State of Quality Report

Edition 2

Quality engineering: Accelerating journey to digital transformation

wipro

Acknowledgments

Contributing partners for State of Quality Report, Edition 2

Contents

1. Foreword

Welcome to the State of Quality Report Edition 2.

In the previous edition of the report, we followed the metamorphosis of testing from its humble and reactive beginnings into proactive engineering of quality. This change continues to be driven by technology, user gravity and business proximity as global organizations aspire to go boundary less while protecting their business interests. This year, we go a step further to share some specific patterns in Quality Engineering that are enabling digital transformation, as organizations try to increasingly humanize the customer experience and aspire to improve engineering productivity. The real question that everyone is trying to identify and answer is, "what are the frequently occurring 'patterns of problems' and how can these patterns, when addressed, enable organizations to build Quality@Source?"

The uniqueness of this report is its fact and ground data-based approach. This report analyses data from over 1,500+ QA projects across 400+ global organizations, data from 1000+ RFPs, consulting assignments, and customer, analyst and expert interactions spread across industries. We have also included data from five leading partners in the industry, our acquisitions and the larger ecosystem.

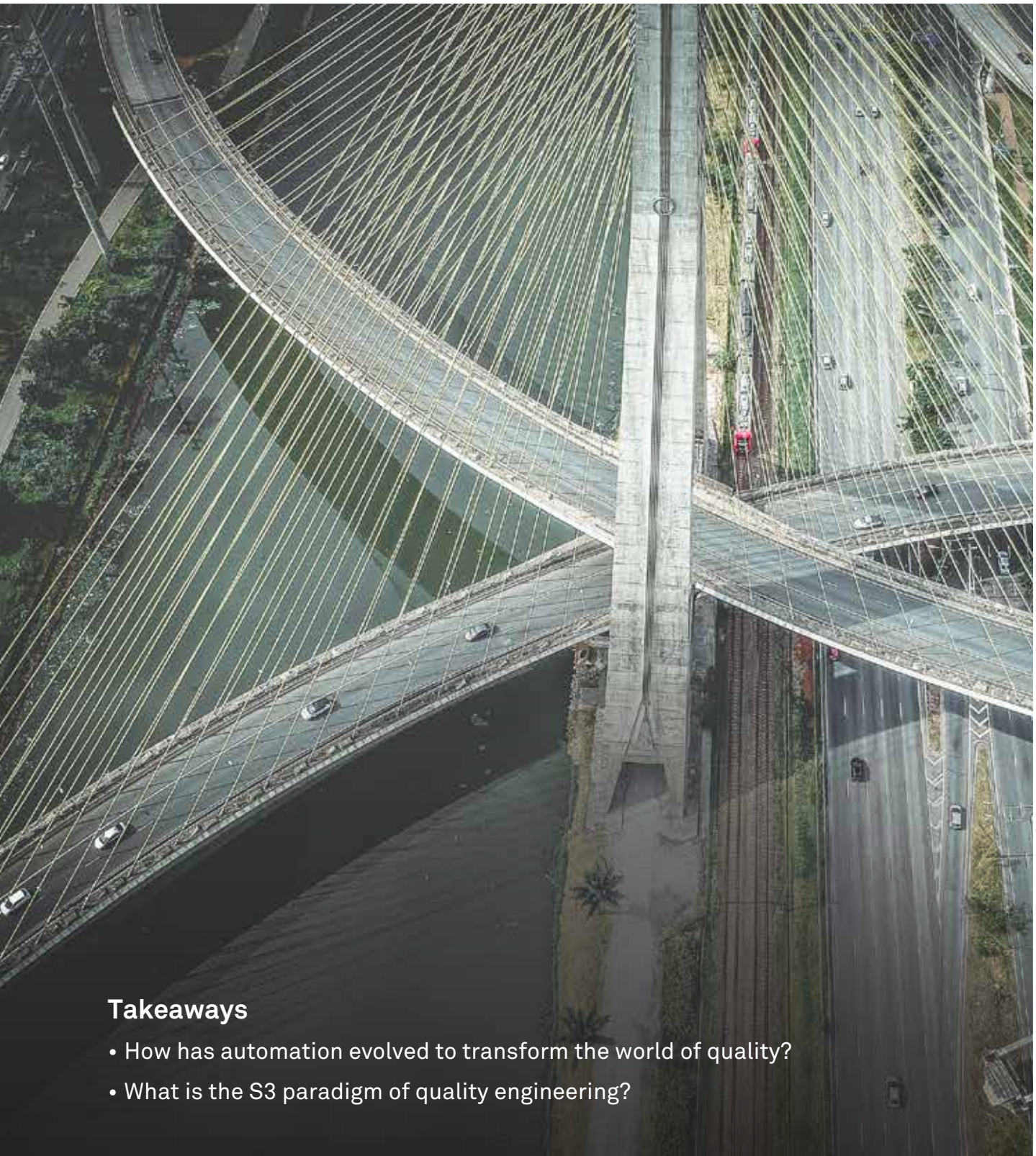
In this edition, we have focused extensively on quality engineering, and how automation remains central to this transformation journey, while calling out select patterns across all aspects. The patterns are classified as Quality Design Patterns and Quality Data Patterns. Quality Design Patterns represent the path to success taken by high performing organizations while Quality Data Patterns represent the present situation on a path currently taken.

The report is further organized around the three core pillars we call ‘S3: Speed, Skills and Structure’, thereby taking a holistic view of transformation that is not just technology-centric but also addresses the key areas of people and organization, which is integral to such a transformation.

I am extremely thankful to some of the foremost thought leaders that are shaping this industry from across some of the most mature engineering organizations worldwide as well as software product partners, who express their views to make this report richer and more valuable to readers. I am confident that the well-rounded industry experience of the team that has put this report together will help you and your organization benefit in your journey to improve speed and engineering productivity while being non-compromising on quality.

Arun Kumar Melkote
Vice President, Wipro Digital

Introduction



Takeaways

- How has automation evolved to transform the world of quality?
- What is the S3 paradigm of quality engineering?

2. Introduction

Automation: The key enabler for agility in digital transformation

Organizations around the world are reimagining their businesses, driven by customer-focused digital strategies. This is calling for quality that enables change and the ability to invent and adapt to the new digital world. In this year's report, we studied the maturity of this transformation in approach to quality and the factors that impact it, using patterns that help us identify and analyze them. We looked at organizations across geographies and domains that are driving transformation and agility across their quality effort. The common thread across these organizations is that they are asking themselves the same questions - Can I serve my customers faster? Can I provide a seamless and ubiquitous experience to my customers? Can I deliver the right user experience at the right price point? Can I deliver targeted customer experience based on their feedback? We see automation as a key enabler of quality customer experiences that holds the key to these questions.

2.1 How automation in quality has evolved

Automation in quality has evolved from Automation 1.0, its traditional and incremental form (c. 1990), to a more end-to-end approach known as Automation 2.0 or Lifecycle Automation that saw the rise of quality engineering (c. 2000 and after). This evolved to a cognitive approach Automation 3.0 (c. 2016 and after). Much like automation in the rest of the industry, it is ultimately evolving into Smart and Intelligent Quality (See Figure 1)

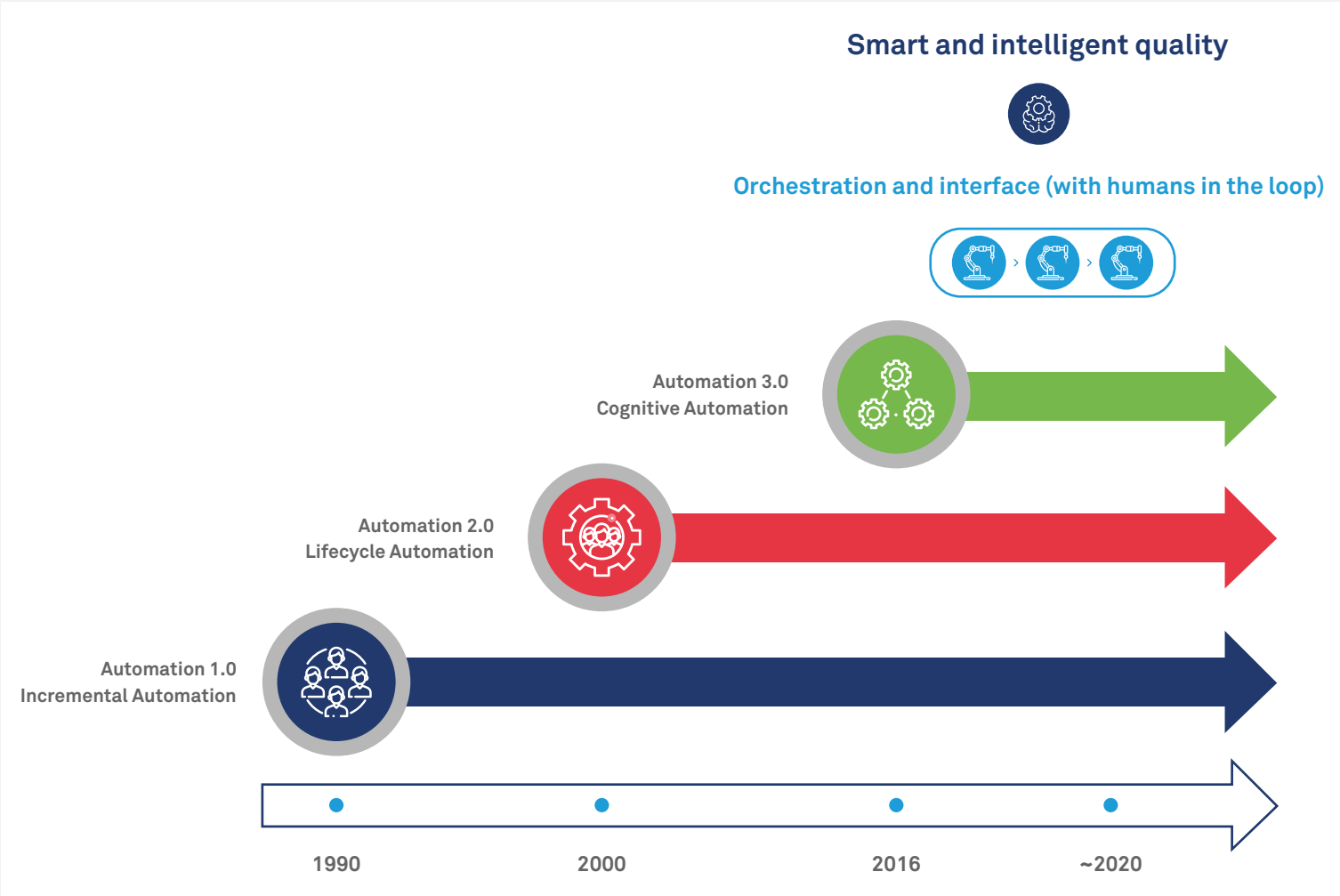


Figure 1: Evolution of automation in Quality

2.2 Automation in the S3 paradigm – Speed supported by Skills and Structure

Today, applications are interacting with other entities such as people, networks as well as with each other in new environments in entirely modern ways.

Consequently, testing has also been through considerable transformation. There are critical and positive changes in the Speed, Skills and Structure – what we call S3 – around the science of testing (See Figure 2).

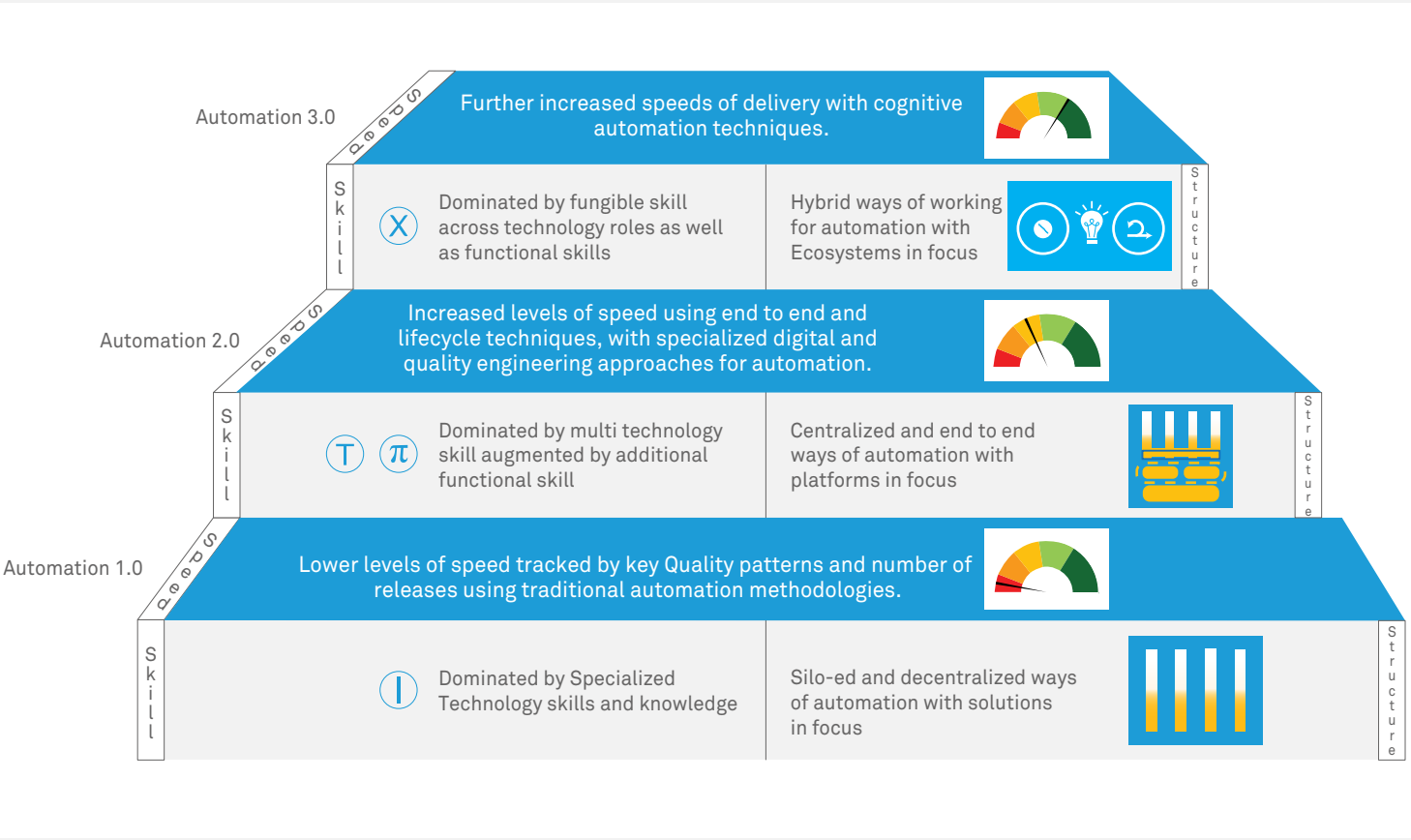


Figure 2: Automation in the S3 paradigm

2.2.1 Speed

As organizations move towards an Agile and DevSecOps based approach with a focus on digital transformation, automation is causing the traditional silos between IT development, security, quality and operations teams to crumble.

They are not only working towards superior user experiences, they are meeting the much desired need in accelerated delivery, velocity and throughput. Since digital transformation with a focus on agility or speed is the key for business across industries today, we have primarily focused on some key quality design and data patterns driving agility in this report.

2.2.2 Skills

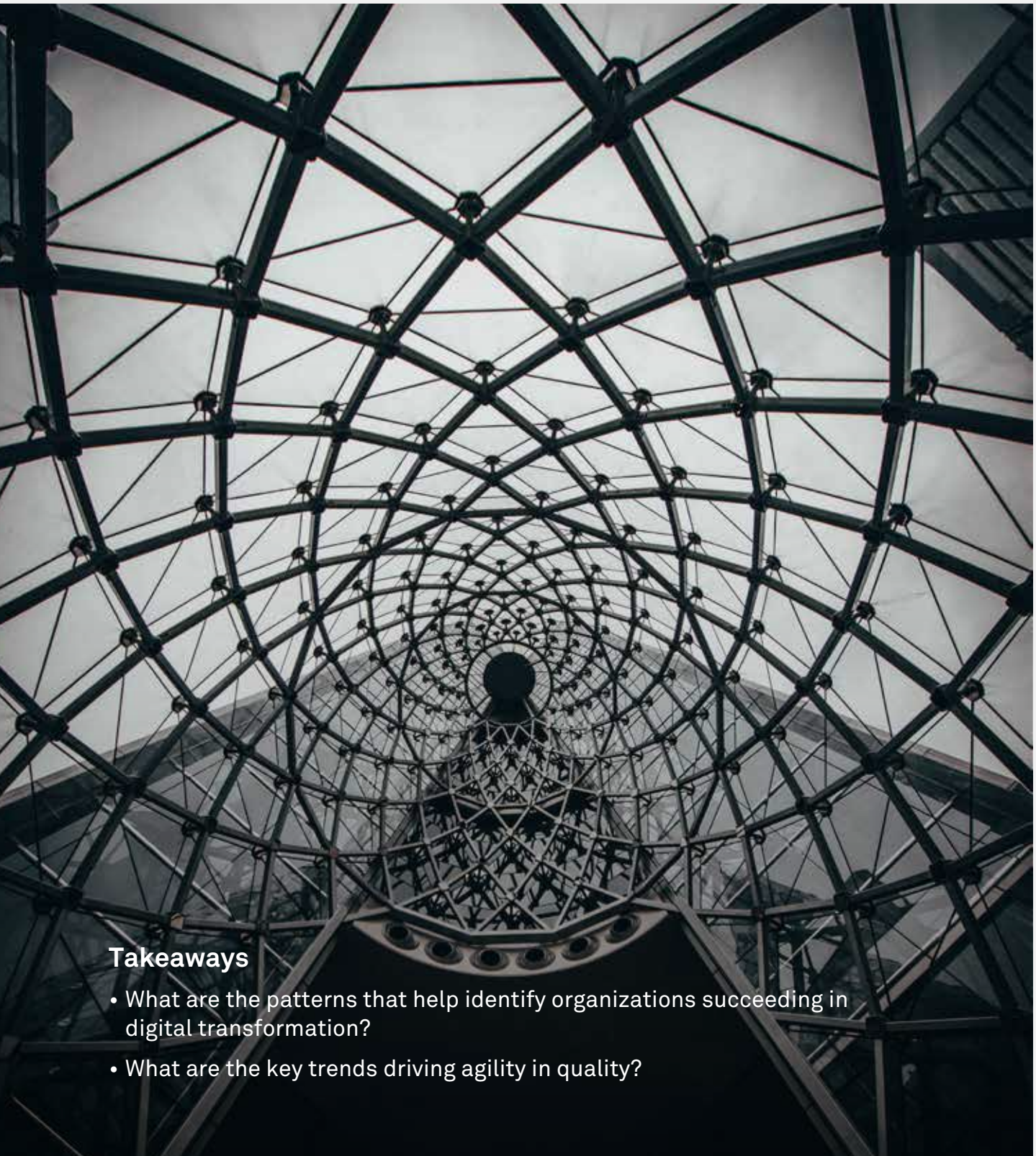
As transformation in digital methodologies take over the world, they are forcing a transformation in the skill sets that resources in the function need to demonstrate. The traditional, pure-play functional testers and developers are giving way to a multi-skilled, multi-speed Quality Engineer, focused on automation from early stages of development. These skills are spread around the world, with distributed ways of working beginning to take hold in the form of right-shoring and no-shoring as the ways of the future. It is the next step in the evolution of the Software Developer in Test (SDET), whose presence revolutionized how quality was addressed earlier in the product lifecycle. The skills related to automation followed by digital assurance are most in demand across all geographies. The trends in skill demand is strongly correlated with the way the offerings in quality engineering have evolved.

2.2.3 Structure

We have seen the Quality Center of Excellence (QCoE), the centralized custodian of quality in the organization, evolve into competency practices that work on federated models called Center for Enablement. These models are more nimble, collaborative, automation-driven and leverage new age design thinking concepts, all with a goal to achieve better product quality and enhanced customer experience. We also see the advent of Quality as a Service (QaaS) as one of the new structures of choice for service engagement and delivery, predominantly led by niche and on-demand services. Center for Enablement can be perceived to make up the operating model for quality organizational structures, with QaaS covering the engagement and delivery models, challenging traditional ways of service delivery (See Appendix).

To get a true picture of the State of Quality we need to do an analysis of the S3. But before that, we need to understand the patterns that help us make sense of the data.

The story in the patterns



Takeaways

- What are the patterns that help identify organizations succeeding in digital transformation?
- What are the key trends driving agility in quality?

3. Quality Design vs Quality Data

Across the world, high performing organizations have common patterns when it comes to their understanding and implementation of quality. While some of these patterns lend themselves to the design of quality systems, others are more data-driven patterns that give us a clear picture of what these companies are getting right.

