z/OS Basics:
JES 201 - Differences Between JES2 and JES3

Tom Wasik
IBM JES2 Development

David Jones
IBM JES3 Development

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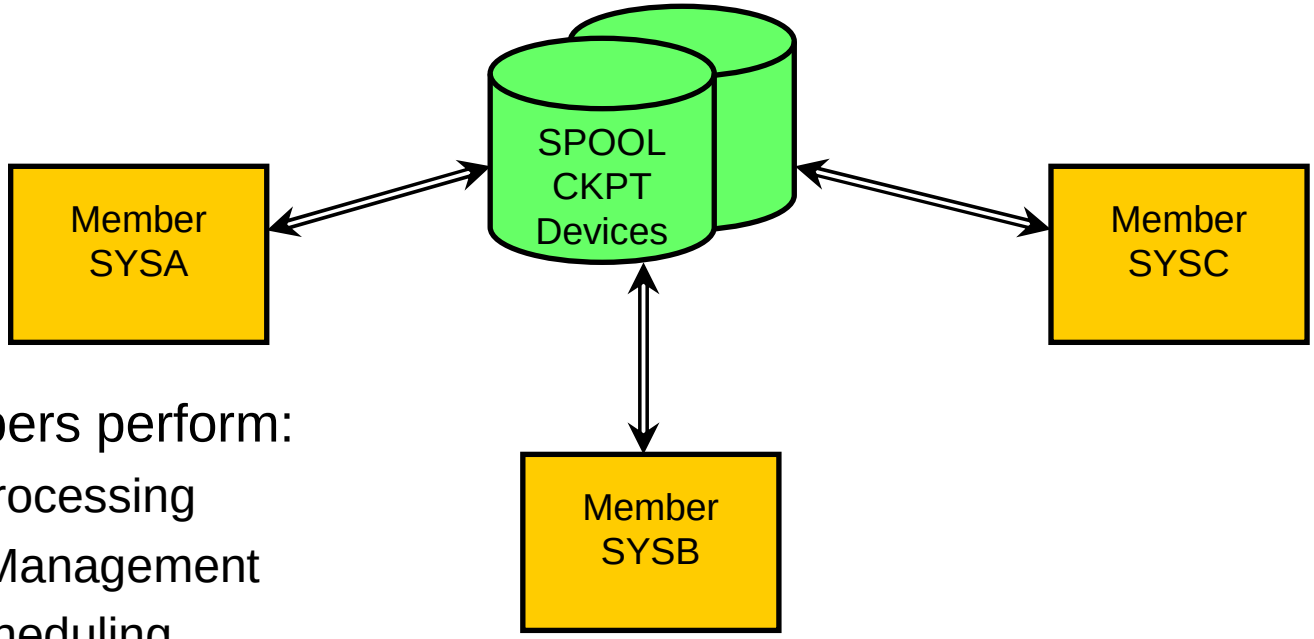
What does JES do?

- Manages SPOOL space to store JCL, SYSIN, SYSOUT
- Manages jobs (started tasks, TSO users, BATCH)
  - Does input processing for job
  - Manages conversion processing
  - Manages JES mode initiators
  - Selects jobs for execution
  - Processes SYSOUT
- Provides execution services and enquiry services
- Does remote processing (NJE/RJE/RJP)
- Performs these functions across multiple z/OS images
  - Integrates images into a single system to process work

JES2

- Common set of work queues stored in its checkpoint
  - Member adds to or selects work from this common queue
  - Checkpoint is time sliced among members
- Simple mechanisms for managing work
  - Resource management done by MVS
  - Depend on MVS (scheduling environment, etc) to determine eligibility to select jobs for execution
  - Jobs sit in initiators waiting for resources
- Peer to Peer relationship between members
  - Members select work that it can process
    - Little regard to other members
  - No single point of control
  - No critical member
- Primary communication via JES2 checkpoint data set

