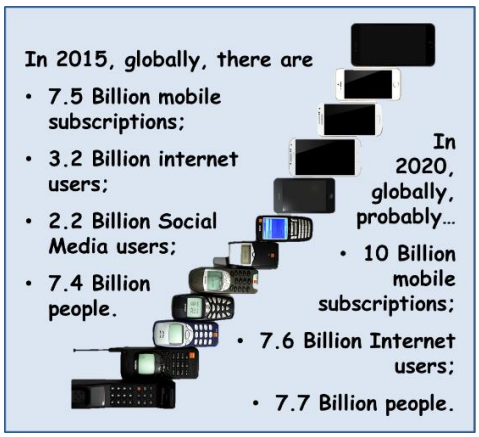
Global Trends in Testing - Digital Transformation & Testing

We live in interesting times. New technologies are providing us with the ability to build applications of ever greater functionality, and ever greater complexity. The rate of change has become so high over the last few years that technology is now changing how many of us live our lives and consequently how businesses fulfil their customers' expectations. Only a few years ago the majority of organizations had the luxury of evolving their processes and business models to adapt to a gradually changing competitive landscape. Now, many businesses are finding that evolution alone is not sufficient to survive the disruption of their business environment caused by these new technologies and that faster, more revolutionary adaptation (a digital transformation) is required if they are to continue to flourish or simply survive.

All of us will have our favourite examples of this digital transformation – and few will have been able to avoid it in some way or the other. Paper maps have been replaced by satellite navigation systems and most of us now get our facts online via Google and from Wikipedia making encyclopaedias collectors' items. Only the most old-fashioned (or trendy young) photographers still use photographic film, with digital photography providing the rest of us with instant and normally better results (even though we rarely print them out). But the makers of digital cameras who rode this first wave of digital transformation cannot stop there - they must now cope with the disruption enabled by the ever-increasing quality of camera functionality built into smart phones – after all, why carry both – and how many of us live today without a smart phone?

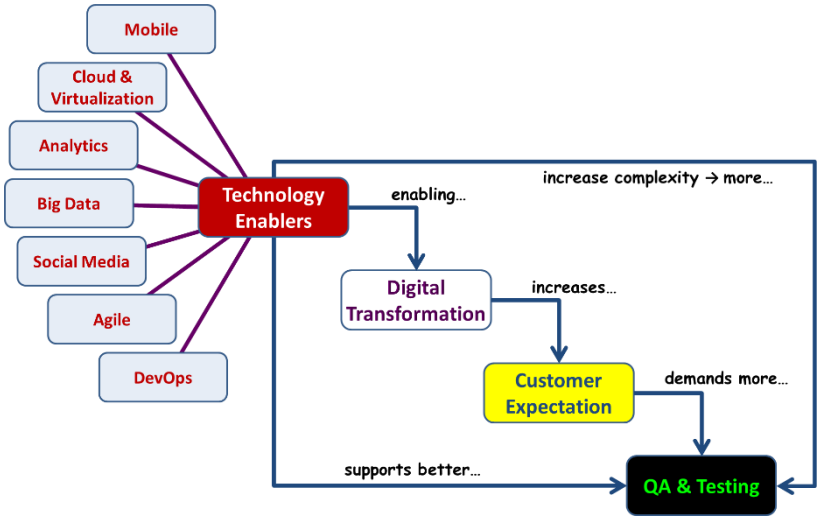


The number of people worldwide able to take advantage of this digital transformation is increasing fast. Currently over 40% of first time product and service purchases are made online and this percentage will only increase as users are given an increasing choice of suppliers and digital channels to use. Satisfying these users is already a difficult task as a new generation is emerging who are not tolerant of slow response times and the need to reboot every 30 minutes – and they are not worried about moving to a new app if they feel it will improve on their current one.

Hoping that your current business model can be tweaked to keep up with this changing world is not normally a matter of choice, with 87% of organizations reporting that they feel that digital transformation is a competitive opportunity while over 50% of these are already investing in the skills needed to exploit this digital transformation. Depending on your industry, digital transformation is not optional, instead it is simple survival – as reported by 27% of executives questioned.

So, how does this affect the testers? As systems become larger and more complex they naturally require more testing, while users' increasing levels of expectation from their software means that quality levels also need to increase. These two factors are simultaneously driving us to provide more testing. We either need more testing resources, to use current resources more efficiently, or, better still, to exploit the technology driving the digital transformation to make our testing more effective.

