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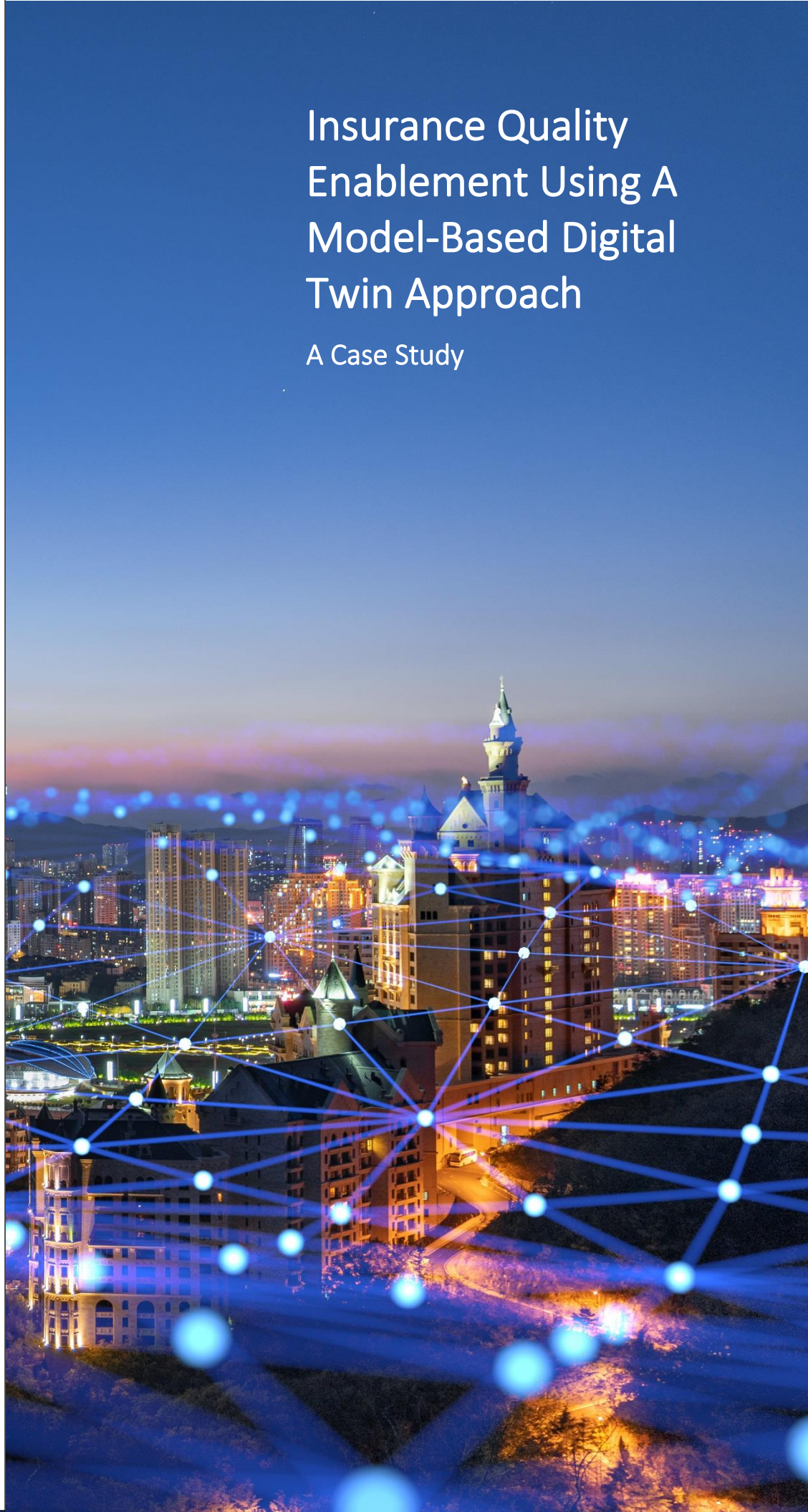
# Insurance Quality Enablement Using A Model-Based Digital Twin Approach

## A Case Study



PUBLISH DATE:

**FEBRUARY 2023**

February 2023

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# INTRODUCTION

Mantissa Group initiated a case study on a highly specialized approach to testing software systems and quality assurance (QA), known as *Q*A *M*odel-based *T*esting for *I*nsurance, or QMTi. Model-based testing takes a slightly different approach from traditional testing models, such as unit testing, functional testing, regression testing, integration testing and user acceptance testing. In this solution, a visual, model-based framework is employed to dynamically generate end-to-end automated tests across an entire functional business workflow, which may span multiple individual systems, subsystems, or components.