JES2 MAS



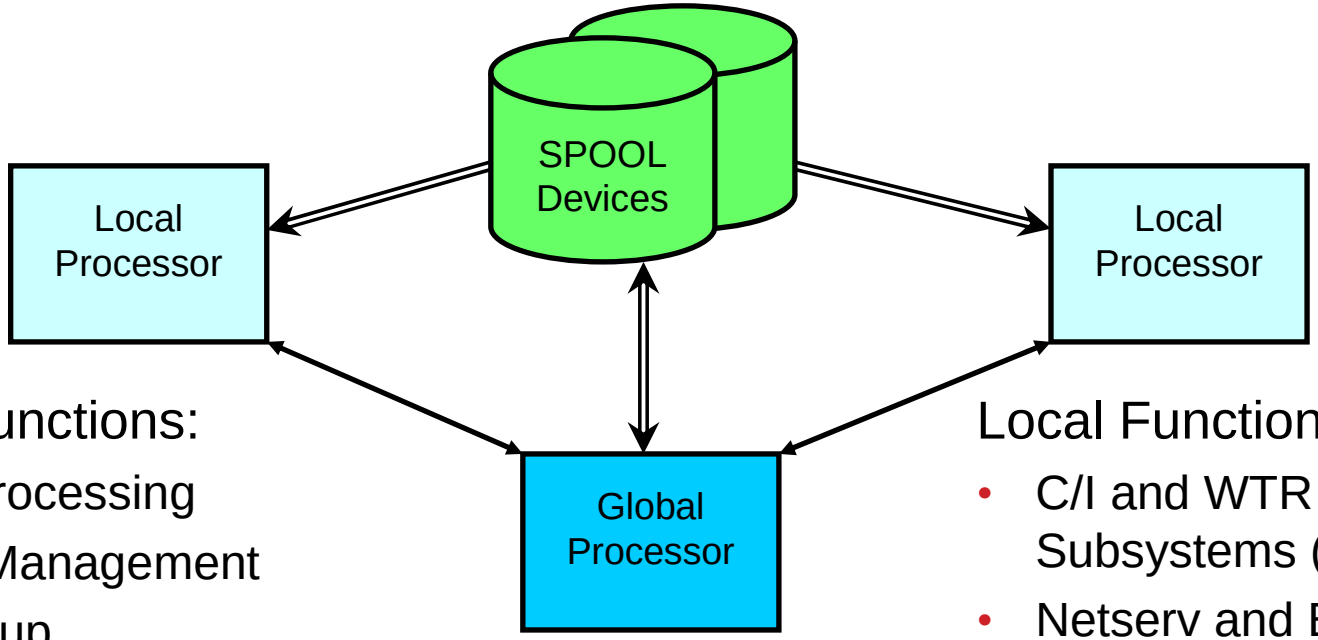
All members perform:

- Input processing
- Spool Management
- Job Scheduling
- SYSOUT scheduling
- SSI processing
- NJE/RJE

JES3

- JES3 does resource and workflow management before and after job execution.
- MVS does resource and workflow management during job execution.
- JES3 exercises centralized control through the global processor.
  - Global performs job selection, scheduling, and device allocation functions for the local processors.
  - Provides increased job scheduling control, deadline scheduling capabilities, and increased control with JES3 device allocation.

JES3 Global vs Local Function



Global Functions:

- Input processing
- Spool Management
- Job setup
- Job scheduling
- SYSOUT scheduling
- SSI processing
- C/I and WTR Functional Subsystems (FSS)
- Netserv and BDT

Local Functions:

- C/I and WTR Functional Subsystems (FSS)
- Netserv and BDT
- Some SSI processing

JES3 Global

- Introduces all jobs into the system
- Handles scheduling of JCL Conversion/Interpretation (C/I)
- Pre-execution setup of JES3 managed devices
- Schedules jobs to all main processors (locals)
- Has awareness of all jobs in execution
- Handles scheduling of SYSOUT data sets for writers
- Manages space on the shared-spool devices

JES Structure

- JES address space
  - Main task
    - Sub-dispatched (shared) with multiple processes
  - Subtasks to perform tasks that must MVS wait
- Auxiliary address space to own processes/objects
  - Allows JES address space to fail yet JES functions continue
- JESXCF services
  - Provide XCF communications between address spaces
    - Primary communication between JES3 global and locals
    - Mainly used for enquiry/posting function for JES2
  - Manages status of JES address spaces
    - Notifies other members of a JES failure

JES2 PCEs

- JES2 Main task processing is performed by PCEs
  - Sub-dispatchable units of work running under main task
- Each job phase is processed by a PCE type
  - Conversion, Execution, Output, purge
- JES2 functions are also implemented by PCEs
- Table pairs can be used to define and created PCEs
  - Tables are defined in modules loaded via JES2 LOADMOD statement
  - Can be dynamically created using $ADD LOADMOD command
- Table pairs can be used to extend other things in JES2
  - For example commands and initialization statements

