Progress®

Progress Application Server for OpenEdge:
Tuning Guide for 11.7

OpenEdge®

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Introduction

As with tuning any web server environment, Progress Application Server for OpenEdge requires you to spend the time to monitor, adjust, and observe your application under load to attain maximum performance. This document provides basic guidelines for tuning a PAS for OpenEdge instance. The default configurations were designed to support a *development* environment that included a small number of web applications with moderate client loads across many platforms. Moving application to a *production* system requires testing in a *production staging* environment. This environment needs to be sized and tuned the demands that will be placed on the final production system.

Goals:

- Provide a basic understanding of monitoring and tuning an instance for optimal performance

Non-goals:

- Provide in-depth architectural and run-time information for advanced scaling when applications reach maximum capacity

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Quick Tuning Tips

Before you read a detailed account of PAS for OpenEdge architecture and tuning, know that there are a few parameters that you can tune to affect your application's performance immediately. These parameters, if set correctly, could improve the performance of your application in production.

A well-tuned PAS for OpenEdge instance configuration balances the use of OS CPU, memory, and processes to service the largest number of concurrent client requests with the best response time. A poorly-tuned PAS for OpenEdge instance configuration can overload the server instance, Multi-session Agent, or OS, which will degrade client response times or even cause server outages.

For details, see the following topics:

- Example Configuration

Example Configuration

The following example illustrates a PAS for OpenEdge instance configuration that is capable of running 200 concurrent client requests to a single stateless/statefree ABL application that has a hot-standby Multi-session Agent that enhances application availability. This configuration can be mimicked in your environment or altered based on your needs. One caveat is that this example does not show how to load-balance multiple instances or applications. This tuning guide describes how to tune a single instance to get the best performance. Scaling and sizing considerations are discussed in the PAS for OpenEdge Sizing Guide. This example shows which parameters can deliver the best application performance when tuned correctly.

Server Configuration	Description
psc.as.executor.maxthreads=200	The maximum number of client requests (i.e. request execution threads) that can be executed by the server before they are placed in a wait queue. The maximum applies to all deployed Java/ABL applications.
psc.as.http.maxqueuesize=100 psc.as.https.maxqueuesize=100	The maximum number of client requests that can be queued waiting for a request execution thread.

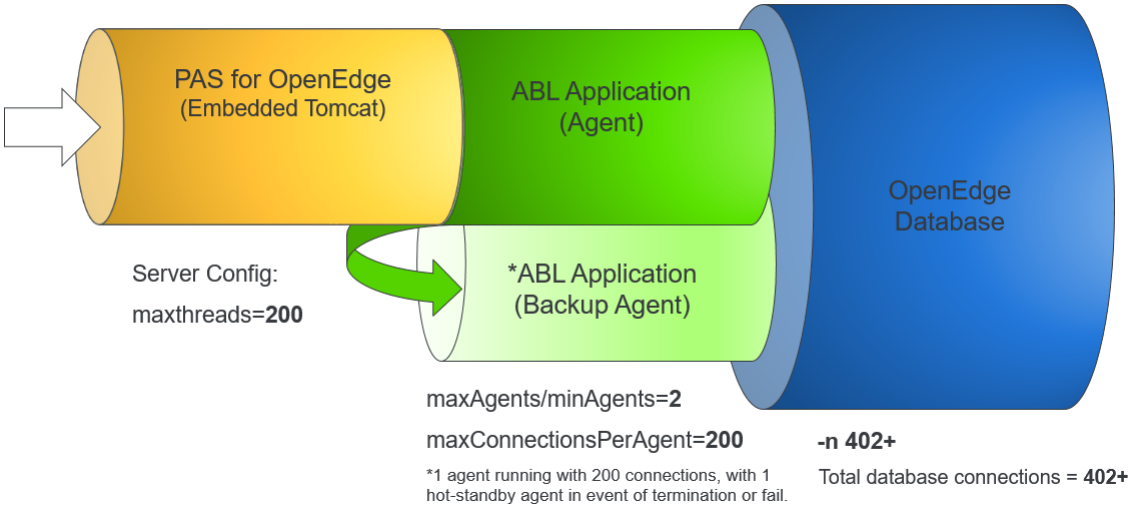
The sum total of the above properties plus the size of the client request data affects the total process memory size of the PAS for OpenEdge server process.

The **psc.as.executor.maxthreads** configuration property determines the high-water limit for how many concurrent client requests the PAS for OpenEdge instance can execute. Because each client request executes in one of these threads, the value must be as large, or larger, than the sum total number of client requests by all deployed [Java/ABL] applications. PAS for OpenEdge, which runs an embedded version of Tomcat, does not load balance client requests by deployed application. Therefore if the thread size is not large enough, you may find that client requests to random applications are ‘queued’ and the end-users sees pauses in the application’s behavior. The number of queued threads is set with the **psc.as.http.maxqueuesize** or **psc.as.https.maxqueuesize** configuration property. Both properties can be set through the **tcman config** utility. For more information on tuning the server configuration, see section **Tuning the PAS Server**.

ABL Application Configuration	Description
numInitialAgents=2	Start two Multi-session Agent OS processes: one handles all client requests and one remains idle in hot-standby mode.
minAgents=2/maxAgents=2	Maintain two running Multi-session Agent processes at all times, where if one Agent stops a second is automatically started.
maxConnectionsPerAgent=200	Set to the maximum number of concurrent client requests handed by the PAS for OpenEdge server (Set equal to psc.as.executor.maxthreads).
maxABLSessionsPerAgent=200	Set equal to the maxConnectionsPerAgent in stateless/statefree ABL application architectures.

The above configuration will handle the maximum client request load of 200 using 1 Agent OS process and the second Agent OS process stays in standby mode until the first Agent OS process exits by, for example,admin directive. The admin does not have to manually create a second Agent OS process if one terminates because PAS for OpenEdge does it for them. This example assumes that after load testing, a single Agent OS process can run concurrently 200 client requests without exceeding OS process CPU/memory/IO limits. For more information about tuning ABL application configurations, see section **Tuning the OpenEdge Web Applications and MS-Agents**.

The following diagram shows a configuration in which the server or ABL application agents do not throttle connections to the database because the Tomcat server and ABL Applications have been tuned:



If you are running OpenEdge11.7.3, you can run the **paspropconv** utility to set these parameters to match your classic AppServer. If you are not running OpenEdge 11.7.3, you can set the properties manually.