Mantissa was able to observe this solution in practice for a US Life Insurance carrier and see the results firsthand. This QMTi approach is an insurance-specific implementation of a broader model-based testing framework that was initially developed to create a "digital twin" to test physical systems such as autonomous vehicles and robotics applications. It has since been customized to test specific insurance applications and ecosystems. Standard integration technologies such as XML are employed with many of today's modern ecosystems and the QMTi framework takes advantage of this by inspecting the XML structures (i.e. tags and xPath) to determine the full range of valid combinations and permutations of both input and output data. Using this information, the framework is designed to automatically generate a suite of end-to-end test conditions and run them in real time. For example, an end-to-end test might cover all permissible permutations of a policy application entry from digital enablement and eApp platforms, to the underwriting engine, and ultimately through to the policy administration system as well as print output – all in one automated set of automated tests.

This modern method of software testing is yielding strong results where it is employed, vastly increasing test coverage, and improving quality outcomes when used. Additionally, since it is an end-to-end solution and spans the entirety of the ecosystem, it can reduce or eliminate the need for other traditional functional testing activities. This case study presents a deep dive into one such scenario and presents carriers with an alternative to improve quality outcomes.

# OUR REPORT

The life insurance industry is evolving to meet the demands in the marketplace. Customer and agent expectations are driving the evolution of the industry not only with expectations for flexible product designs to meet life stage needs, but also expectations for an easy to use digital experience. Complex ecosystems are evolving to address dynamic needs across many aspects of the insurance industry, including areas such as: digital customer engagement/acquisition, electronic and traditional modes of customer engagement, modernization of core policy administration systems, increasingly unique product designs, and more sophisticated underwriting engines.

As these insurance ecosystems grow more complex, so do the Quality Assurance challenges associated with ensuring that not only is each individual system is correct, but also that the integrations between them are correct. More importantly, the critical objective is ensuring high quality final test output.

Failure to do so can have significant negative ramifications ranging from reduced customer/distributor retention and satisfaction to more serious considerations such as fines from departments of insurance (DOIs). As such, carriers are placing a tremendous amount of effort to ensure that their respective systems and the integrations between them are of the highest quality.

With this in mind, this report strives to present some best of breed solutions carriers should consider employing in their IT ecosystems and technology stacks, and we seek to present effective alternatives to traditional testing approaches.

This report is based upon deep background research and interviews of life insurance technology leaders. Detailed discussions were held with carriers as well as solution providers to understand the state of the art of QA Model Test frameworks used in insurance today. While this case study focuses on a specific carrier, we also considered background information from other carriers.

## A Case Study on QA Model Test Frameworks for Insurance

The following case study focuses on Quality Assurance & Quality Engineering improvements throughout the Life Insurance Value Chain and a new approach to model-based testing. This has enabled significant improvement in quality with less resource effort for a leading, century-old domestic US Life & Annuities Insurance carrier.

As the carrier was implementing their core and digital modernization journey, software quality challenges became a prevalent problem across their ecosystem. Like most Life & Annuity carriers (and most firms, in general), this carrier has a complex ecosystem of core and supporting platforms. As the carrier's technology teams and vendor partners were in the midst of modernizing their platforms and components, the interdependencies between them began to create some persistent quality challenges that needed to be addressed with a different way of thinking about the "quality problem". The carrier's technology leadership team tackled this challenge directly and with an innovative mindset.

> *A digital twin is a digital representation of a real-world entity or system. The implementation of a digital twin is an encapsulated software object or model that mirrors a unique physical object, process, organization, person or other abstraction.*
>
> Source: Gartner

*Figure 1 – Definition of a "Digital Twin"*

## The Challenges

Traditional QA strategies and approaches were not yielding a sufficient, scalable, financially sustainable, and repeatable set of results to support the complexity of the technology stack and overall ecosystem. Specifically, a number of challenges continued to plague the carrier:

