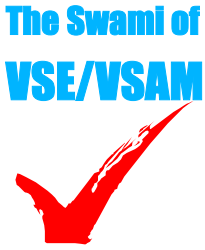
The Swami's Performance Methodology Ideas

Dan Janda
The Swami of VSAM



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The Jargon of VSAM, File Systems and Performance

- The topic of performance can mean many things to many people
  - Speed -- how fast is the CPU -- often referred to as MIPS
    - MIPS -- "Meaningless Indicator of Processor Speed" unless the architecture and workload used for measurement are defined
  - Power -- how much work can be done by this CPU in a unit of time
    - If the CPU has more engines, its throughput capacity will be higher than a CPU with fewer engines of the same speed
  - Throughput -- number of jobs, transactions, or other units of work per unit of time
    - This is often not repeatable on a detail level because of random variation of workload factors
  - An approximation: Engine Speed x Number of Engines = Power
    - As you add engines, the effective speed of each engine is less

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The Jargon of VSAM, File Systems and Performance

- The topic of performance can mean many things to many people...
  - Time terms:
    - Elapsed Time -- the difference in "wall clock" times between start and end of a process, job, transaction, or other unit of work -- also Response Time
      - The sum of the Elapsed Times of a group of concurrent jobs exceeds the elapsed time of the group
    - CPU Time -- the amount of time the CPU was busy actively processing a unit of work -- in VSE, measured by a system facility called the CPU Timer
      - On multi-processor CPUs, the amount of CPU time available per unit of time is equal to the number of engines times the unit of time.
      - On a 3-engine CPU, 180 seconds of CPU time is available each minute
    - Wait Time -- the amount of time the CPU was not busy actively processing a unit of work
      - Total wait time for a job may exceed the elapsed time
    - Overhead Time -- Time the CPU was busy but its activity was not directly attributable to one or another unit of work
      - Paging, initial I/O interrupt handling, ...

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The Jargon of VSAM, File Systems and Performance

- The topic of performance can mean many things to many people...
  - Input and Output (I/O) performance terms...
    - I/O rate -- number of I/O operations per unit of time
    - The following items account for the elapsed time of a single I/O operation on a DASD (or disk device) -- I/O Response Time
      - I/O queueing time -- time spent by a process waiting its turn to use an I/O device -- queueing within the operating system, generally
      - Pend time -- queueing time within the I/O subsystem
      - Seek time -- time during which a disk device arm is in motion
      - Rotational Delay time -- time during which a disk rotates to the position where the desired data is to be found
      - Transfer time -- time during which data is moved from I/O device to CPU storage
    - In addition, CPU time is used during I/O activity to prepare channel programs, translate them to reflect real storage addresses, and then to process the interrupt indicating the completion of the I/O operation

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Performance Basics

- What is performance?
  -
- How can you define performance?
  -
- How does your boss (or your boss's boss) define performance?
  -
- How can you measure performance?
  -
- Let's understand some of the pro's and con's of various alternatives...

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Performance Basics

- Performance Views
  - Overall System View -- throughput perspective
    - Jobs per hour, shift, day
    - Average utilization
    - I/O rate
    - . . .
  - Subsystem View -- throughput or speed perspective
    - Transactions per second
    - I/O rate per device
    - . . .
  - Job step (or transaction) view -- speed or throughput perspective
    - Elapsed (or response) time
    - I/Os (overall or by device)
    - CPU time, wait time
    - . . .