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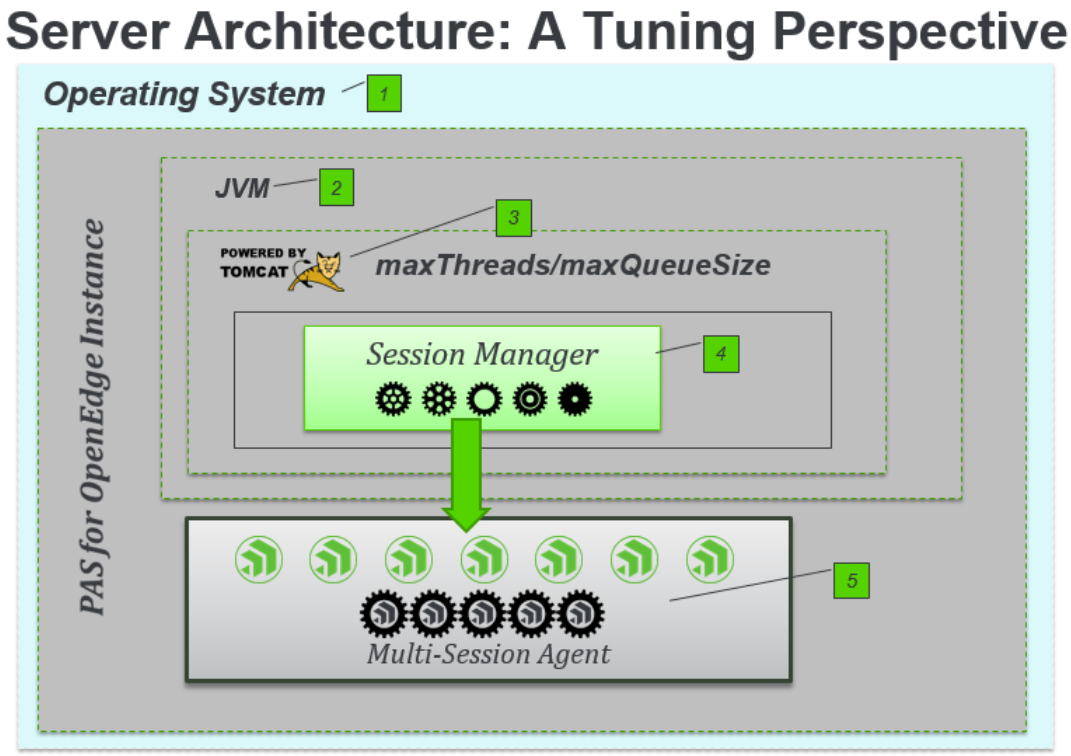
Server Architecture

Before you begin tuning your PAS for OpenEdge environment, it will help to understand the PAS for OpenEdge architecture, how your ABL application relates to it, and where certain critical subsystems operate.



From a tuning perspective, an ABL application running in PAS for OpenEdge can be viewed as comprising these major subsystems:

1. The OS process and its configured limits, which can be tuned at the OS level.
2. The Java Virtual Machine (JVM), which can be tuned at the OS level, catalina.properties, and JVM.properties.
3. The Progress Application Server (PAS) based on Apache Tomcat, which can be tuned at catalina.properties.
4. Session Manager serving ABL Applications, which can be tuned at openedge.properties.
5. The Multi-Session ABL language agent (MS-Agent), which can be tuned at openedge.properties.

Each of the major subsystems is described below to provide you with a basic understanding of the role it plays in tuning PAS for OpenEdge for optimal performance.

Because the JVM and Apache Tomcat are used industry-wide, there are many Internet-accessible resources that provide additional tips and guidance. This document strives to use real product terms so that your internet searches will return better results. Note that to simplify local and remote administration, PAS for OpenEdge has externalized most of the Apache Tomcat server configuration options using a Java property file. Where applicable a cross reference is provided to assist in reading Apache Tomcat documentation.

For details, see the following topics:

- PAS for OpenEdge and OS Process Limits
- Java Virtual Machine (JVM)
- Common PAS Web Server
- PAS Startup Time
- Session Manager serving ABL Applications
- Multi-Session ABL Language Agent

PAS for OpenEdge and OS Process Limits

PAS for OpenEdge and any of its spawned subcomponents run in OS processes and therefore are affected by the imposed resource maximums for memory, open files, and so forth. Many times process limits differ between OS vendors, so being aware of what these limits are in the OS you are running will assist you in knowing what the maximum setting can be for some aspects of a PAS for OpenEdge configuration.

Other implied OS process limits also apply, such as CPU and memory. The number and speed of the OS CPUs greatly influence the concurrent execution speed of client requests, and the memory influences the number of concurrent client requests.

Java Virtual Machine (JVM)

The Progress Application Server (PAS), in which OpenEdge web applications are deployed, runs in a JVM. The JVM supplies all of the memory management, threads, and I/O resources. The JVM is the point where you make critical tuning decisions that affect every aspect of server performance such as determining which web applications you deploy, how many clients it will support, and how fast it processes those client requests.

Monitoring the JVM

External products exist that allow you to connect to a JVM and sample its operating metrics. The most basic of these products is JConsole distributed in the Java distribution. The JVM itself has some logging capabilities that allow a level of debugging things such as memory management. These logs may also be helpful in determining whether to make changes to the JVM configuration.

Java Distribution Tools	Description
JConsole	A JMX-compliant graphical tool for monitoring a Java Virtual Machine
jvisualvm	Java VisualVM provides memory and CPU profiling, heap dump analysis, memory leak detection, access to MBeans, and garbage collection
jps	Lists instrumented HotSpot Java Virtual Machines on a target system
jstat	Collects and logs performance statistics as specified by the command line options

There are a number of 3rd party utilities that can be found on the Internet if the tools listed above are not sufficient.

The JVM also has garbage collection options that can be set that provides you with text output on STDOUT for longer-term monitoring.

JVM Option	Description
-verbose:gc	Enable verbose garbage collection output
-XX:+PrintGCDetails	Print detailed garbage collection information
-XX:+PrintHeapAtGC	Print before & after heap information when garbage collection is run
-XX:+PrintGCTimeStamps	Add time-stamps to garbage collection data
-XX:+PrintGCDateStamps	Add date-stamps to garbage collection data
-Xloggc:<file>	Output garbage collection data to <file>

Note: Garbage collection tuning is a highly technical topic which this paper does discuss in great detail. There are many excellent books, Internet articles, and Oracle documentation that provide a wealth of information on this topic.

JVM Memory Management

The JVM supplies two different memory regions that may be tuned for your specific ABL application running in an staging or production environment: a stack region and a heap region.

The JVM stack region holds local variables and method call parameters, with everything else allocated out of the heap region. Each JVM thread allocates space in the stack region. You can estimate the size that the stack region will grow to by multiplying the maximum number of JVM threads by the stack size configuration option value. Generally, you do not need to tune the JVM stack region, but it is tunable to save memory when running smaller web applications or to support very large complex web applications.

The JVM heap region is subdivided into generations, which indicate the longevity of allocated objects before they are scanned and garbage-collected after which the memory is made available for re-allocation. Once a JVM allocates OS process memory it does not return it, even though the Java application may return to an idle state and garbage-collection has made heap space available again. The OS process view of memory allocation indicates the JVM peak memory load on the OS memory allocation, but it is not indicative of the application steady-state memory usage. The JVM internal memory allocation needs to be accessed using JVM monitoring tools.

Understanding the JVM generations becomes very important when configuring the amount of memory available to application run-time operations and in the amount of memory available to load and store application code. The JVM provides two separate configurations to control the amount of memory:

Generation	Configuration Category	Description
Young	heap (-Xms & -Xmx)	Newly allocated memory allocated for run-time operations that may have a short lifetime
Old	heap (-Xms & -Xmx)	Young generation memory allocations whose lifetime has existed past a certain point and may exist for a longer time
Metaspace	XX:MaxMetaspaceSize	The metaspace size flag is automatically set to unlimited, but if you want to size your container smaller you could change it.