With the adoption of agile methodologies gaining rapid ground around the world (See Figure 3), quality practitioners aiming for successful digital transformation are asking themselves the same question: 'What are the key quality patterns which automation can influence to drive agility?' Of the patterns that our research identified, some influence business, others have a technical impact.

When this data is shifted to create patterns of knowledge, a quality practitioner can use these insights to solve key challenges in the state of quality today.

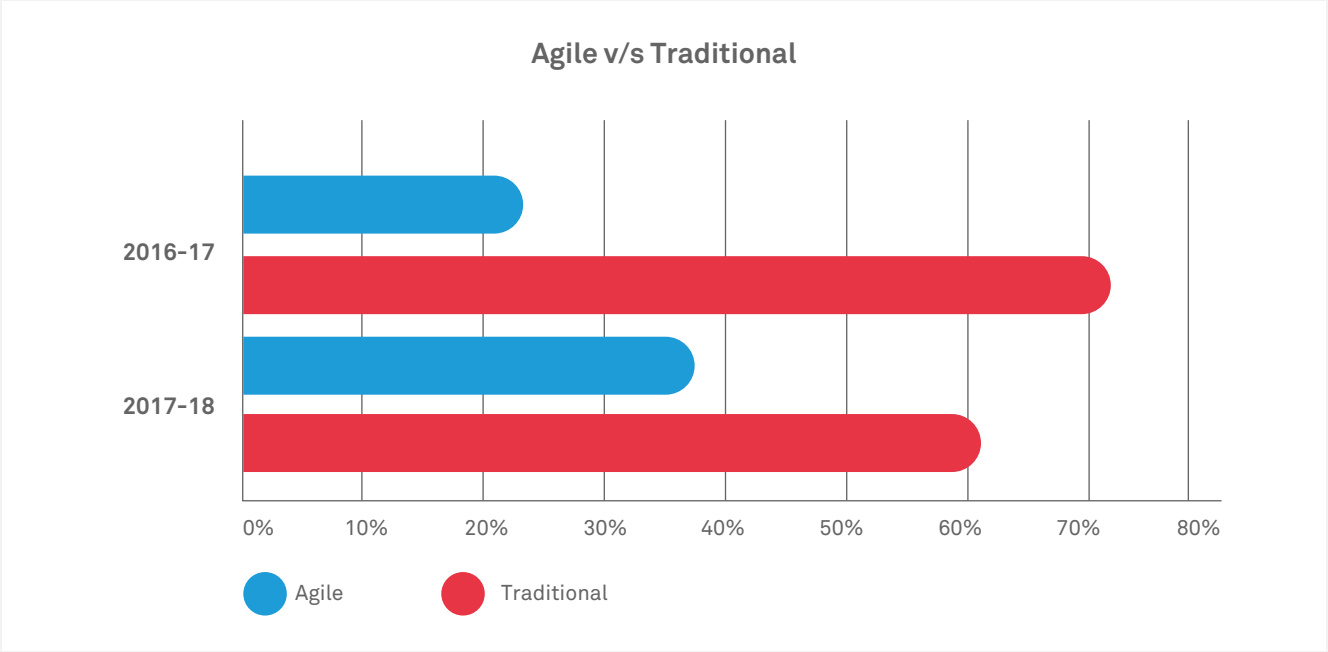


Figure 3: Increase in Agile adoption

Fact file

Agile adoption across industry domains in 2017-18

- Financial Services: Expected - **60%,** Implemented - **50%**
- Communications: Expected - **56%,** Implemented - **35%**
- Energy, Natural Resources, Utilities & Construction: Expected - **50%,** Implemented - **27%**
- Healthcare: Expected - **60%,** Implemented - **30%**
- Retail and Consumer Goods: Expected - **82%,** Implemented - **45%**
- Manufacturing and Hi-Tech: Expected - **64%,** Implemented - **40%**

3.1 Decoding design patterns for agility

The following key quality design patterns for business agility are critical for the reason that they drive ROI with increase in automation maturity:

- **High severity production defects -** Number of high impact defects found after production release
- **Mean Time To Repair (MTTR) -** Average time required to repair high severity defects found before production releases
- **Release counts -** Number of times an end software product is to be handed over to the customer/client to implement/use it in real business environment
- **Agile velocity (User stories per sprint week)-** Number of story points delivered in an agile iteration cycle

The three key quality design patterns for technical agility that we see are:

- **Test data set up cycle time-** Time taken for creating a set of data for testing the adequacy of a software application
- **Test environment set up cycle time-** Time taken to set up infrastructure (software and hardware) for execution of test cases
- **Performance Mean Time to Repair (P-MTTR)-** Time taken to resolve performance issues found before production releases

3.1.1 How did we analyze?

This year we have analyzed data patterns through the snapshot of high performing organizations. This enabled us to define the design patterns that allows visualization of how automation has evolved over a timeline. It was based on cluster analysis of data across industries with our Intelliassure 2.0 platform. To this end, we have traced a scatter chart taking a sample space of around a hundred customer records at different levels of automation maturity. The assumption for this sample space is that the organizations have implemented automation 1.0 first before evolving into automation 2.0 and then 3.0. All the design patterns have been compared in relative terms as percentages to their previous values and not actual numbers to aid in comparative representations within the same charts.

3.1.2 Business agility archetype

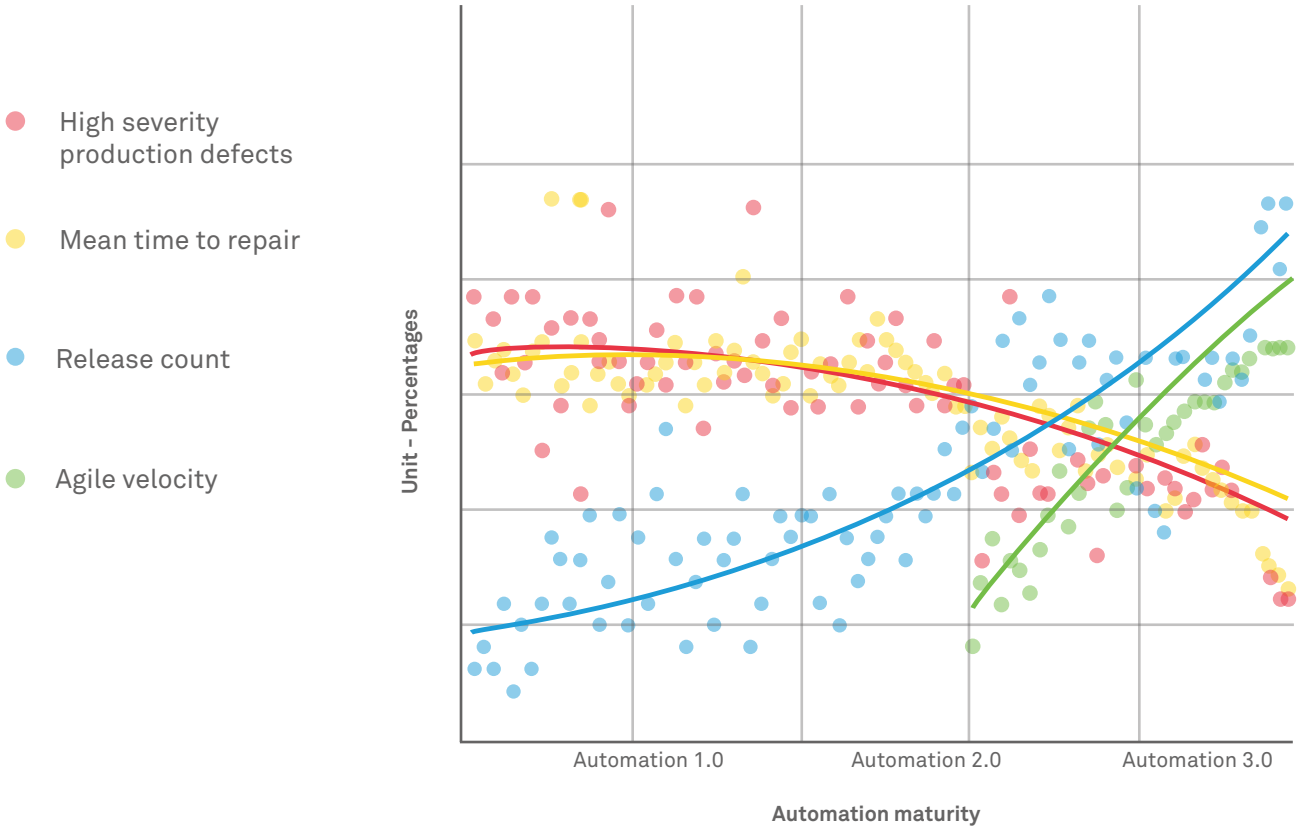


Figure 4: Key quality design patterns for business agility

The patterns clearly show that embracing and investing in automation results in greater benefits of agility for business (See Figure 4). You may ask whether maturity in automation is the only factor that is driving these patterns. We realized that while automation maturity is the key factor, there are several supporting factors that influence these patterns. (See Appendix)

To conclude, agility is improving further with the implementation of cognitive automation techniques (Automation 3.0) for use cases such as smart defect allocation, automation failure analysis, application log profiling, automatic data synthesis, SDLC data analytics, early performance checks etc.

3.1.3 Technical agility meets business agility

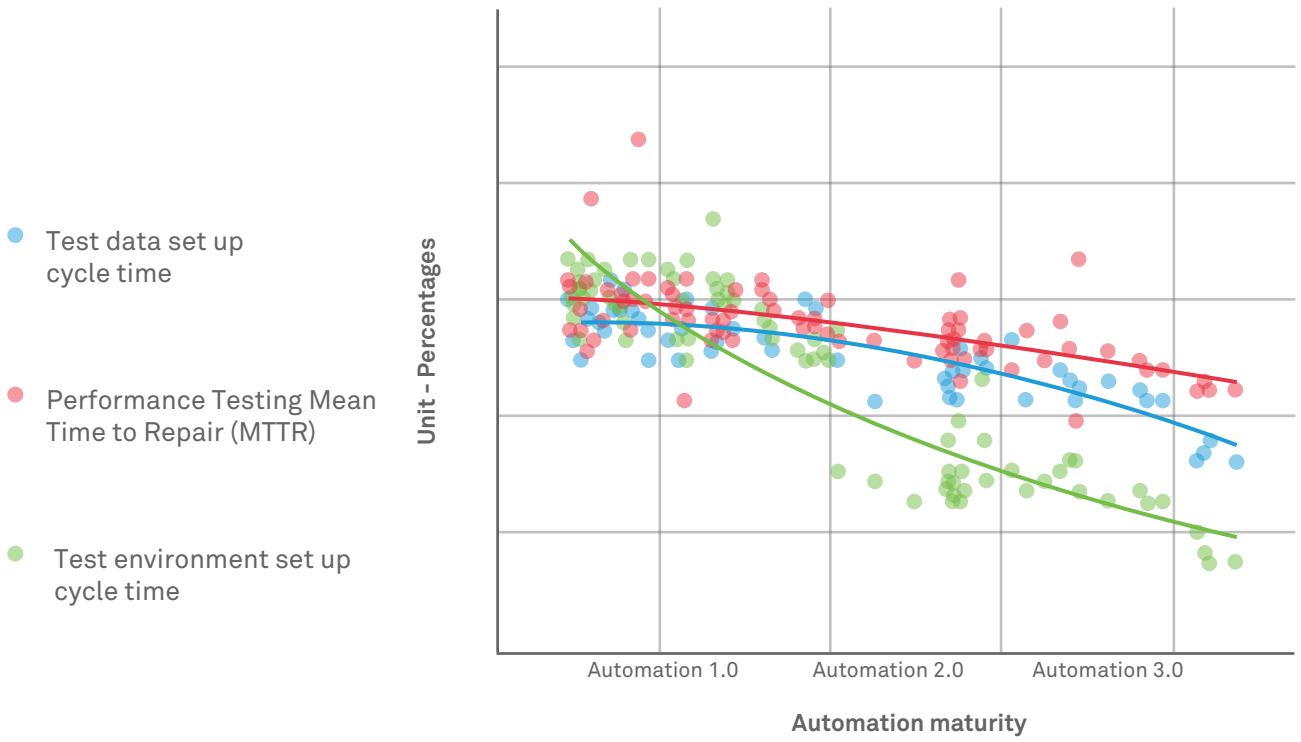


Figure 5: Key quality design patterns for technical agility

Similarly, from a technical perspective we have traced scatter charts for three key quality design patterns for agility (See Figure 5). We find that test data and environment setup timelines have improved by 40-50% as customers have matured from Automation 1.0 to 3.0.

Performance testing MTTR timelines have improved by 100% as automation matures from 1.0 to 3.0. As before, we have an analysis of automation maturity's impact on the quality patterns vis-a-vis the other factors (See Appendix).

3.2 Decoding data patterns for agility

To make sense of the data on the ground across quality engineering offerings, we look at it through the lens of evolving automation maturity. This is why we have broken the trends into the buckets of Automation 1.0, 2.0 and 3.0 (See Figure 6). However, the overall automation percentages have increased by 34%.

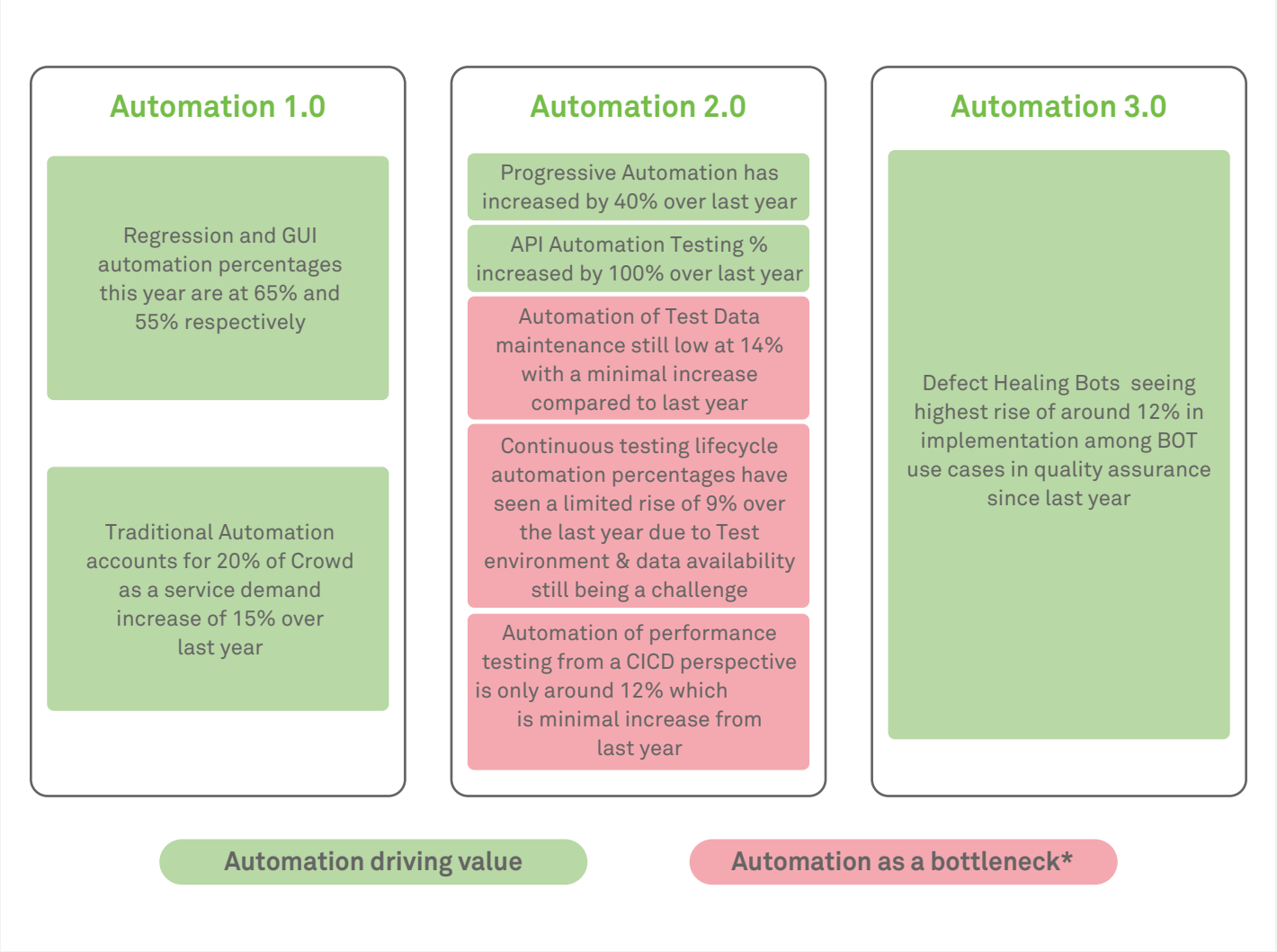


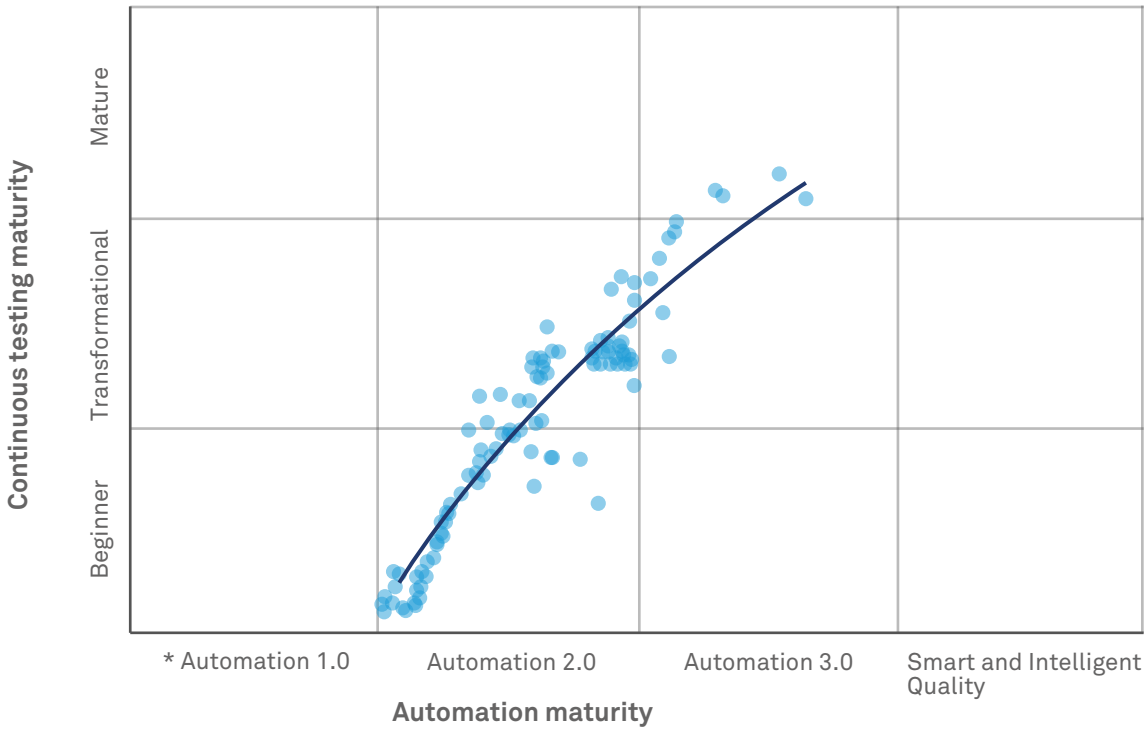
Figure 6: Automation in Quality - Data patterns driving agility

*While automation efforts have been driving agility in some cases, there are others where automation has been a bottleneck due to unavailability of mature infrastructure and teams such as right-skills, adequate environment and test data, etc.

3.3 How automation enables continuous testing

Automation has emerged as the game changer, turning Quality from a bottleneck into a competitive advantage for organizations in the quest for digital transformation. While in its earlier avatars, it had to face questions of whether the returns were really justifying the investments; the attitude to automation has changed today based on what we see on the ground. Asks from automation are no longer about just driving down costs and delivering ROI. Instead, success factors now account for customer experience, product reliability and speed.

Imagine a scenario where as soon as a code release is available you link it to an automated system which is integrated with production. Before you know it, it tests the code continuously and completely unattended with auto deployment ability. The ability to achieve this level of automation-led maturity in continuous testing is closely linked to success in digital transformation, leading to rich benefits like accelerated time to market, higher productivity of teams, and greater efficiency in time and effort. To achieve this, organizations are implementing Continuous Integration, Continuous Testing and Continuous Delivery in Agile and Iterative models as a preferred way of working in digital projects. They break features into user stories, develop and test scenarios iteratively. This approach to agile development is a new-age approach to working. In summary, the quality patterns along with patterns across quality engineering offerings are charting out a journey towards maturity in Continuous Testing of organizations on the digital path. The tracing of this summary data pattern serves as an exciting insight based on data as illustrated in the Figure 7.