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Performance Basics

- **All CPUs wait at the same speed**
  - It does not matter to the critical job why it is waiting
    - It could be waiting because another job (of higher priority) is running
    - It could be waiting because it has requested an I/O operation
    - In fact, the CPU could be executing instructions on behalf of the critical job which could have been avoided by:
      - Better program design
      - Better program coding (or optimization)
      - and the processing required by the critical job is not being done
    - I/O operations (and the CPU time to manage them) that could be avoided

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Performance Basics

- **All CPUs wait at the same speed**
  - They Wait for work
    - The CPU may be idle
    - The CPU may be processing lower priority work
  - They Wait for I/O
    - During I/O operations
    - The CPU may be processing lower priority work
- In each of these cases, the processor is not processing this job
- Our role as performance people is to
  - Reduce the amount of this wait
  - Reduce the amount of CPU resource used to accomplish a task
  - Free system resources for use by other tasks

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Performance Basics

- CPU Dispatching Priority vs. Job Priority vs. Job Importance
  - Job Importance...
    - Printing paychecks is more important than playing solitaire
  - Job Priority...
    - POWER job scheduling priority controls sequence jobs start within POWER's work classes
  - CPU Dispatching Priority...
    - The order in which the operating system dispatcher will search for work to be done among those tasks "ready to run"
- VSE permits dispatcher priority to be dynamically changed (balanced) among workloads based on their CPU usage during a measurement interval
  - The VSE balancing measurement interval is set by the IPL MSECS parameter
    - The system default (about 1 second) seems reasonable in most cases. Try smaller value for >100 Mips processors and short job steps

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Performance Basics

- A CPU can only be in one of two states:
  - Running
  - Waiting, divided into
    - Waiting for work -- there is nothing for it to do -- it is idle
    - Waiting for I/O -- one or more I/O activities have been started, but no work can continue until one of them completes
- A job can only be in one of four states:
  - CPU Running with no I/O operations active for this job
  - CPU Running together with I/O operations for this job active
  - CPU Waiting while I/O operations for this job are active
    - Lower priority job(s) may be running on the CPU
  - CPU Waiting with no I/O operations for this job active
    - Higher priority job(s) are running on the CPU
    - Wait for operator, scheduling holds, etc.
      - These may be (indirectly) other jobs' I/O causing the delay

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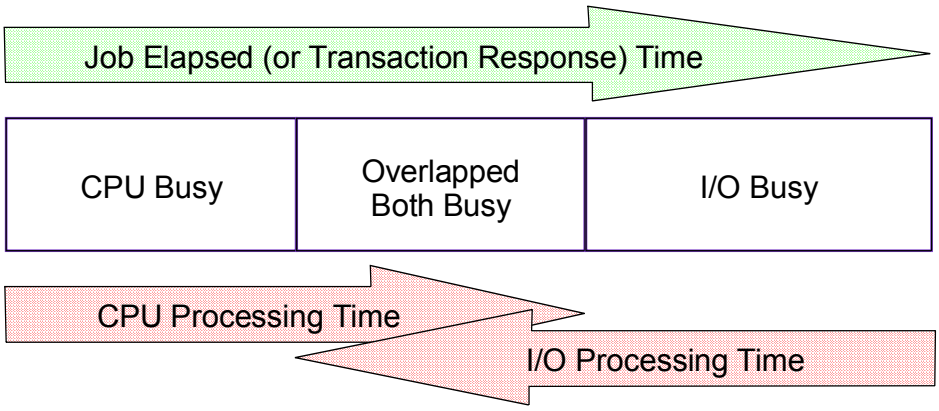
Performance Basics

- **A simple job example shows some basic concepts:**
  - **Job reads records from file**
  - **Job computes result using data from those records**



This description of a workload is called its "profile"

