended Interactive Data Transmission Facility, and the CMS SENDFILE command.

1.6.1.3 Interactive "Conversations"

There are also facilities to send short (one line) messages between interactive users on NJE-connected systems. An example of this is the TELL or SMSG commands in VM/CMS.

Again, these are not defined elements of the NJE protocols, but applications designed for the use of NJE facilities.

2.0 NJE Protocol Layers

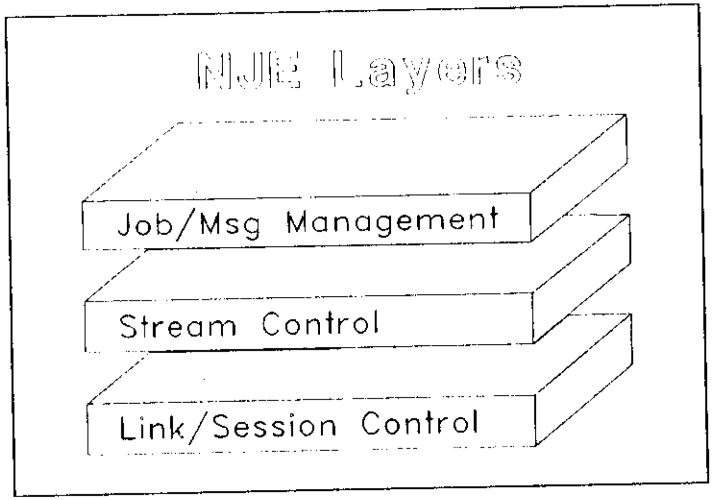


Figure 10. NJE Layers

The NJE protocol can be viewed as a layered structure (although the implementation boundaries are not always obvious).

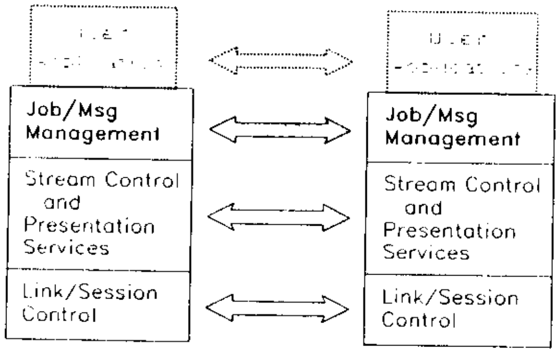
1. SYSIN/SYSOUT/Command/Message Management

2. Stream Control and Presentation Services

3. Session and Connection Control

The remainder of this paper is organized to discuss these layers from the top down.

2.1 SYSIN/SYSOUT/Command/Message Management Layer



There are three types of streams at this level:

1. SYSIN Job
2. SYSOUT Job
3. Commands and Messages

Since NJE results in asynchronous execution of work at remote nodes, command flow is required so that a user may query or modify the work elements representing portions of his network job at remote nodes. Message flow is required to carry responses to these commands and to report the progress of his network job request back to the originating node or user.

The types of asynchronous remote work elements are:

- SYSIN Job Execution
- SYSOUT Job Processing
- Job (SYSIN or SYSOUT) Transmitting

A user application layer (which is not part of the NJE protocols) is also shown above the job management layer.

2.1.1 SYSIN Job Stream Structure

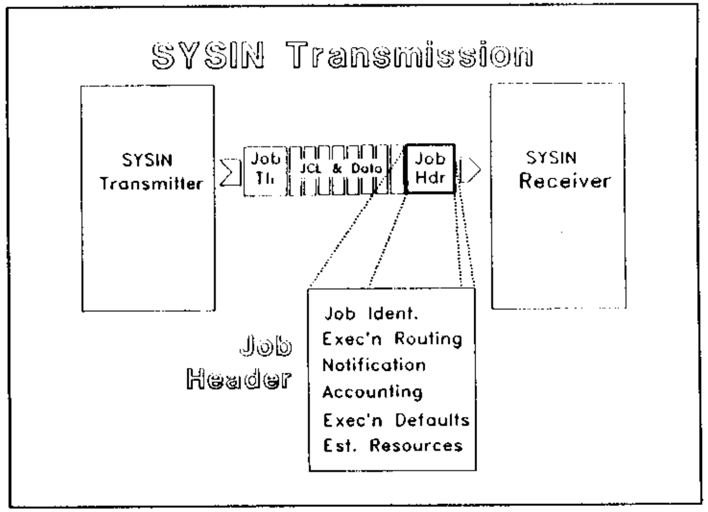


Figure 11. SYSIN Stream Structure and Job Header

A SYSIN stream consists of several types of records. It begins with an NJE job header record and ends with an NJE job trailer record. Between the header and trailer is a single job or work specification. The syntax of the work specification is that of the node where the job will execute. The NJE protocol does not standardize work specification syntax. If the executing node is JES3 then the work specification will be MVS JCL and JES3 JECL. There may be embedded SYSIN data files in the work specification.

The job header record and job trailer record are variable length records containing one or more variable length sections. The protocol assumes the work specification record length (SYSIN record length) is 80 bytes fixed. Trailing blanks may be truncated before transmission. All NJE data is transmitted in transparent mode (unprintable characters are not translated).

2.1.1.1 Job Header

The job header contains the following types of information:

1. Network Job Identification
2. Execution Routing
3. Notification Routing
4. Accounting Information
5. Execution Defaults
6. Estimated Resources Required.

2.1.1.2 Job Trailer

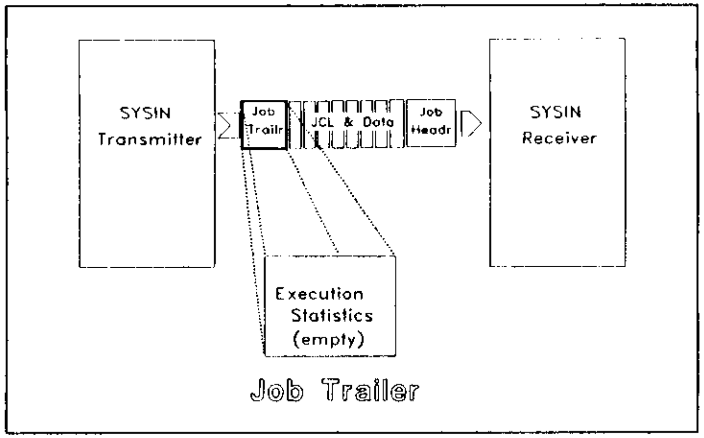


Figure 12. Job Trailer Record

The job trailer was designed for execution time statistics and, although present at the end of the SYSIN stream, contains no usable data until after job execution. On a SYSOUT stream it may contain execution statistics for the job which created the SYSOUT data set.

