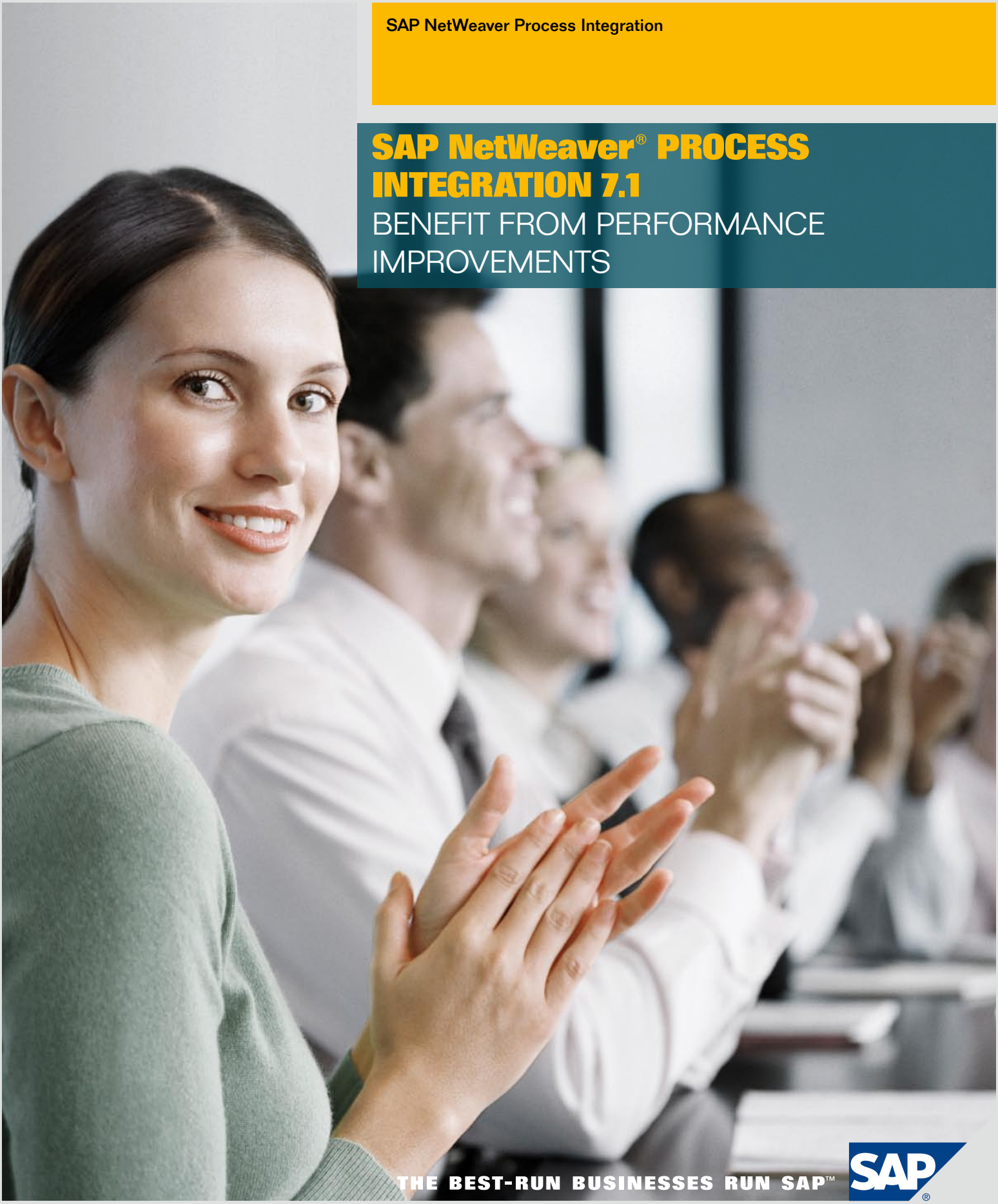
SAP NetWeaver Process Integration

SAP NetWeaver® PROCESS INTEGRATION 7.1

BENEFIT FROM PERFORMANCE IMPROVEMENTS



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EXECUTIVE SUMMARY

TESTING THE BENEFITS OF SAP NetWeaver® PROCESS INTEGRATION

Over 3,000 organizations are using the SAP NetWeaver® Process Integration (SAP NetWeaver PI) offering as their enterprise-class, service-oriented architecture (SOA) middleware to perform application-to-application and business-to-business (B2B) integration and accelerate composite application development. SAP NetWeaver PI includes:

- Enterprise Services Repository (ES Repository) to build, model, and manage Web services
- A high-volume enterprise services bus that supports distributed integration
- Principal propagation for trusted communication and for helping ensure compliance
- B2B integration functionalities
- Support for predefined integration scenarios and adapters to jump-start integration projects

The performance of the enterprise services bus of SAP NetWeaver PI is specifically tuned for a high-volume, reliable exchange of information across distributed business applications. The functionality helps optimize process performance on the basis of real-world process scenarios required for enterprise resource planning, supports high-volume transactions, enables distributed integration versus broker-based integration, and provides local processing including mapping and routing. Performance features such as message packaging, parallel queue processing, and transaction handling at the transport and process levels further help accelerate the performance of distributed end points for high-throughput message processing.

