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JES2 Bootcamp - Part 1 of 3
What is JES2 and what does it do

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Brief History of JES

- Original 2 versions
  - Attached Support Processor (ASP)
    - Developed in 1966 in Burbank, CA
      - S/360 follow on to the direct couple function of the 7090/7040
  - Houston Automatic Spooling Priority (HASP)
    - Developed in 1967 at Manned Spacecraft Center in Houston
      - Developed as a single system version of JES3
- Both affiliated with the US space program

Brief History of JES

- Both were field developed programs
  - Not part of the operating system – Think APPs
  - Driven by customer requests and requirements
- Both addressed the problem of slow peripheral I/O
  - Card readers, printers, and punch
- Spool was staging area for input (jobs) and output (SYSOUT)
  - Disk drivers were faster than unit record devices
    - Read cards to spool and then process from there
    - Write output to spool and then printed from there
- Made more efficient use of expensive CPU resource

History of JES

- Both were mods (or hacks) to the operating system
  - Front ended functions to intercept normal processing
- Provided functions the operating system (MVT) chose not to
- Eventually became JES2 (HASP) and JES3 (ASP)
  - JES - Job Entry Subsystem
- JES1? Came out with OS/VS1 (from dev)
  - Users hated it
  - Had too much invested in their mods to HASP and ASP
  - Convinced IBM to give them their products
    - But with new names (JES2 and JES3) and formal interfaces (the SSI)

Why do I need a JES? (What does it do?)

- JES implements spool
  - Staging area for job JCL, SYSOUT, SYSIN
- Entry portal for started tasks and TSO logons
  - Some system address spaces bypass JES
- JES manages batch
  - Gets jobs from multiple sources and places them on SPOOL
  - Schedules batch jobs to execute (manages work queues)
  - Provides interfaces to influence job scheduling

Why do I need a JES? (What does it do?)

- JES manages SYSOUT
  - Interfaces to JES printers
    - Still has support for line printers written directly by JES
  - Provides output to “FSS” printers (PSF)
    - FSS – Functional subsystem
  - Has interface for generic “print” drivers (InfoPrint, etc)
    - SAPI – SYSOUT API
- JES connects multiple MVS images
  - MAS/Complex predates SYSPLEX
  - Allows multiple systems to process single job/output queue (1975)
  - JES2 is always a MAS (Multi Access Spool) even if only one members (single member MAS)

Why do I need a JES? (What does it do?)

- JES implemented early “client server”
  - RJE/RJP – Remote Job Entry
  - Allows jobs from client computers to be run on MVT and get output back (1967)
  - Uses BSC and SNA protocols
  - Protocol still used today (though use is fading)
- JES implemented multi-node connections
  - NJE – Network Job Entry
  - Allows peer systems to interchange jobs and output for processing (1976)
  - Uses BSC, SNA, and recently added TCP/IP protocols
  - Early e-mail is TSO transmit over NJE
  - Still actively used by many installations

What makes JES special?

- Source distributed and maintained
  - Mostly assembler code (HLASM) – Some OCO parts
  - Customers/vendors look to JES for examples of how to do things
  - Lots of customer written exits to enhance functions
    - One customer has 35K lines of JES2 exit code
    - One man's clever exit is another man's mill stone
  - Code modifications have greatly reduced over the years
    - But they still exist in some shops
- Customer "interface" to the operating system
  - Customer use JES2 exits implement functions IBM chose not to

What makes JES special?

- Mini operating system within an operating system
  - Sub dispatches single main task TCB
  - Manages “data sets” on spool
  - Supports rich set of operator commands
  - Implements network protocols
    - BSC is at a CCW level
  - Drives real devices
    - At CCW level
  - Manages work queues, does scheduling
  - Manages initiators that run work
    - Selects work to run in initiators (even WLM initiators)
    - Also manages JES mode initiators

What makes JES special?

- Batch is still critical in many shops
  - Multiple customers run 300,000+ jobs per day
  - Some customers have 200+ SPOOL volumes
    - Full 64K track 3390s
    - Movement to 1M track data set reduced number of volumes
      - *But again growing in some shops*

OK, but why 2 JESes?

- 2 philosophies of system management:
  - JES2
    - A collection of peer systems sharing a single job/output queue
    - Each system selects the work it can processes
  - JES3
    - A single job/output queue managed on one system with work being passed from main (global) system to worker (local) system for processing
    - Centralized control of where work is sent to be processed

OK, but why 2 JESes?