*Assumption here is that projects only really begin their journey of Continuous testing with Automation 2.0 – an end to end approach to Automation

Figure 7: Mapping automation in organizations enabling continuous testing

"Business leaders cannot expect that process initiatives like DevOps or Continuous Delivery will be successful unless they also transform testing. Far too often, I see organizations invest in training and maturing Development and Operations resources while leaving software testing teams to their own devices to 'catch-up.' Continuous Testing is required for DevOps and Continuous Delivery success - and Continuous Testing is change. For most software testing organizations, the degree of change required to keep pace with new business expectations is way beyond their expectations. Extreme test automation techniques must replace a primarily manual process. To achieve this, organizations need to apply the appropriate resources to make techniques like session-based exploratory testing, API testing, risk-based test design and Continuous Load Testing a reality."

Wolfgang Platz
Founder and Chief Strategy Officer, Tricentis

The pattern from the data we analyzed indicates a near linear curve. However, we observe that at a certain optimal point, before which continuous testing maturity grows almost proportionally to maturity in automation, the increase in automation maturity towards trailing end of Automation 3.0 and attaining smart and intelligent quality will not directly impact continuous testing. Other factors like skills, collaboration across teams, urge to adapt faster etc. will play a more important role.

While the automation footprint continues to expand, quality experts predict a plateau. Incremental benefits are no longer going to stem from increasing automation percentage alone, much like there is an optimum point where continuous testing maturity levels out with automation maturity. There are other factors in the digital journey that begin to play a role in how well a quality organization can reap the benefits of automation. The telltale signs are already showing in matured projects where automation coverage is hitting the sweet spot on the maturity curve.

Nonetheless there is reason to cheer in the rise in automation coverage as each domain takes its own route to the sweet spot.

While traditional forms of automation still have the greatest absolute share of the automation pie, we see more and more organizations embracing hyper automation and cognitive automation goals as is evident from the analysis of our data below.
As IT organizations mature, we see lesser need for testing as an after-thought as quality becomes integral to the development process.

This sets the stage for the central question that this year's State of Quality Report seeks to answer: How can quality engineering better enable the digital transformation that organizations across domains have embarked on? To answer this, we break down quality engineering into its building blocks of Speed, Skills and Structure, and bring together data and insights across our projects, partners and affiliates to paint the truest picture we can.

Fact file

Increase in test automation footprint

- Financial services 40.62% (from 32% to 45%)
- Communications 21.21% (from 33% to 40%)
- Energy, Natural Resources and Utilities 33.33% (from 27% to 36%)
- Healthcare 34.61% (from 26% to 35%)
- Retail and Consumer Goods 18.60% (from 43% to 51%)
- Manufacturing and Hi-tech 35.71% (from 27% to 47%)

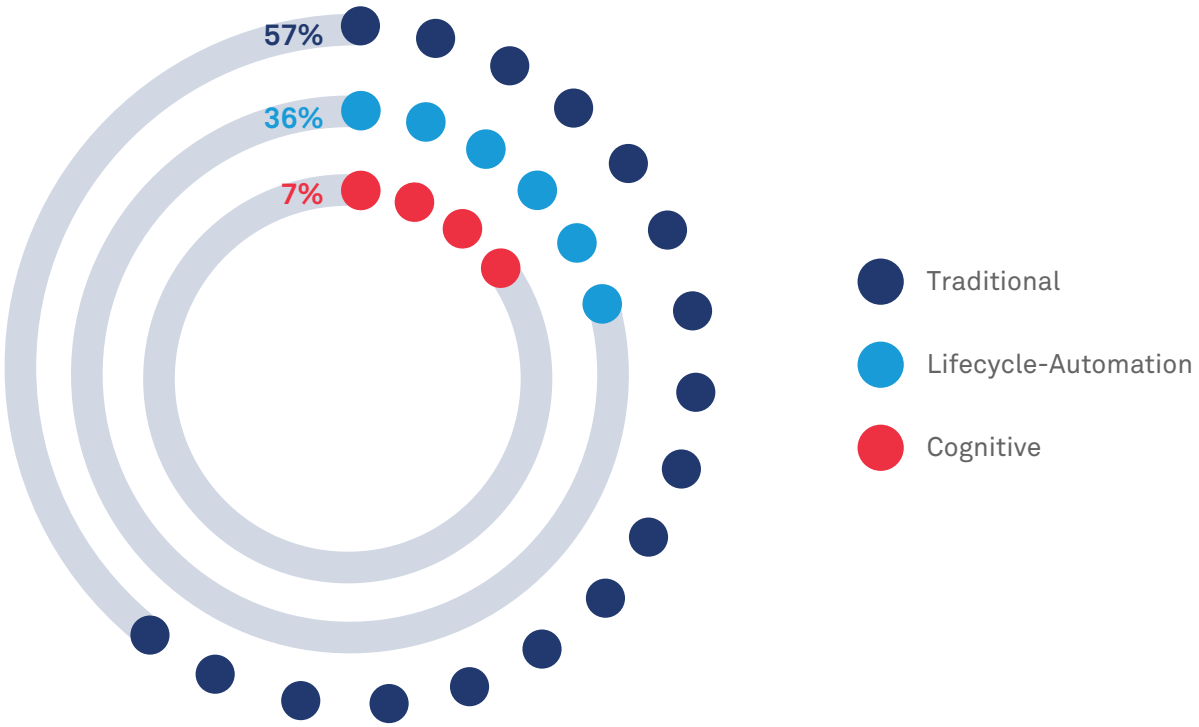


Figure 8: Automation maturity across industries

The First ‘S’

Takeaways

- How is automation across the phases of the software lifecycle leading to better speed in delivery?
- Which disruptive technologies are driving organizations’ move towards Agile and DevSecOps based approach with a focus on digital transformation?

4. The First 'S'

How speed in quality engineering is enabling digital transformation

One of the hallmarks of an organization that has embraced digital transformation is the agility with which it responds to changing needs of the customer and the marketplace. From a time where a product refresh would take months, if not years, to the current scenario where updates need to happen in close to real time, there has never been a greater need for organizations to respond nimbly to what their customers are asking for. The need of the hour - how quality engineering offerings are enabling speed, an essential ingredient in the digital transformation journey. From Cloud and Crowd as a Service, Mobile and IoT first product strategies, digital marketing to traditional quality engineering offerings like Test Environment and Data Management to Performance Testing and Packaged Applications Testing, every quality function is getting a 'speed makeover' in an attempt to enhance the experience of today's connected consumer. From a Non-functional Testing perspective we are seeing an increased demand in services for Security Assurance across DevOps cycles in several industries, especially in the context of cloud migrations and Internet of Things (IoT).

DevSecOps throws up a lot of use cases for automation as well due to shrinking software deployment lifecycles. Please refer to our report ' State of Cyber Security <https://www.wipro.com/en-BR/forms/state-of-cybersecurity-report-2018/> ' for more details on Security Assurance.

In this section, we look at how these offerings are faring in driving this digital transformation, their areas of focus to enable this transformation and how automation is helping drive quality design patterns for agility across these offerings.

4.1 API automation gaining ground

Shifting focus of assurance from Graphical User Interface (GUI) to Application Programming Interface (API)

There used to be a time when testing a product meant having to wait until the GUI was ready. But smart quality practitioners figured out a way to do this faster – hence the move from GUI-based testing to API-centric.

The share of API-based testing has doubled in the past year going from 15% in 2016-17 to 30% in 2017-18. There is a story hidden in this - it indicates that agile ways of working are gaining ground, where validation of a piece of software does not require its GUI to be ready. APIs are enabling innovation and digital transformation across industries as they enable easy collaboration between testers and developers by abstracting code bases for enabling quality engineering. In fact, many experts contend that GUI-based automation is an inefficient and vulnerable kind as interfaces tend to change, and their scripts need maintenance. APIs, on the other hand, are the business logic of the application. They are pieces of code that could be written in any language, but work seamlessly with each other to deliver a result. When automation happens at this level, it is far more efficient, and shifts the entire assurance process to the left.

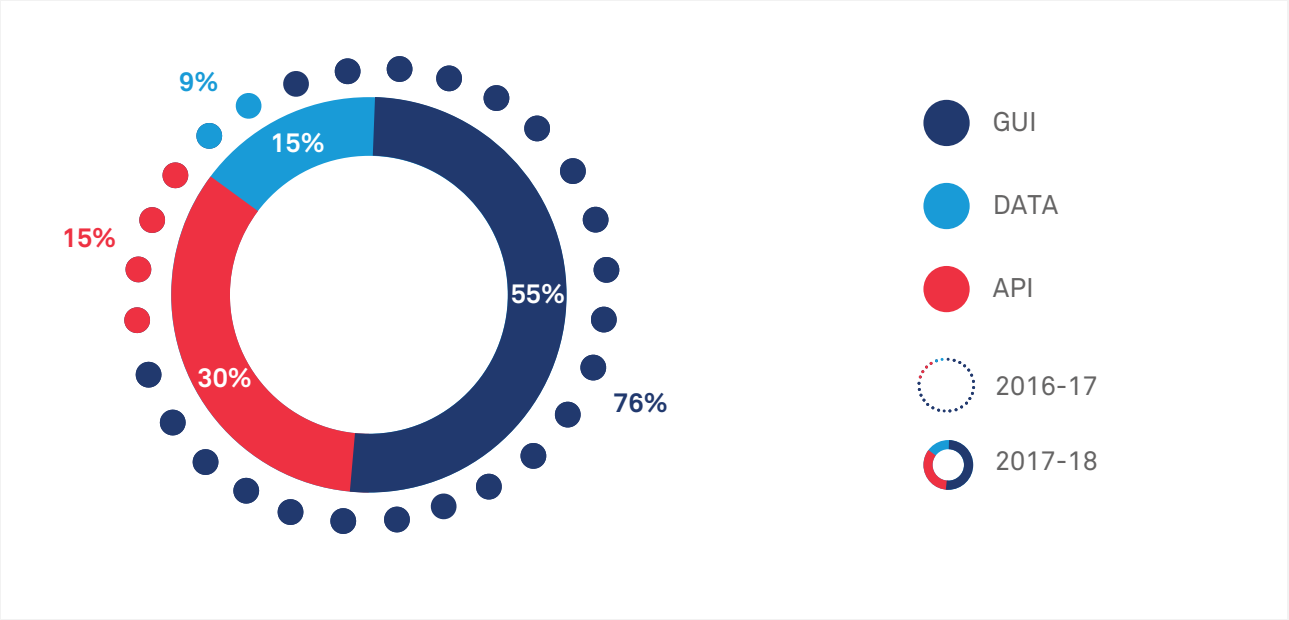


Figure 9: Automation across application tiers 2016-17 vs 2017-18

4.2 Regressive to progressive automation

The agile movement is taking on the 'bottleneck' phase in testing and all but eliminating it

Progressive testing is the new watchword in the quest to cut product release cycles, in response to the shift towards iterative ways of working. Here automated test scripts are written simultaneously with code, an example of how quality is adopting newer, agile and iterative ways of working (See Figure 10). The Quality team does not need to wait until the development cycle is complete to test for defects. It becomes a part of the development process. In the past year, we have seen progressive testing make huge leaps, with the share increasing from 25% in 2016-17 to 35% this year (Please refer Figure 10: Regressive and progressive automation 2016-17 vs 2017-18) an increase of around 40%. This trend is echoed in the share of agile quality engagements over traditional operating models.

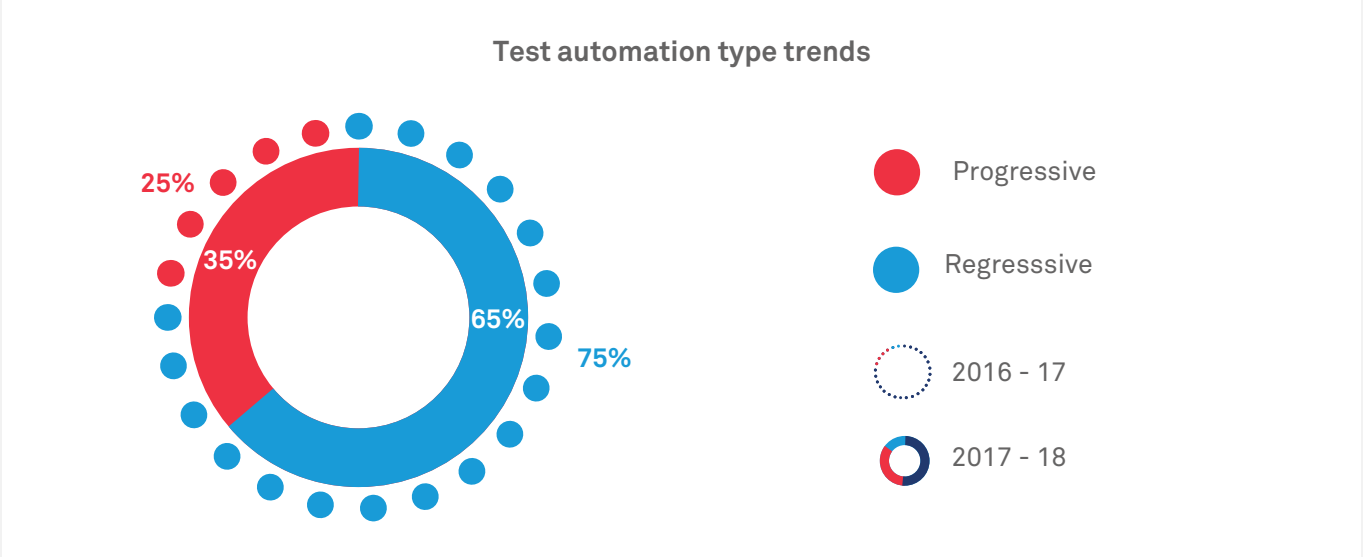


Figure 10: Regressive and progressive automation 2016-17 vs 2017-18

"While DevOps and Agile practice are helping to accelerate the creation of new applications, testing has become a huge bottleneck in delivering those applications. 63% of DevOps practitioners point to the QA/Testing phase as the biggest pain point today, despite the fact that organizations spend roughly $2.5 Billion in testing tools. Organizations who are testing continuously at every phase of their application lifecycle, not just at a specific QA phase, are seeing tremendous results, including 1.5X more likely to deliver 10X faster, 2.6X more likely to reduce defects by 50%, and 3.9X more likely to experience rapid revenue growth. Continuous testing is a critical tenant of becoming a modern software factory to improve quality and speed at the same time."

Jeff Scheaffer,
GM of Continuous Delivery Business Unit, CA Technologies

4.3 Mobility and IoT Assurance: Enabling an agile world of business

The brave new world is not just mobile – it is smart, responsive and connected

With 30 billion mobile moments a day, the world of smart devices like phones, tablets, watches, augmented reality devices are moving towards a day when we could get answers for questions like - "Who was sitting next to me in the bus yesterday?" With more smart phones than the number of humans in the world, mobile is poised to change the way literally every transaction is carried out. Companies that are able to see the opportunities for business agility in these emerging technologies will be the success stories of the future.

IoT is opening a world where cameras, sensors, gadgets and even cars are getting connected to internet, taking instructions remotely and creating more immersive app experiences. Augmented Reality (AR) and Virtual Reality (VR) technologies are getting smarter and sharper every day, delivering extremely personal experiences across connected devices.

Mobile quality is moving towards service models, which provide cloud-based access to these devices. Testers across different teams will schedule their tests on their interface of choice (phone, car, emulator or stub) from wherever they are and the solution will get it executed on the right interfaces and deliver results to a common dashboard. New pricing models will emerge based on the interfaces, time and number of test cases consumed. Mobility testing is poised to get uberized in the near future.

We set out to identify the key aspects that are driving transformation of quality in the mobility and IoT space especially from an agility perspective. Across geographies, there were a few common refrains from across industries that we studied.

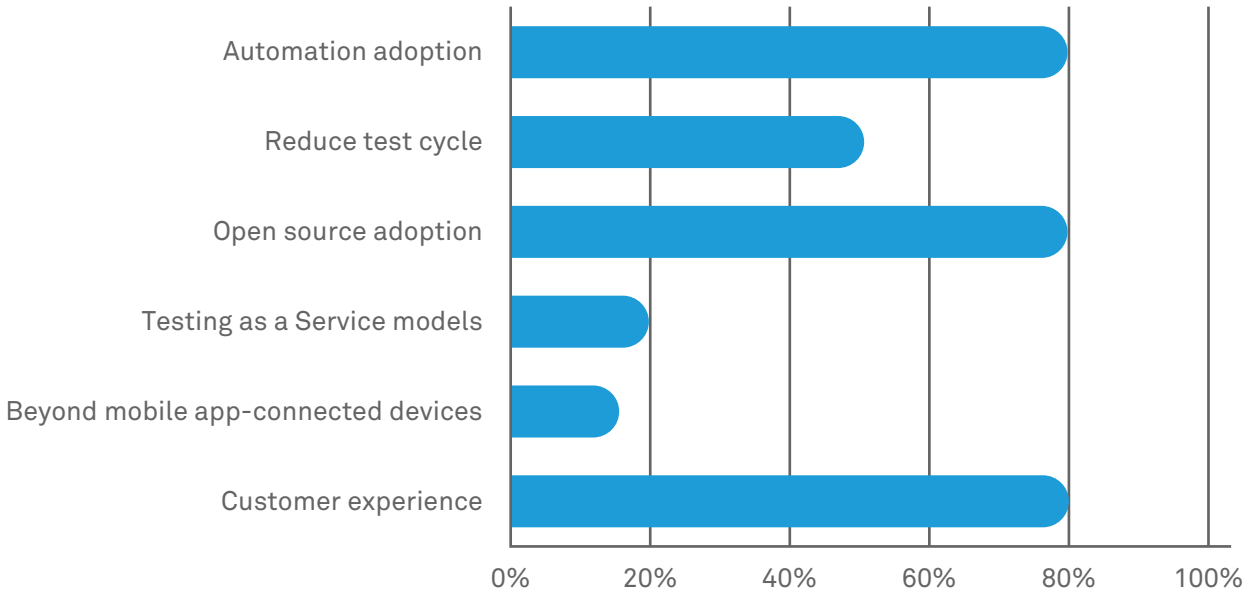


Figure 11: Key mobility assurance focus areas driving agile and digital transformation

All of this points to one thing: the ask from the world of mobile is for enhanced user experience and simplified transactions; and if customers don't get it, there is little hesitation to switch loyalty, almost with the very first poor experience. This puts enormous pressure on application providers to provide glitch-free performance: there are no second chances. To provide hurdle-free user experience, many organizations are adopting the agile way of continuously testing mobile apps via techniques such as remote testing (Detecting and fixing the bugs via access to devices connected to mobile networks), API testing (Continuous integration with real time world conditions), continuous monitoring and self-healing (Proactive 24X7 monitoring), and real time performance management through predictive analytics (Real time visibility into customer experience issues).

Fact file

- Healthcare and Retail and Consumer Goods lead automation in mobility with 63% and 61% adoption

Based on our data for customer ratings of mobile applications across industry domains:

- When we compare the customer experience in terms of satisfaction levels in this edition (data from 2017-18) with the last edition (data from 2016-17), results indicate much higher satisfaction level this year at 62% (vis-a-vis 33%). This indicates that mobility assurance and engineering practices are adapting well to digital transformation, keeping customer experience at the center
- Customer satisfaction ratings are highest for Performance, Privacy and Usability while other factors like Content, Interoperability, Security, Elegance and Stability still need to improve

4.4 Cloud migrations and their contribution to agile and digital quality

Integrated assurance for the 'Cloud First' business

Organizations adopting a 'Cloud First' strategy are focusing on having an integrated assurance on both infrastructure and application layer. There is a panoramic shift to cognitive automation which focuses on micro services, cloud resiliency, elasticity and security compliance on cloud platforms. This brings definitive advantages of the shortest possible time to production that ends up saving considerably on costs. We found that organizations on the ground were more inclined to public variants of the cloud as against private and hybrid variants. The choice of Cloud Assurance was tightly coupled with the deployment model with over 60% of organizations preferring "Lift and Shift" for cloud first. Security, compliance and performance are key factors while designing the assurance strategy, and data migration and big data adoption are two major factors that organizations worry about when making the transition. For holistic test coverage, while assuring IaaS, PaaS and SaaS aspects during cloud migrations, we see about 70-80% of the automation activities focused around script-less scheduled execution and reporting of tests.