Since becoming generally available, SAP NetWeaver PI 7.1 has seen a rapid growth in the number of companies going live with the offering and enjoying its features. This release includes functionalities for helping improve performance and reduce hardware requirements to lower the total cost of ownership (TCO) significantly. For example, you can now process messages locally in the Java stack by using the advanced adapter engine, which gains a performance improvement up to a factor of 10. Message-packaging functionality allows you to bundle small messages for achieving optimal resource utilization, leading to higher throughput up to a factor of 3.

We conducted a performance test using SAP enhancement package 1 for SAP NetWeaver PI 7.1, which complements some of the performance-relevant functionalities delivered with the 7.1 release. For example, you can benefit from **typical customer integration use cases** such as SOA scenarios, batch data transfers, and cross-component business process management (ccBPM). These have been tested with real-world applications such as the SAP® ERP application for sending or receiving data. We tested the scenarios under stress-level conditions with high loads in terms of number of messages.

For the test landscape, we chose a **medium-sized hardware environment** (with 10 CPUs and 47 GB of RAM), which corresponds to common sizing of customer installations. We set up a **standard software system installation** on a single host. You can achieve higher throughput rates than listed in this document by running multiple installations of the technology with a load balancer (horizontal scaling).[1]

The results demonstrate that SAP NetWeaver PI is an enterprise-ready, scalable, SOA middleware solution for high-volume scenarios. The performance test results show that SAP NetWeaver PI 7.1 with SAP enhancement package 1 can **process 325 small messages per second and beyond** (or calculated to 28 million messages per day) by utilizing some of the performance-enhancing features. This is helpful if speed is a crucial factor for your business. If throughput is more important, the test results showed that you can process 23.57 MB per second with SAP NetWeaver PI, or a calculated **daily throughput of more than 1,988 GB.**

This test is a follow-up of a performance test that we conducted in 2007 for the previous release: SAP NetWeaver PI 7.0.[2] We reused most of the test scenarios of the earlier test. Note that the results of both tests cannot be compared one-to-one because, for instance, we used less hardware for the test for release 7.1 (about 50% less hardware)[3] for simulating a common customer environment.

SAP NetWeaver PI 7.1 has the following performance-relevant functionalities. For details on how to use these functionalities, please consult online help from SAP at http://help.sap.com.

Advanced Adapter Engine

SAP NetWeaver PI 7.1 (support package stack [SPS] 06) features the advanced adapter engine[4] (AAE), and enhancements are provided with SAP enhancement package 1. The AAE supports message processing without invoking the integration engine of SAP NetWeaver PI residing in the application server for ABAP™, if both sender and receiver adapters are located on the same adapter engine. In this case, the messages are processed locally in the Java stack, which leads to a higher message throughput and faster response times due to less resource consumption in memory and CPU. This can lead to an improvement up to a factor of 10, depending on the type of integration situation.

To use the AAE, you must configure the integrated configuration object in the integration directory.

Within the performance test, the following scenarios used the AAE:
- Synchronous SOA scenario
- Asynchronous SOA scenario (with one receiver)
- Asynchronous SOA scenario (with multiple receivers)

Message Packaging for the Integration Engine

As of SAP NetWeaver PI 7.0 (SPS 13), the technology has generic message-packaging functionality.[5] Several messages within a message queue are grouped together in packages and are processed within one logical unit of work (LUW). If many small messages are bundled using the message-packaging functionality, you can increase the throughput because you can conduct some processing steps only once rather than multiple times. You can achieve throughput gains of up to three times that of nonpackaging, depending on the type of integration scenario. Semantically, each package contains individual, unrelated messages that are saved to the database individually and shown in the message monitoring as single messages. You can use message packaging for several types of asynchronous integration scenarios, such as for information documents (IDocs), ccBPM, and so on.

Within the performance test, the following scenarios used message packaging:
- Batch data transfer scenario
- Service orchestration scenario using mediated integration processes

Improvements to the Business Process Engine

In addition to the packaging functionality of the integration engine, SAP NetWeaver PI provides a similar mechanism[6] for the business process engine. This helps improve performance by delivering multiple messages to instances in the business process engine in one transaction, leading to increased message throughput. The extent of the throughput improvement that you can obtain depends on the type of scenario. The collection pattern scenario as used for the performance test for the business process engine is particularly suitable for message packaging. This packaging functionality is available as of SAP NetWeaver PI 7.0 (SPS 13) or SAP NetWeaver PI 7.1 (SPS 4).

The SAP NetWeaver 2004 (SPS 19) technology platform and SAP NetWeaver 7.0 (SPS 10) include options for transaction handling[7] in processes that use ccBPM . This allows the developer to reduce the number of persistency steps for improving the performance. In addition, you can process messages in parallel using multiple queues.[8]

The ccBPM performance features were tested in the scenario for service orchestration using mediated integration processes.

Point-to-Point Connections

In contrast to mediated scenarios, point-to-point connection[9] allows a direct message exchange between a sender and a receiver without involving the central middleware server at runtime. The message processing is optimized because of decentral processing and exploits all the functionalities at design time, at configuration, and for central monitoring.

This feature was not used in the performance test, because the purpose was to test integration scenarios that are mediated at runtime with SAP NetWeaver PI.