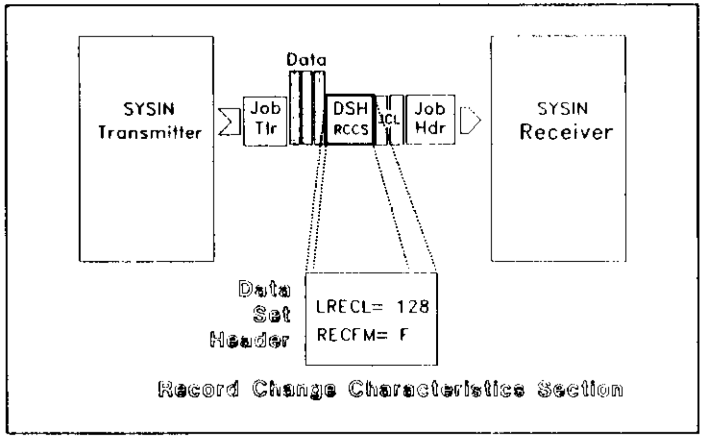


Figure 13. SYSIN Stream with other than 80 byte Records

Under certain circumstances, one or more data set header records may appear in the SYSIN stream, between the job header and trailer. If there are groups of records in the SYSIN stream (JCL or data) which are other than 80 byte fixed (before blank truncation), they must be immediately preceded by a "Record Characteristics Change Section" data set header record. This is a special type of general section for SYSIN data sets. It is sent alone and defines the new record format (U, F or V) and the record length (up to 32K).

2.1.2 SYSOUT Data Stream Structure

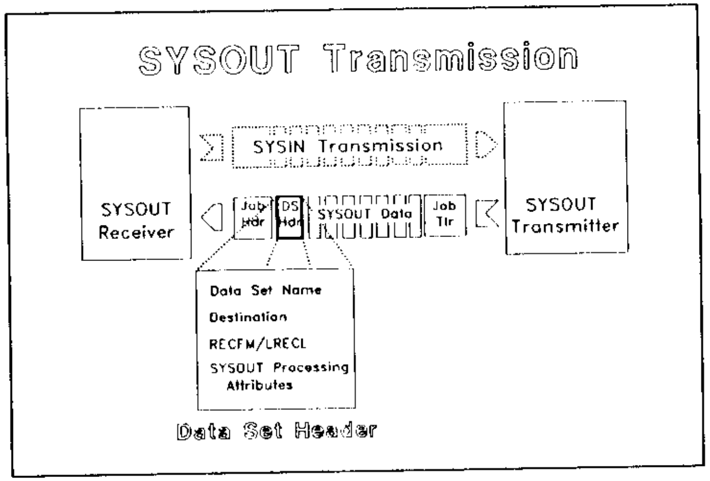


Figure 14. SYSOUT Stream Structure

A SYSOUT stream also begins with a job header record and ends with a job trailer record. Between the header and trailer there will be one or more SYSOUT data sets created by the job identified in the job header. A node executing a routed job will retain the original job header and use it on all SYSOUT streams created as a result of the execution.

2.1.2.1 Data Set Header

Each SYSOUT data set is preceded by one or more data set headers. The data set header record contains the following information:

1. Data Set Name (unique only within the creating job)
2. Destination Node
3. Destination Work Station or Userid or Program (External Writer)
4. Source Data Record Format and Logical Record Length
5. Destination Processing Attributes such as SYSOUT Class, FCB and Forms ID.

2.1.2.2 SYSOUT Data Records

Each SYSOUT data record is preceded with a one or two byte length field. Control information appended ahead of the length field to indicate a one or two byte LL will be described later. This length value does not include itself. The NJE protocol requires the SYSOUT records be split into segments no larger than 256 bytes before being placed in the transmission buffer. This requires logical record spanning. The spanning technique used for user data records, headers and trailers will be described later in this section.

2.1.2.3 SYSOUT Fan-Out

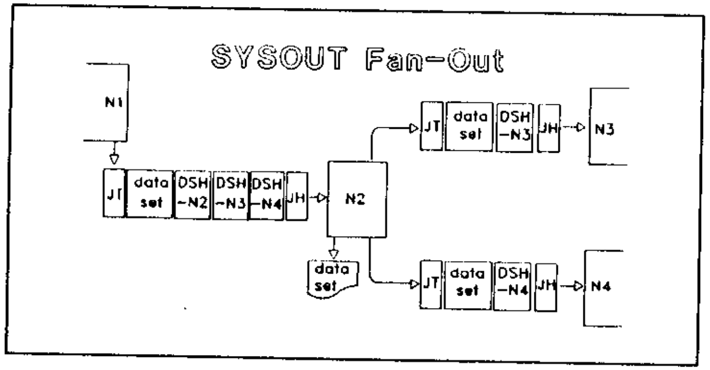


Figure 15. SYSOUT Fan-Out

Since more than one SYSOUT data set may be in a single SYSOUT stream and each data set may have a different final destination, SYSOUT nodes and intermediate nodes must have the capability to split or "fan-out" a SYSOUT stream into multiple streams to be forwarded. The node may also find SYSOUT data sets in the stream which are to be processed locally.

It was noted above that a SYSOUT data set may be preceded by more than one data set header. If a single SYSOUT data set has more than one destination node it may be transmitted as a single data set with multiple headers. This feature is referred to as "optimized fan-out". It is optional as to whether an NJE node creates an optimized fan-out SYSOUT stream, however all intermediate or SYSOUT must be able to receive and process such a stream.

2.1.3 Command and Message Records

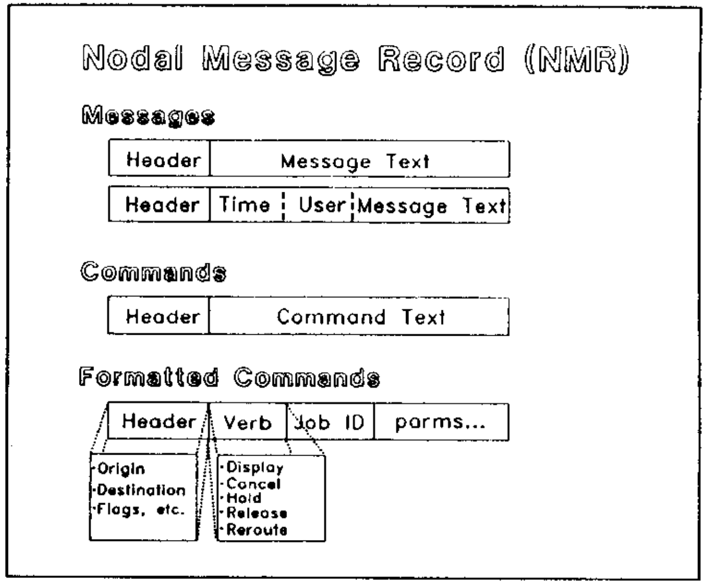


Figure 16. Nodal Message Record

Commands and messages do not really constitute a stream but are sent as individual, 256 byte maximum length records. These records are called Nodal Message Records or NMR's. There are three forms of NMR's. One form is used for messages, another for commands with system dependent syntax. A third is used for commands which have a system independent or "global" syntax. All forms begin with a NMR header followed by either unformatted text or a formatted command area.

For messages, the NMR header fields are used to specify the origin node destination node and either a destination remote, userid or console ID. If the message is in response to a command, then the command origin becomes the message destination and the command destination becomes the message origin. There is also an importance level and output priority for unsolicited status messages which is not used for command responses.

The message text may optionally begin with a time stamp and/or an origin userid. An indicator in the NMR header portion defines whether neither, either or both of these fields are present at the start of text. The origin userid in the message text provides message routing facility between two consoles or users.

For commands, similar NMR header fields are used, except that the qualifying userid, remote or console ID applies to the origin of the command instead of the destination. The execution node retains the header portion and uses the command origin information as the destination routing for the command response. The authorization level of the origin console, workstation or user and the text length or an indication that the NMR contains a global command is provided.