What is this technology? The SMAC technologies (social media, mobile, analytics and cloud) are often cited as the main drivers. Of course, analytics won't happen without big data, so that should also be included, while the need to deliver faster means that agile, DevOps and continuous delivery also need to be considered.



Perhaps unsurprisingly, at present the trend has been to throw more resources at the problem and figures for the proportion of IT spend on testing increased again this year to 35%, with a forecast for this to rise to 40% by 2018. Even though many testers may feel that this increased spend on their area is only right and a welcome change from years of under-investment, those organizations who want to come out on top have already recognized that this trend cannot continue too far. In the future it will be the organizations that invest in new technology and bring out new innovative products who will thrive – and this cannot happen if too much of the budget is being spent on testing and QA. Instead of simply throwing more resources at the testing problem we need to make it more efficient and cost-effective.

In the next instalment we will look at how testers can contribute to controlling their costs through such measures as Testing Centres of Excellence, and in future weeks we will consider how each of the different technology enablers can be both addressed by testing and contribute to improving testing effectiveness.

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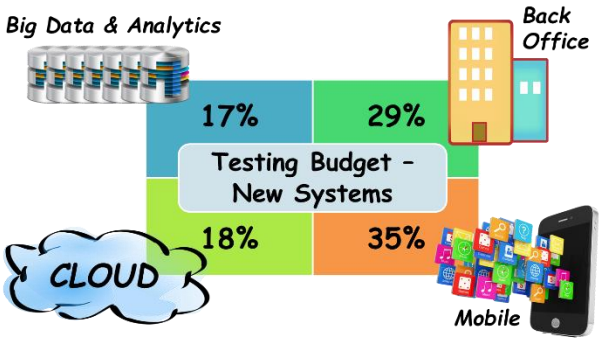
Global Trends in Testing - Testing Centres of Excellence

With the increasing budgets being spent on testing (35% of the total IT budget in 2015), the requirement (and rewards) for optimising the testing continues to rise. When asked about their QA & Testing priorities, 75% of managers cited 'cost optimization' as a priority – the 3rd highest priority behind security and customer experience. A popular and effective approach to this optimization for organizations that are large enough is to implement a Testing Centre of Excellence (TCoE). At present only 37% of organizations report having a TCoE with only two-thirds of these believing it to be fully operational. In many organizations testing knowledge is dispersed on a project-by-project basis with little central organization to encourage the sharing of best practices.

By implementing a TCoE organizations create a central resource of testing knowledge and skills that can be shared by all projects. If done well, this means that specialists are used more efficiently, with internal specialists being able to concentrate on their specialist area and external specialists only being brought in when a specific need is identified.



Today's varied budgets for new systems means many organizations need an increasing number of specialists to implement new technologies – and the TCoE is often the most efficient way to resource these specialist skills. Organizations are already reporting that 54% are using data scientists for analysis and validation, 53% are using mobile testing specialists, and 51% are using their own internal security test teams. Two-thirds of organizations are also employing specialists to determine those risk areas that should be the testing focus for new systems and applications.

Test automation is a separate area where a TCoE can play an important role in optimizing testing, with a TCoE being able to provide advice, skills and cost-effective access to testing tools that may be too expensive for individual projects to afford. In 2015 on average 30% of testing budgets was spent on testing tools, while manual test cases still account for over half of all testing.

As testing budgets and staffing increase it generally means that more testers with lower levels of experience are being used. A standardized test process, as part of a TCoE, can be used to assist in the efficient use of less experienced testers by identifying those tasks that do not rely so much on background knowledge of the application domain. For instance, while exploratory testing will still be used on most projects as one of a number of complementary approaches, its use by less experienced testers is known to be less effective. A good TCoE will include staff development processes to ensure that less experienced testers are provided with mentoring and coaching to enable them to improve their testing knowledge and skills. The standardization of test processes across projects also makes it easier for testers to move between projects and it makes the comparison of project results easier and so supports test process improvement across the whole organization.

