

## The Evolving STARS Ecosystem: from Automotive Development to Material, Bio and Healthcare 進化するSTARSエコシステム：自動車開発からMaterial, Bio Healthcare領域へ

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STARS Automation is a software platform developed to automate testing in automotive development. It has evolved and improved continuously through ongoing enhancements. In recent years, new platforms have been added to the STARS ecosystem. STARS Enterprise provides laboratory-level data management and process automation capabilities beyond the automotive field, while STARS Process functions as a flexible sensor management layer. This article will discuss the history of STARS Automation and consider the outlook for the STARS ecosystem to underpin business growth across HORIBA.

STARS Automationは、自動車開発における試験の自動化を目的として開発されたソフトウェアオートメーションプラットフォームであり、継続的な強化を通じて進化と改善を続けてきた。近年では、自動車開発以外の領域に対して、STARS Enterpriseが研究室レベルのデータ管理およびプロセス自動化機能を提供、STARS Processが柔軟なセンサーマネジメント層として機能するなど、新たなプラットフォームがSTARSエコシステムに加わった。本稿では、STARS Automationの歴史を振り返るとともに、HORIBA全体の事業成長を支える基盤としてのSTARSエコシステムの将来展望について考察する。

### Introduction

In the 1960s, HORIBA's automotive division developed the first MEXA, establishing itself as a global brand in automotive exhaust gas analyzers. By integrating analyzers with peripheral devices such as sample handling systems, HORIBA provided comprehensive exhaust gas measurement systems to meet diverse customer needs.

In the 1980s, to address increasingly complex testing requirements, HORIBA introduced "Test Automation" - an integrated system using computer technology to control automotive test equipment, including analyzers - pioneering digital test automation long before the term Laboratory Digital Transformation (Lab DX) emerged.

HORIBA launched the current test automation platform, STARS, in 2005, which has been continuously enhanced with new features and global support.

This paper outlines the evolution and future development of the STARS platform, including its extended ecosystem - STARS Enterprise and STARS Process - and discusses its application beyond the automotive field as part of

efforts toward realizing Lab DX.

### Overview and background

Automobile development has become increasingly complex due to stricter emission regulations, fuel economy standards, and efforts toward carbon neutrality, including the push for electrification.

To meet these demands, modern vehicles integrate more control devices and sensors, increasing the complexity of control system optimization. As a result, automated testing via test automation systems is now essential to maintain or reduce development time. In fact, automation of every aspect of test operations has become the norm.

The STARS ecosystem currently comprises 3 platforms that combine to provide vertical automation solutions ranging from individual sensor management, through test stand automation, up to test enterprise management (Figure 1):

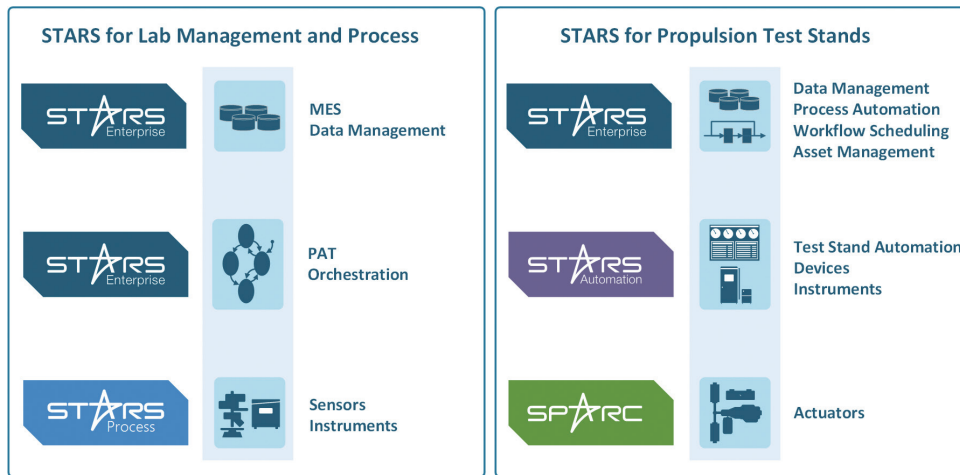


Figure 1 The STARS Platform stack.