"Faster app delivery is becoming an executive priority. Applications are at the heart of a digital enterprise, and with technologies such as cloud computing, predictive analytics and mobility driving business needs, it is imperative that we deliver apps faster than ever. Automating performance testing processes and increasing visibility are key to accelerating app delivery, ultimately, improving the customer experience. Learnings from Wipro's State of Quality Report can help businesses make informed decisions and balance costs when undertaking ambitious digital transformations."

Raffi Margaliot
Senior Vice President and General Manager, Application Delivery Management, Microfocus

4.5. The explosion of data and what it means for quality

Data is the lifeblood of the modern enterprise, and it is coursing through businesses in exponentially higher volumes with each passing day. Those that are able to gain the insights and information from data are able to channelize resources and make strategic decisions that outpace competition. Though it has not been traditionally seen as an enabler of agility, the quickness with which a business can go from disparate data source to actionable data insight will become a definer of success in the not-so-distant future. In this section, we study how data-driven agility is setting apart the digital transformation winners from the also-rans.

4.5.1 Challenges in Big Data Assurance: The automation hurdle

85% of organizations say that creating end-to-end big data automation is a challenge

Let us look at a store that handles over a million transactions per hour. The data from these transactions go into databases estimated to contain over 2.5 petabytes of data — the same amount of data you would consume if you read every book in the US Library of Congress 167 times over! Such large datasets cannot be processed using traditional computing techniques. Testing Big Data involves new tools, techniques and frameworks for creation, storage, retrieval and analysis that address the 3 Vs: the large Volume of data, the Variety of file formats and the Velocity at which data is generated. In our study for this year's report we see that the world of Big Data testing is moving away from traditional ETL testing processes to cloud based approaches with more and more organizations moving their storage to cloud.

However, making this transition to the cloud is fraught with challenges. Clients frequently find that though they intend to make the journey to the cloud, they are not as ready for the move as they may have hoped. 85% of organizations involved in Big Data testing say that creating end-to-end big data automation is a challenge given the diversity in technology and application landscape. When it comes to the skills required, most companies say that Big Data testers have a limited understanding of the components of the ecosystem. The exponential growth in the technology landscape, where Big Data tools demand stands at 35% of the total demand, makes it harder to identify testers with the right skill set for Big Data testing. Clarity in business requirements often does not percolate down to the layer of those involved in analyzing and structuring the test data which leads to challenges (See Figure 12). It is simply not enough that you want your enterprise to be Big Data ready; you must have clarity on the roadmap and business model that will get you there.

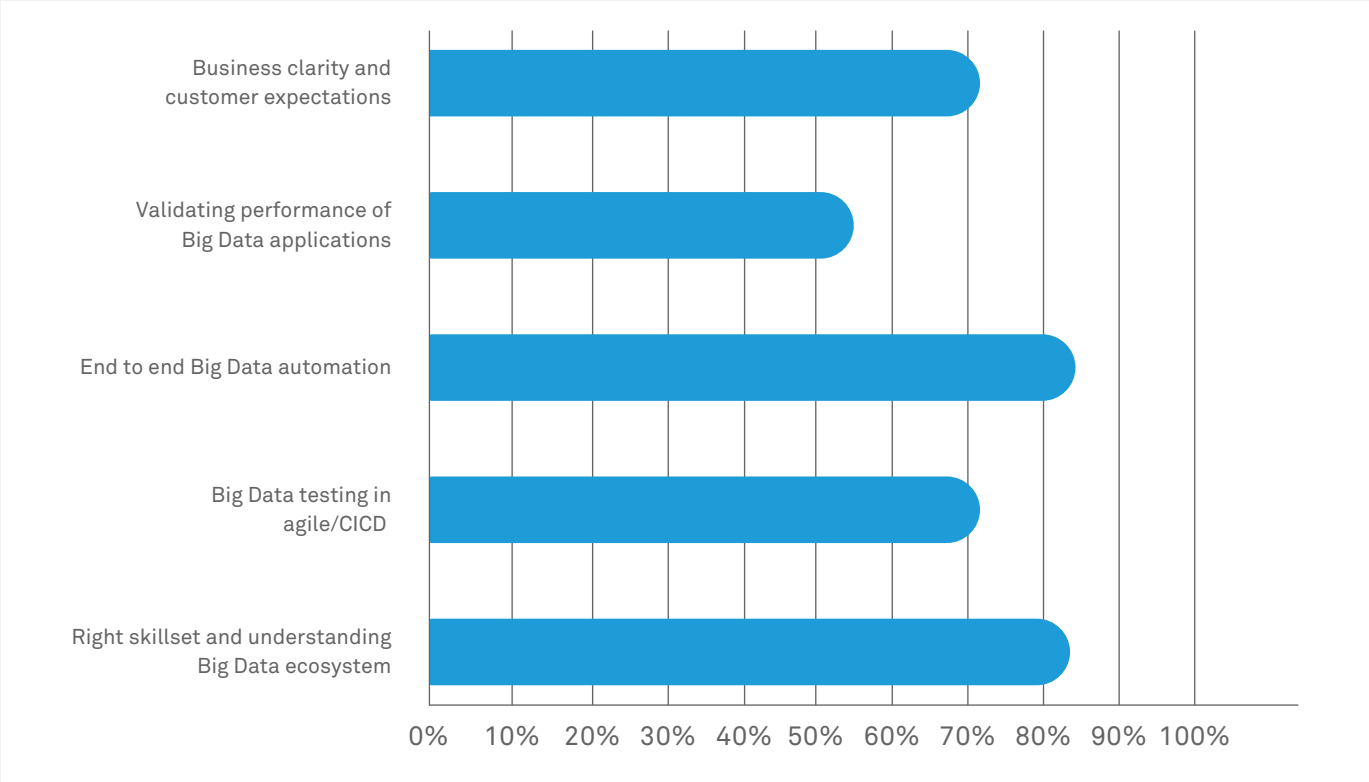
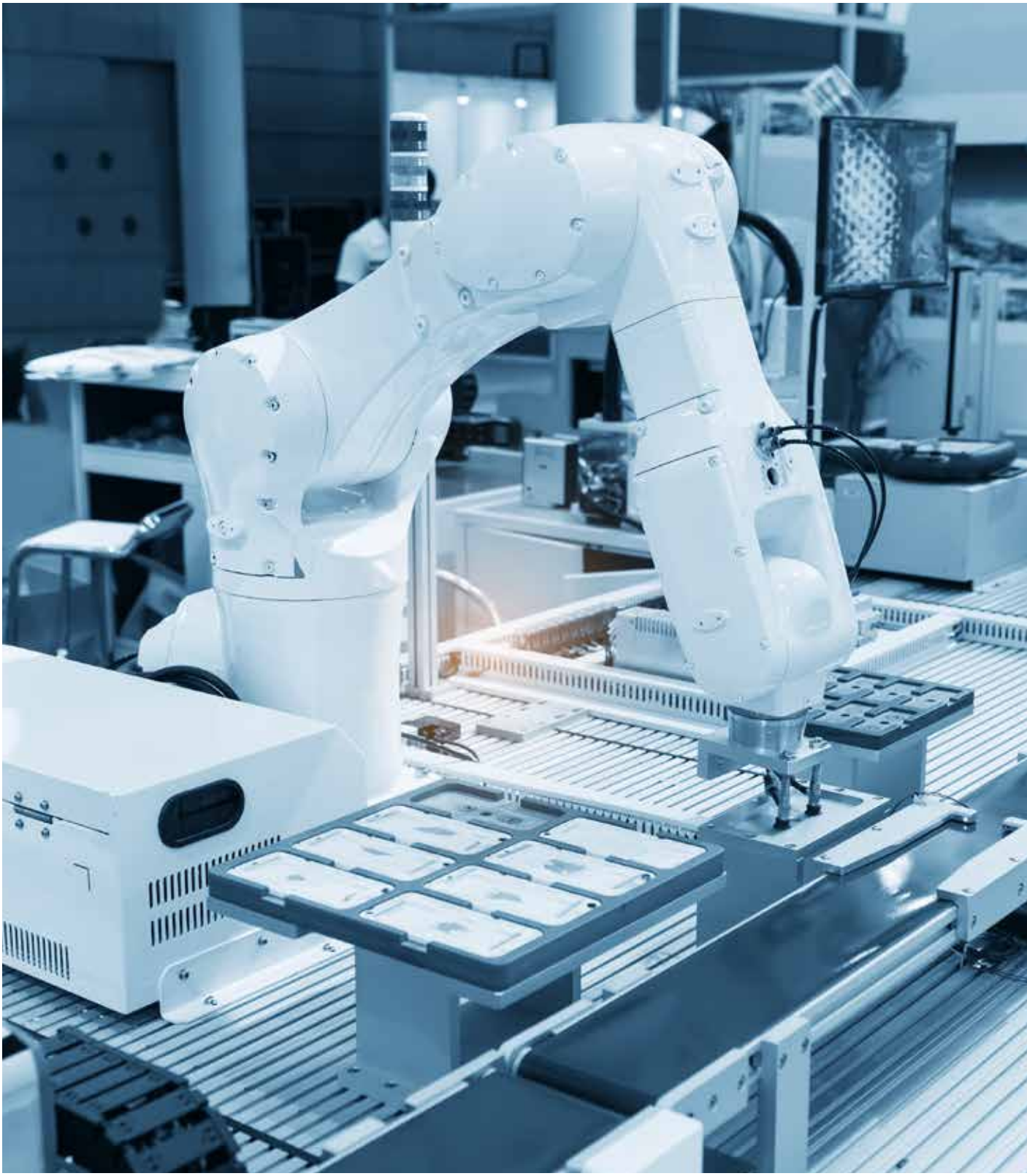


Figure 12: Key Big Data testing challenges



Automation in Big Data assurance is bringing relief to many organizations faced with enormity of ensuring coverage and precision of data at the same time. The breadth and depth of such a challenge puts most testing out of manual reaches. A quick look at the chart in Figure 13 shows the implementation levels of automation in Big Data testing. The Data ingestion layer has lent itself most friendly to automation while other areas like Data Quality, Metadata, Workflows, Analytical areas are catching up.

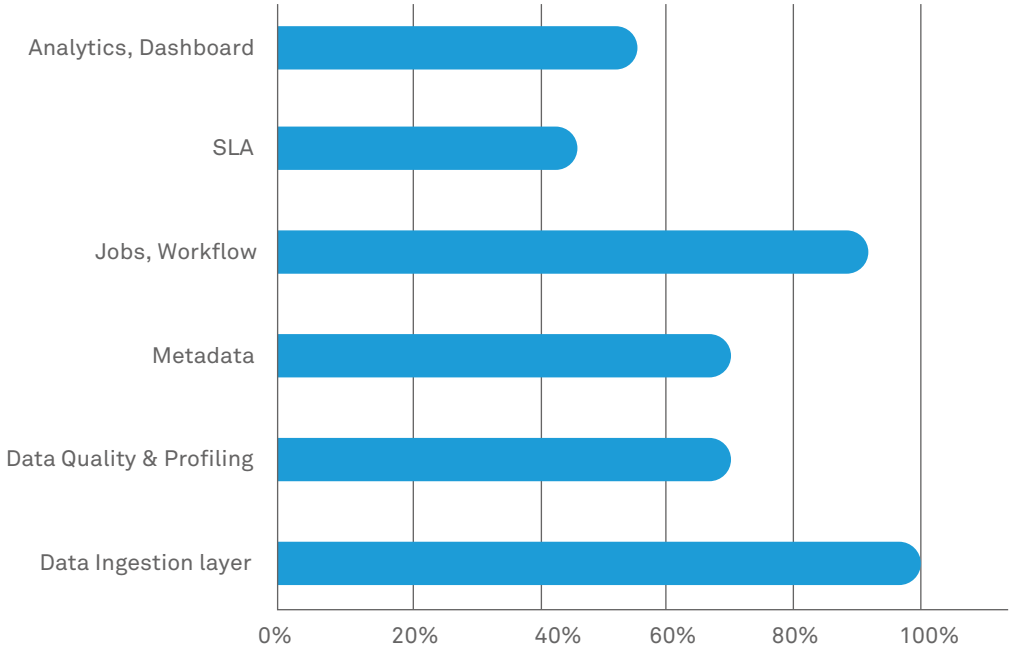


Figure 13: Automation adoption layers for Big Data

4.5.2 Automation in test data management: Leapfrogging over a traditional hurdle

79% of organizations report that generation and maintenance of test data continues to be a concern

The creation and maintenance of test data continues to be a pain-point for organizations. While this number has come down from the 90% reported last year, teams are still struggling to find automated, repeatable and scalable ways to create and maintain test data. This leads us to believe that the future belongs to those who can create test data with a relevant business context better than competition. This means that data generation tools will be game changers of the future, as the need to not rely on production data is gaining momentum. Integrated solutions that address test data along with test environment and service virtualization are gaining precedence.

Based on our data, we were able to draw some interesting insights into how test data management is faring from a digital perspective with newer ways of working, and with automation tools gaining ground.

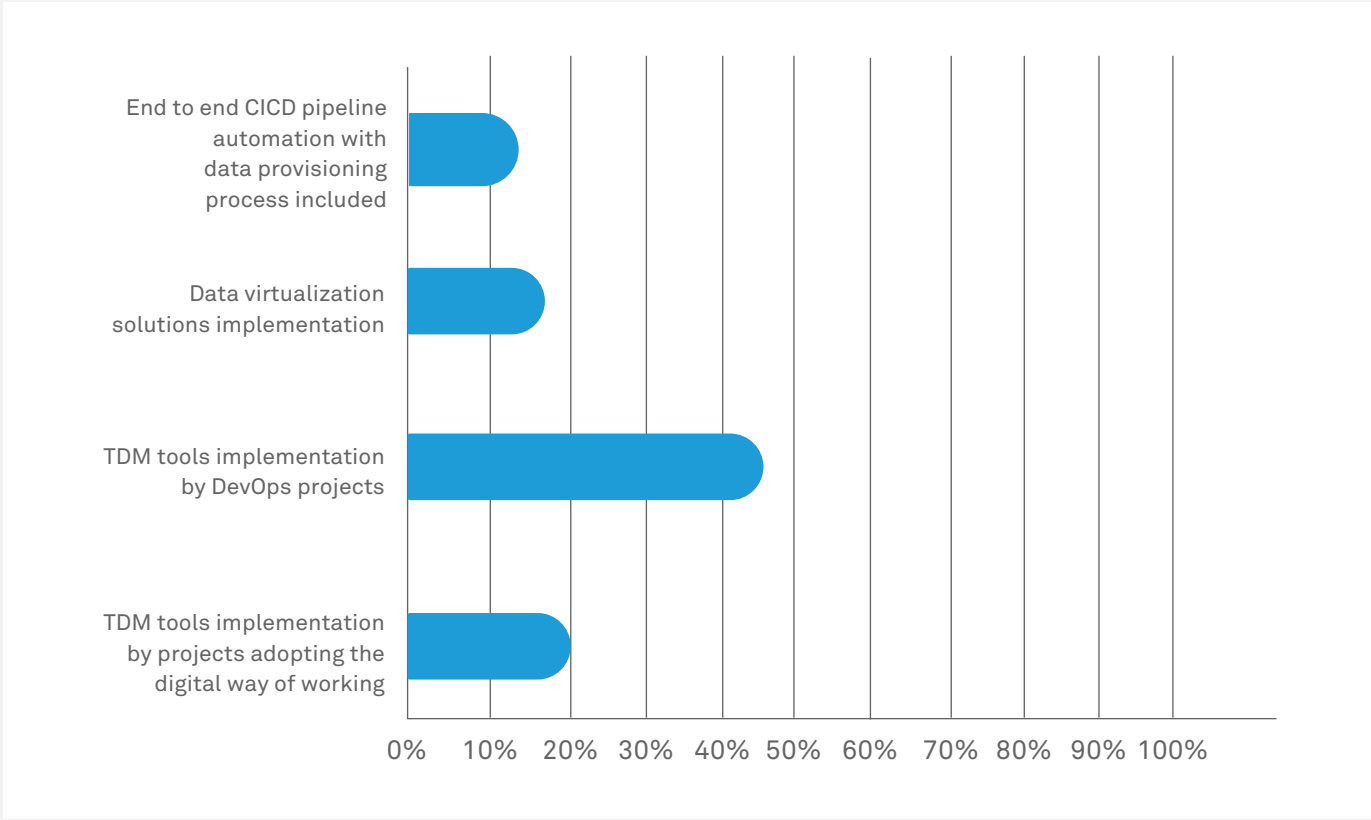


Figure 14: Automated test data management solution implementation to drive agility

In a world where manual generation and maintenance of test data is fast becoming passé, we checked for telltale signs that automation was finding its way into the world of test data management. Our two-year comparative analysis clearly shows that the use of commercial tools for data provisioning increased from 51% to 57% while the automation of synthetic data creation has more takers, 43% this year over the 35% reported last year. What's more, the usage of in-house automation scripts by customers increased to 71% from 65% last year. These data points are to be seen with the fact that manual data creation process decreased to 65% from 75%. This just goes to show that automation is slowly making inroads where cumbersome, error-prone and time-consuming manual processes held sway.

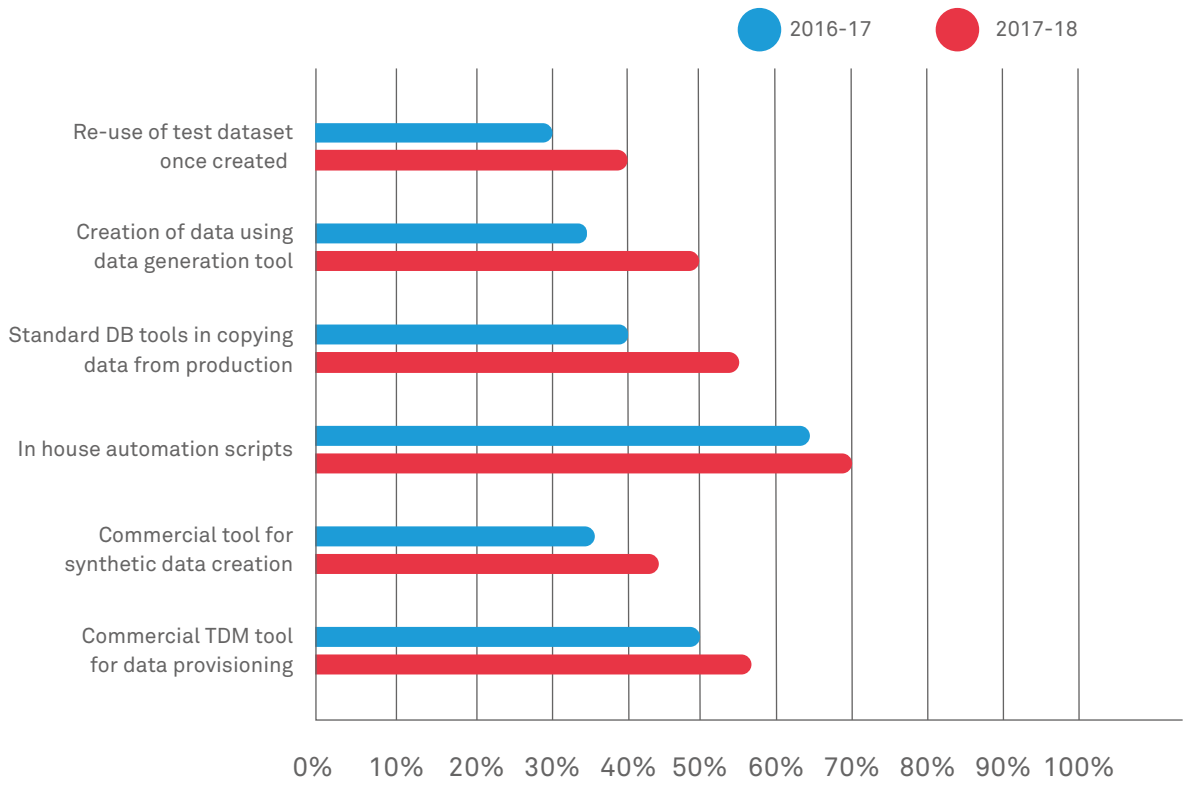


Figure 15: Adoption of automation in TDM

Fact file

- **86%** of organizations struggle to create and maintain test data
- Only **5%** of the organizations take 1-3 days to deliver test data
- Usage of in-house automation scripts increased from **65%** to **71%**
- **93%** organizations are facing challenge in regulatory compliance
- **43%** organizations now automating synthetic data creation process in comparison to **35%** last year

"In the oil and gas industry, our primary bottlenecks today from a Quality Assurance perspective are the areas of test data management and Regression testing. Test Data needs to be managed in a controlled manner for process validations and a method to automate this area is a key focus for us. Functional Automation of Regression scripts is another key focus area as we have several releases where regression scripts need to be run repeatedly. We see Automation as a key driver in enabling Agility in these focus areas."

