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SPARC SERVERS

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Tuning and Performance for Oracle SOA Suite 11*g* on Oracle's SPARC T4 and SPARC T5 Servers

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Introduction

This report describes testing performed on the Business Process Execution Language (BPEL) and Oracle Service Bus (OSB) components of the Oracle Service Oriented Architecture (SOA) Suite on Oracle's SPARC T4 and SPARC T5 servers running Oracle Solaris 11. The goal of the testing was to determine the best throughput for BPEL and Oracle Service Bus workflows by determining the optimal tuning parameters for best performance. Two test efforts are described in this paper. One set of tests revolved around the Fusion Order Demo (FOD) sample framework, with SOA-specific aspects specifically recorded. The second set of tests was run to determine Oracle Service Bus performance with a set of benchmarks created by Oracle engineering to stress test that one component.

Oracle SOA Suite BPEL Test Overview

The Fusion Order Demo (FOD) "FODOrderProcess" is used as the test application, and the Faban test harness is used to drive the load.

FODOrderProcess is a SOA specific application that simulates a typical order processing application. The application deployed as a fulfillment service, and it processes XML requests with an order ID. The application also simulates changing the behavior based on rules and allows for overriding the predefined rules using the Human Workflow service.

The FOD schema is created on an Oracle Database system, which is connected to the Oracle SOA Suite application server. The FOD schema includes a number of orders that already have been created as well as customer data (addresses, etc.). The application uses the following Oracle SOA Suite components:

1. Oracle BPEL Process Manager
2. Mediator
3. Database Adapter / File Adapter

BPEL flow:

This application has two code paths. One follows the Human Workflow and the other does not invoke the Human Workflow. All the performance data was gathered without using the Human Workflow code path. Here are the steps that each XML request goes through:

1. ReceiveInput
2. GetOrderInfo using the DatabaseAdapter
3. GetCustomerInfo using DatabaseAdapter
4. CheckDiscountandShipping
5. AdjustforDiscount
6. FulfillOrder