- Functional differences
  - JES2
    - Simpler to use and set up
    - Changes can be made dynamically
    - No single control point to fail
  - JES3
    - More functions
      - *Dependent job control*
      - *Resource scheduling*
      - *Deadline scheduling*
    - Additional complexity to set up, less dynamic

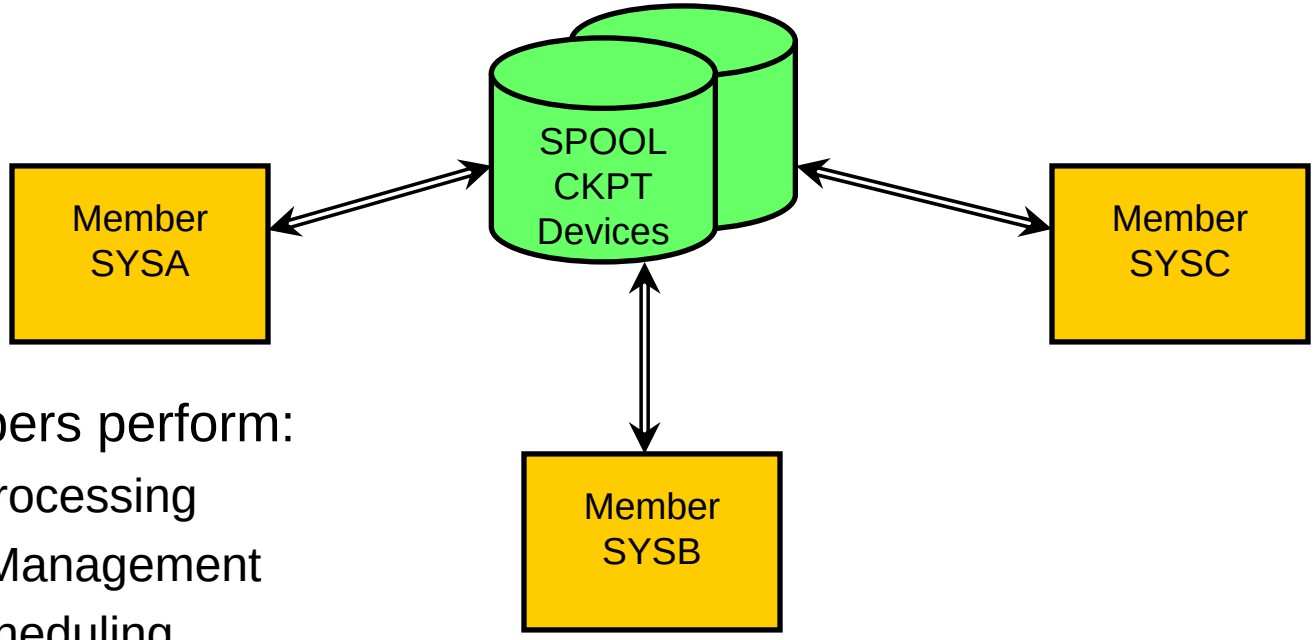
OK, but why 2 JESes?

- Output processing differences
  - JES2
    - Output collected and “bundled” when job completes
    - Bundles are selected by printers
    - Predictable contents of output bundles
  - JES3
    - Output is not grouped
    - One SYSOUT selected for printing
    - Others SYSOUT added that can be processed by same writer
    - What prints depends on writer that selects output
      - *Fewer output bundles*

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 (eg DSN ENQs)
- 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

