



K2 blackpearl Performance Testing

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This whitepaper details the test scenarios, hardware, and testing results for K2 blackpearl 0807 with the KB000450 update. This whitepaper is an example of potential K2 blackpearl performance and scalability.

INTRODUCTION

K2 blackpearl provides the platform for delivering process-driven applications that improve business efficiency through the use of visual design tools and scalable server components. As an enterprise-class platform, K2 blackpearl caters to numerous installation configurations allowing for great flexibility in hardware and software configurations that will best meet the needs of the customer. The performance data in this document can be used to understand how K2 blackpearl can scale within a high volume environment, and as the basis for measuring the performance of K2 blackpearl in customer environments.

AUDIENCE

This paper is intended for system administrators and operations personnel responsible for the installation and performance of the K2 blackpearl platform installed at their company. The tests and data provided in this paper **are specific to the K2 test environment and will not necessarily reflect expected results in customer environments**. The performance testing methodologies as explained should be used to configure similar tests in your environment to provide baselines that can be used to monitor overall performance, scalability, and health of your K2 servers.

TEST SCENARIO OVERVIEW

Test scenarios were created based on logical and user transaction flows. Then test scripts and data were created and tested to provide a solid foundation for the performance testing. The scenario tests were then loaded and executed.

The purpose of this test scenario was to see how well K2 blackpearl scales within a simulated large organization under heavy load.

For the purposes of this testing, the following user base was created to simulate a large organization:

- 50,000 users within Active Directory
- Each user was a member of 10 different Active Directory groups

Note: *K2 relies heavily upon Active Directory for authentication and authorization and thus it is important to have a large Active Directory structure in place for realistic testing results.*

The following was loaded into the K2 system before the test executed:

- 100,000 active process instances
- 100,000 worklist items assigned to 10,000 different users (10 tasks / user)

Note: *It is important to have large volume of test bed data in place before running a test of this type as it more accurately reflects a real world scenario. Running against a database with little or no transaction data can*

skew the performance to provide an unrealistic view of the results. It is always important to factor in existing data load before executing your tests, as the performance or lack thereof of your SQL server can dramatically alter your test results.

In order to more accurately simulate a diverse workflow environment multiple K2 process definitions were used. The key workflow design factors that were modeled differently in order to understand their impact on load were:

Destination user

Within K2, the users assigned a task are referred to as destination users. K2 has the ability to assign tasks in many different ways. In this testing, different scenarios assigned tasks to individual users, Active Directory groups, and K2 Roles. This allowed the test to determine if there was a significant difference in the task interaction based upon how the task was assigned.