- Multiple teams and vendor partners were engaged in various implementation and QA initiatives, leading to varying approaches and inconsistent results
- The existing automation frameworks, resulted in an overly complex and non-sustainable approach to QA automation
- Automation, where it did exist, was inconsistent in its approach and design, hard-coded, not scalable, and had long execution times
- The overall cost burden of quality assurance was high and there were significant inefficiencies in the process
- Negative stakeholder perceptions plagued the technical development teams, often with defects being identified for the first time in production
- Existing test suites typically only covered the "happy path" and were not very effective at uncovering real-world defects prior to production releases
- There was no clear and effective strategy to fully test the integrations between the carrier's various platforms and systems of record
- Extremely complex sets of test conditions had to be run with complex data sets and more than two hundred thousand test scenarios; managing this was an extremely difficult proposition for the company
- Finally, there was little to no visibility into what quality issues existed in the production system and it was very difficult to know what types of production issues to expect

*"Model-based testing, while not new to our industry, has rapidly become an excellent facilitator for QA programs and automation architects to build solutions for complex systems. Instead of automating a series of tasks, the model is a graphical representation of the workflow that is automated, allowing for dramatic improvements in test coverage, defect detection, and time to production with the added benefits of cost savings and reduction in ongoing maintenance."*

Source: Brian Bernknopf, Managing Director, QA Consultants

*Figure 2 – Description of QA Model Test (QMT)*

As a result of these challenges, the carrier's technology leadership embarked on a deliberate effort to address these various challenges head-on, ultimately working with their strategic partner to shift to a model-based Digital Twin framework.

## THE APPROACH

The carrier selected a leading firm in the quality assurance arena to implement a holistic, scalable, and effective quality automation framework and help them address their pain points. While the initial focus would be starting on a new digital-enablement solution, the ultimate QMTi solution would end up spanning the entire ecosystem.

The solution re-purposed an existing model-based testing framework initially designed for testing physical systems (e.g. robotics and

*2 – 3 Months Investment*
*(of a small team)*
*Yielding 35,000+ Automated Tests*

*Figure 3 - Initial QMTi Investment*

autonomous vehicles) and applying the QMTi methodology against one portion of the carrier's ecosystem for digital enablement.

There were three key steps in the development of the solution:

1) Comprehensive Assessment of Current State
    - Analysis of the existing QA frameworks and practices to assess for any potential reusability
    - Comparison against industry and QMTi best-practices to assess for potential re-usability of existing software assets
2) QMTi Solution Development
    - Pivot from staff-augmentation to a solution-oriented approach (i.e. shift from "run rate thinking" to "value add approach")
    - Using common technologies (e.g. XML introspection), integrate the QMTi solution across the extended technology ecosystem
3) Stabilization and Transition
    - Stabilize the overall solution, gradually increasing the coverage of the codebase
    - Transition execution of the solution to the carrier's internal teams to manage reliance on third parties

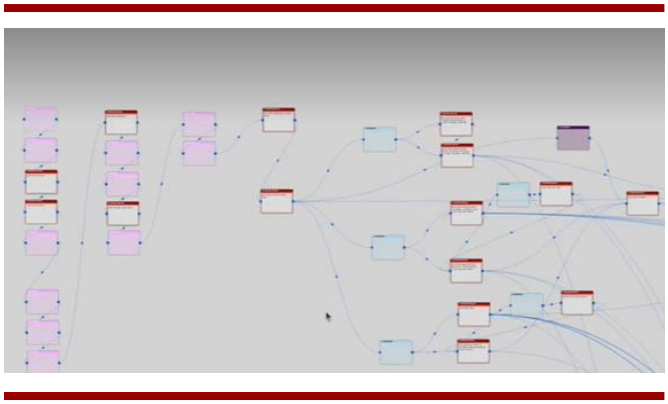

*Figure 4 – Visual Process Modelling in QMTi*

While the initial the QMTi solution was focused on the digital enablement platform, New Business, Underwriting & Core Policy Admin System testing quickly followed. QMTi is now the standard approach for test automation at the carrier. (See *Figure 6 – QMTi Process Scope*.)

## THE TECHNICAL SOLUTION

The QMTi solution was developed in Python due to the needs of complex combinatorial computation, data processing, and image processing engines to enable its automated test design capabilities. A web-based execution engine integrates capabilities of Selenium web-driver and Selenium Grid with its python-built test execution mechanism. (See *Figure 5 - QMTi Architecture*.) QMTi is easily integrated with any DevOps CI/CD tools due to its advanced CLI (Command-line Interface) engine, as well as with any test management tool that offer importing capabilities.

