19

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Mobile App Testing

We all did make the experience that some mobile apps did not work according to our expectations.

It is not only that the app just crashes and you have to start it again. It is more than that. I had some funny situations when I uploaded pictures via an app, and they were doubly displayed, or now seemed to belong to my friends. More interesting is when you do online banking via the app, that's where the fun stops. Mobile app testing has a lot of different facets. We have a lot of very good articles discussing many different aspects of it. I want to thank all the authors for the great articles, and of course all the sponsors that make the magazine possible.

I think that "mobile" app development and testing will become more and more important. Microsoft is now bringing "Surface" to the tablet market, and after seeing the promotion videos – looking very promising – I guess that this will provide the impetus for the whole world to move in a new direction. I wish this for Microsoft, but I also wish it for us, the users. We are moving forward, and this is always positive. Take a second to think back 10 years. How was your mobile and what could you do with it? Stop now for a second and try to imagine what could be possible in 10 years. Knowledge and imagination will take the teams to a new level.

Most of the companies that I know develop mobile apps using agile techniques. The Agile Testing Days in November will cover interesting aspects that can be used in your daily work. Don't miss it. For more information please go to *www.agiletestingdays.com*.

Based on the great success of the Agile Testing Days, we decided to set up the Agile Dev Practices as the conference that also allows agile developers and those who want to a career in agile developing to meet and discuss it. We have set up a great line-up of keynote speakers, tutorials, workshops, etc. Don't miss the conference. Have a look at *www.agiledevpractices.com*.

Last but not least, I want to thank Katrin Schülke for the great job she did over the past years to develop Testing Experience. It was a pleasure to work with her, and I wish her the best for her new career path. Our door is always open for her.

Enjoy reading and have a pleasant time.

José

contents 19/2012

Context-Dependent Testing of Apps

Applications propel the versatility of smartphones and tablet PCs. However, testing apps is a cumbersome task. It is particularly complicated since apps have to cope with frequent changes of the context they run in. Mobile devices move, which leads to changes in the available network connection and varying environmental parameters, such as coordinates derived from a geolocation service. Moreover, patterns of usage change. We propose a novel concept to deal with context changes when testing apps. It is based on basic blocks of code between which context changes are possible and helps testers to manage complexity. Moreover, it supports the maintenance of a suite of test cases that would become much larger if test cases were simply duplicated to deal with different contexts. In addition to the introduction of our concept, we highlight its application and benefits.

66

What Makes a Good Tester?

This article discusses the common personality traits displayed by experienced, successful professional testers to help you understand what makes a good tester, to help you structure your testing team, and for evaluating new possible recruits.

52

Mobile Business Application Testing Automation: A Novel Approach

In this document, we will present the approach of automating mobile business applications testing using emulators and real time devices.

76

From the editor 1

What Makes a Good Tester? 2

Context-Dependent Testing of Apps 2

Mobile App Performance – How to Ensure High-Quality Experiences 6

Roadblocks and their workaround while testing Mobile Applications 8

Main issues in mobile app testing 18

Beyond the Smartphone – Testing for the Developing World 22

Best Practices in Mobile App Testing 26

Mobile Test Strategy 30

Driven Development for the Android platform 34

There's a test for that! 40

Testing on a Real Handset vs. Testing on a Simulator – the big battle 42

What Makes a Good Tester? 52

4E Framework for Mobile Network Variability Testing 56

Enterprise Mobile Testing for Success 60

Mobile App Testing 64

Context-Dependent Testing of Apps 66

Column: Testing Maturity – Where Are We Today? 72

Mobile Business Application Testing Automation: A Novel Approach 76

Masthead 80

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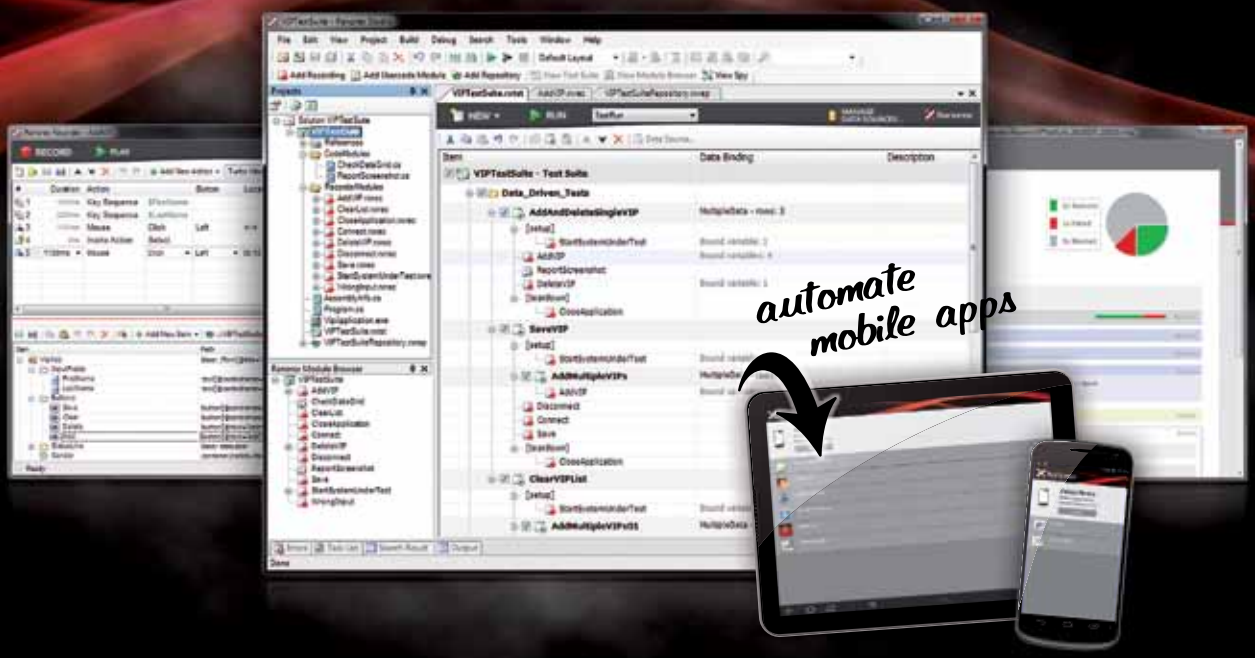

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Editorial Board

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Graham's experience in testing spans more than 30 years and has covered a wide range of domains and technologies. As a test manager he has been responsible for the testing of mission-critical systems in spaceflight, telecommunications and police incident-control. Graham has designed tests to the highest levels of rigour within real-time aerospace systems. As a principal consultant for T-Systems, the systems division of Germany's leading telecommunications company Deutsche Telekom, he has mastered the Quality Improvement Programs of major companies, primarily in the financial and government sectors. In his current position Graham is responsible for the test consulting group. He has built up a training program to include all levels of the ISTQB certification scheme, including the new Expert Level, for the company's large staff of testing professionals. Graham is the chairman of the ISTQB Expert Level Working Party and co-author of both Advanced Level and Expert Level syllabi.

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Andreas leads the Agile Software Factory (ASF) at codecentric. For more than four years, he is a certified Scrum Master. Since then he could contribute his competencies in small and large (> 300 persons), internal and external, or local and global projects as developer, scrum master or product owner. Meanwhile, he's also a Professional Developer Scrum Trainer, conducting a hands-on training for Scrum team members, which codecentric has developed together with scrum.org and in which he shares with joy the knowledge gained in the ASF. More than 15 years ago, his interest in JavaSE/EE awakened, and it never vanished since then. His focus at codecentric is the continuous improvement of the development process in the Agile Software Factory, where technical, organizational and social possibilities are the challenging, external determining factors.

Paul Gerrard

Paul is a consultant, teacher, author, webmaster, programmer, tester, conference speaker, rowing coach and most recently a publisher. He has conducted consulting assignments in all aspects of software testing and quality assurance, specialising in test assurance. He has presented keynote talks and tutorials at testing conferences across Europe, the USA, Australia, South Africa and occasionally won awards for them. Educated at the universities of Oxford and Imperial College London, he is a Principal of Gerrard Consulting Limited and is the host of the UK Test Management Forum.

Mieke Gevers

In the IT industry for more than twenty years, Mieke Gevers has developed a special interest in the techniques and processes relating to performance management and automated testing. Mieke is a regular speaker at conferences and organizations worldwide. She served on the Program Committee for the EuroSTAR conference in 2007 and 2009 and was Program Chair of the Belgium Testing Days 2011 and 2012. A co-founder of the Belgian Testers Organization, Mieke has been a board member of KVIV and the ISTQB-affiliate Belgian Software Testing Qualifications Board.

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57 years old. Specialist in software testing. Independent consultant in software testing and testing improvement matters. Guest lectures at several universities in Norway about Quality Assurance and Software Testing. Public and inhouse seminars in Software Review and Testing in Scandinavian and European countries. Regularly speaking at conferences. Several best paper awards (Best presentation award at CONQUEST 2003, best paper in 2004). Test coordinator, ISEB Certified Tester (Foundation Level), ISTQB Certified Tester (Foundation and Advanced Levels) Chairman of Norwegian Testing Board. Active participant in running museum trains in Norway, certified for safety critical services on steam locomotives. M. Eng. from Technical University of Braunschweig, Germany. Computer science, railway signaling. Development of real time process control software at the Fraunhofer-Institute in Karlsruhe, Germany. Work with Center for Industrial Research in Oslo, Norway. Development of parts of an IDE-tool (Systemator). Later developing test tools and leader of quality improvement program. Consulting and lecturing about software quality.

Yaron Tsubery

Yaron has been working in software since 1990, and has more than 20 years in testing field as a Test Engineer, Testing TL, and Testing Manager. His original profession was Systems Analyst.

Yaron Tsubery is the current CEO and founder of Smartest Technologies Ltd and has been a Director of QA & Testing Manager at Comverse since 2000 until 2010. Yaron was in charge of a large and distributed group that includes Testing Team Leaders and Test Engineers. The group deals with Functional, Non-functional, Load & Performance tests, some of which are done off-shore. The group has much experience in managing and controlling acceptance tests. Yaron is also known as a manager who has built testing groups in his past and also acted as a consultant to testing managers while they were building their testing groups.

Yaron worked in Product Management, Project Management and Development for at least 3 years before becoming a Director of QA & Testing. Yaron has wide experience in banking business processes. For the last 10 years he has implemented best practices in a field where he is in charge of producing complex systems for telecommunication companies such as Vodafone, T-Mobile, NTT DoCoMo, Verizon Wireless etc.; Main systems in Mobile technology: i-mode, Mobile GateWay and Billing Proxy; in System Integration projects: Content Data Management solutions including OSS & BSS sub-systems, Video Solutions, IPTV and IMS.

Yaron is the current President of ISTQB® (International Software Testing Qualifications Board – *www.istqb.org*) and is also the President and founder of the ITCB (Israeli Testing Certification Board – *www.itcb.org.il*). He is a member of IQAMF (Israeli QA Managers Forum) and in SIGiST Israel. Yaron has been invited as a speaker to some important international conferences to lecture on subjects related to testing, as well as he wrote articles that were published in professional magazines.

Erik van Veenendaal

Erik is a leading international consultant and trainer, and a widely recognized expert in the area of software testing and quality management with over 20 years of practical testing experiences. He is the founder of Improve Quality Services BV (www.improveqs.nl) and one of the core developers of the TMap testing methodology and the TMMi test improvement model. Erik is a regular speaker both at national and international testing conferences and holds the EuroSTAR record winning the best tutorial award three times! In 2007 he received the European Testing Excellence Award for his outstanding contribution to the testing profession over the years. He has been working as a test manager and consultant in various domains, including finance, government and embedded software. He has written numerous papers and a number of books, including "Risk-based Testing: The PRISMA Approach", "ISTQB Foundations of Software Testing" and "The Little TMMi". Erik is also a former part-time senior lecturer at the Eindhoven University of Technology, vice-president of the International Software Testing Qualifications Board (2005–2009) and currently vice chair of the TMMi Foundation.
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Klaus Enzenhofer

Mobile App Performance – How to Ensure High-Quality Experiences

The Need for Speed

No matter the technology, one thing's for certain – people always seem to want it faster. According to various surveys three seconds or less is now the threshold most end-users are willing to wait for a web application to load before growing frustrated and going to a competitor. These high expectations have increasingly carried over to the mobile web; and now, mobile apps.

Like the web, today's mobile apps have had their share of performance problems and need some fine-tuning. Recent research shows that 47 percent of mobile users had a problem in the past year when accessing an app on their mobile phone, with slowness and unresponsiveness being the biggest complaint. It's not uncommon for apps to be decried on Apple's App Store as "horribly slow." For Facebook's iPhone application, out of 38,000 reviews, more than 21,000 customers have given the application only a single star. Users repeatedly describe the app as slow, crashes and "is always loading."

"Mobile apps live and die by their ratings in an app store ... when the rating suffers, customer adoption suffers," says Margo Visitacion at Forrester. This may be the reason why 80 percent of branded iPhone, Android and Blackberry applications fail to achieve 1,000 downloads. Poor mobile application performance directly impacts customer acquisition and retention. So what can you do to ensure your mobile app performance is as strong as it can possibly be?

"Get Real" by Capturing Real World Mobile Application Performance

First and foremost, to truly understand mobile application performance, you must measure the performance that your real end-users are experiencing out in the field. Testing on simulators in datacenters can help but it often has little to do with the actual experiences of your real end-users. There are so many performance-impacting variables standing between your data center and your end-users, including the cloud, third-party services/integrations, CDNs, mobile browsers and devices. Measuring what real-users experience is the only way to accurately assess performance across this vast complexity at the edge, and determine a baseline for performance improvements. Measuring the performance that your real users experience allows you to report on mobile application performance across key parameters such as all the geographies, devices and networks that your customers use.

Today, mobile application testing and monitoring using SDKs to instrument native apps is available to give you a quick and easy bird's eye view into mobile application performance across all your customers. Load testing from the end-user perspective is also important, especially before launching an app, and synthetic testing networks allow you to gauge performance levels under various traffic conditions.

Understand the Business Impact of Poor Performance

It is important to identify mobile application performance issues and their impact on conversions: for example, you will notice that an increase in mobile app response times often closely correlates to a decrease in conversions. From there you can conduct triage, i.e., prioritize problem-solving efforts based on considerations such as, which of my customers are impacted and how many of them are there? If a particular geography has a very high traffic share and is having issues, and another has a low traffic share, you know which performance problem you need to address first on your list.

Make Sure that Third-Party Integrations Work

Like web applications, many mobile apps incorporate content from a variety of third-party services with the goal of delivering a richer, more satisfying experience to end-users. An example of this is social media integration, such as Twitter being integrated into Olympics mobile applications. Unfortunately, if you rely on third-party services, you are at the mercy of their performance excellence. Before going live with an app featuring third-party integration, you need to make sure the integration works seamlessly and smoothly, and can deliver the performance that you expect. In addition you need to make sure that you keep an eye on third-party performance and that your app is designed to degrade gracefully in case of third-party problems.

Make Your Mobile App Fast

In the fast-moving world of mobile apps one maxim holds true more than ever – fast is better than slow. There are certain tools and techniques you can apply to make your mobile apps faster, including the following:

- Optimize caching – Keep your application's data off the network altogether. For apps that are content intensive, caching content on the device can boost performance by avoiding excessive trips through the mobile network and your content infrastructure.
- Minimize round-trip times – Consider using a CDN which can provide numerous services that can speed up your app including edge

caching to reduce network latency, network routing optimization, content pre-fetching, and more.

- Minimize payload size – Focus on compression and reduce the size of your data by using whatever compression techniques are available for your content. Be sure that images are sized properly for your most important device segments. Also, make sure you leverage compression. If you have a large piece of content that takes too long to load, then you can load it little by little. Your app can start using the content while it loads rather than waiting for the whole thing to load. Retail apps often use this technique.
- Optimize your native code. Poorly written or bug-filled code can also cause performance problems. Run a profiler on your code or do code reviews to identify potential issues.
- Optimize your back-end services performance – If, after performance testing your app, you identified back-end services as a performance sapping culprit, then you have to conduct an assessment to determine how to speed up those services.

Conclusion

Smartphone users are no exception to the "faster is better" rule, and they expect their apps to be blazingly quick. Every so often, mobile carriers and smartphone manufacturers announce faster networks and faster devices which helps, but unfortunately, the speed of mobile apps has just not kept pace.

A primary reason for this is the set of diametrically opposed goals that make achieving lightning-fast performance difficult. Mobile app developers are consistently expected to provide richer experiences, while increasing speed all the while. This demand for more content and features can quickly gobble up any increases in bandwidth, memory, and computing power.

This article provides just a short sample of performance best-practices for native mobile apps. The room for performance tweaks is large, but so is the room for mistakes. Thus, if there's one important takeaway, it's to always test your apps early and never leave performance to chance. And remember – fast is always better than slow. ■

> about the author

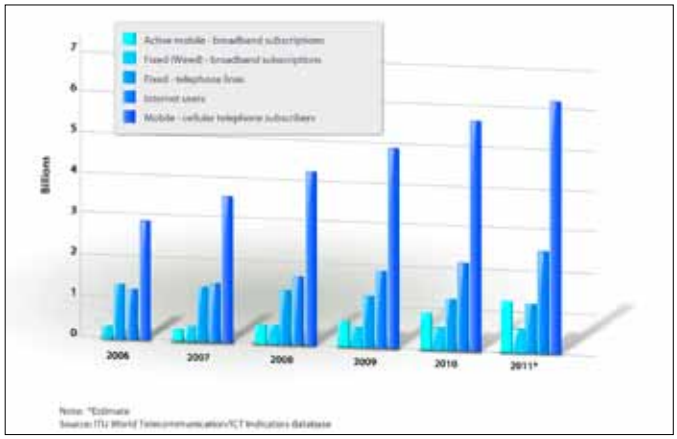
Klaus Enzenhofer has several years of experience and expertise in the field of Web Performance Optimization and User Experience Management. He works as Technical Strategist in the Center of Excellence Team at dynaTrace Software. In this role he influences the development of the dynaTrace Application Performance Management Solution and the Web Performance Optimization Tool dynaTrace AJAX Edition. He mainly gathered his experience in web and performance by developing and running large-scale web portals at Tiscover GmbH.

Jeesmon Jacob & Mary Tharakan

Roadblocks and their workaround while testing Mobile Applications

Where are we today?

It is estimated that six billion people are already using mobile phones. A graphical analysis given below on this growth trend actually shows us the alarming speed at which mobile users grew over the last five years.



The world is moving faster than ever towards minimized gadgets. Smartphone user statistics are rewritten almost every week. No one is able to effectively predict the total number of Smartphones flooding into the market. All expectations and predictions are broken when it comes to Smartphone users and Smartphone applications. Every day, millions of users depend on their mobile browser to update themselves with current happenings, mail services, social networks, etc. This major turn of events, in which people are slowly stepping away from their laptops or computers and getting more addicted to their handheld devices, leaves us with a large window of opportunity to explore. Everyone is exploring the option to drive their world from their fingertips. Applications are being loaded into the app stores of leading mobile operating providers at a speed which is beyond our imagination. Every day, each user wakes up to the war between the Smartphone companies trying to deliver the best to the end user.

Quarter one sales of leading mobile manufacturers show that users have a number of options to choose the best. Many leading manufacturers who enjoyed the top position on sales of their handsets are seeing rock bottom due to their failure to keep the users attracted with new features or additions.

The sales details below give us a very clear picture of this:

Quarter 1, 2012
Market shares of top mobile vendors

	Q1 2012		Q1 2011 -> Q1 2012
	Shipments (in millions)	Share	Change
Samsung	93.8	23.50%	35.40%
Nokia	82.7	20.80%	-23.80%
Apple	35.1	8.80%	88.40%
ZTE	19.1	4.80%	27.00%
LG Electronics	13.7	3.40%	-44.10%
Others	154.0	38.70%	-8.60%
Total	398.4	100.00%	-1.50%

Data by IDC

Surprisingly we see that many written-off manufacturers have bounced back with the support of open source operating systems like Android and have gone on to lead the pack. This trend clearly gives us the idea that users are no longer just looking at having a device to make calls or send messages. They have all started to look beyond all the basic facilities and are becoming closer to their handheld devices than any other gadgets.

And this quest by the users for better facilities leaves us with the freedom to imagine, create and be successful in mobile application development. These days, we very often hear the term "There is an app for that...". Not just individual users, but also companies, are accepting these changing trends and are already allotting a major chunk of their budget to mobile applications that help their employees to achieve targets faster and better.

Applications are flooding onto the market and studies shows that there are more than two billion applications just for the Apple and Android markets alone. So what are we waiting for? It's high time we turned our attention to tapping this potential market and reaping the benefits as early as possible. Hence it is very much necessary to do an in-depth analysis on how we, as quality analysts, should approach this situation and train ourselves to tackle potential roadblocks to bring the best out of the application under quality analysis.

While approaching a mobile application from the QA perspective, one must be very clear that things are no longer the same as they used to be. Anyone with vast experience in desktop application QA or web-based application QA may not find it as easy as it used to be when given a mobile application for QA. A lot of preparation and training in modern day tastes, styles and look are very much necessary for a QA resource to ensure successful release of a mobile application. It should be kept in mind that we deliver the best because even a single crash in the functioning of the application can irritate the user and may even force them to look for other, better applications for the same purpose. The QA team always needs to be on its toes when it comes to delivering mobile applications because it is satisfied customers who make an application a big success.

Every day we are faced with challenges from all corners and it is a must when it comes to mobile applications that we tackle all these challenges effectively to deliver the best to the end customer. In this paper we will be sharing with you some of the most widely faced challenges and some practical tips that we have applied to overcome them. Listed below are some of the most discussed/faced challenges when working with a mobile application:

- Environment
- Application
- Users
- Device
- Network
- Automation

1. Challenges from the environment perspective

What exactly does "environment" mean from a mobile application testing perspective? It is nothing but the collection of all the components associated with a mobile application's development. It is very much necessary to understand and prioritize these components and ensure their availability when needed, to avoid undue delay. Set out below are the major components that contribute to this environment:

I. Targeted Devices

This should be the first thing on the check list when an application is discussed with QA. Ground work to prepare the list of targeted devices should begin as soon as we plan for the QA. It been a major challenge for

an application to determine the device in which it will be used and every day we see many new devices loaded with latest OS introduced onto the market. So, while going for the release of an application, we should ensure that the application is created so it will cover the entire intended user group. And QA should do a detailed study and ensure test cases are built to incorporate these parameters.

II. Adapting to frequent OS changes

The devices have different versions of Operating Systems (OS) and they get updated very frequently. The QA team should ensure that our applications work smoothly after the OS updates. The tests for the same may not be possible at the time of the application's final QA but should be a continuous process which will come into play as and when the device OS is updated. We should have a common test case repository created to deal with OS updates. During this phase we should also ensure we cover all the major functionalities so that, if there are any inconsistencies we should have updated the team on the failed points and should work out a fix at the earliest window possible to release the updated version.

III. Domain constraints

When approaching an application from the QA perspective, it is very important to understand the domain for which it is being developed. User controls that are used for applications in a gaming domain cannot be reused as is possible for an application from some other domain. A stock index updating application should ensure continuous and error-free updates of rates for each of the stocks selected by the user. Movie streaming should ensure continuity and for an application that records and updates the same to a designated folder, should ensure that the device is not "killed" when performing these actions. Hence, behavior of the application and its effects on the device must be closely scrutinized and studied to make sure that domain requirements are matched.

How do we get over this?

✓ Target devices that are most used by end users

The QA should have a clear understanding of what the app is and who uses the app. So, before analyzing and testing the app, a QA should first do a survey and make a list of the devices used by the users. It is very important that we have the target devices listed out so we can tune our QA-related activities to the application accordingly. In most cases this also helps the whole team decide on the design points, which ultimately may even end up giving the end user additional functionalities which will add to the success rates.

✓ Check the application on different OS versions

As mentioned earlier, there are some of the same devices with different OS versions. So the QA should undertake a thorough study of the available OS versions and test the app in the different OS versions. The QA should first consult with the user on the OS requirement of the app. Let us consider an example of Android phones. There are different OS versions in Android like Cupcake, Donut, Eclair, Froyo, Gingerbread, Honeycomb, Ice Cream, etc. For instance, in the requirement the user has specifically mentioned that his app should work from Gingerbread OS version. In this case he is least bothered about the app working on the lower OS versions. So when the app is not compatible with the lower versions, the QA should make sure that the user gets an alert: "The app is not compatible with 'x' OS version". He should also make sure that the user is alerted when an update of the app is available.

✓ Efficient use of gestures and device controls

Each device available in the market has some peculiar characteristics. QA should be aware of these before he starts analyzing the app. Let us take the example of comparing two devices. An Android phone (say Samsung) will have a physical "Back" button built into the device whereas an iPhone, on the other hand, has a single "Home" button. So, while using an app, when the user has to navigate from the present page to the previous page, he makes use of the "Back" button. In the case of the iPhone, he searches for the "Back" option inside the app. The app should have uniformity across all the devices. Factors like landscape view and portrait view (when the device is device is kept horizontally and vertically respectively), zooming-in of the page (zoomed when doubled tapped) and switching between desktop view and mobile view (if the app has both desktop side and mobile side) must all be checked by the QA.

The QA team should also look out for opportunities where gestures like tap, pinch, rotate and shake, which can be converted into meaningful actions within Smartphones, are used wisely wherever possible.

2. Challenges from the application perspective

Basically, this should be the primary point of discussion when it comes to developing a mobile application. The team should consider the most suitable method for the development of the application right from the design phase. We should analyze the intended audience, devices to be deployed, etc. Some major points that should be considered from the application perspective are detailed below:

I. Native/web/hybrid-based applications

This should be the first decision the team should decide on when going into application details. Basically, as you know, all mobile applications are classified into three types: native, web-based and hybrid. Native applications are those which are built to work on specific operating systems and which can be adapted to different devices running on the same operating system. Web applications are those applications which, when run, download fully or partially from the web. A hybrid application is a mobile web application (HTML/CSS/JavaScript) that has been wrapped in a native shell. These applications typically work with the mobile device's web browser. So, depending on the end users and the devices used, we must choose wisely between the two. The QA team should then adapt to this selection and prepare test cases specific to these. There are many pros and cons for both these types. But one major advantage of native application development is the freedom to implement many OS-specific functions into the application, which can help the end user a lot. As for web application, we say the major advantage is the fact that same application can be used in most of the devices that are available in the market without any modifications. In the case of hybrid application development, the end user will get the best of both web and native blended in the best way possible to produce the best output.

II. Behavior on different devices

Another major roadblock we face while developing these applications is their behavior pattern on different devices. We especially need to keep a keen eye on the way native application behaves on multiple devices with different versions of operating systems. Even though, theoretically, it is believed that these applications will perform the same way on different OS versions, since we have different development platforms for these applications, QA must ensure that the same application performs the same

way on different devices like iPhone, BlackBerry or Android phones. It is also advised that the QA team tries to capture look and feel differences. We should always try to keep the same user interface across different OSs. This will help the user a lot while working with the same application on devices that have different OSs. In short, this saves the organization time and money for training individually for this application on separate devices.

III. Different development processes for multiple device OSs

As most of you know, iPhone and iPad applications are created using objective C, whereas BlackBerry and Android applications are created using JAVA but different SDK (Standard Development Kit). So this leaves the QA team with the very tedious task of ensuring the same application works flawlessly on all these platforms. The primary focus of the QA team in such cases should be to ensure that all the devices have the same functionality implemented and working perfectly.

IV. Constant comparison of the mobile application with existing desktop/web application

Another major hurdle we face most of the time is the constant comparison made between the mobile application and its existing web or desktop application counterpart. This can be a major point that the end user would like to check out as soon as the application is made live. So, in order to ensure the success of the application, the QA team should think from the user's point of view and should point out differences in the early stages.

How do we get over this?

✓ Keep the application as similar as possible to the existing one

It is always advised that, when working with mobile applications which already have existing web or desktop applications, the QA team gets familiar with this first, makes a checklist of major functionalities and compares this with the application under development. This check list should be the basis on which the QA team approaches the mobile application and looks for missing points, mismatches, etc. Early detection and updating of such cases to the development team can always help in saving a lot of time in the later stages.

✓ List out the targeted devices initially

It is also good practice to understand the end user base. An analysis of the devices intended would also help in preparing the test cases to cover them effectively. For example, if an organization offers its employees Blackberry devices only, then there is no point in creating a web or iPhone application for the organization. So we have the freedom to build a native Blackberry application straight away. This will ensure that the application is useful to all the employees within the organization and we can also assist them by providing extra features that are device-dependent.

✓ Check the behavior of the application on different targeted devices

If we are targeting multiple devices, the QA team should ensure it has at least one actual device of these and carries out all the test cases on each of these devices at least once for every build released. This would ensure defect-free delivery across multiple devices. This will also give the QA team a clear idea of how the application is going to behave on different devices and what the changes are that need to be made to make it work smoothly on each of them. Hence, actual device testing is a very important factor in mobile application success.

✓ Ensure application works across these devices in a similar manner

Most of the time when different devices are targeted by an application, the QA team needs to ensure that the look and feel, usability, actions, links, etc are placed and organized as similarly as possible for each of them. The QA team should ensure that the user experience is the same for the application, no matter which device the end user uses. Any deviation noticed should be immediately put forward to the design and development team so they can work out a solution for this.

