SAP Mobile Platform

SAP® Mobile Platform

Cloud Performance and Scalability

The Best-Run Businesses Run SAP™

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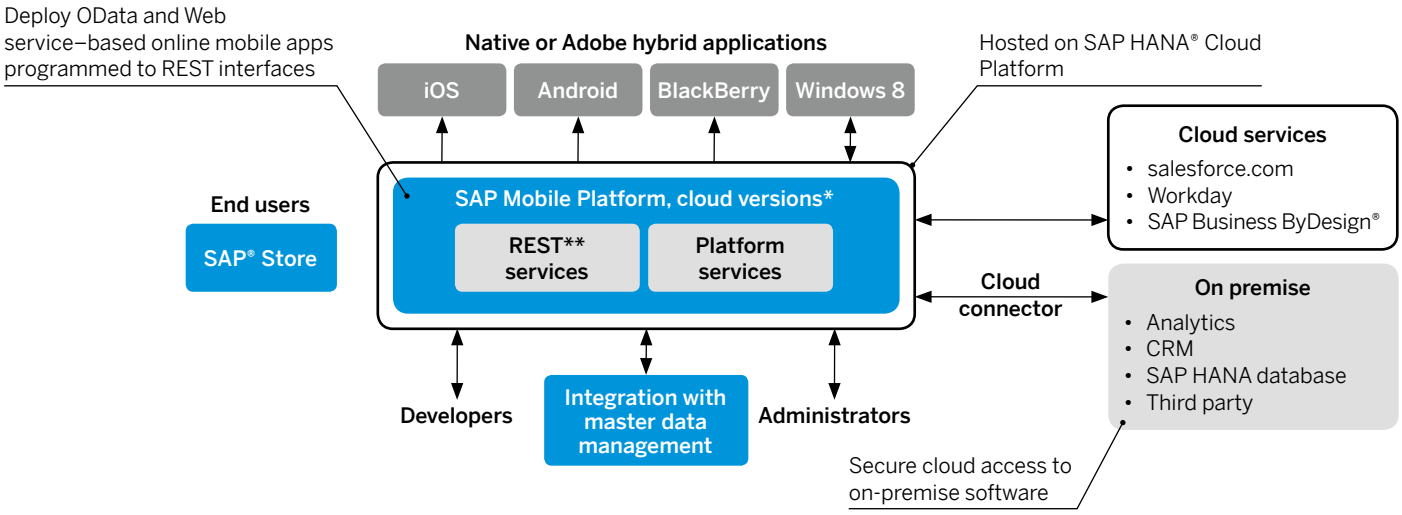
Consumers have flocked to mobile devices like smartphones and tablets for a core set of reasons: they offer greater productivity, easy access to entertainment, and person-to-person engagement through social media. As consumers bring their devices to work, or use them to stay productive while on the go, the bring-your-own-device (BYOD) trend is in full force. Many corporations realize the value in BYOD, and they are providing access to back-end systems to serve the enterprise and the customer.

By leveraging an existing mobile application development platform from a partner you trust, you can focus on your application's user interface, data model, and business logic and leverage the platform services to realize enterprise mobility. SAP® Mobile Platform is **the** mobile application development platform for the enterprise. And with its support for cloud-based services, the burden on you and your IT staff is significantly reduced.

The cloud versions of the enterprise and consumer editions of SAP Mobile Platform offer mobile as a service (MaaS), unique support provided in an existing, secure, cloud environment. MaaS saves you time and money because you don't need to build, deploy, or support mobile services for each mobile application you build (see Figure 1).

The cloud versions of the mobile platform provide the same core mobile services as the on-premise versions but without your having to host them. The overarching question is, how do the cloud versions perform and scale? This paper addresses that question and its related concerns.