The applicability of QMTi to the Life Insurance Life Cycle is focused on:

- Automating the design and build of automated tests
    - Instead of traditional models of automated testing where business flows or individual test cases must be documented and automated using a traditional scripting approach, a model-based solution allows for the creation of automated tests, automatically, as the data, flows, and test conditions change over time
    - These complex tests have been historically impossible or not-cost effective to be designed manually, where multiple variables are involved, business decisions (i.e.

expected results) are based on several criteria, or the correlation between conditions is required

- Everything is created codeless and through a visual modelling approach (See *Figure 4 – Visual Process Modelling in QMTi*.)

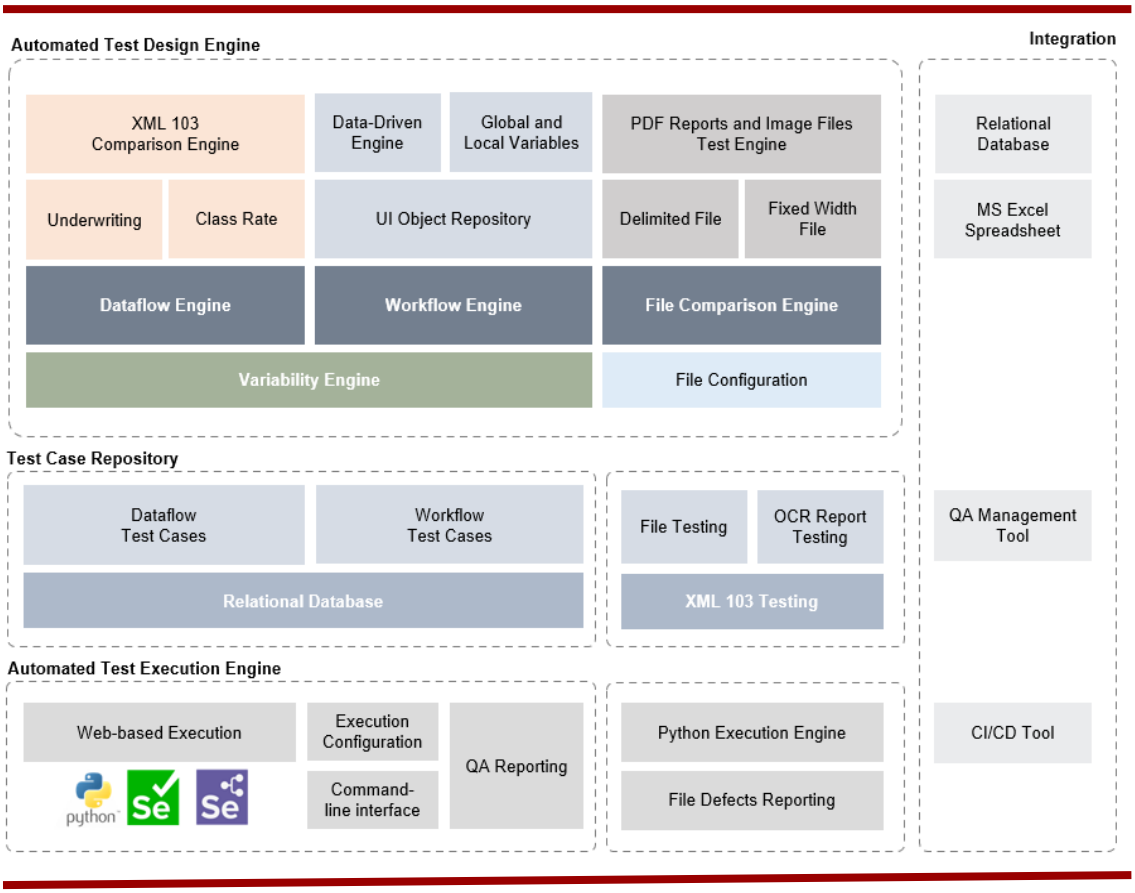


*Figure 5 - QMTi Architecture*

- Supporting complex scenarios that included underwriting rules, rates and premium classes based on personal information and habits, medical history, beneficiary address, etc., to ensure implemented underwriting rules in production really reflect business rules and expectations
- Integration testing capabilities (specifically an XML 103 automated validations) that scan and verifiy different possibilities and permutations of data as input to insurance applications (Part-A and Part-B), how they were organized through tags and xPath inside the XML files, and how the XML file was consumed by both the underwriting system and the policy administration system
- Capabilities that leverage OCR (Optical Character Recognition) and other validation techniques to test PDF correspondences and reports, checking content and layout and automation of extract files (supporting multiple formats such as CSV, Fixed-Width, JSON, text, etc.)