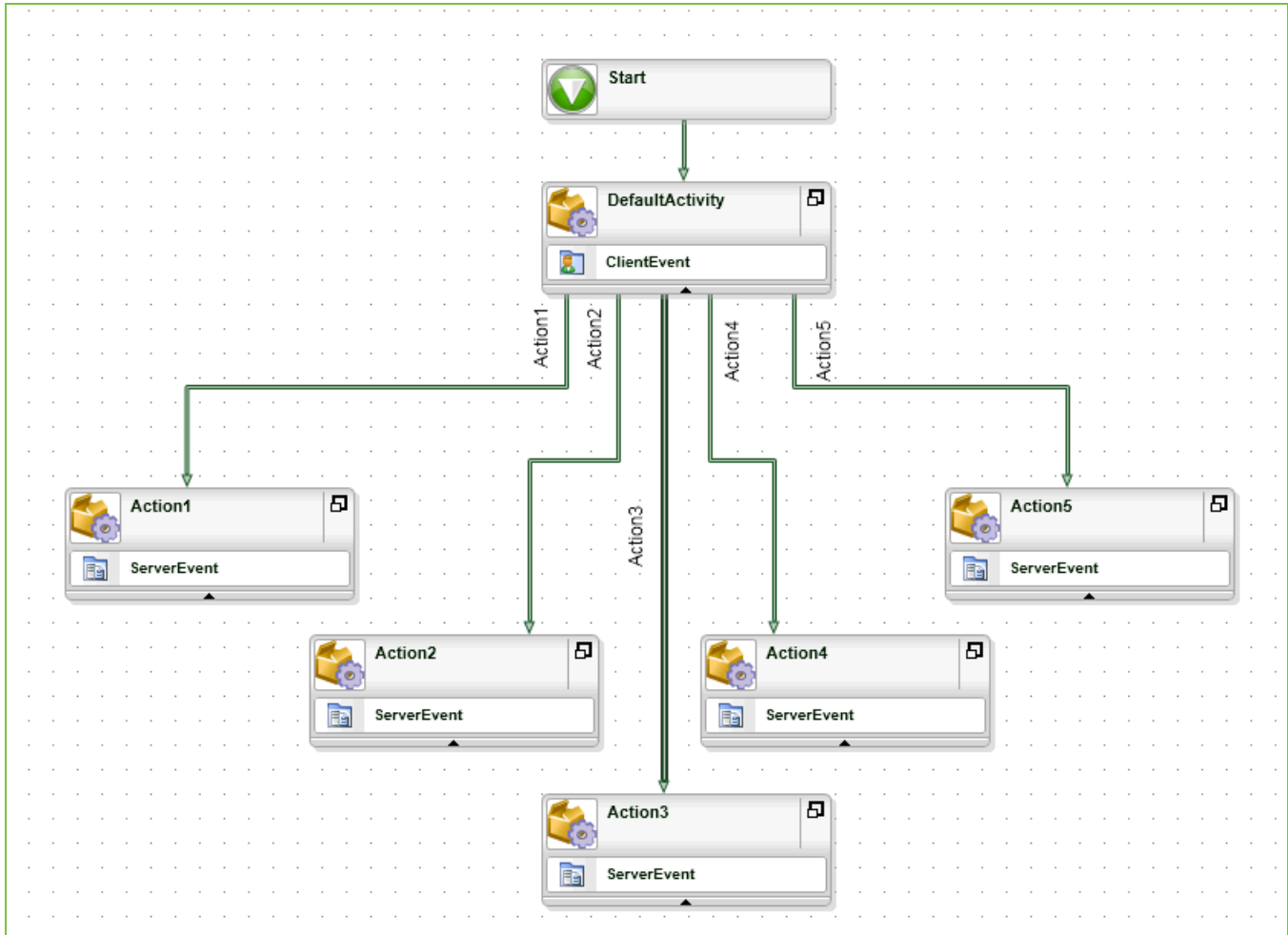
Number of actions

Each task in K2 has at least one decision point that is surfaced to the destination users. This decision point is called an *action*. These task actions translate to more data in the K2 transaction databases. The testing covered both single action and multiple action tasks to better simulate real-world processing.

With these process design factors, six individual K2 processes were created:

1. Single User Destination, Single Action
2. Group Destination, Single Action
3. Role Destination, Single Action
4. Single User Destination, Multiple Actions
5. Group Destination, Multiple Actions
6. Role Destination, Multiple Actions

Below is one of the sample processes (Single User Destination, Multiple Actions):



Note: The processes used for these tests do not represent the variety of processes that can be run on a K2 server. Larger, more complex processes may require more resources from the K2 server and supporting technologies. It is recommended that you run tests on your processes in your environment to accurately determine your specific performance thresholds.

Multiple test scripts were then created, one for each of the above mentioned six process definitions. Each script executed the below functionality within a single user context:

- Select a random user
- Query his worklist for the desired process
- Select a random work item
- Select a random action and finish the work item (and process)
- Start a new process to replace the one completed

The other parameters of the test run were:

- Continuous load, ramping up from 0 – 300 users, each executing the above test scenario
- Test duration was 60 minutes

K2 TEST HARDWARE DESCRIPTIONS

The test machines in the K2 test bed were dedicated to performance testing and did not host applications other than K2 blackpearl or SQL Server. Additionally, the test bed ran in a standalone network domain separate from the corporate network and domain.

The table below shows the machines that comprised the K2 test platform. CPU (cores), memory and important software configuration information is provided for each machine:

| Machine Role | # of Cores | Memory | Configuration |
|------------------|------------|--------|------------------------------------------------------------------------------------------------------------------|
| K2 Server Node 1 | 8 | 16 GB | <ul style="list-style-type: none"> Windows Server 2008 SP2 64 bit K2 blackpearl 807.3 |
| K2 Server Node 2 | 8 | 16 GB | <ul style="list-style-type: none"> Windows Server 2008 SP2 64 bit K2 blackpearl 807.3 |
| K2 Server Node 3 | 8 | 16 GB | <ul style="list-style-type: none"> Windows Server 2008 SP2 64 bit K2 blackpearl 807.3 |
| K2Server Node 4 | 8 | 16 GB | <ul style="list-style-type: none"> Windows Server 2008 SP2 64 bit K2 blackpearl 807.3 |
| SQL Server | 8 | 16 GB | <ul style="list-style-type: none"> Windows Server 2008 SP2 64 bit SQL Server 2008 |
| Test Controller | 2 | 4 GB | <ul style="list-style-type: none"> Visual Studio 2008 Test Suite 1 GB network connection |

For those servers that are load balanced (the four K2 Server Nodes), a Cisco load balancing device was utilized.