The global commands are Display, Cancel, Hold, Release and Reroute. They apply either to a SYSIN job or SYSOUT job.

The formatted area also contains several command arguments such as the job name, number and origin node name. For rerouting, it also contains the new destination node name and remote or userid.

2.1.4 Store and Forward

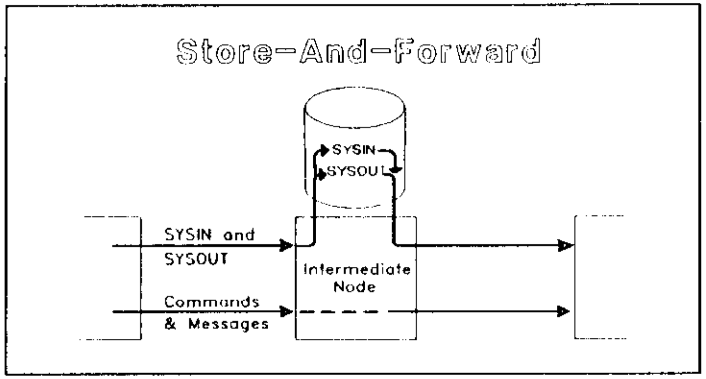


Figure 17. Store and Forward

The intermediate node must store and forward the above SYSIN, SYSOUT, command and message streams without change, with the following variations:

1. SYSOUT streams with multiple data set headers with different destinations must be "fanned-out". The transmission of "optimized fan-out" streams (multiple data set headers in front of a single data set) is optional.

2. Certain fields in the job or data set header may be changed explicitly by operator commands on intermediate nodes, such as priority or destination.

3. NMR's are currently forwarded without being stored on the intermediate spool. If the next node is not up, they are discarded. For commands, the origin is notified if the NMR is discarded. For messages, only the local operator is notified if it is discarded.

This handling of NMR's in a store and forward environment seems appropriate in view of the interactive nature of commands and command responses.

2.1.5 Header, Trailer Record Format

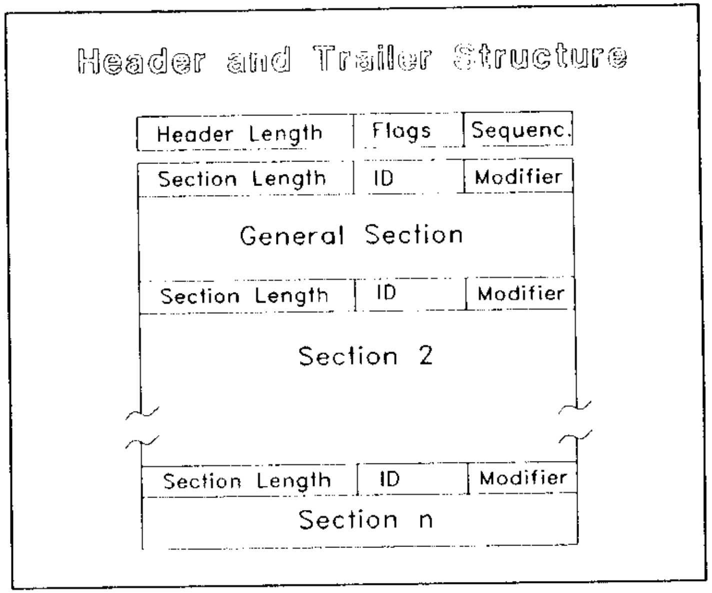


Figure 18. Header and Trailer Structure

Job header, data set header and job trailer records contain one or more variable length, formatted sections. Each record type begins with a common section which contains general information common to all NJE products. Additional formatted sections may be present which are product dependent.

Each section starts with a 2 byte length field (the length value includes these 2 bytes), followed by a section identifier. The identifier defines the format of the section. The product dependent sections can be used when like products are communicating with each other to invoke product dependent functions. There is one more byte, used as a section modifier, which permits multiple formats for a particular section type.

In front of this multi-section record there is a four byte field containing a two byte length, one byte of flags (unused) and a sequence byte for spanning control.

This variable section structure permits easy addition of product and release dependent information to the header and trailer records. It also facilitates enhancement of NJE with new, optional functions or device support.

2.1.6 Record Spanning

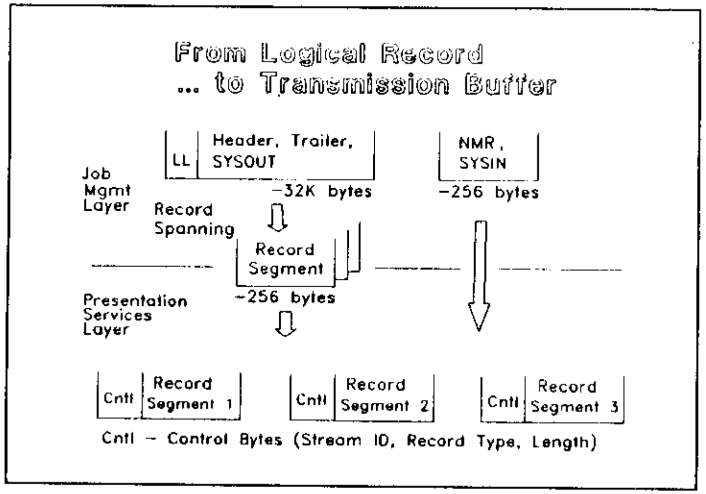


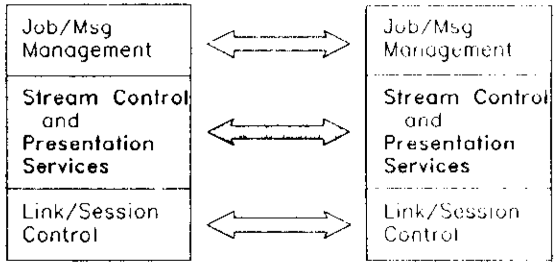
Figure 19. Flow of Logical Records to Transmission Buffers

The spanning technique is the same for both SNA and BSC. Spanning occurs before the record is compressed. For the remaining discussion a "stream record" refers to a segment of a job header record, job trailer record, data set header record, NMR or user record (SYSIN or SYSOUT). The NJE protocol limits stream records to 256 bytes (including any length or spanning fields). NMR's and SYSIN records can never exceed 256 bytes, so spanning is not required for these record types.

During the spanning process, trailing blanks on a record segment may be truncated. The spanning control information must tell the receiver how many blanks to insert when the original record is recreated.

Compression occurs later in the presentation services layer. (See below.)

2.2 Stream Control and Presentation Services Layer



Stream control handles the multileaving function and the starting and stopping of individual streams.

Presentation Services handles the compression and compaction of the stream records and the filling or emptying of the transmission buffer.