The use of a TCoE and a standardized test process also opens the way for more of the testing to be performed by testers external to the organization. For some of the new specializations associated with the emerging new technologies then buying in this expertise will be necessary as the initial demand for it within the organization will not be enough to justify employing in-house resources. Where this occurs organizations should actively promote technology transfer from the external specialists to in-house testers. And it should be noted that a TCoE does not need to be wholly

resourced and located within the organization. In some cases, outsourcing, and even off-shoring of some aspects of the TCoE will be the most cost-effective approach.

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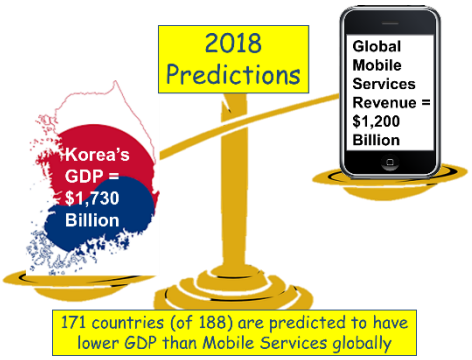
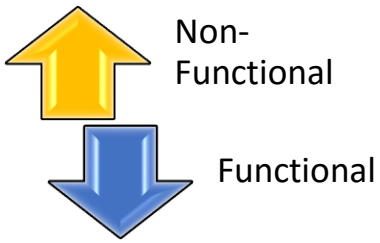
Global Trends in Testing - Mobile Testing

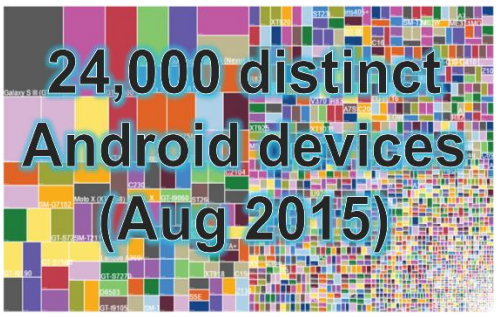
Mobile is an integral part of digital transformation. Nearly three-quarters of all organizations are planning on increasing their spending in this area in the next year. This is not surprising when you learn that the revenue for mobile services is predicted to be in the region of $1.2 Trillion by 2018. In the same year the number of mobile connections is expected to reach 8.5 Billion (more than one for each person in the world). Mobile is thus a growing opportunity and challenge for software testing (two years ago 52% of organizations were performing mobile testing, whereas this figure is now 92%).



In line with the overall figures for all technology areas, security is the primary focus for those building mobile solutions. This is largely because the extra channels created by mobile invite many potential security vulnerabilities. The second highest focus area is performance, mainly because of the need to provide a consistent user experience no matter what channel is being used. Functionality is the third highest focus area, and this highlights a move away from the traditional approach to testing that primarily concentrates on functionality, often to the detriment of the other non-functional quality attributes. It appears that businesses are starting to learn that it is better to de-scope functionality while maintaining focus on the other quality attributes, rather than delivering lots of features that can be difficult to use, slow and insecure.



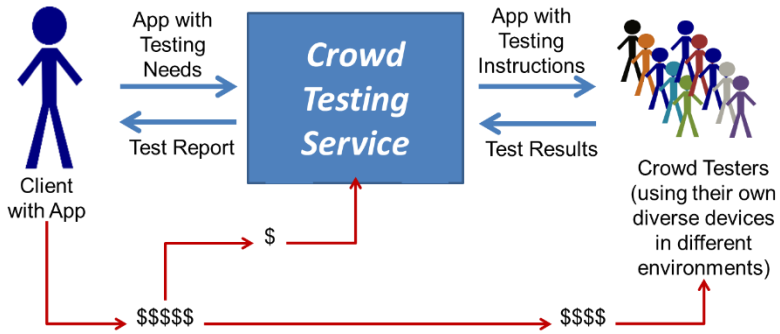
Test managers believe that the lack of internal test environments is their biggest challenge in mobile testing, while another related challenge is the lack of availability of mobile devices for testing. The difficulties of managing an internal mobile test lab are numerous. Often it is difficult to agree who will pay for the lab – is it project-funded or is it a shared lab paid for by the organization? Day-to-day management of the lab must also be factored in, and it has be decided if there is a centralized lab or if the lab simply provides devices for testers to borrow as they are needed. The level of required device coverage decides the number of devices needed. Despite there being over 24,000 distinct Android devices to choose from in mid-2015, it may be surprising to find that only about 30



devices are needed to achieve 80% market coverage at any one time. And do not forget that the rate at which new devices become available means that the maintenance costs of an internal mobile test lab are in the region of 35% per year.