Figure 1: Cloud Versions of SAP® Mobile Platform



* For both enterprise and consumer editions of SAP Mobile Platform
** Representational State Transfer software architecture

Performance Test Configurations

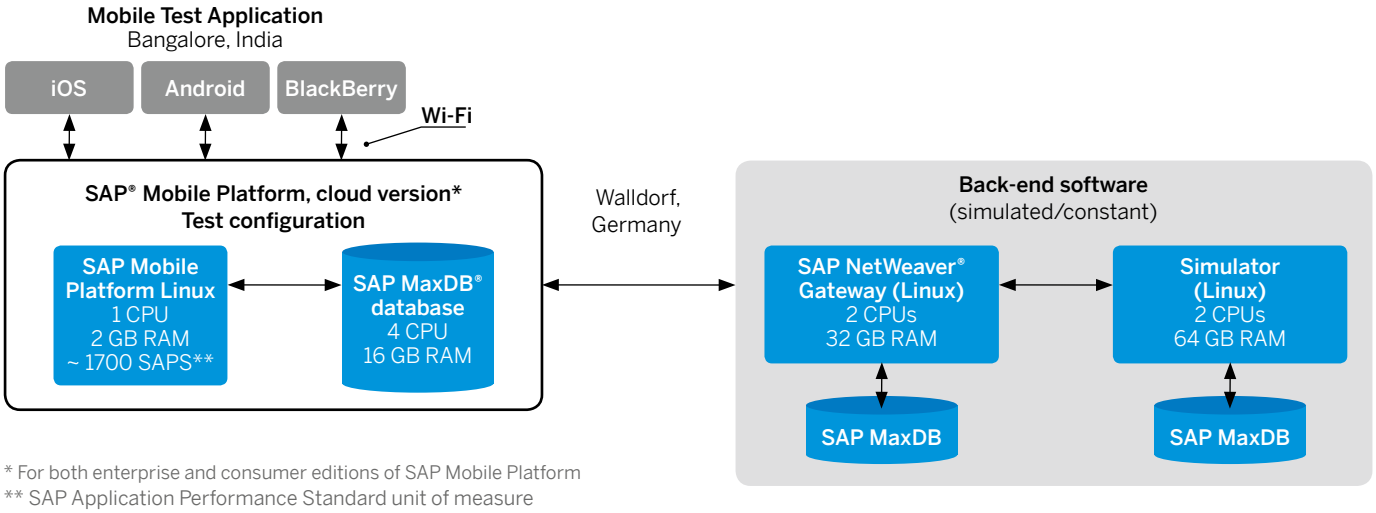
The cloud versions of SAP Mobile Platform eliminate the need to purchase, provision, deploy, and manage your own servers to support your growing mobile users. SAP HANA® Cloud Platform (read more about SAP HANA software here) provides the security and scalability needed to host your mobile services in the cloud safely and reliably. To ensure that performance and scalability are maintained for all mobile users, SAP built a distributed test framework (see Figure 2) and test procedures to measure and report the results in a real-life environment.

The entire cloud and simulated customer back-end software environments were hosted and executed in Walldorf, Germany. In that configuration, summarized in the table "Cloud and Database Configuration," SAP Mobile Platform ran on a single cloud virtual machine (VM). (For a review of standard application benchmarks used at SAP, please see www.sap.com/campaigns/benchmark/index.epx.) The typical VM production configuration for the cloud versions of the mobile platform includes 8 CPUs with 16 gigabytes of RAM. The VM connects to a database server with 4 CPUs and 16 gigabytes of RAM running the SAP MaxDB® database (http://maxdb.sap.com).

Cloud and Database Configuration

Platform	Cloud Configuration	SAP® MaxDB® Database
Hardware	One cloud compute unit "lite"; 2 gigabytes of RAM	One cloud compute unit "lite"; 16 gigabytes of RAM
OS	Linux	Linux
Location	Walldorf, Germany	Walldorf, Germany

Figure 2: Test Environment Configuration



* For both enterprise and consumer editions of SAP Mobile Platform
** SAP Application Performance Standard unit of measure

SAP NetWeaver® Gateway technology for SAP Mobile Platform, summarized in the table "Gateway and Database Configuration," is executed on a server running the Linux OS with dual 3.07 GHz Intel Xeon CPUs (24 cores total) and 32 gigabytes of RAM, connected to an SAP MaxDB database running on the same server. The customer back-end systems, also summarized in the table, are executed on a server running the Linux OS, connected to an SAP MaxDB database running on the same machine. The goal was to simulate all back-end customer transactions and execute them with constant time. This focuses the performance and scalability measurements solely on the cloud infrastructure for the mobile platform.