2.2.1 Presentation Services in BSC

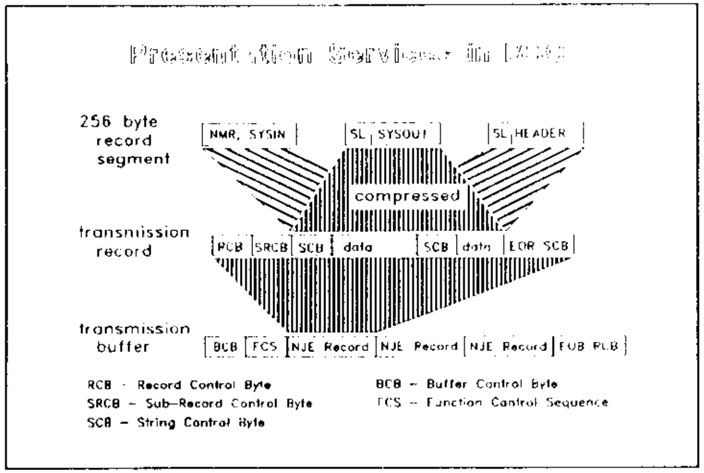


Figure 20. NJE Presentation Services with BSC

In BSC, the stream record segments are first compressed. BSC compression results in String Control Bytes (SCB) interspersed in the stream data with duplicate characters strings compressed. The resulting format will always begin with an initial SCB and may have additional SCB's interspersed. The SCB defines how many blanks or repeating non-blank characters are to be inserted by the receiver (up to 31 characters) or the length of strings without any duplicate characters (up to 63 characters).

After compression, 2 control bytes are placed in front of the compressed segment. The first control byte is called the Record Control Byte (RCB) and contains the stream identifier (type and number). The second byte is called the Sub-Record Control Byte (SRCB) and defines the record type (job header, data set header, job trailer or user data record) plus SYSOUT carriage control type and user data spanning indicators (first, last or middle segment).

A "stand alone" SCB with a value of zero is always placed at the end of each transmission record, sometimes referred to as an "EOR SCB". In the BSC protocol an end-of-file (end of the stream) is represented by an RCB with the stream id, an SRCB of hex '80' and an SCB of hex '00'. The sender may abnormally terminate a SYSIN or SYSOUT stream with the same RCB/SRCB and an SCB of hex '40'.

2.2.1.1 BSC Transmission Buffer

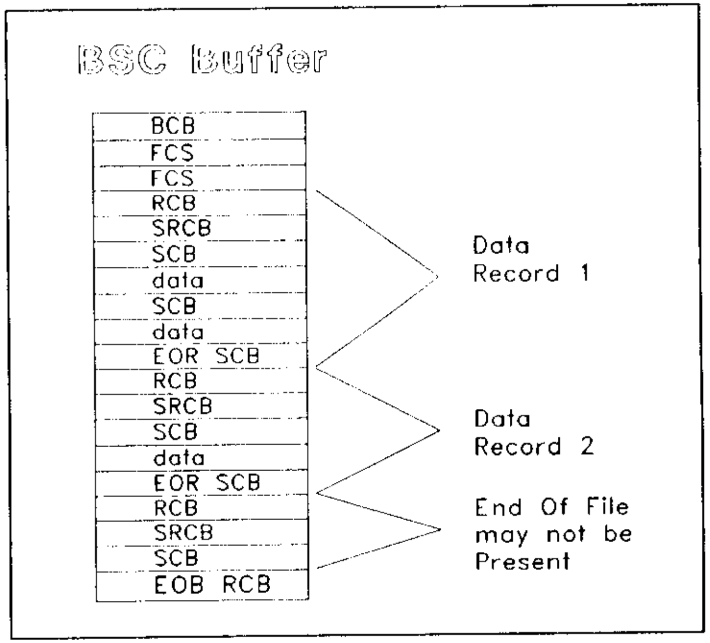


Figure 21. BSC Transmission Buffer

Every BSC buffer begins with a Buffer Control Byte (BCB) containing the outbound buffer sequence number (modulo 16). Each end of the BSC connection maintains an outbound and an inbound buffer sequence counter.

Following the BCB are two bytes used by each receiver to control his inbound flow. These bytes are called the Function Control Sequence (FCS). There is one bit to hold (bit off) or enable (bit on) each of 9 inbound streams and one bit to hold or enable all inbound streams. The latter bit is referred to as the "wait-a-bit". The 9 stream bits are assigned as follows:

- Suspend All Streams
- Command and Message Stream
- SYSIN Stream 1
- SYSOUT Stream 1
- SYSIN Stream 2 or SYSOUT Stream 7
- SYSIN Stream 3 or SYSOUT Stream 6
- SYSIN Stream 4 or SYSOUT Stream 5
- SYSIN Stream 5 or SYSOUT Stream 4
- SYSIN Stream 6 or SYSOUT Stream 3
- SYSIN Stream 7 or SYSOUT Stream 2

It is the FCS bit assignments that cause the BSC protocol restriction of a maximum of 8 SYSIN and SYSOUT streams concurrently, in each direction.

The compressed transmission records are placed in the buffer after the FCS bytes. The format does not prevent placing transmission records from different streams in the same buffer but the common protocol precludes it. (No products create such a mixed stream buffer.)

When the next compressed transmission record will not fit in the buffer, a special stand-alone RCB of hex '00' (EOB) is placed after the last record and the buffer is truncated at this point for transmission.

Note that compressed stream segments are never spanned across transmission buffers, however, a complete stream record may span transmission buffers.

2.2.2 Presentation Services in SNA

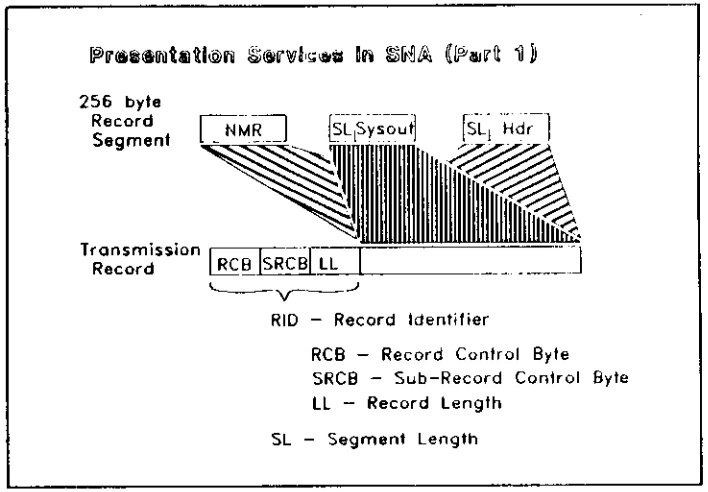


Figure 22. NJE Presentation Services in SNA (Part 1)

The major difference between presentation service for SNA and BSC is that compression and, optionally compaction, occur in SNA *after* the control bytes are placed on the front of the stream record segment. There are three bytes of control data placed in front of each stream segment. They are the RCB, SRCB and LL (Length) bytes and very similar to the same fields in BSC. The LL byte contains the true segment data length minus 1 (before compression and compaction). The length byte is used by the receiving presentation services to locate the next RCB in the inbound RU. When used to locate the next RCB, the length value must be incremented by one. The RCB/SRCB/LL bytes are referred to as the Record Identifier (RID).