Ian Powney
Head of IT strategy and projects at a large oil and gas corporation operating in Europe and Middle East

4.6 The need of the hour - Automation in test environment management

Testing teams today are challenged with unstable, fragmented test environments. With the majority of testers' time wasted on fixing environmental issues, teams are not able to gain as much as they could from the testing effort. Organizations have begun to realize that unstructured test environment management can impact release timelines and test coverage, eventually leading to defects and taking away the customer experience. The heterogeneous nature of the test environment, comprising of different kinds of technologies, servers, and systems makes its management a challenge. We took a closer look at what these challenges are, and how organizations are responding to them. The question we asked is 'How close are we in the quest to create ecosystems that enable quality engineering efforts, instead of hampering it?' Ultimately, are there tools available that help transform test environment management to a zone where it becomes an enabler of agility rather than a factor that holds it back?

What do inventive individuals do when faced with repetitive tasks? They automate as much of the task as they can. In testing terms, individuals began with the ad-hoc automation of tasks by writing a macro or a piece of code. Then in the mid-90s came test management tools (ex: Test Director) that started grouping test cases and results, making them available in one place. Alongside were basic tools like Quick Test Professional (QTP) that recorded and played back the test steps. Serious automation in testing was kicked off by more mature tools that went beyond organized recording of results. These tools provided options for checkpoints, ways to manage object repositories, requirements tagging and finally, defects management. Over a period of time different aspects have had to be considered in order to build a platform for end-to-end automation. These aspects include:

- Integration with HP QC/ALM
- Integration with SVN repository
- Supporting of multiple tools (HP QTP/UFT, Selenium, eggplant, Eclipse)
- Scheduling of tests execution
- Parallel execution of multiple tests
- Queueing of tests execution
- Easy maintenance of Virtual Desktop Infrastructure

The most challenging part of testing is simulating user environments. The luxury of using a production environment such as a shop floor, a back office or a CRM for testing doesn't exist in the development stage. Creating the user environment for testing is a time consuming process and therefore a good reason to automate.

Regression testing looks at each change and how it impacts all parts of code. When it is a repeatable process, it becomes a candidate for automation. In addition, regular and routine tests such as the daily smoke tests to check if the code is stable and the weekly mini regression test that keeps development on-schedule should be automated.

There are two further aspects of regression testing that are good targets for automation. The first is post deployment testing. This provides the team with the production environment to test applications instead of depending on test environments that often lack the data for dependable testing. But the real

clincher is that production environments expose unknown impact areas. Development programs that are not precisely planned and executed depend on the test outcomes in a production environment.

Quality assurance becomes simpler when test data is accurate. In the telecom industry, this means preparing data related to simple contracts, activation of contracts and subscriber account history. Automation can accelerate the process of randomly generating this data by using a script that assists in data selection.

In the telecom industry, Robotic Process Automation from a Quality perspective is increasingly helping in agility for Digital transformations. The main focus for RPA has been in the automated validation of business processes. For us at TMPL, it began with verification of data inserted into the system (typo validation) and is now focused around verification of packages prepared for external cooperants (for example: DHL and vindication process).

For a telecom business, these are manual processes and in addition, they are time-intensive – both of which the telecom industry can ill afford. They therefore take on special importance from a QA perspective.

Mirosław Dąbrowski
Head of tests section at a large European telecom operator

4.6.1 Understanding the fragmented nature of the test environment

The pressure of going to market faster and adopting new technologies is affecting the approach to Test Environment Management (TEM). We noticed that most organizations have fragmented TEM practices, which are largely ineffective as a part of the “overall IT delivery”. The symptoms are lack of coordination and accountability of the ownership of test environments that cause sub-optimal environment utilization. Not only does this lead to higher operational cost, it lowers the availability of environments. Our study revealed key challenges at various levels of the test environment lifecycle.

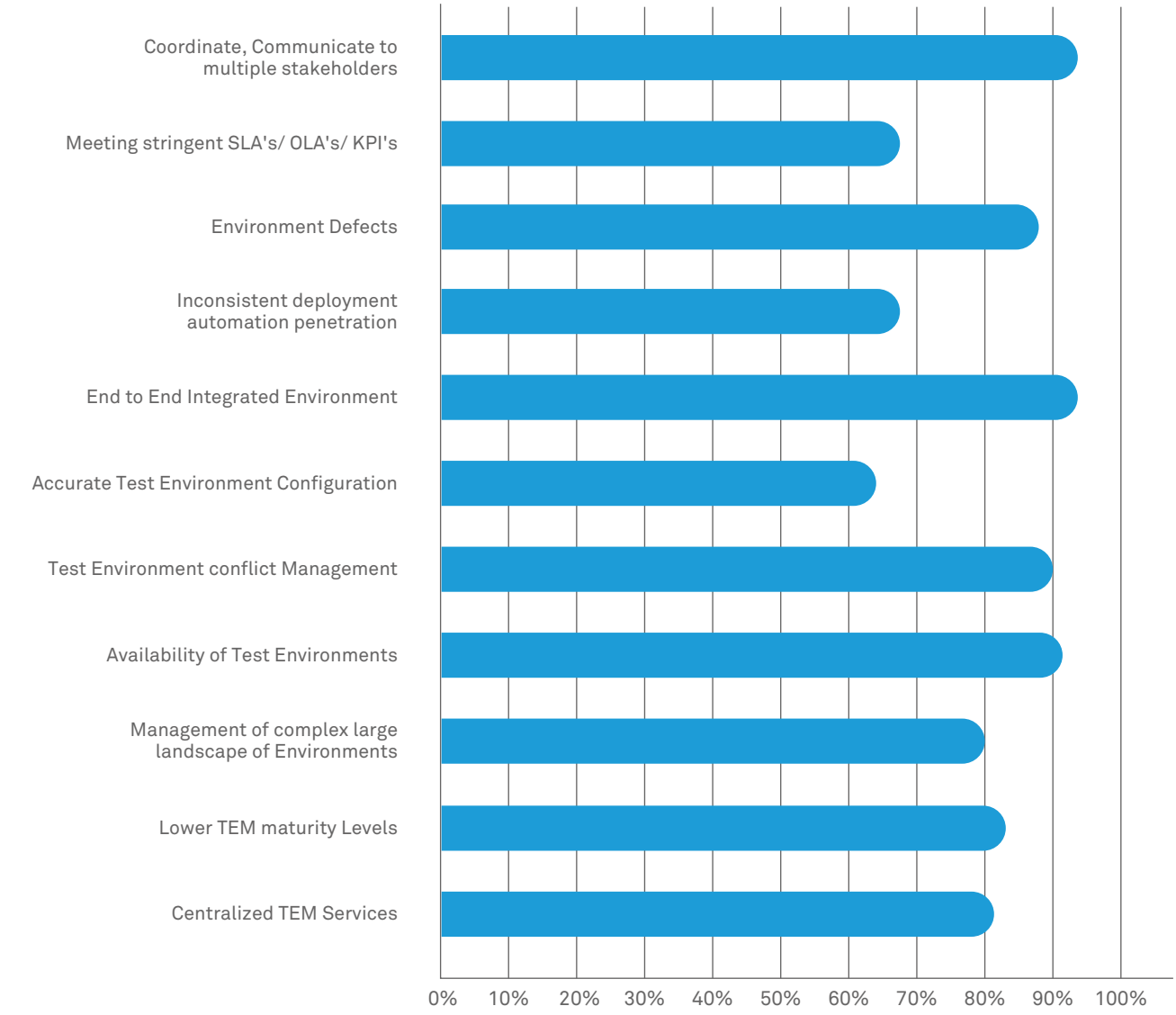


Figure 16: Key test environment management challenges

Data from over 70% of organizations revealed that end-to-end integrated environments and coordination with multiple stakeholders were major challenges. Issues like provisioning and configuring the right environment at the time, utilization of environments and associated assets, environment availability and booking and contention management were key concerns. It appears to point in the direction of building environment management as a dedicated service at an organizational level. This approach will help address the challenge that many organizations face: the ability to assess the level of maturity of their TEM and identify mechanisms to address the challenges at multiple levels - infrastructure, application, database and operations.

4.6.2 Harnessing the automation racehorse

Trends and tools for robust TEM frameworks

Organizations have been quick to realize the importance of the role that automation could play to accelerate the test environment readiness and availability. We have observed significant investments in the area. Most of the efforts are in the direction of environment provisioning in virtualized, cloud environments and deployments of test environments. It is easy to see why: With the sheer number of iterative changes that a test environment needs to go through to keep

pace with the evolving requirements, it makes sense to widen the automation footprint as much as possible in all facets of the environment delivery process. In a period of about 12-18 months, an organization can achieve around 60% automation in this area, given robust governance and continuous investment. Some organizations are already beginning to see results with a reduction in team effort on monitoring and provisioning from 25% to 15% because of automation.

This is set to decrease further with the adoption of bots that will drive down human intervention required in the area. Automation of test environment maintenance is emerging as a key focus area after build, deploy and report stages of the tasks.

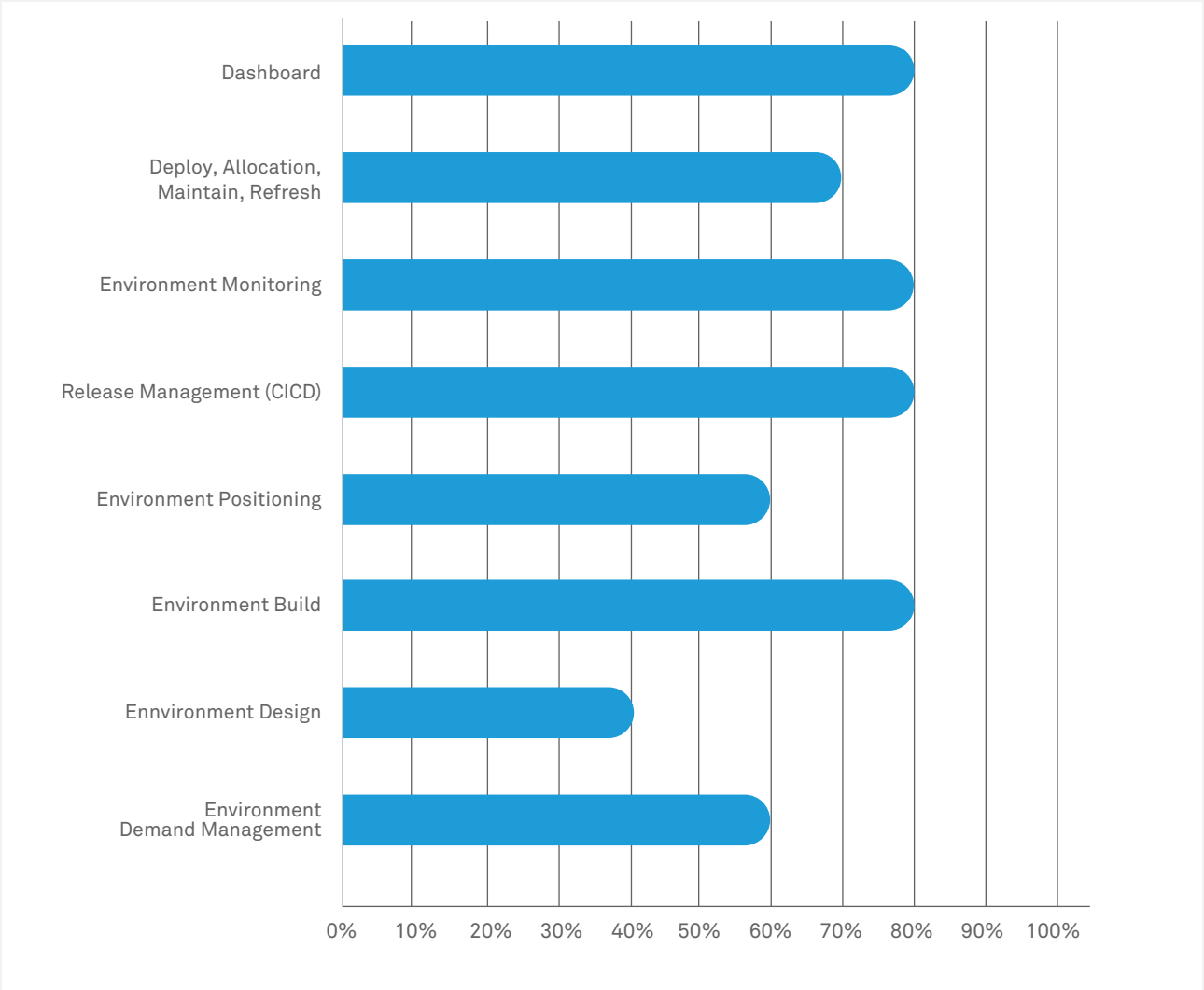


Figure 17: Mapping automation trends in TEM

Fact file

- **13%** of the total defects are due to environment issues, taking **25%** of the team's effort to fix the issues (down from **28%** last year)
- Around **20 - 30%** of effort can be saved by managing all the test environments with a centralized team
- Around **10%** environments issues can be avoided by following proactive monitoring

4.7 Performance Engineering – Product quality for stress scenarios

Performance engineering is a critical ingredient in the IT system recipe: one that allows you to rest assured of system behavior under stressful conditions. It ensures a level of customer experience that could make or break your business in the age of the demanding and fickle digital customer.

However, does everyone believe that this is truly the case? In the previous edition of the report, we realized that there were no readily available benchmarks for the maturity of tools, processes and people, and so we created them. This year, we revisit those findings with a broader scope. As it sometimes is when you taste a gourmet dish, there were some things comfortably familiar, and some that took us quite by surprise.

The use cases for performance engineering include code and log profiling and Application Performance Monitoring (APM) as against a focus on response times and throughput in performance testing.

While performance testing relies very much on automation scripts for its scope, when we sought to understand how performance test execution is faring from a CICD and DevOps perspective, we noticed that the traditional challenges plaguing continuous testing manifested here as well. Test environments and data still present challenges in performance test execution automation along with the complexity of the performance test use cases.

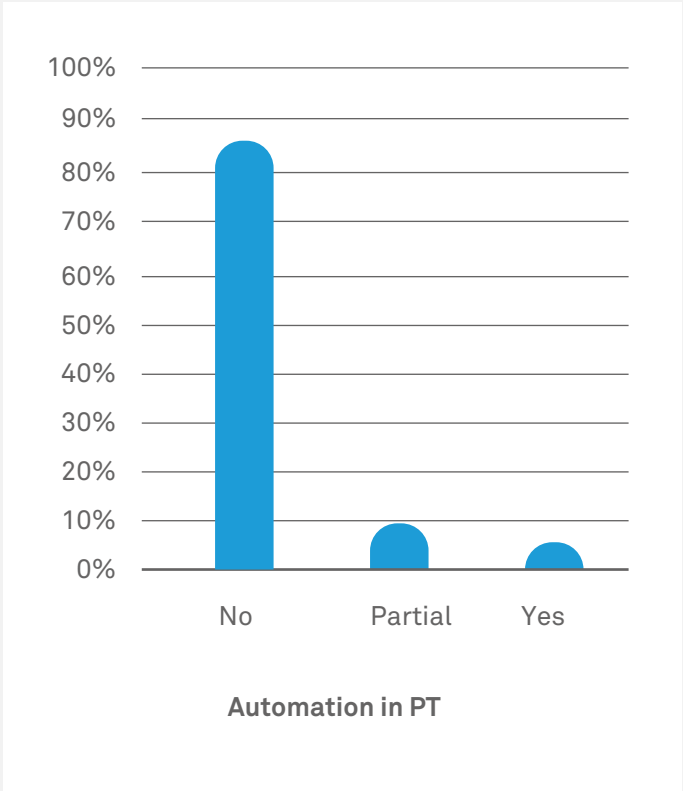


Figure 18: Automation of Performance Test (PT) execution in the world of continuous testing

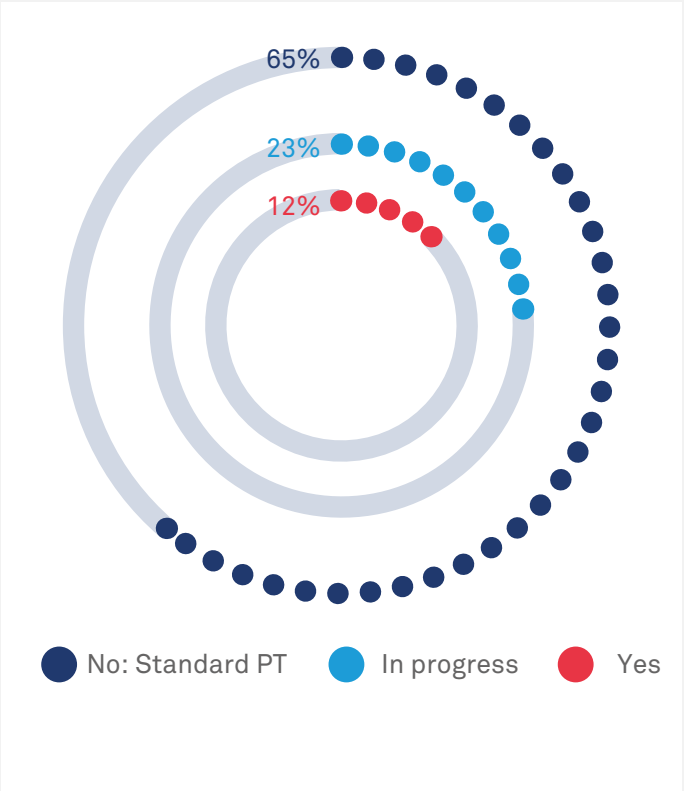


Figure 19: State of performance engineering across organizations

While the adoption of Performance Engineering is still low as is evident from the data in figure 19, the progress has been steady and the guidance for the way forward is clear.

4.7.1 Conventional tools still rule in performance testing

Despite a surge of interest in open source, the licensed, incumbent, conventional performance testing tools remain the preferred choice.

If you are exploring a new age open source performance testing tool, you will find to your dismay that the proven success of the licensed, traditional tool is tough to beat. The sheer breadth of technologies it supports is a definite reason for it to continue to hold sway; little appears to have changed in the year past. However, we could see this changing in the coming years with the world of DevOps and the emerging ways of building code. There are signs of a building undercurrent favoring less expensive open source performance testing technologies. It could well be only a matter of time before the superior functionality that is offered by new generation open source performance tools find a foothold in industry. This is echoed by the fact that whatever little ground has been lost by the incumbent tools, has been gained by the open source brigade, and not another licensed tool.

4.7.2 Web technologies and performance testing: The affair continues

Greater digital nativity makes Web Technologies the leading platform that undergoes performance tests

We are riding a trend where the proliferation of digital technologies directly in the hands of consumers is raising the bar for the product quality of performance that companies need to provide.

With greater digital nativity being baked into products across segments, we see that the cookie crumbles in much the same way as it did in 2017 with over 70% of performance testing focused on web applications. The total share of other technologies undergoing performance testing is a mere 13% of the overall number of applications (See Figure 20). Closer examination of this trend reveals the reason: we are seeing more and more code being pushed to the client side of applications - a trend in computing that reduces the transaction load on the server side. This has been made possible due to better quality devices that are being used to access these services. The latest tablets and smartphones now have enough processing power to run code on their end. This not only gives consumers a better user-experience, but also brings down the load on the servers. But to ensure that this new architecture works according to plan, organizations are focusing on device side testing, by simulating real-world scenarios under a variety of network conditions. It is as if a theatre company invited audiences into the dress rehearsal in order to be better prepared for the opening night.

Over the last year, mobile computing has seen the blurring of device boundaries, with tablets, smartphones and hybrids tending towards each other in ways never seen before. With the rapid proliferation of customer touchpoints, the definition of what mission critical means is at its widest ever, and performance testing is critical to achieving reliable, consistent results.