Gateway and Database Configuration

Platform	SAP NetWeaver® Gateway	SAP® Business Suite
Hardware	Dual 3.07 GHz Intel Xeon, 24 cores total, 32 gigabytes of RAM	Dual 2.13 GHz Intel Xeon, 16 cores total, 64 gigabytes of RAM
OS	Linux	Linux
Location	Walldorf, Germany	Walldorf, Germany

HP LoadRunner software is an automated performance and test automation package used to generate actual application load and then measure its resulting performance. HP LoadRunner can simulate potentially thousands of users generating application load concurrently, and then measure the effects on key application components such as Web servers, application servers, and databases. Performance data is gathered and recorded over time as a predefined ramp-up period of concurrent users and system load is generated. This pattern gives additional insight into exactly how increased load affects the system incrementally. HP LoadRunner was used to generate the concurrent multiuser test loads for many of the results presented in this paper. Details regarding user count and ramp-up are described with the tests.

Mobile tests were executed with a mobile test application running on an iPhone 4S running iOS 5.1, a Samsung Galaxy SIII running Android 4.0.4 (Ice Cream Sandwich), and a BlackBerry Bold 9900 running BlackBerry OS 7.0, each from Bangalore, India, over a Wi-Fi network. The detailed technical specifications are summarized in the table "Mobile Devices Used for All Test Results."

Mobile Devices Used for All Test Results

Mobile Platform	Apple iOS	Google Android	BlackBerry
Device	iPhone 4S	Samsung Galaxy SIII	Bold 9900
Hardware Specifications	Dual core, 800 MHz, 512 megabytes of RAM	Quad core, 1.4 GHz, 1 gigabyte of RAM	Single core 1.2 GHz, 768 megabytes of RAM
OS	iOS 5.1	Android 4.0.4 (Ice Cream Sandwich)	BBOS v7.0
Device Location	Bangalore, India	Bangalore, India	Bangalore, India

Let's look at the test plans and scenarios executed in detail before diving into the results.

By introducing the cloud versions of SAP Mobile Platform, there is **no longer any need to provision, deploy, and manage your own servers** to support your growing mobile users.

THE TEST PLANS

The scenarios used to test the performance and scale of SAP Mobile Platform were:

- **Push notification test** – Measure the amount of time required to generate and produce a push notification to the device from SAP Mobile Platform.
- **Single-user test** – Measure the end-to-end user experience for each of the three devices (iPhone, Samsung Galaxy SIII, and Bold 9900) against SAP Mobile Platform with the SAP ERP application serving as the back-end software without any other load on the system. This includes user login tests as well as push notification processing tests per device.
- **Multiuser test** – Measure system load introduced by many simultaneous users executing common transactions at the same time. The number of concurrent users is increased over time.
- **Mixed-scenario test** – While the multiuser test is executing, run and measure the single-user test to understand an individual user's experience with the cloud versions of SAP Mobile Platform and the back-end software under concurrent user load.

All the tests involved actual user authentication as would be used in a production enterprise mobile application, with single sign-on (SSO) and encryption. The test plan from there included common create, read, update, and delete (CRUD) operations, along with tests to download and upload large attachments. The individual test details are:

- **Perform user onboarding and authentication** – Perform SSO and user authentication
- **Retrieve a collection of records** – Request and retrieve 290 uncompressed records (approximately 300 kilobytes) and then deliver them to the mobile device in compressed form (10 kilobytes)
- **Create record** – Create a new record (584 bytes)
- **Get record detail** – Make a request for an individual record (584 bytes)
- **Update record** – Update an existing record (584 bytes)
- **Delete record** – Delete the request to update or change an existing record
- **Upload** – Send an attachment of approximately 112 kilobytes
- **Download** – Request and receive an attachment of approximately 112 kilobytes

When the single-user test is executed, each individual test operation is executed in sequence. Individual CRUD operation transaction times are then measured and recorded. For the multiuser tests, there is a ramp-up period where users are logged in and tests begin once every 10 seconds. This continues until 500 users are logged in and executing test transactions simultaneously. This ramp-up is executed by an HP LoadRunner instance running on a dedicated server. The server VM for SAP Mobile Platform and simulated gateway and back-end performance are measured as the user count hits 100, 200, 300, 400, and 500. The results of this specific test plan are described in the next section.

Finally, while the multiuser test plan is ramping up to 500 users, the single-user test plan is executed with transactions measured and recorded. The goal of this hybrid test is to measure the throughput of a loaded VM for the mobile platform. Let's take a closer look at the results of all three tests.