SAP offers written information regarding other functionalities that you can use for improving performance (for example, message prioritization, large file handling, and time-controlled message processing) and best practices regarding performance tuning. Consult the following documents:

- SAP NetWeaver How-To Guide "PI Best Practices: Sizing & Performance Tuning"[10]
- "SAP NetWeaver Process Integration Tuning Guide"[11]
- "PI Performance Check"[12]
- "PI Troubleshooting Guide"[13]

These are available on the SAP Service Marketplace extranet.

TEST SETUP AND RESULTS

HOW IT WORKED

For this test, we reused the scenarios of the last performance test for SAP NetWeaver PI 7.0.[14] They simulate real-world integration use cases such as SOA-based scenarios, batch data transfer, and mediated integration processes using ccBPM. Every scenario was tested for at least 10 minutes. While the short-ramp-up phase demonstrated linear resource consumption proportional to the load, the high-load phase checked for stability and reliability over time. Regardless of the high load, the CPUs were utilized in most cases between 70% and 80% in order to ensure stable and robust error-free message processing over the long term. You can find details regarding the hardware and software specification in the appendix of this document.

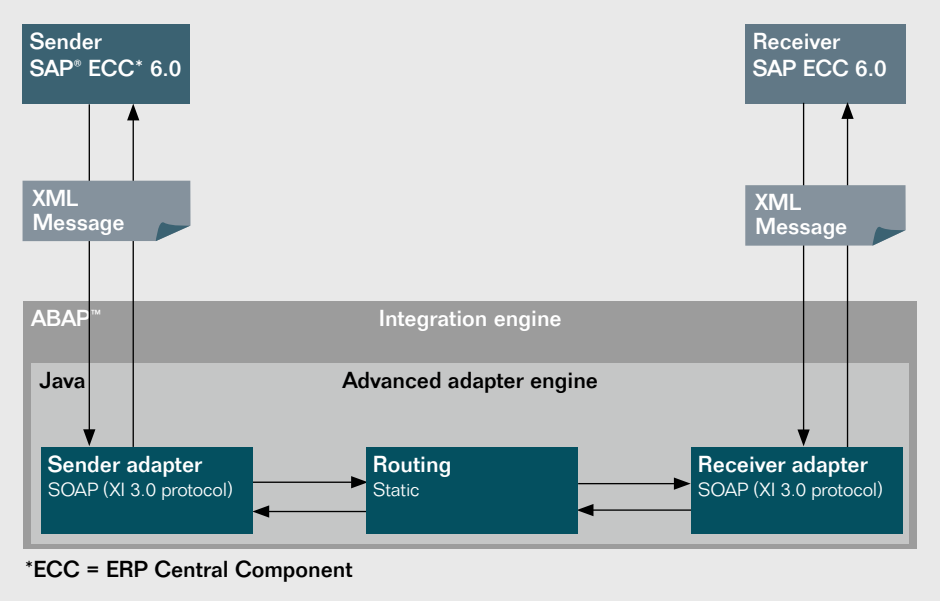

Figure 1: Synchronous SOA Scenario

Synchronous SOA Scenario

A very common use case for SAP NetWeaver PI is the consumption of enterprise services from SAP software or any kind of Web service. In this scenario, an SAP application sends a request to another SAP application, and the message is mediated through SAP NetWeaver PI. Because SAP NetWeaver PI does this, the service providers and their consumers act independent of each other. From a technical perspective, this corresponds to a request and response pattern in synchronous mode. Business examples for this pattern include requesting business partner details and purchase order information. For synchronous scenarios, the main goal of performance improvements is to optimize the message-processing speed, aiming to decrease latency for the request and response cycle (best effort).

The message exchange is mediated through SAP NetWeaver PI using the SOAP adapter. SAP NetWeaver PI determines the message receiver through static routing and transforms the outbound message format into the inbound format needed on the receiver side. You can process these kinds of use cases within the Java stack only by using the AAE.

We performed the test using messages of 1 KB each.

Test Results

We began the test with 10 CPUs and two Java cluster nodes. To test the scaling behavior, we increased the number of CPUs to 16 and increased the number of Java cluster nodes to four. To achieve high throughput for the end-to-end scenario, we scaled the sending and receiving application systems accordingly. With the latter, 325 messages per second were processed in parallel, which corresponds to 28 million messages per day.

Even though the results of the last performance test for SAP NetWeaver PI 7.0 cannot be compared one-to-one with the performance test results for SAP NetWeaver PI 7.1, we can say that significantly less hardware is needed for processing the same amount of messages. With the AAE, you can process messages much faster, which is very important for synchronous integration scenarios requiring fast response times. In addition, this example shows that the message processing increases nearly linearly as more CPUs are added.

Test Results: Synchronous SOA Scenario

		Throughput: Number of Messages per Unit of Time		
Number of CPUs	**Message Size in KB**	**Messages per Second**	**Messages per Hour (Calculated)**	**Messages per Day (Calculated)**
10	1	220	792,000	19,008,000
16	1	325	1,170,000	28,080,000

Asynchronous SOA Scenario (with One Receiver)

We performed a modification of the scenario described in the synchronous SOA scenario, using asynchronous communication and one-way communication. We processed the messages exactly once through message queues, ensuring reliable end-to-end messaging from the sending to the receiving application.