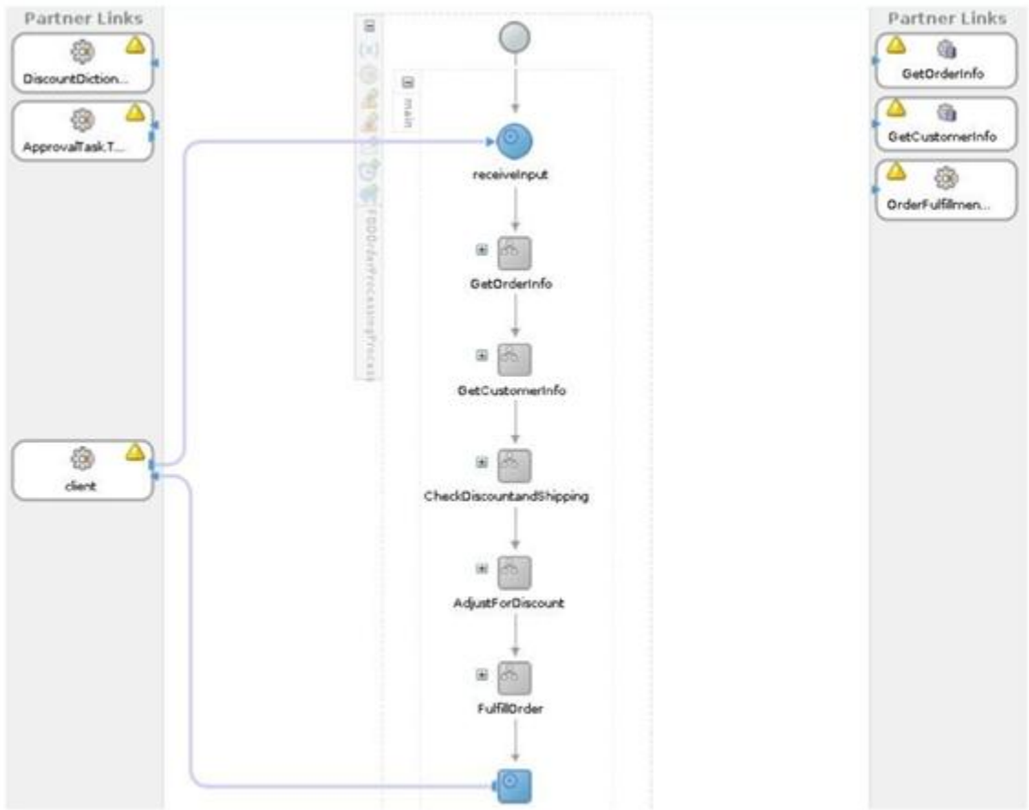

Figure 1. FOD Order Process—BPEL Process

Oracle Service Bus Microbenchmark Test Overview

Three tests were performed as part of the Oracle SOA Suite profiling:

Http Passthrough (http_passthrough)

The client sends a 5 KB message to a HTTP Web Services Description Language (WSDL)-based proxy service on an Oracle Service Bus server. The proxy routes (using route action) the message to the backend servlet in a WLS domain. Oracle Service Bus monitoring is enabled as the message goes through the bus. The proxy's operation selection algorithm is SOAP Action Header. This workload involves more networking load than any of the other Oracle Service Bus microbenchmarks described.

Dynamic Transformation (dyn_transformation)

In this benchmark the HTTP proxy receives a 5 KB XML document. The XML document has an Xquery resource name in one of its leaf nodes. The pipeline uses an Xpath to retrieve the Xquery resource name and executes transformation on the inbound XML. The majority of CPU is spent on XML processing.

Body Encryption (body_encryption)

This benchmark tests the crypto performance within an Oracle Service Bus service. The client sends a 5 KB message, within which a 100-byte element is encrypted, to the WSDL-based Oracle Service Bus proxy service over HTTP. The WSDL binding references an Oracle Web Services Manager policy. The business service is also WSDL-based. The element is encrypted with AES and signed with RSA128. The encrypted element is decrypted, and the message is routed to the backend service as a clear SOAP message.

Test Configuration

The test described in this document was done on Oracle Solaris, SPARC T4 and SPARC T5 servers, while keeping the local storage the same, using Oracle's Sun Storage 2540-M2 Fiber Channel array. The test environment was configured to be able to drive the maximum amount of load in order to characterize performance and scalability.

The sections below provide more detailed information on both the hardware and software setup along with guidance on how to most effectively utilize the system resources.

Hardware Configuration

The following diagram shows the hardware setup for the test for the SPARC T4 based servers. Each box represents a physical system/storage unit.

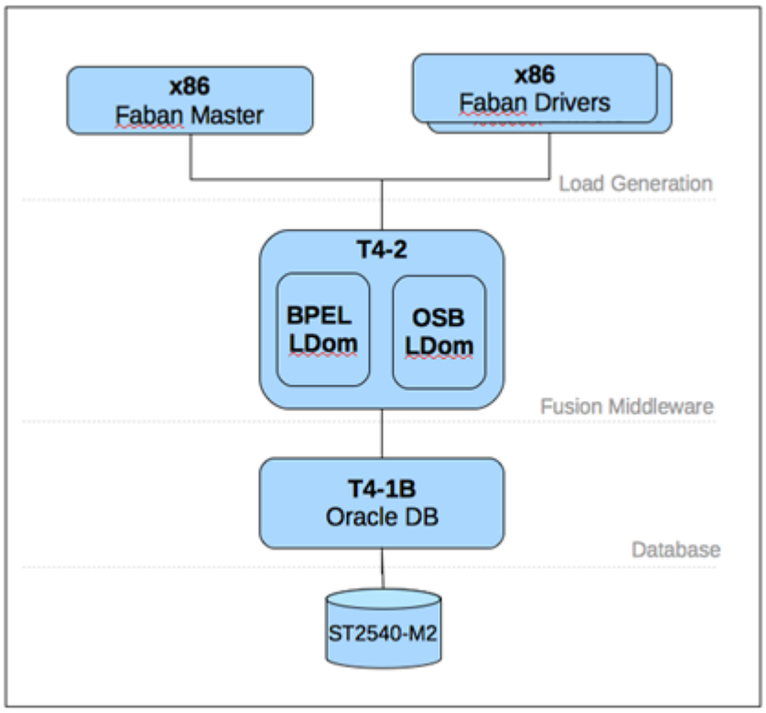

Figure 2. Diagram of Test Topology for T4 testing

The test setup for the SPARC T5 testing did not change the overall topology. Notably, the SOA server was changed to a T5-2 server, and the database layer was also changed to a SPARC T5-2 server.