Performance Test Results

Three tests were designed to measure single-user performance, multiuser scalability, and overall throughput of a single VM for SAP Mobile Platform in an actual deployment. With SAP ERP serving as the back-end software and devices executing tests in a geographically remote location, the performance results are focused almost solely on the server of the cloud versions of SAP Mobile Platform. The portion of the total time spent processing on the device itself (parsing XML) is broken out for each test, as this varies according to each device's capacity. Let's begin with a detailed look at the single-user tests and results.

SINGLE-USER TEST RESULTS

As described earlier, the single-user tests measure the end-to-end user experience for each of the devices (iPhone, Samsung Galaxy SIII, and Bold 9900) against the mobile platform and ERP back-end software without any other load on the system. This includes user login tests and push notification processing tests per device. Additional noticed delays are due to device connection initiation time and network transmission times between Walldorf, Germany, and Bangalore, India.

User Onboarding and Login Tests

Let's look first at the individual user onboarding and authentication test results for each of the device types (see the table "User Onboarding and Login Performance Results"). All test results are averages of up to 10 iterations of the user login and authentication process initiated from the device for SAP Mobile Platform.

User Onboarding and Login Performance Results

	Cloud Time for SAP® Mobile Platform	Delay from Authorization Server	End-to-End Total Time
Android (with basic authentication)	137 ms*	39 ms	549 ms
iOS (with single sign-on)	184 ms	39 ms	841 ms
BlackBerry	95 ms	39 ms	2746 ms

* milliseconds

Push Notification Processing Tests

On average, the time taken for processing push notifications inside a VM of SAP Mobile Platform from an Android device is about 52 milliseconds. Similarly, from an iOS device, the processing time is about 79 milliseconds on average (see the table "Push Notification Processing Test Results").

Push Notification Processing Test Results

Push Notification Processing Test	Total Time (Average of 10 Iterations)
Android	52 ms*
iOS	79 ms

* milliseconds

Single-User Transaction Tests
Next, let's examine the results [see the table "Single-User Test Results for iOS and SAP Mobile Platform (Cloud Versions)"] from the single-user CRUD transaction tests. We'll begin with a look at the results of these tests executed from an iOS device against the test configuration described earlier.

In this test configuration, the criteria were met: each operation was completed within 1500 milliseconds, and the component process time of SAP Mobile Platform consisted of 15% of that total time. The notable exception was the large upload and download times for attachments. This is viewed as a network throughput limitation at this time.

Single-User Test Results for iOS and SAP® Mobile Platform (Cloud Versions)

iOS Single-User Test	Device Time	Network Time	Cloud Time for SAP® Mobile Platform	Back-End Time	End-to-End Total Time
Collection list (GET – 10 Kb)	227 ms*	590 ms	101 ms	187 ms	1105 ms
Retrieve record (GET – 584 bytes)	36 ms	313 ms	46 ms	58 ms	453 ms
Update record (PUT – 584 bytes)	<10 ms	312 ms (device and client **or** device and network)	86 ms	61 ms	459 ms
Create record (POST – 584 bytes)	<10 ms	332 ms	85 ms	61 ms	478 ms
Delete record (PUT)	<10 ms	259 ms	39 ms	51 ms	349 ms
Upload attachment (114,594 bytes)	<10 ms	271 ms	949 ms	85 ms	1305 ms
Download attachment (114,594 bytes)	<10 ms	394 ms	841 ms	73 ms	1308 ms

* milliseconds

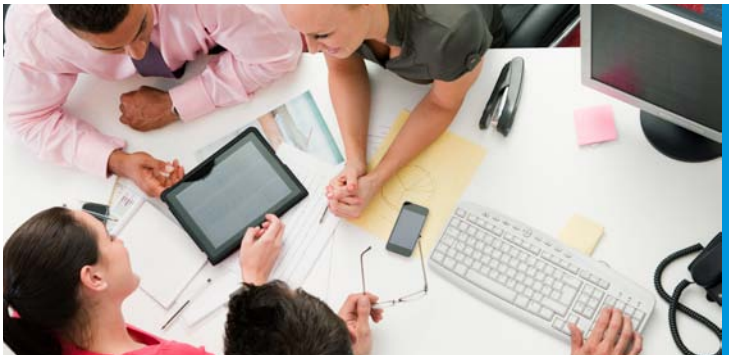
Let's compare the same test results on an Android device with the identical configuration for SAP Mobile Platform and the back-end configuration [see the table "Single-User Test Results for Android and SAP Mobile Platform (Cloud Versions)"].