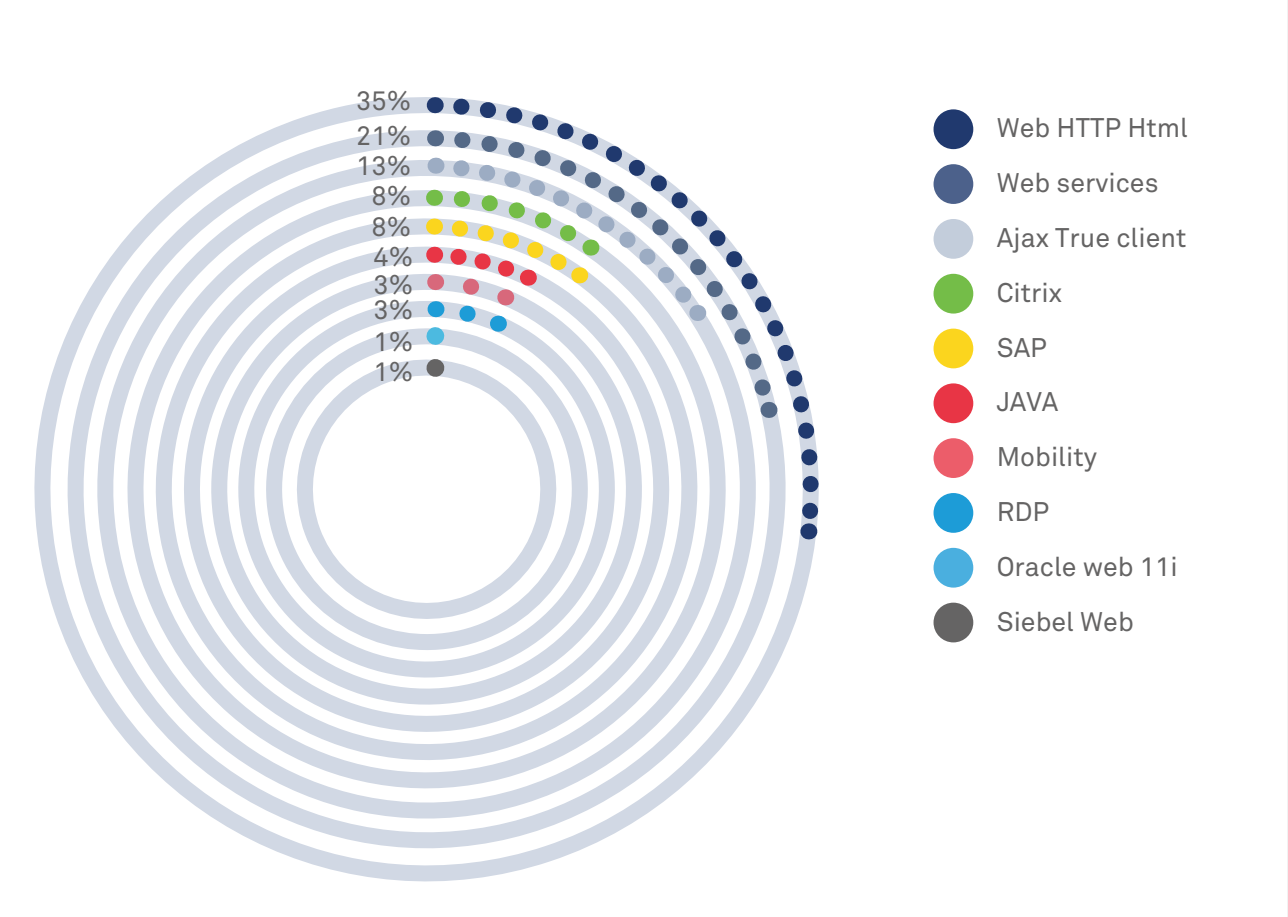


Figure 20: Performance testing - Protocols usage across application landscape

4.7.3 The battle for the application performance monitoring pie

Products that offer a bundle of infrastructure, application and logs are growing in strength

Application Performance Monitoring (APM) helps in detecting and diagnosing application performance problems to maintain an optimal level of service.

Reporting on APM, leading analysts picked three service providers who would, in their opinion, carve a greater share of the future of the practice. The facts on the ground about actual usage and deployment resonate with this, with two of the leading providers coming out on top in the tools that are in use for APM. We went deep into the realities on the ground when it came to these tools and came back with some intriguing insights.

Traditional APM requires the production server to respond to the monitoring request, putting an additional load on a system that is already likely to be stretched. The practice of analyzing system logs to arrive at performance metrics addressed this issue. This capability is one of the reasons why some providers are doing better than others when this is offered as part of a bundle. The new age tools have another advantage: the ability to offer APM as a Service. This precludes the need for an on-site installation of the tool or for a datacenter. We foresee this as a trend that will take greater shape as more and more APM providers take to offering this as an on-demand service, especially when Infrastructure monitoring, APM and logs-based analytics are unified as a part of the offering.

Fact file

- Automation adoption in performance testing stands at **12%**
- Significantly high presence, awareness, execution, engagement of performance testing in financial services with **28%** and healthcare being the lowest with **7%**

"Performance is not an afterthought any more. Performance has to be built in by design and controlled at each step of the SDLC.

Detecting performance regression on the main components reduce the risk and allow the team to focus on new features, rather than solving defects. Since user experience has become the ultimate KPI, limiting performance only to architecture components is not enough. Measuring end-to-end performance by taking into account the user's device, browser, location and network quality has become paramount to reduce risk to any business before going live.

APM is now a standard within most organizations. Customers take advantage of great products to proactively monitor applications, real user's behavior, their EUX... Today, enterprises are sitting on a virtually limitless bank of data on how users interact with their applications. In order to extract meaningful information that will lead to timely decisions, AI-powered APM tools, integrated with NeoLoad, allow to build performance model and do predictive analysis on load testing results."

Laurent Gaudy
Vice-President Business Development - Global Strategic Alliances, Neotys

4.8 Packaged applications on the cloud gaining ground

How smart testing strategies are managing highly customized and integrated organizational application environments

Organizations today leverage a broad spectrum of packaged applications, with a view to making a shift towards newer, more agile ways of doing business. With the advent of cloud based hosting of applications, packaged applications are also offering cloud based versions along with their traditional on-premise counterparts. We are at an interesting inflection point for packaged applications, given the speed at which the landscape is evolving with the adoption of cloud over on-premise solutions, and the shift from waterfall to agile development. It is no secret that you need a smart testing strategy to effectively manage and maintain such a highly customized and integrated application environment. As per our data, cloud assurance in packaged applications stands at 18%. As business needs evolve with the market, it calls for frequent changes to configuration or fast-tracked upgrades that have risks that need to be mitigated. The world of packaged applications is now faced with challenges in adapting to these shifts for smart test strategies with a constant push for faster turnaround times from a quality perspective. Automation is one of the key

drivers which is helping meet these demands with a lot of commercial off the shelf (COTS) testing tools offering options to test packaged applications and existing testing tools making efforts to adapt to these changes. Open source tools are still playing a game of catch up in this area.

Automation has made significant advances in the world of packaged application testing. With 62% of organizations reporting the presence of automation in their QA cycles, automation is the new order of the world in packaged applications enabling agility for business (See Figure 21).

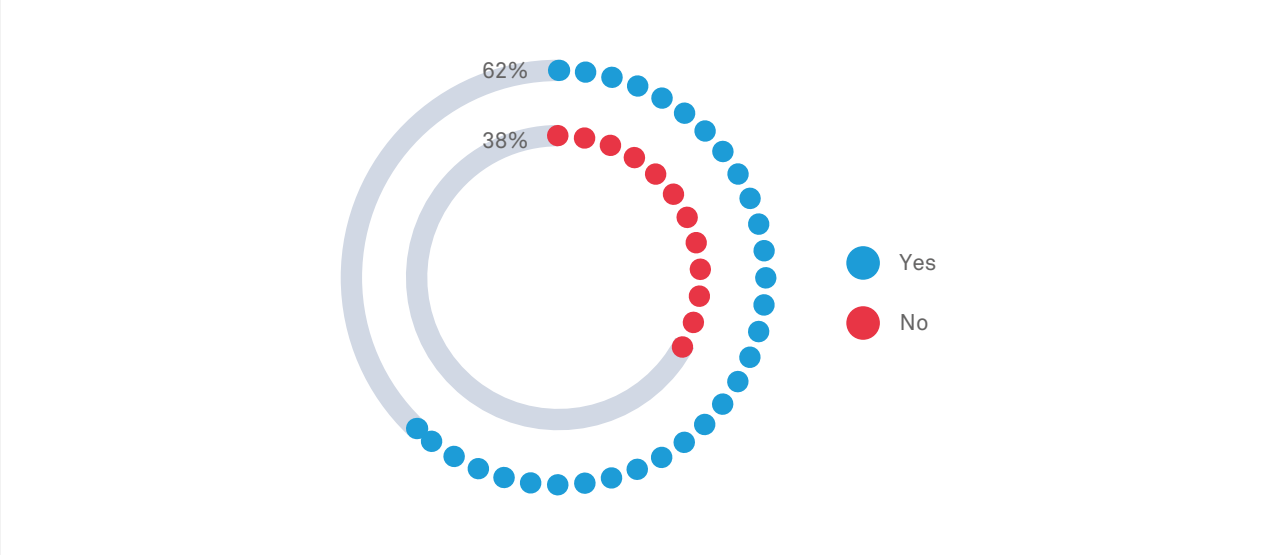


Figure 21: Packaged applications assurance test automation presence

"Optimizing the Software Validation effort in a regulatory space through automation is the way forward for improving Time to Market. DevOps and Continuous testing is at the heart of this transformation."

Balasubramanian, Sriram
Director of the Testing Center of Excellence of a large corporation

The Second ‘S’

Takeaways

- How the multi-skilled, multi-speed quality engineer - software developer in test (SDET) has emerged
- The reason for the focus on automation skills from early stages of development

5. The Second 'S'

Evolution of quality craftsmanship: Skills in quality engineering

There are clearly observable patterns in the way skills have matured in the journey of Quality Assurance with Automation. As Agile, DevOps, Continuous Delivery and other digital methodologies take over the world, they are forcing a transformation in the skill sets that resources need to demonstrate to engineer quality. The traditional, pure play functional tester and developer are giving way to a multi-skilled, multi-speed Quality Engineer. A multi-speed operating model for testing has evolved along the same lines of skill development. We have observed this multi-skilled operating model evolve as shown in Figure 2 from dominant One in the Automation 1 Stage to dominant T-Pi in the Automation 2 Stage and dominant X in the Automation 3 Stage.

- **1(One):** A traditional tester with specialized technology skills predominantly in manual testing
- **T:** A tester with a specialized technology skill augmented by a functional skill (for example, a tester working on banking platforms only)
- **Pi (π):** A multi-technology tester supporting a domain, driving programs on Agile, some one who can specialize in one skill and generalize in others to become a Software Developer in Test (SDeT) - for example an expert working within a SCRUM team for digital function, playing roles across Dev and Test.
- **X:** An ultra-speed testing role requiring completely fungible skill across technology roles as well as functional skills using principles of DevOps (Digital Assurance Engineer), Machine Learning and cognitive skills.

With distributed ways of working beginning to take hold in the form of right-shoring and no-shoring as the future, quality offering skills are beginning to spread all around the world. It is the next step in the evolution of SDeT, whose presence is revolutionizing the way quality was being addressed earlier in the product cycle. Skill set data demand analysis indicates that specialized testing skills that add to speed in delivery are most sought-after, after automation and digital. These specialized skills are Packaged Application Tools, Big Data and Open Source tools - with Open Source tools at 12% of the total demand, while Big Data tools account for 10% of the total skill demand. Across verticals, open source automation tool skills are the most sought after, followed by those for Behavior Driven Testing (BDD) and Commercial Off-the Shelf (COTS) test automation skills. The trends in skill demand is strongly correlated with the way the offerings in quality engineering have evolved.

"The pursuit of speed and quality is driving the need for tools that help drive continuous testing. Organizations making this journey are increasingly driving automation at not just the UI level, but at the API level also. Open source tools like Appium, SoapUI, and Selenium continue to gain a lot of momentum in the process. Simultaneously, manual environment management, deployment, and tear down practices are giving way to activities that help development and test teams access environments for scaling automation in a matter of minutes."

Ole Lensma
CTO, SmartBear Software

5.1 Mapping skill related trends: Full stack and specialized

A look at organization requests indicate that demand for services in the future from a quality perspective will be related to digital and automation. Organizations are now looking for people with a wide range of skills, and not just experts in a tool or domain. Meet the full-stack resource, a proverbial jack-of-all-trades, who keeps pace with the briskly changing technologies of today. The full-stack resource is an asset in the early phase of testing, while in the later stages a resource with deep domain knowledge and the patience of a specialized tester becomes paramount.

This is why sprints are dominated by full-stack whereas the hardening or release phase is dominated by specialized skills with the the split being 27% and 73% respectively.

We see organizations move towards full-stack skill sets but each domain shows its own trend. To break this down, we looked at domains more closely and noticed a trend manifest itself where organization requests call for a requirement of digital and cloud almost as a default.

In the healthcare domain, we notice that the highest demand is for Mobility followed by Cloud, with no sign of DevOps making an entry. This may be because, in this domain, quality takes priority over speed, although solutions are making their way to customers via mobile and cloud. On the other hand, we see financial services domain with demand for all the specialized skills at the same pace leaving a mere 3% only for traditional skills. This may be because the domain keeps quality and speed on par when it comes to priority. Other services requested are in the realm of DevOps, Data Centric Testing, Cloud Migration and usage of open source tools (See figure 22).

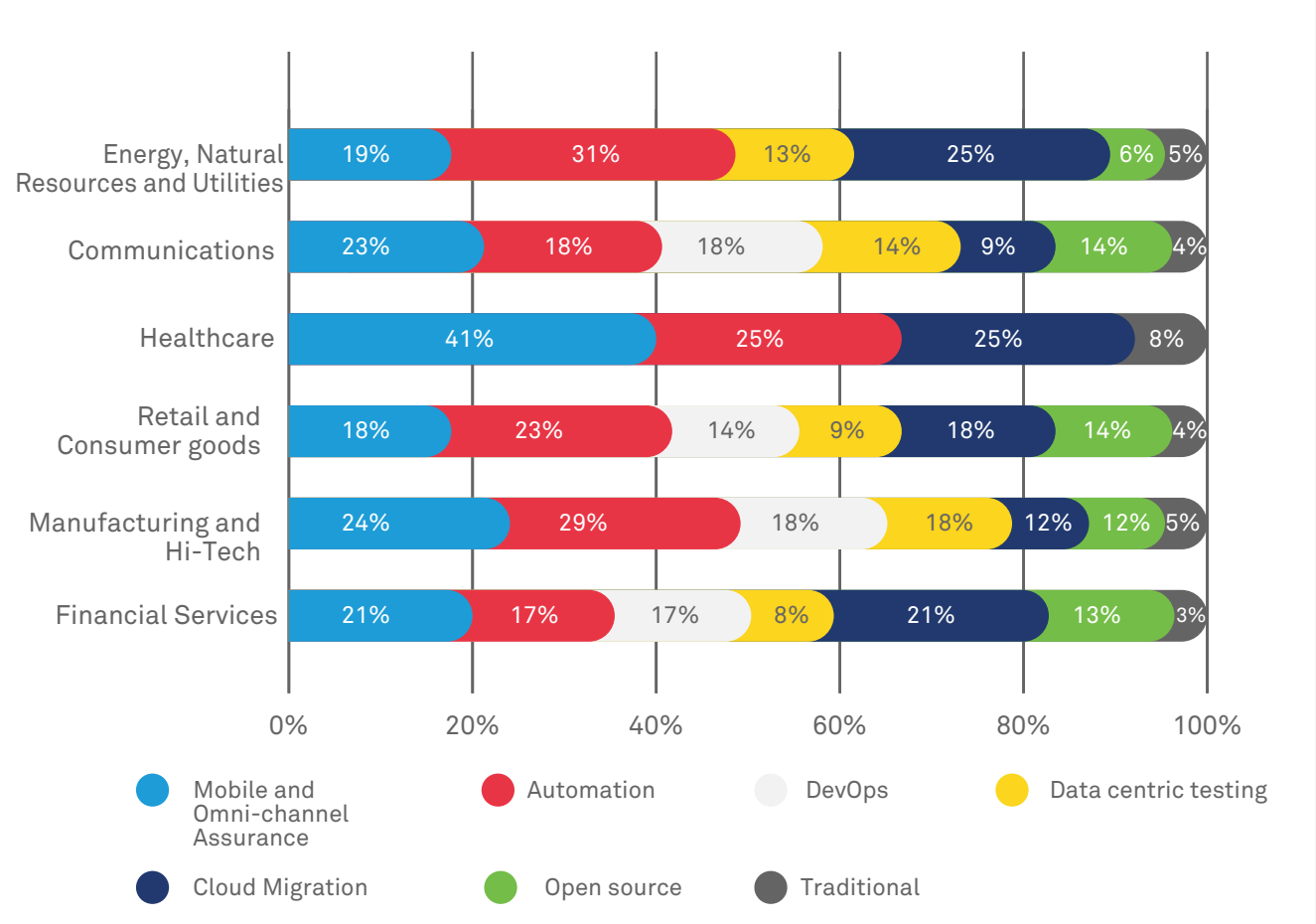


Figure 22: Quality engineering services customer demand split across industry domains

5.2 Dawn of the open source age: Rethinking skills for open source tools

Sharpening the digital transformation edge with a focus on open source tool skill sets

Think of open source tools as the pretender to the throne that some did not take seriously in the early days. Those organizations who doubted its capabilities in its early days are now throwing the doors of their closely held palaces open to it: 60% of digital organizations are now favoring open source tools; and now need the skills in their quality professionals. They are focusing on a narrow set of agility enabling commercial tools along with open source ones. However, as the delivery cycles get shorter, testing is getting integrated earlier into development lifecycle with a hybrid of open source and commercial tools for doing functional testing, performance engineering, security testing, continuous integration, acceptance testing, project management, tracking and defect management to ensure cost optimization, better time to market and test reliability for the application under test. Time and right skills set is of the essence in this space: the quality arm of an organization should be quick to review the use cases and identify what combination of tools could benefit the organization the most and get the skills by training or hiring. As Agile, DevSecOps, continuous delivery and digital methodologies take over the world, 50% of organizations are using open source tools as the CICD-CT tools for continuous integration and delivery. In parallel, they are working on transformation in the skill sets that resources in the function need to demonstrate to work on the open source tools. The dynamic nature of this world could mean a decision made six months ago no longer holds as newer tools evolve. A relentless focus on skill-sets in open source tool space will help to sharpen the technical edge and also serve as speed enhancer in the world of Agile and DevSecOps.

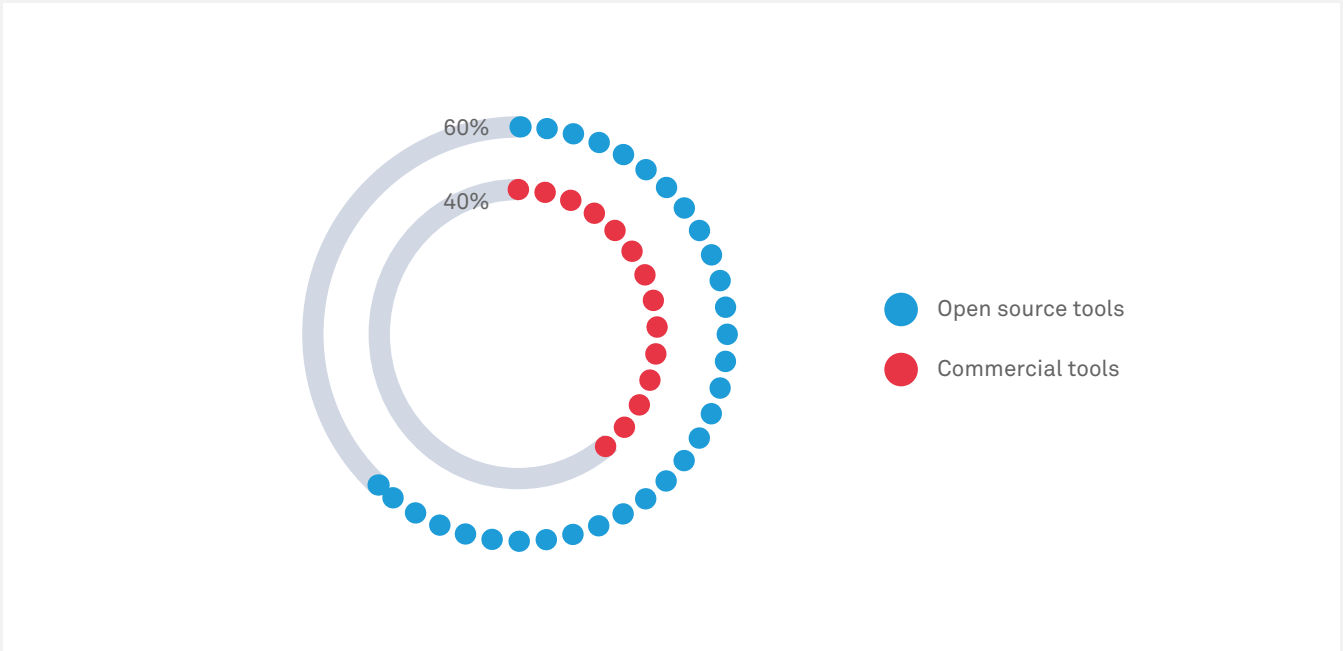


Figure 23: Adoption of open source v/s commercial tools 2017 -18

5.3 Adopting New Ways of Working: Re-skilling vs hiring

How talent transformation is complementing speed and enabling digital transformation

As organizations adopt New Ways of Working and move towards agile structures, talent becomes the driver to navigate the transformation vehicle. Talent has to be realigned to be fungible, collaborative, integrated, self-driven, and future-ready with technology and business perceptive. Therefore, digital transformation demands re-skilling of the existing resources and aligning them with the SDeT and specialized skill set. Organizations choose to re-skill and hire to meet the talent transformation needs. As per our data, overall re-skilling of existing talent stands to be 68% and specialized skill hiring stands at 32%. Based on our interaction with various organizations we have identified following as the topmost challenges for talent:

1. Manual testing skill is still prevalent in various organizations and typically, there is a high percentage of manual skills (~80%) and low percentage of automation skills (~20%). Hence, organizations lack new age talent that can do automation engineering, performance engineering or other non-functional automation.