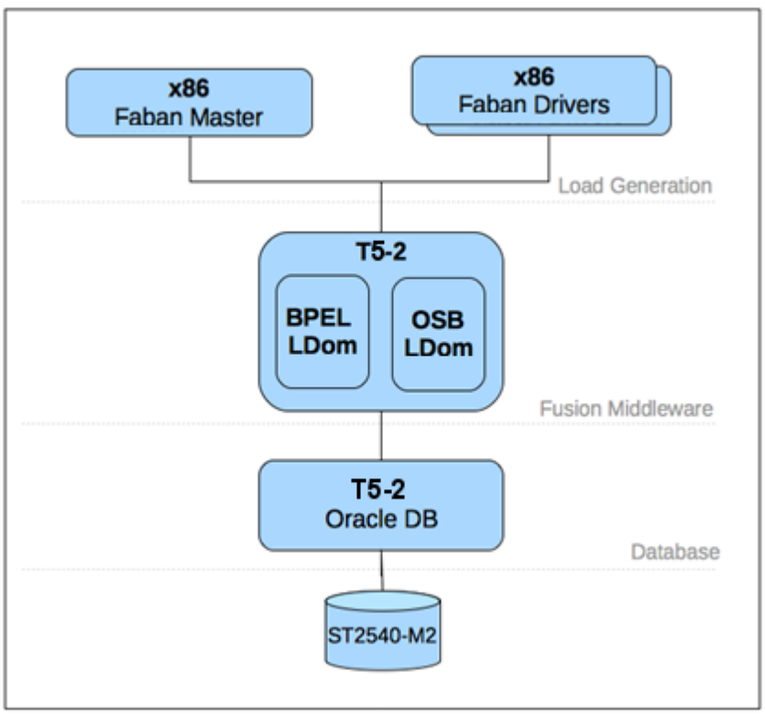

Figure 3 Diagram of Test Topology for T4 testing

All servers reside in the same subnet, with dedicated 1/10 Gigabit Ethernet as appropriate. The table below lists the specifications for each system.

TABLE 1. HARDWARE USED IN SPARC T4 TEST ENVIRONMENT

MODEL	USE	CPUS	CORES PER CPU	CPU STRANDS PER CORE	TOTAL HW STRANDS	TOTAL MEMORY
SPARC T4-2	SOA / BPEL / Oracle Service Bus	2x 2.8 GHz UltraSPARC T4	8	8	128	128 GB
SPARC T4-1	Database	1x 2.8 GHz UltraSPARC T4	8	8	64	128 GB
Sun Fire X2270 M2 (3x)	Load Generation	2x 2.93 GHz Xeon 5670	6	1	12	96 GB

TABLE 2. HARDWARE USED IN SPARC T5 TEST ENVIRONMENT

MODEL	USE	CPUS	CORES PER CPU	CPU STRANDS PER CORE	TOTAL HW STRANDS	TOTAL MEMORY
SPARC T5-2	SOA / BPEL / Oracle Service Bus	2x 3.6 GHz UltraSPARC T5	16	8	256	256 GB
SPARC T5-2	Database	2x 3.6 GHz UltraSPARC T5	16	8	256	256 GB
Sun Fire X2270 M2 (3x)	Load Generation	2x 2.93 GHz Xeon 5670	6	1	12	96 GB

Software Configuration

The SPARC T4-2 runs Oracle Solaris 11 and the SPARC T4-1 system runs the Oracle Solaris 10 latest update. Load generation is done from Faban on multiple x86-based servers, directing load to the Oracle Fusion Middleware components (Oracle WebLogic Server, under which is running the Oracle SOA Suite components) are installed on the SPARC T4-2 system as shown in the Figure above; the Oracle Database is installed on the SPARC T4-1B server, with direct-attached disk array. The table below lists the software versions used in these tests.