✓ Always Carry out a Certification Test

If the application created is to be published to application stores such as Apple's Apps store, Google's Play or RIM's App world, then the QA team should ensure it carries out the certification tests. Certification tests are merely cross-checking with the guidelines these Smartphone owners have set and which our application should meet if they are to be published through their application stores. These guidelines are easily available on their respective sites and the QA team should mould their test cases to accommodate them to ensure that the application passes the certification tests when submitted for publishing.

3. Challenges from the user's perspective

Mobile phones have become increasingly popular these days and people are now totally dependent on them. For instance, taking into account the minor items we use in our daily lives... like alarm clocks or simple calculators. Where are they now? The usage of all those is considered outdated nowadays. It is due to the simplicity the user feels when they get all these in their mobile phones. So, when a person develops an application for a mobile phone, the first thing taken into consideration is the ease of use felt by the user.

Hundreds and thousands of mobile applications are added to the stores daily and these are available to the public. So, getting a mobile app recognized in the market has a lot to do with "What your application has the others don't". So, the team needs to build an app that is more user friendly, an app which a user can navigate through easily, an app which is easily accessible and has more functionality and an app which requires less input from the user to ensure success.

The challenges while developing a mobile app from the user's perspective are:

I. Keeping it simple and easy for navigation

Making it simple and easy for navigation means the application should not have long forms which force the user to scroll down to the bottom. Instead, the QA should ensure that similar kinds of data inputs are grouped and are tabbed properly so that the user has access to each of them from a visible area of the screen. The QA should also make sure that there aren't any long forms used in the app, as it may lead to time-out issues. Even if time-out happens, the application should load the same module with all the inputs that the user entered, once the user enters the credentials correctly.

II. Accommodating maximum functionality in the mobile application

Most of the time, mobile applications are developed from some existing desktop/web application that allows the user to perform 'n' number of functions. But when it comes to the mobile application, diligent decisions should be taken to choose the right functionality to be accommodated, bearing in mind the memory, input, network constraints, etc. The QA team should ensure that the application serves the main purpose for which it has been created and should also make sure that they are in sync with the web/desktop application from which it originated. The QA team should also make sure that the look and feel matches the existing app, so the user feels comfortable working with it.

How do we get over this?

✓ **Try to reduce the key inputs to the fewest possible**

A user won't be happy to fill in details and do so many things to get things done. The less work he has, the happier the user will be. So, a QA makes sure that the app has made wise use of drop-down menus, check lists and radio buttons wherever necessary to minimize the effort from the user's side.

✓ **Ensure quick access to the application**

To make the app more user-friendly, a QA ensures that the app is easily accessible. For instance, let's take a situation where the user is using an application in the device. Suddenly he remembers that he needs to make a call or text someone. So he needs to come out of the application.

In such a case, he should be able to minimize the application. Then after his call when he opens the app, he should be navigated to the same page where he stopped, unless the app is sessioned-out (a pre-defined time when the app shuts down automatically if kept idle). Or else the user should log in with his credentials each time he opens the app, which is more time-consuming and makes an impatient user irritated. Also, if possible, we should provide OTA (Over the Air) if requirement permits, so that the user can download the app to the device directly from the website where it is hosted. This is nothing but "installation testing", where we test if the application installs correctly on the intended device. Installation testing should be part of every release.

✓ **Keep the menus simple and easy to access**

Use of simple menus that are easily accessible would please the users to an extent. Common menus like Home, Log Out, and Help, About, etc should be present on the different pages inside the application. If the app is complicated, the Help should provide the necessary instructions and guidelines. The QA has to make sure that the user can navigate through the app easily.

4. Challenges from the device perspective

Mobile devices have evolved from a brick to a notepad within a decade. This growth has been tremendous and shocking. Hence, even though we are discussing devices in terms of many challenges within this paper, we have a number of specific points that need to be mentioned under this heading so the QA team understands the importance of tuning the testing to cover these roadblocks.

I. Browser limitations of the devices

The world has a totally different outlook when accessed through mobile browsers. Every day we see them growing and making lives better. There are many advantages that are available nowhere else when we use a mobile browser; some of them are hand gestures which can be converted to meaningful actions. But, at the same time, they have many constraints, too. Some of the common constraints are space, clarity and loading time, etc.

II. Touch and non-touch devices

Another major roadblock that we have in terms of the device perspective is the touch and non-touch device outputs. Touch devices recognize the pressure a user puts on the visible area of the screen and work on this basis, whereas non-touch devices are those which have physical keypads. Even though most of the Smartphones that come onto the market these days are touch phones, we still have some major players, like Research In Motion which produces BlackBerry, who prefer non-touch devices and also have mass acceptance.

III. Memory constraints

Most of the devices have different memory limits. Hence the application being created should be tested with the lowest memory-holding device to ensure that it works well under these conditions. Any crashes that occur should be marked as critical issues and should be passed on to the development team with detailed steps to reproduce. It will also be good if we can capture the logs and share them with the development team for further analysis.

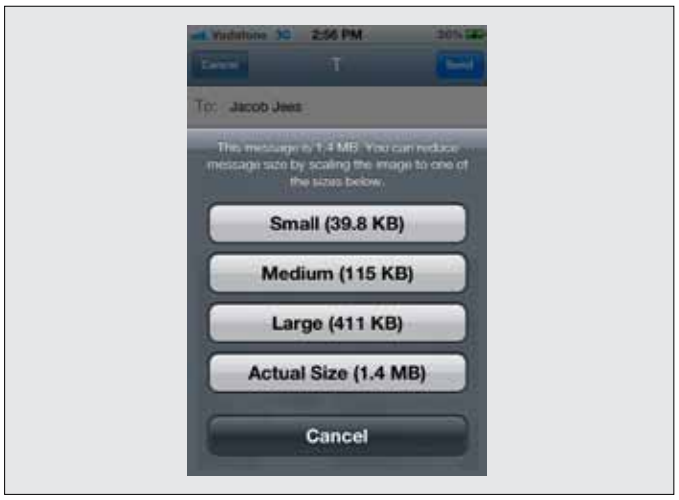
IV. Battery Drainage

This is a very important point of consideration from the mobile device point of view. End users should in no way be crucified for using our application because it eats away their device's battery life. Some of the common areas where battery drainage can be checked are GPS and data management. In the case of GPS in applications that do not need the exact location to be shown, always ensure that lower accuracy rates are mentioned so that the battery won't need to work so rigorously. The QA team should assess the need for accurate location tracking in the application and should discuss its priority with the team. Another important point where we can save data transfer rate and mobile battery is image processing. On average, the size of a normal photo taken with a 5 MP camera in an iPhone 4 is somewhere between 1.5 MB and 2.7 MB. In most cases we may not need such a high definition picture for processing within our application. So, we should ensure that the application processes the image and reduces its size so the upload time is brought down considerably. This again helps in saving a lot of battery drainage. The QA team should always be on the lookout for such instances and work on reducing the effect on the mobile battery. A good example of image processing can be seen in the default mail client available in iPhone which is shown on the right.

How do we get over this?

✓ **Ensure memory usage tracking from initial QA levels**

QA should also be concerned about the memory constraints of the app. Test cases should be created to check for the total memory used by the app and try to keep it to the minimum possible. Wise use of image processing, video, audio size restrictions and data uploads should always be checked and it should be ensured that everything falls within the limits. In no way should we let the application crash on a device due to memory overload.



These days, many applications are available which are easy to use for checking memory leakages. IPhone or iPad development platform Xcode has a built-in tool which is called "Instrument" – a very simple tool that helps the user check for memory variations in the code of the application under development. QA teams should get familiar with such easy-to-use tools and should use them as often as possible to ensure that the code does not cause any high memory usage.

✓ QA across all mobile browsers and ensure uniformity of output

Each device has different browsers. An application that is compatible and aligned in Safari (an in-built browser in iPhone) may not be compatible with the other browsers used in BlackBerry, Nokia or any Android phones. So QA has to check the application in various browsers and make sure the app fits correctly into the browsers used by the user in the case of a web application. The output should look similar on both touch and non-touch devices, too. As we all know, the non-touch device's screen area is smaller than the touch device's; hence, we should ensure that the application under test behaves exactly the same on both these devices.

✓ Check on all possible device simulators and actual devices if possible

Thousands of devices come into market on a regular basis. So, it is impossible for a QA to check the app functionality on each and every device available on market. For this, they make use of simulators. Simulators are nothing more than a virtual platform or an imitation of the real world process/device. Testing to a level of almost 70–75% accuracy can be done using these simulators. Factors like network modes, involvement of interruptions like incoming calls, alerts, messages, etc. can all be tested using the different simulators. But not all these facilities are available in the simulators, hence it is very important that we test our application on the actual device. These actual devices have different versions of operating systems (OS). And they get updated almost every month. So, to make the app more accurate, the QA should do a thorough testing using a simulator and again test it on one or more actual devices with different OS versions.

5. Challenges from the network perspective

One of the most important aspects to be considered when testing a mobile application is the network factor. Unlike any other application that works on the desktop or any other platforms that solely depend on wired connections, mobile depends most of the time on the Internet connection provided by the service provider whose SIM we use in the device or the WIFI connection to which the device is connected. So, ensuring that our application works fine under different network conditions is a must for the success of the application.

I. How does our application behave in poor/no network situations?

One of the primary points that needs to be ensured is the smooth functioning of the application in different network situations. The application should be tested under different network conditions and we must also ensure that the application does not crash or hang because of the varying signal conditions. Data updates and communication to the server for fetching data, etc. should be smoothly carried out under these changing circumstances. If there is any unsuccessful attempt to fetch or update data, the user should be informed at the very next instance using an alert. BlackBerry simulators have built-in options which mean we can vary the network signal strength and test the application's behavior on our own systems. You can access this on the simulator from the "Simulate" menu under "Network Properties".

But iPhone or iPad simulators do not have this facility, hence we will have to carry out these tests on actual devices. In such cases, we will have to turn on the airport option, which in fact kills the network availability on the device, and then work with the application to see how it reacts to this. Another method is to turn off the Network options provided under settings. Shown on next page is the screen shot of the iPhone Network settings.

Once the cellular data option is turned off, the device will have no access to the Internet (assuming that WIFI has been turned off) and this should be a mandatory test case when we work with mobile applications. We should also ensure that we check the application's behavior when we change from 3G to normal GPRS connection, which, in fact, is a point to be considered for applications that are developed for countries like India where 3G connections are available only at selected locations. Our application should be able to handle these connectivity changes and should adapt to these accordingly without crashing.

II. Ensuring off-line support

Some of the applications allow the user to store data in offline mode. That is, even when the user does not have access to any network, they are allowed to access the application, fill in the details and save it on the hand-held device itself. We should check to see if the application supports

offline and, if it does, we should ensure that we create test cases to cover all possible offline activities so as to avoid the application crashing while working in offline mode.

III. Ensuring the application works on WIFI

The image in the middle gives us a clear idea of how Smartphone users are addicted to using WIFI on their devices to connect to Internet.

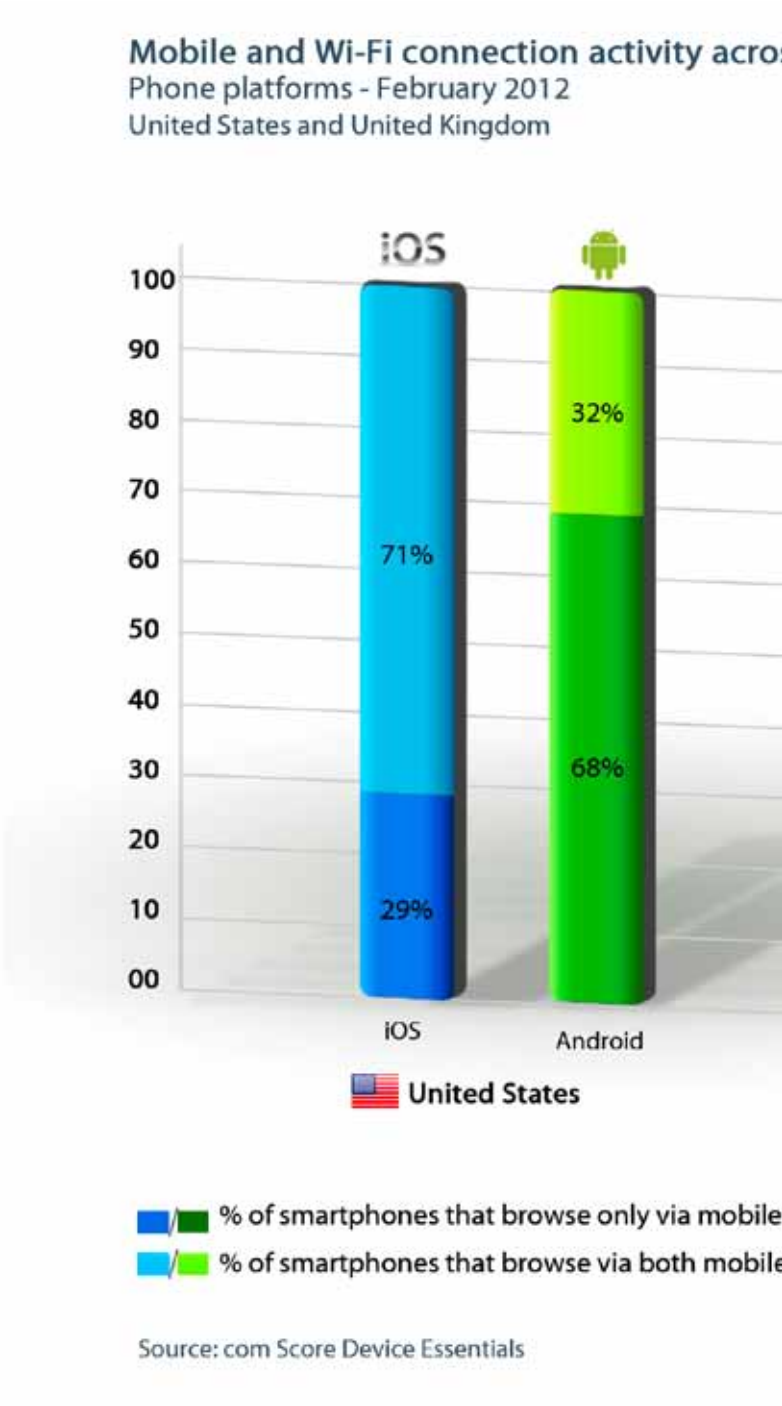
The high cost of data plans is a major concern for Smartphone users when accessing applications using the device's connection. Hence, the majority of users prefer to use the applications over WIFI. Therefore, it is very important that our applications are made compatible with use over WIFI connections. Hence, tests should also be designed to ensure that the applications work perfectly on WIFI. WIFI connectivity issues should also be addressed by the application. That is, if the WIFI connection is lost while the user is working on the application, they should be immediately alerted that their connection is lost and this should avert the application crashing.

IV. How does the application respond to interruptions?

We should ensure that the application responds in an agreed manner to the interruptions. Some of the most common interruptions that can happen in a Smartphone are listed below:

- Incoming SMS/MMS
- Incoming calls
- Alerts for push mails/chats/updates
- Low battery alerts
- Alarm clocks
- Force the application to minimize to access the menu or home screen

Just to make things clear, imagine we are testing a time-bound game in which we are to clear a puzzle in a two-minute window. Now, if an incoming call comes on to the device while we are playing the game, the device should automatically go into pause mode and allow the user to continue from where he had left off when taking the call.

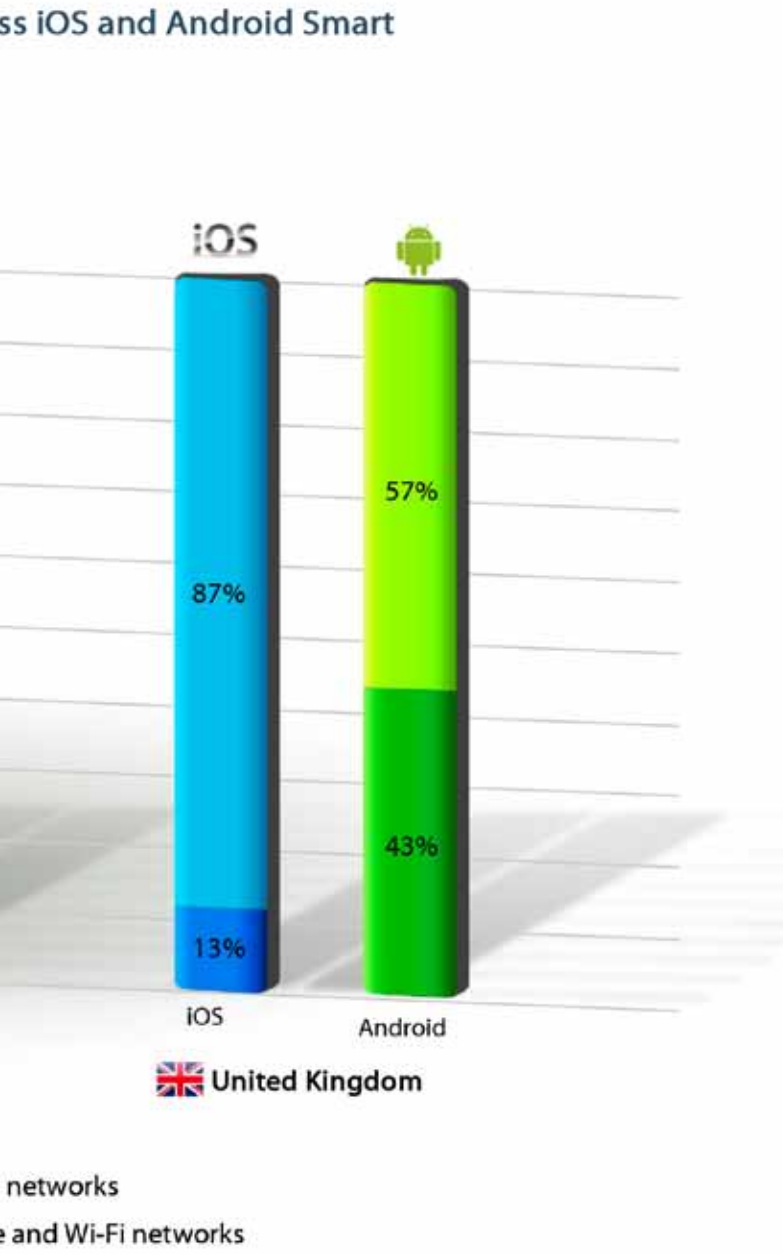


How do we get over this?

Every type of network fluctuation and its associated actions should be considered when developing and testing the applications. The QA team should ensure that all possible check points are covered and the expected results are clearly achieved.

✓ Track the response of the application to interruptions

Every possible interruption should be considered and test cases should be prepared, keeping them in mind to test the application. The expected response of the application should be decided in the event of any interruptions and QA should ensure that these results are achieved whenever interruptions occur. One example to help understand this situation in detail is described in the following. In the case of an application that records voice while it is functioning, if a message alert comes in which



in fact is an interruption, we should decide on the due course of action. There are multiple options, like asking the user if they want to continue to work in the background, or want to pause the application, or want to exit the application, etc. This expected response should be discussed with the development team and the end user, and must ensure that a mutually acceptable result is implemented.

✓ **Decide and implement the course of action the application should take in response to interruptions**

The application's response to interruptions should be decided well in advance and corresponding response actions should be implemented accordingly. A data-saving application should have the capacity to pause the data-sending event if an interruption occurs. It should be also borne in mind that, of late, most Smartphones have the capacity to multi-task and, accordingly, we should also modify the test cases to ensure that multi-tasking works as intended for the application under test.

✓ **Ensure off-line capability is tested**

The application should be checked for proper syncing to the server once the device is linked to the network. It is important to check the application's data storage capacity and ensure that all the data that is stored offline are updated to the right destinations once online. Importance should be given to those applications that manage heavy data like video, audio or pictures. The application should also have the capacity to restart syncing in case of network failure or any other interruptions which we will be discussing below. Some of the applications are also capable of downloading updates and making them available offline. In such cases we should also ensure that applications update their local database when connection is available. A detailed message should be provided upon successful syncing. In case of failure, there should be an option given to the user to re-sync at some later point of time. But, in such cases, one important point to ensure is that there is an option for choosing the network connection for uploads or downloads. Under settings we should give the user the choice to select updates when connected to WIFI or the mobile network. This is important, since data usage may be costly and the user may not want their applications to download huge amounts of data when using the mobile network.

✓ **Ensure network fluctuations are addressed**

The application should be run through various network signal strengths to assess the output. The most time-consuming operations should be carried out on the application at the lowest signal strength possible to see how the application behaves. Network time out, session time out, etc. should be handled effectively.

A very common practical method to test the application for network fluctuations is to carry the device into an elevator and keep testing while it is on the move. As we all know, every time the elevator stops and opens the door we see the device accessing the network and this allows us to understand the exact behavior of the application in a real life scenario. Another good place to test is the basement of the building where network issues are common.

6. Challenges from an automation perspective

Automation is slowly catching up in terms of mobile application testing. But, on doing a detailed analysis, we see that there is a great deal of room for improvement. Even though automation is at the very initial stages, the pace at which tools are introduced for helping users with mobile applications testing has been on the rise of late. We need to have a detailed look at various factors that affect QA from the automation perspective.

I. Most of the available tools are device/OS specific

In fact, this happens to be the major reason why companies are still reluctant to embrace a particular solution to automate their mobile applications testing. It is difficult to find a single tool that can help us test applications across multiple platforms. This is basically because most of the Smartphones out there use different operating systems. Some use Windows Mobile, some use iOS, some use Android and some others use BlackBerry OS. Going by their popularity, the leaders in the table are, of course, iOS and Android, the latter planning to overtake in terms of number

at any time as we write this paper. The reason we are mentioning this here is that all these operating systems use applications that are specific to them. That is, in the case of the iOS system the extension of the application should .ipa, for Android .apk, for BlackBerry .jad, etc. Now, from this it is very clear that it is almost impossible to create an application which can create automated tests for applications intended for all these devices. So, if we are to create an application that is for both BlackBerry and iPhone users within the company, we have to create automation test scripts for both these applications individually. This, as you may all know, will lead to doubling your testing time.

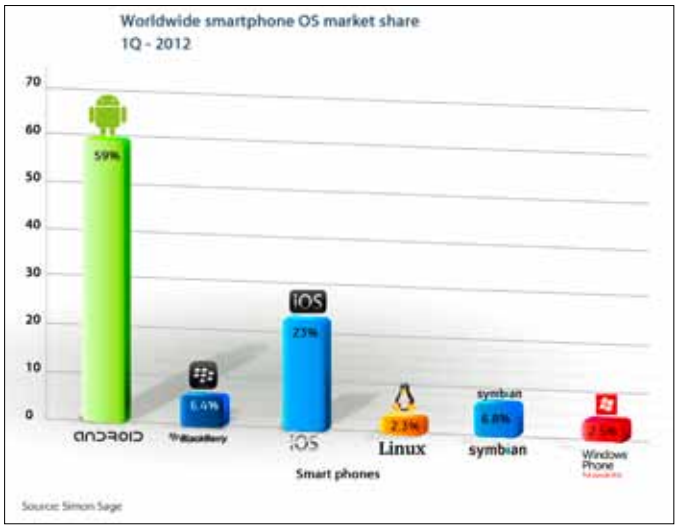
There are a couple of applications which ensure that single script can be run for both the code bases, but the end results are yet to be assessed in depth. However, there is always an element of skepticism about the results, as we all know that each Smartphone has its own unique functionality base and that the same test approach may not work for all of them.

II. Most of the tools' capabilities are limited to web application testing

There are many tools available on the market that help us test web-based applications for mobiles. But, as we know, most of the traditional applications are still native which intensively use the special features that are built into the development tool used for native application building. Web mobile applications limit the user from performing many regular actions that could have easily been carried out had there been a similar native application. Because of this limitation, most companies try to assess their user group and, based on the statistics, build native applications for the most commonly-used Smartphone, which gives them the advantage of incorporating the maximum number of features into the application under development. Hence, most people still have an appetite for native applications. This, in fact, stops most of the companies from investing in automation tools that are just intended for web-based mobile applications.

III. Testing for multiple OS automation just adds work...

Talking of multiple OS, the graph below on the share of Smartphone OS across the globe will give us a clear picture of where we stand currently.



So, which is the OS that your company is using most? Which is the OS that your end users are using most? Which are the OSs that are approved by your IT security team?

These are some of the questions we have to find the exact answers to before starting to develop a mobile application for the mass market. Once these questions have been answered, it is also a must to plan your QA also accordingly. Finding the resource or training the resource, and identifying the tool to be used for testing these applications are some of the routine jobs associated with this. But the priority should be to find a tool that has the capability to run tests for different OS devices with minimum rework. However, no automation tools are known to support the video/audio capabilities that are part of a normal mobile application. Image management is also known to have failed in many instances when working on automation tools. Hence, complete automation testing of mobile applications still remains a distant dream.

How do we get over this?

Having talked about a dream in the above paragraph, we would like to quote Mr. APJ Abdul Kalam, one of India's most distinguished scientists, who said:

> *"Dream, dream dream*
> *Dreams transform into thoughts*
> *And thoughts result in action."*

So the day is not that far away when we will have the right tool to accommodate the scripts that can run for multiple OSs. Most of the applications that are on the market are currently linked to already established QA tools like QTP. Soon we should be also seeing automation tools that can handle images, videos and audio. Some of the steps we, as the QA team, should take to familiarize ourselves with automation tools would be:

✓ Keep updating yourself on the tools available

Always check for sites that support mobile application testing like *www.qatestingtools.com* or *www.mobileappstesting.com* which provide us with information on tools available in the market, feedback on them and useful links associated with them. Googling reviews and comments will help us update our knowledge base on automation tools.

✓ Always check out and evaluate new tools

Any automation tool that comes onto the market will have an evaluation copy associated with it. The QA team should always ensure they install this evaluation version and try to match the requirements with the tool under test. Another good way to keep updated on these tools is by attending webinars that are offered by these companies. Automation testing tool development companies conduct free webinars on a regular basis to inform their clients about their products and new features added. Attending these webinars helps us to rate the product and also to compare it with other similar applications.

The evaluation copy of the tool should be installed in our own environment to ensure that it is suitable for our applications and complies with our network settings. Once installed, we must also ensure we evaluate it from the security point of view to ensure that no data of ours or our clients are transmitted to any other external servers. Evaluation should be done to ensure that the application suits our requirements from all angles. Some of the major check points while evaluating a tool should be:

- Types of phone supported
- Types of emulators supported
- Types of connections supported
- Can the same test be run on different devices (multi-device support)

- Is the tool compatible with existing automation tools?
- Security – VPN connections, data sharing, etc.
- Functionalities supported – swipe, drag & drop, zoom, scrolling, pinching, rotating, shaking etc
- Image/text recognition

It would be possible to write another paper on tool evaluation, but the major points to be taken into account are the ones mentioned above.

✓ Get familiar with Device Anywhere, Perfecto Mobile, etc. for real device testing experience

Currently these are the most trending mobile applications testing platforms. These are merely mobile device providers who allow us access to their real devices via remote connections. So, no matter where you are located, all you need to have is an account with any of these sites which allows access to most of the currently trending Smartphone devices. All actions can be carried out remotely over the web and more accurately, since these tests are happening on the actual devices. Most of these sites provide us with regular updates on devices and they keep adding new models, as and when they are available in the market.

Device Anywhere – www.keynotedeviceanywhere.com
Perfecto Mobile – www.perfectomobile.com

> about the authors

Jeesmon Jacob is an electronics and telecommunications engineer with a MBA in IT & Systems. He is a certified professional in CSTE & ISTQB with over 6 years of experience in the field of quality assurance. Currently he is working as the QA lead for a mobility team at UST Global® who are a leading provider of end-to-end IT services and solutions for Global 1000 companies. He has also written a number of white papers on mobile application testing. In his free time, he loves spending time with his eight-month-old angel, Rose, who is trying to learn from her mom how to master the art of getting things done effortlessly.

Mary Tharakan who holds an Engineering degree in Instrumentation and a diploma in Embedded Systems, has been with UST Global for a year now. Currently she is working for a Fortune 100 client as a quality engineer. She is an avid follower of the new technologies and has a weakness for the latest gadgets. She is also part of the mobility testing team of UST Global. In her free time she likes shadowing her mom to learn some of the culinary arts in which she claims she is the best, but most of her friends disagree unanimously.

Kerstin Knab

Main issues in mobile app testing

For everybody who uses a smartphone or tablet apps are indispensible. An app is an application that is developed for a specific environment. Within the mobile context, the commonly used name is mobile app.

App technology has been well known since the commercial launch of the iPhone in 2007. With the release of the Apple App Store, a new sales channel for software applications was opened. Comparable app stores for other operating systems, such as Android Market, Nokia Store, BlackBerry App World, Mac App Store, Samsung Apps, and Windows Phone Marketplace were launched soon afterwards.

For a long time, only apps for personal use were in the spotlight, but now this has changed. The usage of apps for business purposes is increasing significantly. Companies are using apps for banking, sales, marketing, or internal communication. In addition, B2B or enterprise apps, which facilitate interaction with back end tools and mobile devices by means of web services or cloud platforms, are capturing market share. In the course of this development, the demand for methodical quality management is increasing.