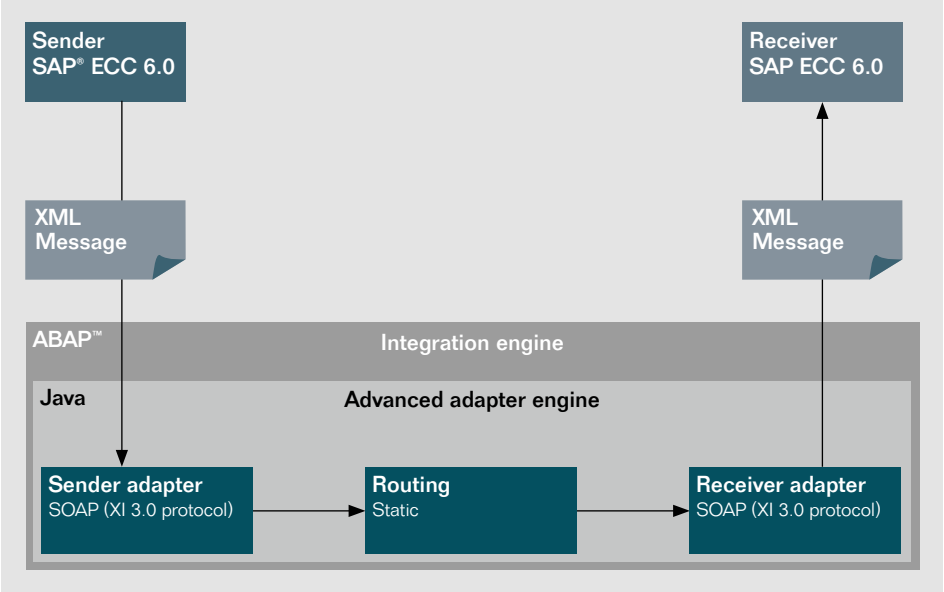

Figure 2: Asynchronous SOA Scenario (with One Receiver)

In real-world situations, you may use this notification pattern mainly for submitting information such as a confirmation for a purchase order. The main goal of performance improvements in asynchronous scenarios is to increase the throughput – that is, the volume of information processed in a determined period of time – which is typically achieved by parallel processing.

In contrast to the synchronous scenario, we tested the asynchronous scenario with 10 CPUs but with different message sizes (9 KB, 113 KB, and 1,097 KB).

Test Results

Even though the total number of messages processed within a specific period of time decreases with the message size used, the total throughput increases in terms of megabytes or gigabytes processed.

The results confirmed the results of other tests conducted regarding the best-performing message sizes for SAP NetWeaver PI (see Figure 3).

For smaller messages, context-switching overhead and header processing cause a loss in performance; for larger messages, performance loss is due to garbage collection by the Java Virtual Machine. Thus, you should carefully calculate the average message size when designing integration scenarios whenever possible in order to optimize the resource consumption in total. To achieve the best-performing message size, you can use message-packaging functionalities for small messages (see the section of this document titled "Batch Data Transfer Scenario") and message-splitting functionalities for large messages (not used in this performance test).

Test Results: Asynchronous SOA Scenario (with One Receiver)

		Throughput: Number of MBs Processed per Unit of Time		
Message Size in KB	**Messages per Second**	**Processed MBs per Second**	**Processed GBs per Hour (Calculated)**	**Processed GBs per Day (Calculated)**
9	260	2.28	8.03	192.81
113	152	16.77	58.97	1,415.26
1,097	22	23.57	82.86	1,988.58

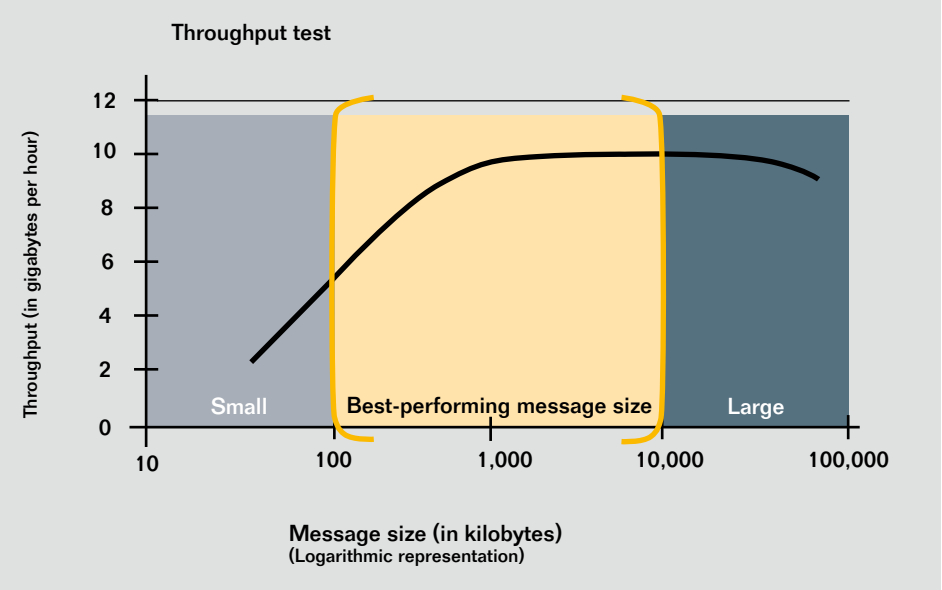

Figure 3: Best-Performing Message Sizes for SAP NetWeaver PI 7.1

Asynchronous SOA Scenario (with Multiple Receivers)

We enhanced the same scenario defined in the asynchronous SOA scenario (with one receiver) with an additional receiver. This simulates a broadcasting pattern (one-to-many communication).