The obvious alternative to an internal test lab is to move to a commercial external lab, but test managers would not be so worried about the lack of internal test labs if this was a simple solution. External labs can be expensive, and they also don't provide testers with a true hands-on experience as most commercial labs provide remote access to devices that typically sit on the cloud. Usability issues, such as using the mobile device on the move, in sunlight, or in a noisy environment cannot be addressed in the lab. Also, if tests are only performed in the lab then performance issues due to different connections and carriers are likely to be missed.

A third option, which, in practice, should be considered as complementary to the test lab is to get real users to test the mobile application in the real world. Crowd testing allows you to select a (typically large) set of testers who are truly representative of the application's target audience - and using their own devices. Perhaps more importantly, these crowd testers perform their testing in the application's target environment – the real world - with all its associated imperfections. If the real world for a localization test is a foreign country, with a different language and different culture, then crowd testing can also be used to test that the application has been suitably localized for its new environment.



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Global Trends in Testing - Big Data & Analytics

Although not on the same scale as mobile, big data is still big business. In 2015 it is forecast to generate about $35 Billion globally, increasing to $60 Billion by 2020. Similarly to Mobile, test managers consider security to be the primary focus for those building big data solutions, with cost coming a close second.

Testing big data and analytics has two distinct perspectives. First there is testing using big data and analytics. Although in its infancy, analytics can be used to focus testing on specific areas by providing information on how a system is used, so providing the basis for a risk-based approach. Analytics can also be used to identify how similar, previous systems have failed in use – so supporting a defect-based approach to testing.

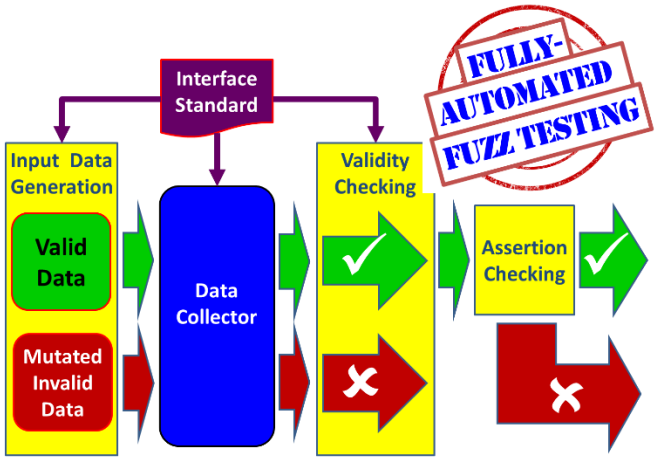
Second, there is the question of how we test systems that employ big data and analytics technology. This question comes with a number of diverse characteristics. One of the most interesting problems is that data analytics is rarely simply deterministic – often the algorithms applied by data scientists to extract knowledge from big data are both complex and subjective. Many apply a probabilistic approach, which makes the determination of whether test results are right or wrong a judgement based on probabilities, which really needs to be made by testing experts with the same level of expertise as data scientists (or data scientists trained as testers) – and even then the results can be arguable. Big data is often transformed into 'Business Intelligence' – creating reports to support activities such as marketing and finance. Testing that these reports accurately reflect the source data requires knowledge of Extract, Transform and Load (ETL), how data transformations are performed, how to interpret the results, and strong knowledge of the business domain.

Another interesting characteristic of data analytics is how quickly the results are needed – big data has a required velocity. If being used as the basis of next year's marketing and sales campaigns then the time required to generate results is probably not a problem, but the results from many types of system are needed in real-time. For instance, imagine that the big data is associated with a smart city and the data analytics is being used to manage the transport infrastructure; in this situation we need results nearly instantaneously – so we need to test that the performance of the data analytics meets real-time constraints.

When testing big data we must manage lots of test data - this is an inherently big task. In this context test data typically needs to be large scale, and setting up test environments becomes even more complex when the applications require the data to change in real-time. In many cases the big data will be considered to be personal, and so data protection becomes an issue. There is already a growing industry in the field of test data sanitization, and as big data becomes more widespread this will create opportunities in this area.