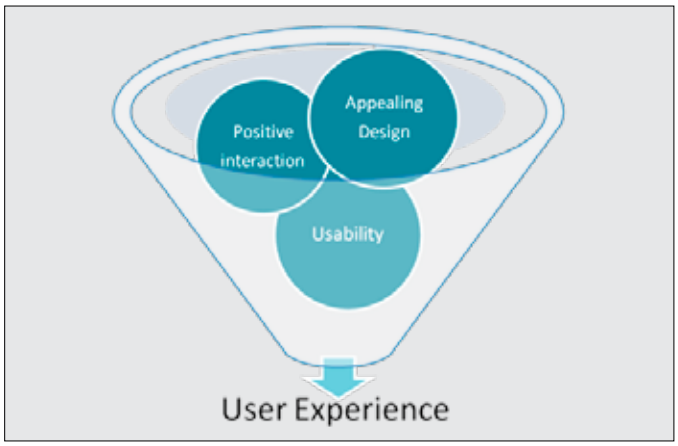
This article will show four main issues that have to be dealt with by mobile app testing and the basic requirements needed. Furthermore, it will describe the integration of testing methods in an agile development model.

The main issues that have to be covered in mobile app testing are:

- User experience
- Coverage of available mobile hardware
- Connectivity
- Security

User experience

The user experience is critical for the success or failure of an app. The user experience will be mirrored by the rating of the app in the app store and negative ratings can be the source of significant sales losses. So, the user experience is a key issue in mobile app testing. It cannot actually be tested directly, because of the subjective nature of the experience. But you need to be aware that you can and should cover the critical success factors for a positive user experience through the test.



Success factors for a positive user experience are appealing design, positive interaction and usability. Based on these three themes, you can derive the following test criteria:

User Experience	Test	Factors
Design	Layout	continuous, relative
	Navigation	logical
	Position of icons	logical, clearly laid out, functional
	Different display format	suitable
	Readability	look, display duration
	Language	grammar, spelling
	Text display	alignment, overlap, text wrapping
Interaction	Touch screen	gestures, input
	Motion sensor	pan, overturning
	Error messages, warnings	comprehensible
Usability	Screen set-up	logical, duration
	Action chains	logical, comprehensible
	Progress bars	timing
	Performance	load duration, multitasking

Coverage of available mobile hardware

The variety of mobile devices, especially for Android is increasing continuously and it is no longer possible to give an overview of the mobile device market. This is a great challenge for quality management, because the limiting factors like display sizes and formats, operating system versions and basic device characteristics vary. An additional factor is the device-specific customization of the operating system (Android) by the device manufacturer, which should be tested explicitly on the device.

When testing, it is necessary to limit the devices that will be supported by the apps. System combinations (hardware/operating system) and downward compatibility have to be defined. To maximize the coverage of system combinations it is necessary to develop flexible strategies for the test execution.

Variations are:

- simulators, emulators
- beta-testing network ("field-testing")
- mobile testing in the cloud, for example Mob4Hire, testCloud
- mobile testing in the crowd, for example PerfectoMobile, Soasta

These variations have to be combined and prioritized taking into account the project context.

Connectivity

Connectivity is another big issue in mobile app testing. Ideally, network connections for apps will be implemented in separate threads which should not interfere with each other. Furthermore, an app has to react adequately on network abort, delay, change and weak connections. If these reactions are implemented by a warning or caching mechanism, this has to be clarified within the project context.

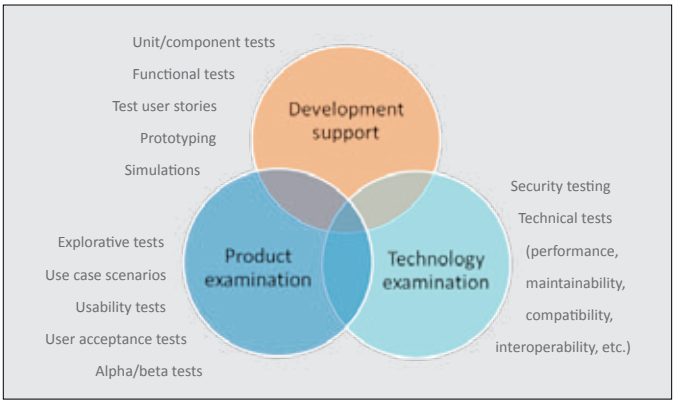
Security

Beside connectivity, security is another main issue.

Important themes are:

- authentification and authorisation
- data security
- allocation of data in offline mode
- protection of the file system, options, hardware, network resources, etc.

Basically, the development of an app will be executed within a "sandbox", which enables or disables access to resources outside of the app. The access rights are programmable or pre-defined, depending on the operating



system. Appropriate tests have to be defined explicitly.

Another aspect in the context of security testing is protection against illegal access via "jailbreaking" (iOS) or "rooting" (Android).

Beside these four main issues, there are basic requirements that have to be considered in mobile app testing.

Basic requirements in mobile app testing

One requirement for app testing is a beta-testing environment. For this purpose, operating system manufacturers offer either their own testing environments, such as Testflight (iOS), or enable the usage of free commercial tools such as HockeyApp (Android).

There is multitude of testing tools on the market for mobile app testing. Variations include add-on modules for established test suites like Tosca Mobile, or stand-alone tools with standardized interfaces.

In the mobile context, test automation is an essential factor. Examples of well known tools for this purpose are SeeTest (iOS/Android), Robotium (Android) and MonkeyTalk (iOS/Android).

All requirements have to be tested in a methodical fashion. One method is described here.

Integration of testing methods in an agile development model

Apps are developed and tested on the basis of the underlying software development model. Both traditional and agile models are commonly used.

Traditional software development models, like the V-Model, are characterized by their high planning dependability, standardization and easy scalability and adaptability. Weaknesses are the high requirements for documentation, the necessary tailoring, and the lack of flexibility.

In contrast, agile models score with high flexibility, quick system deployment, low documentation requirements, and little formalism. Disadvantages are difficult time and budget planning, high communication effort

within the agile teams, and a distinctive dependency on the individual abilities of the team members.

Generally, apps are developed within tight "time-to-market" cycles. Customizing is performed via continuous updates, which are mostly a result of feedback from the app users.

Subject to these circumstances, an agile development model delivers more pros compared with a traditional model and so will be described here in brief.

The testing tasks in the agile model can be split into three main concerns:

Each concern will be underpinned with suitable testing methods which have to be brought in line with the timeline of the sprints (Scrum).

When using agile models, it is necessary to ensure that

- definition of what has been done is consistent,
- automation is planned in detail within the sprints and mock-up services are established,
- the regression needs are monitored throughout the sprints,
- external service providers (crowd, beta-tester network) are integrated wisely and
- testing experience gained flows back into the process.

Caution: Agile models are not the best solution in every project context. A traditional model is often the better way, especially in projects where there are company-specific issues with clear-cut and detailed requirements or narrow budget and time specifications. However, if an agile model is used it is essential to consistently monitor the product backlog and the baseline adapted to this.

Conclusion

There are many aspects in mobile app testing which have to be considered. Important issues are user experience, coverage of available mobile hardware, connectivity, and security. The quality criteria of a mobile app testing project are individual to each project, i.e. the weighting of the testing criteria varies significantly.

Integrating the test into the underlying software development model is critical for a successful mobile app testing project. Due to the narrow timeline of mobile app projects, it is necessary to customize the testing methods, adapt the test scope, and define the test coverage.

It is essential to adapt approved methods to the determining factors of the app development in a quick and flexible way. ■

> about the author

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Stephen Janaway

Beyond the Smartphone – Testing for the Developing World

In Western Europe and the US, the mobile device industry is focused heavily towards smartphones and their associated ecosystems. However, for a majority of device consumers in the world, the feature phone still rules and it is estimated that 70% of mobile devices currently in use in the world are feature phones. Feature phones, although still basic in comparison with smartphones, are becoming increasingly feature rich and represent a real challenge for those who test them. Some of these challenges are common with testing in other disciplines, whereas some are unique to the mobile device area and feature phones themselves.

Before we look into these unique testing challenges, it is important to first explain why feature phones and feature phone consumers are in some ways different and in others the same as those who purchase and use smartphones.

It is true to say that there is no official definition that distinguishes feature phones from smartphones; the most commonly used distinction is price. Given the lengths to which manufacturers discount devices in the extremely competitive mobile device market, this is not the best distinction to use. For the purposes of this article, we shall assume that a feature phone is a mobile device which runs an OS which is typically manufacturer-specific, unlikely to allow true multi-tasking or third party native applications, and has a small screen. It will be cheaper than a smartphone, in terms of both the cost to the consumer and the cost of manufacture and parts. It may have a camera or may not, and will certainly have a lower-speed processor and less memory than a smartphone. Touch screens are available at feature phone price points, but more traditional device styles, such as ITU-T keypads, are also still available – in fact the range of different mechanical styles and phone capabilities is greater in the feature phone space than within smartphones, where the monoblock touch screen device dominates.

The way consumers use feature phones is also very important to understand, especially when considering feature phones from a testing point of view. Whilst the more expensive feature phones, retailing at between €60 and €120 may be on sale in Western Europe and the US, often on pre-paid plans, the feature phone segment extends all the way down to the lowest price points of €20 and below. This may not appear to be much to the affluent Westerner, but to consumers in developing countries this can represent a significant financial purchase, often necessitating many months of saving. This in itself has a real effect on the perceived quality of the device and, therefore, the level of testing required to give confidence in quality prior to launch. Feature phone consumers feel a greater pride in their devices, since they may well have saved for a significant time to afford them, and do not expect their pride to be dented by poor quality. They are more likely to return devices for repair and they have a higher expectation that those devices will not fail. A reasonable analogy would be that of TV, or even car ownership, in developed countries.

Feature phone consumers in developing countries also have high aspirations. A majority would buy smartphones if they could afford them and they expect their feature phone to offer an experience which is approaching that of a smartphone. As a result, we see increasing attempts by mobile device manufacturers to make their feature phones increasingly feature rich, in particular Nokia's S40 platform and Samsung's SGH platforms, and all the while delivering these features on platforms with low memory and processor capability. This means squeezing the maximum out of each platform and makes effective testing extremely important.

Typical use cases for feature phone consumers are also different when compared with smartphone users. In developing countries, and particularly in Africa, a village may share a phone; in fact, businesses have been formed (for example the Village Phone Program: *www.grameenfoundation.org/what-we-do/empowering-poor*) around sharing and using a single mobile device to ensure communication outside of the village. Some feature phones offer functionality such as multiple address books and call logs, enabling multiple users. Saving costs by using multiple SIM cards is particularly popular in developing countries where one network may offer low cost local voice calls, whereas another offers lower cost calls outside of the local area. Consumers typically swap SIM cards frequently and devices are available which support more than one SIM card. Nokia offers devices where one SIM card can be swapped as easily as a memory card, with both cards active at the same time, and other manufacturers offer devices which can support up to four different SIM cards in the same device.

Whilst feature phones do not, typically, offer the third party developer the ability to deploy native applications to the devices, they typically do come with some sort of third party runtime environment. The most prevalent is the Java Mobile Edition (JME, formally known as J2ME) environment whereby third party developers can write small programs called MIDlets which run on the device. JME is the most widely available mobile application environment in the world and contains standard APIs, although most manufacturers have extended them or even added their own. Through these APIs, third party developers can assess an increasing amount of native phone functionality, such as the address book, GPS, touch screens and messaging. The market reach for developers focusing on JME is huge, given the estimated 70% market share for feature phones worldwide.

Some devices also support the Binary Runtime Environment for Wireless (BREW) platform from Qualcomm. While this is not a true virtual environment like JME, it does offer APIs, and applications can be coded in C, C++ or Java.

Currently the most significant challenge facing testers of third party applications is that of platform fragmentation. Given the large number of mechanical styles, screen sizes and platform hardware used in the feature phone segment, together with the fact that device manufacturers often support less than the full set of defined APIs, and often add their own proprietary ones, testing across a wide range of devices is necessary to ensure sufficient test coverage.

Applications can be deployed to devices in a variety of ways. The most popular are apps stores, such as GetJar and the Nokia Store. Applications can be downloaded and installed in a similar way as for smartphones, and usage of these stores is large – there are over 100,000 applications in the Nokia Store for devices running S40, whereas GetJar has over 3 million downloads a day and can claim to be the second biggest App Store in the

world. It is important to ensure that app store submission, download, install and uninstall are all tested.

So, as a tester, what in particular should you look out for when testing for feature phones and feature phone applications? A useful checklist of areas should contain:

Areas That Would Be Tested on a Smartphone Application

In some ways, a feature phone is not really that different to a smartphone and the gap between the two, particularly at the top end of the feature phone price points, is becoming increasingly blurred. Therefore it is important that a successful test strategy focuses on areas such as application functionality, network interaction, stress and loading, and location where appropriate. A good starting point would be to take a look at the recent mind map from Ministry of Testing. Top end feature phones now support maps, push email and games such as Angry Birds. However, some areas become more important when considering the feature phone space.

Network Interactions

Feature phones are used, particularly in the developing world, in areas where the mobile network is not as reliable, nor the signal as strong, as in developed countries. Infrastructure in cities is typically more overloaded with users and network cells are typically larger in the countryside, meaning that the distance from cell tower to mobile phone is greater. This means that any mobile application needs to be highly resilient to network, or data carrier, loss or degradation. Considering cases where network interaction is abruptly lost, and the effect that has on the application under test, is critical. Use cases, such as going into and out of network coverage whilst using an application, are also highly relevant.

Battery Life

The effect of an application on battery life should be well understood when testing mobile devices, irrespective of the platform. However, in the feature phone case, battery life can become even more important when one considers a typical developing world use case related to battery life. In countries where the electricity supply can be erratic and homes may not have their own supply at all, necessitating charging at 'charging shops', then good battery life becomes crucial. A well written application should not use excessive battery, and it is important to test for battery life impact, either by using an off-device monitor, or by executing typical cases and monitoring the battery life via the device's battery level indicator. It is also important to consider the performance of the device or application when the battery runs out; does it crash or does it exit gracefully when power becomes low?

Device Use Time

Feature phones typically have much better battery life than smartphones and, as a result, are often left for longer before either being power cycled or rebooted. Some typical use cases also lead to longer device use times. A good example would be music player usage – in developing countries the mobile device is often used as the primary music player and radio, and therefore the music player applications can be left running for 10 hours or more. Ensuring that the applications themselves continue to function, and that bugs such as memory leaks are not present, requires a different approach to testing. Long use case tests are more important in the feature phone space than the smartphone one and can reveal bugs than otherwise would not be found by shorter functional testing.

SIM Cards

If the application under test uses data stored on a SIM card or memory card, then it is very important to ensure a relevant number of cards are obtained and used for testing. Not all SIM cards are created the same and some are considerably slower than others; this seems to be a particular problem in developing countries, such as India. Some brands of memory card can also be slower and this can have an effect on the functionality of the device or application. Obtaining, and testing with, cards that are relevant to the intended launch country/area for the application or device will help to reduce the risk of early field returns due to incompatible or slow cards.

Significant numbers of feature phones support multiple SIMs and may also support the swapping of these SIMs without a need to power down the device. There are a number of related use cases to consider including:

- What happens to the application when removing the battery without shutting down the application? This is a typical use case when swapping SIMs.
- What happens to an application which uses SIM data when the SIM is swapped? Is the data still available or is it removed?

Data Sharing

Although data usage and its cost are becoming highly prevalent and increasingly cheap in the West, this is less so in developing markets where consumers are extremely cost conscious. As a result, usage of applications such as cloud based proxy browsers, which reduce data usage by compressing webpages prior to delivery to the mobile device, are very popular. Users are also most likely to share content via free channels such as Bluetooth and Infrared. It is important to consider all sharing methods when testing and also to consider whether the application under test offers the lowest cost methods.

Usability

Feature phones typically have smaller screens and different input mechanisms when compared with smartphones. Feature phones can have screens as small as 128 × 128 pixels and ensuring that an application makes the most of the limited screen estate is an important consideration when testing. Issues such as text size, the level of information detail to present per page, and the amount of scrolling required in order to view the most important information, become more important when the screen is so small. Since an application may need to support a large range of screen sizes, it is important to test that the UI scales well.

Although a significant number of feature phones have mechanical keypads, typically in an ITU-T (i.e. numbers only) or QWERTY configuration, and this makes selecting options on the screen easier, more and more are now being produced with touch screens. These are typically the cheaper resistive panels which require a harder and more accurate press in order to select options and it is important to ensure that the usability of the application or device does not suffer too much as a result. Consideration should be given to how the user will scroll and pan around the screen, and how they will select areas using either finger or stylus.

It is also relevant to consider, and test for, multiple language support. In countries where more than one language is spoken, applications may need to support multiple languages and this is equally true for an application

which launches in multiple countries. One particular area to focus on is ensuring that, if appropriate, the application supports both left-right and right-left languages without layout or readability issues.

Limited Device Memory and Processor Capability

Feature phones, by their cheaper nature, contain less device memory and lower specification processors than smartphones. They are unlikely to have dedicated graphics processors. Therefore it is crucial that any test strategy for the device or application considers use cases where the memory is full and where the device is being stressed by multi-application usage. Users will often run their feature phones with almost all available memory full, since often only around 10Mb is available, and the behaviour of any application should be tested under these conditions. Although few feature phone OSs offer multitasking and background applications, it is also important to test for interruptions from other applications such as incoming calls and SMSs, the music player (typically allowed to run in the background on feature phones) and data synchronisation via Bluetooth, cellular data or IR. Other functionality, such as backup and restore, can also run in the background on some feature phone OSs.

Devices

As mentioned when discussing third party runtimes, there is significant device and OS fragmentation within feature phones. The level of support for JME or BREW APIs, as well as the sheer number of available hardware and software configurations, can become very confusing. As a recommendation, it is a good idea to take time to understand the market in the area in which the application is intended to launch. Find out what the more popular new devices are and which devices are already available. This can help focus strategy towards a smaller number of devices which then should be purchased for testing usage. In the feature phone world where processing power and device memory are lower, testing on the device becomes even more critical than with smartphones. Emulators will not do and, although some feature phones are supported on the popular cloud based services such as Perfecto Mobile (*www.perfectomobile.com*), the offering is not comprehensive and nothing beats having the device in the hand to assist with testing.

A Successful Feature Phone Application Test Strategy

In order to successfully launch an application for feature phones, it is important to consider all of the above areas. The market reach for feature phones is still very large and, therefore, any application could be in the hands of millions, all of whom will expect it to work as intended. Testing should work to reduce the risk of a poor quality application release and it is sensible to consider at least the following areas.

- Test on the device and do not rely on emulators. Feature phone fragmentation is large and the devices themselves have slow processors and low memory, which cannot be emulated.
- Battery life is key to a feature phone. It needs to be great and the user may not be able to recharge it easily. Make sure it remains good when the application under test is being used.
- Feature phone users are often more financially constrained. They will use the lowest cost method of carrying out their particular use case. That could mean swapping a SIM, sending via Bluetooth, copying to, and then removing from, a memory card. Does the application under test use the cheapest method and does that work?
- Consider usability. Feature phones have smaller screens, applications typically support more languages, and input mechanisms are different when compared with smartphones.
- Feature phone users may connect using less reliable networks with lower signal strength. How does the application under test handle this?
- Feature phone users do use apps stores. They download millions of apps a day and those stores are probably bigger than you think. It is important to ensure that app store submission, download, install and uninstall are all tested.
- Feature phones run out of processor capability and memory more quickly and more often than smartphones. Stress them and stress the application under test. If you don't then you can be sure the users will.
- People use feature phones in different ways to smartphones. They run applications like the music player or radio, for example, for much longer. They share phones. They swap SIMs. Take time to understand use cases like this and test for them. Take time to understand the consumer and think about how they will use the application, maybe not in ways that you would.

Taking all of this into account, there is a lot of scope for testing feature phone applications and the devices themselves. The feature phone market share is still very high. Feature phone users are more quality conscious and less willing to tolerate poor quality when compared with smartphone users. They expect more and when an application can be in the hands of millions or even billions of people, via a feature phone, it should receive the most comprehensive testing that it can before launch. ■

> about the author

Stephen Janaway has been working in software testing for over 12 years, focusing on mobile devices and applications. He has worked for companies such as Ericsson, Motorola and Nokia in software testing and test management roles and, until recently, was heading a software test and quality assurance group in Nokia UK, focusing on mass market devices. Stephen is now an independent consultant offering mobile testing services.

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Daniel Knott

Best Practices in Mobile App Testing

When testers think about software testing, they will most likely check the documentation, functionality, API, performance, and make sure the software is secure, along with the many other things that depend on that particular piece of software. When it comes to mobile testing, testers have to think about mobile-related functions based on the user's mobile usage patterns.

This article is based on my work experience as a software quality assurance manager in an agile software development team, focusing on mobile apps for iPhone, Android, Windows Phone 7, and mobile web apps. During my daily work within the XING mobile team and exchanges with other mobile test experts, I have gained a lot of insights into the challenging job of mobile testing. Over time, I have defined mobile best practices that helped my colleagues and I to improve test activities and to provide our customers with a higher quality app. Some of these best practices will be covered in this article.

Functional Testing

Every new feature that is developed needs to be tested. Functional testing is an important aspect when it comes to mobile app testing. Based on the developed test cases, mobile testers should do manual and automated testing. At the beginning of the test phase, a tester must test the mobile app manually as a "black box" to see if the functions provided are correct and work as designed.

Besides textbook software testing, like clicking a button to see what happens, mobile testers must perform more functional, mobile-device-specific testing. Today, modern mobile devices have a touchscreen requiring multitouch gesturing to interact with them. Devices can be used in portrait or landscape mode. They provide motion, tilt and gyroscope sensors. They have different interfaces to communicate with other devices or services like GPS, NFC, cameras, LEDs and many more.

A mobile software tester must be sure that the app will work with all these specific device functions if they are used within the app. The sheer number of different mobile devices means that it is not possible to cover all of them during testing, so testers need to focus on key areas of their app during functional testing.

What has proven to be very useful, yet simple, is device rotation. During my testing activities, I found so many bugs just by rotating the device from portrait to landscape mode and back again.

Besides the entire manual testing process, it is really important to have good test automation in place for mobile applications. Every code change or new feature could affect existing features and their behavior. Usually there is not enough time for manual regression testing, so testers have to find a tool to perform automated regression testing.

Currently, there are a lot of mobile test automation tools on the market, both commercial and open source, for each different platform like Android, iPhone, Windows Phone 7, BlackBerry, and mobile web apps. Depending on the development strategy and infrastructure, quality assurance experts need to find the test automation tool that best fits their environment.

From an Android perspective, there are open source tools like Robotium [ROB01], Robolectric [ROB02], Roboguice [ROB03], MonkeyTalk [MON01], Monkeyrunner [MON02], NativeDriver [NAT01] and Calabash for Android [CAL01]. The Android test automation tool Robotium has become the de facto standard in the open source world, as it is able to simulate real user interaction on real devices. It is really easy to use and is based on Android test instrumentation.

iPhone test automation tools include KIF (Keep It Functional) [KIF01], UIAutomation [UIA01], MonkeyTalk [MON01], Calabash for iOS [CAL02], Frank [FRA01], Zucchini [Zuc01], and many more. All of these tools are also able to simulate real user interaction on a device or on the iOS simulator

Choosing a tool for test automation is not easy, but one fact should always be kept in mind when making a decision, as it is crucial – the test automation tool should use the same programming language as the production code. If the test and production code are written in the same language, it provides a number of benefits for both testers and developers, as it makes it easy for them to do pair programming. Testers can exchange with developers on the same level, they can ask questions related to the programming language, and they can perform code reviews of the test and production code. When it comes to test automation, developers can write their own scripts in the language they are used to.

Summary:

- Test the app as a "black box" and try to break it.
- Open every screen of the mobile app and change the device from portrait to landscape mode and back again.
- Don't forget to test device-specific functions, like sensors and communication interfaces.
- Write test automation scripts for mobile apps.
- Choose a test automation tool that fits into the company strategy and infrastructure.
- The test and production code should be in the same language.

Non-Functional Testing

Another important area of mobile app testing is testing the non-functional requirements of a mobile app. There are several issues that mobile testers need to test before a release or further development.

The first tests to be performed during the early development phase should be usability tests. These should be carried out by alpha users or work colleagues. Go to a café or restaurant and ask people questions about their app usage. Show them a first version of the current development state and collect their feedback. See if the users are able to work with the new features to get a first impression.

Inspect the performance of the app. Compare the released version with the current version to see if the performance is the same, better or perhaps even worse. Install the app on older devices to see if the app still runs on them, despite poor hardware specifications. Do the same with state-of-the-art devices as well.

Test how the app reacts to incoming phone calls, SMS, MMS, tweets or other notifications. Check the battery drain while using the app. Be sure that the test device is fully charged for testing and verify the battery usage every 10 minutes to see if the app is consuming too much power. Install the app on devices with a very low battery level and check what happens.

Validate the app's memory usage. If the app is storing data on the local file system, test the usage of different memory cards. Consider what will happen when the local storage is nearly full – will the app crash or notify the user with a proper error message?

Test the app's installation and deletion process. Even more importantly, test the update process from an older to a newer version. Maybe the local database has changed, which in turn could cause some serious migration problems.

Is the app localized? Testers need to test the app in different languages. Make sure that every string has been translated into the required language.

Don't forget to test on different network carriers and at different network speeds. Make sure the app works with GPRS, EDGE, UMTS, LTE and WiFi. Don't forget to check how the app reacts if the network connection is sketchy or drops completely. Use the app in flight mode and see what happens if a request fails.

Connect the test device to a computer and validate the development log files to see if there are any exceptions, warnings or other strange abnormalities there.

These are just a few of the non-functional requirements mobile testers and developers should think about when developing and testing an app. It is simply not possible to check everything, and the whole team should support QA members in covering most of the above scenarios in order to prevent the user from receiving a bad experience.

Summary:

- Do usability testing.
- Compare performance levels between the released and the new version of the app.
- Check how the app reacts to incoming calls, SMS, MMS, or tweets.
- Validate the battery drain of the test device.
- Test the app's memory usage.
- Install and delete the app.
- Test updating from an old to the latest version.
- Verify the translation into other languages.
- Use the app on different carriers and network connections like GPRS, WiFi, or LTE.
- Check the log files for errors or exceptions.

Test Devices – Fragmentation

The key question regarding mobile test devices for a mobile quality assurance person is, *"Which devices are right for testing?"* This question needs to be answered because it is simply not possible to do testing on every device!

As things stand, there are two big players on the mobile device market: Android and iOS! But there are several other platforms that are used fairly often, depending on the geographical region. These are Windows, BlackBerry, webOS, SymbianOS, and feature phones. The chart (*Figure 1*) shows smartphone operating system usage by vendor in China, Germany, and the USA.

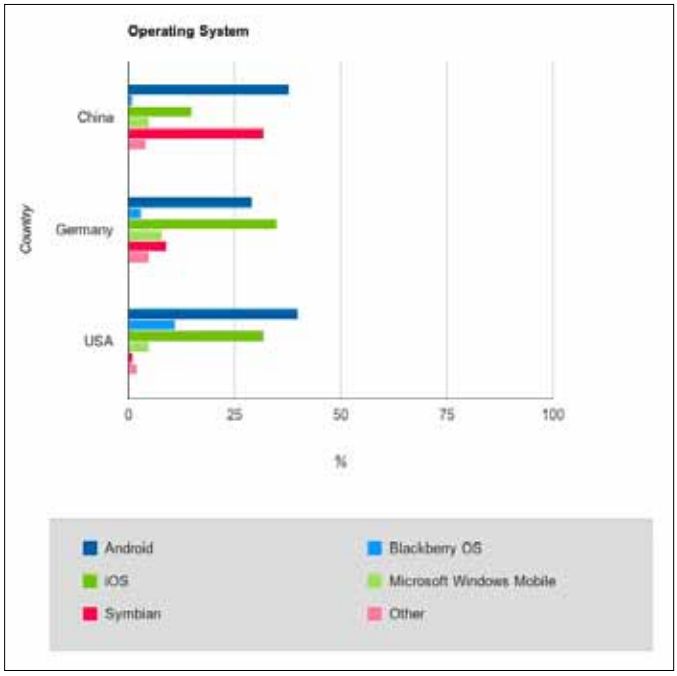

Figure 1: Smartphone operating systems by vendor. Data from www.thinkwithgoogle.com/mobileplanet/en

Nearly every platform has different device vendors who sell smartphones with different hardware and software specifications, as well as customized user interfaces. For example, in the Android world there are vendors like Samsung, HTC, ASUS, LG, Motorola, Sony, Huawei, and many more. This is a serious case of device fragmentation and it is really difficult to find the right devices for testing.

Thinking about mobile websites is another challenge that can be really painful, due to the various mobile browsers such as Safari, Opera Mini, Dolphin, Android and RIM native, Google Chrome, Firefox, Internet Explorer 9, and some other feature phone browsers!

So what is the right choice for testing? Just use the latest devices and browser versions? Buy every device on the market? Or use simulators or emulators?

A little side note about simulators and emulators: don't use them for testing! They may be useful for basic testing, but the results are not the same as on real devices.

In my opinion, a really good approach to solving the test device problem is to group the devices and browsers. For example, mobile testers can group devices depending on their hardware and software specifications. Each group is assigned a priority, like A = highest, B = average, and C = lowest. Each group contains devices that are assigned to that category, depending on the platform and vendor.

Overview of possible group categories:

- **Group 1, priority C:** Small devices with a small CPU, RAM and low resolution. Older software versions and older browsers.
- **Group 2, priority B:** Mid-range devices with an avg. CPU, RAM (<512 MB), good screen size and resolution. The software is not the latest.
- **Group 3, priority A:** High-end devices with a dual/quad-core CPU, RAM (>512 MB) and a high screen resolution. Latest software versions.

These three groups cover most of the users on a specific platform and also represent other phones on the market that fit into the same group. This will downsize the amount of effort required during developing and testing.