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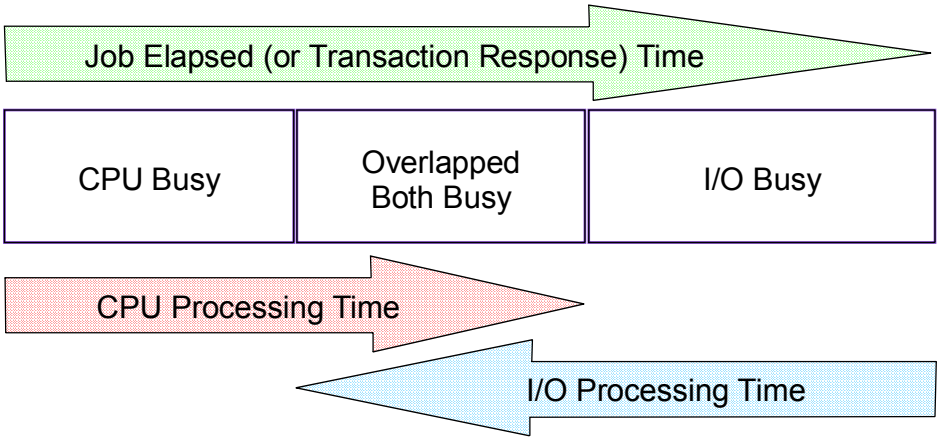
Performance Basics

- **System changes' effects can be seen:**
  - **CPU changes affect only CPU Busy and Both Busy segments**
  - **I/O changes affect only I/O Busy and Both Busy segments**



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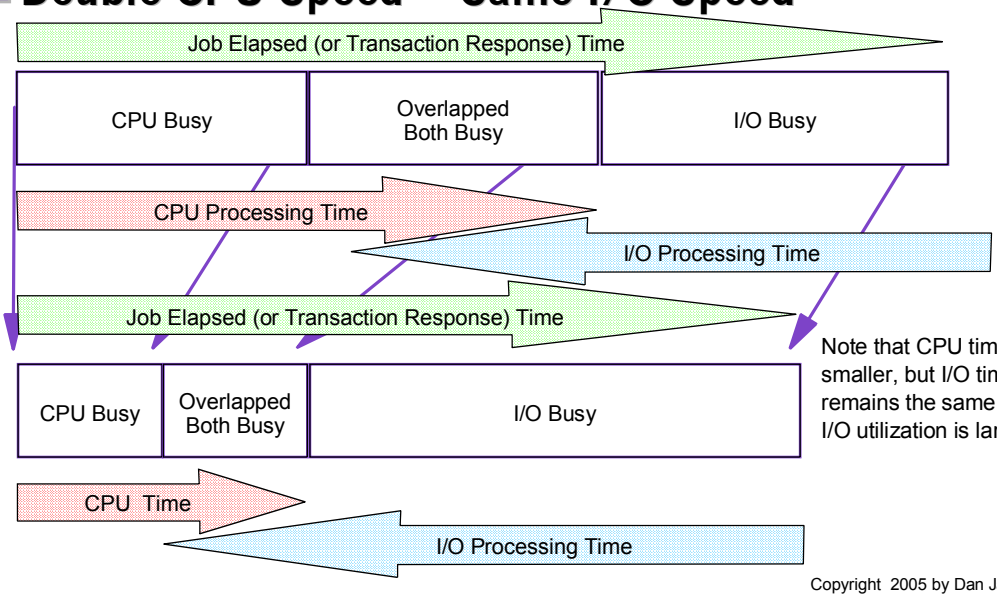
Performance Basics

Double CPU Speed -- Same I/O Speed



Note that CPU time is smaller, but I/O time remains the same, thus I/O utilization is larger