The JVM garbage-collector is a highly complex mechanism whose job it is to reclaim orphan/abandoned memory heap space allocations and make it available for use again. The JVM supplies different implementations of tunable garbage-collectors to handle different types of Java application loads, which in this case is Tomcat and its deployed web applications. Selecting the right garbage-collector implementation and tuning it is largely determined by which web applications are deployed and the amount of client request traffic.

The general rule is to minimize the allocation of stack and metaspace and give the rest of the available process quota to the heap. The general rule for garbagecollector selection is to strike a balance between running infrequent huge collections that stall the PAS server and running frequent collections that deny CPU to the running web applications. The balance point will be different for each combination of web applications and its client request frequency and data load.

JVM Class Loaders

A JVM uses a subsystem named a class-loader to load Java class byte code into metaspace memory space and initialize that code. This relates to PAS in two ways: the Java security system (which is discussed in the **PAS for OpenEdge Administration Guide**) and the allocation of metaspace memory. The class-loader subsystem is really a hierarchy of individual classloader instances. When a class reference is made and it has not already been loaded, the JVM walks its hierarchy of class-loaders to find it, from the root node to the current. In this way classes can be shared across multiple class-loaders by loading them by a class-loader at a higher level in the hierarchy. This in turn reduces the load on metaspace because multiple class-loaders do not load multiple copies of the same class into metaspace.

PAS for OpenEdge implements a hierarchy of classloaders:

1. JVM
2. Apache Tomcat **System** - loading specific libraries found in the bin directory

3. Apache Tomcat **Common** – normally not used, but PAS uses it to share common libraries (common/lib) across multiple web applications to reduce metaspace allocation
4. Web application – each web application instance has its own class-loader to service its WEB-INF/classes and WEB-INF/lib directories

It is important to understand how Web application class-loaders can inflate metaspace allocation. For example: if one application is deployed five times (under different names), or five different web applications are deployed one time, and they all contain the same set of libraries and classes, the metaspace allocated is (library + class size) X 5. If those five web applications were to use the Common class-loader to load those common sets of libraries and classes, the resulting metaspace allocation would be (library + class size) X 1. The negative aspect of using a Common class-loader is that all web applications must use the compatible library and class versions. This is a common Java conundrum: shared Java libraries for far less memory utilization and updates in a single location, versus the flexibility of mixing and matching various versions of the Java libraries.

Note: PAS for OpenEdge uses the Common class-loader for 90+% of all Java classes to support its combination of web applications and consume the least amount of metaspace.

Common PAS Web Server

At the core of PAS for OpenEdge is the common Progress Application Server (PAS) platform that is used by all Progress web-based products and is capable of supporting most 3rd party web applications that conform to the Java Servlet 3.0 standard. PAS is subject to the JVM tuning of process threads, memory allocation, and file or network I/O.

Measuring PAS memory and CPU resources should begin when all of its web applications are loaded and their initial memory allocations are completed.

PAS Memory Usage

A PAS server consumes a certain amount of JVM memory according to the types of server options configured, the number of deployed web applications, and the number and size of concurrent client requests.

Once a PAS instance has reached its JVM memory limits and you still need to support additional web applications or client data loads, you need to consider starting additional PAS instances and balance the deployment of additional application and/or client load. This is an advanced tuning subject covered in the OpenEdge documentation under the title **Load balancing options for PAS for OpenEdge**.

The following sections provide a breakout of what operations consume memory and can be manipulated to control JVM memory consumption.

PAS Startup

PAS consumes both heap and metaspace at startup time. The number of additional server options started from within the Tomcat conf/server.xml configuration file controls metaspace allocation. The size of the various server-wide object pools for threads and client request handling consumes the greatest amount of heap allocation.

Loading and Starting Web Applications

After the PAS core server is loaded and initialized, it begins the serial loading and starting of the deployed web applications. Loading and starting a web application consumes CPU, heap, and metaspace resources according to how the web application was implemented. Each web application loaded has a dedicated class-loader in the Tomcat class-loader hierarchy. Web application classes can be shared in metaspace memory if they are loaded by a class-loader that exists higher in the classloader hierarchy. If a class is not loaded by a higher level class-loader it may appear in metaspace memory multiple times, once for each web application that references it.

PAS does not become fully available for client access until it completes the loading and starting of all deployed web applications. At the time when PAS is fully available, the web applications are still not fully loaded. Incremental loading of web application classes and memory allocations continues as client HTTP requests begin arriving for the web application to execute. It is advisable that any CPU and memory measurements begin after a warmup period of client traffic across all deployed web applications.

Note: PAS may fail to start due to lack of heap or metaspace.

PAS Startup Time

The time PAS requires to start and begin accepting client requests can be an issue in some environments. This can be somewhat influenced by the number and type of web applications deployed and by the individual web application configuration.

PAS loads web applications serially. When each web application begins loading you can control how many of the application servlets are loaded and started immediately rather than waiting until the first client request is executed. Fewer servlets loaded and initialized at load time means faster PAS loading of the next web application and faster time to complete the startup sequence. This is balanced against the time required to service the initial client requests.

Many classes needed to execute client requests are not loaded at web application startup and initialization time.Therefore, the initial client requests will load a significant number of additional classes and will result in slower execution times. We recommend running your performance analysis after a warm-up of five client requests, at which time the loading of new classes will be reduced to near zero.

HTTP Client Connections and HTTP Requests

PAS manages all client network connections as HTTP/S protocol connections. Managing client network connections includes handling:

- TCP/IP connections
- TCP/IP disconnections
- Message timeouts
- Terminating infrequently used client connections to enable servicing new clients

PAS initializes and maintains two resource pools to manage the influx of client connections and HTTP requests:

- A pool of JVM threads to execute individual HTTP requests
- A pool of queued HTTP requests waiting for a JVM thread to execute in

When an HTTP client makes a socket connection, PAS waits a configurable amount of time for the HTTP request to arrive before returning an error. When the client HTTP request is received it is either assigned directly to a JVM thread for execution or queued until a JVM thread is available.

The size of the PAS thread pool directly affects how many client HTTP requests can be executed concurrently. The size of the HTTP request queue dictates the maximum volume of client HTTP requests before PAS begins returning errors to the clients. Tuning the TCP/IP connections, HTTP request queue, and thread pools is key in managing client connections and response times. Both pools consume memory space, and the size of the thread pool controls how much stack region space is used and the size of the request queue determines how much heap region space is used.

HTTP Request Execution

When a JVM thread is available from the PAS thread pool to execute a [queued] HTTP request, a new HTTP request execution context is created and passed to the thread that then executes it. The JVM thread is bound to that HTTP request context until it either ends successfully or with a failure. Once the HTTP request is complete, the JVM thread returns to the pool to service another client HTTP request.

Unlike the classic OpenEdge AppServer, handling of HTTP requests by PAS does not inherently have the concept of “timeout” once a HTTP request begins execution. PAS does make an Apache Tomcat valve available that monitors HTTP request execution times and to log a message if any request runs over the configured amount of time. The HTTP request execution monitor valve name in reference to PAS for OpenEdge is **tcman feature StuckSessionValve**.