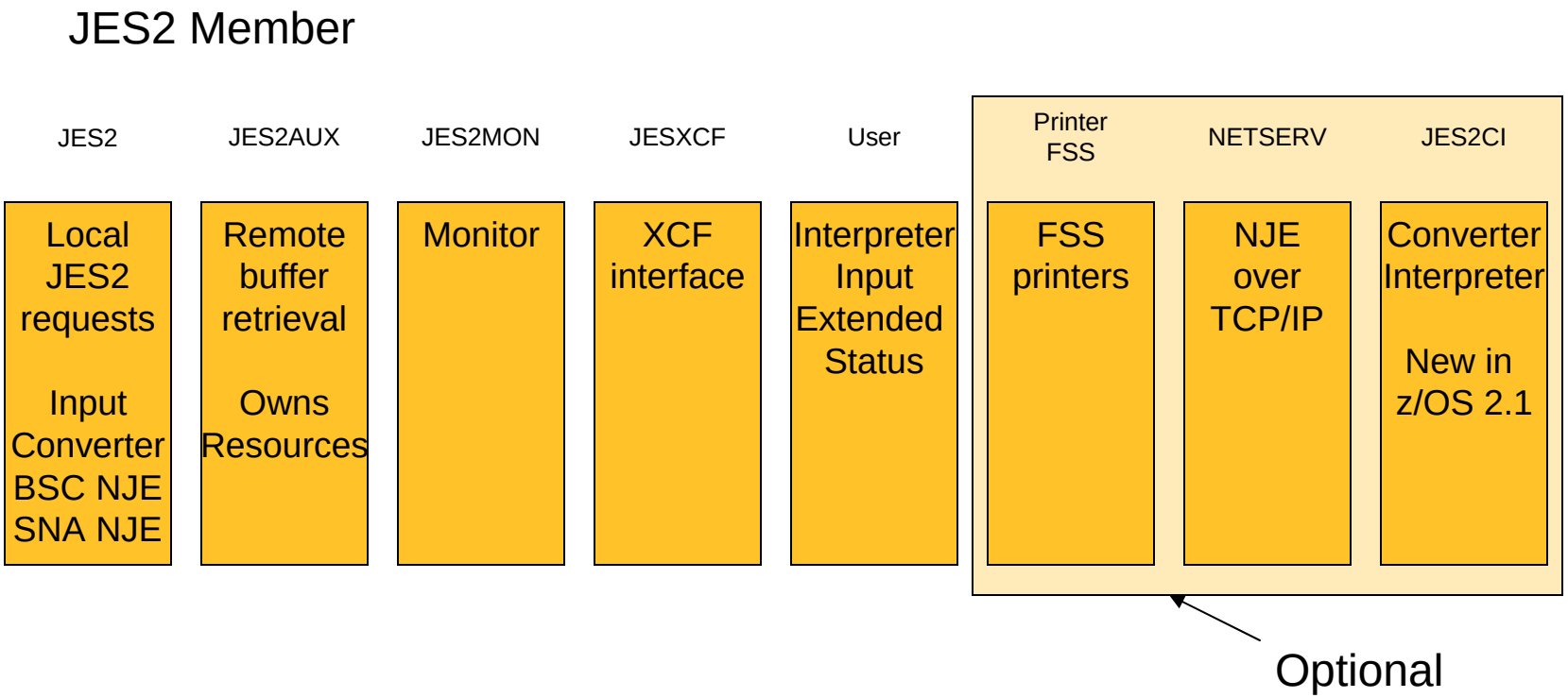
JES2 MAS



All members perform:

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

JES2 related address spaces



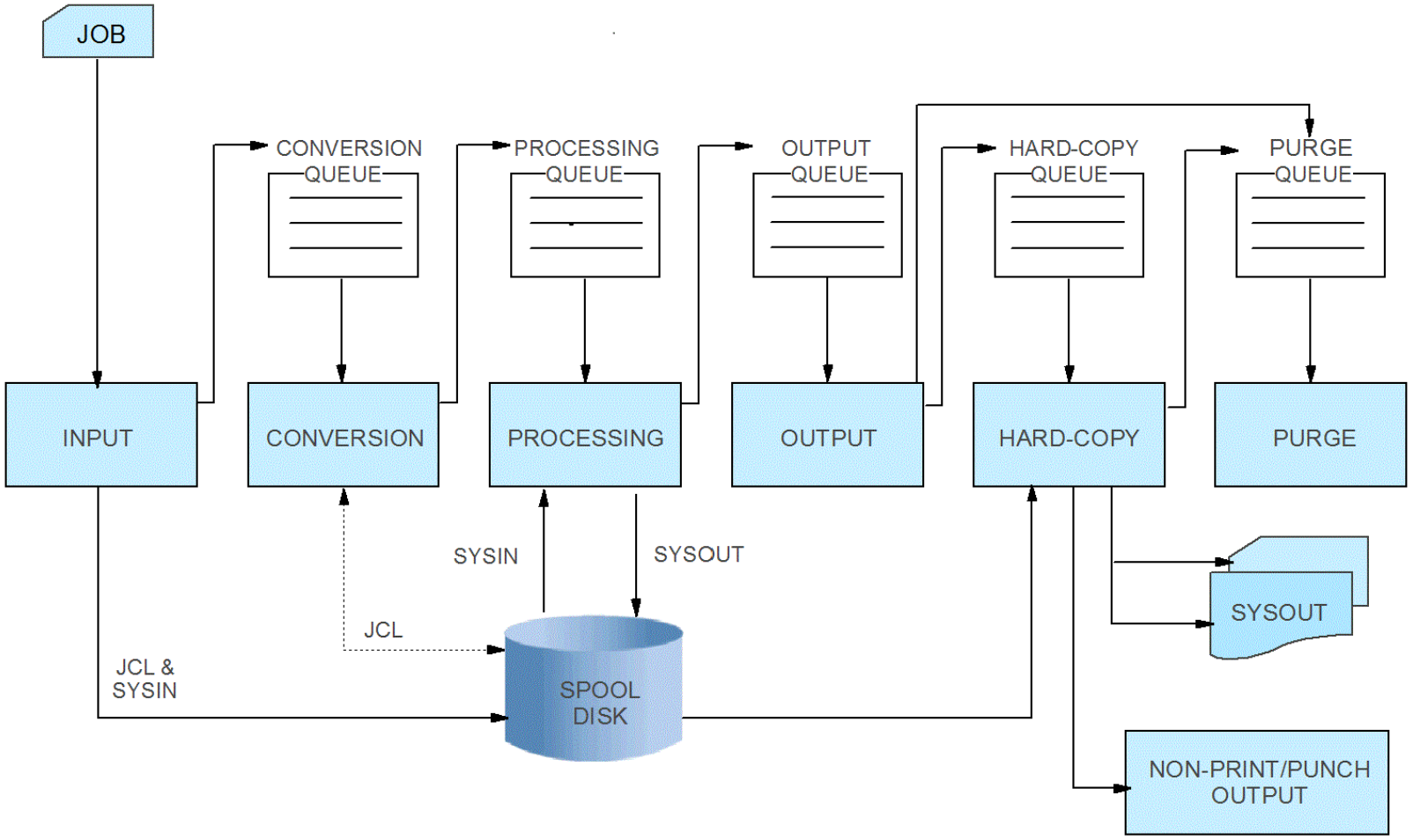
JES2 Structure

- JES2 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 JES2 address space to fail yet JES functions continue
- JESXCF services
  - Provide XCF communications between address spaces
    - Mainly used for enquiry/posting function for JES2
    - More messaging is done in recent releases
  - Manages status of JES2 address spaces
    - Notifies other members of a JES2 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 initialization 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

Job Phases



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
  - Passed symbols are saved on SPOOL (JES2 2.1)
- Job completes input processing when
  - ENDREQ macro is issued
  - /*EOF card submitted
  - New job card is encountered
  - INTRDR “data set” is closed
- NJE/TCP processing is similar (occurs in NETSERV address space)
- Other input processing occurs in the JES2 address space (main task)
  - BSC and SNA NJE, RJE, SPOOL Reload, and card readers
- 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)

JES2 Conversion Processing

- Converts JCL into internal format needed to run job
  - Two part process – Conversion and interpretation
- JCL interpretation can occur either
  - Before job starts execution in target address space
  - After conversion processing in the JES2CI address space
- Controlled by JOBDEF INTERPRET=JES|INIT
- In either case
  - PCE selects job and sets up environment
  - Subtask used to call z/OS converter and optionally interpreter
- Certain JCL error only detected by interpreter
- Converter parms (defaults) based on JOBCLASS settings
  - Journal, BLP, SMF exits, PROCLIB, region, SWA ABOVE, etc

Execution phase - 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

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 statement

JES2 – Managed Initiators

- Type of initiator used based on a JOBCLASS MODE=
  - Applies to all members of the MAS
- MODE=WLM JOBCLASS uses WLM initiators
  - MODE=WLM cannot be selected by JES2 initiators
  - Work selected by service class
- MODE=JES JOBCLASS uses JES2 initiators
  - Initiators started and managed by operator commands ($SI)
  - Number of initiators defined at initialization
  - Work selected by an ordered list of job classes and/or job class groups
- 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 job class

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

Execution services

- JES is involved to provide services while a job executes
  - Creation of SYSOUT data sets
  - Job submission services
  - Job message logging
  - Other JES services (SSI functions)
- One special type of SYSOUT data set is a SPIN data set
  - Allocated separate from normal job output on spool
  - Queued to JES for output processing when closed/unallocated
  - Available to print while job is still running (separate JOE)
  - Purging data set (JOE) frees spool space