As with the iOS results, the single-user test results met the 1500 millisecond end-to-end times for all operations from an Android device. Similarly, due to common network limitations for SAP Mobile Platform, the large upload and download times for attachments did not meet our key performance indicator (KPI) consisting of 15% of the end-to-end time. However, this time frame is not currently viewed as a limitation or a performance or scalability issue, as it's likely related to bandwidth.

Single-User Test Results for Android and SAP® Mobile Platform (Cloud Versions)

Android Single-User Test	Device Time	Network Time	Cloud Time for SAP® Mobile Platform	Back-End Time	End-to-End Total Time
Collection list (GET – 10 Kb)	320 ms*	376 ms	84 ms	162 ms	942 ms
Retrieve record (GET – 584 bytes)	<10 ms	348 ms	50 ms	74 ms	476 ms
Update record (PUT – 584 bytes)	<10 ms	375 ms	64 ms	59 ms	498 ms
Create record (POST – 584 bytes)	<10 ms	382 ms	53 ms	70 ms	505 ms
Delete record (PUT)	<10ms	362 ms	55 ms	54 ms	471 ms
Upload attachment (114,594 bytes)	<10 ms	354 ms	698 ms	89 ms	1141 ms
Download attachment (114,594 bytes)	<10 ms	419 ms	791 ms	63 ms	1273 ms

* milliseconds



For the multiuser tests, there is a ramp-up period where **users are logged in and tests begin once every 10 seconds.** This continues until 500 users are logged in and executing test transactions simultaneously.

Finally, let's examine the results for the same tests run with the BlackBerry device, with the identical configuration for SAP Mobile Platform and the back-end configuration [see the table "Single-User Test Results with a BlackBerry Device and SAP Mobile Platform (Cloud Versions)"].

Unlike with iOS and Android devices, the performance numbers for the BlackBerry miss their threshold of 2500-millisecond end-to-end times most of the time. These numbers, including processing time for SAP Mobile Platform, miss their targets due to the BlackBerry device's poor on-device processing as well as network stream processing.

Single-User Test Results with a BlackBerry Device and SAP® Mobile Platform (Cloud Versions)

BlackBerry Single-User Test	Device Time	Network Time	Cloud Time for SAP® Mobile Platform	Back-End Time	End-to-End Total Time
Collection list (GET – 10 Kb)	2379 ms*	2572 ms	57 ms	114 ms	5122 ms
Retrieve record (GET – 584 bytes)	41 ms	1921 ms	31 ms	53 ms	2046 ms
Update record (PUT – 584 bytes)	<10 ms	2270 ms	32 ms	56 ms	2538 ms
Create record (POST – 584 bytes)	<10 ms	2989 ms	35 ms	57 ms	3081 ms
Delete record (PUT)	<10 ms	1834 ms	31 ms	49 ms	1914 ms
Upload attachment (114,594 bytes)	<10 ms	1957 ms	1853 ms	82 ms	3892 ms
Download attachment (114,594 bytes)	<10 ms	4957 ms	41 ms	56 ms	5044 ms

* milliseconds

Let's examine the final set of end-to-end performance numbers per device side by side (see the table "Single-User Test Results Summary per Device").

Single-User Test Results Summary per Device

Single-User Test Results per Device	iOS End-to-End Time	Android End-to-End Time	BlackBerry End-to-End Time
User onboarding and login	841 ms*	549 ms	2746 ms
Collection list (GET – 5 Kb)	1105 ms	942 ms	5122 ms
Retrieve record (GET – 584 bytes)	453 ms	476 ms	2046 ms
Update record (PUT – 584 bytes)	459 ms	498 ms	2538 ms
Create record (POST – 584 bytes)	478 ms	505 ms	3081 ms
Delete record (PUT)	349 ms	471 ms	1914 ms
Upload attachment (114,594 bytes)	1305 ms	1141 ms	3892 ms
Download attachment (114,594 bytes)	1308 ms	1273 ms	5044 ms

* milliseconds

Let's take a closer look at the multiuser test results, where scalability for the cloud versions of SAP Mobile Platform is specifically measured.

MULTIUSER TEST RESULTS

The multiuser test plan was designed to test and measure scalability over time with an increasing system load on SAP Mobile Platform. Specifically, as the single-user tests were executed for an increasing number of users over time, measurements were taken for average response time per transaction (CRUD operations, upload, and download), transactions per second, CPU load, memory used per transaction, and network throughput required. (See the table "Performance Results of the Multiuser Test Plan.")