Summary:

- Group and prioritize test devices and browser versions.
- Do not use simulators and emulators for testing.

Combine Tools

As mentioned before, mobile testers must do test automation for mobile apps in order to make sure that code changes do not affect current functionality. Another best practice is to combine testing tools and integrate them into a continuous integration server in order to execute them from a central place. Developers need to write unit tests for their code to be sure that each small component is safe and works as expected. In addition, it is very useful to use tools like Robotium or Keep It Functional to implement end-to-end integration tests, which behave in the same way as a user.

Summary:

- Combine testing tools and integrate them into a continuous integration system.

Internal Beta Releases

If a mobile team wants to get early beta testers of the mobile app, they can set up their own internal app store, e.g. for Android and iPhone. With the hockeykit [HOC01] tool, the team is able to distribute new versions of the app to colleagues via the company WiFi. This is an extremely helpful way of getting initial feedback from colleagues, especially if the team or tester doesn't have an opportunity to show the app to the outside world. Hockeykit also provides useful statistics about how well the app has been tested and which OS versions and devices are used by colleagues. It also includes a crash reporter to see what causes errors and crashes in the current development version.

Summary:

- Use internal beta releases to get early feedback.

Know the Customer

Mobile testing is far more effective if the developer and testing team knows the customers who will use the app later on. A good place to gather information about customers is the app store of the specific vendor (Apple App Store, Google Play Store, Windows Marketplace, and so on).

If a team already has an app in one of the stores, they will receive information about devices, software versions, languages, and carriers used by the customers. Figure 2 below is an example from the Google Play Store which shows statistics about a released Android app.

When it comes to mobile web pages, there is no app store to provide such user data. It therefore makes sense to collect information about the 'user_agents' (devices, browsers) used within the mobile website. With that knowledge, the team can optimize and decrease the amount of development and testing effort required for the various devices and software versions.

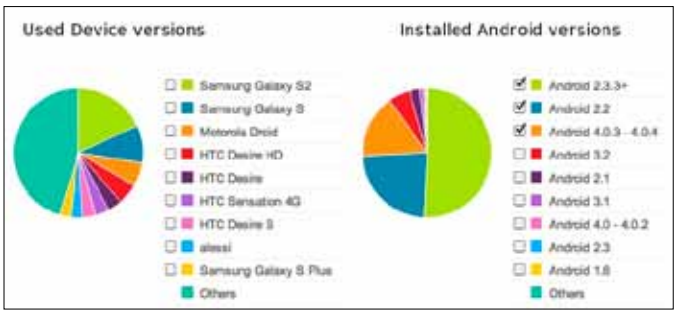

Figure 2: Statistics from Google Play Store about used Android devices and OS versions.

Besides user statistics, customer reviews in the app store should be carefully digested in order to collect vital feedback and feature wishes, and react to reported bugs.

Summary:

- Know the devices and software versions your customers use.
- Use statistics from vendor market places.
- Take app store reviews seriously.

Be Active in Communities

This is one last best practice that is not directly relevant to daily mobile testing activities, but may help you to think differently and get new ideas. Be an active software tester in communities like:

- utest (*www.utest.com*)
- mobileqazone (*www.mobileqazone.com*)
- softwaretestingclub (*www.softwaretestingclub.com*)
- etc.

In such communities, software testers can exchange views with other (mobile) quality assurance experts on various testing topics. They can share their knowledge and help other people to solve problems they encounter. Testers can receive great new ideas when it comes to writing test cases, on how to write good bug reports, and improve their own testing and test automation skills. ■

> about the author

Daniel Knott has a technical background involving various different programming languages and software quality assurance tools. He has been working in the field of software development and testing for seven years, and has been working at XING AG in Hamburg, Germany, since 2010. During the course of several projects, e.g. XING search and XING recommendations, he was responsible for test management, test automation and test execution. Daniel's currently position is Team Lead Quality Assurance for the XING mobile and XING API teams. Within the XING mobile team, he is also responsible for the test management and test automation of the XING Android and iPhone apps. Daniel has a broad range of experience in software test automation involving tools like Robotium, KIF (Keep It Functional), Selenium and Java. He has also held presentations at various agile conferences and regularly posts on his blog (*www.adventuresinqa.com*) and the XING devblog (*devblog.xing.com*).

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Kiran Rayachoti

Mobile Test Strategy

I have been in the IT industry for more than a decade and spent most of my time in quality assurance, covering wide range of testing types including manual, automation, performance and mobile testing and also in setting up TCoE. Out of all these, I can see mobile testing presents a completely different range of challenges and learning that one has to adopt to implement it successfully. Below is my experience for testing mobile applications end to end, which includes all kinds of testing with various tools.

Enterprise applications delivered on mobile devices are extending across the workplace like never before. Many applications that were deployed as desktop applications are now being ported to mobile devices, and mobile applications are being built to be as agile and reliable as PC-based applications. In order to meet the challenge, mobile application testing has evolved as a separate stream of testing.

In this paper, I outline the unique challenges in mobile business applications testing and briefly explain the critical success factors, mobile tools, and approach for manual, functional, automation and performance testing of mobile applications.

Mobile Environment Growth

To say that the use of mobile applications is booming would be an obvious understatement. In 2010, mobile application stores recorded an estimated $6.2 billion in overall sales, including $4.5 billion in application downloads.

By 2013, some analysts expect mobile application revenues to exceed $21 billion. As Figure 1 indicates, mobile devices are already the most commonly owned technological devices in the world. There are 3.3 billion mobile subscribers in the world, as opposed to 1.5 billion televisions, 1.4 billion credit cards, 1.3 billion landline telephones, 0.9 billion personal computers, and 0.8 billion cars.

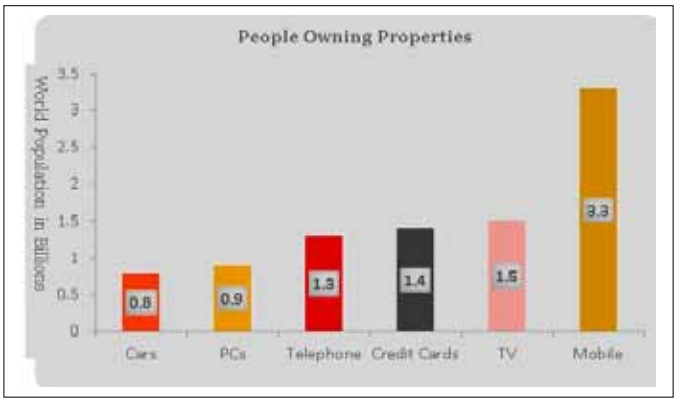


Figure 1. Mobile Device Ownership (Compared to Ownership of Other Technological Devices)

There are currently 3.75 billion unique mobile subscriptions worldwide, and 1.45 billion mobile subscribers have a second or third mobile subscription. This makes for a total of 5.2 billion mobile subscriptions worldwide.

In 2010, mobile voice calls grew by about 2% (to $625 billion), while mobile data accounts grew by about 17% (to $295 billion).

The Mobile Application Landscape

The mobile application landscape consists of the mobile web and mobile apps. The mobile web is typically a general website, adapted for use on a small-screen mobile device. Its functionality tends to be more limited than that of mobile apps. Mobile apps, on the other hand, are applications that are actually downloaded and run on the mobile device. Mobile apps tend to have much faster speed and performance than the mobile web; they also tend to offer a much wider range of features and capabilities than the mobile web. For example, with the Amazon mobile web you can shop online from your mobile device; with the Facebook mobile app you can post a message on someone's wall from your mobile device.

Figure 2 shows an example of a mobile website (for Amazon) on the left and some examples of mobile apps shortcuts (for Facebook, Bank of America, Skype, etc.) on the right.

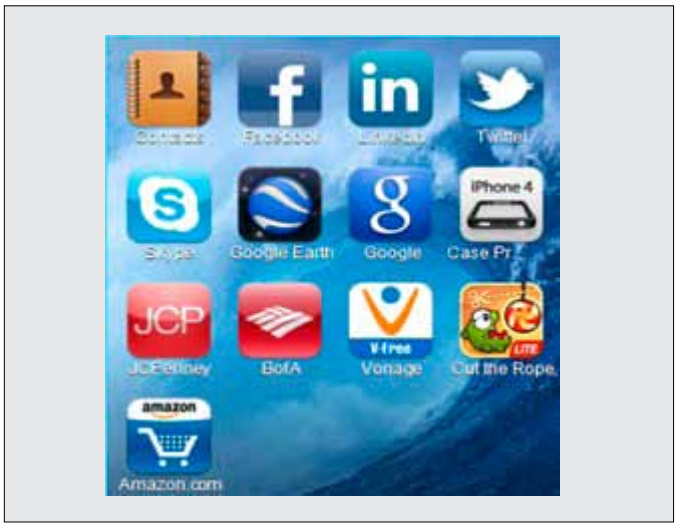


Figure 2. A Mobile Website and Some Mobile App Shortcuts

Key Challenges in Mobile Testing

Unlike the PC-based environment, the mobile environment consists of a plethora of devices with diverse hardware and software configurations and communication intricacies. This makes the testing of mobile web and mobile apps a much more complex matter than the testing of websites and applications for personal computers; testing on many different devices and models can become very expensive and time-consuming. Other challenges in mobile testing include the following:

- Due to the wide variety of display sizes and resolutions across mobile devices and models, the rendering and positioning of images can vary widely.
- The network latency will be unpredictable when applications communicate over network boundaries.
- Testing with real devices allows testers to verify that what is shown on the device's LCD "looks cosmetically correct", but provides very

little access to any type of diagnostic information other than what is shown on the LCD of the real device.

- For most performance problems (e.g. slow page loads) testing with a real device does not provide the detailed root-cause analysis that is needed to solve the problem.
- With an actual device, it is not possible for the tester to know the URL redirect/page inner text context.
- Test automation is not feasible in a seamless manner on an actual device.

Mobile Testing Approaches and Tools

To conduct effective testing for mobile web and apps, a combination of emulators, simulators and real devices is needed. This has to be a blended approach of emulators, simulators, tools and real devices.

Let's take a look at the kind of testing that we should target for mobile web and apps.

- Usability testing
- Functional testing – manual
- UE testing
- Regression testing – automation
- Accessibility and security testing
- Performance testing

All mobile testing centers around the emulators, tools and devices.

So, let's understand what an emulator and a simulator are!

Emulators

An emulator is a hardware replica of an actual mobile device. The emulator simulates the mobile device and enables the tester to test a mobile app on a PC without having to test it on an actual mobile device.

There are three types of emulator:

- Device emulators are generally provided by the device manufacturer. The device emulator is specific to a particular model of a device.
- Operating System (OS) emulators are provided by Microsoft and Google for their respective operating systems. An OS emulator mimics the specific operating system for a device and runs on a PC. OS emulators typically have a dependency on the build tool that is used to emulate the mobile environment; for example, Xcode is a build tool for the iPhone and the Eclipse Emulator is a build tool for the Android.
- Browser emulators are generally available on the respective device web sites; they run on a browser that is not necessarily on a mobile device (i.e. they can run on a PC browser). There are a great many open source emulators on browsers, such as MobiOne for the iPhone and Android Emulator 1.5 PC for the Android.

One of the greatest advantages of testing with emulators is that an emulator will let you know exactly what is happening "behind" the device LCD, allowing a tester to do a debug and actually open up a screen to see what is happening. This provides the tester with a great deal of insight into problems and makes it easier for the developer to fix the defects. The tester can also provide the developer with screenshots, high-level information, and data messages. This reduces the level of effort that will be required on the part of the development team to solve the problem.

Other advantages of using emulators are the following:

- Emulators tend to be cost-effective because most of them are freeware.
- Because the virtual device (emulator) is in control of its own software stack, testers can collect important information on "each component" of a content page. Some examples of this information include inner text and page redirect URLs.
- Many types of content compatibility tests – such as verifying image sizes or identifying broken links – can be accurately and quickly performed.

Simulators

Whereas device emulators are hardware replicas of specific devices, simulators mimic the software of the device for testing purposes. Testers typically use the native browser of a PC for mobile browser simulation. (Note that simulators are used for testing the mobile web, not mobile apps.)

To get a native browser to simulate a mobile browser, testers change the "User Agent" settings in the native browsers. This approach is typically used for automated functional testing.

With simulators, testing can be done quickly and easily without the use of emulators. In addition, simulators are cost-effective because they can be used without purchasing any new software.

For Firefox browsers simulating iPhone and Android, automation is possible with tools like QuickTest Professional.

But this is mainly from the functional rather than look and feel perspective and is primarily used for functional automation testing. To reduce manual effort/cost, one of the popular ways is to go for functional automation. For mobile web, this is the way automation can be successfully done and can greatly reduce effort.

Test Automation

Because mobile testing must be performed on many different combinations of devices, browsers, and operating systems, it is time-consuming – and costly – to do all of the testing manually. Test automation can be used to reduce the time and costs associated with testing. In addition, test automation can be used to increase the productivity of the test team. But key call out, automation testing is not intended to replace manual testing it is to reduce the effort/time to market for the product.

Testing tools stack will be different for automating mobile web compared with mobile apps. For mobile web, my experience is with HP QTP and it works to the optimum usage of functional regression testing. The test automation frameworks (key word/data driven/hybrid) are supported in the QTP testing tool. By simulating the native PC browser as a mobile browser, we can run the QTP scripts on the mobile web. This gives us good coverage of the functional areas of the mobile web regression test cases that has to be repeated.

For mobile apps testing, the recommended test tool depends on the device platform:

I have been involved in doing POCs and also some implementation of automation for mobile apps, leveraging QTP (with Muex), FoneMonkey (open source), and DeviceAnywhere tools. There are also a few other tools on the market for mobile apps testing.

But there has to be a clear goal/objective defined before investing in mobile apps testing. Because it has its own challenge like tools support, personnel learning curve and infrastructure support as well. If the project team is serious about leveraging automation benefits, they can look at the available tool options for apps automation. This will mainly be useful for the e-commerce/retail apps, as the app's stability is key in generating revenue for the companies.

Load and Performance Testing

The performance of the mobile web, or mobile app, is the most significant factor affecting conversion rates for mobile device users. (If the performance is too slow, the user will leave the site.) Load and performance testing is critical in spotting load and performance issues that can have a negative effect on user conversion.

For the mobile web, HP Load Runner/Performance Center can be used for load and performance testing. This product tests mobile web browser performance by getting a native browser to simulate a mobile browser.

For mobile apps, it depends on the platform and architecture of the mobile apps. Most mobile apps get their data through the service layer. One way we can do performance testing is by stressing the service layer of the mobile app while manual users simultaneously access the apps. For example, if the data layer is through web services or a REST services call, the performance of these services is tested while manual testers simultaneously access the mobile app. With this approach, something close to real metrics can be achieved.

Using the "Prioritized Platform Matrix" for Testing Actual Devices

When doing testing of actual devices, it is necessary to test the application on every possible device platform. For example, if you are testing an Android application, you could end up having to procure 20 or more devices (e.g. Samsung, Motorola, etc.) and test on all of them. To avoid this scenario, you can utilize a Prioritized Platform Matrix in your testing. This approach can actually reduce the number of combinations that you have to test.

This testing approach consists of two steps:

1. Define parameters of importance. The parameters of importance are the factors that influence the importance of specific hardware and software combinations. We can assign the relative priorities based on the scope of the project. For example, if the scope is only iPhone and Android, there will not be any relative rating for Blackberry and Windows; if we are building a mobile web application, the OS will not have much weightage, as we will deal primarily with the browser version. You need to get this information from the business requirements. Some of the factors that influence the importance of this combination are:
    - Manufacturer
    - Resolution
    - Aspect ratio
    - Recommendation of business to conduct test or get statistics for a particular device or OS
2. Prepare a matrix for all possible combinations. A matrix is prepared which represents the score for each combination. The score is calculated as per the relative scores of the combinations. A higher score indicates the higher criticality of the combination.

Figure 3. An Example of a Prioritized Platform Matrix

User Experience Testing

It is a good idea to start user experience (UE) testing very early in the test cycle. Most people tend to make it the very last test they perform, but UE testing can uncover lots of problems with such elements as appearance, fonts, text colors, background colors, content, layout, etc. It is a good idea to catch these things and fix them as early in the cycle as possible. The scope of this testing is based on the style guides, copy documents and content from the business requirements.

For mobile applications, this testing plays an important role, as even a small discrepancy is highly visible to the end customer. So, this has to be prioritized at the beginning of the project, rather than waiting until the tail end of the project.

Accessibility and Security Testing

For accessibility testing, the W3C guidelines 'A', 'AA', and 'AAA' apply for mobile devices depending on the organization's standards (i.e. organization standards can override priority of any one of these criteria but not the content in this selection). Some web tools that can be leveraged for accessibility testing include WAT, WAVE, JAWS, and Outspoken.

For mobile apps, there are in-built tools for some of the devices which can be leveraged to test the accessibility testing. For example, iPhone apps can be tested with the help of the in-built tool it has.

For security testing, 10 OWASP rules apply and regular security checks – such as authentication checks, input validation checks, session management checks, encryption checks, application checks, and injection checks – should be performed. Some web tools that can be leveraged for security testing include HP WebInspect and Web Proxy Editor, and there are few other tools as well which can be leveraged for the security testing.

For effective mobile testing, the following would be the critical success factors.

- Usage of emulators and simulators
- Testing on selected actual devices, at least one round of testing for look and feel validations
- Effective implementation of test automation

- Thorough user experience testing for styles, fonts, content, images, layouts
- Performance testing
- Usage of various tools to support different kinds of testing
- Testing on multiple networks (depending on scope). There are companies who provide this service on the SaaS model, like DeviceAnyWhere
- Choosing the right OS, browser, and device versions using 'Prioritized Platform Matrix' to have good coverage of devices

Guidelines for Mobile Application Testing

Observe the following guidelines when doing mobile testing:

- Have an understanding of the network and device landscape before you begin the actual testing.
- Simulate the real-world mobile web and mobile app environment to the greatest possible extent.
- Select the right automation tool. The following are things that you should look for in an automation tool:
    1. It should support multiple platforms.
    2. It should support various testing types.
    3. It should support end-to-end testing, even if it is necessary to connect to third party applications.
    4. The learning curve for the tool should be easy.
    5. Test script maintenance should be simple.
- Use the Prioritized Platform Matrix for testing different combinations on actual devices.
- UE testing – and some high-priority test scripts for performance testing – should be done on the actual device.
- The agile project's general staffing ratio of 1:3 (tester:developer) may not work for mobile testing projects. As the combination of devices will be greater, and due to some automation challenges, the general ratio should be 1:2. (The efforts actually depend on the project/testing scope and may differ from the 1:2 ratio). But for large mobile testing projects, we cannot manage the entire testing with a lower number of testers without leveraging tools. ■

> about the author

Kiran Rayachoti is a Senior Manager Program Management at Sapient. He has 10+ years' of rich experience in QA engagements, process, methodologies, test automation, performance testing and business UATs. He initially started the career in development and then moved to different domains like Pre-Sales, Program Management and QA. He deals with defining architecture of test systems, converging systems after acquisitions, manage people, implement process improvement and change management, project management, data driven decision making and setting up the best practices for TCoE.
Kiran has successfully executed QA functions with large teams across geographies for major Clients, QA process/automation testing end to end working for transport, e-commerce, CMS and CRM & ERP clients. He was part of the small startup and initiated the TCoE earlier.
Kiran is currently managing the entire QA program function for a large multi-million $ retail project which spans across multi-channel including mobile web and apps as well. He is an active member of QA forums and has presented white papers, webinars on QA Strategies and Automation methodologies.

Pawel Oczadly

Driven Development for the Android platform

Introduction

Behaviour Driven Development is a popular agile methodology developed by Dan North. The main goal of BDD is to support the cooperation between programmers, QA engineers and non-technical people in software projects. Dan North gives us the following description: "BDD is a second-generation, outside–in, pull-based, multiple-stakeholder, multiple-scale, high-automation, agile methodology. It describes a cycle of interactions with well-defined outputs, resulting in the delivery of working, tested software that matters." BDD focuses on writing test cases in natural language in the Given-When-Then pattern. It is clear to understand and easy to discuss current test cases with project managers or stakeholders. Nowadays, there are a lot of tools which help implement user stories according to BDD methodology. In this article I would like to describe how BDD best practices can be used in Android web applications.

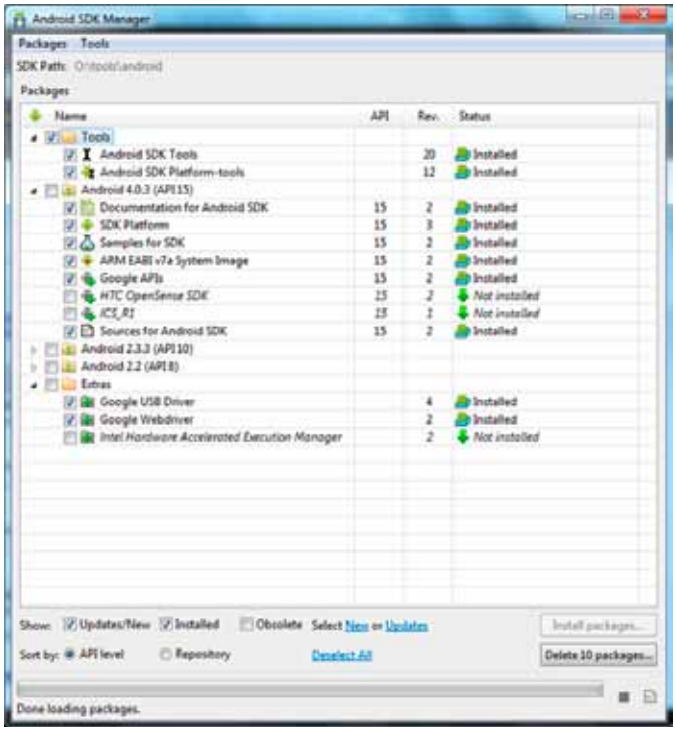
In this article I will show you how to build advanced automated tests for Android mobile browsers. I will use Eclipse, Maven, Cucumber, Jenkins, Android SDK and Selenium Webdriver. The BDD tool which will be presented is Cucumber JVM. This is a framework which executes plain-text functional descriptions as automated tests. Furthermore, it is created in pure Java implementation and supports JUnit framework. Cucumber uses feature files which contain test scenarios and runs JUnit tests when it finds Given, When or Then annotation. Here is an example of the feature file:

```
#author: Pawel Oczadly

Feature: Login page

      This feature contains test scenarios connected
      with login into user account

      It tests logging in with correct and incorrect
      credentials

Scenario: Logging in with correct credentials

      When the user types correct login

                And the user types correct password

      Then the User Account page is displayed

Scenario: Logging in with incorrect credentials

      When the user types incorrect password

                And the user types incorrect password

      Then the Login page is displayed
```

Environment

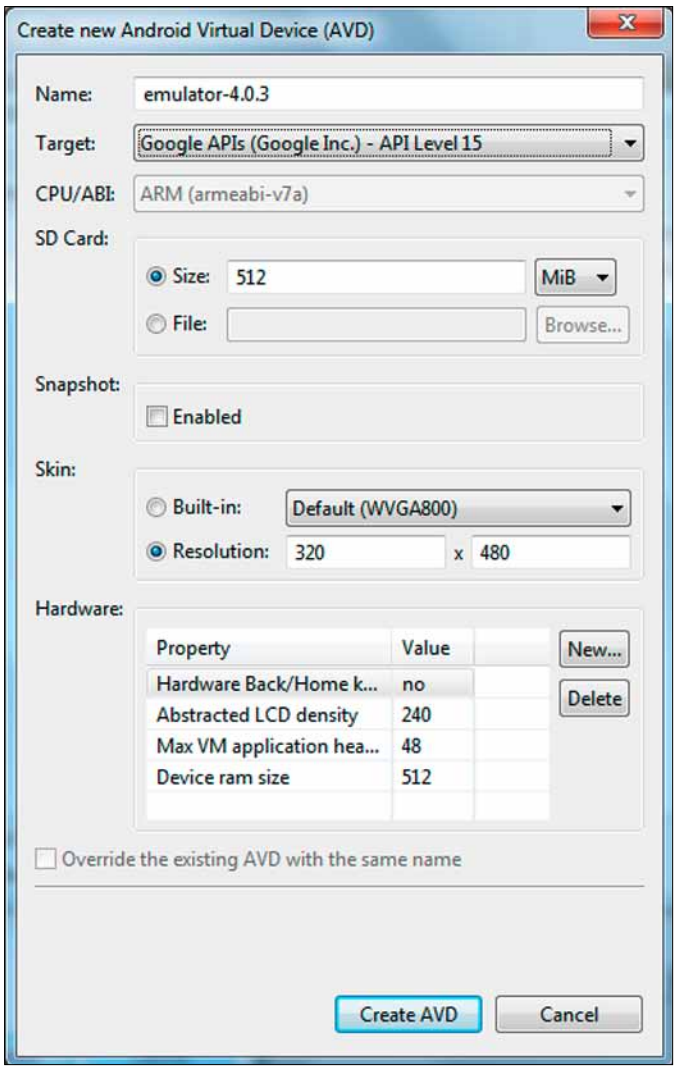
Now, it is time to set up the project and apply BDD in Android. The first things which are needed are JDK, Android SDK and Eclipse environments. After running Eclipse, it is necessary to install Maven within the application. Apache Maven is a software project management and comprehension tool. It is based on the concept of the project object model (POM). Maven can manage a project's build, report and prepare documentation.

After this process, it is time to configure Android SDK. Firstly, it is necessary to download SDK from the official Android website, then run SDK Manager and install the following packages.



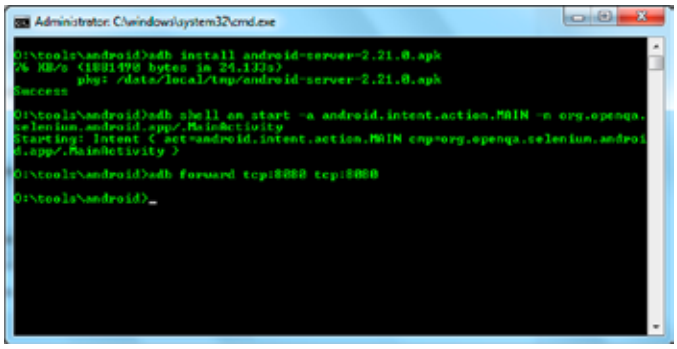
Android SDK contains modular packages that can be downloaded separately using the Android SDK Manager. For example, when SDK Tools is updated, SDK Manager can be used to download it quickly to the environment.

The next thing which is needed is to create the Android emulator. Run AVD Manager and create the new Android emulator as shown in the screenshot below.



The AVD Manager is an easy-to-use user interface for managing your emulator configurations. An Android Virtual Device (AVD) allows the modeling of different configurations of Android-powered devices.

Then start the emulator and install the Selenium Android Webdriver on it. Selenium Android Webdriver allows the running of automated tests on Android devices to make sure that web applications work properly on the mobile web browser. It simulates some user interactions, such as clicks, flicks, finger scrolls or long presses. To run Webdriver on emulator it is necessary to download the "apk" file from the Google Code website . Then install this "apk" file from the command line and set up port forwarding from the machine to the emulator as shown below:



As a result, the Android server is available at *http://localhost:8080/wd/hub*. The emulator is ready to perform the tests.

Now, it is time to configure Jenkins. Jenkins is a Continuous Integration (CI) tool which enables the executions of repeating jobs to be monitored. It supports more than 300 plugins of all kinds of software development. In this article I would like to show how to run and build a set of functional tests using this tool.

First of all, it is necessary to download Jenkins from the official website and install it using the command line by typing:

```
java –jar jenkins.war --httpPort=9090
```

This should take a while and then Jenkins will be available at the *http://localhost:9090/* address. The main page should look like the screenshot below.

Next it is recommended to add Jenkins Cucumber plugin. This is useful as it generates pretty reports which can be shown to stakeholders or other non-technical team members. Please refer to the following website: *https://github.com/masterthought/jenkins-cucumber-jvm-reports-plugin-java/wiki/Detailed-Configuration*. At this address, there are detailed install and configuration instructions. The environment configuration is complete now.

Sample project

Finally, I will briefly show you the example project. It contains some BDD scenarios and automated tests for the jQuery Mobile website using Android Webdriver. JQuery Mobile is a lightweight library which enables the creation of web user interfaces for all popular mobile devices. I have applied Page Object pattern for easy future maintenance of test scripts.

Let us begin with creating the project. Firstly, run Eclipse and create a new Maven project. In the "pom.xml" file add the following dependencies:

```
<dependencies>
 <dependency>
    <groupId>info.cukes</groupId>
    <artifactId>cucumber-java</artifactId>
    <version>1.0.11</version>
    <scope>test</scope>
   </dependency>
   <dependency>
      <groupId>info.cukes</groupId>
      <artifactId>cucumber-junit</artifactId>
      <version>1.0.11</version>
      <scope>test</scope>
   </dependency>
   <dependency>
      <groupId>org.seleniumhq.selenium</groupId>
      <artifactId>selenium-java</artifactId>
```

```
        <version>2.24.1</version>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>junit</groupId>
        <artifactId>junit</artifactId>
        <version>4.10</version>
        <scope>test</scope>
    </dependency>
</dependencies>
```

This process adds required Java libraries to the project classpath.