OUTPUT phase – SYSOUT Grouping

- The OUTPUT phase builds output groups from SYSOUT data sets
  - 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
- Grouping based on various characteristics
  - SYSOUT class, forms, writer name, hold type, destination, security info, etc
- Print scheduling based on output group (JOE)
  - PSO conversational support is only exception

SYSOUT Grouping

- 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

Hardcopy phase

- Parking place for job that have run and are waiting to print
  - No real actions taken on the job level
  - Processing is based on the output groups (JOEs)
- Once output for the job has been processed, job complete
  - Job queued to purge processing

Functional Subsystems (FSS)

- Interface to offload function to separate address spaces
  - Reduces workload on JES main task
  - Used in JES2 for printer support
  - Removes printer “driver” knowledge from JES2
    - Associates them with FSS software
  - JES managed interface
    - Controlled by JES commands

SYSOUT API (SAPI)

- A general purpose API to process output groups (JOEs)
  - Another way to implement a “printer”
  - Application manages the device
    - No JES2 definition or control for the device
  - Local/RJE destined output (no NJE data passed)
- Can also be used as a logical interface to manage output
  - Can chance certain characteristics at a data set level
  - Results in JOEs being re-grouped
    - Only SAPI can regroup any JOE’s data sets
    - PSO (an older API) can regroup certain held JOEs
- Very common SYSOUT interface (use growing)

Purge phase

- Frees spool space and deletes jobs and output groups
  - Both job and JOEs can be queued to purge
- Job purge processing
  - Jobs enter purge when all JOEs are processed (gone)
  - All track groups returned and control blocks frees
- Output group (JOE) purge processing
  - Used for SPIN data sets (JOEs)
  - Used to perform cleanup for data set purge
  - If appropriate, frees spool space
  - Control blocks are then freed

Is it JES or MVS?

- JCL processing:
  - JES processes
    - /* (JES2) and //* (JES3) JECL cards
    - //XMIT cards
    - Instream (SYSIN) DD data
      - *Except in PROCs and INCLUDES*
    - Some keywords on JOB, DD, and JCLLIB cards
  - MVS converter process
    - All other JCL cards
    - SJF is an MVS service that defines and processes JCL
  - PROCLIBs defined and OPENed by JES2
    - Read and processed by MVS converter

Is it JES or MVS?

- SYSLOG
  - MVS writes to SYSLOG data set
  - JES stores data on spool
- JOBLOG data set (1st data set in output)
  - JES captures messages to place in JOBLOG
- System messages data set (3rd data set)
  - MVS writes messages to the data set
- TSO TRANSMIT/RECEIVE
  - TSO formats data and writes it to spool
  - JES sends data to correct system

Is it JES or MVS?

- RACF checking for new work
  - Started tasks and TSO logon is verified by MVS/TSO
  - Batch jobs are verified (VERIFYX) by JES
- TSO SUBMIT
  - Submit pre-processes JCL and submits it to JES
- DD SYSOUT=(A,INTRDR)
  - Each record written is processed by JES directly

JES Trivia

- JES2's color is orange and JES3 is blue
- Garfield the Cat is associated with JES2
- An asp snake is associated with JES3
- Customers at SHARE used to have a sing along on Thursday night sponsored by the JES2 project (Esprit de Corps)
- More customers run JES2 than JES3
- JES does own and use in testing a real RJE device (with a card punch and reader)
- You can still buy punch cards (at least you could a few years agao)
- JES was developed for a time in a burned out A&P storefront in Saugerties, NY

System z Social Media

- System z official Twitter handle:
  - @ibm_system_z
- Top Facebook pages related to System z:
  - Systemz Mainframe
  - IBM System z on Campus
  - IBM Mainframe Professionals
  - Millennial Mainframer
- Top LinkedIn Groups related to System z:
  - Mainframe Experts Network
  - Mainframe
  - IBM Mainframe
  - System z Advocates
  - Cloud Mainframe Computing
- YouTube
  - IBM System z

- Leading Blogs related to System z:
  - Evangelizing Mainframe (Destination z blog)
  - Mainframe Performance Topics
  - Common Sense
  - Enterprise Class Innovation: System z perspectives
  - Mainframe
  - MainframeZone
  - Smarter Computing Blog
  - Millennial Mainframer

Questions?

Questions?

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