Big data is one of the mainstays of the Internet of Things, and this envisages the collection of data from many diverse sources through many channels. For instance, the next generation airliner engines incorporate more than 5,000 sensors and create about 10GB of data per second. With airliners flying about a quarter of a million hours per day worldwide between them, airliner engines alone will generate a phenomenal amount of data. Of course, most of this raw data is filtered before it is stored as much of it is useless, otherwise we would have to store an overwhelming amount. The number of data sources and input channels reinforces the earlier point about security; not only must the data be filtered for usefulness, it must also be screened to ensure that malicious inputs are not accepted. Testing at this level should be straightforward as long as the data format is well-specified as the functionality being tested is relatively simple.

Fuzz testing, which has been around for a number of years, can be used for the simple testing of data filters. With this approach, the data specification is used to randomly generate valid input data and the filter is checked to determine that it does not reject any valid data. Fuzz testing is also used to randomly generate invalid data to check whether the filter mistakenly accepts any invalid data. As both the input test data generation and checking can be largely automated fuzz testing can be performed with little human intervention, and so many millions of test cases can be run.



Depending on the data being filtered it is also normally possible to create assertions about the data that should be accepted. For instance, if we consider a health monitoring application that continuously records a patient's heart rate, then we can set assertions about the valid range of values the recorded heart rate can take (e.g. outside the range 25bpm to 250bpm could be considered invalid data). If we can define such assertions about the data being filtered then it would be sensible to include automated assertion checking as part of the fuzz testing. If the automated test input generation could also use the assertions to guide test data creation so that wildly unrealistic data was not randomly generated too often then this should make the fuzz testing an even more effective approach.

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Global Trends in Testing - Cloud Testing

The global market for cloud services ($555 Billion in 2020) is predicted to be about ten-times the size of that for big data and 57% of organizations worldwide are planning to use the cloud in 2015, while in some countries, such as the UK, this number rises to 84%. The cloud provides some notable benefits to users. By moving to the cloud, users gain access to near unlimited processing power and storage space, and they have the benefit of an 'elastic' resource which can expand and contract as needed. The cloud is perceived by many to have near perfect reliability, (although some users have found this is not always true) and as the cloud is managed by the cloud provider then users have few maintenance worries.

Nothing's perfect, however, and, as with mobile and big data, security (along with data privacy) is the primary issue with users of the cloud. One way of addressing this worry is to perform additional cloud security testing, but even if specialist security testers are available (and affordable) getting suitable access to the cloud platform can make this difficult. An alternative way to address the security issue is to use a private cloud to host sensitive applications and data. A private cloud typically means you own and control a network and servers using virtualization technology and you do not share this environment with others (as you do if you use the public cloud, such as with Amazon Web Services (AWS) and Microsoft Azure). Some organizations get the benefits of both public and private clouds by using a hybrid approach and splitting their applications and data across both types of cloud depending on their security constraints. Naturally, hybrid clouds are more complex and can open up the requirement for the specialist testing of systems that span both public and private clouds.

A major driver for using the cloud is to save money, however the cost of using the cloud is an issue for 78% of users. Saving money is normally achieved on public clouds by using a pay-per-use model and only using the provided service when it is needed rather than paying for it to be available all day, every day. Cost savings will only be made if the cloud is carefully used and there are examples where the cost of using the cloud exceeds the cost of owning and maintaining the servers.

Testers use the cloud to support testing in a variety of ways. The software as a service (SaaS) model provides users with access to software tools when they are needed – testers can make use of this model by, for instance, only paying to use performance testing tools when they are needed rather than paying for an annual licence. Some tools, such as those supporting test management, would appear less appropriate for applying this pay-per-use model, however even these tools are now moving to using a model where individual licenses are purchased on either an annual or month-to-month basis, which can make it really expensive if you have a large testing group.

The Platform as a Service (PaaS) model provides users with access to a virtual platform – with this testers purchase the use of virtual test environments (again, only when they are needed). Where the cloud is used as the production environment there is an added benefit to using the cloud for testing as then a cloud test environment identical to the production environment can be spun up to support representative system and acceptance testing. Savings of 20-30% are achievable by using the cloud for test environments. Even if the application will be deployed on internal hardware it is often more cost-effective to pay for test environments in the cloud (IBM estimate that testing hardware is only used 10-20% of the time on the average project).