Then make an src/test/resources source folder inside the project. This catalog stores packages and Cucumber feature files (hereafter referred to as "features"). Create a package for these files within the source folder. The following text shows an example of a feature:

```
Feature: Home

    Testing Demos and Documentation page.
    author: Pawel Oczadly
    Background:

    Given I have http://jquerymobile.com/demos/1.1.1/
    @done

    Scenario: Navigating to Introduction page
    When I click Intro to jQuery Mobile
    Then the Introduction page is displayed
```

Next step is to make a test package in the src/test/java source folder and to create the Cucumber runner class within it. RunCukesTest class will launch the JUnit tests. It is shown below:

```
@RunWith(Cucumber.class)
@Cucumber.Options(
format = {"pretty",
 "html:target/cucumber",
 "json:target/cucumber.json"},
tags = "@done"
)
public class RunCukesTest {}
```

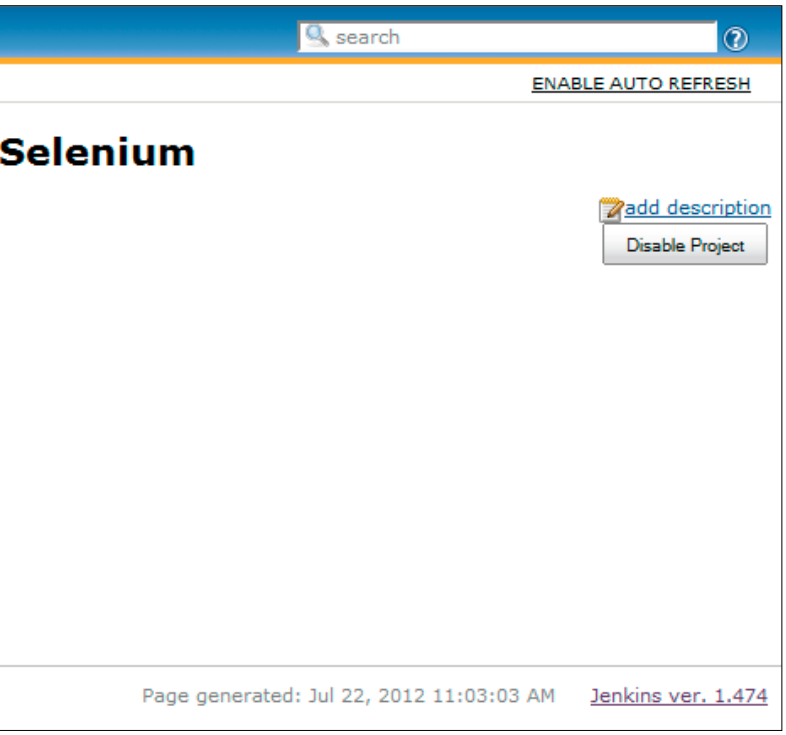
The "Format" option enables Cucumber output to be presented in different ways, whereas the "Tags" option indicates which scenarios should be run.

Finally, create a test package and example JUnit test class within the src/test/java source folder. Please note that the test package name in the src/test/java folder must be the same as the features package in the src/test/resources folder. The example test class is presented below:

```
public class HomeTest {

        private static final String HUB_ADDRESS =
                  "http://localhost:8080/wd/hub";

        private WebDriver webDriver;

        private DemosAndDocumentation homePage;
```

Figure 1: Created Job for a Project in Jenkins

```
@Before
public void before() throws MalformedURLException {
        if (webDriver == null) {
                webDriver = new
        RemoteWebDriver(new URL(HUB_ADDRESS),
                DesiredCapabilities.android());
        }

        homePage = new DemosAndDocumentation(webDriver);
}

@Given("^I have http://jquerymobile.com/demos/1.1.1/$")
public void I_have_http_jquerymobile_com_demos_() throws
Throwable {
        webDriver.navigate().
to(BddAndroidSeleniumTestCase.JQUERY_MOBILE_URL);
}

// Scenario: Navigating to Introduction page
@When("^I click Intro to jQuery Mobile$")
public void I_click_Intro_to_jQuery_Mobile() throws Throw-
able {
 homePage.clickIntroToJQueryMobile();
}

@Then("^the Introduction page is displayed$")
public void the_Introduction_page_is_displayed() throws
Throwable {
        String introductionUrl = BddAndroidSeleniumTest-
Case.JQUERY_MOBILE_URL
+ "docs/about/intro.html";
        assertCurrentUrl(introductionUrl);
}
```




```
private void assertCurrentUrl(String expectedUrl) {
                WebDriverHelper.sleep();
                String currentUrl = webDriver.getCurrentUrl();

                Assert.assertEquals(expectedUrl, currentUrl);
        }

        @After
        public void after(ScenarioResult result) {
                webDriver.close();
        }
}
```

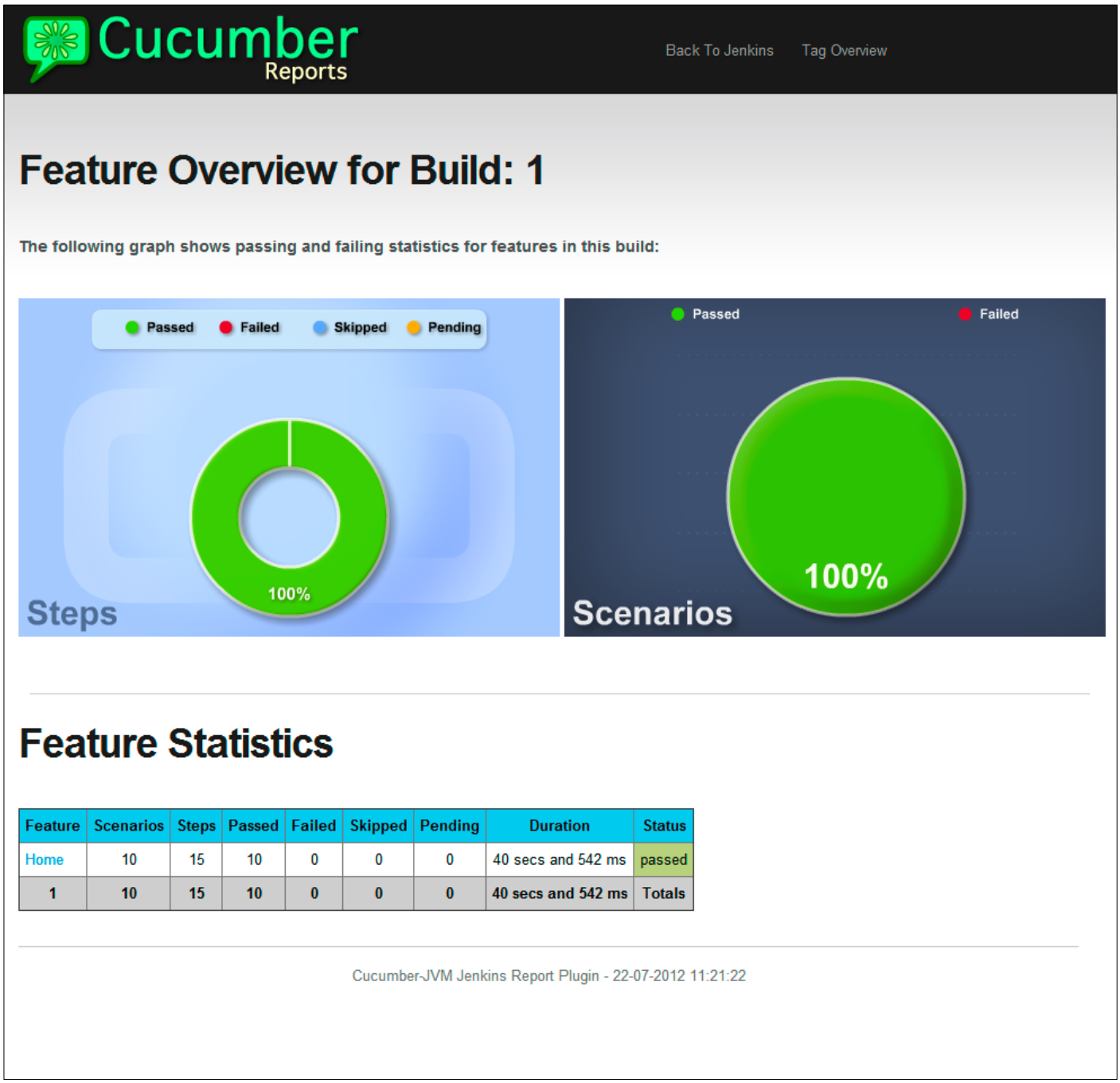
As mentioned earlier, I have used the Page Object pattern in my example test. The DemosAndDocumentation class which described my PageObject class is shown below:

```
public class BddAndroidSeleniumPageObject {

        protected WebDriver webDriver;

        public BddAndroidSeleniumPageObject(WebDriver webDriver) {
                this.webDriver = webDriver;
        }

        public BddAndroidSeleniumPageObject() {}

        public void setWebDriver(WebDriver webDriver) {
                this.webDriver = webDriver;
        }
}
public class DemosAndDocumentation extends BddAndroidSeleniumPa-
geObject {
```

```
public DemosAndDocumentation(WebDriver webDriver) {
        super(webDriver);
}

public DemosAndDocumentation() {
        super();
}

public BddAndroidSeleniumPageObject clickIntroToJQueryMo-
bile() {
        return clickMainMenuItem(Content.INTRO_TO_J_QUE-
RY_MOBILE);
}

public BddAndroidSeleniumPageObject clickQuickStartGuide()
{
        return clickMainMenuItem(Content.QUICK_START_
GUIDE);
}

public BddAndroidSeleniumPageObject clickFeatures() {
        return clickMainMenuItem(Content.FEATURES);
}

public BddAndroidSeleniumPageObject clickAccessibility() {
        return clickMainMenuItem(Content.ACCESSIBILITY);
}

public BddAndroidSeleniumPageObject clickSupportedPlat-
forms() {
        return clickMainMenuItem(Content.SUPPORTED_PLAT-
FORMS);
}

private BddAndroidSeleniumPageObject
clickMainMenuItem(String itemName) {
        WebElement mainMenuItem = WebDriverHelper.
getFromTheList(webDriver,
By.xpath(Xpaths.LIST_ITEM_XPATH), itemName);

mainMenuItem.click();


return new BddAndroidSeleniumPageObject(webDriver);
}

}
```

The feature and the example test using Cucumber JVM and Android WebDriver are ready. The whole project is available on github .

Now, it is time to use Jenkins. In the main page, click “New Job”, type the “Job” name, select “Build a free-style software project” and press the “OK” button. In the configuration page in the “Build” section, click “Add build step” and then select “Invoke top-level Maven targets”. In the “Goals” field, type “clean integration-test”. Finally, in the “Post-build Actions” pick “Add post-build action” then select “Publish cucumber results as a



report" and press the "Save" button. Jenkins will create the job for this project (see Figure 1).

The last thing required to run the build is to copy the project content to the .jenkins/jobs/BddAndroidSelenium/workspace directory. Now, the project is ready to run. Press "Build Now" and wait until Jenkins builds the job. After that, the "Build History" table should display the first entry. If the Jenkins Cucumber plugin installation has been successful, click "Cucumber Reports" to see the outcome of the test, as shown in the picture on top.

Conclusion

To sum up, BDD is an interesting agile methodology. It enables effective cooperation between QAs, developers, and stakeholders or other non-technical people. Furthermore, it may be applied in mobile platforms. I have focused the article on mobile web applications for the Android platform; however, it can be also used for the iOS one. The environment architecture shown allows its distribution and facilitates work on software development in international companies. ■

> about the author

Pawel Oczadly – QA engineer at Future Processing, a company in Gliwice (Poland), and fourth-year student at the University of Silesia in Katowice. His everyday work includes testing mobile and web applications, especially test automation, creating test cases, and configuring environment for mobile and web applications. He is keen on java and mobile technologies as well as test automation. In his free time he is interested in music, movies and sport.

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Jasper Sens

There's a test for that!

The mobile app market is big and still growing. How big? The two most popular mobile platforms, iOS and Android, show the following figures:

- 1,250,000 apps for download (85% growth in the last year)
- 63,000 new submitted apps (not all approved)
- 2 billion downloads each month
- 765,000,000 active iOS and Android users
- 70,000 specialized app developers

These are pretty impressive figures. And where software development takes place, testing (should) take place! In this article I try to answer the following question: does the testing of mobile apps require any specialized testing knowledge, or is it just a matter of using your common sense?

In the following sections, I will analyze the differences between testing mobile apps and "regular" software and try to find the answer.

Changes in test strategy

Of course, a good test strategy is based on a product risk analysis. In "regular" test strategies, it often turns out that 80% of the test effort is expended on the functionality of software. Let us use our common sense and see if this also holds true for the test strategy of mobile apps:

Usability

Why are mobile apps so popular? Because they are fast and easy to use. In fact, to benefit usability, redundant functions are often even removed from apps. This is in contrast to desktop software which often seems to have an excess of (unused) functionality. Hence, usability prevails over functionality. Therefore it is logical to make usability testing part of the test strategy.

Portability

Most of the apps are deployed on multiple platforms (iOS, Android, Windows, RIM). Different OS versions of these platforms are used on different devices from different manufacturers. By performing portability tests, the test team can confirm if the app will function correctly in all these different configurations.

Security

In contrast to desktop applications, mobile data is sent over unsecured wireless networks (3G, WiFi spots). Hence, there a much greater security risk, e.g. with mobile banking. Therefore security testing is an absolute must-have in the test strategy.

Efficiency, performance and continuity

Using a mobile data connection costs the user money. Users will benefit from an app that is light on data usage. Besides that, the 3G network is often the weakest link in the performance of an app. Therefore testing for efficient use of data is important. Users are also often confronted with interruptions and loss of their data connection. What happens to the data in these moments? Depending on the risks, testing the continuity of the data processing should be part of the test strategy.

In a nutshell, besides functionality, a number of different quality attributes are important when testing mobile apps. This brings us a step closer to answering the question: does a test engineer need special knowledge for this?

The app tester

When testing the performance or security of an application, we are used to involving experts in these areas. There is no difference when it comes to testing apps. Less common is the involvement of a usability test expert. But this specialized knowledge and the use of, e.g., usability labs will add much value to the testing process, since usability is such an important factor.

Portability is not a new concept in the test world. It is common for web applications to be tested in the most popular browsers. Performing such tests for an app is a whole different story. How does a test engineer perform the same tests on such a rich variety of platforms and devices? Emulating devices looks interesting, but often leads to unreliable results. Fortunately, new initiatives are popping up. For example, the Testdroid Cloud (Bitbar) enables a test engineer to automatically execute physical tests on many devices at once.

Knowledge about these kinds of solutions makes it possible to efficiently test the portability of an app. In addition, a test engineer must have the knowledge to execute test cases regarding interruptions to the data connection. This is also not a typical daily activity for a normal test engineer

To answer the question

With the help of a good product risk analysis, the test manager will be able to define a solid test strategy just by using his common sense. However, executing this test strategy will be a whole different story. Hence my answer to the above mentioned question: yes, a test engineer will need specialized knowledge for testing mobile apps!

Is there a tester for that? ■

> about the author

Jasper Sens – After studying Cognitive Artificial Intelligence and receiving his master's degree at the University of Utrecht, Jasper stepped into the world of testing. Starting as a test engineer, he soon started to coordinate and manage test projects at different companies and organizations. Parallel to that, he has expanded his knowledge of usability testing and accessibility.

Rubén Fernández Álvarez

Testing on a Real Handset vs. Testing on a Simulator – the big battle

Introduction

The mobile software industry is booming. Everybody has a mobile phone and browsing the web or installing software on phones is becoming more and more commonplace. At the moment, the number of mobile phones in the world is approximately twice the number of personal computers. Knowing this, we can imagine why the development of mobile applications is now considered a very profitable business in which consumers are constantly in need of more functional applications.

This new global situation means that companies can not afford to go to market with an application that might have a critical bug or usability issue. If users do not have an excellent experience with the application, they will switch to a rival product. For this reason, dealing with the necessary QA on mobile platforms has become an important task. But sometimes, this task can be tricky because today there is a wide range of handsets with a variety of features. Due to this, the simulator has become an important tool for development and QA teams to use.

On the one hand, simulators are very powerful tools for developing mobile applications because they have unique features which enable them to provide a debugging environment. However, by definition, they are simulators and lack the real target environment. Learning to fly a fighter plane using a simulator is much safer and less expensive than learning on a real fighter plane.

On the other hand, since mobile applications are used on real handsets and not simulators, testing on real devices during the QA process is required to ensure the highest level of application quality.

Real handsets or simulators? The eternal question. The pros and cons of each of these approaches must be carefully considered by enterprises when formulating a mobile testing strategy. Here are some of the main advantages and disadvantages of each approach:

Handset Simulators

A handset simulator is a software application which mimics all of the typical hardware and software features of a typical mobile device in its real environment. Put simply, simulation is a representation of a real system.

> *"I'm going to test it on the simulation system, it's better than a real handset."*

Simulator gives us some feature to help us to perform testing activities. These are the biggest advantages performing testing on a simulator.

Time&Money

The big advantage is money. Designing, building, testing, redesigning,rebuilding and retesting, can be an expensive project in any event. Simulations take the building/rebuilding phase out of the loop by using the model already created in the design phase. Most of the time, simulation testing is cheaper and faster than performing multiple tests on the design each time.

Moreover, simulation systems are easier. Most of the current simulators are free and mobile phone manufacturers have made enormous efforts to ensure their platforms are easy to test and that there is a wide range of solutions available. The quality of these tools is also very high, they are very reliable and there is a lot of variety.

Level of Detail

Another big advantage of a simulation is the level of detail that you can get from a simulation. A simulation can give you results that are not experimentally measurable with the current level of technology. We can set the simulation to run for as many time steps as we wish and at any level of detail, the only restrictions are our imagination, our programming skills, and our CPU.

Hardware connections

Simulation systems are sometimes used with specialized hardware. But when emulators are simply client software that runs locally on your PC, they have less latency than real devices connected to the local network or in the cloud. Depends on the application, this latency should be carefully considered when the application runs on a real devices to avoid negatives effects in our application.

> *"All that glisters is not gold"*

Simulators are great friends for development and QA teams. They saves a lot of money and time, but obviously there are some disadvantages performing testing on a simulator. These are the main disadvantages.

Simulation errors

The first of these disadvantages is simulation errors. Any incorrect key stroke has the potential to alter the results of the simulation and give us wrong results. Also, we are usually programming using theories of the way things work not laws and theories are not often 100% correct. Provided that we can get your simulation to give us accurate results we must first run a base line to prove that it works. In order for the simulation to be accepted in the general community we have to take experimental results and simulate them. If the two data sets compare, then any simulation we do of your own design will have some credibility.

Hardware-Software differences

Another aspect of testing on a simulator is the differences between software and hardware. Simulators do not reflect the specific hardware and software features of each supported device.

Performance

The last important aspect of simulators is where the PC is running. Depending on the processing power of the PC running the emulator and the type of handset or smartphone, with limited CPU and memory, being used for testing, performance on the emulator may be unrealistically good or bad.

Real Handsets

By definition, handsets are physical resources which need to be managed. Unlike simulators, where additional "handsets" can be either additional software installed or simple configuration, real handsets are something physical to own.

> *"Testing on simulators will never replace testing on real handsets"*

For one, it is important to note that testing on real handsets is not an optional task, it is always a given task. As the simulators, there are some advantages with testing on real handsets.

User Experience

Mainly, the application will be run by different kind of users and on different devices, and testing on real handsets always gives us a true user experience, because is the only way to truly understand the user experience. In addition, working with real handsets always gives us accurate results and we will find actual application issues.

Performance Testing

Performance testing is always an important task when testing. This task is difficult to perform with a simulator, but, when using real handsets, it is easier to expose performance defects, as well as defects which are the result of the handset itself or its environment. In addition, we will find crashes, and memory leak issues which can not found on an emulator

Interoperability Testing

Some of our mobile applications will work through mobile communications networks. It is important to perform Interoperability testing in a live network with real device, because if we perform this kind of testing running on simulator, the network connection will be different. With testing on real handsets we can find jitters, due to interference and crosstalk with other signals which can affect the performance of processors in our application, introduce clicks or other undesired effects in audio signals, and loss of transmitted data between network devices. It is important to note that the amount of tolerable jitter depends on the affected application.

Security

A common concern amongst mobile users is security. People are sensitive to data, such as bank account numbers that remain on handsets, or if passwords are displayed on the screen. Testing for these types of security concerns in a simulated environment is not a good use of time because is the behavior of the actual handset that needs to be tested. Adding to the challenge, not all handsets have the same security designs, so each device must be individually tested.

> *"Testing activities on real handset take a lot of effort"*

Real handsets have not been designed with testing in mind. It means there are some disadvantages to consider when the testing activities are performed with real handset.

Time & Money

Firstly, if you have an application that targets a multiplicity of handsets, all with different form factors, technical specifications, and service providers, how can you go about testing your applications? It is simply not feasible to acquire all the phones you need to test on. But if our company could acquire all the phones we need, it will take a lot of effort perform the testing activities in all the phones.

IDE

It is only money that is important. In the early stages of development, real handsets are difficult to connect to an Integrated Development Environment which can delay development and testing tasks. This delay could affect the delivery time of our application.

Interoperability Testing

As commented above, interoperability testing is performed in a real handset. But sometimes advantages become disadvantages. Interoperability testing requires, not only handset costs, personal costs and time; this kind of testing is hard (although there are some expensive simulators for telecommunications networks) and takes too long.

Conclusion

We have seen both advantages and disadvantages between testing on simulator and testing on real handsets. Taking a look, simulators are great, but we should not assume that just because our software works perfectly on an simulator, it will work in the same way on the real device. However, sometimes there is just no substitute for the real thing. For this reason, simulators are a very useful step in any testing program, but should never be used to replace real handset testing, because it gives you always a real state of your application.

A good approach is to use simulator in the early stages of testing, when the maturity level of the application is low and simulators accelerates the resolution of problems, and the use of real handsets in the late stages. However, the decision at what stage should be use a simulator or a real handset depends on the organization. A lot of factors should be carefully

considered, as deadlines, costs, personal involved in QA activities and customer demands.

Using the combination a simulator and real handset, along with a solid test plan, brings us to the point where our software is stable and appears to be working correctly on a large number of devices. ■

> about the author

Rubén Fernández Álvarez has five years of experience as a QA – test engineer in medical and industrial environments in different companies, including Sogeti, Ingenico and Grifols. He presently holds the role of QA Engineer at Aurigae – Telefonica R+D. He is a qualified telecommunications and electronics Engineer and is a certified ScrumManager.

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Tutorials

Time	Tutorial
08:00–09:00	Registration
09:00–17:30	**"Management 3.0 Workshop"** Jurgen Appelo
09:00–17:30	**"Making Test Automation Work in Agile Projects"** Lisa Crispin
09:00–17:30	**"Transitioning to Agile Testing"** Janet Gregory:
09:00–17:30	**"Introduction to Disciplined Agile Delivery"** Scott W. Ambler
09:00–17:30	**"Beheading the legacy beast"** Ola Ellnestam
09:00–17:30	**"Fully integrating performance testing into agile development"** Scott Barber
09:00–17:30	**"Mindful Team Member: Working Like You Knew You Should"** Lasse Koskela
09:00–17:30	**"Mind Maps: an agile way of working"** Huib Schoots & Jean-Paul Varwijk
09:00–17:30	**"Winning big with Specification by Example: Lessons learned from 50 successful projects"** Gojko Adzic
09:00–17:30	**"Software Testing Reloaded – So you wanna actually DO something? We've got just the workshop for you. Now with even less powerpoint!"** Matt Heusser & Pete Walen

All tutorials include two coffee breaks (at 11:00 and 15:30) and lunch (13:00–14:00).

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Conference Day 1

Time	Track 1	Track 2	Track 3	Track 4	Vendor Track
08:00–09:20	Registration				
09:20–09:25	Opening				
09:25–10:25	**Keynote: "Disciplined Agile Delivery: The Foundation for Scaling Agile"** – Scott W. Ambler				
10:25–10:30	Break				
10:30–11:15	**"5A – assess and adapt agile activities"** Werner Lieblang & Arjan Brands	**"Moneyball and the Science of Building Great Agile Team"** Peter Varhol	**"Get them in(volved)"** Arie van Bennekum	**"Testing distributed projects"** Hartwig Schwier	
11:15–11:40	Break				
11:40–12:25	**"The Agile Manifesto Dungeons: Let's go really deep this time!"** Cecile Davis	**"Balancing and growing agile testing with high productive distributed teams"** Mads Troels Hansen & Oleksiy Shepetko	**"We Line Managers Are Crappy Testers– Can We Do Something About It"** Ilari Henrik Aegerter	**"The many flavors and toppings of exploratory testing"** Gitte Ottosen	
12:25–13:45	Lunch				
13:45–14:45	**Keynote: "Myths About Agile Testing, De-Bunked"** – Janet Gregory & Lisa Crispin				

Time	Track 1	Track 2	TBD	TBD	TBD	Vendor Track
14:45–16:15	**Consensus Talks** 10 min. each	**Open Space** Cirilo Wortel	**TestLab** Bart Knaack & James Lyndsay	**Testing Dojos**	**Coding Dojos** Meike Mertsch & Sebastian Keller	**Product Demo**

Time	Track 1	Track 2	Track 3	Track 4	Vendor Track
16:15–16:40	Break				
16:40–17:25	**"The Beating Heart of Agile"** Andrea Provaglio	**"Why World of Warcraft is like being on an agile team, when it isn't and what we can learn from online role playing games"** Alexandra Schladebeck	**"Agile communication: Back and forth between managers and teams"** Zuzana Sochova & Eduard Kunce	**"Developers Exploratory Testing – Raising the bar"** Sigge Birgisson	
17:25–17:30	Break				
17:30–18:30	**Keynote: "Self Coaching"** – Lasse Koskela				
19:00	Social Event				

Conference Day 2

Time	Track 1	Track 2	Track 3	Track 4	Vendor Track
07:30–09:20	Registration				
08:10–08:55	**Early Keynote: TBD**				
09:20–09:25	Opening				
09:25–10:25	**Keynote: "How to change the world"** – Jurgen Appelo				
10:25–10:30	Break				
10:30–11:15	**"Continuous Delivery of Long-Term Requirements"** Paul Gerrard	*TBD*	**"How releasing faster changes testing"** Alexander Schwartz	**"Testers are bearers of good news"** Niels Malotaux	
11:15–11:40	Break				
11:40–12:25	**"Experiences with introducing a Continuous Integration Strategy in a Large Scale Development Organization"** Simon Morley	**"Skills & techniques in the modern testing age"** Rik Teuben	**"Continuous Delivery: from dream to reality"** Clement Escoffier	**"Ten qualities of an agile test-oriented developer"** Alexander Tarnowski	
12:25–13:45	Lunch				
13:45–14:45	**Keynote: "Adaptation and Improvisation – but your weakness is not your technique"** – Markus Gärtner				

Time	Track 1	Track 2	TBD	TBD	TBD	Vendor Track
14:45–16:15	**Consensus Talks** 10 min. each	**Open Space** Cirilo Wortel	**TestLab** Bart Knaack & James Lyndsay	**Testing Dojos**	**Coding Dojos** Meike Mertsch & Sebastian Keller	**Product Demo**

Time	Track 1	Track 2	Track 3	Track 4	Vendor Track
16:15–16:40	Break				
16:40–17:25	**"From CI 2.0+ to Agile ALM"** Michael Hüttermann	**"Testers Agile Pocketbook"** Stevan Zivanovic	**"Extending Continuous Integration and TDD with Continuous Testing"** Jason Ayers	**"Excelling as an Agile Tester"** Henrik Andersson	
17:25–17:30	Break				
17:30–18:30	**Keynote: "Reinventing software quality"** – Gojko Adzic				

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Conference Day 3

Time	Track 1	Track 2	Track 3	Track 4	Vendor Track
07:30–09:10	Registration				
08:10–08:55	**Early Keynote: TBD**				
09:10–09:15	Opening				
09:15–10:15	**Keynote: "Fast Feedback Teams"** – Ola Ellnestam				
10:15–10:20	Break				
10:20–11:05	**"Exceptions, Assumptions and Ambiguity: Finding the truth behind the Story"** David Evans	**"BDD with Javascript for Rich Internet Applications"** Carlos Blé & Ivan Stepániuk	**"Automation of Test Oracle– unachievable dream or tomorrow's reality"** Dani Almog	**"You Can't Sprint All the time – the importance of slack"** Lloyd Roden	
11:05–11:30	Break				
11:30–12:15	**"Combining requirements engineering and testing in agile"** Jan Jaap Cannegieter	**"TDD-ing Javascript Front Ends"** Patrick Kua	**"Archetypes and Templates: Building a lean, mean BDD automation machine for multiple investment platforms"** Mike Scott & Tom Roden	**"Taking over a bank with open source test tooling"** Cirilo Wortel	
12:15–13:00	**"Agile Solutions– Leading with Test Data Management"** Ray Scott	**"Changing Change"** Tony Bruce	**"Technical Debt"** Thomas Sundberg	**"Changing the context: How a bank changes their software development methodology"** Huib Schoots	
13:00–14:10	Lunch				
14:10–15:10	**Keynote: "The ongoing evolution of testing in agile development"** – Scott Barber				
15:10–15:15	Break				
15:15–16:00	**"Thinking and Working Agile in an Unbending World"** Peter Walen	**"Sprint Backlog in ATDD"** Ralph Jocham	**"Mobile test automation at mobile scale"** Dominik Dary & Michael Palotas	**"Quality On Submit, Continuous Integration in Practice"** Asaf Saar	
16:00–16:05	Break				
16:05–17:05	**Keynote: "The Great Game of Testing"** – Matt Heusser				
17:05	Closing				

Please note that the program is subject to change.