TABLE 3. SOFTWARE VERSIONS USED IN TEST

Component	Version
Oracle WebLogic	10.3.6
Oracle SOA Suite	11.1.1.6 (PS5)
Oracle Service Bus	11.1.1.6 (PS5)
Sun HotSpot JVM	JDK7
Oracle Database Server	11.2.0.3

For the T5-2 testing, all systems run the Solaris 11 latest update. Load generation is still performed by the same x86 servers as before, running the Faban test harness. The T5 testing utilizes the **same** software versions as what is stated above for the T4 testing.

Partitioning Using Oracle VM Server for SPARC

All SPARC T-Series servers have several means for virtualization of the operating environments. One way, called *Oracle Solaris Zones*, uses kernel-level virtualization to house multiple operating systems, all managed by the same kernel. The use of Oracle VM Server for SPARC domains (formerly called Logical Domains, or LDOMs) is the other way to virtualize Oracle Solaris on these servers. The domains do not share the same kernel, and they use a combination of on-processor hardware support (hypervisor), as well as software, to create completely separated Oracle Solaris environments that have the added benefit of being able to independently own and control specific server hardware I/O slots. **Oracle VM Server for SPARC was the method chosen for all tests described in this paper.**

The SPARC T4-2 server has a total of 128 CPU strands (16 cores) while the T5 server has double the processor capabilities, at 256 CPU strands (32 cores). To isolate the BPEL and Oracle Service Bus test environments on a single system, domains were used to partition the system into multiple virtual environments. This not only isolates the environment but also makes it easy to allocate resources such as CPU and memory to each domain.

The terms *Primary* and *Guest* in reference to Oracle VM Server for SPARC domains merely talk about the originating domain, allocating server resources. In both test cases ¾ of the server was dedicated to BPEL / Fusion Order Demo, and ¼ of the server was dedicated to Oracle Service Bus (OSB) testing. At different times those tests were running concurrently, and by themselves. The following table provides the details of the domain configuration:

TABLE 4. LDOMS CONFIGURATION FOR BOTH TEST RUNS (SPARC T4 ANDF SPRAC T5)

SERVER PLATFORM	DOMAIN	SOFTWARE DEPLOYED	CPU STRANDS	MEMORY ASSIGNED
T4	Primary	Oracle WebLogic Server, Oracle SOA Suite BPEL	96	96 GB
T4	Guest	Oracle WebLogic Server, Oracle SOA Suite, Oracle Service Bus	32	32 GB

T5	Primary	Oracle WebLogic Server, Oracle SOA Suite BPEL	192	192GB
T5	Guest	Oracle WebLogic Server, Oracle SOA Suite, Oracle Service Bus	64	64GB

Two sets of tests were run separately as well as concurrently. The tests that were run are described below:

1. BPEL / Fusion Order Demo running alone
2. BPEL / Fusion Order Demo running in one domain while Oracle Service Bus was running in another domain
3. Oracle Service Bus tests running alone

Generalized Performance Data

For all of the testing that was performed on the Oracle SOA Suite software, specific concern was given to profiling performance deltas from older SPARC T-Series servers, compared to the SPARC T4 and SPARC T5-based servers. Due to slower clock speeds on the SPARC T2, T2+, and T3 platforms, Oracle SOA Suite performance for some workloads was decreased due to the serial nature in which Oracle SOA Suite classes were loaded, and the reliance on single-thread performance for processor clock operations. The SPARC T4 and SPARC T5 processor incorporates a significantly faster clock than previous SPARC T-Series processors:

TABLE 5 SPARC T-SERIES PROCESSOR SPEEDS

SERVER	CLOCK SPEED
SPARC T2	1.2 GHz
SPARC T2+	1.6 GHz
SPARC T3	1.67 GHz
SPARC T4	2.8 GHz (3.0 GHz in the SPARC T4-4)
SPARC T5	3.6 GHz

The faster processors in the SPARC T4 and SPARC T5 family allow for performance in all SOA uses that Oracle engineering has seen to be acceptable, with no performance degradations in any use case.