- Improvements to traditional functional testing, focused on the policy administration system where automated tests are created and generated based on visual workflows, as well as a combination of dataflow and workflows built for a broader end-to-end testing coverage
- Several capabilities were developed to optimize the test execution such as integration with any CI/CD/DevOps tool, mobile testing (both locally and via device farms), parallelization of execution to allow hundreds of tests to be executed simultaneously, with good reporting, and easy analysis of defects
- Complex variability capability implemented that allow retest to be focused on portion of features that were impacted by changes in a new release, reducing the use of test execution resources by retesting features that have not changed and focus on areas with a greater potential of quality risks

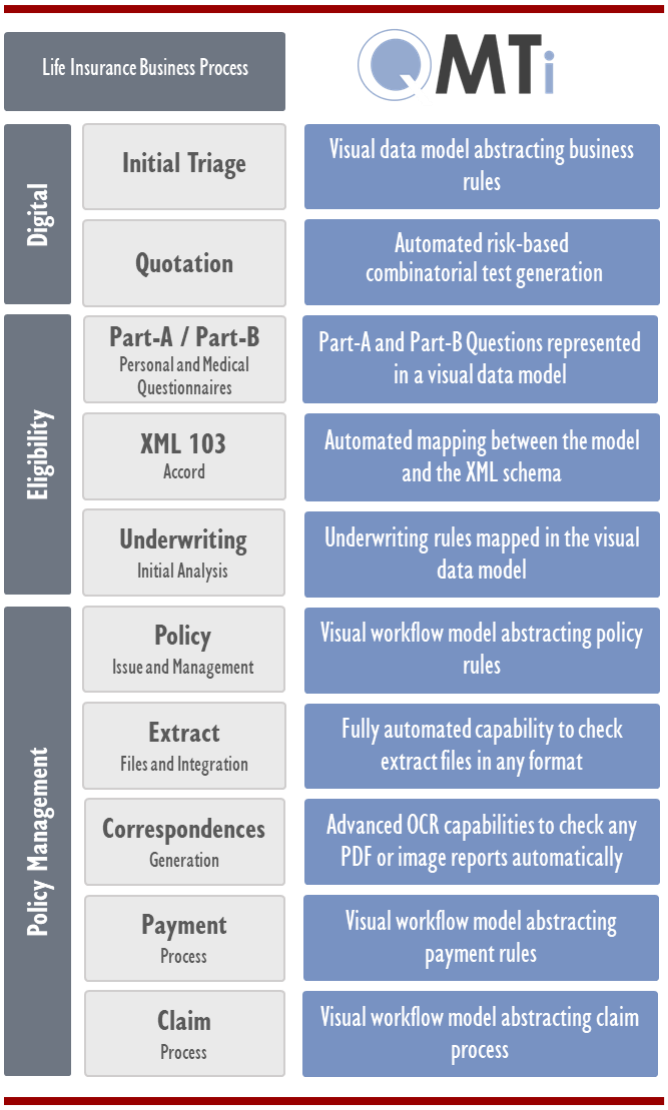


*Figure 6 – QMTi Process Scope*

## THE RESULTS

As the carrier increased their capabilities in QMTi, the organization was able to accrue a number of benefits across people, process, and technology:

- By shifting the focus on quality to earlier in the SDLC, they were able to improve customer and stakeholder perceptions (e.g., defects were found earlier, not after going to production)
- Eliminating testing on things that have not changed has improved efficiency (e.g., allowing teams to focus on more value-adding activities)
- Agile support for in-sprint testing allowed for the QA teams to keep pace with development teams (e.g., able to update tests mid-sprint as base code changes without having to wait for the subsequent sprint to test)
- As a result of creating such a comprehensive end-to-end automated test suite, the carrier was able to reduce the effort & costs of functional testing on individual components and sub-systems