2. More than 60% of the teams have an understanding of agile, but not more than 20% of the teams have working expertise of agile.

3. Most of the organizations do not have a system to baseline the skills of their existing talent. This leads to difficulty in moving right talent across the organization and in identifying the right training required for the talent.

4. 90% of the organizations do not have a mechanism to cross-skill and cross-lever age existing talent across the projects. This impedes the change to New Ways of Working.

5. More than 70% of the organizations that have embarked on the transformation journey do not have an updated Learning Management System aligned to new age skills.

With a shift towards New Ways of Working, traditional roles and job descriptions have to be refreshed. However, organizations are still trying to align existing roles into new structures leading to conflicts.
As organizations shift towards new age talent, they also need to have the right mix of I, T/TT and X skills (Refer ‘Evolution of skills in quality engineering’ section for details). Organizations should not look at replacing the complete talent with X shaped skills. Additionally, this will require re-skilling within the organization and hiring the talent from the market. A typical approach can be as described in figure 24.

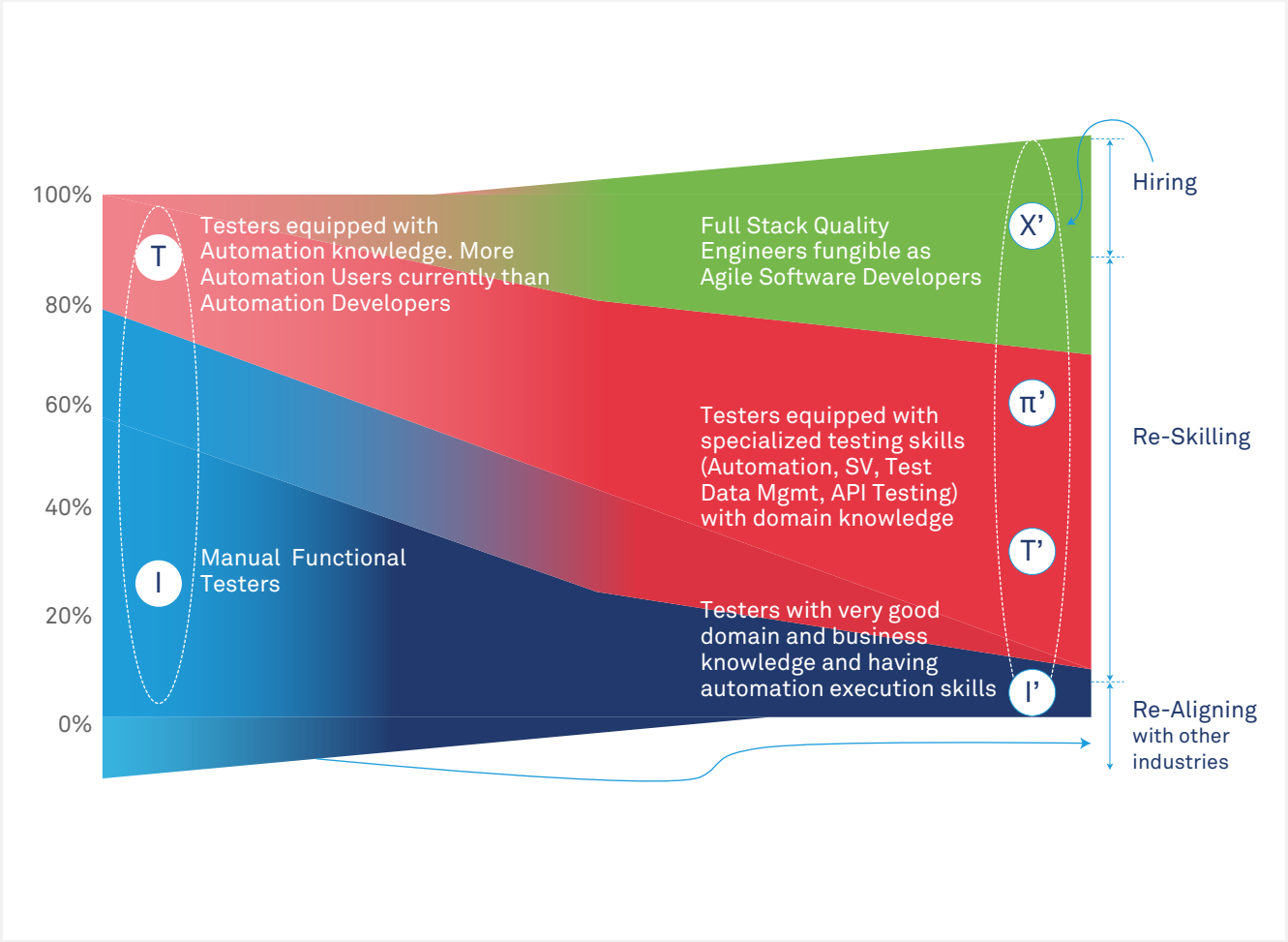


Figure 24: Approach towards transforming talent to New Ways of Working

The Third ‘S’

Takeaways

- How are new delivery and service engagement models in the world of Agile and DevSecOps transforming the QCoE?
- How are emerging disruptive models improving the efficiency and effectiveness of delivery?

6. The Third 'S'

Rearranging the building blocks: How quality engineering structure is aiding digital transformation

As quality engineering partners the rest of the organization to help fulfill the digital transformation agenda, we see traditional models of engagement giving way to new age models. We see this shift in two ways: the external shift in how organizations are engaging with suppliers to drive the outcome and the internal shift in how organizations are operating within the quality engineering team.

The external shift is mainly driven by how organizations are driving the overall outcome of engagement. It began with organizations looking at fulfilling the immediate project requirements through additional resources coming from the suppliers. This evolved to the managed services state, where the provider was committed to delivering outcomes, which then matured to Quality as a Service (QaaS) model for on-demand services giving clients the choice of resources based on business needs. Figure 25 represents the external and internal shift in the quality engineering organizations driven by outcome and operations. In this section, we look at how these shifts are working to help in the transition to agile and nimble ways of working.

The provider commits to deliver inputs under a simple staff augmentation model. However, under a managed services model, where the engagement maturity is the highest, the provider commits to deliver outcomes. This new age engagement model uses the yardstick of the desired outcome as against in outs, which are nothing but the performance of an activity with no commitments. An organization must define the units for the consumption of a service and performance criteria for the outcomes bound by SLAs. Hence, the managed services model is proposed to drive a measure of value based on planning. We looked at inputs from organization connects, various forums and the organization requests coming in to our pre-sales team. There is no better reality check of the State of Quality, than to go through the exact nature of solutions that clients are asking for. After all, it is one thing to believe that the future is the horizon, but you will only get there if you are moving towards it, one customer request at a time. And as we studied what organizations are asking for and contrasted it with customer level data of what they were actually doing, we uncovered some surprises.

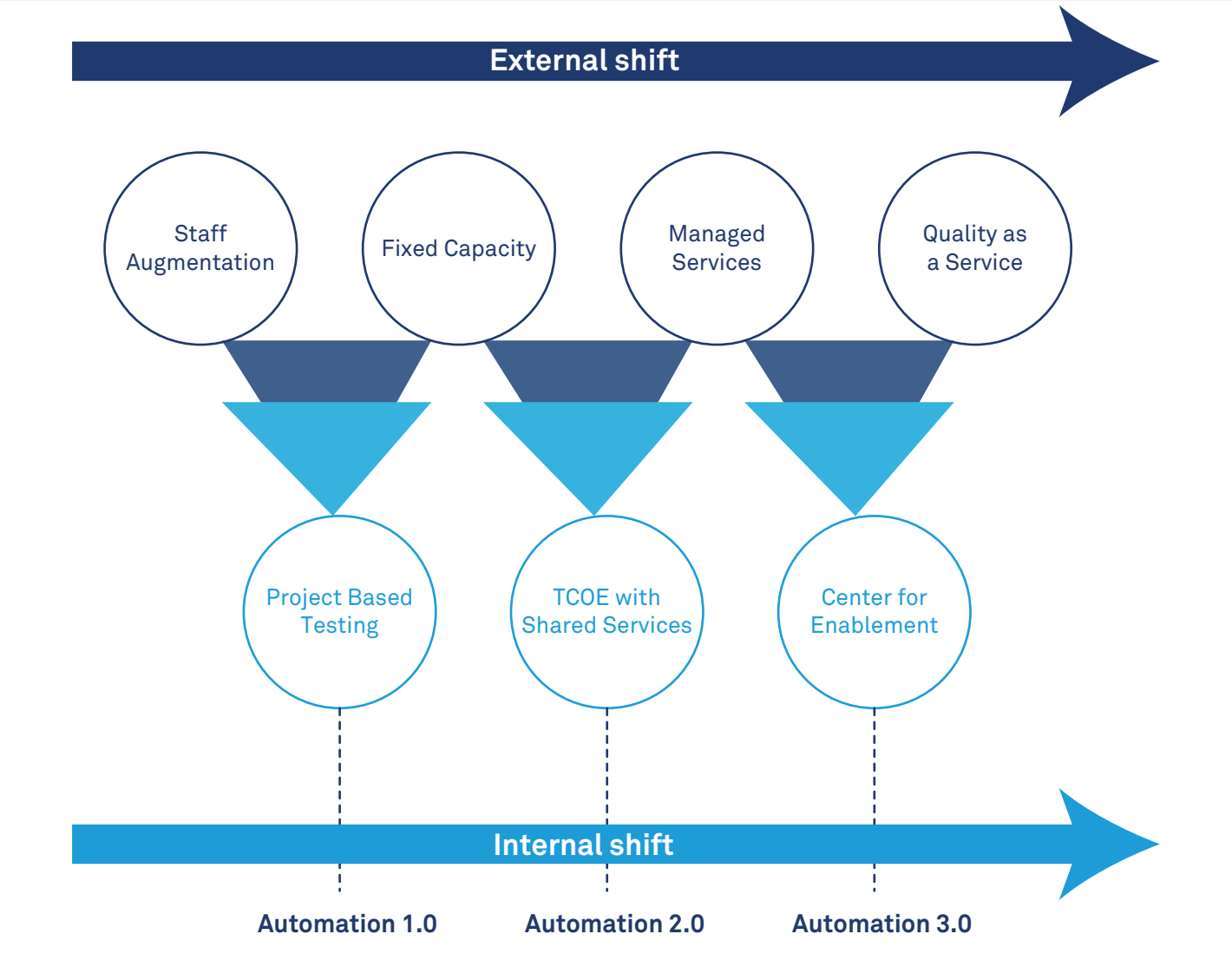


Figure 25: Transformation of operating models in quality engineering

6.1 The move to Quality as a Service model: Easier said than done?

This year a closer look at the engagement models that have come in the form of organization requests indicate that while a significant number of engagement models are still in traditional formats of Fixed Price and Staff Augmentation, we are seeing trends of moving towards Quality as a Service models delivered in a Managed Services mode. The main ask from the Quality as a Service model is for on-demand services giving clients the choice of opting for services based on business needs. Given that business need today is rapidly changing and agility in delivery is paramount, the shift to Quality as a Service model of delivery naturally follows. Some domains are leading the way, for instance in financial services, 84% of organizations are moving towards asking for Fixed Capacity or QaaS engagements in their requests.

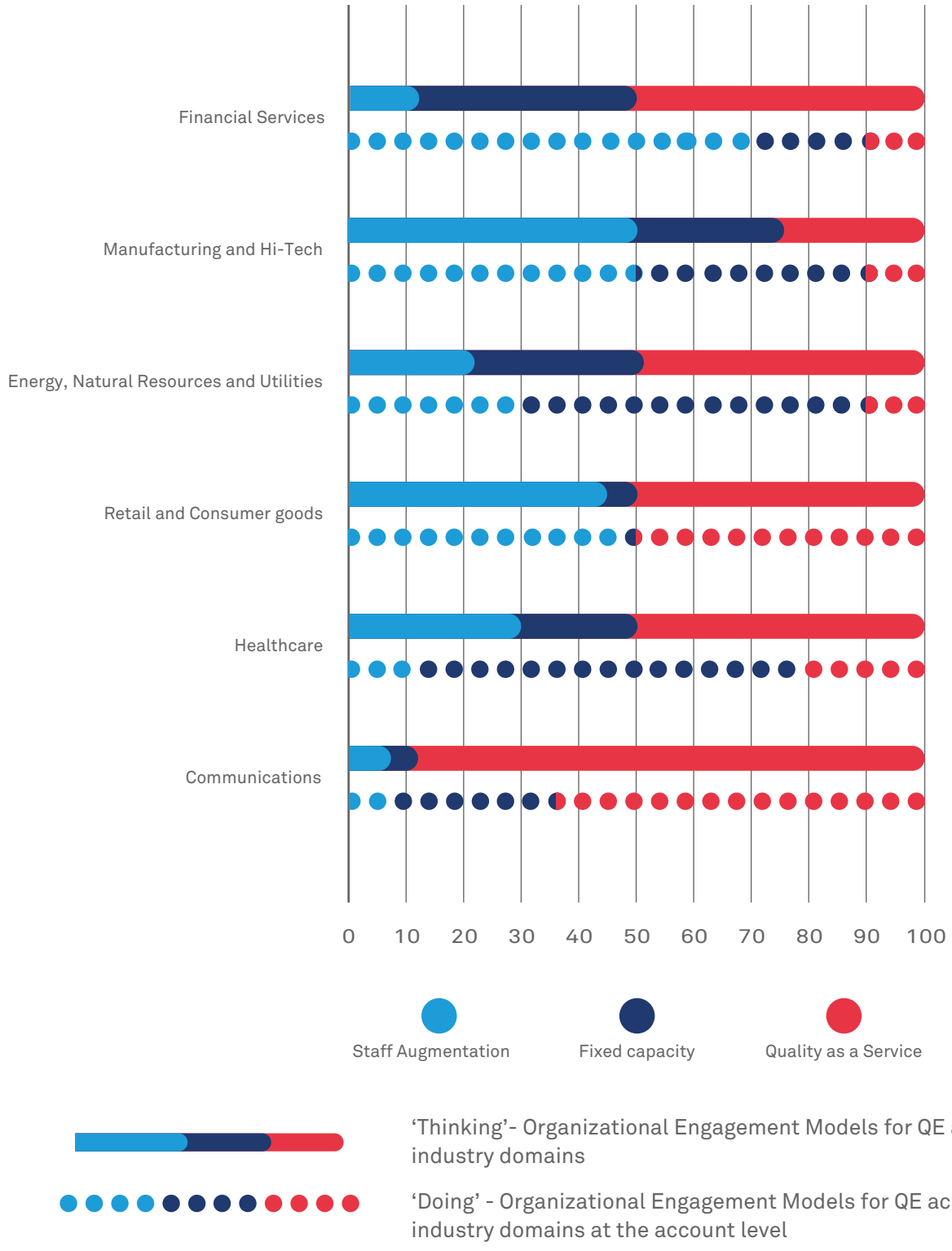


Figure 26: 'Thinking' Vs 'Doing'- Organizational engagement models for quality engineering across industry domains

However, customer level data tells a completely different story, with Financial Services being a case in point. The actual number of QaaS engagements is dramatically lower than the number being asked for.

This tells us that while it may be the way of the future, QaaS has not trickled down from the 'organization think' to the 'organization do' space.

6.2 Crowd Assurance – the X factor for agile and digital transformation

The more the merrier: Crowdsourcing product quality

If there is one trend that is raising eyebrows when it comes to disrupting the structure of quality engineering teams, it is Crowd Assurance. Enabled in the cloud or over digital platforms, crowdsourced testing allows more individuals to participate, at a reduced cost, often with better testing coverage and with multiple times the speed. A quick look at the forces at play shows that there has been an upswing in the beta testing of prototype software and products by a broader group of people rather than testing them traditionally. We have seen organizations working with private and public crowdsourced teams having a network of simulated or real devices. With time, we have seen greater acceptance towards real device network setup giving assurance with higher coverage. The demand for Crowd Assurance as a Service, Mobility and IOT as a Service, Performance Testing as a Service and Cloud Migration Assurance as a Service has picked up. Functional exploratory testing generates highest demand in the crowd with 40% and 30% for usability testing whereas the demand for Mobility and IOT as a Service, Performance Testing as a Service, Cloud Migration Assurance as a Service stands at 20%, 10% and 40% respectively.

Clients have seen a 50% rise in release frequency with approximately 70% of critical defects captured within first 2-3 days of the launch of the first test cycle. There is a broad range of benefits that crowdsourced testing brings to the table, including improved risk coverage and delivering a superior digital user experience. Testing in the crowd, typically sees holistic coverage through browser-device configurations, testing from multiple geographical locations, network conditions, and user types. A caveat in this scenario comes in the form of getting crowd-testers to follow organizational standards. While automated testing by a crowd is still evolving, it does not take much to see the benefits in terms of structure and speed that crowd tests can bring to the table. Over the past year, we saw a sharp spike in the number of organizations adopting crowd testing, especially from an exploratory and usability testing perspective, once they were convinced that the benefits outweigh the risks.

6.3 Operating Models: From chasing Waterfalls, to embracing an Agile world

How smart testing strategies are managing highly customized and integrated organizational application environments

Organizational structures for quality have evolved from their decentralized forms (c. Automation 1.0) to more centralized and hybrid (Federated) forms (c. Automation 2.0) and more recently to Center for Enablement (Automation 3.0). Organizations are moving to Center for Enablement as an operating model swiftly in order to be able to harness the benefits of faster code releases enabled by continuous integration, testing and delivery. We look at the requests for the old and new ways of working coming in across industries and see that financial services, manufacturing and hi-tech industries lead the way in the sheer number of requests for full Agile ways of working, while other domains are catching up. The traditional models are requested only by energy, natural resources and utilities followed by communications, but here too, the need for a shift towards digital and agile ways of working are clearly observed.