You can use this type of integration scenario for dispatching business documents to multiple receiving applications. When you send messages to more than one receiver, the message needs to be split in SAP NetWeaver PI.

Test Results

The number of messages processed decreases with the message size, similar to the asynchronous SOA scenario with one receiver. However, with the message split in the AAE, you can process more than twice as many messages as you could separately end-to-end per receiver.

Batch Data Transfer Scenario

To transfer batch data with SAP applications, many people still use classical IDoc scenarios. In the batch data transfer scenario, an SAP application sends IDocs as packages through SAP NetWeaver PI to a third-party system as comma-separated files. You can apply this pattern, for example, to replicate master-data information to legacy applications.

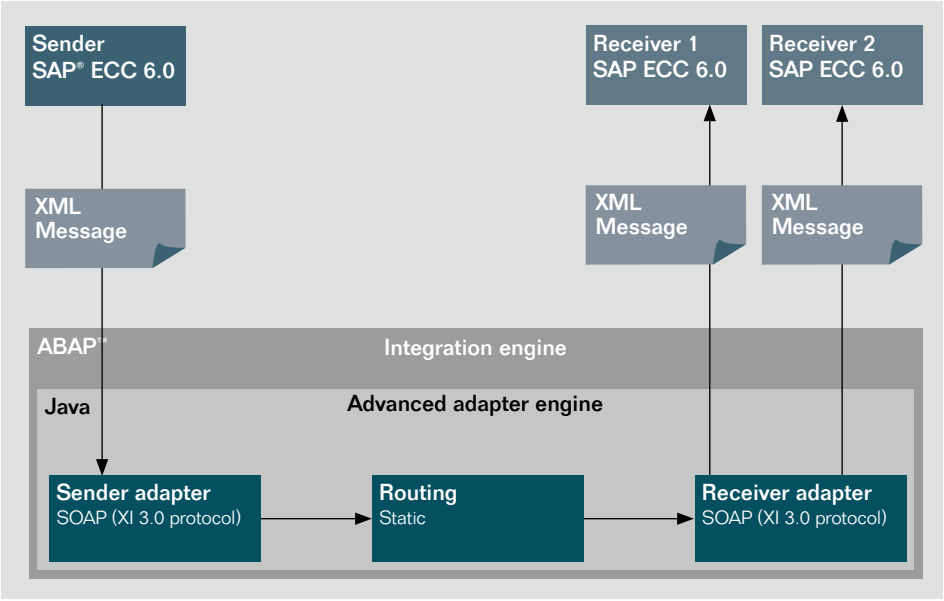

Figure 4: Asynchronous SOA Scenario (with Multiple Receivers)

Test Results: Asynchronous SOA Scenario (with Multiple Receivers)

	Throughput: Number of Messages per Unit of Time	
Message Size in KB	**Messages per Second with One Receiver**	**Messages per Second with Two Receivers**
9	192	2 x 128
113	152	2 x 97
1,097	22	2 x 12

From a technical perspective, IDocs are sent as packages (consisting of 10 IDocs each) from SAP ERP Central Component (SAP ECC) to SAP NetWeaver PI as usual in asynchronous mode through the IDoc inbound adapter. Two test variants were used, as follows.

End-to-end packaging: The inbound IDoc adapter is configured to process IDoc packages that reach the inbound channel of the integration server without splitting the IDocs into single messages (new functionality of SAP enhancement package 1). When receiving an IDoc package, the technology creates one message in IDoc-XML format in SAP NetWeaver PI. Then SAP NetWeaver PI sends this message out through a file adapter that generates from the message a file in comma-separated value (CSV) format, which is then put in the file server.

Single-message processing in SAP NetWeaver PI: The inbound IDoc adapter generates one message in IDoc-XML format per IDoc of the package. Therefore, 10 messages are generated per IDoc package. SAP NetWeaver PI sends every message to an outbound file adapter, which generates one file per message in CSV format. In this case, 10 files are created per initial IDoc package.

In contrast to the SOA scenarios, the messages for the batch data transfer scenario cannot be processed in SAP NetWeaver PI through the AAE, because the IDoc adapter is currently available only in ABAP. However, you can already realize performance improvements with the current release when processing the IDocs end-to-end as packages.