**STARS Process**, the newest member of the STARS family, provides control and data acquisition at the instrument/sensor level.

**STARS Automation**, the original STARS platform, provides real-time control, automation and data acquisition for test stands. Developed to meet the diverse and demanding requirements of test automation in automotive development worldwide, STARS Automation offers a compelling combination of ease of use and functionality, with a comprehensive application engineering toolset. It is scalable from single test stands to large test labs.

**STARS Enterprise** provides centralized data management and process automation at the test field level, as well as instrument and process line orchestration. STARS Enterprise provides a framework for managing test requests, test scheduling, device management and centralized data handling, accommodating standard and customized workflows. STARS Enterprise solutions significantly enhance development efficiency.

In 2024, HORIBA launched its current mid-to-long-term plan, MLMAP2028, and reorganized its structure from

five segments into three business field groups to strengthen cross-segment collaboration. One of the three central pillars of the plan is the shift from product-based offerings to integrated solutions. By leveraging system integration and solution expertise developed in the automotive domain, HORIBA aims to expand these capabilities across all business fields to drive sustainable growth.

The STARS ecosystem is a key enabler for this expansion, with many of the solution patterns developed in the automotive domain proving to be equally relevant to non-automotive fields. Practical implementations include Lab DX in scientific laboratories, QC systems for the biopharmaceutical industry, and autonomous experimentation systems. Deployment across diverse sectors is actively underway (Figure 2).

### HORIBA's history in automotive test automation

In 1964, HORIBA launched the “MEXA-1,” a three-component exhaust gas analyzer that became a globally recognized brand. In 1972, the company introduced the “CVS-31,” a constant volume sampling system employing

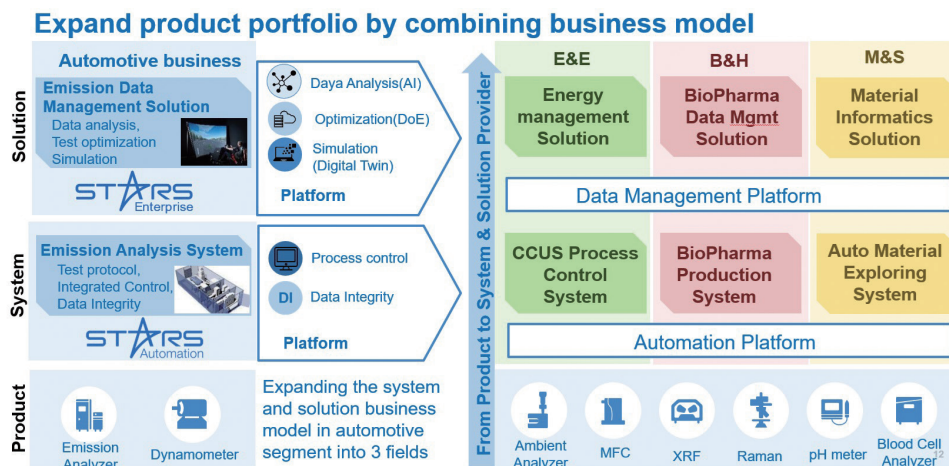


Figure 2 Shift from product-base to system and solution provider.

critical flow venturi (CFV) technology. By combining this system with gas analyzers, HORIBA enabled the measurement of exhaust gas flow rates, thereby meeting the requirements of the new exhaust emission regulations that came into effect in 1973.

In the late 1970s, HORIBA entered the field of exhaust gas test automation through the acquisition of the chassis automation business from InterTestAutomation.

With the rise of personal computing, HORIBA developed the “HERT-100” in 1985, a test automation system for engine development. This was followed by the “HERT-200” for chassis dynamometer testing of complete vehicles. These systems marked one of the origins of HORIBA’s Lab DX approach, integrating analyzers, sampling systems, and dynamometers into comprehensive solutions.

