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## The IntelliMagic Class on:

# I/O Subsystems Architecture & Performance Analysis for z/OS

- Taught By:** Dr. Gilbert Houtekamer, co-author of “MVS I/O Subsystems”, and Andries (“Dries”) de Jong
- Dates:** Monday – Thursday, October 15-18, 2007
- Location:** Baltimore, MD at the Tremont Plaza (near the inner harbor area)
- Cost:** \$2,350 including a performance analysis of your mainframe I/O data  
10% discount for registrations by September 14, 2007
- Register:** For Registration form and location details, please contact Brent Phillips: [brent.phillips@intellimagic.net](mailto:brent.phillips@intellimagic.net) or 214.432-7920 ext. 704  
**Or click here:** <http://www.intellimagic.net/en/doc.phtml?p=Classes>

## About the instructors:

This class has been developed by Dr. Gilbert Houtekamer and Andries de Jong.

*The standard reference text on MVS I/O, “MVS I/O Subsystems”, was written by Dr. Gilbert Houtekamer together with Dr. H. Pat Artis.*

Dr. Gilbert Houtekamer is director of IntelliMagic, a software company specialized in capacity planning and performance monitoring software for Disk and Tape Subsystems attached to z/OS and Open. He has over 20 years experience in MVS I/O and performance analysis and has written numerous papers on I/O performance. He has also been a frequent speaker at industry events such as CMG.

Andries de Jong works for IntelliMagic as a consultant and instructor. He worked for IBM from 1968 to 1995, specializing in mainframe storage solutions. He was a member of the GDPS development team from 1996 to 2002, and he was active in the EMEA advanced technical support team.

IntelliMagic’s ongoing work with customers around the world and with strategic partners such as IBM means that they remain on the leading edge of knowledge regarding I/O measurement and management on zSeries platforms.

Previous class attendees have provided these instructors with a rating of 9.2 out of 10 when asked the question about how likely they would be to recommend this class to their colleagues.



## **Audience:**

This class is designed for Enterprise Storage Professionals, Storage Architects, Performance Management Professionals, Capacity Planning Professionals, and Systems Programmers.

## **Class Description:**

This class covers current I/O subsystem architecture for the zSeries processors running the z/OS operating system. This includes all aspects of I/O from the fundamental hardware architecture to the implementations provided by the various vendors, and from the hardware measurement facilities to the interpretation of the RMF and SMF measurement information.

In the class you will learn how to configure your disk subsystems to best exploit their capabilities for your I/O workloads. We will discuss what RAID implementations are best for which I/O workloads, discussing the pro's and con's of RAID-10, RAID-5, RAID-6 implementations.

An impressive range of disk drives with vastly different performance characteristics is available in today's disk subsystems. In the class you will learn how to evaluate the options for your installation, so that you can make the right investment decisions.

For more and more installations a copy services implementation between the primary and secondary data center is essential. In the class we will discuss the performance planning and monitoring for synchronous (PPRC, TrueCopy, SRDF/S) and asynchronous (XRC, Global Mirror, TrueCopy, SRDF/A) implementations. With this information you will be able to size the links between your sites, and you will be able to monitor the impact of the copy services process on your I/O installation.

The class will cover the many sources of I/O measurement information available in z/OS from SMF, DFSMS and RMF. An application and I/O tuning approach will be provided, helping you to make the choices that are relevant for your workload.

## **Customized I/O Report and Consultation:**

Participants are invited to send one or several day's worth of RMF or CMF data to IntelliMagic before the class. IntelliMagic will create a detailed I/O performance report of the data which can be useful throughout the class. Extended consultations can also be arranged for Thursday afternoon or Friday. Please contact IntelliMagic for more details.

## **Class Materials:**

Attendees will receive a binder with over 450 detailed slides that contain up to date content for the entire course.

## **Pre-Requisites:**

This class provides a foundational understanding of z/OS I/O architecture and performance monitoring and management. Familiarity with the z/OS environment is assumed. No particular tools are required. The product RMF Magic will be used on occasion to illustrate certain concepts.



## Class Contents:

### **Part 1: I/O Architecture**

- Introduction to zSeries I/O architecture
  - How IBM grew the architecture from System 360 to z/Architecture
- Count-Key-Data disk evolution
  - Why CKD was introduced and how it works today
- Disk Caching concepts
  - Overview of read and write caching algorithms
- RAID architectures from RAID-1 to RAID-6 and LSF
  - “A Case for Redundant Arrays of Inexpensive Disks”, the RAID architecture paper from David Patterson et al.
  - Reliability metrics and results for RAID
  - RAID-0, RAID-1, RAID-10, RAID-4/S, RAID-5 and RAID-6
  - The Log Structured File system
- I/O Control flow from z/OS application to hardware
  - The layers of I/O handling: application, access method, I/O supervisor, channel subsystem, disk subsystem and hard disk drives.
  - zSeries hardware instructions
- Channel programs
  - Channel Command Words
  - Extended Count Key Data
  - Locate Record, Define Extent, and cache controls
- Caching for z/OS: a closer look
  - Read and write caching
  - Predicting cache hit probabilities
  - CKD Write caching for RAID
- Capacity Planning metrics for z/OS I/O
  - Discussion of the factors that determine performance in modern disk subsystems

### **Part 2: Implementation, Copy Services and Measurements**

- Queuing Theory
  - Little’s Law and simple queuing models
- I/O Subsystem Implementations
  - Discussion of the products from IBM, EMC, HDS and STK.
- Understanding hard disk performance
  - Why 15 k RPM drives make sense and the dangers of 300 GB drives.
- Channels
  - ESCON and FICON considerations
- Copy Services
  - Overview and the need for a consistent copy
  - Synchronous Copy Services performance considerations



- Asynchronous Copy Services, discussing XRC, Global Mirror, TrueCopy and SRDF/A in detail
- Planning for Copy Services implementations
- Measurement information for Copy Services
- I/O measurements
  - Measurement methods
  - SMF 30 and 42 records
  - RMF records
- Understanding I/O response time components
  - Discussion of what contributes to IOSQ, Pending, Disconnect and Connect times
  - Ways to optimize each of these response time components

### **Part 3: How to Manage Performance**

- Performance Management, Service Level Agreements and Tuning Objectives
  - How to define your performance objectives
  - Daily, weekly and monthly disk performance management tasks
- Application I/O tuning
  - How to use the available measurement information to achieve the most benefit
- Configuring for performance
  - Why balancing your I/O workload gives better performance
  - Using subsystem and z/OS features to achieve I/O workload balance
- Parallel Access Volumes (PAV)
  - What are PAVs and why do they work
  - How many PAVs do you need for your installation
  - Multiple Allegiance and I/O Priority Queuing
- Performance Reporting examples from RMF Magic
  - Overview of the RMF Magic product
  - RMF data requirements
  - Controlling the data reduction process
  - Data analysis capabilities and controls
  - From subsystem to device level data
  - Capabilities of the RMF Magic Windows user interface
  - Using Excel capabilities to analyze your workload
- Discuss Participant's RMF data
  - Apply class concepts to your own installation
- The future
  - Trends in I/O Subsystem and z/OS design
  - IntelliMagic's vision on I/O performance management

### **Part 4: RMF Magic Tips & Techniques**

- Thursday afternoon, after the regular class has finished, IntelliMagic will provide an optional free session providing an overview and advanced analysis techniques and samples using the RMF Magic reporting tool.