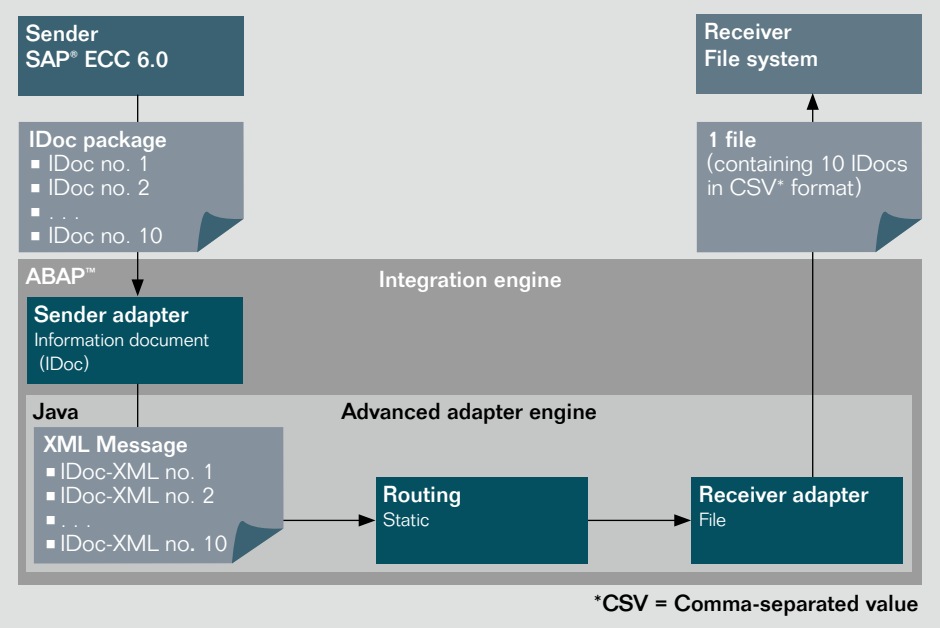

Figure 5: Batch Data Transfer Scenario, End-to-End Packaging

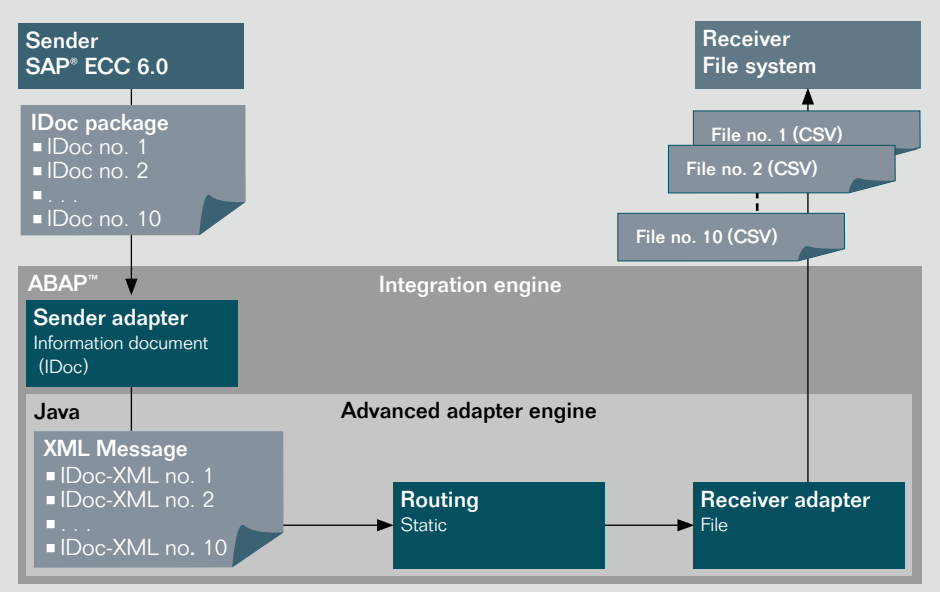

Figure 6: Batch Data Transfer Scenario, Single-Message Processing

Test Results

We performed the test using messages sized 17 KB and 42 KB. The results show that you benefit from end-to-end packaging, especially for small and medium-sized messages: the total number of messages processed per unit of time can be increased by up to a factor of 3. The same improvements apply to the throughput in terms of data volume per unit of time.

Test Results: Batch Data Transfer Scenario

	Number of Message Packages Processed per Second		
Message Package Size in KB	**Single Message Processing Within the Integration Engine**	**With End-to-End Packaging**	**Improvement Factor**
17	102	320	3.14
42	78	160	2.05

Whenever you can process the data on the receiver side as it is generated on the sender side (that is, one IDoc package resulting in one file), use the IDoc packaging functionality for small messages. By doing so, you can shift the actual message size to the best-performing message size range (see Figure 3) to increase the throughput. This is important for asynchronous scenarios with high loads.

Service Orchestration Using Mediated Integration Processes

To test the performance of the business process engine, we chose a collection pattern. A sending application generates a large number of messages that need to be collected up to a predefined limit and handed over in bundles to the receiving application in the same order. You may use this pattern, for example, to transfer lots of small messages from an SAP application to a warehouse application system.

Technically, this is an asynchronous scenario; the sending and receiving applications are integrated using the SOAP adapter. The messages cannot be processed within the Java stack, because the business process engine resides in the application server for ABAP. However, you can achieve performance improvements because many small messages, which semantically belong together, are not processed one by one but are together transferred to, and handled by, the application system. In addition to the message packaging of the integration engine, you can use the message-packaging functionality of the business process engine. You can realize performance gains when using some of the options for transaction handling in integration processes if the business scenario allows you to do so. The same applies for using multiple queues, allowing a parallel processing of messages.