Performance deltas between older SPARC T-Series servers generally show a generalized 3x improvement moving to a T4 based system, and 25% improvement on top of that for T5-based systems with double the concurrency due to the doubling of compute resources:

TABLE 6 STARTUP TIMES FOR SOA ON SPARC

Server	Startup Time	Delta
SPARC T3	~15 minutes	3x slower than SPARC T4
SPARC T4	4.75 minutes	At parity with Intel 5600-class processors
SPARC T5	25% time improvement	25% faster, core to core than Intel 5600-class processors with 2.5x higher core count

The above startup times describe the SOA Admin server loading 24K classes, the SOA Server itself loading 49.7K classes. Both the SPARC and Intel servers had the same effective number of cores/threads for this testing, and all tests were performed on the same software platform of Oracle Solaris 11 with the HotSpot JVM.

Oracle SOA engineering also created a workload based on a specific large customer workload. The SOA infrastructure tested the time it took to run the "Import" and "Activate" functions of Oracle Service Bus. The

results are also shown below to help illustrate the performance delta between SPARC T3 servers and SPARC T4 servers:

Oracle Service Bus Function	SPARC T3 (8cores, 256GB mem, Oracle Solaris 10)	SPARC T4* (8 Cores, 128GB mem, Oracle Solaris 11)
Import	1x	4.1x
Activate	1x	2.2x

**SPARC T5 was not tested in this scenario as this tested referred to specific customer tests, but the SPARC T5 server has a 25% faster clock speed, which in all other tests, resulted in 25% performance gains across the board. This guidance should apply here as well, though was not tested.*

The Import and Activate functions for which these deltas were determined were run with this configuration

- 2762 XML Schemas
- 305 XQueries
- 82 XSLT's
- 1MFL File
- 125 Proxy Services
- 166 Business Services
- 4 split-joins

As a general statement, while performance for some workloads was slower than other workloads on the SPARC T3-based servers, there was no workload that Oracle engineering tested that performed slowly on the SPARC T4-based servers.

Additionally, performance, core for core, was generally equal between Intel 5600-series processor cores and SPARC T4 cores with another 25% increase in performance (at double the concurrency) on the SPARC T5 servers due to the increased clock speed, and the higher-resourced processor design.

Performance Tuning Methods

Using the test applications and driver described above, the scalability tests were performed by injecting load from the Faban test driver into the SOA server. The user load was then increased until the CPU cycles were saturated.

The tests were done by applying various tunings to different components in the test configuration to obtain the best possible throughput, and the details of the tuning are listed below. Tuning parameters for the Oracle Service Bus-specific tests are detailed in the sections entitled "Oracle Service Bus", while the tuning parameters for the Fusion Order Demo / BPEL testing are labeled by "BPEL" titles.

BPEL Performance Tuning

Tuning parameters for the BPEL workflow are shown below:

TABLE 7 SOA BPEL / FOD INFRASTRUCTURE PARAMETERS

SOA Infrastructure Parameter	Old Value	New Value		Component
		T4	T5	
DispatcherEngineThreads	30	300	350	BPEL
DispatcherInvokeThreads	20	250	300	BPEL
DispatcherSystemThreads	2	30	30	BPEL
MaxNumberOfInvokeMessagesInCache	100000	2500000	2500000	BPEL

DispatcherMaxRequestDepth	600	1000	1000	BPEL
AuditLevel	Inherit	Off	Off	SOA-INFRA
LargeDocumentThreshold	100000	10240000	10240000	BPEL

Oracle WebLogic Server settings for T4:

```
-Xms32768m -Xmx32768m -Xmn16384m -Xss256k -XX:PermSize=768m -
XX:MaxPermSize=768m -XX:SurvivorRatio=9 -XX:TargetSurvivorRatio=90 -
XX:+AggressiveOpts -XX:+UseParallelOldGC -Xnoclassgc -
XX:ParallelGCThreads=64  -XX:ReservedCodeCacheSize=128m -
XX:CICompilerCount=8 -XX:+AlwaysPreTouch -XX:+PrintReferenceGC -
XX:+ParallelRefProcEnabled -XX:MaxTenuringThreshold=15 -XX:-
UseAdaptiveSizePolicy -XX:+PrintAdaptiveSizePolicy  -XX:+DisableExplicitGC
-Dweblogic.threadpool.MinPoolSize=200 -
Dweblogic.threadpool.MaxPoolSize=200
```