By moving beyond standalone products and offering integrated systems - including hardware and software - HORIBA has addressed diverse customer needs. The system-based approach remains a core strength of its automotive business.

In 2001, HORIBA joined SRH Systems Ltd., a joint venture between Schenk AG and Ricardo PLC, marking the transition from regional to global test automation platform development. This collaboration led to the 2004 release of STARS Engine, the first product based on the STARS Automation platform for engine testing, and from that point STARS Automation has played a central role in HORIBA’s integrated solutions. In 2005, HORIBA acquired the test systems business from Schenck AG, making SRH a subsidiary of HORIBA.

Designed for broad applicability, STARS Automation was soon extended to cater for vehicle, component, and brake

system testing. HORIBA expanded the product lineup with specialized applications such as STARS HDEET for heavy-duty engine emissions, STARS Calibrate for ECU calibration, and STARS VETS for vehicle emissions testing.

To enhance efficiency in multi-test stand environments, HORIBA introduced the STARS Cluster Server, enabling centralized configuration and test result management. Evolving customer needs and software technologies led to the development of STARS Enterprise, a cloud-native platform that supports comprehensive data management and process automation across the test field, serving both engineering and operations teams (Figure 3).

### Architecture and technology of the STARS platforms

Test automation systems are characterized by their requirement to perform highly deterministic real-time control and data acquisition tasks. Besides this, they must provide the operator with powerful and intuitive tools to create test routines, observe the execution of tests and work with the test results afterwards. To address the real-time requirement, STARS Automation incorporates a multitasking hard real-time test execution environment, with test execution step and data acquisition rates of up to 5 kHz. Determinism and low latency are achieved through a real-time Windows<sup>®\*1</sup> extender subsystem (RTX), which effectively hives off some of the computer’s resources to support a real-time kernel and scheduler which are isolated from the indeterministic environment of the Windows<sup>®\*1</sup> operating system.

The operator’s workstation environment, which does run in Windows<sup>®\*1</sup>, provides an intuitive, graphically oriented user experience for the configuration of all the artefacts

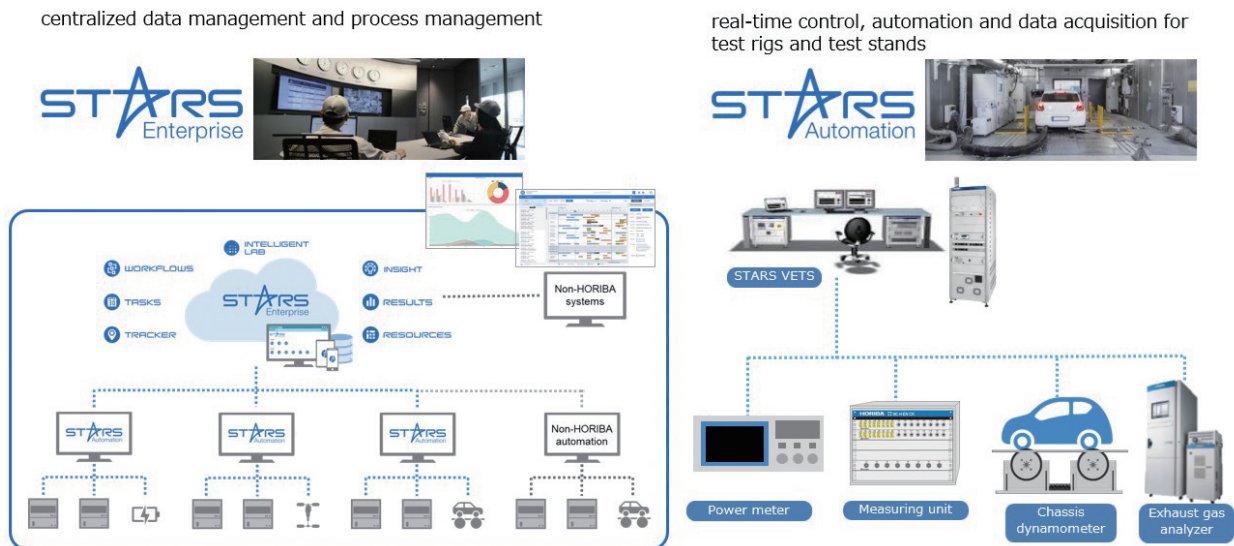


Figure 3 STARS Platform for automotive industry.

that combine to create a test application. Tabbed, launchable work areas and multi-display support provide a productive multitasking workspace in which applications can be configured and results analyzed while simultaneously monitoring test execution. The real-time and workstation elements are deployed side by side on a high-performance Windows<sup>®\*1</sup> PC, providing a convenient single-box package.