JES3 DSPs

- JES3 is composed of routines called Dynamic Support Programs (DSPs).
  - DSPs are schedulable units that are processed the same as jobs.
- Resident DSPs are fixed parts of JES3 processing.
  - Dynamic Allocation (DYNAL)
  - Output Service (OUTSERV)
  - Modify commands processor (MODDRVR)
  - Main Device Scheduler (SETUP)
- Callable DSPs are invoked by the operator with *CALL,dspname.
  - Display
  - Writer (WTR)
  - Network Job Entry (NJE)
  - Dump Core (DC)
  - JES3 Monitoring Facility (JMF)
- DSPs that process pieces of work required by a job.
  - Converter/Interpreter (CI)
  - Main service (MAIN)
  - Purge (PURGE)
- To customize job processing, JES3 users can add DSPs, replace existing DSPs, or alter behavior with installation exit routines.

JES2 Input Processing

- Internal reader processing occurs in submitter address space
  - Request sent to JES2 address space to get a job number, job structure (in checkpoint), and initial SPOOL space
  - JCL is parsed, SYSIN data sets created, and SPOOLed in submitter address space
- Job completes input processing when
  - ENDREQ macro is issued
  - /*EOF card submitted
  - New job card is encountered
  - Data set is closed
- NJE/TCP processing is similar (occurs in NETSERV address space)
- BSC and SNA NJE, RJE, SPOOL Reload processing occurs in the JES2 address space (main task)
- Single submission streams are limited by ability to access the JES2 checkpoint
  - Parallel streams can submit much faster (10 parallel streams are 10x one single stream)

JES3 Input Processing

- Input processing occurs in JES3 global address space when:
  - Reader completes input of a job to spool.
    - Disk reader, tape reader, card reader including RJP workstation.
  - INTRDR spool data set is closed or ENDREQ macro used.
  - NETSERV spool data set is closed.
  - BDT spool data set is closed.
- Job Id(s) are created at:
  - ENDREQ
  - When control statements are processed from the spool data set.
- JES3 job control blocks are built and written to spool when the control statements are processed.

JES2 Conversion Processing

- Converts JCL into internal format needed to run job
- JES2 calls MVS converter in the JES2 address space
  - PCE selects job and sets up environment
  - Subtask used to call z/OS converter
- JCL interpretation occurs when job executes in target address space
  - Certain JCL error not detected until job is in execution
- Converter parms (defaults) based on JOBCLASS
  - Journal, BLP, SMF exits, PROCLIB, region, SWA ABOVE, etc
- TYPERUN=SCAN just performs conversion processing
  - Errors discovered during interpretation not detected

JES3 Converter/Interpreter (C/I)

- C/I takes place in the JES3 global address space (C/I DSP) or can be offloaded to C/I FSSes.
  - JES3 C/I invokes the MVS C/I function to process the JCL.
- JCL interpretation is done immediately after conversion.
  - In the C/I DSP or FSS rather than after job selection in an initiator.
  - Can provide quicker feedback of JCL errors.
- Converter parms (defaults) set from CIPARM statement based upon the input device.
  - Journal, BLP, SMF exits, PROCLIB, region, SWA ABOVE, etc
- TYPRUN=SCAN will also invoke the MVS interpreter.
  - Parameter and specification errors can be detected and corrected before a job is submitted for execution.

Functional Subsystems (FSS)

- Interface to offload function to separate address spaces
  - Reduces workload on JES main task
  - Original use for printer/writer support
  - Removes printer “driver” knowledge from JES and associates them with FSS software
  - JES managed interface
    - Controlled by JES commands

- JES3 extended FSS to support Converter/Interpreter service
  - Allows conversion to be processed outside JES3 address space
    - Runs on both the Global and Local processors

MVS Allocation

- A job's resource requirements are not known until a system initiator begins the step allocation process.
  - The job's requirements are satisfied one step at a time.
- Attempts to satisfy requirements are in contention with every other job step currently executing in the SYSPLEX.
- Jobs waiting for resources hold other available resources (an initiator, an address space, data sets, devices).
- Waiting jobs complicate the task of determining how many JES initiators are needed to keep the system full.