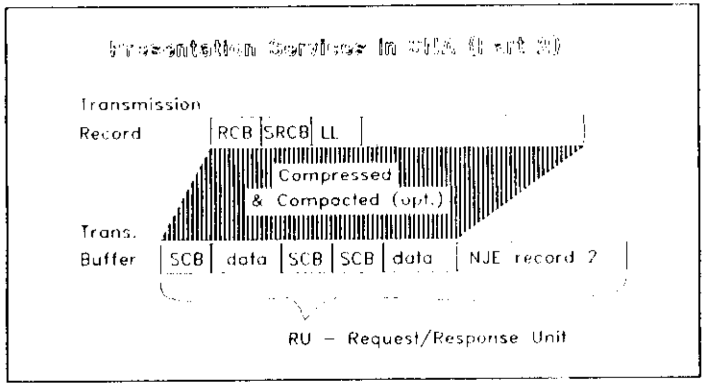


Figure 23. NJE Presentation Services in SNA (Part 2)

The SNA SCB defines compression lengths as the BSC SCB does. This SCB encoding does, however, support compression of up to 63 duplicate characters or blanks. Unlike the BSC SCB, the SNA SCB supports compaction of two characters into a single byte, for defined master characters. (Note that SCB's are always used even if compaction and compression are not actually implemented.) The SNA SCB is not used for EOR, EOF or sender cancel. The SCB is not used in SNA to define the end of record. EOF and sender cancel are defined in the SRCB.

2.2.2.1 SNA Request Units (RU)

After each stream segment is compressed, including the RID, it is placed in the output buffer which will become the SNA RU. There are no buffer control bytes preceding the first stream record. Each RU will begin with a SNA SCB. There is no end-of-buffer indicator. This is defined by the RU length. When the next compressed, compacted stream record segment will not fit, the buffer is truncated and sent.

2.2.3 Stream Control and Control Records

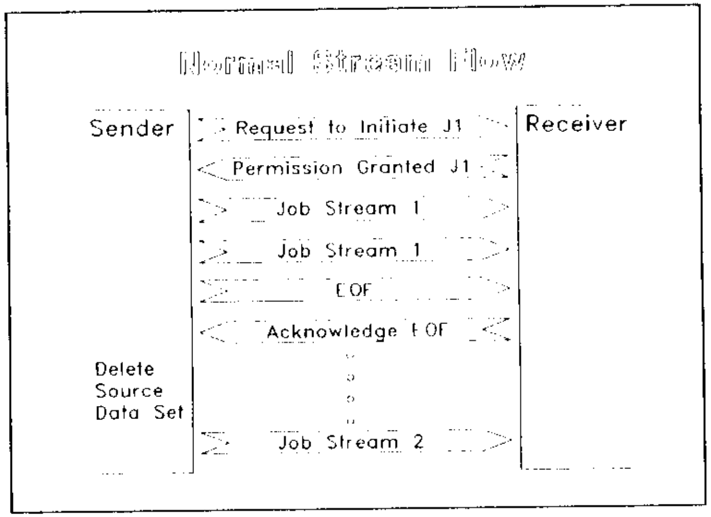


Figure 24. Normal Stream Flow

While RCB/SRCB bytes in BSC and RIDs in SNA are used to identify SYSIN, SYSOUT and other records and streams, they are also used to control these streams. These control records are encoded as stand-alone RCB/SRCB bytes (no data) in BSC and as stand-alone RID's (length of 0) in SNA. The stream control encodings are always sent stand alone in a buffer or RU. There are also control records used for initialization, termination and network topology changes. These records are always preceded by an RCB/SRCB/LL in both SNA and BSC and are always sent uncompressed and uncompacted (i.e., no SCB's are used). They are described in the next section.

The stream control encodings in the RCB/SRCB or RID provide:

- Sender to Receiver
  - Request permission to initiate stream
- Receiver to Sender
  - Permission granted to initiate stream
  - Permission denied to initiate stream or receiver cancel
  - Acknowledge end of stream (EOF received)
  - Ready to Receive (sent after previous permission denied)

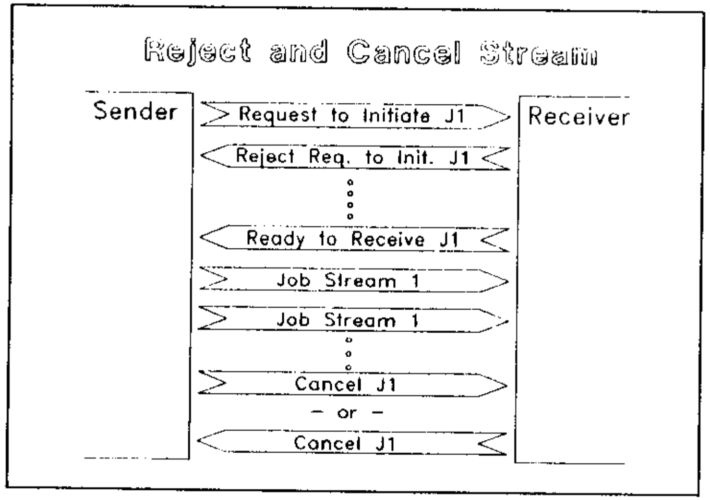
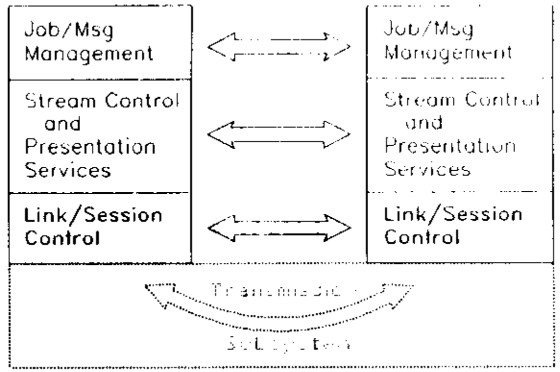


Figure 25. Reject and Cancel Stream

For these control encodings, the request is encoded in the RCB and the stream identification is placed in the SRCB. The encodings are the same for both SNA and BSC. There are two other control encodings used for stream control which are different for SNA and BSC. EOF and sender cancel is encoded in the SRCB for SNA and in an SCB following the SRCB for BSC.

There is one other control encoding used in BSC only. A receiver signals a transmission error with an RCB encoding and the expected buffer sequence number in the SRCB.

2.3 Session and Connection Management Layer



The lowest layer of the NJE protocols is the Link Control layer for BSC or CTC communications, or the Session Control for SNA environments. This layer establishes and terminates the communications between NJE nodes, as well as sending other control information about other sessions or connections.

2.3.1 BSC Connection Initiation

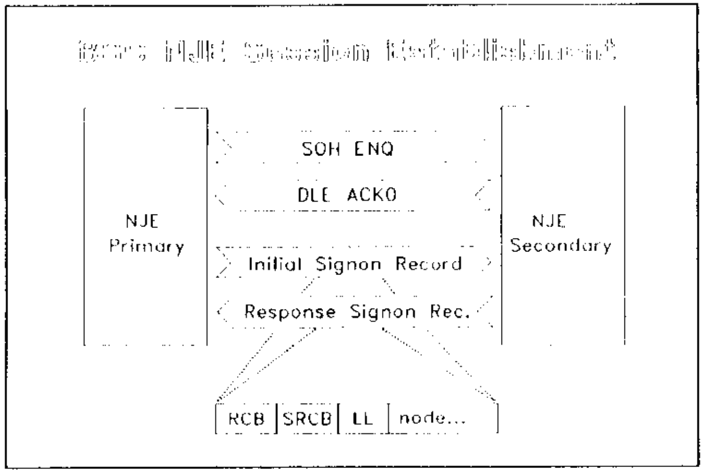


Figure 26. BSC Session Establishment

The concept of a primary and secondary NJE node is used for connection initiation in both BSC and SNA. The determination of these roles is, however, different between BSC and SNA. In BSC, either node (or both simultaneously) may attempt to initiate the connection by sending "SOH ENQ". Because of the synchronous protocol, one end receives the "SOH ENQ" first and becomes the NJE secondary, responding with a "DLE ACK0". The other end becomes the NJE primary. The NJE primary then sends an NJE initial signon control record (uncompressed) and the NJE secondary responds with a response signon record. Both records have the same format but different RCB encodings. Since these records flow uncompressed there is no initial SCB after the SRCB. Instead a one byte length field is present. This length byte contains the total length of the record including the RCB/SRCB/LL.