PAS does incorporate configurable limits for how long a TCP/IP connection can be idle before a HTTP request is received and how long it can be queued before a thread from the thread pool is available. Tuning the HTTP request execution parameters affects how well PAS is able to handle client connection load and spikes in client requests

Session Manager serving ABL Applications

Each web application employs a common ABL Session Manager to manage a pool of ABL sessions. The Session Manager ABL session pool acts as a buffering and dispatching mechanism for handling incoming client requests. The size of the pool dynamically scales up and down according to the client load and its configuration settings, dynamically increasing and decreasing the amount of heap space used. The ABL session pool queues client requests for a certain period of time when the incoming client load outpaces the ability of the ABL sessions to handle them. If a client request exists in the ABL session pool for too long, it is canceled and an error returned to the client. When both the ABL session pool is at its maximum and the queue space is full, an error is immediately returned to the client.

An ABL application session pool manages a pool of one or more Multi-Session Agent (MS-Agent) OS processes that hold the physical ABL sessions where client requests are executed. One MS-Agent process is always created at PAS for OpenEdge startup, with additional MS-Agent processes added if or when more ABL sessions are required to service client requests. The recommendation is to maximize the use of a single MS-Agent and only scale to more than one if necessary.

The ABL session pool maintains a configurable number of local socket connections to each MS-Agent process. The number of local socket connections dictates the maximum number of ABL requests any one MS-Agent can execute concurrently. You can configure the ABL session pool parameters to control its total size, the number of queued client requests, and the number of concurrent client requests that can be executed.

There is a side effect of the Session Manager queuing of client requests and the ABL application request execution times: long running requests can lead to PAS thread pool exhaustion and rejection of client requests. Both of these contribute to longer running client requests, meaning that a PAS thread is bound to the client request longer and is unable to be reused to handle other client requests. This requires a balance of managing the PAS thread pool, versus the Session Manager ABL session pool, versus the design and implementation of the ABL application.

Multi-Session ABL Language Agent

Because the ABL language cannot physically execute in the PAS JVM process, the physical ABL sessions that execute client requests are hosted in external MSAgent(s). A MS-Agent process is constructed to host multiple ABL sessions that use a threaded architecture to provide concurrent (single threaded) client request execution.

There are at least as many ABL sessions in a MS-Agent as the number of client requests it can execute concurrently. The number of client requests that can execute concurrently is limited by the maxConnectionsPerAgent parameter. Each ABL session has a small amount of memory for language engine state and data storage, but that amount is relatively insignificant. The maximum number of ABL sessions any single MS-Agent can host is closely related to the memory/file/network resource consumption of the ABL application that runs in them. The memory footprint of any single ABL session is determined by the summation of the ABL local variables, global variables, temptables, number of database connections, the amount of r-code loaded, and other elements provided by the AVM.

The number of concurrent client requests any one MS-Agent can execute concurrently is implied by, but not physically tied to, the OS process threads used to execute them. Rather, the maximum number of concurrently executing client requests is based on the lesser of:

1. The maximum number of local socket connections configured to exist between the ABL Session Manager and the MS-Agent
2. The number of ABL sessions that are free [i.e. idle] to execute client requests

The relationship between the Session Manager network connections and the number of physical ABL sessions in a MS-Agent is relative to the ABL application implementation. If the application is implemented to use [stateful] bound client connections the ratio of ABL sessions to local sockets is n-to-1. When the ABL application uses [stateless] unbound client connections the ratio of ABL sessions to local sockets is closer to 1-to-1.

Monitoring OpenEdge Web Applications and Multi-Session Agents

Monitoring PAS for OpenEdge involves using its extensive set of metrics gathering and query operations that are available via the PAS JMX console, and optionally via its OpenEdge remote administration web application OpenEdge Explorer or OpenEdge Management. PAS for OpenEdge relies on lower overhead metrics services rather than the heavyweight logging used by a classic OpenEdge AppServer. In many cases you will not find the same logging messages in the PAS for OpenEdge log files that you found in the classic OpenEdge AppServer.

This document does not teach you how to use the PAS for OpenEdge metrics gathering and queries; that information can be found in the PAS for OpenEdge Administration Guide.

This document points out general information you can gather and query for:

- Listing of ABL Agent Sessions, clients, and MS-Agent connections
- Listing of hung clients (who exceeded a specified amount of time)
- List the currently executing client ABL requests
- Reset metrics counters
- Runtime Session Manager metrics: Concurrent client metrics, Connection timeouts, Request queue counts, Request counts, and Read/write counts
- MS-Agent ABL session metrics, per ABL session: start & end times
- APSV, REST, WEB and SOAP transport metrics: Request counts, and Success/failure counts
- REST, JConsole, and OEJMX for viewing and querying Java Beans

4

Tuning PAS for OpenEdge

After gaining a basic understanding of the PAS for OpenEdge environment your ABL application will execute in, you are now ready to begin the tuning process. Tuning PAS for OpenEdge begins with installing the production version of the PAS for OpenEdge product. The PAS for OpenEdge development product has throttles applied that are not conducive to performance tuning. After the production server product is installed, follow the normal steps to create a PAS for OpenEdge instance with your ABL application installed and configured. This instance is the target of your tuning process.

Note: Do not tune the core PAS server installation files located in DLC/servers/pasoe!

For details, see the following topics:

- Tuning Goals and Common Steps
- Tuning the PAS - Server-side
- Tuning the OpenEdge Web Applications and MS-Agents
- Monitoring your PAS for OpenEdge with OEJMX

Tuning Goals and Common Steps

The overall goal for tuning a PAS for OpenEdge instance is to support an ABL application that meets the end user requirements for concurrent client requests, response times, and OS CPU and memory resource consumption. Achieving this goal is an iterative process starting in your ABL application development process where you determine the initial PAS for OpenEdge configuration defaults that fit your ABL application target deployment. More refined tuning then occurs at the end customer site where the OS CPU, memory, and file system comes into play.

The tuning process typically follows this sequence of steps:

1. Tune the PAS server
2. Tune the OpenEdge (and any 3rd party) web application(s)
3. Tune the OpenEdge Multi-Session Agent

The following is a general set of steps to get started:

1. Deploy the [OpenEdge] web applications that make up your ABL application to the PAS for OpenEdge instance, increasing the metaspace memory as needed until all web applications start cleanly.
2. Determine and set the maximum number of ABL sessions any one MS-Agent can support based on your ABL application memory allocation of variables, rcode, buffer space, etc.
3. Calculate the maximum ABL session pool size where the maximum number of ABL sessions across all MS-Agents is based on the sum of:
   a. Estimated maximum number of concurrently bound client application connections
   b. Estimated maximum number of concurrently executing unbound client requests
4. Set the maximum number of MS-Agents as (*session-pool-size* / *maximum sessions per MS-Agent) + 1.* The +1 is for handling abnormal load spikes.
5. Set the maximum local socket connections any one MS-Agent can have. The goal is to maximize the number of concurrently running client requests any one MS-Agent can process. The hardware CPU resources and the level of I/O switching of the individually executing ABL requests influence the value. This number needs to be <= the maximum number of ABL sessions per agent.
6. Set the idle resource timeouts to lower the resource load on the server without causing MS-Agent or ABL session thrashing. These settings are directly related to how long it takes an ABL session to be started in your ABL application.
7. Set the number of initial ABL sessions a MS-Agent starts when it is created. This number should be kept to a minimum as it affects how long it takes the PAS for OpenEdge server to become available to handle client load. The goal is to initialize enough ABL sessions to handle the initial client load and gradually scale up (trading off initial client response times) to the PAS for OpenEdge instance full capacity.