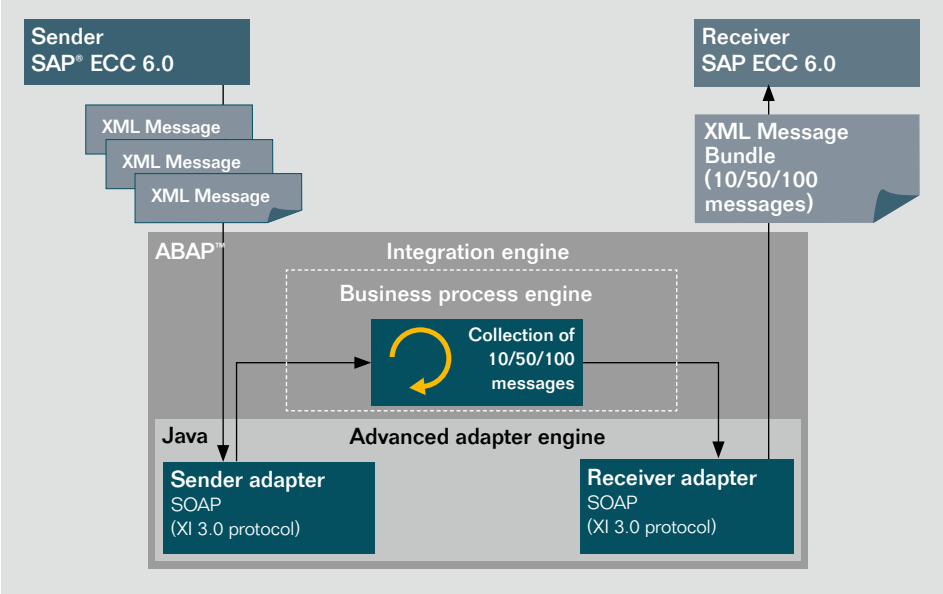

Figure 7: Service Orchestration Using Mediated Integration Processes

For the test, we used message packaging in the integration engine and business process engine, parallel processing, and transaction handling. For transaction handling, we kept the number of persistency steps to a minimum: the messages were persisted once when entering and once when exiting the business process engine. We activated 17 queues for parallel message processing. We configured the business process engine to collect 10, 50, or 100 messages of 10 KB each, which were sent as bundles to the receiving applications.

Test Results

The top table lists the results of the scenario of the service orchestration using mediated integration processes.

With the bundling of messages, you can reduce the message size, because you need only one SOAP header per bundle. When you look at the data volume processed in a certain time frame, the throughput gains with message bundling become much clearer (see table).

The results show similar performance compared with the last test using SAP NetWeaver PI 7.0.[15] For details, see the performance report for SAP NetWeaver PI 7.0. This is because all performance-relevant functionalities were already available for the previous release. Nonetheless, we retested this scenario to ensure completeness.

Test Results: Service Orchestration Scenario with ccBPM

Number of Messages (Bundles) Processed per Hour

ccBPM Collection of 10 Messages		**ccBPM Collection of 50 Messages**		**ccBPM Collection of 100 Messages**	
Number of Messages In	Number of Message Bundles Out	Number of Messages In	Number of Message Bundles Out	Number of Messages In	Number of Message Bundles Out
230,400 with 10 KB each	23,040 with 61.3 KB each	360,000 with 10 KB each	7,200 with 281 KB each	400,000 with 10 KB each	4,000 with 555 KB each

Test Results: Service Orchestration Scenario with ccBPM (Throughput View)

ccBPM Collection of Messages	**Data Volume Processed per Hour (Output)**
10 messages	1.35 GB
50 messages	1.93 GB
100 messages	2.12 GB

SUMMARY AND CONCLUSION

PERFORMANCE TEST RESULTS FOR SAP NetWeaver PI 7.1

The performance test demonstrates that you can realize major performance improvements for SAP NetWeaver PI 7.1 when making use of the performance-relevant functionalities of this release. On medium-sized hardware, you can decrease the overall message-processing time or increase the message throughput for integration scenarios, depending on your specific business requirements. For example, you can:

- Accelerate message processing, using the AAE, up to a factor of 10
- Enable message packaging to lead to higher throughput up to a factor of 3
- Reduce sizing requirements to allow for using medium-sized hardware in high-volume scenarios, reducing overall TCO

In general, the test results affirm that SAP NetWeaver PI is enterprise-ready SOA middleware supporting high-volume scenarios using a standard implementation. However, to benefit from these improvements, you need the following:

- A proper software and hardware set-up (for example, the sizing of the SAP NetWeaver Application Server component and configuration options with SAP NetWeaver PI)[16]
- A proper design, configuration, and implementation of integration scenarios in accordance with the best practices for performance tuning recommended by SAP[17]
- A performance-optimized setup and configuration of related application systems supporting end-to-end performance[18]

The strength of SAP NetWeaver PI regarding high-volume scenarios has been proven in many customer implementations. For examples of customers running high-volume scenarios with SAP NetWeaver PI, read "SOA Middleware – High Volume Scenarios with SAP NetWeaver Process Integration" published on the SAP Developer Network (SDN) site. The document includes some high-volume use cases.[19]

APPENDIX
HARDWARE AND SOFTWARE SPECIFICATIONS

We conducted the performance test in a lab environment using the following hardware setup for SAP NetWeaver PI and the sending and receiving business systems.