STARS Automation provides some tools and interfaces targeting more advanced application developers, leveraged both by HORIBA solutions teams and customer application engineers. For example, the integrated VSTA (Visual Studio Tools for Applications) environment includes a lightweight version of the Microsoft<sup>®</sup> Visual Studio<sup>®\*1</sup> IDE, which can be used to implement new automation features and apps using C# or VB.NET. The integrated driver development kit (DDK) provides a no-code environment for the creation of ASCII protocol device drivers.

The STARS Enterprise platform was created to enhance the operational efficiency, integrity and cost effectiveness of testing organizations. Serving a distributed community of engineering users and test operations staff, critical features include data management integrity, exceptional scalability, ease of deployment and maintenance, and software update with zero downtime. To achieve these objectives, STARS Enterprise employs a cloud-native microservice architecture, with each microservice playing a well-defined, focused role. They are implemented with minimum dependency on other microservices and are designed to be stateless, i.e. to hold no memory within themselves of previous invocations or requests. When deployed in a Kubernetes orchestration environment this stateless quality allows duplicates of any microservice to be started or stopped according to the demands on the deployment, without interruption to service; so-called horizontal scaling.

Underpinning the STARS Enterprise platform is a NoSQL MongoDB database, capable of accommodating both structured and unstructured data. The diversity of needs that STARS enterprise aims to address, along with the constantly evolving structure of the data involved, requires the schema-less concepts of a NoSQL database, which follows a less normalized data model, for this platform. Changes or extensions to the data model can be accommodated at application level, avoiding the need for expensive and time-consuming database remodeling. Structured data, with well-known, consistent relationships between entities and fields, are also accommodated by NoSQL databases, although a less normalized database

design is required compared to that typically employed in an SQL database.

Security by design ensures that STARS Enterprise has strong cybersecurity credentials. Tenancy support implemented in the data service controls who has access to what data, and a granular role-based user management system gives fine control over the functionality assigned to different users.

A STARS Enterprise solution starts out by creating a data model tailored to the needs of the customer. The solution is then created by combining standard platform components with customer specific web apps, mobile apps and services. A typical requirement for a STARS Enterprise solution is that it integrates into the customer's existing ecosystem of data and business systems. STARS Enterprise was designed with this role in mind. The flexible data model and event driven notification support in the platform are key features in this respect.

Data security is enforced through a secure data client design pattern, in which any application (data client) to be connected to STARS Enterprise must first be registered with the relevant STARS Enterprise deployment by an administrator. Through this registration the data client will be granted a secure access token encapsulating its identity and access rights.

Valuable synergies are realized by coupling a STARS Enterprise (SE) deployment to a cluster of STARS Automation (SA) workstations. In this scenario the datasets of the two platforms are transparently synchronized, with designated data resources being automatically uploaded from SA to SE and/or downloaded from SE to SA upon change. For example, in a mechatronic testing laboratory, the end-to-end workflow, starting with an engineering request, through test creation and transmission to the test stand, to results upload and automated analysis, can be fully automated, leading to significant increases in the efficiency of test operations (Figure 4).

Recent years have brought an increasing demand for STARS Enterprise solutions to be provided as a HORIBA operated cloud service, rather than as software to be procured and deployed on premises by the customer. The service model allows customers to focus on their core business with confidence that, through HORIBA's STARS Enterprise platform knowledge and cloud operations expertise, system availability is assured and their data is secure.