JES2 Job Scheduling

- Device/Data set scheduling managed by MVS
  - Job starts in initiator and waits for needed resources
  - GRS ENQ at allocation performs serialization and reports contention
- Allocations managed at a STEP level
  - No issues if one step creates data sets used by later steps
  - Steps that are skipped (due to conditional JCL) do not reserve resources
- System affinity and Scheduling environment used
  - Controls what jobs can be selected for execution
- Some balancing done for WLM initiators
  - Keep same percent busy on all members

JES3 Main Device Scheduling (MDS)

- A device management facility that can wholly or partially support the MVS allocation process.
  - Useful on a single system (global only) or multi-image (global-local) complex.
  - Optional and can be defined with JES initialization statements, JCL control statements, and JES3 operator commands.
- Satisfies the job's I/O resource requirements before and during job execution to prevent allocation delays.
  - Job's resources (devices, volumes, and data sets) are setup before execution.
  - Maximizes use of devices across the system.
  - An initiator should never be idle waiting for a job's resources.

JES3 MDS (continued)

- Considers the resources for all steps of a job and across all mains in the JESplex.
  - Has more information than is available to MVS allocation.
  - Can schedule combinations of jobs that will execute on a main without contention of resources attached to the main.
- Cooperates with Workload Management (WLM) to ensure scheduling environments for jobs are honored.
- With setup before job execution, dependencies between jobs or steps in a job cannot be determined.
  - Important for cataloging and passing data sets.
  - **JES3 assumes all steps will execute** and cannot determine if conditional job steps are skipped.

JES3 Generalized Main Scheduling (GMS)

- Selects and schedules a job for execution when an MVS initiator requests work.
- GMS features can be used to control when jobs execute.
  - Deadline scheduling
    - JES3 periodically increases a job's selection priority in an attempt to run the job by a specified deadline.
  - Dependent Job Control (DJC)
    - A "network" of jobs can be executed in a specific order or in parallel as determined by job dependencies.
    - //*NET control statements are used to define a DJC network and the dependencies between jobs in the network.
    - Can manage data dependencies, device utilization, or the job stream.

WLM–Managed Initiators

- Initiators started and managed by WLM
- Initiators associated with WLM service class
  - Only select work for a specific service class
  - Job class can influence service class assignment
- WLM starts initiators based on
  - System capacity (WLM tries to balance work across SYSPLEX)
  - Whether service class is meeting goals
  - Relative importance of the service class
- JES tells WLM on each system how many jobs are waiting
  - Based on service class, resource availability, where jobs can run
- JES decides what job to start in each initiator
- Specified by MODE=WLM on
  - JOBCLASS for JES2
  - Job class group for JES3

JES2–Managed Initiators

- Type of initiator used based on a JOBCLASS MODE=
  - Applies to all members of the MAS
  - MODE=WLM cannot be selected by JES2 initiators
- MODE=JES JOBCLASS uses JES2 initiators
  - Initiators started and managed by operator commands
  - Number of initiators defined at initialization
  - Initiators select jobs based on a ordered list of job classes.
- Start job command, $S J(nnn), causes WLM to start an initiator to run a specific job
  - Job can be in a WLM or JES mode class

JES3–Managed Initiators

- Associated with a job class group.
  - GROUP initialization statement.
- Expressed in terms of resources, not goals.
  - How many to start, what systems, when to start/stop defined with EXRESC parameter of GROUP initialization statement.
- Started/stopped by JES3 based on definitions and the backlog of jobs.
  - Also with *MODIFY,G command.
- Jobs selected within the job class group.
  - Selected based upon priority within the group.
- Workload balancing is difficult to define and static in nature.

Why WLM–managed over JES–managed?

- Fewer and simpler externals are needed to control WLM-managed initiators and to perform workload balancing.
- Managed according to the service classes and performance goals specified in the WLM policy.
- Externals reflect customer expectations typically in terms that are found in service level agreements.
- Workload balancing is automatic as the number of initiators running is based on performance goals and the importance of batch work with respect to other work.
- Dynamic, goal oriented initiator management allows the system to adapt to changing conditions and how well the work is meeting its performance goals.