TESTING TOOLS USED

To facilitate automated testing the Visual Studio Team System 2008 Test Edition was used. Test scripts were created using the automated test tool for performing K2 blackpearl specific actions such as:

- Retrieving a user's worklist
- Actioning a worklist item
- Starting a process instance

PERFORMANCE TESTING OF THE K2 BLACKPEARL APPLICATION

Results of key tests are provided below. Actual performance on your network may vary from these results due to differences in network configuration, number of users, process design options, line of business systems integration, and other topology and application structure differences. These numbers should be used as a reference point and do not replace real-world solution testing. For more information about performance monitoring



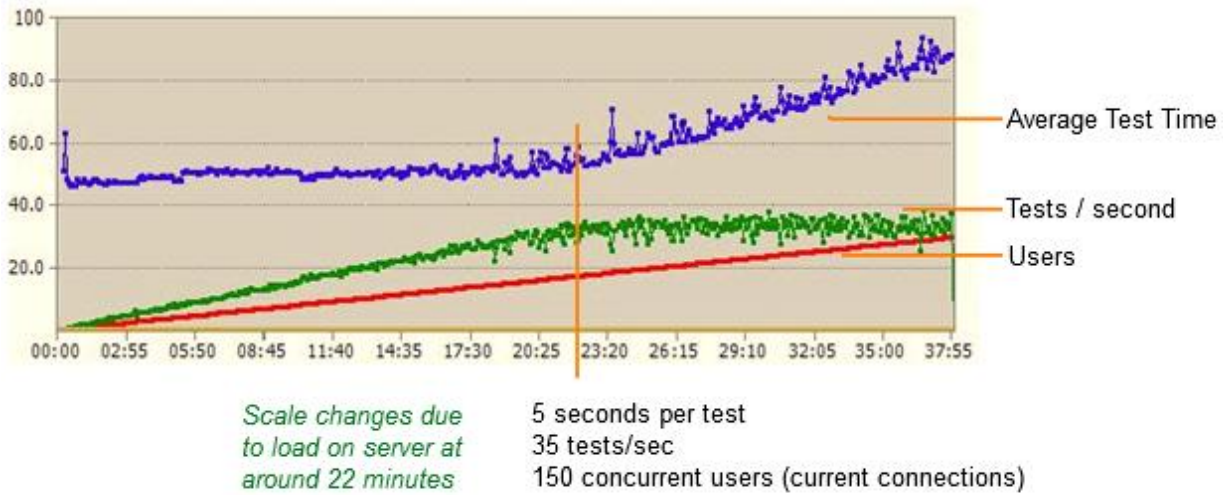
in a K2 environment, see the whitepaper associated with the K2 Knowledge Base article [KB000297 - Monitoring the K2 blackpearl Environment](#). K2 portal access is required to view this and all KB articles.

CPU Utilization

| Machine | Min (%) | Max (%) | Avg (%) |
|------------------|---------|---------|---------|
| K2 Server Node 1 | 0.0013 | 53.9 | 24.3 |
| K2 Server Node 2 | 0.00064 | 46.8 | 20.9 |
| K2 Server Node 3 | 0.0013 | 40.6 | 19.9 |
| K2 Server Node 4 | 0.0013 | 46.6 | 23.6 |
| SQL Server | 1.89 | 27.9 | 14.2 |

Test Response Time

| Test | Min (seconds) | Max (seconds) | Avg (seconds) |
|-------------------------------------------------------------|---------------|---------------|---------------|
| 1. Single user destination, single action, start process, | 1.12 | 72.1 | 16.4 |
| 2. Group destination, single action, start process | 1.06 | 71.6 | 16.1 |
| 3. Role destination, single action, start process | 1.08 | 74.1 | 16.5 |
| 4. Single user destination, multiple actions, start process | 1.07 | 72.4 | 16.4 |
| 5. Group destination, multiple actions, start process | 1.12 | 76.9 | 16.2 |
| 6. Role destination, multiple actions, start process | 1.05 | 67.6 | 16.4 |



EXTRAPOLATING THE RESULTS

This test above shows that, on average, 35 tests per second can be executed.