STARS Process is the most recent addition to the STARS ecosystem, positioned closest to devices in the STARS

\*1 Registered trademark of Microsoft Corporation in the United States and other countries.



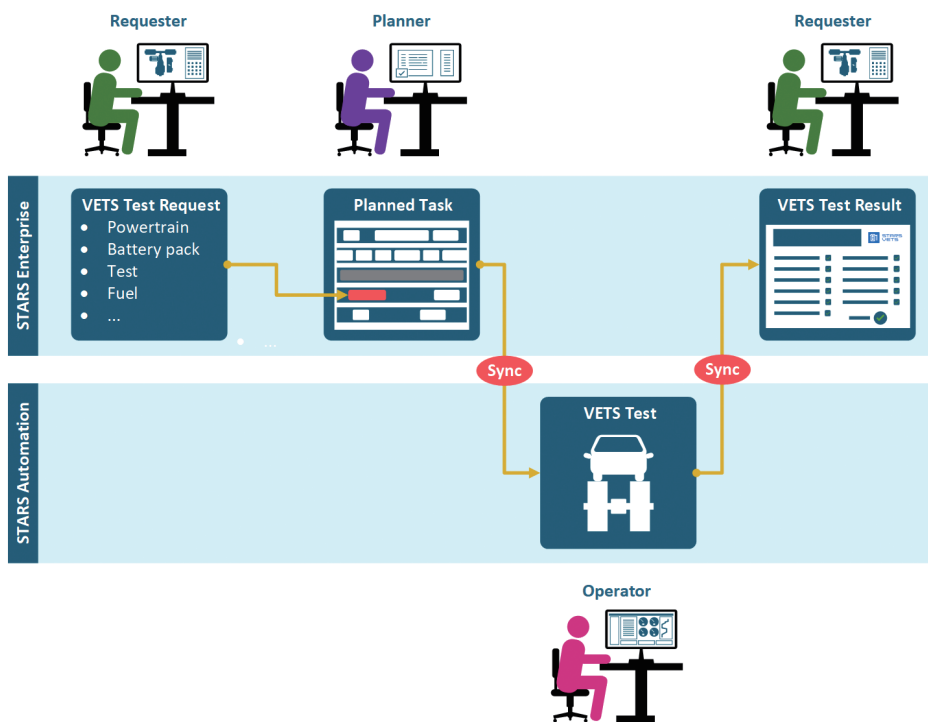


Figure 4 VETS Test Request Solution.

platform stack. Conceived for instrument control and sensor management, and developed in C++/Qt, STARS Process is a lightweight, efficient framework in which to implement smart sensor interface modules and instrument controllers. It is generally deployed on low power consumption hardware targets such as an embedded PC or System-on-a-Chip (SoC).

The architecture of STARS Process features a modular, message-based paradigm, with the platform’s middleware supporting Publication/Subscription or Request/Reply communication patterns. Web and QML based user interfaces are supported for local display/control panels, and standard communications modules accommodate popular communication protocols and connect STARS Process based devices to the STARS Automation and STARS Enterprise platforms.

### STARS across all HORIBA business fields

While the roots of the more mature STARS platforms lay in the mobility business field, the opportunity to deploy STARS solutions in other business fields in which HORIBA operates is clear. STARS Enterprise in particular, being a robust, secure and performant cloud-based platform upon which to implement modular solutions, offers huge potential in this respect.

In the Life Sciences field, although having established a world class reputation for its analytical instruments, HORIBA has not yet moved up the software stack to offer solutions for instrument management and coordination.

This situation is changing, as the potential of the STARS Enterprise platform is embraced. In pharmaceutical manufacturing, customers are showing strong interest in device orchestration and Process Analytical Technology (PAT) solutions from HORIBA, taking confidence from HORIBA’s stellar reputation for measurement in general, and for automation and system integration in the mobility sector. ‘Device’ in this context refers to smart sensors, instruments, sample conditioning subsystems, material transport subsystems and the like.