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Adam Osburn

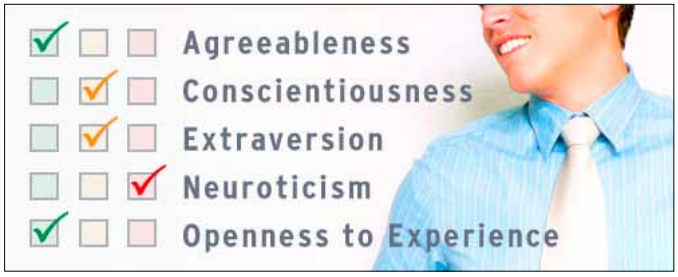
What Makes a Good Tester?

This article discusses the common personality traits displayed by experienced, successful professional testers to help you understand what makes a good tester, to help you structure your testing team, and for evaluating new possible recruits.

Introduction

Professional software testing has changed dramatically over the last number of years, and changed for the better. The days of 'anyone can do testing' are, thankfully, long gone. Businesses no longer entrust the quality of their product to someone without the relevant testing skills set or personality type. This does, however, mean that not everyone is or can become a high quality professional tester.

Test professionals who consistently work to a high level of excellence all demonstrate a similar set of traits, and these personality traits are what makes them good at their job. Therefore, identifying these characteristics is key to evaluating a person's testing ability and their potential to be a test professional.



High-level skills of a professional tester

Before getting into more detailed personality traits, there are a number of generic skills and characteristics that a professional tester should have. Many of these are not specific to a professional tester, but are required in many professions. These include, but are certainly not limited to:

- Strong analytical skills. A professional tester needs to be able to logically break down a problem into its constituent parts and create a test plan around them. To put it simply, a professional tester needs to be smart.
- The ability to communicate effectively to a wide audience. Whereas software coding is sometimes seem as an isolated role (a guy in a darkened room hacking away at his keyboard – an old and incorrect stereotype), a professional tester must to be able to communicate, verbally and in the written form, with technical staff such as developers, with business stakeholders to discuss requirements, with end users to ensure the system is fit for purpose, and with Project Managers. The list is endless. A high-level, expert tester must have the ability to communicate at all levels of the business.
- To understand the bigger picture. It is all well and good being able to test a certain area of code/system, but to be an expert in the testing field, a tester needs to thoroughly understand the company's overall business strategy. This enables an expert professional tester to understand where the particular part of the system under test fits into the overall system. It is common sense that a tester who understands the business at multiple levels is going to be better placed to assess the quality than someone who can only operate at one level.
- A passion for analysis and testing. The key to success in any job is having a true passion for what you do. The quote "Do what you love, the money will follow" may be overused, but it still holds true. A passion for analysis is innate – something you are born with. According to behaviourists, behaviour, for example how one deals with conflict, is not innate but can be learned. Being passionate about something, such as analysis, is a different matter; this seems to be something that you are born with rather than something you can learn.
- The final characteristic listed here, Technical Skill, is up for debate. The initial school of thought is that a great tester must have significant coding skills in order to understand the system under test,

communicate with developers, and write test scripts. However, I disagree with this. Software development and software testing are two different skill sets. A tester needs to have the analytical skills to understand what should happen to a particular system and what could happen to that system. The coding logic is not so important to a tester, the business and functional requirements are. This is not to say that a person of one discipline cannot move over to the other discipline, but one is not a pre-requisite of the other.

This details at quite a high level some of the desirable characteristics of a professional tester – being analytical, passionate, and strategic with good communication. The following section goes into more scientific detail regarding the personality traits required for a professional tester.

Definition of the big five personality traits

In 1990, Lewis R. Goldberg (Ph.D.) proposed that a person's character can be broken down into five personality traits. Since then, these five traits have become widely accepted by the scientific community as the personality benchmark and have come to be known as 'the Big Five personality traits'. The big five are Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness to experience. Goldberg states that we all display each of these five personality traits, but to a different degree.

A study in 2007 ("An Improved Assessment of Personality Traits in Software Engineering" by A. S. Sodiya, H. O. D. Longe, S. A. Onashoga, O. Awodele, and L. O. Omotosho) theorised that for someone to do a certain job well, certain personality traits are required. The study focused on software engineering to include project managers, developers, business analysts and testers.

As part of the study, the level (high, medium, low) of each of the five personality traits to be a successfully, professional tester was calculated.

The following section details each of the personality traits, what is required to be a good tester, and how to spot this in someone. Hopefully this will give you an idea of whether that person is, or could become, a high quality professional tester.

Agreeableness

Definition: This is the tendency to be compassionate towards others and not antagonistic. Its components include being pleasant, tolerant, tactful, helpful, trusting, respectful, sympathetic and modest.

Rating for being a good test professional: High

As a professional tester, being able to discuss and communicate with the whole project team and business is vitally important. A good tester needs to be able create professional relationships at all levels of business, based on sound skills and a mutual respect. Agreeableness is a tendency to be pleasant and accommodating in professional and social situations.

How to spot someone with a high agreeableness rating:

- Someone who is interested in other people's problems. A person with a high agreeableness rating is a good listener as well as talker. In an interview, such as person will listen intently to a situation or problem and then offer an answer or solution. Someone who makes an interview flow like a professional conversation could have a high agreeableness level.
- A person who has an equal amount of time and respect for someone, irrespective of the position they hold within the business.

Conscientiousness

Definition: This is the tendency to show self-discipline, to be dutiful, and to strive for achievement and competence. Its components also include self-discipline, a consultative approach, competence, order, dutifulness and thoroughness.

Rating for being a good test professional: Medium

This medium level surprises a few people. A tester certainly does need to be thorough, ordered and disciplined, but they also need to be able to think creatively, unimpeded by orthodox constraints. Each system or piece of software is different; each project's budget and timeframe is different. Therefore, although a standard test methodology can be used, testing often requires the tester to think differently, from a new perspective. How can I test for something unexpected? A tester has to foresee the unforeseen.

How to spot someone with a medium conscientiousness rating:

- Someone who is able to talk through the various different testing methodologies but also give examples of creative thinking to solve unexpected problems.
- Someone who understands the need for processes, timelines and structure, but also has the flexibility to deal with project issues such as delays, budget constraints and resource issues.

Extraversion

Definition: This is the tendency to seek simulation and enjoy the company of other people. Its components include warmth, sociability, assertiveness, energy, adventurousness, and enthusiasm.

Rating for being a good test professional: Medium

A professional tester needs to be able to communicate with a number of different professionals to ensure a quality outcome, but does not need to be the centre of attention (we can leave that to the project managers!). People who are at a medium level in extraversion are often called ambivert – a person who is half way between an extrovert and an introvert. Fortunately for our search for high quality testers, about 68% of the population fall in to this ambivert mid-range.

How to spot someone with a medium extraversion rating:

- Someone who comes across as personable but not as if the world revolves around them.
- Someone who is normally comfortable with groups and enjoys social interaction, but also relishes time alone and away from the crowd.
- According to one study, extraverts tend to wear more decorative clothing, whereas introverts prefer practical, comfortable clothes. An ambivert will be somewhere in between.

Neuroticism

Definition: This is the tendency to experience unpleasant emotions relatively easily. Its components are anxiety, hostility, depression, self-consciousness, and impulsiveness.

Rating for being a good test professional: Low

I am sure this result is not a surprise, although I am not sure which jobs require someone to have high levels of neuroticism to perform well!

How to spot someone with a low neuroticism rating:

- Essentially, someone with a sunny disposition!

- Someone who sees the shades of grey. This is someone who can see the possibilities in the middle of two extremes. Someone who understands the bigger picture. All-or-nothing thinking, or black-or-white thinking with no middle ground, is a sign of high neuroticism.
- Someone who doesn't over-generalise, who understands the importance of past experiences but doesn't extrapolate a poor outcome as a blanket rule. Someone with the tendency to inaccurately generalise a single negative event, such as "I gave a poor speech, therefore I am a bad public speaker", could have a high neuroticism rating.

Openness to experience

This is the tendency to enjoy new intellectual experiences and ideas. Its components include being imaginative, curious, unconventional, broad-minded and cultured.

Rating for being a good test professional: High

A tester must be capable across numerous methodologies, experiences, companies and problems. The world of testing is constantly changing, so to be an expert test professional requires keeping up with the times by being open to new experiences. A tester must be able to welcome new ideas and enjoy a new intellectual challenge.

How to spot someone with a high openness to experience rating:

- Someone who has a number of varied interests outside of testing.
- Someone who has worked as a tester in a number of different professional domains. This is not someone who has repeatedly changed careers or jobs, though.
- Someone who has worked in a number of different locations.

An expert test professional is a balanced individual, both professionally and personally. To summarise the five personality traits discussed, an expert, professional, effective tester should have the following:

Agreeableness: High

Conscientiousness: Medium

Extraversion: Medium

Neuroticism: Low

Openness to experience: High

Conclusion

In conclusion, a test professional requires a complex set of skills and personality traits. It may be difficult to find someone with all the desired skills and traits, but that does not mean that the person would not make a good tester. Skills can be learnt. And, although personality traits cannot be fundamentally changed, they can be modified.

Assessing someone's suitability to be a test professional is not an easy task, and trying to judge where someone fits on the Big Five personality traits spectrum is a skill in itself. By engaging that person in conversation, armed with the personality traits to look out for, you should be able to ascertain the level of each of the five personality traits and make a decision as to whether they would make a good test professional.

If you can find someone who wants to become a test professional, is enthusiastic and open, and disciplined, but not inflexible or dogmatic, they would certainly seem to have to the required foundation to become a successful tester. If that person is also analytical and has an understanding of test processes and methodologies, you could well be on to a winner. ■

> about the author

Adam Osburn is a principal consultant at Planit Test Management Solutions. He is an expert in the field of testing, has extensive experience in developing business-wide test process improvement strategies, has advanced knowledge of testing best practices, and a record of success in building and uplifting test divisions. As a principal consultant, Adam is responsible for identifying and critically evaluating new sales opportunities, in conjunction with negotiating and preparing tenders of service, and for initiating, maintaining and developing client relationships to ensure client accounts mature and grow. He has over 14 years of industry and commercial experience.

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Kiran Marri and Sundaresa Subramanian

4E Framework for Mobile Network Variability Testing

Mobile phone communication standards have advanced from the basic analog communication channel to high-speed fourth generation (4G) today. Today a smartphone/tablet user enjoys a ubiquitous status, thanks to advancements in wireless network technology. Figure 1 depicts the evolution of wireless networks over the years and the impact it has on the phones we use:

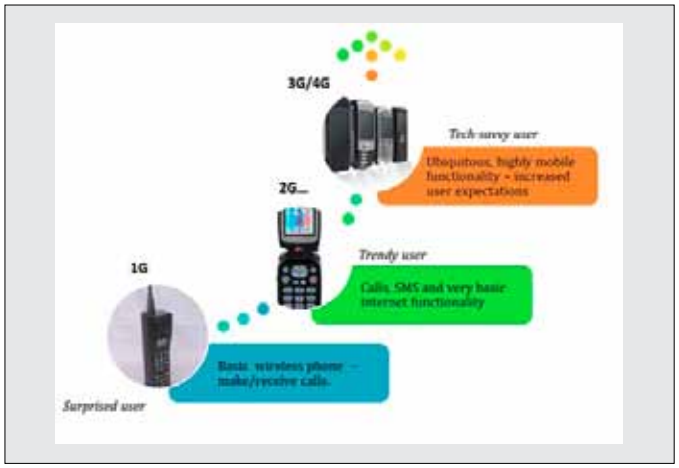

Figure 1: Evolution of mobile networks over the years

Why network performance is key?

With advancements in technology, there has been a radical shift in the way we communicate. From being surprised users awed by the first mobile phone, today's users have become extremely tech-savvy, expecting their mobile applications to perform 'like' their desktop or laptop. Excerpts from a survey conducted by Compuware for tablet users reported (1):

- Almost 70 percent of tablet users expect a website to load in two seconds or less. More than two thirds of tablet users expect websites to load just as quickly, or quicker, than on a desktop/laptop computer.
- Nearly half of tablet users will retry a website only once or twice if it did not work initially.
- A bad website experience will also drive 46 percent of tablet users to competitors' web sites
- 35 percent are less likely to visit the problematic website on any platform, and 33 percent are less likely to purchase from that company.
- Customers expect transactions that are fast and work flawlessly. Failure to deliver quality web experiences to tablet users through slow or malfunctioning sites will result in lost business. Nearly half of tablet users would only retry a website twice if it did not work initially, while 24 percent would retry it only once, and six percent would not retry it at all.

At the end of 2011 there were 6 billion mobile subscriptions, according to an estimate by the International Telecommunications Union (2011) (2). That is equivalent to 87 percent of the world's population, and is a huge increase from 5.4 billion in 2010 and 4.7 billion in 2009(3). Many exogenous and endogenous factors influence an application's performance when it is hosted on a mobile device. Network is one such example of an exogenous factor. Incomplete and improper testing of network parameters can result in a bad user experience. Table 1 below provides four such real-life scenarios of mobile network issues leading to bad user experience:

#	Scenario	Consequence
1	▪ User places an order for items from an online retail store through his 3G mobile phone on his way back home. ▪ Upon reaching home, the mobile device is configured to pick up the home Wi-Fi signal automatically and switch over. ▪ However, the online transaction fails when this switch occurs.	**Outcome:** bad user experience User may not be aware of the background network switch but all he sees is that his transaction has not been processed.
2	▪ User is performing a critical banking transaction onboard a NY subway train. ▪ Application hangs frequently due to variation in signal strength. ▪ This results in intended transaction not being processed.	**Outcome:** application unable to perform a graceful exit from the scenario. Application to build in capability to keep the user informed about the lack of signal.
3	▪ User is uploading a soft copy of mediclaim bills to the insurance website for claim initiation. ▪ Due to packet loss, the image gets corrupted and the application throws an unrelated exception error and closes automatically.	**Outcome:** application fails to perform a graceful exit. Irrelevant error message provided by application (out of context with the actual problem).
4	▪ While doing an online fund transfer, a bandwidth issue and packet loss were noticed. ▪ Application reported a false transfer even though transfer didn't go through.	**Outcome:** application is not robust enough to handle a low bandwidth/packet loss scenario. Result is an erroneous status report (false transfer) which leads to a bad user experience

***Table 1:** Real-life scenarios of mobile network issues*

Network variability testing – the difficult way

Various components/factors can affect network performance:

- Signal strength – varying signal strength leading to occasional disconnect of the network
- Bandwidth – constrained network bandwidth due to heavy traffic (GPRS/3G/Wi-Fi)
- Packet loss/packet duplication – dropping of data packets due to signal degradation or data congestion. Duplication of data packets resulting in corrupted data transmission.
- Delay/jitter – latency of data originating from mobile application and the related variance.
- Network hopping – switching from 3G/4G to Wi-Fi or vice versa

All these parameters are applicable to any real-time network signal and, so, it has become imperative for organizations to focus on in-field testing of mobile applications/devices under real-time network conditions. In-field network testing can be cumbersome, as it is difficult to reproduce scenarios due to varying signal parameters in a specific location. Figure 2 shows some of the typical limitations of in-field network performance testing of a mobile application:

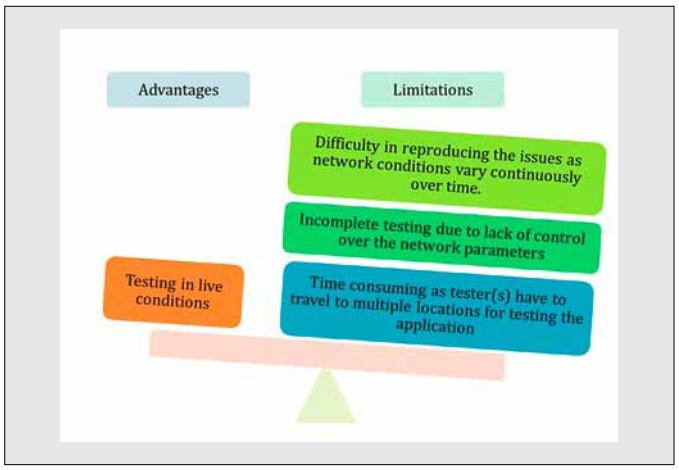

Figure 2: In-field network testing – advantages and limitations

Characteristics of an ideal mobile network testing setup

Since in-field network performance testing has its own limitations, testing of network parameters in a controlled lab environment is another solution. Listed below are some of the characteristics of an ideal mobile network testing setup:

1. Real-time simulation: although testing happens in a controlled way, the test data should mimic or resemble the real-time network signal as close as possible.
2. Location-based pre-calibration: the system should be able to store pre-calibrated network data from various locations and 'feed' it to the mobile device under test.
3. Integrated view of dynamic network state: system should have the ability to monitor the network parameters (signal strength, delay, packet loss etc.). It should also provide an option to 'manipulate' these parameters in order to identify the response from the mobile application under changing network conditions.
4. System should be able to support end-to-end mobile network testing

4E framework for mobile network variability testing

Evaluate:

This is the discovery phase of the entire QA framework. When collecting requirements for testing the mobile application, extensive profiling of the possible locations from which the mobile application can be accessed is required.

Almost all smartphones have the ability to record signal parameters, such as signal strength, bandwidth, packet loss, jitters, etc., and so it is possible to make a live recording of the network at various locations for various carriers. Over a period of time, the database of live signal parameters will keep growing into a comprehensive list. Ad hoc locations can always be added to this database, based on individual requirements. The key part in the Evaluate phase is to prioritize the test scenarios based on business criticality and impact.

To give an example, consider a banking application which serves customers in New York state. In this scenario, we would ensure that we include the following locations:

- Signal strength and characteristics in Manhattan high-rise for various carriers (Verizon, AT-T, T-Mobile, etc.,)
- Signal strength and characteristics near Niagara Falls for various carriers
- Signal strength and characteristics in NY subway and tunnel systems
- Signal characteristics in the countryside

Enhance

These recorded signal parameters should be fed to the network variability QA setup to evolve into a framework. The framework should be able to perform the following functions:

- Advisory role – for a given mobile application based on input parameters (location of use, carrier information), the system should be able to generate test cases/test data from pre-existing signal data.
- Configurability – apart from pre-existing signal parameters, the framework should have the ability to test manually, i.e. testers should be empowered to change the input values for network parameters and verify the behavior of mobile applications when subjected to those parameters.
- Integration with the test management system – the framework should be integrated with test management systems (such as Quality Center). Exporting/importing of test cases, test results and defects should be possible in order to maintain the test artifacts at a centralized location.

Experience

The mobile application should be subjected to network variability testing based on test scenarios derived from the QA framework. The signal parameters should be simulated by a network simulator to:

- Integrate with the network variability QA framework to run pre-calibrated scenarios.

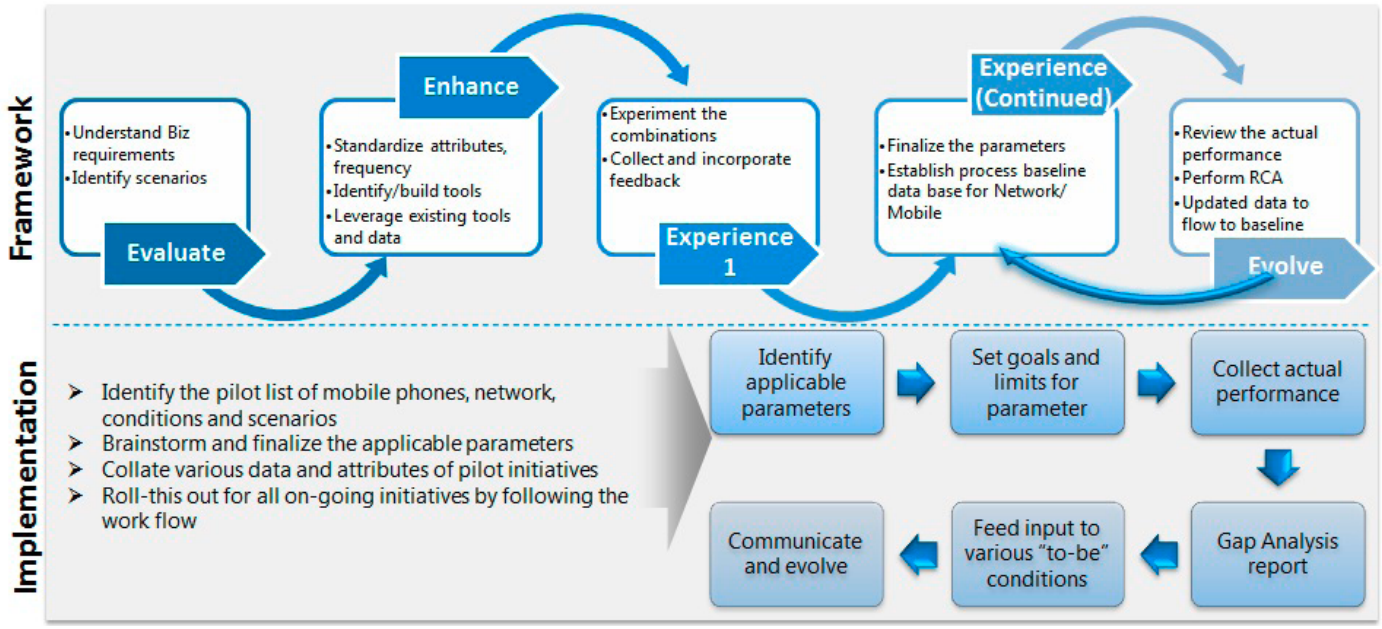

Figure 3: 4E Framework for Mobile Network Variability QA

- Connect to the mobile application/device in a non-intrusive way, i.e. device or application under test should not be altered or modified to accommodate network simulator.
- Simulate all types of signal – 3G, GPRS, or Wi-Fi, depending on the type of testing.
- Enable signal change or hopping, i.e. 3G to Wi-Fi and vice versa.

The measurable outcomes would be the user experience and behavior of application based on the network variability.

Evolve

The network variability QA framework has to keep evolving continuously to add new scenarios. It could be enhanced to include:

- Key city and carrier trend verification – to verify mobile application response in selected cities for key carriers under various scenarios (day, night, evening, Christmas, New Year's Eve, etc.).
- Simulation of abnormal network scenarios to see how the application responds to these (e.g. 10% bandwidth or 90% packet loss).
- Mobile platform-specific network variability testing – how network variability QA affects an Android phone/tablet vs. iOS phone/tablet vs. other operating systems.
- Custom and on-demand test packages for network variability QA based on ad hoc or one-time requests.
- Continuous improvement of test conditions based on best practice and lessons learnt.

Afterthought

The underlying thought behind developing the 4E framework for network variability QA is to subject the mobile application to various possible real-time scenarios in a controlled environment. The errors/exceptions thrown up by the mobile application when subjected to varying network signal strengths will help developers debug the application and make it as robust as possible. This framework can also be extended to desktop application testing. At the same time, the application has to ensure that the user is kept informed in the event of a network outage (e.g. 'signal strength is low', 'upload is not successful due to network issues') and that the app performs a graceful exit from such exceptions. The 4E framework will also minimize the need for in-field testing, as most of the scenarios would have already been validated in-house. ■

> about the authors

Kiran Marri, BE MS, is currently working as a delivery manager at Infosys Limited, Bangalore (NASDAQ: Infy, *www.infosys.com*). He has 16 years of IT experience in project management, client relations and developer roles. He has published and presented several papers at conferences in the field of project management, software testing, clinical data management and biomedical engineering. He has also conducted workshops, and tutorials on creativity, thought leadership, risk management, test management and defect prediction methods. His current research interest and publications are primarily in specialized testing, test maturity practices and innovation strategies. He received his bachelor's in Electronics & Communication Engineering from Madras University in 1993 and his master's by research in Biomedical Engineering from the Indian Institute of Technology Madras, Chennai in 1996. Kiran is also PMP certified. Kiran Marri can be contacted at *kirankmr@infosys.com*.

Sundaresa Subramanian has 11 years of experience in software testing, embedded systems testing, and digital signal processing research and development. Currently he is a senior project manager with Infosys Limited (NASDAQ: Infy *www.infosys.com*) and part of the Independent Validation and Testing Services unit. Before Infosys, he was involved in strategizing and delivery of testing projects in the automotive multimedia domain, and also in research and development of digital signal processor-based embedded applications. He has authored and presented papers at national and international conferences on the topics of risk identification, data warehouse test strategizing, mobile QA, specialized QA services and project management. He earned his Bachelor of Engineering degree from Manonmanium Sundaranar University, India. Sundar can be contacted at *ssubramanian_gv@infosys.com*.

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Enterprise Mobile Testing for Success

How important is mobile testing?

The adoption of smartphones and other mobile devices is rapidly increasing. In the short term, mobile Internet usage will take over desktop Internet usage and the world's population will be outnumbered by the quantity of active mobile devices.

Traditional websites started to have an optimized version for mobile devices, as a complement. However, nowadays the focus is on the apps that are downloaded and installed on the device. In some cases they are not a complement to a main product, but are the main product themselves. Unlike mobile websites, apps can take advantage of all the features of the mobile device and increase customer loyalty.

Bearing in mind that devices and operating systems (OS) are evolving continuously and the app market is highly competitive, we notice that time to market tends to be reduced in order to deliver before the competition. In this context, an effective testing strategy becomes a critical success factor.

The testing scope

The mobile world is highly diverse. Are you aware of all the variables that should be considered when designing a test plan for mobile testing? The following is a list of most of them:

- One app per operating system. There will be a different app per supported platform and each one should be tested. The main ones are Android and iOS, followed by Symbian (Nokia), BlackBerry OS and Windows Mobile. You will also need devices for each platform.
- Operating system version – different versions of the same OS may have different supported features. For instance, as of iOS 5, Twitter API integration is supported by the OS while former versions required an external library. The app should have both implementations in order to work properly on all OS versions. That is something that should be checked. It will be important to have a device with the last OS and one or two more with previous versions. Take into account that Apple doesn't allow you to downgrade the OS version of the device.
- Support for previous versions of the app – when a new version of the app is released you should make sure that previous versions, where users have not updated it yet, will not face bugs because of the changes introduced.
- Device capabilities – smartphones can make calls, but iPod Touch and some tablets cannot. The iPad version 1 has no camera. How well does your app adapt to the available features?
- User settings – the user may have no email account set up on the device. Some features like geolocation, push notification alerts, and sound can be disabled by the user.
- Interruptions – mobiles are all about multitasking. How does your app do if the device receives an incoming call, SMS, application alert, low battery alert, or application switch?
- Features of your app – if your app adapts the interface to the orientation (landscape or portrait), or supports multilingual or other local configuration, these should be considered in the testing scope. The languages with the longest words or special characters are the more error prone in the visual presentation.
- Real connection – if the app is supposed to be used through a slow connection (like 2G, 3G, Edge, GPRS, etc.) it should be tested with that connection speed.
- Policies and guidelines – your app must comply with the policies and guidelines of the distributor (Android Play Market, Apple App Store, etc.). It is worth checking them. If the app gets rejected, you may lose valuable time in the process.

In addition to the apps, you may want to have a mobile website or an application based on web (Webapp) for those users who do not want to download and install an app just yet. You will need to check a wide range of screen sizes and web browsers. Finally, you may have one version for each device generation – WAP for non-smartphones, HTML 4 for most smartphones, HTML5 Webapps for the new ones and tablet versions.

If you want to see an example of all this diversity, try accessing Twitter and Facebook with a desktop computer, a tablet, a smartphone, a WAP-capable mobile phone, and also download their apps for Android, iOS, Symbian, BlackBerry OS and Windows Phone. You will find different products for each platform.

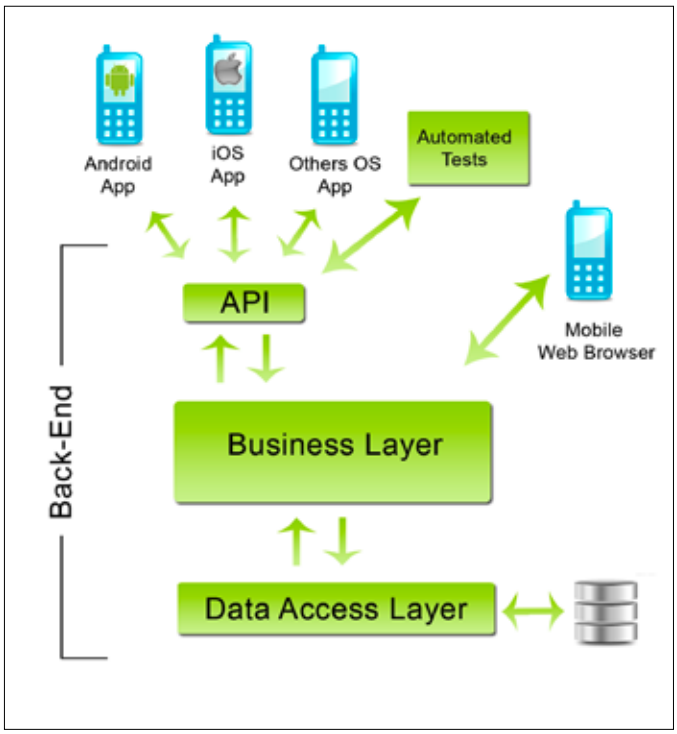
Handling complexity

Complexity should be addressed by using a solid architecture. Most apps need to store data in a database and undertake some data processing. This data is shared between apps and, maybe, websites. The different platform versions of the app follow the same goal and business logic.