JES2 Job Limits and Affinities

- JOBCLASS limits exist on a JESPLEX and member level
  - Number of concurrent jobs that can be active in JOBCLASS
  - Applies to JES and WLM mode JOBCLASSes (JOBs)
  - Limits affect number of available jobs reported to WLM
    - Impacts number of initiators WLM starts
- JOBCLASS affinity controls member where class is active
  - Lists systems that can select from the job class
  - Holding class same as null affinity list
  - Applies to JES and WLM mode JOBCLASSes
  - Affect number of available jobs reported to WLM
- Service class affinity limits where service class is active
  - Service class only registered if member in affinity list
  - WLM only starts initiators if service class is active

JES3 Job Class Groups and Job Classes

- Job class group is a named set of resource assignment rules to be applied to a group of job classes.
  - Essentially job class groups define the initiators available and where.
  - GROUP definition includes the mode (JES3 or WLM), the mains the initiators can run on, and a name that can be used to assign job classes to the GROUP.
- Job class is a named set of job processing and scheduling rules.
  - CLASS definition specifies a GROUP, the systems where the job class can be scheduled to run on, and many other options that are used to control the jobs scheduled within the class.
  - 8-character job class names can be defined and used on the //*MAIN statement.

JES3 Job Resources

- Device Fencing/Pooling
  - Can reserve devices for use only by jobs within a job class group or DJC network.
- Spool Partitioning
  - Can specify the spool partition to be used for jobs in a job class.
  - More on spool partitioning in a moment.

JES3 Job Class Limits

- Class limits can control the number of jobs in execution.
  - TDEPTH to limit the total number of jobs in a class that can run in the entire JESplex.
  - MDEPTH to limit the number of jobs in a class that can run on a particular main.
  - TLIMIT to limit the total number of jobs in a class that can run in a JESplex based on the number of jobs running in that JESplex in another class.
  - MLIMIT to limit the number of jobs in a class that can run on a particular main based on the number of jobs running on that main in another class.
- Limits apply to JES3 and WLM managed job class groups.
  - Class limits are applied to each service class separately during sampling.

SYSOUT Grouping

- A SYSOUT group is defined as the set of data sets that prints between a set of job separator pages
  - Always for the same job and security information
  - For SAPI, between group begin and group end indicators
  - For SDSF, data sets in a row on the O or H panel
- JES2 does early binding
  - Groups data sets into JOEs during OUTPUT phase
- JES3 does late binding
  - No groups until writer select output
    - Output selected that match writer's criteria

JES2 SYSOUT Processing

- JES2 performs grouping during the OUTPUT phase
  - Data sets grouped into a JOE (Job Output Element)
  - Data sets in a group have same class, destination, security info, etc
- SPIN data sets are never grouped with other data sets
- Can influence (prevent) grouping using JCL (GROUPID=)
- Re-grouping only done with SAPI
  - PSO for certain held data sets
- SYSOUT cloning can create multiple copies
  - /*JOBPARM COPIES=
  - Allows multiple copies of entire job output
    - ABC – ABC vs AABBCC
  - Cannot be re-grouped
    - Problem for SAPI/PSO

JES3 Output Service

- JES3 has Output Service Elements (OSE) to maintain output characteristics and processing options for SYSOUT data sets within a job.
  - Each OSE represents 1 to 16 data sets with similar output characteristics within the job.
- “Best fit” approach to matching SYSOUT data sets, via OSEs, to the characteristics of a writer when requested.
  - Can be considered late binding.
- A SAPI output group is based upon the OSEs and may consist of 1 to 16 SYSOUT data sets.
- SYSOUT attribute defaults can be associated with the defined SYSOUT class.

JES2 SPOOL

- Up to 253 SPOOL volumes supported
  - 1 single extent SPOOL data set per volume
  - Maximum data set size 1M tracks
- Basic unit of SPOOL allocation is the TRACK GROUP
  - 1-20 tracks per track group
  - Size can differ from one volume to another
- Each member performs allocations for job/processes on that member
  - Cache of 255 entries for when checkpoint is not owned
- SPOOLs can be added (started) or deleted (drained) via operator command

JES2 SPOOL

- SPOOL affinity limits what SPOOLs a member can allocate SPOOL from
  - Can associate volumes with systems running a particular workload
  - Guideline rather than a hard limit
- SPOOL fencing can limit how many volumes a job can be spread over
  - Can limit impact of loss of SPOOL volume
  - Has negative performance implications
  - Specify the number of volumes that can be used

JES3 SPOOL

- Limited only by the amount of DASD used.
  - Up to 1024 SPOOL extents (i.e. spool data sets).
- Track Group is the basic unit of spool space allocation.
  - Each is a group of spool records.
  - Spool record size = JES3 buffer size.
- SPOOL partitioning
  - Logical groups of spool data sets.
  - Can isolate spool data in separate partitions to improve spool performance, spool recovery procedures, and spool space management.
  - Can specify the partitions JES3 is to use for each processor, for each job class, and for each SYSOUT class.
- JES3 supports dynamic SPOOL add – z/OS V1.13.