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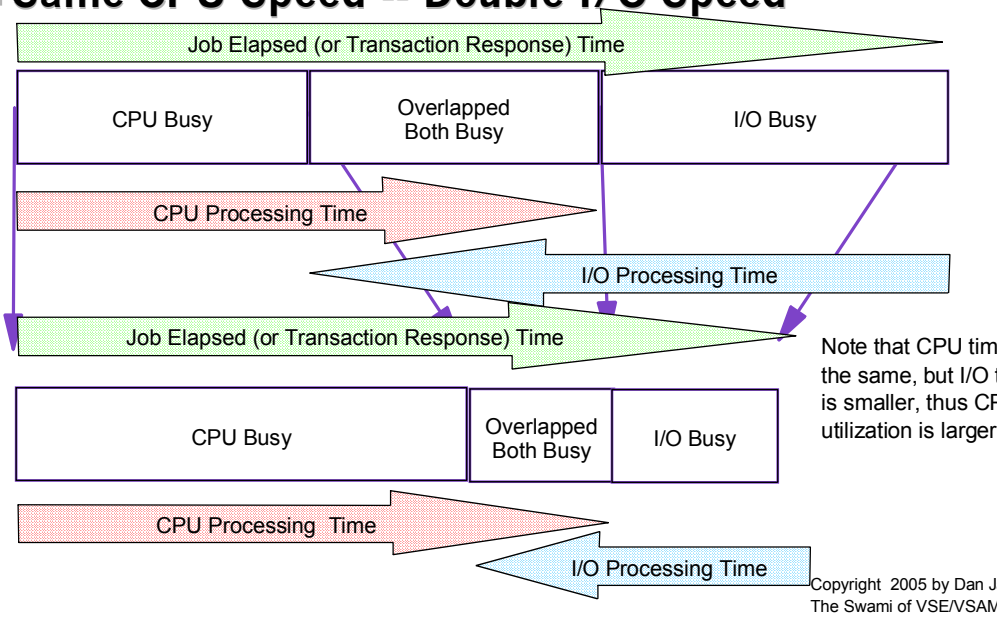
Performance Basics

Same CPU Speed -- Double I/O Speed



Note that CPU time is the same, but I/O time is smaller, thus CPU utilization is larger

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Performance Basics

- This technique is called Profile Conversion...
  - A simple approach to predicting the effect of system changes on system performance
  - Rigorous mathematical basis, but only simple math is needed to use the process
  - Gathering data for profile conversion is not trivial
    - Tools to measure Elapsed time and CPU time exist
    - Tools to measure I/O time and Overlapped time do not exist (as far as I know -- but see next page)
    - IBM's VSE/PT produced data for this purpose, but it is no longer available nor operational
  - Reasonable estimates can be made in many cases

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Performance Basics

- Profile Conversion...
  - Gathering data for profile conversion is not trivial
    - Reasonable estimates can be made in some cases
    - VSE's SIR command can be very useful

```
SIR
SIR ?                          Displays SIR commands
SIR RESET                      Resets SIR counts/totals
SIR SMF[={ON|OFF}][,VSE][,cuu] Subsystem Measurement Facility
```

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Performance Basics

- **Profile Conversion...**
  - **Reasonable estimates can be made in some cases**
  - **Job Accounting gives us CPU time accurately**
  - **Job Accounting gives us number of I/Os by device**
  - **EXPLORE, TMON, OMEGAMON can give us average I/O time for devices during the time in question**
  - **Total I/O time for a device is just product of the Number of I/Os and Average I/O Time for device**
  - **Sounds like something a spreadsheet could do!**
    - **Calculators, pencils, and similar tools can too!**

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Performance Basics

- **Resource Utilization issues**
  - **Increase the speed of a component (CPU or some I/O device(s))**
  - **The system runs the workload faster (less elapsed time)**
  - **Wait on that component is now less**
  - **Utilization of other component(s) increases during the (now shorter) duration of the workload**
  - **Another component will immediately become the key bottleneck for that workload**