Compared with the test for SAP NetWeaver PI 7.0, only approximately 50% of the hardware was used for SAP NetWeaver PI 7.1 (including SAP enhancement package 1) this time. We performed the installation according to "Installation Guide: SAP NetWeaver Process Integration 7.1 including Enhancement Package 1 on AIX: IBM DB2 for Linux, UNIX, and Windows,"[20] as follows.

SAP NetWeaver Process Integration 7.1 (SAP enhancement package 1, SPS 0):

- IBM pSeries 9119-595 with 8 CPUs per LPAR
- Processor: 10 x PowerPC Power 5, scaled up to 16 CPUs for the synchronous SOA scenario
- RAM: 47 GB, scaled up to 68 GB of RAM for the synchronous SOA scenario
- Storage: IBM DB2 database layout, following the installation guide – with the exception of using 8 sapdata directories (15 GB each) instead of 4 (default) – altogether, 140 GB = (8 x 15 + 20) GB
- Operating system: IBM AIX 5.3 patch level 8 (hot-fix level 3)
- Database: IBM DB2 v9.5.0.2

Sending and receiving business system:

- Software: SAP ECC 6.0 (SPS 16)
- IBM pSeries 9119-595 with 8 CPUs per LPAR
- Processor: 8 x PowerPC Power 5
- RAM: 32 GB
- Storage: IBM TotalStorage DS4500 (assigned 500 GB)
- Operating system: IBM AIX 5.3 patch level 8 (hot-fix level 3)
- Database: IBM DB2 v9.5.0.2

Performance measuring:

- Software: The SAP LoadRunner application by HP 8.1.4.0
- Processor: 4 CPUs
- RAM: 8 GB
- Operating system: Microsoft Windows 2003 Server EE

ENDNOTES

1. For details see the master and installation guide for SAP NetWeaver Process Integration (including SAP enhancement package 1) published on the SAP® Service Marketplace extranet (www.service.sap.com/installNWPI71).
2. For details see "End-to-End Process Integration with SAP NetWeaver: A Performance Report" published on SDN (www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/90e5745d-5dbc-2a10-ddb1-b40140a68d02).
3. The application performance standard (APS) unit is a hardware-independent unit of measurement that describes the performance of a system configuration in an SAP software environment. Note that 100 APS units equal 2,000 fully processed order line items per hour. In technical terms, this throughput is achieved by processing 6,000 dialog steps (screen changes), 2,000 postings per hour, or 2,400 transactions in SAP software.
4. For details see online help "Advanced Adapter Engine" (http://help.sap.com/saphelp_nwpi71/helpdata/en/8f/d906d01f77fa40a4c84683c3f8326f/content.htm).
5. For details see online help "Message Packaging" (http://help.sap.com/saphelp_nwpi71/helpdata/en/46/79e8e13872275ae10000000a11466f/frameset.htm).
6. For details see SAP online help "Message Packaging for Integration Processes" (http://help.sap.com/saphelp_nwpi711/helpdata/en/46/7aa65037ca0ed5e10000000a155369/content.htm).
7. For details see SAP online help "Transactional Behavior of an Integration Process" (http://help.sap.com/saphelp_nwpi711/helpdata/en/46/7aa65037ca0ed5e10000000a155369/content.htm),
8. For details see SAP online help "Configuring Queue Assignment for Inbound Processing" (http://help.sap.com/saphelp_nwpi71/helpdata/en/45/1a97be109921a0e10000000a1553f6/content.htm).
9. For details see SAP online help "Configuring Direct Communication" (http://help.sap.com/saphelp_nwpi711/helpdata/en/48/ce5bf1a0d7154ee10000000a421937/content.htm).
10. See www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/2016a0b1-1780-2b10-97bd-be3ac62214c7.
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12. See SAP Notes service, number 894509: "XI Performance Check" on www.service.sap.com/notes.
13. See SAP Notes, number 806546: "XI 3.0/7.0/7.01: XI Troubleshooting Guide" on www.service.sap.com/notes.
14. For details see "End-to-End Process Integration with SAP NetWeaver: A Performance Report" published on SDN (www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/90e5745d-5dbc-2a10-ddb1-b40140a68d02).
15. For details see "End-to-End Process Integration with SAP NetWeaver: A Performance Report" published on SDN (www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/90e5745d-5dbc-2a10-ddb1-b40140a68d02).
16. For details see information provided in the Appendix and available on SAP Service Marketplace (for example, www.service.sap.com/quicksizer and www.service.sap.com/instguides).
17. Best practices are published on SDN at http://sdn.sap.com. For example, read the following how-to guides from SAP: "PI Best Practices: Sizing and Performance Tuning" (www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/2016a0b1-1780-2b10-97bd-be3ac62214c7) and "SAP NetWeaver Process Integration Best Practices: Design" (www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/e0715b1d-68a6-2b10-9f8f-86c5b059cb18).
18. For SAP applications, please check the documentation for the respective solution (http://help.sap.com) and information on SAP Service Marketplace (www.service.sap.com/solutions).
19. For details see www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/00982670-748c-2a10-3985-cdd42fb43e50.
20. For details see www.service.sap.com/~sapidb/011000358700002002962008E.

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