Keep in mind that the maximum capacity of a single PAS for OpenEdge instance is finite for any given combination of ABL application and OS hardware. Once you reach a single PAS for OpenEdge instance limits within the environment it runs in, and you have still not met the end customer requirements, you are then in a position where you need to either increase the OS hardware capacity or run additional PAS for OpenEdge instances and load balance.

The scaling of PAS for OpenEdge instances is not covered in this document; that information can be found in the PAS for OpenEdge Sizing Guide.

Tuning the PAS - Server-side

The most important aspect of tuning your PAS for OpenEdge instance is the JVM stack/heap/metaspace memory allocations and the garbage-collection. The memory configuration ultimately determines how many and what type of web applications the PAS for OpenEdge instance can have deployed, and the number of clients it can support for those web applications.

The tuning process involves an iterative process of monitoring PAS behavior for a given client and web application configuration, changing configuration values, and then returning to the monitoring phase. You can expect to control the following attributes from PAS configuration:

- JVM stack, heap and metaspace memory allocations
- JVM garbage collection cycles and overhead
- The number of HTTP client connections
- The size of the thread pool used to execute HTTP client requests
- Client connection timeout (without a HTTP request)
- The queue size for parking HTTP client requests until a thread is available from the pool
- Socket buffer size
- HTTP compression for SOAP and REST clients
- Turning Tomcat optional features on/off
- Determining which web applications will be deployed to which PAS for OpenEdge instance(s)

JVM configuration parameters exist in the PAS instance **/conf/jvm.properties** file as Java system properties. You manually edit this file to make changes.

PAS configuration parameters exist in the PAS instance **/conf/catalina.properties** file as Java system properties where they are easier to manage from local scripts and remote administration tools. Those Java system property values are used as variable values in the PAS **/conf/server.xml** file. Normally you do not edit the PAS /conf/server.xml file as it may cause the server to not start. Progress recommends that you use the **/bin/tcman.{bat|sh}** command line utility or a text editor to maintain the /conf/catalina.properties file.

The Java distribution, commercial tools, or open source products can be used to monitor PAS resources and operations. There are a number of these products available that provide excellent viewing of the web servers behavior.

Tuning the JVM Memory and Garbage Collection

PAS process memory and garbage collection are a critical point in your tuning strategy. PAS (Apache Tomcat) reacts badly when either the heap or metaspace memory regions run low on space. To keep memory available to the JVM, its garbage-collector needs to run periodically to reclaim unused space. Every time the garbage collector runs it stops all of the other JVM threads, such as client HTTP request execution threads. If the garbage-collector runs too infrequently, large amounts of unusable memory may accumulate and the collection process will take a long time resulting in spikes in client response times. If the garbage-collection process runs too often you lose CPU cycles while checking the entire memory space and you will see client response times elongate due to constant CPU drain by garbage-collection cycles.

The goal is to ensure PAS for OpenEdge has sufficient heap and metaspace memory allocated to handle the loading of web applications, web application memory allocations, concurrent client requests, and to reduce garbage-collection processing time.

The things that influence memory consumption are:

- The number and type of web applications deployed
- The size of the HTTP request thread pool
- The number of concurrent requests and the data size of those requests

The following JVM properties configured in the /conf/jvm.properties file are relevant in determining memory and garbage collection limits:

Property	Default	Description
-Xms<size>	512m	Initial Java heap size

Property	Default	Description
-Xmx<size>	1024m	Maximum Java heap size
-Xss<size>	1024k	Java thread stack size
-XX:NewSize	64m	Initial space used for short duration objects and indirectly how often garbage collection runs
-XX:MaxNewSize	128m	Maximum space used for short duration objects
-XX+DisableExplicitGC		Disable explicit garbage collection
-XX:MetaspaceSize	unlimited	Find information from Javadoc to modify

Tuning tips:

- Reduce the frequency of garbage collection by starting the JVM with a larger maximum heap memory space (-Xmx)
- Reduce repeated reallocation of heap memory by setting the initial heap memory space equal to the maximum amount (-Xms == -Xmx)
- Reduce repeated reallocation of metaspace memory by setting the initial size equal to the maximum size (-XX:MetaspaceSize == -XX:MaxMetaspaceSize)
- Carefully lower the JVM stack size (-Xss) to save process memory for heap and metaspace allocations
- Increase metaspace memory when PAS stops due to an out-of-metaspace error

The default PAS for OpenEdge configuration provides a reasonable starting point, but due to the influences of the combination of OpenEdge and 3rd party web applications, they can only be considered as a starting point.

Tuning the PAS Client Network Connections

Tuning the PAS client network connections involves controlling the HTTP client TCP/IP connections. Many of the network connection properties are defined as Java system properties in the PAS /conf/catalina.properties file and have “psc.as.” name prefixes. These properties can be managed using the tcman command line utility (recommended) or a text editor. Each named “psc.as…” Java system property in /conf/catalina.properties is related to an Apache Tomcat /conf/server.xml file xml element or attribute. You can find that relationship using the command “tcman.{bat|sh} help psc.as.xxxxxx”.

Note: OpenEdge recommends that you do not edit the PAS instance conf/server.xml file unless an Apache Tomcat configuration attribute is needed that is not supplied via a “psc.as” configuration property. If a new Apache Tomcat configuration attribute is required, Progress recommends adding the attribute to the conf/server.xml file using a “psc.as.” property and adding that property to the conf/catalina.properties file where it can be remotely managed by administration tools and automated scripts.

PAS client network connections are a server-level resource and exist for each open HTTP/HTTPS/AJP13 port [connector]. You cannot control client network connections per web application. Your primary goal is to ensure that PAS for OpenEdge has enough network connection capacity to handle the total client load for all deployed web applications, inclusive of OpenEdge web applications and any additional external 3rd party web applications.

Tuning tips:

- Coordinate the maximum client connections to be at, or larger, than, the size of the PAS thread pool and the number of queued HTTP client requests.

- Do not attempt to enable HTTP message compression for HTTP-connected OpenEdge clients by adding its mime-type to **psc.as.compress.types** property: it will not work.
- The HTTP-connected OpenEdge clients use HTTP POST messages with a maximum size of 8KB, so the maximum **psc.as.msg.maxpostsize** is not an issue. If you are using REST or SOAP clients with very large ProDataSet transfers, this property setting may become important.

The secondary goal is to modify the HTTP message-handling if the default settings do not allow very large message/response data exchange required by some web applications.

HTTP connection properties:

Property	Default	Description
psc.as.HTTP.connectiontimeout	20000	The max time in milliseconds between a TCP connection and the appearance of a HTTP or HTTPS message
psc.as.HTTP.maxconnections	-1	Max client connections on the HTTP network port
psc.as.HTTP.compress	on	Turn HTTP compression support “on” or “off”

HTTPS connection properties:

Property	Default	Description
psc.as.HTTPs.maxconnections	-1	Max client connections on the HTTPS network port
psc.as.HTTPs.compress	on	Turn HTTPS compression support “on” or “off”

HTTP message properties:

Property	Default	Description
psc.as.msg.timeout	10000	Timeout for async requests in milliseconds
psc.as.msg.maxpostsize	2097152	The maximum size of a POST HTTP message in bytes
psc.as.msg.socketbuffer	9000	The HTTP message buffer size in bytes

Property	Default	Description
psc.as.compress.min	2048	The minimum message size, in bytes, enables compression for HTTP responses
psc.as.compress.types	text/html text/xml text/javascript text/css application/json	A comma separated list of which mime types can be HTTP compressed

Tuning the PAS HTTP/HTTPS Request Processing

PAS handles all HTTP client requests, including OpenEdge, REST, SOAP, and others. Tuning concurrent client request handling involves managing the PAS thread pool and the HTTP request queues. The goal is to tune the thread pool size to handle the maximum number of concurrently executing client requests across all web applications, within the bounds established by the JVM configuration.