The signon record contains:

1. Sending Node Name - The Member Number is also included for multi-CPU complexes.
2. Line and Node Passwords
3. BSC Buffer Size - The smallest is used if the two sides are different.
4. Signon Concurrence Flags - This is a new, optional feature to allow two systems to determine what extended capabilities of the other are supported.

2.3.2 SNA Initiation

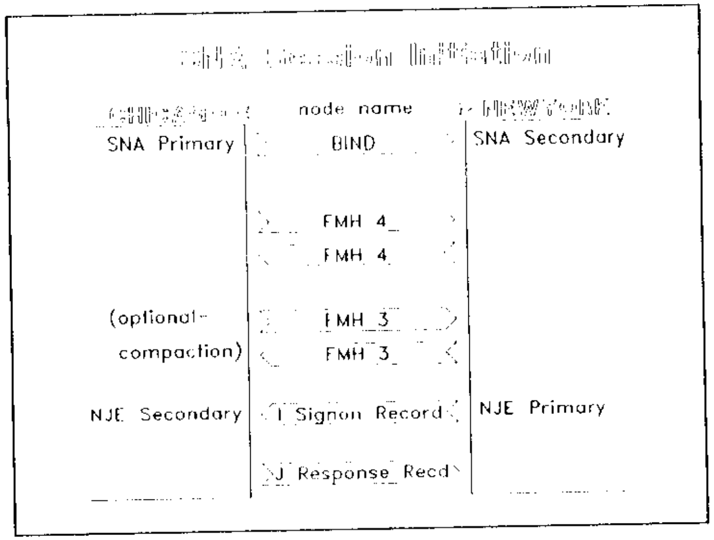


Figure 27. SNA Session Initiation

Either node can become the SNA primary and send the BIND. The session protocol defined in the BIND are full-duplex, only-in-chain, exception responses. Compaction may be used.

Following the completion of the BIND process, there is an exchange of a private NJE Function Management Header type 4 (FMH4) records to exchange node capabilities. The FMH4 exchange may be followed by an exchange of SNA FMH3's (compaction tables) if the FMH4 indicated compaction is to be used. The SNA primary initiates each of these exchanges. These records are sent with "definite response". This is the only time definite response is requested in the NJE protocol. All other RU's are sent "exception response only". If a negative response is received, the only defined action is to terminate the session.

The FMH4 describes the sender's capabilities in terms of:

1. RU Size
2. Compaction
3. Network Topology Records

After the previous exchange is complete, the NJE primary sends the NJE initial signon record and the NJE secondary responds, as in BSC. For SNA the NJE primary is always the node with the higher node name. Note that in SNA an NJE node has two names, an LU name as defined to VTAM and the NJE node name appearing in the signon records, job and data set headers and NMRs. It is a product option as to whether these names are identical for itself but it must support remote NJE nodes where they may be different.

2.3.3 Network Path Manager

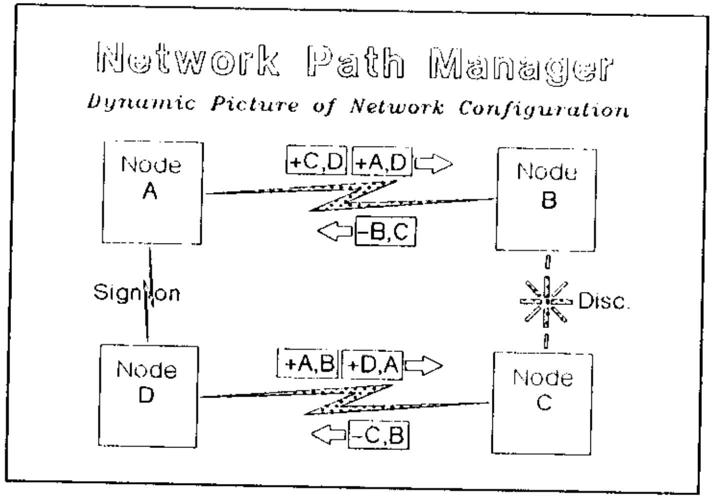


Figure 28. Network Path Manager

The Network Path Manager is responsible for connection protocol between the members of the network, promulgating connection information to the other members, maintaining information about which lines should be used to reach a given node, and informing other subcomponents which nodes should be reached over a given line. The Network Path Manager provides routing information for jobs and messages, processes NJE signon and connection/disconnection records from other Network Path Managers, and makes "best choice" decisions for line selection based on resistances specified by system programmers.

Note: The Path Manager protocols are only supported by JES2.

2.3.3.1 Connection Status Information

Whenever a dynamic connection is agreed upon, each Path Manager involved will send an Add Connection control record to systems not involved in the connection over all other NJE lines. The add connection control record will be used by receiving Path Managers to determine best paths to nodes within the network. Each Path Manager will forward the add connection control records to other nodes.

2.3.3.2 Disconnections

When a NJE line has disconnected, the path manager then clears its own reachable nodes in its tables, validates the queues, and notifies attached nodes that the disconnection has now taken place.

Disconnections are promulgated to the members of the network using a Subtract Connection control record. Disconnecting connections may cause nodes formerly reachable via the disconnected line to no longer be available to the system. In this case, dependent connections are automatically determined by each system experiencing the disconnection or receiving the resulting subtraction control records.

2.3.4 BSC Termination

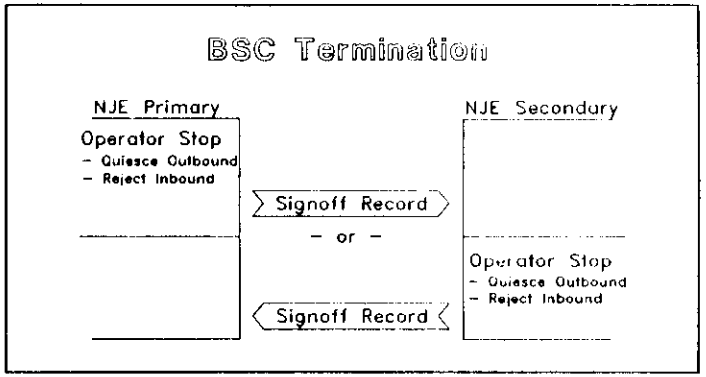


Figure 29. BSC Termination

An orderly termination of the traffic preparatory to terminating the connection can be initiated by either the primary or the secondary. By use of the "permission denied" response and the stream hold bits in the FCS, either end can quiesce traffic in both directions. When all traffic is stopped, the connection is terminated by a signoff RCB/SRCB (with no data).