JES3 SPOOL Partitioning Advantages

- Limit impacts of spool data set failures.
- Limit competition between mains for each partition to improve system performance.
  - Spread the use of spool partitions across jobs, job classes, and SYSOUT classes,
- Tailor spool space allocation to the requirements of jobs using that partition to improve performance.
  - Track groups size can be specified for each partition.
- Isolate critical work to specific partitions to ensure that spool space is available for critical jobs and users.

JES2 SPOOL I/O

- Each address space does EXCP(VR) to read/write SPOOL
  - Each JES data set does its own EXCP(VR)
  - Writes to SYSOUT done asynchronously
  - I/Os can be done in parallel with PAV
    - Even within a single address space
- Uses 31 bit private buffers in application address space
- Supports 31 bit callers (ACB/RPL interface)
- Allocations can use XTIOT – z/OS V1.13

JES3 SPOOL I/O

- JES3 does its own STARTIOs for spool reads/writes.
  - Data buffers are copied from/to ECSA or JES3 AUX address space
    - Number of buffers in each area and number fixed is specified for each main.
  - When buffers are queued, check is done to see if I/O active to the extent:
    - If not active and needed resources are available, a new I/O is started for the extent.
    - If active, new buffers are processed as part of completing the active I/O.
  - One active I/O per extent per JES3 main.
- Supports 31 bit callers (ACB/RPL interface) – z/OS V1.13
- Allocations can use XTIOT – z/OS V1.13

Miscellaneous Features

JES2

- NJE
  - BSC – Native
  - SNA – Native
  - TCP/IP – Native common
  - Dynamic and static routing (NPM)
    - Dynamic not as interesting
  - Automatic restart (NRM)
- RJE
  - Native BSC and SNA
- SPOOL offload
  - NJE format dump

JES3

- NJE
  - BSC – Native
  - SNA – BDT
  - TCP/IP – Native common
  - Static routing
- RJP
  - Native BSC and SNA
- DUMP job
  - Internal control block format

Miscellaneous Features

JES2

- Performance Monitoring
  - JES2 Health Monitor
  - PERFDATA command
    - WTO records
- INIT deck
  - Processed on every start
- Instream data set max LRECL 32K
- DESTID and DEST processing
- ENF 70 job transition notification

JES3

- Performance Monitoring
  - JES3 Monitor DSP
  - JMF – JES3 monitoring facility
    - SMF records
- INISH deck
  - Processed on certain starts
  - Offline inish deck checker
- Instream data set max LRECL spool buffer size-46
- DLOG (consolidated SYSLOG)

JCL

- JCL that works differently depending on JES
  - DD or OUTPUT COPIES=1-255 (JES2) vs 0-255 (JES3)
  - DD DLM= processing
  - HOLD= processing
  - JOB accounting field
  - NULL statement processing

JCL

JES2 Unique

- /* JECL
- DD SEGMENT=
- JOB TYPRUN=COPY
- JOB TYPRUN=JCLHOLD
- OUTPUT GROUPID=
- OUTPUT INDEX=
- OUTPUT LINDEX=
- OUTPUT LINECT=
- OUTPUT OUTDISP=

JES3 Unique

- //* JECL
- EXEC PGM=JCLTEST
- EXEC PGM=JSTTEST
- OUTPUT OVFL=
- OUTPUT THRESHLD=
- XMIT SUBCHARS=

JES3 DLOG

- **SYSLOG** individually records command and message traffic for each system in MVS format.
- **JES3 DLOG** centrally records command and message traffic for systems in a JES3 complex in JES3 format.
  - Written to SYSLOG on the global processor.
  - Precursor to OPERLOG.
- **OPERLOG** centrally records command and message traffic for systems in a sysplex in Message Data Block (MDB) format.
  - “IBM recommends use of OPERLOG on all systems.”

Questions?