Property	Default	Description
psc.as.executor.maxthreads	300	Maximum number of threads that can be created to execute client requests
psc.as.executor.minsparethreads	10	The minimum number of threads retained in the pool to service client requests.
psc.as.HTTP.maxqueuesize	100	Max queue size for parking HTTP connection requests until a thread from the thread pool is available
psc.as.HTTPs.maxqueuesize	100	Max queue size for parking HTTPS connection requests until a thread from the thread pool is available

Tuning tips:

- Each thread in the pool allocates memory from the JVM heap space. Having too many threads detracts from the amount of JVM memory available to the applications. Having too few threads detracts from the ability of PAS to handle concurrent client requests.
- Another factor in setting the thread pool properties is PAS startup time. The larger the number of threads initially started (minsparethreads) the longer it takes PAS to start and be available for clients. Not starting enough threads, or keeping too few threads active results in irregular client response times as new threads are created and initialized before they can be used.
- Monitoring for determining these values is generally obtained during peak and slack client activity times. Look for client errors due to overloaded queues or thread pool exhaustion as indicators that values need to be increased. Look for irregular client response times that indicate the minimum retained thread count is not sufficient.

Tuning the PAS Server Features

PAS comes preconfigured with certain server features and HTTP request filters (referred to as valves) that are executed on each client request. While the PAS defaults work for most situations, some server features and/or filters can be turned off in the right situations to adjust security or HTTP request processing time. The recommended method of controlling server options is to use the tcman command line utility:

```
tcman.{bat|sh} feature <feature-name>={on|off}
```

The complete list of tcman features can be found by typing:

```
tcman.{bat|sh} feature
```

A description of each individual feature can be found by typing:

```
tcman.{bat|sh} help <feature name>
```

Tuning tips:

- The StuckSessionValve applies to all deployed web applications, including the OpenEdge ones that execute the ABL language requests. This setting can result in false-positives, so interpret the information as informational and not an error.
- The CrawlerSessionManager valve protects against large numbers of HTTP sessions being started by external web page indexers, which use up a lot of heap space. For internet-facing PAS for OpenEdge instances, Progress recommends that you leave the feature on. If you have intranet PAS for OpenEdge instances you may turn the feature off.
- The AccessLog feature uses processing time to format and write the tracking of HTTP clients. Its value to an enterprise is subjective and it should be turned off unless deemed necessary.
- The SingleSignOn (SSO) feature allows the user to log into the PAS for OpenEdge instance one time for all web applications in a certain realm. Both the Apache Tomcat management and OpenEdge remote administration web applications share the same realm and benefit from this SSO. OpenEdge web applications (oeabl.war) can also benefit from this functionality if they are configured for container security. If your production PAS for OpenEdge instance does not deploy those administration web applications or needs to benefit from SSO, disable this feature.
- PAS for OpenEdge instance clusters are advanced web server architectures and should be left turned off until necessary to support your ABL application using multiple PAS for OpenEdge instances.
- The SecurityListener feature is seldom used but is provided when needed for best-practice production security configurations. Only enable this feature when you are sure PAS for OpenEdge instance(s) are deployed using the required OS file/directory permissions.
- The RemoteHostValve and RemoteAddrValve default configuration allows all host names and addresses, so their overhead is small. Both DNS and IP addresses are considered unreliable for identifying internet clients so you may turn these off if PAS for OpenEdge is internet facing. They may be of more use when PAS for OpenEdge is running on what the end user site considers a secured intranet.

Tuning the OpenEdge Web Applications and MS-Agents

After you tune PAS for handling client requests, you can begin working with the OpenEdge web application(s) and MS-Agent process(es). The types of information found in this section of the document includes:

- Controlling the size of the ABL Session Manager ABL session pool
- Managing resource consumption within a Multi-Session agent process
- Managing concurrent ABL request execution
- Managing PAS for OpenEdge startup time

The design and implementation of your ABL application affects the PAS and all web applications deployed in it. In most cases the ABL application design and implementation cannot, and should not, be changed. Your goal is to strike a balance between PAS for OpenEdge instance startup times, supporting client requests to your ABL business logic, and the response time to those clients.

One of the realities in getting the most performance from your PAS for OpenEdge instance is that the OpenEdge web applications and the MS-Agent process execution of client requests is gated by your tuning of the PAS they operate in. For example, it does not matter if you configure OpenEdge to handle 400 concurrent client requests if the PAS it runs in can only manage supporting 200 concurrent client requests – the net maximum client support will be 200.

Another reality is that the execution speed of the ABL language engine and the OpenEdge RDBMS storage engine are tied to the speed of the OS, the CPUs, and the file system, not the PAS for OpenEdge. You cannot tune PAS for OpenEdge to execute the same ABL r-code and data storage operations to run faster than does a batch process or a classic OpenEdge AppServer.

The ABL application ABL session pool is managed by the SessionManager subsystem, which is common to all of its configured OpenEdge web applications. How the SessionManager manages the ABL session pool, its pool of MS-Agents, and the local network socket connections, is controlled through properties found in the PAS for OpenEdge instance /conf/openedge.properties configuration file. This file is managed by using the PAS for OpenEdge instance **/bin/oeprop.{bat|sh}** command line utility, OpenEdge Explorer/Management (if the OpenEdge remote administration web application is installed), or via a simple text editor.

Property [AppServer.SessMgr]	Default	Description (per ABL Application)
numInitialAgents	1	Number of MS-Agent processes to create at server startup
maxAgents	10	Maximum number of MS-Agent processes that can exist
maxABLSessionsPerAgent	200	Maximum number of ABL sessions per MS-Agent process
maxConnectionsPerAgent	16	Maximum number of network connections between Session Manager and an MS-Agent

Property [AppServer.SessMgr]	Default	Description (per ABL Application)
requestWaitTimeout	15000	Maximum time, in milliseconds, that a client request will be queued waiting for an ABL session before an error is returned
idleSessionTimeout	300000	Maximum time, in seconds, that an ABL session can remain idle before it is shut down
idleAgentTimeout	300000	Maximum time, in seconds, that a MS-Agent can remain idle before it is shut down
agentListenerTimeout	300000	Maximum time the SessionManager will wait for an MS-Agent to report “started” before an error is raised
minAgents	0	Minimum number of agents expected at any time. If the number of agents drops below this number, a client request will cause the session manager to start enough agents to equal this number. - Default setting of 0: minAgents disabled - Any value greater than 0: that value will be used for minAgents - If minAgents is greater than maxAgents, the minAgent value will be lowered to match the maxAgents Session manager makes sure that there is always 1 agent available all the time before running the request.
idleAgentTimeout	300000	Timeout value in milliseconds for an idle agent. If an agent is idle for more than the specified timeout value, then the session will be deleted when idleResource cleanup is done.

