This presentation will act as an introduction to JVM tuning when using WebSphere Application Server V6.

JVM tuning

After completing this topic, you should be able to:

- Present a tuning methodology
- Understand tuning considerations
- Describe special considerations for the Sun JDK

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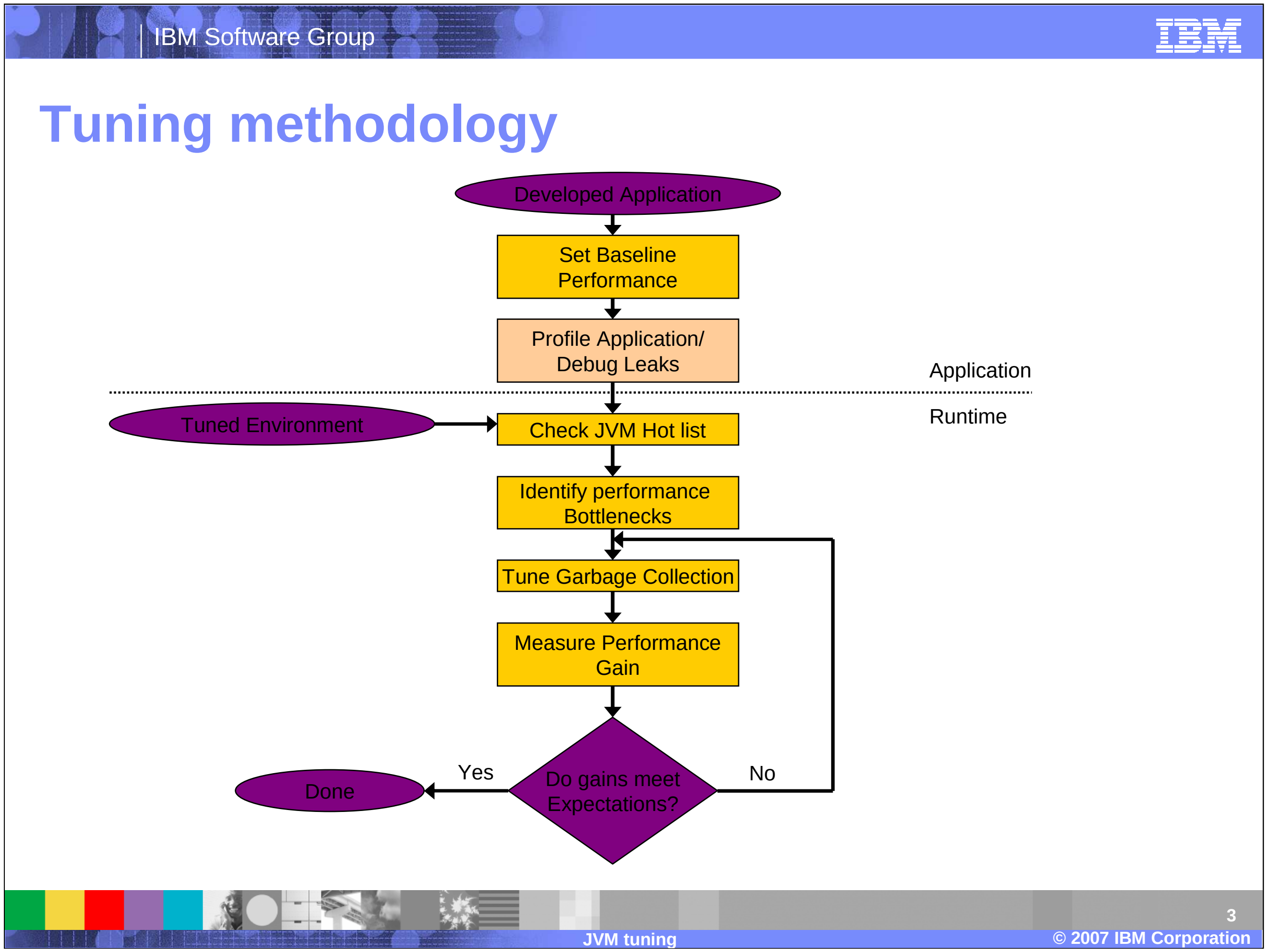
After completing this topic, you should be able to present and understand a JVM™ tuning methodology.



JVM tuning is a key component in the tuning methodology of WebSphere Application Server and the applications it runs.