- Seamless integration with internal CI/CD pipelines and DevOps tooling enabled complete traceability, eliminating blind spots
- Improved span and scope of functional testing, including new capabilities to test all the way through integrations (e.g., eApp → underwriting rules engine → policy administration systems)
- QMTi increased overall resiliency and improved their ability to make new technology decisions as they could easily replace any one system for another and update the automation to support the new system with minimal impact since all the business flows are modeled and documented
- Material cost savings resulting from significant reductions in manual QA efforts by both the carrier and vendor partners and improved efficiencies
- The IT teams were able to improve trust and establish a track record of success with the business stakeholders
- The carrier is able to ultimately manage the solution going forward without reliance on any vendors/partners, but could also manage it in a QA as a Service (QAaaS) model

### By The Numbers

**30x increase in automated test coverage** vs. traditional manual testing methods

**Shift from approximately 30 test scenarios to 100% coverage of test cases** covering thousands of permutations

**80% reduction in FTE demand** for QA capabilities Due to increasing the level of automation

**Shift from approximately 2,500 manual person-hours to 30 hours** of automated testing runtime to achieve 100% test coverage at a lower run rate

*Figure 7 – Quantitative Benefits of QMTi*

## CONCLUSIONS

A leading domestic US Life & Annuities Insurance carrier was facing significant and persistent challenges with quality of deliverables, costs and efficiency issues, and battled a negative perception from internal stakeholders and its distribution teams. To solve these problems, the carrier made a conscious shift from traditional quality assurance processes and shifted to a Quality Model Test (QMTi) framework that any other carrier, or any other business or industry can easily adopt. This QMTi model enabled the carrier to model its end-to-end processes, effectively creating a Digital Twin of its real-life business processes to improve quality outcomes.

The various aspects of Quality Assurance present a challenge to technologists who must modernize core platforms, while at the same time deploying leading edge digital capabilities that need to integrate with these legacy platforms. Agents and consumers are driving the pace of this change and are demanding a high-quality product, regardless of the method or mode of interaction, and regardless of the complexities inherent in the backend ecosystem.

To meet these objectives, insurance & technology executives should consider the following:

- **Automation Frameworks vs. Traditional Testing:** Technology executives and organizations should consider the balance between traditional testing methods (including traditional automation methods) and alternate approaches. Newer QMTi frameworks can more quickly and efficiently enable technology teams to achieve higher test coverage and efficiency than traditional methods, where they can be employed. Shifting to frameworks, like QMTi, that can automatically generate automated tests can radically improve test coverage in an automated manner, leading to improved coverage, better quality outcomes, and reduced costs at the same time.
- **Integration with Development Sprints & Technical Teams:** Whether your organization is running Agile or traditional SDLCs, the ability to integrate test teams and test suites directly into the SDLC pays dividends. By being able to introspect systems and integrations through a QMTi framework and generate test cases in real-time, test suites can be available as soon as the code is delivered from the development teams. In traditional models, testing is structurally delayed from delivery of the code to allow "traditional automation" or manual testers to define and develop test cases. QMTi frameworks allow this delay to be bypassed through their ability to generate test cases in near real-time.

*"QA is no longer a hinderance or a limiting factor, rather it enables organizational objectives"*

Source: Carrier's Chief Information Officer

*Figure 8 – Impact QMTi*

- **Functional vs. End-to-End Testing:** Many organizations follow a traditional QA model of unit testing, functional testing, integration testing and user acceptance testing. While these models still serve us well, QMTi models have the potential to enable a quicker focus on end-to-end testing sooner than our traditional models allow. This effectively allows comprehensive testing (across disparate systems and integration points) to occur sooner, and effectively shifting QA engagement substantially earlier in the process. The end result is quicker time to market, more comprehensive testing across systems and components and ultimately lower defect leakage into production. Furthermore, the automated nature of the QMTi framework enables all of this at a significantly lower price point.

In this case, the adoption of a QMTi framework facilitated and improved the carrier's posture relative to all these considerations, allowed them to address internal and external stakeholder perceptions and improved their posture from an overall risk perspective.

## About Mantissa

Mantissa Group provides business and technology strategic consulting services and insights to the insurance industry as well as clients across industries. The mission of Mantissa is to serve business and technology executives. Mantissa's highly integrated services leverage Strategic Consulting, Executive Coaching and Leadership Development, enhanced by targeted Research and a Global Delivery model.

Mantissa Group was formed by leading former Fortune 100 CIO and CTO executives. They are industry leading experts on wide variety of strategic matters affecting business executives, the CIO, and their leadership teams. They are deeply experienced senior technology executives helping leaders with their technology strategic plans, as well as simultaneously focusing on leadership development and culture.

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