Performance Results of the Multiuser Test Plan

	Multiuser Test		
	100 Users	**200 Users**	**400 Users**
Response time per transaction (milliseconds)	95	107	459
Number of transactions per second	10	20	32
CPU utilization (%)	19	38	82
Memory per transaction (megabytes)	3.38	3.70	4.02
Network throughput (bytes per second)	51,762	103,390	201,024

Figure 3 shows how the throughput of a single cloud unit "lite" VM for SAP Mobile Platform increased as the number of users increased over time. As additional concurrent requests are made across an increasing number of users, the server continues to respond with enough capacity, hence the increase of transactions per second as shown in the chart. When the detailed data for the transactions-per-second measurement is charted (as shown in Figure 3), it becomes evident that the VM of the cloud versions of SAP Mobile Platform reaches a maximum value at around 400 simultaneous users. The official sizing recommendations from SAP for a single cloud VM instance is between 200 and 250 users per VM. These performance tests show that supporting 250 users is well within the capacity of a single VM. Once this value is reached, the cloud will spin up new VMs for the customer in order to support additional user load.

Accordingly, as the detailed data for average response time is charted (Figure 4), response times drop dramatically between 350 and 400 users.

Figure 3: Transactions per Second As Simultaneous Users Execute Transactions

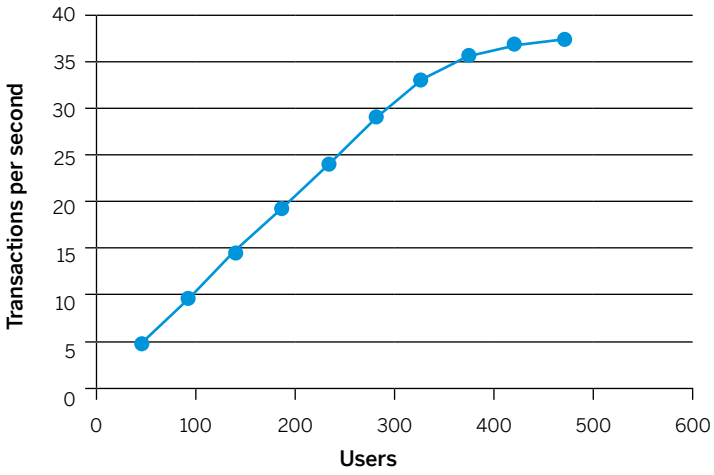
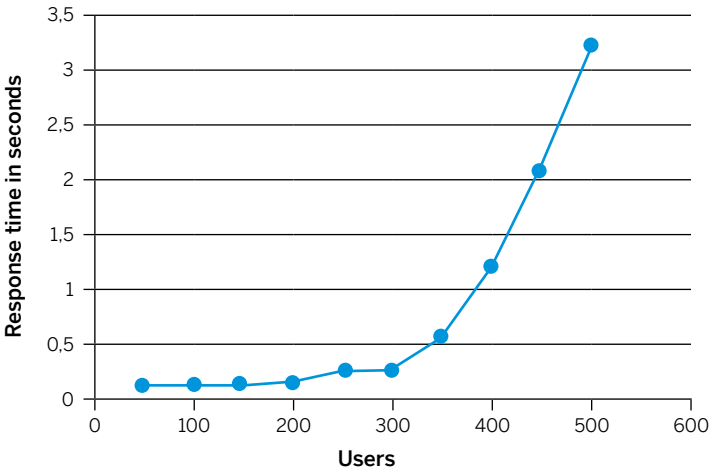


Figure 4: Average Cloud Response Time As Simultaneous Users Execute Transactions



The single-user tests **measure the end-to-end user experience** for each of the devices – for iOS, Android, and BlackBerry – against the mobile platform and ERP back-end software without any other load on the system.

Let's next look at the final test scenario, where the single-user test was executed against a loaded system executing the multiuser test plan.

MIXED-SCENARIO TEST RESULTS

In the mixed-scenario test, the single-user test operations were executed against the VM of the cloud versions of SAP Mobile Platform and the simulated customer back-end system under full load (using the multiuser test plan to generate that load). The results (see the table "Cloud Single-User Test Results on a Loaded System from an Android Device") show an interesting story in terms of the throughput capacity of the cloud versions of SAP Mobile Platform.