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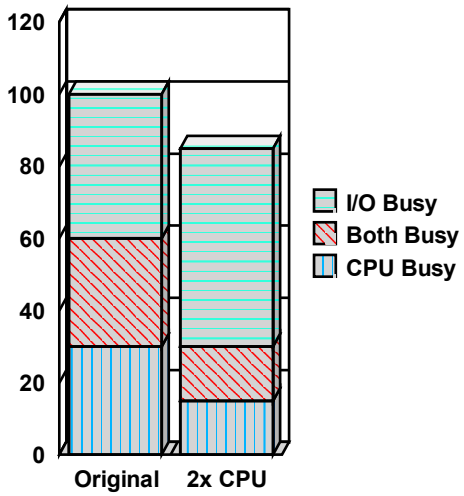
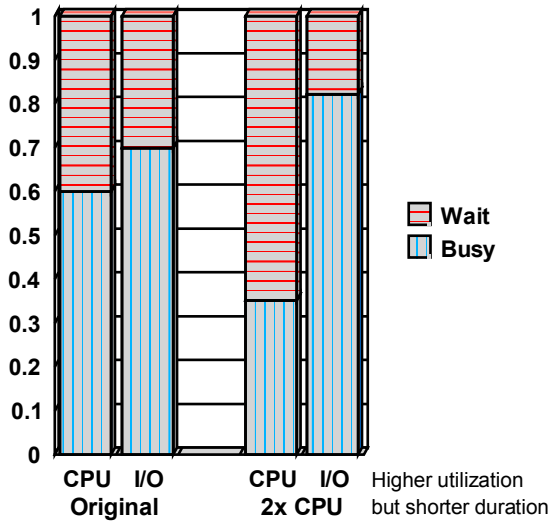
Performance Basics

Resource Busy Time



Resource Utilization Percentage



Higher utilization but shorter duration

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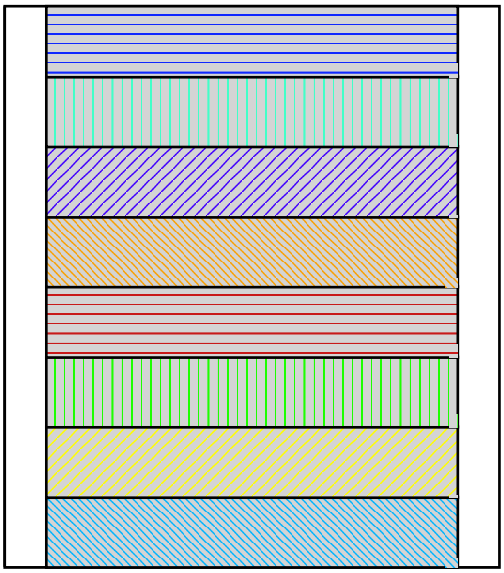
Performance Basics

- **VSE uses a Preempt/Resume Priority Dispatch Algorithm**
  - **The highest priority task that is ready-to-run is dispatched**
  - **When that task must wait, the next highest priority job is dispatched**
  - **When any event completes, the dispatcher suspends the running task and re-evaluates the status of all tasks**
  - **If no task is ready-to-run, then CPU waits for work**



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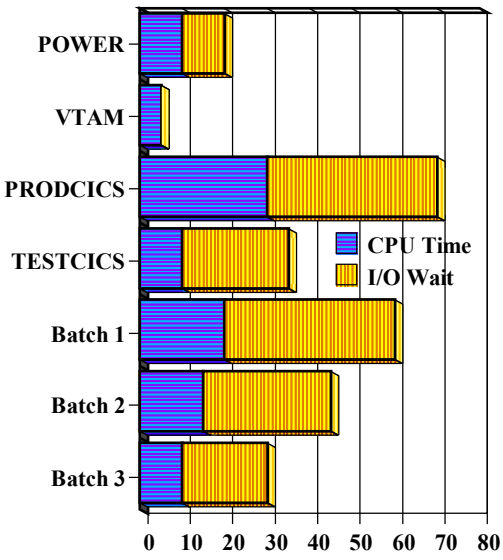
Performance Basics

- CPU is used by high priority task
- Lower priority tasks get what's left over
- If no CPU time is left, the lowest priority tasks get no CPU time
- "Effective CPU Speed" is the fraction of the total CPU speed left after higher priority tasks have used what they will
  - In this case, Batch 3 "feels" a CPU only 1/10th of the full power
  - Tuning a higher priority task to reduce its I/O wait will reduce Effective CPU Speed for lower priority tasks