It has been observed that, given its highly deterministic real-time control capabilities, the STARS Automation platform would appear to be an obvious contender for process device orchestration. In fact, the real-time performance requirements in this application area are relatively relaxed and the features of STARS Enterprise - high availability, zero downtime upgrades, boundless scalability, ease of integration with other data systems and cloud readiness - make this HORIBA’s preferred platform for orchestration.

Although the specifics are different, there is a marked similarity between the orchestration features required for pharma process orchestration and, say, materials R&D applications. It is anticipated that the orchestration core that HORIBA is developing for STARS Enterprise will have broad potential across HORIBA’s business fields. Indeed, a solution for managing an industrial coating formulation facility is a good fit to the orchestration capabilities of STARS Enterprise (Figure 5).

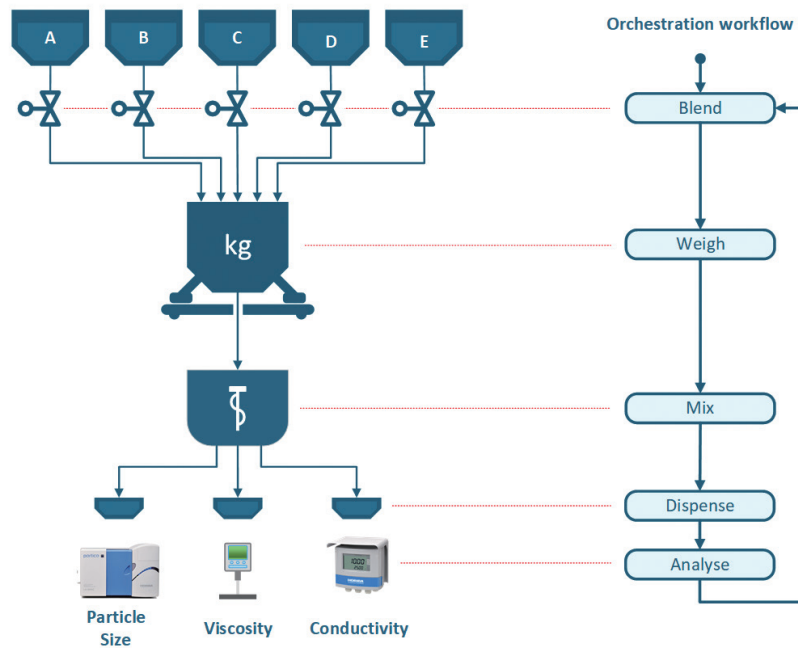


Figure 5 Process orchestration for industrial coating formulation.

In the medical field, STARS Enterprise is being used as the platform to support our next generation biology lab data management solution. The high integrity data management provided by STARS Enterprise, along with its flexible microservice architecture, have facilitated this development. The direction of travel of DX solutions is inexorably towards the cloud and the selection of STARS Enterprise as the underlying platform ensures that the transition from on-premises to cloud-hosted will be a smooth one for this system when the time comes.

Data systems, the purpose of which is to ingress data of different types, act upon those data in an intelligent way to provide business value, and produce actionable outputs, is another area of strong interest and potential for STARS Enterprise based solutions. With the capacity to ingress and store hundreds of thousands of data points per second, and to push these data through analytical pipelines that support advanced machine learning and AI implementations, STARS Enterprise is a good fit here. For example, for the water management industry HORIBA is developing data solutions addressing measurement, data persistence, visualization, and analytics, and offering these end-to-end implementations on a HORIBA hosted solution-as-a-service basis.

## Conclusion

The STARS Automation platform, originally conceived and architected more than 2 decades ago through the combined experience of HORIBA, Schenck and Ricardo, has underpinned a consistent growth in the scale and breadth of automation systems in HORIBA. More

recently, with the addition of STARS Enterprise and STARS Process, STARS has evolved into a comprehensive ecosystem, a stack of platforms spanning the application space from sensor management, through test rig automation to enterprise process automation and data management. Forged in the mobility business field, where system integration is a core strength for HORIBA, the STARS platforms have come of age and are now being leveraged across HORIBA's business fields to power automation and data management at all levels.

\* Editorial note: This content is based on HORIBA's investigation at the year of issue unless otherwise stated.



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