The best approach is a multi-layered architecture, where the app has the presentation layer (i.e. front-end). No business rule should be implemented in the app. The app should have only the logic to show and collect data to and from the user. The data is sent and received from a back end where it is processed and, eventually, stored. It is a good idea to implement this communication as an API RESTful. The API is served by the back end and the apps are thin clients.

The advantages of this approach are:

- No duplicate code, all the logic is in one place.
- A new app does not need to be released after a change to a business rule.
- The separation between layers is clean; apps are agnostic of back-end implementation.
- Back end and app can be easily maintained by different teams.
- APIs are easily extensible, so new functions can be added without harming the existing ones. Different API versions can be supported so functionality of new applications can be separated from that of older ones, if necessary.
- It is easy to identify whether a bug is in the back-end or on the app.
- **Can be easily tested!**



The use of caching allows a reduction in response time and resources, and this might need special treatment on testing. The caching itself can be tested also.

Back-end testing

In order to test the back end, we can write an automated test that executes all the API calls and checks the results. We can interact with the API, emulating a client.

If the app is part of a bigger system, for instance the mobile banking module of a home banking system, the back end is likely to have shared code or dependencies with the main system. In that case, it will be critical to have a self-executed automated test suite which ensures that any functionality has not been broken.

Front-end testing

Since there is no business logic in the front end, you are more likely to find bugs related to user experience (namely stability, response time, usability, etc.) or issues with graphic design, visual presentation of the elements in the user interface, transitions between screens, logic for the navigation between screens, logic for the presentation of data and behavior of the forms that collect data.

All the items described previously under "The testing scope" should be considered. Even though there are automated tools for app testing, manual testing cannot be avoided.

Mobile website testing

This testing is quite similar to traditional website testing. It is important to test the website in each version, with several combinations of device, browser, language, and device orientation (landscape and portrait).

By convention, websites for desktop computers can be found under the subdomain "www", while mobile Websites use others like "wap", "mobile" or just "m". For instance, *www.facebook.com* is the desktop version, *touch.facebook.com* is the Webapp version (for touchscreen smartphones) and *m.facebook.com* is the version for older mobile devices.

Since users may not know the address for the mobile version, they might access "www" and the server should then redirect the user to the right version. The server identifies a mobile device client, browser, and OS by checking a special header that the device sends in each HTTP request, known as a User-Agent string. It is possible to set the header in a normal browser to test from a desktop computer. There are plenty of plugins for Firefox and Chrome to set any User-Agent.

The redirection logic should be in the testing scope.

Testing environment for mobile devices

It is common to have a development environment and at least one testing environment to test new features and changes before deploying code to the production environment. It is necessary to address the mobile device to those environments. This could be a bit tricky, depending on network configuration. Here are a few options to achieve it:

- If there are DNS servers available to reach the testing server, it may be possible to set them in the device under network configuration options. If not, is not hard to set up your own DNS server. On iOS devices it is straightforward to use your chosen DNS servers, while in Android devices it can be done easily only in newer versions. Older versions might need root user access level and an external application (you can search for "Set DNS" in Google Play Market, free options are available).
- If you are not able to use DNS servers, you can still set up a reverse proxy on a web server that resolves the testing server address. You can set the proxy address in the device network configuration options.
- Alter the file "/etc/hosts". The testing server address can be set in that file. This requires jailbreak on iOS and root access level on Android.
- Add a secret feature to the app that allows you to set the address of the API. This is only valid for apps.
- Use a private URL resolving the testing environment. Only valid for websites and Webapps.

Device simulators

All mobile app development platforms have simulators that allow developers to test their apps on a simulated device on the desktop computer. This is great, because developers do not need to deploy on the real device each time they need to run the app to check the latest changes. It is handy to deploy and debug the app on a simulator. Simulators let you set up any combination of device models and OS versions in just a few seconds.

Nonetheless, it is critical to bear in mind that simulators are not the real device. They do not replace on-device testing and they can present issues that do not exist in the real device and vice versa.

Simulators are helpful in the development phase and when a bug is reported for a device that we do not have.

Feedback from final users

"A bug reported for a device that we do not have" is a very important phrase, because there will always be more varied testing outside the company than inside, with real traffic, connections at real speeds and in real situations.

This is why it is very important to pay attention to bugs reported by users. To this end, we should always read the reviews that users leave in the store

distribution market. It is good practice to ask users to rate the app and leave comments after a certain period of use. Finally, we can add a special section in the app with a form for suggestions and issue reporting or an email address they can write to.

Another way to receive feedback from the users, albeit unintentionally, is to include tracking codes (e.g. Google Analytics) in different screens of the app. Using this tool, we will be able to see users' behavior and detect if there is a problem.

Testing Tools

Even though some tools have been described before, here are some other useful tools to try. All of them are free.

- Selenium 2: a very powerful tool to automate testing for websites and mobile apps.
- User-Agent Switcher: a Firefox plugin that lets you set the User-Agent header easily. It comes with a collection of User-Agent headers to choose from.
- RESTful Client: a Firefox and Chrome plugin to interact and test an API.
- GPS Mocker: a mobile app to alter the GPS coordinates and test geolocations through simulating being in different locations.
- Wireshark: a powerful tool to capture data packages from the network. It is useful to analyze which information is sent and received between the mobile app and the back end, as a way to debug.
- *WebPageTest.org*: an online tool that loads a prompted URL. It supports mobile websites and can record a video showing how the landing page loads.
- *ThisMachine.info*: this website informs you of the User-Agent string of the device you are using. This can be handy in some cases.

Conclusion

Mobile apps and mobile websites follow the same principles as desktop applications and websites, but add inherent complexity and increase the diversity of scenarios.

The critical success factors in this context are:

- Count on a solid and properly designed architecture that lets the system be tested.
- Identify where the critical points are and write automated self-executed tests for them.
- Do not just rely on automated test or device simulators.
- Consider all the important scenarios.
- Pay attention to feedback from users.
- Know and use properly the available tools.

If you have been considering the above items you are likely to succeed.■

> about the author

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Assaf Ben David

Mobile App Testing

The world of mobile applications has evolved to the point where it is now one of the basic levels of communication services, becoming essential to the everyday needs of the common mobile user. As the number of users grows exponentially, it is of utmost importance to ensure that mobile application requirements are met and that systems meet their purpose.

What makes mobile applications unique? Why is it not possible for standard test cases and running procedures to be employed to meet requirements?

Complexity is the key to understanding the challenges we face when we want to develop, or in my case to test, mobile applications. We have so many operational systems, and different manufacturers and models, so what should we test? How many devices should we cover? Twenty or one hundred? What are the trends and tools available in the market to solve these questions?

In order to develop a testing strategy for device applications, we should first understand what we want to test, or what the scope of testing is, as device testing includes a variety of testing streams:

a. **Functional testing**
   These are traditional testing methods used to validate compliance of the application/web with the functional requirements and business needs.
b. **Compatibility testing**
   This kind of testing assesses the application/web using a wide variety of browsers, operating systems, device types, device sizes, variations in connection speeds, changing technologies, and multiple standards and protocols.
c. **Usability testing**
   Usability testing ensures that the end user's experience is efficient, effective and satisfactory for user application.
d. **Performance testing**
   This type of testing assesses memory/CPU usage, battery consumption, and load on servers under various conditions. It determines what kind of performance is expected under such loads, and tests the speed of application response under different network conditions (Wi-Fi speed, 3G connection etc.)
e. **Security testing**
   Authentication, authorization, privilege, data protection and hacking attempts are some of the items examined in this kind of testing.
f. **Operability testing**
   This modality tests traditional mobile usage such as calls, SMS and data via several types of network.

Once we identified the scope, and since there are numerous types of OS in the market, the next question we should ask is – what is the available coverage?

- Apple iOS
- Google Android
- Windows Mobile
- Rim BlackBerry OS
- Nokia Symbian
- Other

Each OS has multiple versions, sub versions and releases, requiring multiple testing to ensure a proper functionality of the application on all versions and sub versions.

The market comprises multiple device manufacturers and models:

- Apple
- Samsung
- LG
- HTC
- Motorola
- and many others

Each manufacturer produces various models, sub models and screen sizes.

As the variety of hardware and software is so vast, there is a need to know how to combine the right mix of devices with the right mix of operating systems in order to build the best coverage.

Another challenge is the location-based applications and services that need to be taken into consideration when building an offshore team.

Automation

Automation is a solution that improves testing efficiency, which is even more important in mobile testing for the following reasons:

1. The virtually endless combination of devices, OS models, and device sizes mean that, in order to cover as much as possible, the same functionality needs to be run on different devices.
2. The industry is constantly changing, with OS updates, upgrades, new devices, and new manufacturers, etc. In order to ensure that your application is up-to-date and supported by new trends, you need the ability to test it fast.
3. Applications are regularly and rapidly updated with new features in order to keep up with demand. In order to introduce upgrades into the market quickly, fast testing capability using automation is crucial.

Solution

The following solutions are currently available in the industry and for each solution there are several top providers. I will not elaborate on the providers them self, but will focus on the concept instead.

Simulator/emulator – tests the functionality of the software regardless of the device type and can test all OS and sub versions using automation or manual modes, without running the test on the device itself. This solution is most suitable during early development and testing stages as a prerequisite for testing the devices.

Remote connection – there are several types of software on the market that can operate the system using a USB connection to the device itself. Using this approach, you can build a remote lab using multiple PCs connected to devices and operate the devices from offshore using automation script or manual testers.

Cloud – real devices located in a remote lab. The benefit of this solution is that, instead of operating the system from an SW using USB, you are "really" clicking on the device itself and can see the device's screen in real time. The device sits on a cradle connected to the server in the lab with a camera on top, recording the device's screen. You can rent a specific device and operate it using manual or automation scripts.

So which method is best?

As always, it depends...

When starting a device application testing project, it is crucial to understand the potential coverage in terms of devices and OSs. Once the coverage is defined, the next step is to decide which would be the lead devices. Lead devices are not necessarily the most updated devices, but the most popular ones within the population which intends to use the tested application.

In early stages, and when moving from phase to phase during the testing life cycle, simulators/emulators are the best choice, using manual and automation scripts.

The next stage is to test the functionality of the utilities on the device itself. In order to cover more devices and OSs, the remote connection method can be used again with manual testing, but mostly with automation.

To complete the testing and make sure testing works properly on the device itself, I recommend using cloud testing for lead devices combined with manual testers testing real devices onshore.

This combination of testing methods assures better quality on the device application and the most appropriate combination should be decided according to budget constraints, and on a case-by-case basis. ■

> about the author

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Matthias Schulte and Tim A. Majchrzak

Context-Dependent Testing of Apps

Applications propel the versatility of smartphones and tablet PCs. However, testing apps is a cumbersome task. It is particularly complicated since apps have to cope with frequent changes of the context they run in. Mobile devices move, which leads to changes in the available network connection and varying environmental parameters, such as coordinates derived from a geolocation service. Moreover, patterns of usage change. We propose a novel concept to deal with context changes when testing apps. It is based on basic blocks of code between which context changes are possible and helps testers to manage complexity. Moreover, it supports the maintenance of a suite of test cases that would become much larger if test cases were simply duplicated to deal with different contexts. In addition to the introduction of our concept, we highlight its application and benefits.

Introduction

Since the advent of the first iPhone in 2007, smartphones have dramatically gained in popularity. Smartphones and tablet PCs (Pads), which were introduced shortly after, have become everyday devices used by millions of people. Mobile phones were mostly limited to the functionality they were shipped with – partly for technological reasons despite being able to e.g. run JavaME programs, partly for sociotechnical reasons, e.g. having low-resolution displays that are not fun to use for anything but basic functionality. Mobile applications (apps) propel the success of today's devices. They enable the versatility of the PC on a mobile device, combined with its inherent abilities such as using geolocation services.

App development is a new practice and there is little experience with it. Some of the techniques of software engineering can be transferred and used but, both for reasons of technology and scope, a set of own practices is needed. In particular, testing of apps is a problematic endeavor. After decades of research and industrial practice, software testing remains a laborious activity [1]. Effective and efficient testing strongly contributes to an application's value but, in any case, is a task that requires much time and care.

There are a number of problems with testing apps in contrast to testing applications written for PCs or servers. These are partly caused by the platforms. Apps are not usually developed on a mobile device. Testing them on a PC in an emulator might not yield the same results as testing on devices and can be frustratingly inefficient. Testing them on mobile devices is extremely laborious and hard to automate. Moreover, apps can use a variety of technologies, e.g. a mixture of classical programming and Web languages. The most profound difference to PC software, however, is context. Apps on mobile devices need not only be tested as they are, but need to be checked regarding their robustness to context changes. Such changes for example are dynamic and potentially unstable network conditions or device orientation changes.

In this article we present a concept to deal with context in the domain of app testing. The application of our concept will help to improve the overall success of testing apps. We first highlight why context is important before introducing our concept of block-based context-sensitive testing.

Influencing Contextual Factors of Smartphone Applications

The paradigm of apps is inherently different from applications in traditional computing, as it includes the concept of mobility. Apps are used by means of a smartphone or a tablet in many different situations and environments. Therefore apps are influenced by the context, but are also able to make use of contextual factors. For example, they can utilize information about the current location or are influenced by the current Internet connectivity status.

There are a lot of different types of contexts an app resides in. Context can be physical context and communication context as well as social context. Physical context means the physical execution environment, which is constantly changing while the user is moving. Thus, the most common aspect is the current location of the user. This can be acquired through several techniques, each varying in their availability and accuracy. Moreover, the quality of data that is available to apps changes. For example, GPS does not work in buildings and other sources of information with different accuracy need to be used. Other environmental conditions, like nearby devices contactable via Bluetooth or data gained by the various sensors embedded in devices, also increase the complexity of testing. Apps can react differently in certain situations, depending on the physical context; consequently, they have to be tested in a variety of physical contexts. Including these contexts in app testing is, of itself, a challenge because simulating some of them is hard, or even impossible, using today's emulators. Even if actual devices are used, it might not be possible to simulate all contexts.

Closely related to the user's location is the communication context. The parameters of network connections vary, depending on the current location. These are principally availability, latency, and bandwidth. The quality of the mobile Internet connection, for example, depends heavily on the network provider and the current location. In rural areas, often only "slow technologies" like GPRS or EDGE are available, while in densely settled regions technologies like UMTS, HSPA or LTE are available. Moreover, local access technologies like WLAN are only available in certain areas. Additionally, there can be unpredictable environmental impact, e.g. due to rain or heavy utilization of cells. While an application is being used, the different access technologies with their diverse characteristics are constantly changing. Therefore, apps have to be designed to cope with these dynamic network circumstances. Furthermore, they have to be tested in different communication contexts that are changing during test execution. Key factors to test are how the app is dealing with slow transmission rates, low bandwidth, or changes between technologies with disconnections in between. To complicate testing further, there is no unique answer to which delay, duration of disconnecting, throttling of bandwidth, etc. is acceptable. In fact, this depends on the kind of app and on how it is used.

The social context in which an app is used comprises a number of personal usage particularities. Firstly, many mobile devices are used both for professional and personal purposes. Some apps might be used for both – but not necessarily in the same way on each occasion. Secondly, the user's attention span will not be the same in all situations. For example, it is shorter if an app is used while conversing with others. Thirdly, time and date of usage might be relevant. A study showed that some types of apps are "more likely to be used during specific time periods" [2, p. 228]. Testing whether apps behave as desired can be even more cumbersome when dealing with changes in social contexts, compared with technical context changes.

Besides the main contexts, additional contexts can be defined. Examples are software contexts and hardware contexts. It might be possible to run an app on different versions of a mobile operating system and on a variety of devices. However, it is not clear that they behave equally on each platform and device. To name just a few, there might be differences in APIs and data formats as well as in device performance and available sensors. An elaborate discussion of further contexts is out of scope of this article, though.

To sum up, apps for mobile devices have to deal with the possibility of frequent changes to the context they run in. Context changes have to be tested on top of, and in combination with, "normal" testing of the adherence to functional and non-functional requirements. This can become extremely complex and exhausting. Thus, methods for effectively testing context changes are needed. Ideally, there should be means of automation.

Block-Based Context-Sensitive Testing

To tackle the aforementioned contextual problems faced by apps, the concept of block-based context-sensitive testing is introduced. In particular, its goal is to make it possible to automatically change the context of an

application under test. Ultimately, this will ease the process of uncovering context-related issues when testing smartphone applications.

Status Quo and Basics

Studying the current market for mobile testing support, we found that there is little support in the field of (semi) automatic testing for the varying network parameters available during the use of smartphone applications. However, this tends to be the most essential factor influencing smartphone applications because nearly every application – at least to a certain extent – is using network connections whose properties are changing while being on the move. Therefore, the concept is particularly suited to changes of network parameters, but also applicable to other context changes such as flipping the device or changing localization information.

The questions that arise when trying to approach contextual issues within app testing are:

> **What level of support for context changes is needed and feasible?**
>
> **How is it possible to achieve an automated solution that supports development teams?**

The most simple and naïve approach would be to specify a context in that each test case should be executed a priori. Technically, this could be done by means of annotations or within the JUnit [3] setUp() fixture that is executed before each test case. In any case, independent of the technical solution for specifying a given context, using such an approach means that test cases would be executed in a given context only as a whole. For testing of single (i.e. atomic) code units that react differently in certain contexts, this approach would be beneficial as it allows automatic running of test cases in different contexts. Manual interaction with emulation tools to establish certain contexts is no longer needed and automated unit tests taking into account different contexts would be possible.

However, many influencing contextual factors are not stable, but change dynamically while an application is being used. For example, network connection parameters, such as latency, are constantly changing while the device is mobile. Thus, the static approach mentioned above is less beneficial for uncovering context-related failures by means of test cases mimicking business processes. Of course, providing the possibility (e.g. by means of an API) of specifying context changes also within a given test case would permit the simulation of changing contexts while test cases are executed. Nevertheless, this is also a static approach. By using an API-approach, the changes of context have to be explicitly stated within test cases. This means that when testing scenarios that include different variations of context, many test cases are required with equal test code but varying statements of context changes. This multiplication of test cases is not desirable, nor is it a dynamic solution. Such test cases would be costly to develop and execute and hard to maintain. Therefore, a way to automate context changes within test cases has to be investigated.

In order to develop a concept that offers the possibility of testing apps within dynamically changing contexts, we use the concept of modularization. Test cases are separated into blocks; between each block a change of context is possible. Consequently, by repeating test cases which only differ in context, changes are avoided. Blocks are reused and combined with different contexts. As blocks are the foundation of our concept, we call it block-based context-sensitive testing.

Using Blocks, Assertions and Context Changes

A block is a logical part of a test structure. It contains operations as well as assertions. The former are needed to simulate user interaction or use cases of an application. These could be, for example, `clickSomewehre()`, `enterText()` or `clickButton()`. Assertions are used to verify expected behavior. Both of them are typically included in JUnit or other unit testing frameworks like the Android testing framework. Our idea is to derive blocks from existing test cases (e.g. the happy path – a basic test case without context changes) and, thereby, transform a test case into a structure that can be used to generate many context-dependent test cases. Consequently, blocks have to be ordered (e.g. saved in form of a list) and later executed consecutively, preserving their intention. One given test case can result in a number of blocks that form the structure of a block-based context-dependent test. In some cases there will be only one block, but the number can be much larger.

Blocks realize functionality that is atomic from the viewpoint of changing contexts. Between two blocks, changes of context are possible. To realize different scenarios, the test code does not need to be repeated but only the injected context changes have to be altered. In other words, blocks are reusable or modular. In combination with a generator that automatically creates test cases from these blocks with varying context changes, this solution is expected to be most beneficial. Manual effort is reduced and redundant test code is minimized. Moreover, there is a separation of concerns. Test cases address an app's functionality and are reused to assess the behavior under changing contexts.

The approach sketched above is only useful for testing applications that behave the same in various contexts. When applications include context-dependent behavior and the context is changed during test execution, assertions that are statically included in blocks are no longer able to uncover unexpected behavior.

Consequently, the blocks introduced above have to be defined in a more fine-grained way. In particular, the parts, including assertions, have to be separated due to their potential dependency on a context. In addition to the ordered list of blocks with context changes in between, for each block at least one assertion part has to be added. Moreover, if a block should

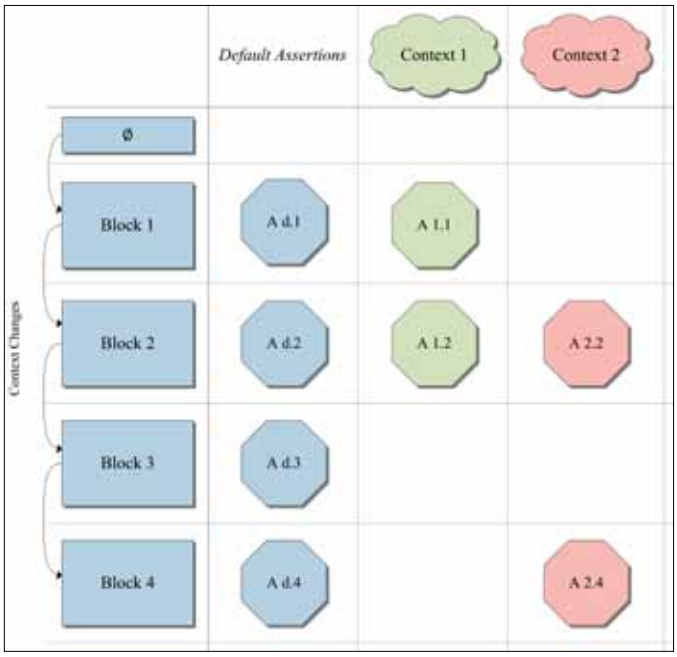

Figure 1: Concept of Block-Based Context-Sensitive Testing

verify different behavior in a certain context, an assertion has to be added for context-dependent verification.

The building-blocks of our concept are shown in Figure 1. The structure of a test case is depicted by a list of blocks. For each block, many assertions (represented by octagons) can exist due to their potential dependency on a context. At least one "default assertion" has to be registered. Test cases can be generated automatically taking various context changes into account. Which assertions are used for each block depends on the context the block is executed in.

Sample Context-Dependent Test Case Execution

An example that can be generated from the elements above is depicted in Figure 2. The execution start point is denoted by the empty set. Before any block is executed, the context is changed to an initial state, namely Context 1. After the operations of Block 1 have been executed, an assertion fitting to the current context is searched for. The specific assertion for Context 1 as shown in Figure 1 is used. As the assertion holds (i.e. the application under test behaved as expected), the test execution is continued.

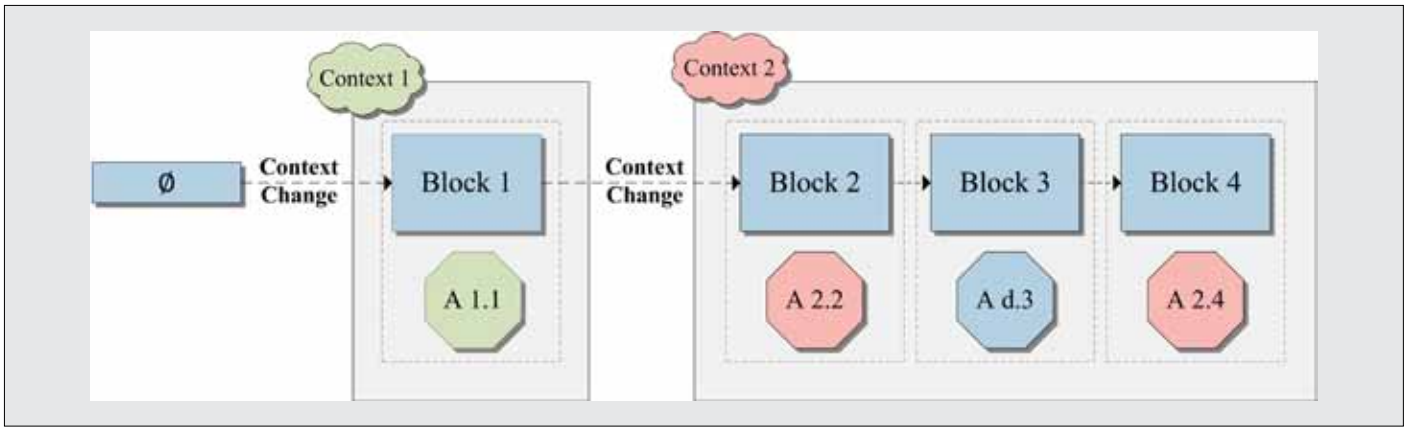

Figure 2: Sample Test Execution Using Block-Based Context-Sensitive Testing

Between the execution of Block 1 and Block 2, the context is changed. This time, Context 2 is established and resides for the rest of the test execution as shown in Figure 2. Similar to the first block, Block 2 is executed together with a context-specific assertion. This changes moving to the third block: as shown in Figure 1, this block does not have any specific assertions defined and the expected behavior does not change between the various contexts. Therefore, the default assertion that verifies this unchanging behavior is used. Finally, Block 4 is executed together with a context-specific assertion, like Block 1 and Block 2.

As the matrix in Figure 1 shows, there are many different execution paths, taking into consideration that, prior to each block, the context is changeable and alternative assertions can be defined. The matrix grows, taking into account more contexts and this growth can become exponential. Nevertheless, the matrix can (and in most cases will) be sparse when not defining specific assertion parts for all blocks. Using the concept of block-based context-sensitive testing, the structure of a test remains static as the list of blocks in the sample shows. However, the context in between is changing and also the used assertions can vary.

Practical Benefit and Application

Based on the idea of block-based context-sensitive testing, we designed a proof-of-concept implementation. Its foundation is the Android Testing Framework, together with JUnit and Robotium [5], a (convenience) framework for testing Android applications that is inspired by Selenium. Applying our test tool to sample applications showed that it is possible to automatically derive many context-dependent test cases from one test structure and, thereby, ease the testing of apps. Our solution uses various generators to automatically create test cases from a given list of blocks. A specific test runner is able to establish certain contexts and, therefore, execute context-dependent test cases. We chose to implement only the communication context and focused on Android. However, implementing our concept with other unit testing frameworks and for other mobile operating systems should be possible without too much effort.

The approach of generating many test cases from a static test structure, together with the modular approach of using blocks, reduces manual effort for creating and executing context-dependent test cases. Due to the automated injection of context changes, failures may be found in application parts where they normally would not be expected. Applying block-based context-sensitive testing supports test teams in finding context-dependent failures that otherwise might remain undiscovered because extensive field testing in various contexts tends to be very expensive in terms of time and budget. However, this concept will not cure all context-related issues that test teams encounter when testing mobile apps. In fact, it is meant to support testing of program parts that are highly influenced by frequent context changes. Moreover, it can be seen as a supportive method of testing the robustness of an application towards changes of context that can be simulated.

A concept such as ours is limited by the ability to simulate certain contexts while executing test cases. Simulating network connectivity, sensor data, or location information is much easier than, e.g., the social context. However, this is not a conceptual boundary but calls for improvements in the testing infrastructure for mobile devices. One further limitation arises from the linear processing of blocks. This does not cover the fact that changes of context may induce alternative business processes to be executed. For example, consider a location-based app that behaves differently depending on the availability of localization information. If GPS localization is not available, it could require the user to manually enter localization information. Changing the context to a situation where no localization information is available induces a change in how the application's business process is executed. Another example is an app that caches data at times of network disconnection and offers different screens and application functionality to the user while being disconnected. In our proof-of-concept implementation it is possible to specify that in certain contexts that induce alternative business processes, test case execution is aborted and treated as successful if all assertions hold true so far.

To tackle the previously described limitation, a solution is conceivable in which test cases are not automatically generated but created by testers individually. This could be done by means of a supporting graphical user interface that allows blocks to be connected to each other and offers the possibility of specifying in which context they are executed. Different instances of the business process reflected by the list of blocks could then be created. This would also tackle the issue of having different execution paths when some code unit is executed in a specific context. Having a repository of blocks available and configuring their execution in a similar way to modeling business processes could be beneficial. As a result, it is possible to branch the execution process when some blocks are executed in a certain context.

Conclusion

In this article we introduced the concept of block-based context-sensitive testing. It is a theoretical foundation of how to support automated testing of apps in various contexts. We first sketched the importance of context when testing apps for mobile devices, before explaining our concept in detail. By applying a tool that implements the concept – like our proof-of-concept implementation – test teams are able to efficiently find context-dependent failures in mobile applications.

Whilst our prototypical implementation is available as open source software [6], we hope to see other projects implementing the concept in the future. For practical use, the implementation has to be further developed and, for example, enriched by the ability to support additional context changes. Eventually progress in this field should yield much more powerful testing tools for mobile devices. As a result, some of the concept's limitations described might be overcome either through refinements or additions. This should include ways of coping with the device fragmentation that can be currently observed. Adapting to differing patterns of user behavior is another important challenge.

In general, much has to be done regarding app testing – particularly bearing in mind how much society nowadays relies on mobile devices. Nevertheless, we are optimistic that we will see swift progress in the very near future. ■

> about the authors

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Testing Maturity – Where Are We Today?

Results of the first TMMi benchmark

Column

With the full TMMi model (release 1.0) having become available recently and the rapid growth in TMMi interest and recognition world-wide, my contribution to Testing Experiences this time had to be on the Testing Maturity Model integration (TMMi). As the first version of the TMMi was already published four years ago, many organizations have since used the TMMi to evaluate and improve their test processes. Together with Jan Jaap Cannegieter, also my co-author for the "The Little TMMi", I analyzed the results of almost fifty (50) TMMi assessments. The results provide an indication of testing maturity today.