Oracle WebLogic Server settings for T5:

```
-Xms48g -Xmx48g -Xmn16384m -Xss256k -XX:PermSize=768m -XX:MaxPermSize=768m
-XX:SurvivorRatio=9 -XX:TargetSurvivorRatio=90 -XX:+AggressiveOpts -
XX:+UseParallelOldGC -Xnoclassgc -XX:ParallelGCThreads=64  -
XX:ReservedCodeCacheSize=128m -XX:CICompilerCount=8 -XX:+AlwaysPreTouch -
XX:+PrintReferenceGC -XX:+ParallelRefProcEnabled -
XX:MaxTenuringThreshold=15 -XX:-UseAdaptiveSizePolicy -
XX:+PrintAdaptiveSizePolicy  -XX:+DisableExplicitGC -
Dweblogic.threadpool.MinPoolSize=300 -Dweblogic.threadpool.MaxPoolSize=300
```

BPEL Oracle Database Tuning

1) SOA FOD Schemas

Due to bottleneck during heavy load, hash partition indexes were created for the following tables:
`BRDECISIONINSTANCE, DLV_MESSAGE, REFERENCE_INSTANCE, XML_DOCUMENT, COMPOSITE_INSTANCE, DOCUMENT_DLV_MSG_REF, HEADERS_PROPERTIES, CUBE_INSTANCE, CUBE_SCOPE, BRDECISIONUNITOFWORK`

Below is an example of a hash partition index creation:

```
CREATE INDEX "DEVSOL_SOAINFRA"."BRDECISIONINSTANCE_INDX1" ON
"DEVSOL_SOAINFRA"."BRDECISIONINSTANCE" ("COMPOSITE_NAME", "REVISION",
"COMPONENT_NAME", "APPLICATION_NAME", "LABEL")

GLOBAL PARTITION BY HASH (COMPOSITE_NAME) PARTITIONS 64 REVERSE

PCTFREE 30 INITRANS 255 MAXTRANS 255 NOLOGGING PARALLEL 64 TABLESPACE
DEVSOL_SOAINFRA;
```

2) Oracle Database Undo and Redo logs

A) Add three additional undo log files of size 32GB each

B) Use two redo logs of size 32GB each

3) Oracle Database parameters

TABLE 8 ORACLE DATABASE PARAMETERS FOR FOD / BPEL

Parameter	Setting
db_writer_processes	8
db_block_size	8192
sga_target	48G
shared_pool_size	2G
db_files	1024
open_cursors	5000
processes	2700
sessions	2975
transactions	3273

BPEL JDK Tuning

```
-server –Xms16384m –Xmx16384m –XX:MaxPermSize=512m
```

BPEL WebLogic Tuning

```
-Djava.net.preferIPv4Stack=TRUE -Dweblogic.threadpool.MinPoolSize=32 -
Dweblogic.threadpool.MaxPoolSize=32 -Dweblogic.SocketReaders=8 -
Dweblogic.MuxerClass=weblogic.socket.NIOSocketMuxer -
Dweblogic.ProductionModeEnabled=TRUE
```

Oracle Service Bus Performance Tuning

The following descriptions describe the optimal tuning settings for the Oracle Service Bus-centric testing.

JVM tuning:

```
-Xms16g –Xmx16g -XX:MaxPermSize=512m
```

Oracle WebLogic Server tuning:

```
–Djava.net.preferIPv4Stack=true MuxerClass=weblogic.socket.NIOSocketMuxer
-Dweblogic.threadpool.MinPoolSize=32 -Dweblogic.threadpool.MaxPoolSize=32
-Dweblogic.SocketReaders=8 -Dweblogic.ProductionModeEnabled=TRUE
```

Oracle Service Bus Oracle Database Tuning

No specific Oracle Database Tuning needed.