In order to understand a theoretical maximum user load on this environment the following criteria were used:

- **Number of worklist items finished by each user per day: 5**
- **Number of new workflow instances created by each user each day: 5**
- **Duration of working day: 7 hours (25,200 seconds)**

Calculations (Estimates)

- 25,200 seconds per working day / 5 worklist items per user per day = **5,040 seconds (84 minutes) between work item interaction for a user.**
- 5,040 seconds * 35 test per second = **176,400 potential users**

The calculation behind the potential user load is based upon the fact that the average user for this targeted scenario will finish an item every 5,040 seconds (5 items per 7 hour workday, or 1 every 84 minutes). This scenario supports 35 distinct *user* transactions per second, with a single user performing a single transaction every 5,040 seconds. Extrapolating this data to a scenario where the system carries a full load every second of every workday, 176,400 potential users could be supported on this hardware. As with any estimation, this figure does not account for spikes and lulls in user activity, and as mentioned above, does not take into account the variety of processes that can be built and deployed on the K2 platform.

The number of tests per second, 35, are users interacting with an ASP.NET-based system that has a total of 150 connections available in a connection pool. It is important to note that the system is not performing 35 *transactions* per second with 176,400 connections, but rather the concurrent connection count is kept at a maximum of 150, which can, in theory, support this number of users spread throughout a workday.

Important: *These numbers should be used as a guide to estimating potential user load based on your particular hardware, the complexity and variety of your processes, the number of integration points with line of business (LOB) software, whether user interactions are spread evenly throughout the day or if there are spikes in user activity, and the other scenarios in which you are using K2 blackpearl that may affect overall performance of the system.*

SUMMARY

K2 blackpearl provides a highly-scalable platform for building and executing process-driven applications. Performance characteristics are based on many factors, including hardware configurations, software configurations, network load and bandwidth, user client hardware, user usage profiles (such as process originator vs. process participant, SmartObject single item vs. multiple item listings, single report vs. all reports, and other factors). Mapping the data presented in this document as it pertains to the hardware and software configurations on your company's network is the first place to start when inferring the results listed here to your environment. The next step is to do testing and monitoring in a staged environment that closely resembles your production environment, and then to do further targeted test in areas of concern in your production environment to accurately measure current conditions and forecast changes to the factors that may affect performance of your process-driven applications.

FOR MORE INFORMATION

Refer to the K2 blackpearl Getting Started Guide for additional information regarding prerequisites and the various K2 components. If you wish to monitor performance within your K2 environment, use the whitepaper included with the K2 Knowledgebase article [KB000297 - Monitoring the K2 blackpearl Environment](#) as a guide, and establish performance baselines for the underlying technology and Windows components that the K2 platform is built upon. The whitepaper contains guidance on what Performance Monitor (Perfmon) counters to monitor for the K2 platform and other technologies that K2 depends on for optimal performance. K2 portal access is required to view this and all KB articles.

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APPENDIX A: HIGH VOLUME K2 BLACKPEARL CUSTOMER ENVIRONMENT PROFILE

| | |
|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Solution Overview: | Review and approval of scanned documents. |
| Number of new workflow instances created in a typical day: | 12,150 |
| Number of workflow tasks generated in a typical day: | 36,600 |
| Number of workflow tasks completed in a typical day: | 36,600 |
| Total number of users that access the system in a typical day: | 74* |
| Number of concurrent users at peak usage period of the day: | 40* |
| Number of K2 servers and specifications: | <p>4 server farm.</p> <p>Each node:</p> <ul style="list-style-type: none"> • HP dual processor • Quad core (2.3 Ghz) blade servers • 16 GB RAM |
| SQL Server configuration: | <p>SQL Server 2005, 2-node cluster</p> <p>Each node:</p> <ul style="list-style-type: none"> • HP DL580 • Quad processor, Quad core • 20 GB RAM per node |

* This customer utilizes service accounts to automate the completion of a number of tasks; thus reducing the number of actual people involved in the processes.