2.3.5 SNA Termination

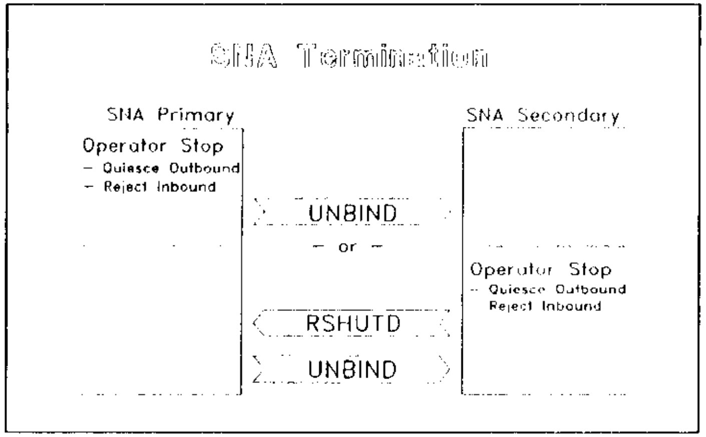


Figure 30. SNA Termination

Either side may initiate graceful termination. New stream initiation may be rejected by the RCB "permission denied". There is no FCS capability to prevent the other side from trying to initiate new streams, however.

The SNA data flow control request to "shut down" is supported (RSHUTD). This can only flow from SNA secondary to SNA primary. In this case the primary can quiesce its outbound streams. It is assumed the secondary will not try to initiate a stream after sending the RSHUTD. When traffic is ended, the primary causes an UNBIND to flow.

If the SNA primary wants to terminate the session, it has no way to notify the secondary other than denying permission to initiate a stream. When activity ceases, the UNBIND is sent. This may cross an inbound request to initiate a stream. The secondary would interpret the UNBIND as "permission denied".

3.0 Summary

3.1.1 NJE Protocol Review Board

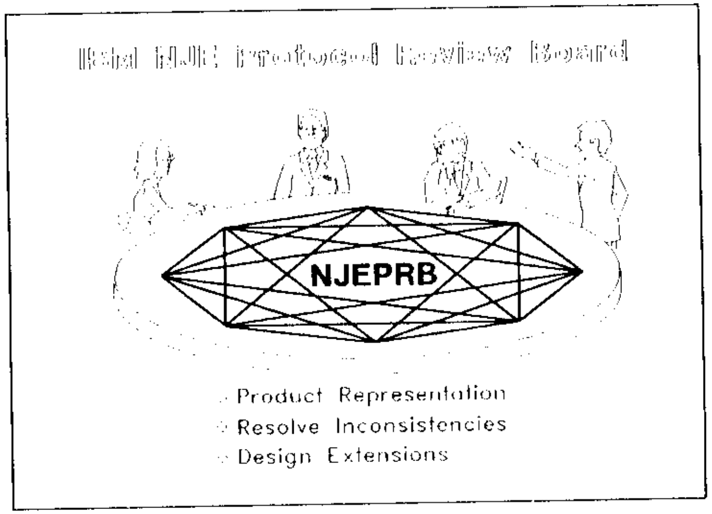


Figure 31. NJE Protocol Review Board

Within IBM an NJE protocol review board exists. The membership of this board consists of one member from each of the supporting products, as well as consultants from other organizations. This board meets periodically to resolve product inconsistencies and to design extensions to the protocols. Because the protocols are used to establish NJE networks among unlike products, requirements for enhancements to NJE protocols must be reviewed by this board.

3.1.2 NJE Information Sources

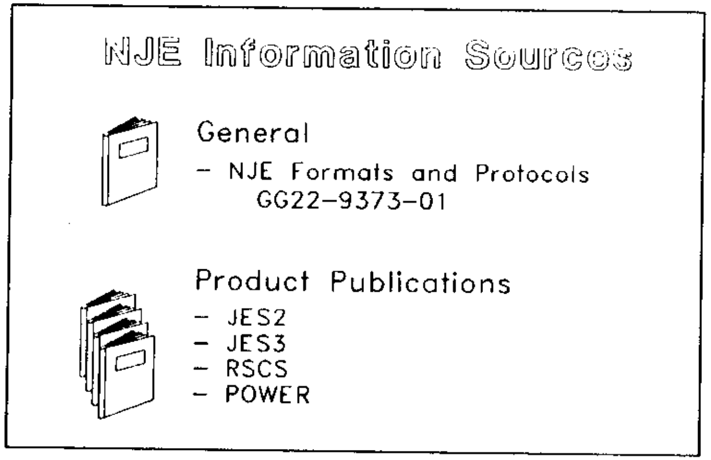


Figure 32. NJE Information Sources

The information contained in this presentation is based on the "NJE Formats and Protocols" which has been published as a Washington Systems Center technical bulletin, document number GG22-9373. This document can be consulted for additional details on the subject, as well as the publications listed in the bibliography below.

Glossary

ACK (or ACK0/ACK1). In BSC, an affirmative acknowledgement, indicating that the previous block was accepted without error, and the receiver is ready to accept the next block of transmission.

Block Control Byte (BCB). A byte used to maintain the integrity of data during a multi-leaving transmission.

BCB Sequence Error. This refers to a multi-leaving record beginning with an RCB of X'E0'. This record indicates that an error was detected in the BCB of the previous block. At this time, data has been lost, and the only correct response is to terminate the line and restart it.

Compaction. A method of reducing the length of records for transmission by representing certain 8 bit characters with only 4 bits.

Compression. A method of reducing the length of records for transmission by removing blanks and duplicate characters.

Channel to Channel Adapter (CTC or CTCA). A feature on S/370 channels that allows two processors to communicate directly to one another. It is described in *IBM S/370 Special Feature Description: Channel-to-Channel Adapter*, GA22-6983. Also see the IBM 3088.

Control Record. All records with an RCB with the low four bits of zero or an SRCB with the two high order bits of one.

Data Record. This term refers to all records with an RCB in the range 98-F8 and the range 99-F9 which do not have an SRCB with the two high order bits set to one.

Data Set Header. A record that generally precedes a unit of SYSOUT data. It may also appear in the middle of SYSIN data to indicate a change in the format of the SYSIN data.

Decompression. The process of restoring a compressed record to its original form.

End Of Block (EOB). In BSC, a special RCB (X'00') placed after tha last record to indicate the end of a transmission buffer.

End Of File (EOF). This refers to a null record that is transmitted at the end of a job, following the job trailer, to indicate that nothing remains to be transmitted. It is acknowledged by a Stream Complete.

End Of Record (EOR). In BSC, a stand-alone SCB (X'00') indicating the end of a logical record.

Fan-Out. The ability in NJE to send a SYSOUT data set to multiple destinations without sending multiple copies down the same link.

Function Control Sequence (FCS). Control bytes used to manage streams in multi-leaving transmissions.

Function Management Header (FMH). In SNA, specialized control format to select a destination and control the way data is sent or presented at the destination.

Job Control Language (JCL). In OS/VS, an esoteric command language used to specify batch work.

Job Entry Control Language (JECL). Specialized control language, interspersed in JCL, read by the job entry subsystem (JES2, JES3, or VSE/POWER).