Oracle Service Bus Tuning

No special Oracle Service Bus tuning needed.

B2B Performance Tuning

JVM tuning:

```
USER_MEM_ARGS="-d64 -Xms8192m -Xmx8192m -Xss256k -XX:PermSize=768m -
XX:MaxPermSize=768m"

JAVA_OPTIONS="-Dfile.encoding=UTF8 -XX:+HeapDumpOnOutOfMemoryError -
XX:HeapDumpPath=/var/tmp/emerson/jvm -verbose:gc -
Xloggc:/var/tmp/emerson/soagc.log -XX:ReservedCodeCacheSize=128m -
XX:SurvivorRatio=9 -XX:TargetSurvivorRatio=90 -XX:+UseParallelGC -
XX:ParallelGCThreads=20 -XX:+UseParallelOldGC -XX:+ParallelRefProcEnabled
-XX:+AggressiveOpts -XX:NewRatio=2 -XX:+PrintTenuringDistribution -
XX:+PrintGCDetails -XX:+PrintGCTimeStamps -XX:CICompilerCount=8 -XX:-
UseBiasedLocking -XX:+AlwaysPreTouch -XX:-UseAdaptiveSizePolicy -
Dweblogic.threadpool.MinPoolSize=50"
```

B2B Database tuning

1. Move B2B_DATA_STORAGE to 16k block size tablespace
2. Partition B2B_CONTROL_NUMBER table and B2B_DATA_STORAGE_PK index
3. Oracle Database Undo and Redo logs

   A) Add three additional undo log files of size 32GB each

   B) Use two redo logs of size 32GB each

4. B2B Oracle Database parameters:

TABLE 9 B2B DATABASE TUNING PARAMETERS

DB Settings	Current Value
processes	1000
memory_target	8724152320
audit_trail	NONE
open_cursors	3000
nls_sort	
filesystemio_options	none
disk_asynch_io	TRUE
db_files	200
db_recovery_file_dest_size	0
fast_start_mttr_target	0
log_checkpoints_to_alert	FALSE
sec_case_sensitive_logon	TRUE
cursor_space_for_time	FALSE
session_cached_cursors	50
plsql_code_type	INTERPRETED
job_queue_processes	1000

session_max_open_files	10
trace_enabled	TRUE
sessions	1105
shared_pool_size	2617245696
java_pool_size	671088640
db_16k_cache_size	134217728
shared_servers	600
Auto Stats Collection Client	ENABLED

Conclusion

Extensive testing of both Oracle Service Bus and Oracle B2B as well as the larger use case for the Fusion Order Demo / BPEL was performed by Oracle hardware and software engineering. As a general statement, the SPARC T4 and SPARC T5 servers are recommended for all SOA workloads, with good all-around performance for everything that was tested, including cryptographic performance both inside of the SOA infrastructure as well as SSL connections over the network. The increase in clock speed on the SPARC T4 and SPARC T5 servers allows all Oracle SOA Suite workloads to perform in a solid and competitive fashion and form a platform upon which to run any SOA application, equaling and exceeding, Intel 5600-series processor performance, core to core.

When deploying middleware solutions, you can also take advantage of Oracle Optimized Solutions. These fully documented, pretested, and tuned architectures take the guesswork out of deploying enterprise software infrastructures. Each solution is based on uniquely matched components including engineered systems, servers and storage, operating system, database, middleware, and applications, and tuned for optimal performance and availability. To learn more, visit http://www.oracle.com/optimizedsolutions.

If knowledge of specific numbers found in this BPEL / SOA testing would be useful to know, please engage with your local Oracle SOA technical sales representative, and they will be able to share with you specific numbers for SOA performance on the SPARC T4 and SPARC T5-based servers under a nondisclosure agreement.

Links and Further Resources

Oracle SOA Suite: http://www.oracle.com/us/technologies/soa/index.html
Oracle Optimized Solutions: http://www.oracle.com/optimizedsolutions
FABAN Test Harness: http://java.net/projects/faban/

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