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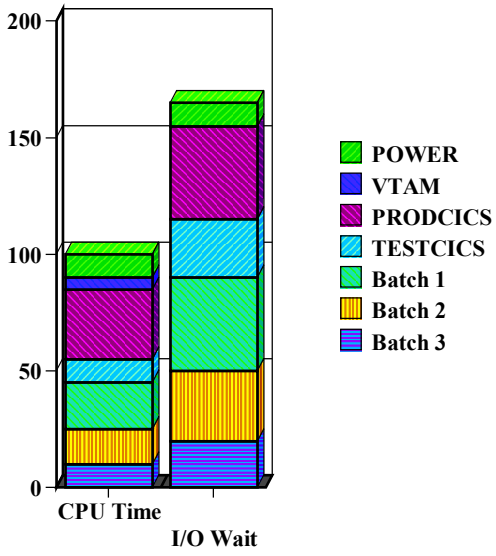
Performance Basics

- CPU is used by high priority task
- Lower priority tasks get what's left over
- If no CPU time is left, the lowest priority tasks get no CPU time
- "Effective CPU Speed" is the fraction of the total CPU speed left after higher priority tasks have used what they will
  - In this case, Batch 3 "feels" a CPU only 1/10th of the full power
  - Tuning a higher priority task to reduce its I/O wait will reduce Effective CPU Speed for lower priority tasks while the higher priority task is running



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Performance Basics

- CPU is used by high priority task
- Lower priority tasks get what's left over
- VSE/ESA's Turbo Dispatcher partition balancing
  - All partitions in a dynamic class are balanced
  - PRTY command can balance static partitions and partitions in dynamic classes
    - PRTY F1,F3,F2,G=F4=F5=BG indicates that dynamic partitions in class G and static partitions F4, F5, and BG form a balanced group
    - Only one balanced group can exist
    - PRTY SHARE,G=100,F4=200,F5=200,BG=50

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Performance Basics

- CPU is used by high priority task
- Lower priority tasks get what's left over
- VSE/ESA's Turbo Dispatcher partition balancing
  - PRTY command can balance partitions and dynamic classes
    - PRTY SHARE,G=100,F4=200,F5=200,BG=50
      - Each class G partition will receive an equal share, and the other partitions in the balanced group will receive an equal, greater, or lesser share based on the relative values specified
        - F4 and F5's shares are twice the share of the dynamic partitions
        - BG's share is half the share of the dynamic partitions
      - If a partition uses up its share of CPU resources, other partitions in the balanced group will be dispatched
      - Partitions which have used their full share are eligible to use more resources if any are available after other partitions in the group have received their share or are waiting

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Performance Basics

- Some special cases:
  - POWER provides services primarily for batch
    - Batch jobs with large print components will cause POWER CPU utilization to increase
      - I call this "reflected batch work"
    - But much of it is processed at POWER's priority rather than the batch priority
    - This can impact VTAM, CICS, and data base services
  - VTAM provides services for CICS, POWER, and TCP/IP..
    - Its CPU use is generally charged to the using partition
    - It is difficult to see VTAM's CPU consumption directly
      - In test environments with scripted workloads, repeatable tests can be done and are the basis of VTAM tuning advice