Job. A job is a unit of work within the network. It consists of all data beginning with a job header control record and ending with a job trailer control record.

Job Header. The control record that provides general information relating to the job as a whole.

Job Network. A collection of peer-coupled systems connected by communication links, using NJE protocols.

NAK. In BSC, a Negative Acknowledgement, indicating that the previous block was received in error, and the receiver is ready to accept a retransmission of the erroneous block.

Job Trailer. A record the terminates the job and generally provides accounting information.

Network Job Entry (NJE). (1) A facility for transmitting jobs (JCL and in stream data sets), sysout data sets, (job oriented) operator commands and operator messages, and job accounting information from one computing system to another. (2) A facility that provides access to batch computing facilities from other host systems. It enables users to transfer work and data throughout a distributed network of batch computing facilities. ("NJE" is not a part of "Systems Network Architecture (SNA)", but is an application layer which uses SNA, BSC and CTC transmission facilities.) (3) The JES2 program product implementation of the NJE Protocol.

Network Job Interface (NJI). The original HASP, RSCS, ASP, or JES3 Programming RPQ implementation of the NJE Protocol.

Nodal Message Record (NMR). A record for transmitting commands and messages to other locations.

Path Management Record. This refers to a record beginning with an RCB of X'F0'. It is a non compressed record and contains network connectivity information.

Permission Granted. This refers to a record with an RCB of X'A0'. It is used following a Request Permission to Initiate Stream when the receiving system is willing to accept the new stream.

Permission Rejected. This refers to a record with an RCB of X'B0'. It is used following a Request Permission to Initiate Stream when the receiving system is not willing to accept the new stream. This same code also goes under the name of Receiver Cancel, and is used whenever the receiver wishes to cancel the job that is being received.

Receiver Cancel. This refers to a record with an RCB of X'B0'. This is used after a Permission Granted has been transmitted and the receiver wishes to terminate the job on a stream.

Record Control Byte (RCB). The byte that defines the stream for each record within a transmission buffer.

Record. All bytes beginning with an RCB up to but not including the next RCB. This term encompasses Control Records, data records, and nodal message records.

Request Permission To Initiate Stream. This refers to a record with an RCB of X'90'. It is used prior to transmitting a stream of data. The other system will either respond with a Permission Granted, or a Permission Rejected.

Record Identifier (RID). The Record Identifier used in SNA transmissions. It is a three byte field made up of the RCB, SRCB, and a byte containing the length of the data record.

Request/Response Unit (RU). In SNA, an element of the Basic Link Unit containing data and data stream controls.

Start of Heading (SOH). In BSC, a character preceding a block of heading characters.

Stream. A logical flow of information.

Stream Complete. This refers to a record beginning with an RCB of X'C0'. This is sent by the receiver after the transmitter sends an EOF. It is at this point that the transmitter may purge the job from its queue.

String Control Byte (SCB). A byte within the data stream that is used in compression algorithms.

Sub-Record Control Byte (SRCB). Defines individual types of records within an RCB.

SYSIN. SYSIN refers to a type of job which is intended to be processed as an execution type job by the operating system at the receiving node. After processing, SYSOUT is usually produced which is usually returned to the origin node. It is possible for a job to execute and produce SYSIN to be executed at the same or another node.

SYSOUT. SYSOUT refers to the output from some program. When received by the networking component at the destination, it is not inserted into the execution job queue. It may be printed or punched immediately on a locally connected output device, or placed into a state from which a user or operator of the system may specify its further processing.

Transmission Block. A collection of one or more records to be transmitted over the network as a unit. Transmission blocks are that portion of each transmission that is independent of the access method.

Transmission Buffer. An area in storage for building and receiving transmission blocks.

Transmitter Abort. This refers to a record with an SCB of X'40'. It is used when a transmitter wishes to abort the job being transmitted.

Bibliography

The following list of publications is a subset of the various product documentation libraries including some *IBM Systems Journal* reprints and Systems Center Technical Bulletins. For a complete list of product documentation, see the General Information Manuals listed under the appropriate product heading, or *IBM System/370 Bibliography*, GC20 0001.

NJE - General

- *Network Job Entry Formats and Protocols for S/370 Program Products*, GG22-9373-01
- *Job Networking (IBM Systems Journal V17 N3, 1978)*, G321 5071
- *Job Networking Facilities* (WSC Technical Bulletin), GG22-9042

Systems Network Architecture (SNA)

- *Concepts and Products*, GC30-3072
- *Technical Overview*, GC30-3073
- *Sessions Between Logical Units*, GC20-1868
- *Reference Summary*, GA27-3136
- *Format and Protocol Reference Manual: Architectural Logic* , SC30-3112
- *IBM Synchronous Data Link Control General Information* , GA27-3093

ACF/VTAM

- *General Information*, GC27-0608
- *Planning and Installation Reference*, SC27-0610
- *Programming*, SC27-0611
- *Operation*, SC27 0612
- *Messages and Codes*, SC27 0614
- *Diagnosis Guide*, SC27-0615
- *Diagnosis Reference*, LY38 3053 (OS/VS), LY38-3058 (VSE)
- *Data Areas*, LY38 3054 (OS/VS), LY38-3059 (VSE)

Binary Synchronous Communications (BSC)

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Channel-to-Channel Adapter (CTC)

- *S/370 Special Feature Description: Channel-to-Channel Adapter*, GA22-6983

JES2

- *Network Job Entry (IBM Systems Journal V17 N3, 1978)*, G321-5072
- *Running JES2/NJE on an ACF/VTAM Network*, G320-5855

MVS/SP JES2 - Version 1 (5740-XYS)

- *General Information*, GC28-1025
- *JES2 Initialization and Tuning*, SC23-0046
- *JES2 Commands*, SC23-0048
- *JES2 Logic*, LY24-6006
- *JES2 Command Language Reference Summary*, SX23-0008
- *MVS JCL*, GC38-1300
- *System Messages Volume 1*, GC28-1374
- *System Messages Volume 2*, GC28-1375

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- *General Information*, GC28-1118
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- *JES2 Commands*, SC23-0064
- *JES2 Logic*, LY24-6008
- *JES2 Command Syntax*, SX23-0010
- *MVS JCL*, GC28-1148
- *System Messages Volume 1*, GC28-1376
- *System Messages Volume 2*, GC28-1377

JES3

MVS/SP JES3 - Version 1 (5740-XYN)

- *General Information*, GC28-1025
- *JES3 Initialization and Tuning*, SC23-0041
- *JES3 Operator's Library*, SC23-0045
- *JES3 Operator's Reference Summary*, SX23-0007
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- *JES3 Messages*, GC23-0043
- *System Messages Volume 1*, GC28-1374
- *System Messages Volume 2*, GC28-1375

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- *JES3 Initialization and Tuning*, SC23-0059
- *JES3 Commands*, SC23-0063
- *JES3 Command Syntax (Reference Card)*, SX23-0012
- *JES3 Logic*, LY24-6007
- *MVS JCL*, GC28-1148
- *JES3 Messages*, GC23-0062
- *System Messages Volume 1*, GC28-1376
- *System Messages Volume 2*, GC28-1377

VM/370

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RSCS Networking (5748-XP1)

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VSE/POWER Version 2 (5666-273)

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- *Messages*, SH12-5520
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Special Characters

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