Property [AppServer.SessMgr]	Default	Description (per ABL Application)
idleConnectionTimeout	300000	Timeout value in milliseconds between an AppServer client and the Session Manager. If a connection is idle for more than the specified timeout value, then the SessionManager will terminate the connection by automatically disconnecting the connection from the AppServer.
idleResourceTimeout	0	Timeout value in milliseconds to determine the frequency with which the PASOE server checks for idle resources. Any resource (e.g. connection, agent, or client session) that has not been accessed more recently than the specified timeout for that property will be terminated. If this property is set to zero, then idle resource checking is disabled.
idleSessionTimeout	300000	Timeout value in milliseconds for an idle SessionManager session. If a SessionManager session is idle for more than the specified timeout value, then the session will be deleted when idleResource cleanup is done.

Property [Appserver.Agent]	Default	Description (per MS-Agent)
numInitialSessions	5	Number of ABL sessions started at MS-Agent startup time

Note: Full property descriptions are located in the PAS for OpenEdge instance /conf/openedge.properties.README file.

How the OpenEdge properties are set depends, to some extent, on the operating model implemented by your ABL application:

1. Stateful (i.e. classic OpenEdge AppServer state-reset/state-aware)
2. Stateless (i.e. classic OpenEdge AppServer stateless/state-free)

Why these application model implementations affect property settings requires an understanding of how the ABL SessionManager manages the client session pool, the MS-Agents where the physical ABL sessions run in, and how ABL sessions are selected to execute client requests.

The first priority of the SessionManager is to conserve system resources by maximizing the pool of ABL sessions and by scaling a larger number than is needed to handle the current client load. Where the classic OpenEdge AppServer used a round-robin scheduler to distribute client requests across all existing ABL sessions, PAS for OpenEdge uses a find-first-free scheduler. For example, when a classic OpenEdge AppServer handled requests from a single client, all of the running ABL sessions were used over time since each new request was serviced by a new ABL Session in the round robin fashion, thus consuming OS memory and file system handles linearly. PAS for OpenEdge uses only one ABL session, consuming only one session's worth of OS memory and file system handles.

For informational purposes, the following is a general description of how the SessionManager implements its find-first-free scheduling of client requests using MS-Agents, local socket connections, and ABL sessions:

1. Receive a client request from an oeabl web application transport.
2. The first MS-Agent in the list of MS-Agents is set as the current agent.
3. If the current MS-Agent has an unused agent connection and a free ABL session, use it to execute the client request:
   a. During this time the local agent connection is placed into an *in-use* state and the free ABL session is *bound* to the agent connection, where neither is available for use by other client requests.
   b. When the client request ends, the ABL session is marked as *free* if a persistent procedure has not been executed and the ABL application code has not set a bound-client condition. The local agent connection returns to the *unused* state as available to execute any other client's request.
4. If the number of current MS-Agent local agent connections is < max, and any ABL sessions are free, create a new agent connection to run requests on. Go to #3.
5. If another MS-Agent exists in the MS-Agent list set it as the current agent, go to #3.
6. If the max number of MS-Agents has not been reached, create a new MSAgent, add it to the end of the MS-Agents list, make the new MS-Agent the current agent, and go to #3.
7. Queue the request if the maximum request queue size is not exceeded. Queued requests are de-queued and executed as soon as a MS-Agent socket connection becomes available.

A classic OpenEdge AppServer has four modes of operation providing two distinct application architecture models: stateful in which one ABL session exists for each application client, and stateless in which the ABL sessions are shared by all application clients. PAS for OpenEdge provides support for both models, where all client requests are handled stateless and the ABL application can, at its direction, [temporarily] bind the client and operate in a stateful manner. The implications of this translate into how many ABL sessions and MS-Agents to configure.

OpenEdge ABL Session Pool and Request Scheduling

This section provides information that allows you to control PAS for OpenEdge startup times, ABL sessions for executing client requests, and the concurrent client request execution.

PAS for OpenEdge startup time and handling initial client requests

The SessionManager must start a minimum of one MS-Agent when a PAS for OpenEdge instance is started. During an MS-Agent startup process the SessionManager stalls until it gets a call-back connection from the SessionManager to report its startup status and any subsequent notifications. The SessionManager stalls for a agentListenerTimeout period before it considers the MS-Agent either unresponsive or unable to start.

PAS for OpenEdge SessionManager uses the property numInitialAgents to begin building a list of MS-Agent processes. The MS-Agent process uses the numInitialSessions property at startup time to begin building its free [idle] list of physical ABL sessions. For example: 1 MS-Agent with 5 initial ABL sessions yields an initial ABL session pool size of 5. Starting 3 MS-Agents with 5 initial ABL sessions each yields an initial ABL session pool size of 15.

Tuning tips:

- The longer the agentListenerTimeout property is set, the longer the PAS for OpenEdge instance takes to start when for any reason the MS-Agent process has startup failures. Too short a time and the PAS for OpenEdge instance may start sooner but the SessionManager may consider the MS-Agent unavailable.
- Setting the number of MS-Agent processes and physical ABL sessions to start at initialization time is dependent on how long the ABL application implementation takes to run its startup procedure. A larger number takes more time, which causes the PAS for OpenEdge instance to not handle incoming client requests for a longer period of time. Too few and the first client requests handled by PAS for OpenEdge will have slow response times while new ABL sessions and/or MS-Agent processes are started.

Scaling up and down MS-Agents and physical ABL sessions

After initial startup the SessionManager automatically scales the number of ABL sessions according to the client load. SessionManager scaling begins with adding ABL sessions to the first MS-Agent process until its maxABLSessionsPerAgent limit is reached. If additional ABL sessions are required to meet client demand, the number of physical ABL sessions are scaled up in the next MS-Agent process until its maxABLSessionsPerAgent limit is reached. This scaling process continues until the maxAgents limit is met, at which time the SessionManager beings to return no session available errors to its clients.

Tuning tips:

- Setting the MS-Agent maximum ABL sessions property is related to the OS process memory and/or file limits. Each ABL session that runs your ABL application code consumes memory and other process resources: do not set the maximum ABL sessions to a higher number than the OS process supports.
- The best performance is achieved by keeping the number of MS-Agents to as small as possible by maximizing the number of ABL sessions and concurrent client requests per MS-Agent.
- The more MS-Agents that are started, the higher the overhead in dispatching incoming stateless client requests for execution. The ideal case for stateless ABL application models is one MS-Agent and a few ABL sessions.
- Scaling to handle more MS-Agent processes is normal when the ABL application supports stateful client requests. Overhead for stateful clients is low because they are directly dispatched for execution to an exact ABL session within an exact MS-Agent, without the need to find an idle ABL session.

As stated above, the SessionManager goal is to conserve resources. It does this by periodically scanning all of the MS-Agent and client sessions looking for ones that have been idle beyond the idleAgentTimeout and idleSessionTimeout periods respectively. When an idle MS-Agent or client session exceeds the idle time it is removed from service and is shut down gracefully.

Tuning tips:

- If your client traffic peaks and valleys often, this may lead to thrashing where client response times suffer because MS-Agents and ABL sessions are harvested too soon and the client must wait for new ones to be started up.
- If you see from the OpenEdge metrics too many MS-Agent/ABL session startups and idle resource shutdowns, lengthen the time they can remain idle before being harvested.
- You also have the option of manually controlling the harvesting of idle MSAgents and ABL sessions. To disable the automatic idle resource harvesting, configure the idleResourceTimeout property to 0 (zero) and use the JMX or remote OpenEdge administration plugin to manually harvest idle resources.