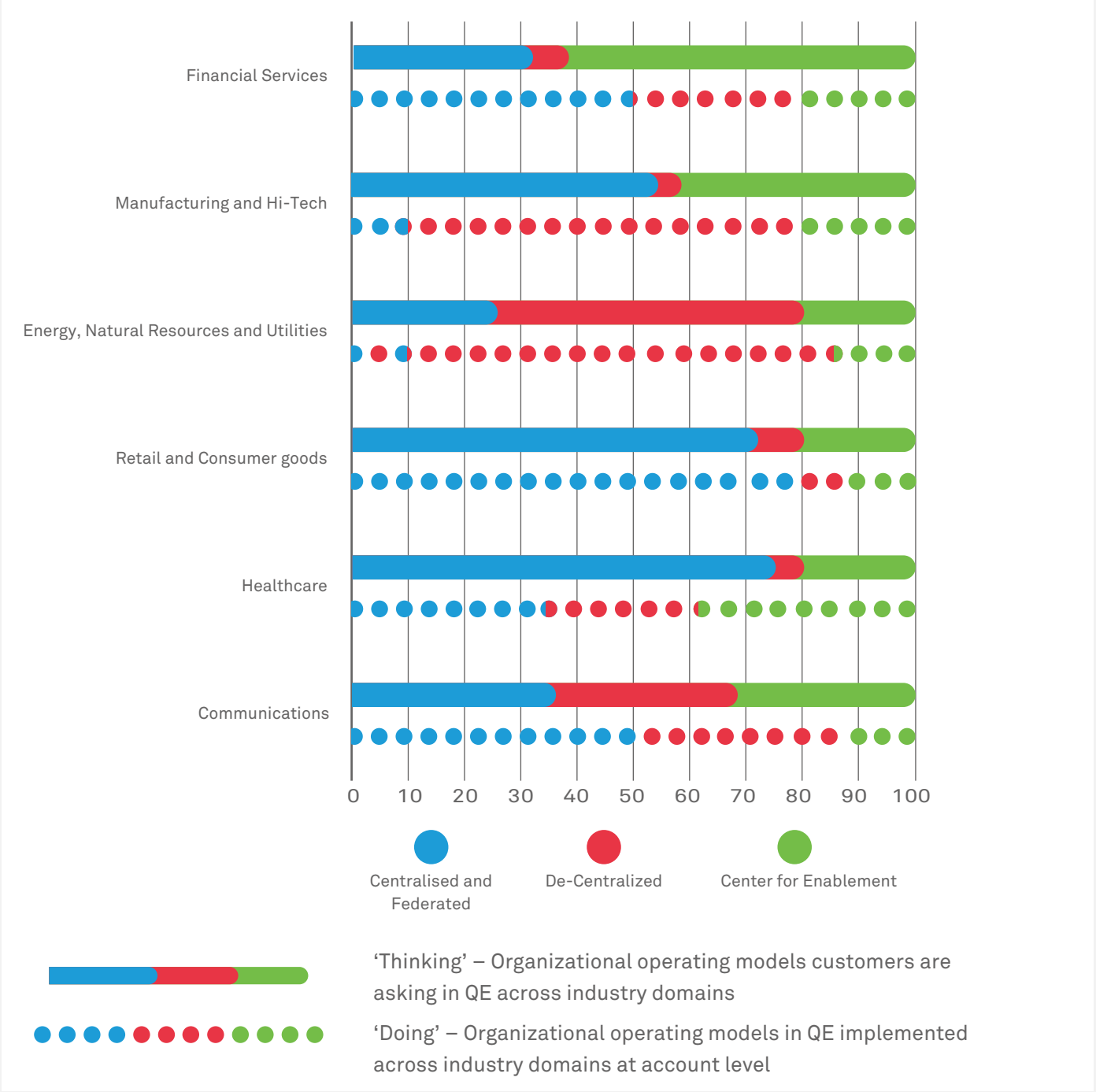


Figure 27: 'Thinking' Vs 'Doing' – Organizational operating models for quality engineering across industry domains

When you examine the data coming in from customers, the picture is a little different. Take financial services: while 63% of requests are for Center for Enablement based models, the implementations based on our data are only in 23% of organization landscapes. When it comes to the manufacturing and hi-tech domain, the customers who have actually implemented a decentralized model are far higher than the number asked for. For energy, natural resources and utilities, 25% of the requests are for a centralized and federated operating model, but in reality, only 5% of the customers on the ground follow it. This tells us that while quality engineering engagement models are evolving towards Agile ways of working, there is still some way to go before the thoughts become actions and the true value of the new age models are harnessed. However, the signs are clear: quality engineering is well on its way to becoming an enabler of digital transformation.

Looking ahead

7. Smart and intelligent quality as a self-service

We trust this report has brought you useful insights and addressed some questions in your mind about key repetitive challenges in quality. These challenges that we have traced as 'Quality design and data patterns for Agility', may have several approaches to address them. Our endeavor has been to state our insights based on our data on the ground with which the reader can make informed decisions. The report was focused on automation in quality engineering as this has emerged as one of the key drivers to enable agility for digital transformation in an organization today, that is embracing new-age technologies like IoT, Cloud Assurance, Mobility and Analytics. To know more on where you stand with respect to our perception of the evolution of automation, please refer (details on Automation 1.0, 2.0 and 3.0) the Appendix. The model will help organizations to benchmark their current stage in automation and thus apply quality patterns effectively to enable agility for business.

Cognitive techniques use the ability to formulate patterns to learn and evolve much like the human mind does. As cognitive abilities mature and sharpen the automation blade, we foresee patterns, which we have gleaned in this report, emerge further as suggestions by smart and intelligent engines based on learning and manual interventions. This mirrors the end goal that we are predicting that quality itself is moving towards – a smart and intelligent state.

To conclude, patterns are constant in nature and with the emerging smart, cognitive and connected world of today and tomorrow, we see data and patterns from that data as being the key to learning and addressing key challenges that plague organizations and put them on a path to success. We leave you with a final thought from the report – do you see a pattern or maybe several that you would like to address today and what do you believe the future State of Quality would look like?

Test Automation (TA) has evolved due to the way software development has changed. Software development has progressed from Waterfall to Iterative, Agile and DevOps and in the last decade, TA too has moved from a detached activity to being at the heart of software development process.

In waterfall projects, TA is used to reduce regression costs for applications which were reasonably stable. TA was seen as a script that mimicked a human being sending a message to an application and checking the reply. The preparation of test data, the execution of tests and the analysis of results were all performed by humans. Therefore TA was only showing a positive ROI if the majority of activities in testing were the checks performed.

Now in the age of Agile and DevOps where formal handovers have been replaced by shared responsibilities and cycle times drastically reducing, TA has had to change along the dimensions of Skill and Time.

The First dimension, the skills, can no longer be unique. All the tools and skills required to build, test and deploy are converging to enable shared responsibilities. Traditional TA tools were standalone applications that required significant training for them to be effective. While tools improved, the community was finding its way to build more sophisticated TA frameworks: simple capture replay, keyword driven, data driven and hybrid. In essence, all these approaches were here to separate skills required to build a solution in a TA tool from the other roles on the project such as analysts or testers. None of these approaches could make TA a shared responsibility, there was always a dependency on

niche skills. The rise of open source solutions can be attributed to the fact that these are built around the core developer skills available in each project and of course, to lower license cost.

With the second dimension, being time, to achieve cycle times of weeks, days or even less TA has to be part of a fully automated delivery chain, which includes automating the manual pre and post execution activities. A TA solution today needs to prepare its data, check the environment, run unattended and send the result to all project staff, which is orchestrated by embedding TA in a Continuous Integration (CI) solution like TeamCity or Jenkins.

As the way of building software has evolved, TA has become an enabler of fast cycle times. No longer does it serve the purpose of reduced regression cost but provides immediate feedback on a change. In order to move test automation forward, not only the skills and tools had to change, but also the approach.

Modern TA frameworks can focus on bringing expected behavior and test definitions together instead of separating available skills, as the skills to build a TA is no longer an exception in the delivery team. Acceptance test driven development, using Gherkin to define requirements and tests alike, are also gaining popularity across industries.

None of the open source TA solutions target to be feature rich. They are narrow and users can mix and match them, based on what they need. This trend has been triggered by time and skill requirements for flexible solutions. This development is difficult for traditional testing service providers to overlook. Not surprisingly, vendors starting with HP, are opening up their complex technologies to support open source. What this means is that assets and tools being developed by open source cannot be ignored and all this has its roots in how software development has evolved.

What ruins this picture of simplicity is the upcoming applications — Big Data stacks, Machine Learning and Artificial Intelligence systems. The core of TA has to be questioned yet again. In a machine learning environment, the response to a request depends on the data that was used for the learning. A key element for success will be hooking TA into finer grained parts of applications and verifying subsystems instead of traditional end 2 end tests.

Put bluntly, the feature list of test tools is an outcome of who has the best marketing department. They are irrelevant. What matters is how easily users can work with the tools – and how tools align with skills in your department.

Christian Räss,
Head of technical testing at a large European multinational investment bank and financial services company

8. Appendix

Evolution of Automation – detailed explanation (Please refer figure 1 in the report):

Much like Industry 1.0, 2.0, 3.0 and now 4.0, which focuses on paradigm shifts in automation in the Industry, we see the evolution of Automation in Quality in terms of Automation 1.0, Automation 2.0 and Automation 3.0 eventually leading to an end state of Smart and Intelligent Quality as highlighted in the Introduction of the report.

Further, within each level of Automation we have identified stages which again marked some simple paradigm shifts to delve a bit deeper in identifying nuances in the field of Quality and help the perceptive reader benchmark his organization better to benefit more from this report.

Automation 1.0 encompasses traditional approaches to automation in testing which include automating functional execution of manual test scripts, performance testing and some bespoke utilities used for testing. It begins with the stage where testing is reactive with custom scripts to solve specific challenges. In following stages, we see the automation of test execution with COTS tools, performance test automation and framework-driven regression automation.

Automation 2.0 is a paradigm shift in the approach to automation as testing matures into Quality Engineering as we now see it. It marks a shift in focus towards end-to-end automation and the filling of gaps within the software delivery lifecycle when it comes to embracing automation. It marks the advent of new and niche offerings in Quality Engineering such as

Test Environment Management, Test Data Management and the Digital and Agile revolution in the IT industry with the use of advanced methodologies such as CICD/DevOps, service virtualization and test data automation.

Automation 3.0 sits at the top of the layers, where the approach is cognitive in nature and is being closely studied by quality practitioners today. It involves sophisticated tools and methods such as predictive and actionable intelligence, AI and NLP based automation as well as self-healing of defects. This is the phase that we see as the precursor to 'Smart and Intelligent Quality', which will be achieved through orchestration of cognitive automated solutions to specific challenges across the lifecycle. Stage-wise guidance to the evolution of automation:

Automation 1.0

- Stage 1 – Reactive with custom scripts for specific challenges with a domain focus
- Stage 2 – Automation of test execution with COTS tools and performance test scripting
- Stage 3 – Framework-driven regression and performance testing automation

Automation 2.0

- Stage 1 – End-to-end test lifecycle automation as an umbrella offering, TDM, TEM
- Stage 2 - Automation for Quality Engineering including non-functional testing like performance engineering, API automation and progressive automation approaches
- Stage 3 – In-Sprint, CICD/ DevOps and preliminary continuous test automation

Automation 3.0

- Stage 1 – Assisted techniques for application of cognitive automation to address disparate use cases
- Stage 2 – Largely unassisted orchestration of cognitive automation across the Quality lifecycle
- Stage 3 – Healing of defects and intrinsic errors
- Finally Smart and Intelligent Quality is a state we define as one where very limited manual control and interventions would orchestrate and assure quality in tandem with bots.
- Each of the levels in automation is a super set of the previous level with Smart and Intelligent Quality encompassing all the parameters in the levels.

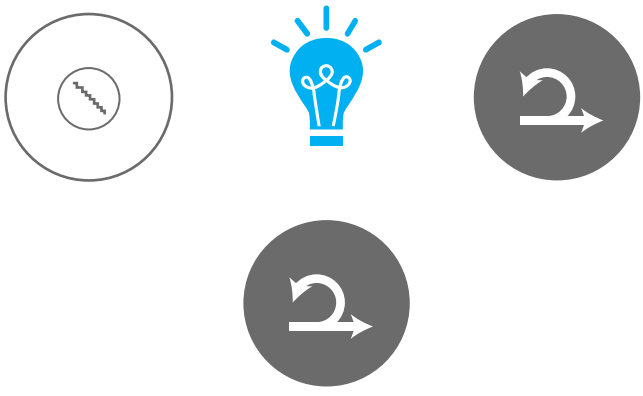
Evolution of structure enabling digital transformation

Organizational structures for Quality have evolved from project based testing to TCOE with shared services and more recently to Center for Enablement.

In project-based testing state, customers are primarily looking at fulfilling resource requirements in projects. Projects drive the demand on need basis and hence the quality assurance operations are very much decentralized and silo-ed. Automation is very primitive and concentrated towards GUI and regression test suite development. Due to every project team driving automation on its own, multiple frameworks and tool sets are used across the organization, leading to inefficiencies and higher costs.
Non-functional testing like performance, load, stress, security, omni-channel, accessibility are done on best effort basis leading to incomplete test execution.As organizations mature towards TCOE with shared services state, the operating model shifts towards Testing Center of Excellence driving the specialized testing and creating centralized frameworks and tool sets. Automation becomes more matured with a centrally governed framework and moves towards progressive automation. TCOE also drives non-functional test automation led through headless automation. Quality Engineering aspect for specialized testing lies within the TCOE while delivery of activities like test data management and performance testing are done in shared services mode.

With digital transformation and Center for Enablement state coming in, Quality Assurance function is transforming to Quality Engineering function, which is delivered by self-driven Quality Engineering workforce tightly integrated into the agile teams. A Center for Enablement at enterprise level is responsible for driving the overall digital transformation and defining the strategy. Testing frameworks are tightly integrated into DevOps tool chain at enterprise level. In order to derive efficiencies, services like final performance testing post-product development and test data management are delivered in shared services mode.

The structure of Center for Enablement for Assurance today are refreshingly different in their ways of working from the traditional and silo-ed federated operating models. They are bringing about a paradigm shift in approaches to an organization's Quality. The smart and cognitive platforms in addition to the agile and continuous collaboration between Dev, QA and Ops teams in IT are transforming ways of working for Assurance and Quality in IT.



State of Cyber Security Report 2018:
Performance, Accessibility, Cross Browser, Cross Platform and Cyber Security etc. To get In this edition of State of Quality Report, we have covered functional and non-functional testing. Non-functional test would cover various aspects of the application such as a detailed insight into cyber security, please refer Wipro's State of Cyber Security Report 2018 < URL: https://www.wipro.com/en-BR/forms/state-of-cybersecurity-report-2018/>.

Quality design patterns for business agility

Pattern	Impact of automation maturity	Impact of other factors
High Severity Production Defect %	With automation maturity, the team achieves higher effectiveness and improved capability to identify defects earlier in lifecycle.	• Overall IT organization process streamlining and maturity • Better quality gates through the product lifecycle • Early involvement of the testing team • Influence of daily standup meetings and shorter iterative cycles for delivery
Mean Time to Repair (MTTR)	With automation maturity, defects are identified faster and earlier in test cycle and immediate notification is sent to developers. While working on the same piece of code, developer finds it easier to resolve it immediately	• Timely, efficient and effective root defects cause analysis including daily standup meeting in the Agile way of working and predictive analysis techniques • Environment and data setup maturity • Defect management process maturity • Business and technical prioritization of defects
Frequency of Release (Release Count) and Agile Velocity	With greater automation maturity, the team's testing efficiency improves. Test cycle time reduces significantly and results in higher number of releases in a year and more user-stories delivered in a sprint cycle.	• Business needs for run/change the business • Cost to business in case of production failure • Risk taking appetite by business • Overall IT organization process streamlining and maturity

Quality design patterns for technical agility

Patterns	Impact of automation maturity	Impact of other factors
Test Data Set up Cycle Time	Improvement in Automation 2.0 by 12%-15% (as against Automation 1.0) due to: • Market leading & established COTS tools • Test data lifecycle automation Improvement in Automation 3.0 and future projection by 25%-35% due to: • Virtual Test Data Management (TDM) • Containerization (Application, Data and Environment) • Database Virtualization • New algorithms using AI, Machine learning – Bots capabilities, self-healing	• Masked production copy • Test data warehouse / Golden copy • Centralized TDM • Process standardization e.g. ITIL adoption • More on synthetic data adoption • Cloud TDM (Private, Public, Hybrid)
Test Environment Set up cycle time	Improvement in Automation 2.0 by 50% due to: • Test Environment Management Systems (TEMS) lifecycle management tools • Provisioning capabilities Improvement in Automation 3.0 and future projection by 40% due to: • New algorithms using AI, Machine learning and Programmatic Infrastructure– Orchestrated bots, self-healing packs Infra monitoring application	• Centralized TEMS • Process standardization e.g. ITIL Adoption
Performance Testing MTTR	Performance Monitoring (APM) and Log analytics combination being the preferred choice, MTTR is going down for Automation 2.0 Defect allocation and self-healing use cases improve the Performance MTTR further for Automation 3.0	• Timely, efficient and effective root cause analysis including daily standup meeting in the Agile way of working and predictive analysis techniques • Environment and data setup maturity • Defect management process maturity • Business and technical prioritization of defects

9. Data sources & methodology

The State of Quality Report is different from most reports available in the market: it is not a survey based report. It is a report based on ground data. Building on our experience from last year, we have analyzed data from several new sources this year, including competency teams, our internal acquisitions, and five of our leading partners (Tricentis, Neotys, Smartbear, Microservices and CA). The data was fed into our Analytics engine Intelliassure 2.0 and used statistical techniques such as Regression Analysis, Cluster Analysis, Hypothesis Testing, Factor Analysis and Correlation Analysis etc. to bring out relevant insights, which form the basis of the report.

Like the previous edition of this report, based on our agreements with all parties concerned, we have sanitized and masked all data to ensure that no sensitive information is presented in the report. Also like last year we have analyzed data from 450+ customers, 1500 + Quality Engineering projects, 1000+ customer Requests (RFPs RFIs etc.), analyst and expert interactions spread across the Banking, Financial Services & Insurance (BFSI), Retail & Consumer, Healthcare & Life Sciences, Hi-Tech & Manufacturing, Media & Telecom and Energy, Natural Resources and Utilities domains and across all geographies –Americas, EMEA (Europe, Middle East and Africa) and APJ (Asia Pacific, Australia and Japan). Our Analysis focused on Automation driving 'Quality design & data patterns for Agility' this year, while the actual insights that we have gleaned from the exercise has far too many patterns to bring into this report. The sample space used specifically for the scatter charts included over a hundred customer records from various sources. Our Analytics engine Intelliassure 2.0 leverages a data mart which is maturing every year as an infonomics engine for predictive analytics.

We also performed a sentiment analysis on 40,000 + customer feedback responses collected across 700 IOS and Android apps distributed across Banking, Financial Services & Insurance (BFSI), Retail & Consumer, Healthcare & Life Sciences, Hi-Tech & Manufacturing, Media & Telecom and Energy, Natural Resources and Utilities domains. The analysis was based on parameters such as content, elegance, interoperability, performance, pricing, privacy, satisfaction, security, stability, usability.

10. Acknowledgements

Wipro would like to thank all the contributors to this report, especially our partners and industry thought-leaders.

- The Leadership team Bhanumurthy BM, President & COO; Hiral Chandrana, SVP & Head of Cloud Enterprise Platforms; Hari Kishan Burle, Vice President Topcoder; Ramachandran Padmanabhan, Vice President Wipro Digital; Aravind Ajad Yarra, DMTS - Fellow Wipro Digital and Arun Kumar Melkote, Vice President Wipro Digital.

- The Quality Engineering and Testing Business Leaders - Srinath Nittur Gopalakrishnan (BFSI), Manvattira P Uthappa (Consumer & Retail), Ashok Mattur (Healthcare), Hitendra Munjampally (Manufacturing), Sunder Chander (Telecom) and Vasudeva Udupi Gopalachar, (ENU).

- **Our Practitioners–**

  •Test Automation and Service Virtualization – Hemantha Kumar C, Group Head; Rohini Nagaraj, Practice Head; Sunitha Anil Kumar, Managing Consultant; and Romil Chennupati, Business Analyst.

  •Performance Testing & Engineering – Dr. Abhijit Shrikant Ranjekar, Practice Head; and Sarvesh Barve, Technical Lead

  •Test Environment Management – Arun Chandramathy Balakrishnan, Group Head Test; Narasimha Murthy Peri, Practice Head; and Vishwanath Sangati, Managing Consultant

- Data Centric Testing – Manish Bhatia, Practice Head; Arunav Rath, Managing Managing Consultant

- Packaged Application Testing (Cloud and On Premise) – Nagarjuna Revenasiddappa, Practice Head; Pramod Marga Bhat, Associate Consultant; Denesh Kumba Srinivasan, Test Lead; Ajay Prasad Pandey, Principal Consultant; and Adhith S, Business Development Associate

- QaaS and Crowd Assurance– Dhanesh Kumar, Principal Consultant

- CICD-CT - Ramesh Pai, Practice Head; and Rajesh C.P., Senior Consulting Manager

- Mobility and Customer Experience – Sudheer Mohan, Practice Head; Naveen Nicholas, Principal Consultant; Rajeev Kumar, Principal Consultant; and Indrani Nori, Project Manager

- Pre-Sales – Niraj Kumar Singh; Rohini Nagaraj, Practice Head

- Quality Engineering and Testing Marketing Alliances, Advisor & Analyst Relations Team – Amit Singh, Practice Head; and Aditya Gautam Hosangadi, Associate Consultant

- Quality Engineering and Test Advisory Services (QE-TAS) team for ideating, researching and analyzing data to bring out emerging insights and program managing and authoring the report - Selvan Nagaraja, Solution/IPs General Manager; Shikha Varshney, Managing Consultant; Srinivas Abhinav Raj, Principal Consultant; Ankur Jain, Consultant and rest of the team for reviews

Wipro Limited
Doddakannelli, Sarjapur Road,
Bangalore-560 035, India

Tel: +91 (80) 2844 0011
Fax: +91 (80) 2844 0256
wipro.com

Wipro Limited (NYSE: WIT, BSE: 507685, NSE: WIPRO) is a leading global information technology, consulting and business process services company. We harness the power of cognitive computing, hyper-automation, robotics, cloud, analytics and emerging technologies to help our clients adapt to the digital world and make them successful. A company recognized globally for its comprehensive portfolio of services, strong commitment to sustainability and good corporate citizenship, we have over 180,000 dedicated employees serving clients across six continents. Together, we discover ideas and connect the dots to build a better and a bold new future.

For more information, please write to us at
info@wipro.com

IND/BRD/OCT 2020 - SEP 2021