Heap tuning

- Proper JVM heap sizing
  - Often the only major area of WebSphere Application Server requiring tuning
- Too little heap
  - Causes the application to GC frequently
  - Consumes CPU
  - Extreme cases
    - Can lead to error conditions/server failure
- Too much heap
  - Wasteful
  - May cause longish response times, especially on Sun
- How do you know how the heap's performing
  - Process size != heap size
  - Use verbosegc to find GC characteristics

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Proper JVM heap sizing is critical to a healthy JVM and WebSphere Application Server. An insufficiently sized heap will force garbage collection to occur too frequently, which wastes cpu. Having a heap which is too large may waste valuable storage; can cause long response times, especially on Sun; and can lead to insufficient native heap, particularly on AIX. It is worth noting that with a min heap size different from the max heap size, the JVM is allowed to resize the heap over time to adjust to changing conditions. Even among the experts, opinions vary on whether that's a a good thing or a bad thing.

Tuning considerations (1 of 2)

- “Throughput” (the JVM definition)
  - Measure of productive time excluding time spent in GC.
- Pauses
  - Measure of time when application execution pauses during GC
- Turn on verbosegc for more information on GC operation
- Avoid calling System.gc() from the application
  - Causes the least efficient, slowest GC to take place
    - Always triggers a compaction
    - System.gc() does not always trigger an immediate GC
  - Allow the JVM to determine optimum time to GC
  - Can disable in IBM JDKs using –Xdisableexplicitgc

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There are two primary measures of garbage collection performance. *Throughput* is the percentage of total time not spent in garbage collection, considered over long periods of time. *Pauses* are the times when an application appears unresponsive because garbage collection is occurring.

Tuning considerations (2 of 2)

- Start with a reasonable maximum heap (-Xmx) size
  - 512M for WebSphere Application Server
- Test different maximum heap sizes to find optimal setting
  - Opposing forces
    - The larger the heap, typically the longer the GC cycle
    - The smaller the heap, the more frequently GC is required
  - Size maximum heap somewhat larger than steady state to allow for peak load
- Setting minimum heap size (-Xms) can improve server startup time
  - If using default, may need to be resized several times during startup
- But setting the minimum too large may impact runtime performance
  - Larger value means more memory space requiring garbage collection
  - The JVM can not compensate if you make a poor choice

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JVM heap tuning is an iterative process, and you should always start with a reasonable maximum heap size. While monitoring verbosegc output, test with different maximum heap sizes to find an optimal setting through load and stress testing.

Tuning considerations native heap

- BEWARE: The GC does not look into the native heap !!
- Ensure JVM is not being swapped out of memory to disk
  - Total Memory Used by JVM > Maximum Heap Size
    - Native objects (ex: Database Connections)
  - Physical Memory Available > Total Memory Used by JVM
    - JVMs do not page effectively due to garbage collection

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Remember that verbose garbage collection does not look into the native heap. Large numbers of thread or database connections can increase the memory used by the JVM outside of the Java heap. Any paging activity will seriously degrade JVM performance.

Sun JDK garbage collection

- Heap is divided into multiple generations
  - Young generation – objects are created here.
  - Older generations – objects are promoted to older generation.
- Shorter GC pauses since not all generations are collected at once.
- Each generation is garbage collected independently
  - Uses different collection strategy for different generations.
- Minor collection
  - Collects youngest generation.
- Full collection
  - If minor collection is not able to free enough memory to fulfill the allocation request, older generations are collected.

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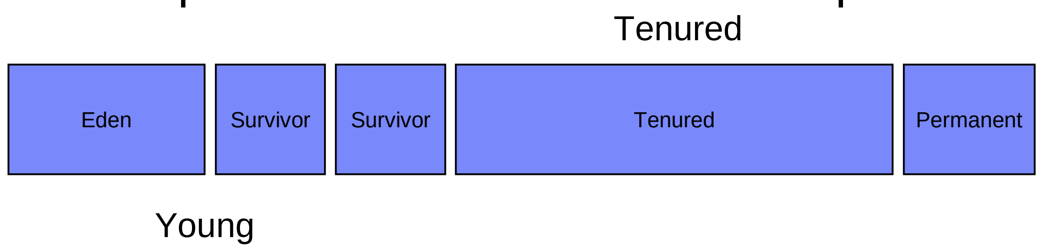
In the Sun JDK, the heap is divided into multiple generations in an effort to reduce garbage collection pauses. The idea here is that as most objects have short lifetimes, it is useful to restrict garbage collection to the most recently allocated objects. Different algorithms are used in each generation. For young generations compaction or by copy algorithms are used. For older tenured generations the normal mark and sweep algorithms are used.

Sun JDK Generational Heap sizes: Young and Tenured ratio

- Consider sizing the ratio between Young and Tenured Generational Heaps (-XX:NewRatio)
  - Depends on lifetime of objects allocated by the application
  - Increasing the young generation becomes counterproductive at half the total heap or less



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There is no one right way to size generations. The best choice is determined by user requirements and the way the application uses memory. For example, a very large *young* generation may maximize throughput, but does so at the expense of footprint, promptness, and pause times. *young* generation pauses can be minimized by using a small *young* generation at the expense of throughput.

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