Managing concurrent request execution

An MS-Agent can only concurrently execute the same number of client requests as it has local socket connections between the SessionManager and itself. The SessionManager automatically scales the number of local socket connections to MSAgents up to the maxConnectionsPerAgent limit while looking for a free (idle) ABL session to execute a client request. A byproduct of managing the number of local socket connections is the MS-Agent management of its pool of OS threads reserved for executing client requests. Each time a new local socket connection is created, a new OS thread is started to execute client requests arriving via that socket. Each time a local socket connection is closed, an OS thread from the pool is stopped. Once a local socket connection is created and an OS thread exists to execute client requests, it can be used by any client request regardless of the bound-client state.

Tuning tips:

- Do not set the maxConnectionsPerAgent higher than the maxABLSessionsPerAgent.
- Do not set the sum of local socket connections for all MS-Agents larger than the PAS thread pool for executing HTTP requests as they will never be used.
- The choosing of an appropriate number of local socket connections is closely tied to the implementation of the ABL application. If the ABL application uses high levels of file/database/socket I/O, you need to increase the number of socket connections and ABL sessions because many of them will have high idle times where CPU resources can be used for executing CPU-bound ABL language statements.

Note: The starting and stopping of local socket connections and the OS threads in its thread pool is not related to the startup/shutdown of physical ABL sessions.

Monitoring your PAS for OpenEdge with OEJMX

PAS for OpenEdge Administrators can monitor their applications in production using Java Monitoring and Management Console (JConsole) and OEManager. With JConsole and OEManager, administrators have access to all java beans operation data. To use these tools locally, you must only supply the Tomcat PID to JConsole. However, if you are running the PASOE instance on a remote server, you must enable remote administration in Java Extensions Manager (JMX) which requires opening a port for administration. If you want to run OEManager, you must use REST calls.

If you don’t wish to open a port or use REST APIs, you can use the OEJMX utility supplied with OpenEdge 11.7.3 and higher. OEJMX provides all the metrics information that are already running as part of JMX Monitoring. OEJMX is a JMX Client that connects to a local PAS for OpenEdge instance through the Tomcat PID. OEJMX provides all the metrics information that are already running as part of JMX Monitoring. The input for JMX are queries which are comprised of definitions of the JMX beans from which we would like to capture specific information. The default queries that are shipped by the product are available in the **<PASOE Instance>/bin/jmxqueries** directory.

To use OEJMX, you must understand JMX using JConsole and all its beans.The purpose and functionality of the bean can be found from JConsole and OEManager REST API documentation. PAS for OpenEdge has a combination of Apache Tomcat and product-specific beans for administration purposes.

To monitor your PAS for OpenEdge instance using OEJMX, follow these instructions:

1. Start your PAS for OpenEdge instance created in 11.7.3 or higher.
2. Create the following query file to monitoring the AgentManager bean:

```
{
 “O”: “PASOE:type=OEManager,name=AgentManager”,
 “M”: [“getAgents”, “oepas1”]
}
```

Those beans provide threadpool and session manager information and which can be used to get thread and session information, status, and other metrics.

Name the file **getAgents.qry**

3. Run the query by navigating to **<PASOE Instance>/bin/** and executing the following command:

```
oejmx.bat|sh -Q getAgents.qry
```

The response is returned in the format of a JSON Object with the operation or query name as the first name.

The output is generated in the **<PASOE Instance>/temp** directory with the filename "**getAgents-<timestamp>.txt**". Each time this query is executed, a new **getAgents.txt** file is generated with a new timestamp.

The output of the query is shown below:

```
Query: Line 1. Object: PASOE:type=OEManager,name=AgentManager, Method:
getAgents(testinst33)
Result:
{"getAgents":{"agents":[{"agentId":"UGwUD9QvQ465l7D1NciL5Q","pid":"8608","state":"AVAILABLE"}]}}
```

The results of this query will give you a list of agents running inside this PASOE instance.

4. To view all beans, run the following command:

```
oejmx.bat|sh -C
```

This command provides a list of all available beans from which you can build custom monitoring queries. It is important you understand what each bean or operation does. The ideal place to find this information is through OEManager REST API Documnetation or JConsole. For more information on OEJMX, see **Getting Started with OEJMX for PAS for OpenEdge**.

Here are some sample queries and responses for monitoring your applications running on PAS for OpenEdge:

Get sessionManager metrics for a specific ABL application:

```
{
     "O":"PASOE:type=OEManager,name=SessionManager",
     "M":["getMetrics","APP_NAME"]
}
```

Get sessionManager metrics sample response

```
{
  "getMetrics": {
 "accessTime": "2018-06-25T15:43:12.766-04:00",
 "avgQueueDepth": "0",
 "concurrentConnectedClients":"0",
 "maxConcurrentClients": "50",
 "maxQueueDepth": "0",
 "readErrors": "0",
 "reads": "30133",
 "requests": "15059",
 "reserveConnectionTimeouts": "0",
 "startTime": "2018-06-25T15:20:33.981-04:00",
 "timesQueued": "0",
 "type": "OE_BROKER",
 "writeErrors": "0",
 "writes": "30132"
    }
}
```

Get hung client connections for a specific ABL application

```
{
     "O":"PASOE:type=OEManager,name=SessionManager",
     "M":["getHungClientConnections","APP_NAME",6000]
}
```

getHungClientConnections sample response:


```
{
   "getHungClientConnections":[
      {
         "httpSessionId":"",
         "reqStartTimeStr":"2018-06-25T15:32:48.139-0400",
         "clientName":"172.16.21.106",
         "executerThreadId":"thd-5",
         "requestID":"3fj1RO35XYk/FDkZSN5UUw",
         "requestProcedure":"retrieveAccnts.p",
         "requestUrl":"http://localhost:29402/apsv",
         "sessionID":"C4F5EA614E9B1F8D94E28D7A87185DA923C4EE22F204.oepas1",
         "adapterType":"APSV",
         "elapsedTimeMs":35298
      },
      {
         "httpSessionId":"",
         "reqStartTimeStr":"2018-06-25T15:32:47.667-0400",
         "clientName":"localhost",
         "executerThreadId":"thd-1",
         "requestID":"rw4IDagih4Q/FDkZAMm8TQ",
         "requestProcedure":"mycustomer.p",
         "requestUrl":"http://localhost:29402/apsv",
         "sessionID":"9E0DDCB1CF61036B5D52587FA41CDEAAE9C8D8713B59.oepas1",
         "adapterType":"APSV",
         "elapsedTimeMs":35771
      },
      {
         "httpSessionId":"",
         "reqStartTimeStr":"2018-06-25T15:33:11.131-0400",
         "clientName":"localhost",
         "executerThreadId":"thd-1",
         "requestID":"gBR4KKyWS6E/FDoZuBeYZQ",
         "requestProcedure":"getlist.p",
         "requestUrl":"http://localhost:29402/apsv",
         "sessionID":"13512413B5FE9737F0180B7439EF7921EA0CDBA52753.oepas1",
         "adapterType":"APSV",
         "elapsedTimeMs":12307
      }
   ]
}
```