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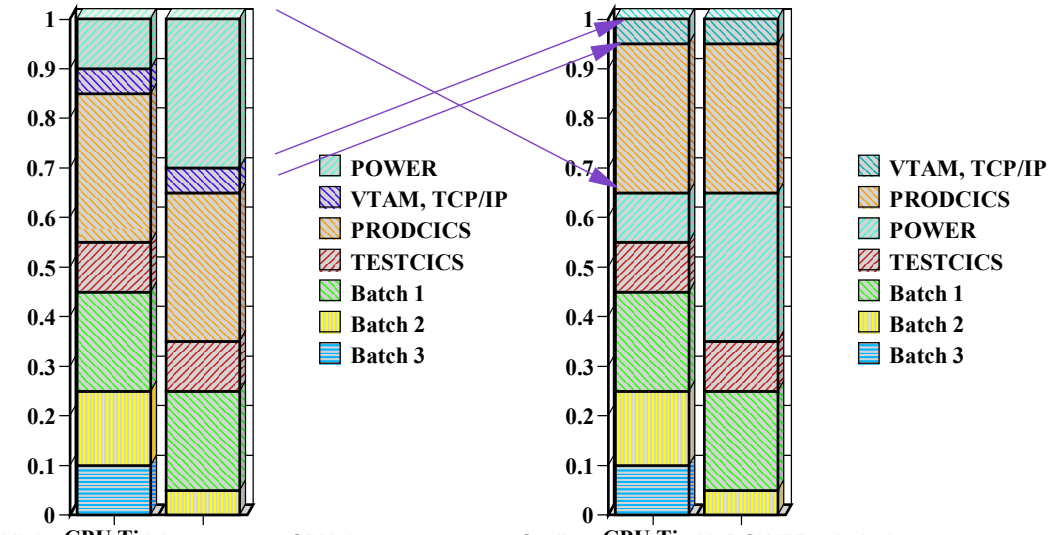
Performance Basics



Higher priority job uses more CPU time and impacts all lower priority jobs including on-line

Similar scenario with POWER priority lower so on-line is not impacted -- only batch

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Performance -- not quite basics

- So, what can we do about it?
  - Measure
    - Data
      - Elapsed time, CPU time, I/O time; I/O counts
    - Performance Monitors
      - Explore, TMON, others
    - Job Accounting
      - CA-JARS, others
      - $JOBACCT, POWER accounting routines
    - Other sources -- Turbo Dispatcher
      - QUERY TD[,INTERNAL]
        - Dependent upon control of workload
      - SYSDEF TD,RESETCNT
    - VM, hardware data

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Performance -- not quite basics

- Some real-world considerations for measurements
  - Multiprogramming effects
    - Impact of other workloads
    - Repeatability -- key factor
      - CPU time
        - Repeatable
      - I/O counts
        - Repeatable
      - Elapsed time
        - Not repeatable
      - I/O time
        - Not repeatable

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Performance -- not quite basics

- SKJOBACC routine in ICCF Library 59
  - Captures VSE Job Accounting data at step end
    - Elapsed time
    - CPU time
    - Overhead time
    - I/O counts by device
  - Display results as a printed page on SYSLST
  - You have source code, so you can modify if desired
    - Simplest:
      - Output on another virtual printer
    - More complex:
      - Output on console
      - Change format, etc...
      - Selective output
        - (e.g. only for jobs named "TUNE....")

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Performance -- not quite basics

- SKJOBACC Metrics
  - Elapsed time
    - Interesting, but not useful unless complete workload is repeatable
  - CPU time
    - Very useful, repeatable, and can compare tuning and environmental changes with good precision
  - Overhead time
    - CPU time not identifiable for a specific task, apportioned among all active tasks on a pro-rata basis
  - I/O counts by device
    - Specific activity by job step to each device used
  - Others: Paging, POWER functions...

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Performance -- not quite basics

- What can I do with this (SKJOBACC or similar) data?
  - I can tune a job step to
    - improve its performance
    - minimize its impact on other concurrent jobs
  - I can make tuning decisions for this job step
    - based on solid evidence
    - even when other jobs are running concurrently.

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Data near programs?

Method	Elapsed Time microseconds	CPU Time microseconds
COBOL Working Storage	1	1
CICS Data Table	10	10
VSAM LSR hit	25	25
VSE Virtual Disk	100	100
VM Virtual Disk	250	250
Well-cached real disk	1000	800
Un-cached disk	20000	800

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Contacting the Presenter

- For more information...
  - You can contact the Swami by e-mail

    theswami@epix.net

  - He's building a web site about VSE/VSAM issues

    http://business.epix.net/~theswami

  - Downloadable ".PDF" files of the handout for this presentation can be found by following the links on that web page.

  - His knowledge and experience can help you, too!