Cloud Single-User Test Results on a Loaded System from an Android Device

Mixed-Scenario Test	Device Time	Network Time	Cloud Time for SAP® Mobile Platform	Back-End Time	End-to-End Total Time
Collection list (GET – 10 Kb)	270 ms*	209 ms	81 ms	165 ms	995 ms
Retrieve record (GET – 584 bytes)	2 ms	342 ms	21 ms	55 ms	420 ms
Update record (PUT – 584 bytes)	<10 ms	386 ms	34 ms	60 ms	480 ms
Create record (POST – 584 bytes)	<10 ms	382 ms	23 ms	65 ms	470 ms
Delete record (PUT)	<10 ms	349 ms	75 ms	51 ms	475 ms
Upload attachment (114,594 bytes)	<10 ms	381 ms	702 ms	102 ms	1185 ms
Download attachment (114,594 bytes)	<10 ms	412 ms	725 ms	86 ms	1250 ms

* milliseconds

In these results, isolated measurements for SAP NetWeaver Gateway technology combined times could not be captured, as they would always include the multiuser processing time. However, the important measurement of the processing time of the VM of SAP Mobile Platform, which is the focus of this paper, is included. In particular, the results closely match those of the single-user test executed against the VM of the cloud versions of SAP Mobile Platform when it was not under load (see the table "Comparison of Same Tests for Single User and Mixed Scenario" with the Android results for comparison).

Comparison of Same Tests for Single User and Mixed Scenario

Single-User Test Versus Mixed-Scenario Test Comparison	**Cloud Time for SAP® Mobile Platform** (Single-User Test Case)	**Cloud Time for SAP® Mobile Platform** (Mixed-Scenario Test, 250 Users)
Collection list (GET – 5 Kb)	57 ms*	81 ms
Retrieve record (GET – 584 bytes)	29 ms	21 ms
Update record (PUT – 584 bytes)	28 ms	34 ms
Create record (POST – 584 bytes)	28 ms	23 ms
Delete record (PUT)	27 ms	75 ms
Upload attachment (114,594 bytes)	698 ms	702 ms
Download attachment (114,594 bytes)	791 ms	725 ms

* milliseconds

CONCLUSION AND GUIDELINES

Based on the test results from the various test scenarios, SAP has drawn up a set of observations, as well as guidelines and recommendations, for deploying mobile application services on SAP Mobile Platform.

A single modest VM for the cloud versions of the mobile platform (described in detail previously) performs consistently and reasonably well for a set of common transactions from a large number of concurrent users. This number appears to be between 350 and 400 users per VM in terms of both transactions per second and average response time per transaction. The official sizing recommendation from SAP for a single VM instance for the cloud versions of SAP Mobile Platform is between 200 and 250 users per VM. These performance tests show that supporting 250 users is well within the capacity of a single VM.

Additionally, SAP Mobile Platform provides remarkable throughput even when under heavy load, as single-user transaction times are vastly unaffected by the test's measured load. We hope you draw the same general conclusion that we have, specifically that the deployment of a VM for both the cloud versions of SAP Mobile Platform and SAP NetWeaver Gateway are more than sufficient for handling the needs of your enterprise mobile application rollout and daily usage.

As shown by the test results, SAP offers these guidelines and recommendations when deploying services to SAP Mobile Platform for both the cloud and on-premise versions, with the following recommended configuration:

- The number of users supported per VM for SAP Mobile Platform should be around 250.
- The average response time per VM for SAP Mobile Platform is 25 requests per second.
- Scaling services across additional VMs for SAP Mobile Platform vastly improves and helps to maintain user transaction and request throughput over time and across geographies.

However, when you use SAP HANA Cloud Platform for your applications running on SAP Mobile Platform, you don't need to concern yourself with any of these sizing guidelines. SAP will handle this for you automatically and dynamically. As your application user base grows, SAP will spin up additional VM instances in real time to meet the growing user demand both in terms of user session count as well as overall data throughput. Businesses can put the power of SAP Mobile Platform and SAP HANA Cloud Platform to work.

Additional Resources
For additional information, please visit SAP HANA Cloud and HP LoadRunner.

SAP Mobile Platform provides remarkable throughput even when under heavy load, as single-user transaction times are vastly unaffected by the test's measured load.

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