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TMMi: the model

TMMi is a non-commercial, organization-independent test maturity model. With TMMi, organizations can have their test processes objectively evaluated by certified assessors, improve their test processes, and even have their test process and test organization formally accredited if it complies with the requirements. TMMi uses the concept of maturity levels for process evaluation and improvement. Furthermore, process areas, goals, and practices are identified. An overview of the TMMi maturity levels is provided in Figure 1. Practical experiences have already shown that applying the TMMi maturity criteria will improve the test process and is likely to have a positive impact on product quality, test productivity, and test lead time.

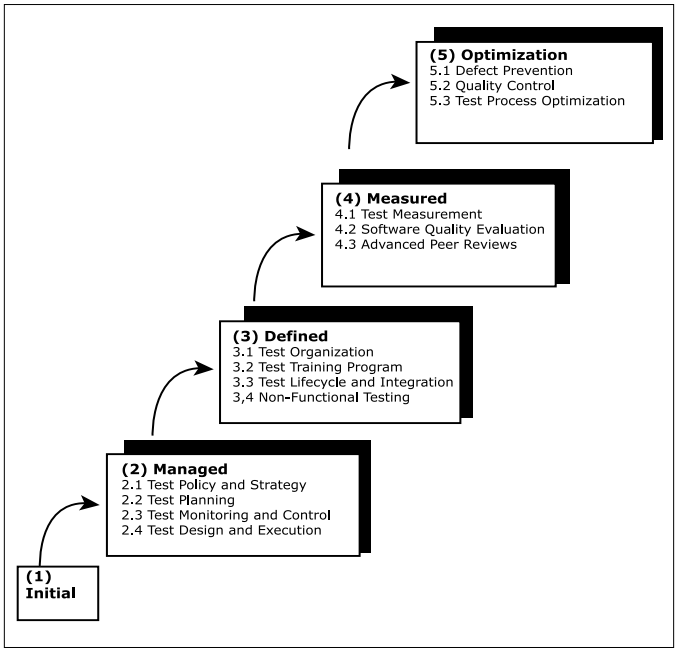

Figure 1: TMMi maturity levels and process areas.

TMMi assessments

A TMMi assessment measures the maturity of test processes. An assessment can also be used to determine whether an organization has achieved a certain maturity level or not. The results of the assessment will be used to formulate recommendations for improvement. The TMMi Assessment Method Application Requirements (TAMAR) describe the requirements that TMMi assessments must comply with. TAMAR distinguishes two types of assessments: formal and informal. A formal assessment has enough depth to officially determine the extent to which an organization complies with the requirements as defined in TMMi. An informal assessment does not lead to an official statement regarding test process maturity – it only provides an indication. From the analyzed TMMi assessments, 14% were classified as being formal TMMi assessments and the other 86%, therefore, were informal assessments. Based on both authors' experiences, these numbers are representative of the TMMi assessment market.

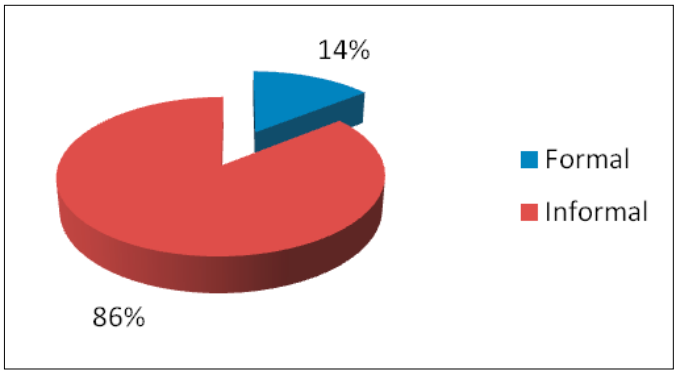

Figure 2: TMMi assessments by type.

Maturity levels

Based on the benchmark results, no less than 84% of the test organizations assessed are still at TMMi maturity level 1, a mere 10% are at TMMi maturity level 2, and only 6% of the organizations are at level 3. None of the organizations that were assessed fulfilled the requirements of TMMi levels 4 or 5.

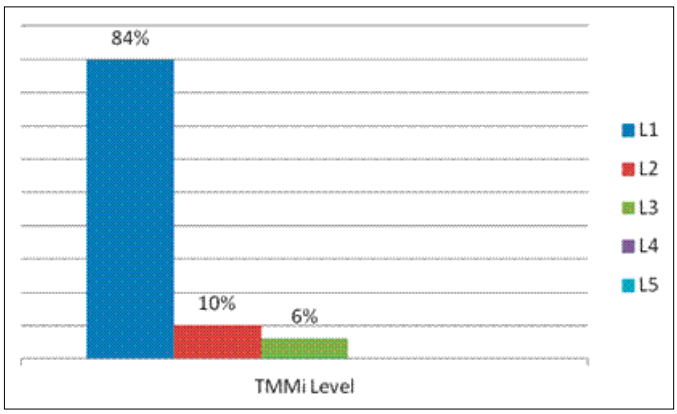

Figure 3: Maturity of the organizations.

Thus, today most of the organizations are still at TMMi maturity level 1. Of course, many differences in maturity can be observed within level 1 organizations. In some organizations, testing is highly chaotic with no defined process, while others are almost at TMMi maturity level 2. Even at level 1 a test project can be successful. However, this is achieved by the dedication and effort of the 'test heroes', not by means of a managed and repeatable test process.

TMMi maturity level 2

Organizations at TMMi maturity level 2 can be perceived as being in the testing "premier league". They are still a rare breed. The main objective of testing in a TMMi level 2 organization is to verify that the product satisfies the specified requirements. At TMMi level 2, testing is a managed process. At component level it is clearly separated from debugging and a company-wide or program-wide test strategy is established. Test plans are written which include a concrete test approach based on the result of a product risk assessment. The test plan defines what testing is required, when, how and by whom. Testing is monitored and controlled to ensure it is proceeding according to plan and appropriate actions are taken when deviations from plan occur. Test design techniques are applied to identify and define test cases from requirements. However, testing may still start relatively late in the development lifecycle, e.g. during the design or even at the beginning of the implementation phase.

TMMi maturity level 3

Organizations at TMMi maturity level 3 can be perceived as being in the testing "champions league". At TMMi level 3, testing is no longer confined to a lifecycle phase after implementation. It is fully integrated into the development lifecycle and its associated milestones. Test planning is done at an early stage of the project, e.g. during the requirements phase, and is documented by means of a master test plan. Master test planning builds on the test planning skills and commitments acquired at TMMi level 2. The organization's set of standard test processes, which form the basis for maturity level 3, has been established and improved over time. Both a dedicated test organization and a specific test training program exist, and testing is now perceived as being a profession with career paths. Organizations at TMMi level 3 understand the importance of reviews in developing a quality product. A review program has been implemented, but not yet linked to the dynamic testing process at this level. Test process improvement is fully institutionalized and is one of the test organization's practices.

Process areas

Figure 4 lists the maturity scores per TMMi level 2 process area.

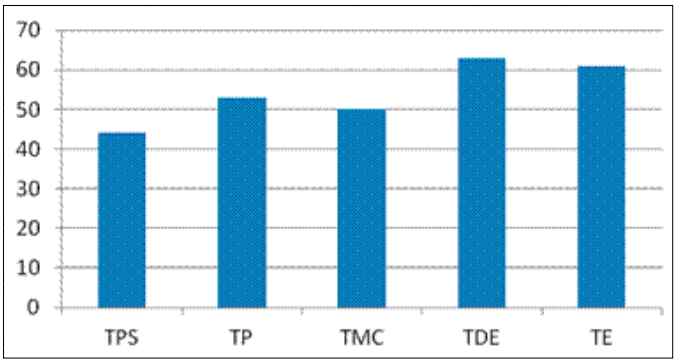

Figure 4: Scores (incl. standard deviation) per TMMi level 2 process area.

One can observe in Figure 4 that the operational testing process areas, Test Design and Execution, and Test Environment, are typically the process areas with the highest maturity scores. The managerial process areas (Test Policy and Strategy, Test Planning, and Test Monitoring and Control) have a large distribution in their maturity score. Although the mean maturity score for these process areas is lower compared with the operational process areas, there are many organizations that have already implemented these process areas quite well. However, there are

also many organizations that have a very low maturity score for these managerial process areas. In these organizations, typically testing is not well integrated and linked to the business drivers and quality policies, and lacks management commitment.

CMMI and TMMi

Practical experiences have shown that TMMi can also be applied successfully in organizations which are not at all familiar with CMMI. However, implementing TMMi is perhaps slightly easier in organizations that are already familiar with CMMI. Analyzing the assessment data, a significantly higher maturity score was observed on especially the managerial TMMi process areas for organizations that are also using CMMI (in blue) compared with those that are not also using CMMI (in red).

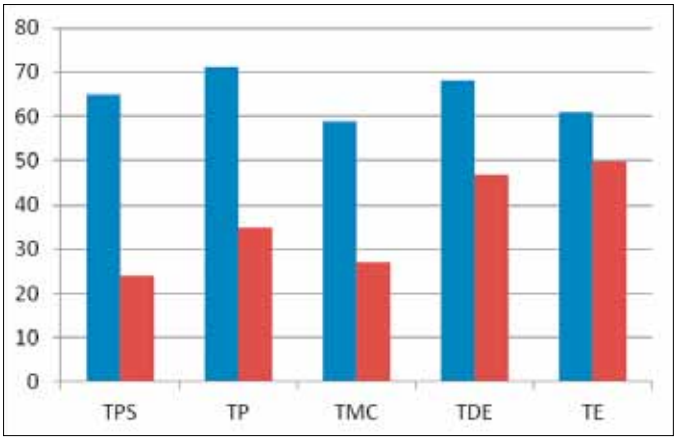

Figure 5: TMMi maturity score – CMMI organizations vs. non-CMMI organizations.

The authors believe that the reason for this could be that organizations also using CMMI already have experience in defining, implementing, and using policies, as well as planning and monitoring processes. This probably applies to having experience in any other software improvement model. It is the experience with process improvement in general that is important and helps here, rather than the specific experiences with CMMI.

Sector results

An analysis was also done on the maturity scores per domain. Is testing maturity on average higher in some areas compared with others? Based on the assessed organizations, three areas were distinguished that had enough data points to be analyzed: industrial organizations, financial institutions, and government bodies. From Figure 6 it can be seen that industry (e.g. medical, automotive, embedded software) has a significantly higher maturity score compared with finance and government. The average maturity score for industry is even higher for all TMMi level 2 process areas, but especially for Test Policy and Strategy, and Test Planning.

Probably due to the risk level of the systems being developed, industry is more mature in terms of testing compared with the other areas analyzed.

Test practices

Although it was hard to draw conclusions for specific practices based on the available assessment data, it was observed that some specific practices within the TMMi process areas were much more commonly applied that others. Incident management and test environment control are typically strong practices and fully implemented. However, reliable test estimation,

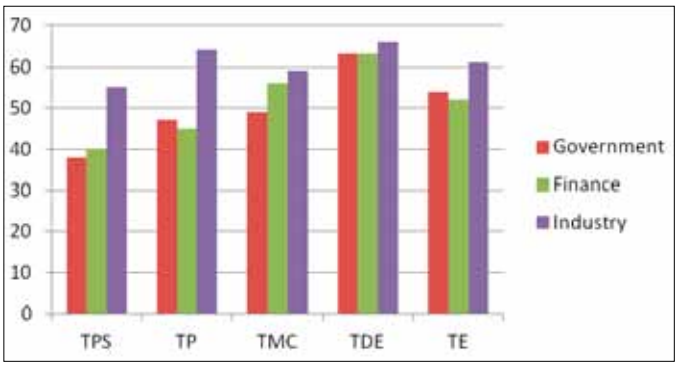

Figure 6: TMMi level 2 maturity scores per area.

the application of test design techniques, and documenting test environment requirements are typical problem areas for many organizations. These observations are much in line with the practical experiences of both authors. Providing a reliable and well-founded test estimate is a problem for most test managers, test design techniques are often not explicitly used, and, in practice, we rarely see requirements for test environments being obtained and specified.

Closing comments

In recent years, much effort has been invested in improving the testing processes. In some organizations this has lead to remarkable results, but not in every organization for many reasons. With TMMi now being fully available, it is expected that it will become even more popular and be used as the standard test maturity framework against which to assess and improve one's test processes. Based on the benchmark results, the testing industry still has many steps to take towards maturity. There is long but rewarding road ahead of us. ■

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Erik van Veenendaal (*www.erikvanveenendaal.nl*) is a leading international consultant and trainer, and a widely recognized expert in the area of software testing and quality management with over 20 years of practical testing experience. He is the founder of Improve Quality Services BV (*www.improveqs.nl*). He holds the EuroSTAR record, winning the best tutorial award three times! In 2007 he received the European Testing Excellence Award for his contribution to the testing profession over the years. He has been working as a test manager and consultant in various domains for more than 20 years. He has written numerous papers and a number of books, including "The Testing Practitioner", "ISTQB Foundations of Software Testing" and "The Little TMMi". Erik is also a former part-time senior lecturer at the Eindhoven University of Technology, vice-president of the International Software Testing Qualifications Board (2005–2009) and currently vice chair of the TMMi Foundation.

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Sathyanarayanareddy Gaddam and Nimmagadda Nivedita

Mobile Business Application Testing Automation: A Novel Approach

Mobile Test Automation – Why?

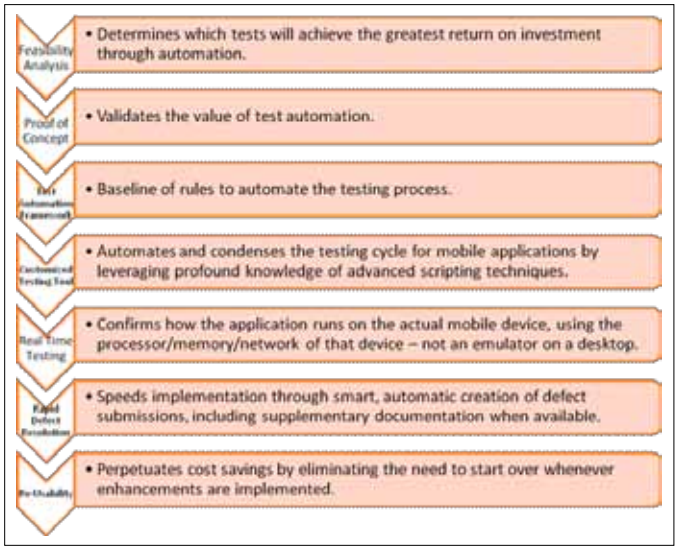
- **"Create Test Once, Run on Multiple Devices"**
  In the mobile environment, the four market leaders in mobile OS are Android, iOS, BlackBerry and Windows Phone 8. They imply uniformity in the way an application looks across all devices that run the same OS. So, for example, an Android application would look practically identical on any Android mobile phone. Therefore an application vendor can create a test on one android device and run the very same test on all Android devices (phone, tablet etc.).
- **Device and Platform Diversity**
  Android has around ten different OS versions. iOS, too, has 4, 5, 5.xx; Windows has 7 and 8 and they are being frequently updated. As a result, application vendors needs to be on their toes to keep their apps in sync with mobile OS providers and this demands a quick and easy way to run the same test on the different OS versions.
- **MTTR: Mean Time To Market**
  The mobile application market is highly competitive and the ability to quickly release an app is of the utmost importance (the average life span of mobile apps in app stores is around 60 days maximum). This requires short development time and, most importantly, short testing cycles that can release a high quality product on time.
- **Requirement of a Singleton Automation Tool**
  Most application vendors launch the same application on all or most of the mobile OSs (Android, iPhone, BlackBerry, Windows Phone 7). Therefore, it is of the utmost importance that one automation tool can handle testing on all mobile OSs.
- **Mobile Test Automation Support for Latest Technologies**
  In the mobile world, business apps are either native or web-based. As a result, the testing of applications needs to support the existing testing tools/technologies like QTP, C#, Java, Perl and Python.
- **Performance**
  How to test performance of mobile business apps? What to test – device or network or server? We need the clear and correct picture in order to test the performance bottlenecks.

Best Practice in Mobile Business Application Testing

Today, most of the functional automated testing of web and desktop-based applications is done using tools such as Quick Test Professional® (QTP) from HP and Visual Studio Team® System from Microsoft. To successfully use these tool capabilities for mobile applications, extensive customization is required. The automation engineer must extend the tool's capabilities by writing an advanced set of functions to replicate the current testing functionality available for web and Windows applications for mobile applications. Many people know how to use automated testing tools, but, until now, organizations have lacked the extremely specialized skills and depth of experience needed to customize the tools for mobile applications. Recent breakthroughs are changing that paradigm by providing a best practice approach for testing automation for mobile business applications. This article describes the components of that approach, provides you with the tools you need to reduce testing cycle times, and frees testers to focus on other critical tasks that require manual intervention.

Best Practice Components

There are seven components to developing a best practice approach in mobile business application testing automation:



Feasibility Analysis of Test Cases

Before any automation is attempted, careful evaluation and analysis of the existing test cases should be performed. Test cases that are highly complex, full of technological hurdles or run infrequently are probably poor candidates for test automation. Based on the returns that testing automation typically generates, these types of test cases do not justify the investment. Realistically, only 50-60 percent of manual test cases should be automated, according to the following criteria:

- Automate repeatable test cases. The more likely a script is to be reused, the greater the justification (and ROI) for automation.

- Apply the 20-80-20 rule. Automate 20 percent of scripts that take 80 percent of the execution time and 20 percent of the test engineer's skills.
- Automate test cases that require comparisons of numbers and strings.

Proof of Concept

To confirm the feasibility of test automation, a proof of concept should be completed as part of any test automation effort for a mobile application. A limited number of the mobile application's manual test scripts should be automated. To prove the value of automation, the initiative should also:

- Test the application in its environment using the physical mobile device.
- Define the expected ROI.
- Demonstrate the scalability of the process and the likelihood that test scripts can be reused on an ongoing basis.

If performed by experts who specialize in mobile test automation, the proof of concept can be delivered within 5-10 days. A proof of concept recently completed for a global retailer involved two of its most complex scripts which take half an hour to run manually. Automation reduced the testing time to two minutes and the scripts were available for immediate reuse in subsequent testing cycles. The analysis results from the proof of concept were continuously applied as the number of scripts increased in the testing phase that followed.

Test Automation Framework

Serving as guidelines for best practice, frameworks define the rules for implementing and testing software. Before automation begins, a test framework specific to the mobile platform and tailored to the organization's application suite should be developed. The test automation framework enables the maintenance of high levels of consistency and quality across testing processes.

The proof of concept example cited previously was followed with the development of a 50+-page framework document that addressed the uniqueness and differences of mobile device application testing.

Customized Testing Tools

Mobile test automation demands profound knowledge that encompasses analysis, the application itself, and the testing tools used by the IT organization. The tools must be customized to accommodate the unique characteristics of mobile platforms. In addition, an intimate knowledge of the application under test is essential.

Real Time Testing

A popular mobile automation method nowadays is to use emulation technology, which is not valid because it uses a simulated version of the mobile application on the desktop. Test integrity is breached, critical defects are missed, and efficiency is lost due to the reporting of false-positive defects. Rather, testing should be performed on the actual devices that the application will run on and in the actual environment in which it will be used.

Furthermore, the architecture created for the automation process should provide maximum flexibility and cost efficiency.

Rapid Defect Resolution

In addition to automating the mobile application test, it is also possible to accelerate the resolution workflow by automating the submission of defects uncovered by the test engineers. Supplementary documentation, such as available screenshots or recorded video, is passed along to the developer as part of the submission. By eliminating the time it takes test engineers to manually compile and submit performance discrepancies, this additional automation capability allows test engineers to focus on other critical tasks. Developers can also address the defects earlier, speeding up both the resolution cycle and time to market.

Re-Usability

The ideal architecture for a mobile test automation solution is not built around an automation tool. Instead, it is one that separates interfaces and logic. Actions that involve interfaces are wrapped in reusable functions. The IT operation gains the ability to minimize the time required to accommodate changes in the tool version and even in the tool itself. The ideal architecture solution is designed with built-in flexibility, so it can be easily applied to new mobile devices. Thorough documentation of the testing scripts greatly facilitates any ongoing changes.

Benefits of the Best Practice Approach

Mobile technology has its own unique development nuances and challenges. It can be extremely difficult, if not impossible, to take standard techniques used to automate testing of web and Windows applications and directly apply those techniques to test automation in the mobile device arena. Adjustments are required, and the crossover involves a significant learning curve.

By relying on highly skilled automation specialists who understand the complexities of mobility, who are experienced in implementing mobile automation solutions and who consistently adhere to best practices, your organization can expect to achieve an exceptional return on investment from automating the testing of mobile applications. This approach:

- Produces dramatic savings in time, effort, and cost by reducing testing cycles.
- Establishes a best-practice framework for future projects, ultimately reducing onshore or offshore development costs.
- Increases testing team efficiency, allowing releases to get to production ahead of schedule.
- Accelerates the ability to accurately identify and report defects so that corrections and implementation can proceed quickly.
- Establishes a repeatable process that can be duplicated throughout the organization to deliver ongoing time and cost savings.

Checklist for Selecting a Mobile Testing Automation Tool

Presently there are a number of tools on the market for mobile automation. Some of the popular automation tools use mobile cloud, while some consider using a simulator or real devices for this. Before considering any tool for automation there are a few key features to be considered.

- Supports all device functionality such as gestures, security alerts, wake and reboot.

- Support for identification of all objects – most of the tools provide image comparison, text comparison. Few tools even provide identification based on Native id and Web HTML5 (DOM).
- Must be able to test the leading mobile devices, OSs and platforms. Flexibility to interchange devices, platforms, and operating systems within a reasonable timeframe.
- Inbuilt intelligent mobile-specific functions should emulate real user operations for easy and maintainable scripting.
- Data-driven and keyword-driven scripting capabilities.
- Secured solution – the tool implementation must meet the same security level as the enterprise in which it is implemented.
- Same test running on different devices and different mobile OSs.
- Should support simulators and real devices, as well devices on the mobile cloud.
- In the case of cloud automation, devices should exactly mimic the actual user. They should not have Jailbreak or Rooting.
- Easy integration with the functional, performance and load automation tools already being used. Perfecto is the best example for integration with HP QTP.
- Tool should provide APIs to integrate with third party tools.
- Good reporting and debugging capabilities. Debugging solution for scripts that includes the ability to review log files.
- Other non-technical factors, like documentation and support, also need to be considered.
- Cost effective.

Tools for Mobile Automation

Here are some automation tools which are well recognized for mobile app automation:

- Perfecto Mobile's MobileCloud™Platform (plugs into QTP, supports Selenium)
- SeeTest Mobile Cloud (plugs into QTP, TestComplete, C#, RFT, Java, Perl, and Python).
- Keynote DeviceAnywhere
- Testdroid Cloud
- Jamo Solutions (plugs into QTP)
- SILK for Mobile
- FoneMonkey

and for many more, please visit
www.qatestingtools.com/mobile-testing-tools-table

Comparison of Mobile Automation Tools

A brief comparison of some mobile automation tools is shown below:

Perfecto Mobile	SeeTest	Device Anywhere
Cloud-based solution, easy access via the Web	Cloud-based solution, onsite internal hosting, offsite external hosting	Cloud-based solution, built for on-demand use in our enterprise cloud environment as well as for private cloud deployments
Plugs into QTP	Plugs into QTP, RFT, JUnit, TestComplete, Python, Perl, Visual Studio and C#	Supports IBM-Rational QM
Keyword-based scripts, uses VBScript, easy to understand	Command-based language, exports into VBScript, Java, C#, RFT, Python, Perl	Visual scripting language, can be created in Java, and exported to Perl, PHP and VBScript
Cannot plug and play local devices into their desktop computers for manual and automated testing	Can plug and play local devices into their desktop computers for manual and automated testing	Can plug and play local devices into their desktop computers for manual and automated testing
Integrated with test management system	Not integrated with QC	Integrated with test management system

Perfecto Mobile

Tool in Focus is Perfecto Mobile's MobileCloud platform, since it provides a strong add-in with HP QTP, a widely used functional automation tool.

- Perfecto MobileCloud is a web-based platform enabling testers and developers to easily access a multitude of REAL mobile handsets and tablets connected to LIVE mobile networks spread across different geolocations.
- Users can rely on Perfecto Mobile handsets to develop, test, deploy and monitor their mobile applications and services without having to physically obtain them.
- Perfecto REST API provides users with integration into third party tools like Selenium.

MobileCloud For QTP

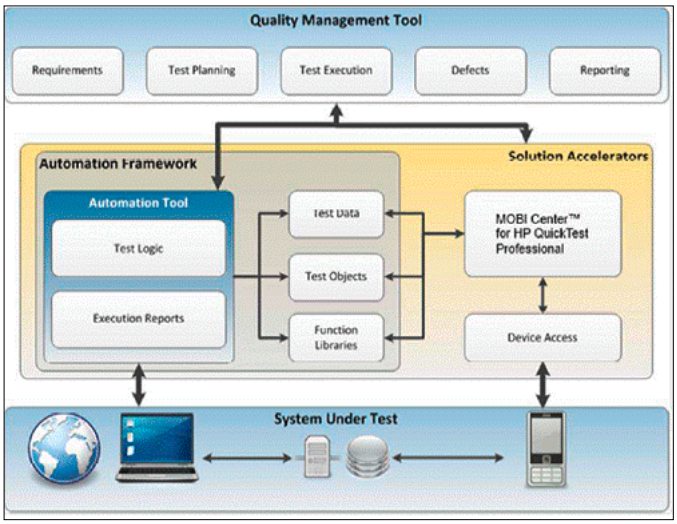
- Single, fully integrated user interface uses QTP feature set and familiar scripting environment.
- Secure private cloud access.
- Intelligent mobile-specific functions emulate real user operations for easy and maintainable scripting.
- Full back-end integration with HP Quality Center enables centralized test management of your mobile apps.
- Rich media reporting embeds active screenshots and video recording into QTP reports.
- Enhanced reusability of QTP Framework with HTML API.
- Variety of handset tools enables efficient scripts (OCR text recognition tool, smart text/image selection and simple text typing methods, etc.).

Selenium WebDriver

Selenium WebDriver is an open source function automation tool and itsability to run automation scripts written using Java by integrating with Selenium WebDriver Android SDK and iOS SDK on their respective emulators is quite well recognized. This tool has been used in most of the organizations where budget constraints do not permit tools with costly licenses to be procured, as mentioned above.

- Android WebDriver supports all core WebDriver APIs.
- Android WebDriver supports mobile-specific and HTML5 APIs.
- Android WebDriver models many user interactions, such as finger taps, flicks, finger scrolls and long presses.
- Android WebDriver can rotate the display and interact with HTML5 features, such as local storage, session storage and application cache.
- iPhone WebDriver enables testing on a UIWebView (a WebKit browser accessible for third party applications) on the iPhone. It works through the use of an iPhone application running on your iPhone, iPod touch or iPhone simulator.

Sample Framework of Mobile Automation



Challenges

So what makes mobile business app testing more challenging than testing traditional web- and PC-based applications?

- Device variety – In theory, there are many devices available that run on the same platform. However, if an application is created for one device or handset, there is no guarantee that the application will run with 100 percent integrity on another device, even in the same product family. This is due to differences in the screen resolution, handset, memory level, battery, operating system, and differences in how manufacturers customize the OS for their device.
- Industry standards – Because mobile applications are at the beginning of the adoption phase, no industry standards have been established for mobile application testing.
- Mobile testing tool availability – Current tools for recognizing screen objects for web and PC applications do not work for applications on mobile devices. In the absence of this object recognition, complex scripting techniques are required.
- Skilled QA automation specialists – With few available tools to conduct automated testing for mobile applications, there is a lack of trained specialists available to develop the automation scripts.

These are key challenges because automated testing of mobile applications, when done accurately and precisely, can potentially reduce test development and execution time dramatically and speed up the time to release the mobile app into the market. ■

> about the authors

Nimmagadda Nivedita works as a test lead with Thomson Reuters and has 8+ years of experience in automation, security and mobile testing. She assesses various mobile automation tools to cater for Thomson Reuters' requirements. She has evaluated Mobile automation tools like Perfecto, Device Anywhere and See-Test Mobile Cloud and has trained and guided teams to built robust mobile automation frameworks. She has extensive knowledge of designing complex automation frameworks and has worked with number of automation tools like QTP, Win runner, telerik test studio, Rational robot, and Selenium. She is keen to manage projects with the utmost emphasis on process and has made a major contribution to the integration of different project management and test management tools.

Sathyanarayanareddy Gaddam is a senior QA engineer with five years of experience, specializing in different types of testing techniques, test automation and testability in different domains, such as investment banking, retail banking, and tax and accounting. He has developed test automation strategies, architectures and frame works using top automation tools like QTP, Selenium, and WinRunner. He is an HP certified automation test engineer and has contributed extensively to the evaluation of mobile automation tools with the emphasis on security. He has a master's degree in Business Administration. He is currently working with Thomson Reuters India.

Masthead

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Index of Advertisers

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Agile Testing Days	45–50	Díaz & Hilterscheid	25	Testing Experience – Knowledge Transfer	17
Agile Record	70	Díaz & Hilterscheid	41	Testing IT	75
ASQF	55	Díaz & Hilterscheid	59	Wirtschaftsförderung Potsdam	51
CaseMaker SaaS	39	Improve QS	757		
CAT – Certified Agile Tester	back	Learntesting	29		

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