The cloud is also used by performance testers who wish to create realistic loads as they can create many (often millions) of virtual users on the cloud and can even distribute them across different regions if there is a need to see how a system responds to dispersed users. Test labs in the cloud are extremely useful for supporting distributed testing as testers anywhere in the world can all access the same cloud-based test lab. Another potential benefit is to use the cloud to provide resources to

speed up automated test execution times (typically for regression testing) to provide quicker feedback, for instance by providing a platform for running unit and integration tests in parallel.

Chaos Monkeys are an interesting open set of source tools from Netflix for testing the robustness of cloud-based applications. The tool randomly disables instances of the application on the cloud to test how well the application and the support staff cope with such failures. Programmed to only fail during working hours, the Chaos Monkeys provide support staff with experience of dealing with failures and highlight where changes to the application are needed to increase robustness and perhaps allow 100% availability to be achieved. Their initial success has now spawned a 'Simian Army' of specialist Chaos Monkeys, such as the Janitor Monkey, Security Monkey and even Chaos Kong, which 'kills' whole AWS regions – all aimed at improving the robustness of cloud-based systems.

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Global Trends in Testing - User Expectation

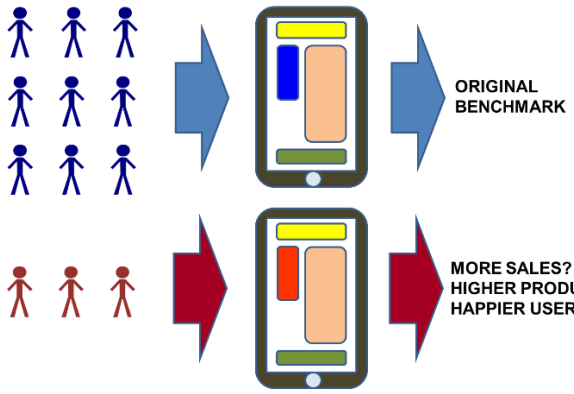
The users of apps in 2015 are quite different from those of 15 years ago. Today's users are not tolerant of frequent failures and poor usability – they have grown to expect secure apps, which are available 24x7, with consistent usability irrespective of the channel used (e.g. laptop, tablet or phone in the office, at home or on the train, etc.). And perhaps most importantly, they have lots more choice than the previous generations of users. If they don't like an app then much of the time they can discard it and move to another (hopefully better) one.

What's more, through social media we have given users the technology to easily tell us (and everyone else) what they think of our apps. While this provides app developers with fast (and generally useful) feedback, it also means that apps launched early (like delicate new buds) are in danger of being killed off by just a few initial bad reviews (do you download a one-out-of-five star app when there are others available?). For larger organizations the danger is not limited to a single app as poor reviews affect the 'brand' and today's executives now have 'protecting the corporate

image' as their number one testing objective. It is doubtful that many testers understand that safeguarding their company's brand is a major part of their employment.

Coming close behind 'protecting the corporate image' in executives' testing objectives is 'ensuring end user satisfaction'. This complements organizations' second-most important aspect of their IT Strategy, which is 'Customer Experience' (just behind Security). The growth of UXD (user experience design) reflects the importance of this aspect of systems and applications today. It seems clear that testing needs to move to include more validation that that applications keep the users happy rather than verifying that specifications are met. Previously 'Crowd Testing' was described in the context of mobile and localization testing as a means of getting real users to test an application in the real world, but crowd testing need not be restricted to mobile and localization testing. Instead it should be considered a valuable part of any test strategy where we want to gain confidence in meeting users' expectations.

Another form of testing that meets the objective of validating the user experience is known as 'A/B Testing'. This testing works on the basis of providing subsets of users with alternative versions of the application under test (A and B versions). Typically users are not made aware that they are part of a test and simply use the application as normal so they cannot be biased by knowing they are part of a test. Their use of the application is monitored and the version which works best is determined.



For instance, imagine the owners of a website want to know which of two home pages is most likely to get visitors to look further at their website. They set up an A/B Test by providing two versions of the website's home page and divert users to each of the two options and measure which performs best (which gets the best click-through rate). When performing A/B Testing it is very important that the test users are truly representative of the actual users as small changes in user demographics can skew results quite dramatically. A/B Testing's usefulness is not restricted to web pages although that is where it is often used (or to just two choices) – it is also useful for testing users' responses to other types of applications, especially where the results are very dependent of user feelings (and so difficult to measure otherwise).

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