



WHITE PAPER

Smart Aerospace Testing

Aerospace development is increasingly driven by simulation, model-based engineering, and digital validation. Yet physical testing remains essential for certification and proving real-world performance. HBK's Smart Testing initiative connects virtual and physical testing through trusted data, helping engineers reduce setup time, accelerate test cycles, and improve confidence in engineering decisions.

Introduction

Modern aerospace development relies on simulation, model-based design, and continuous integration to identify issues before full-scale prototypes become available. Nevertheless, physical testing remains essential to:

- Validate components and structures
- Provide evidence for certification
- Confirm that virtual models accurately represent real-world behaviour

HBK's Smart Aerospace Testing approach connects virtual and physical validation through a common data backbone. Physical tests therefore become more than late-stage pass/fail activities. They generate data with engineering context that supports informed decisions, strengthens digital models, and creates a continuous feedback loop between physical assets and their virtual representations.

The following chapters describe how this approach translates into an integrated testing workflow. They cover:

- The connection between virtual and physical testing through trusted data
- Key opportunities to reduce the time and cost of physical testing
- The four capability pillars of physical testing: Smart Setup, Smart Acquisition, Smart Scalability, and Smart Data
- The potential business value and adoption roadmap

1. Connecting Virtual and Physical Testing

The engineering challenge is no longer whether to simulate or test, but how to combine the two effectively.

“Shift-left” strategies move validation and performance assessment earlier in the development process. Simulation can reduce late-stage rework, shorten development cycles, and improve system robustness. Nevertheless, physical testing remains the authoritative source of validation and certification evidence.

Figure 1 illustrates three major trends in Smart Testing:

- **Digital-first development:** Simulation and model-based methods guide development from the earliest stages
- **Parallel testing:** Virtual and physical testing activities increasingly run in parallel rather than sequentially
- **Lifecycle testing:** Testing continues beyond release to monitor and validate structures throughout their lifecycle.

Together, these three trends are shaping a smart testing development model built on two complementary activities:

- **Virtual engineering** anticipates behaviour and guides design
- **Physical measurements** validate, challenge, and refine those predictions

Trusted data provides the bridge between them. Without consistent data identity, quality, context, accessibility, and interoperability, virtual and physical testing remain separate activities rather than forming a single integrated workflow.



Figure 1: Major trends in testing

2. The Four Capability Pillars of Physical Testing

Even when a shift-left strategy is applied, physical testing of components and full-scale structures remains a significant driver of development time for validation and certification. Figure 2 highlights three factors that determine the duration especially of a physical test programme:

- Setup time
- Testing speed
- Test interruptions and downtime

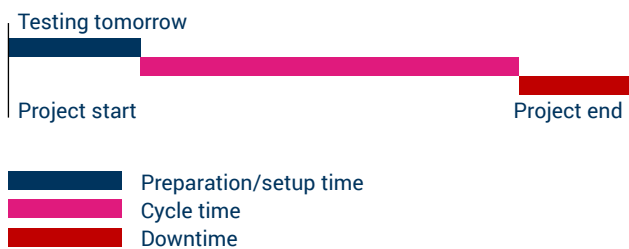


Figure 2: Key phases that determines test duration

Major productivity gains can therefore be achieved by making the physical test smarter. This requires more than isolated improvements to sensors, acquisition hardware, or software. It requires improvements across the entire testing workflow. Keeping these time drivers in mind, HBK defines four capability pillars to improve the overall physical testing workflow during validation and certification:

- Smart Setup
- Smart Acquisition
- Smart Scalability
- Smart Data

Together, these pillars create a connected workflow that:

- Simplifies and automates test preparation
- Ensures reliable data acquisition with full test context
- Scales consistently from a single test bench to enterprise-wide deployments
- Enables measurement data to be reused throughout the engineering process

Each pillar addresses a distinct stage of the physical testing lifecycle, as illustrated in Figure 2. Their combined value lies in establishing a continuous flow from sensor configuration and test execution through analysis, simulation, and engineering decision-making.

2.1 Smart Setup

Large structural tests may involve hundreds or thousands of measurement channels. Manually entering sensor parameters consumes valuable engineering time and creates opportunities for configuration errors.

HBK's Smart Setup workflow uses Smart Strain Gauges with unique digital identities and securely stored sensor characteristics. Once installed, HBK Fusion hardware reads the sensor information and passes it to Advantage Connect, which automatically configures the amplifier settings.¹

This provides a TEDS-like experience optimised for large-scale, cost-sensitive strain-gauge installations. Engineers can install, connect, synchronise, and begin testing with significantly less manual configuration.

Smart Setup also addresses test-bench interoperability. Built-in openDAQ support and real-time interfaces simplify integration with:

- Controllers
- Actuators
- Loading systems
- Third-party hardware and software

Expected benefits include:

- Shorter configuration times
- Fewer manual-entry errors
- Faster test-bench integration
- Lower risk of avoidable downtime
- Protection of existing measurement-system investments

2.2 Smart Acquisition

Once setup is complete, the objective is to acquire the right data at the right time, in the right context, and without unplanned interruptions.

Smart Acquisition focuses on four key behaviours:

Monitor Live. Act Fast.

Channel health monitoring, device-health monitoring, warnings, and alarms allow teams to detect problems early and intervene before they cause prolonged downtime.

¹ HBK has a patent pending for the workflow described.

Predict Measurement Quality

Trend analysis, comparisons with historical data, predictive analytics, and measurement uncertainty analysis can identify anomalies or low-value measurements while a test is still running. Corrective action can therefore be taken before an expensive test cycle is lost.

Record What Matters

Cycle-based recording, parallel recording, fast triggers, and disciplined file management focus system resources on relevant events rather than indiscriminately collecting data.

Create Richer Datasets

Metadata, virtual channels, calculation channels, and channel-to-channel calculations enrich the dataset during acquisition. This reduces dependence on post-processing and makes engineering insights available sooner.

Together, these capabilities transform acquisition from passive recording into active decision support, helping teams act on data earlier and make more informed testing decisions.

The next challenge is to scale these capabilities across the complete solution. This is the role of Smart Scalability.

2.3 Smart Scalability

Aerospace testing ranges from small laboratory installations to distributed programmes involving thousands of synchronised channels. Advantage Connect provides a platform-independent architecture that can operate on:

- Fusion edge devices
- PCs
- Servers
- Enterprise-scale deployments

The long-term vision is to allow acquisition, recording, analytics, and algorithms to be deployed where they deliver the greatest value.

Edge recording helps protect data when network connections are disrupted. Server tiers can consolidate information across facilities or organisations. Interfaces such as openDAQ, MQTT, GraphQL, and EtherCAT support integration between operational technology and information technology environments.

Existing HBK equipment can also be incorporated into the ecosystem, protecting previous investments and enabling gradual migration.

Most importantly, interoperability connects physical and virtual testing, making measurement data more accessible, reusable, and actionable. Figure 3 shows a Fusion and Advantage system at scale.

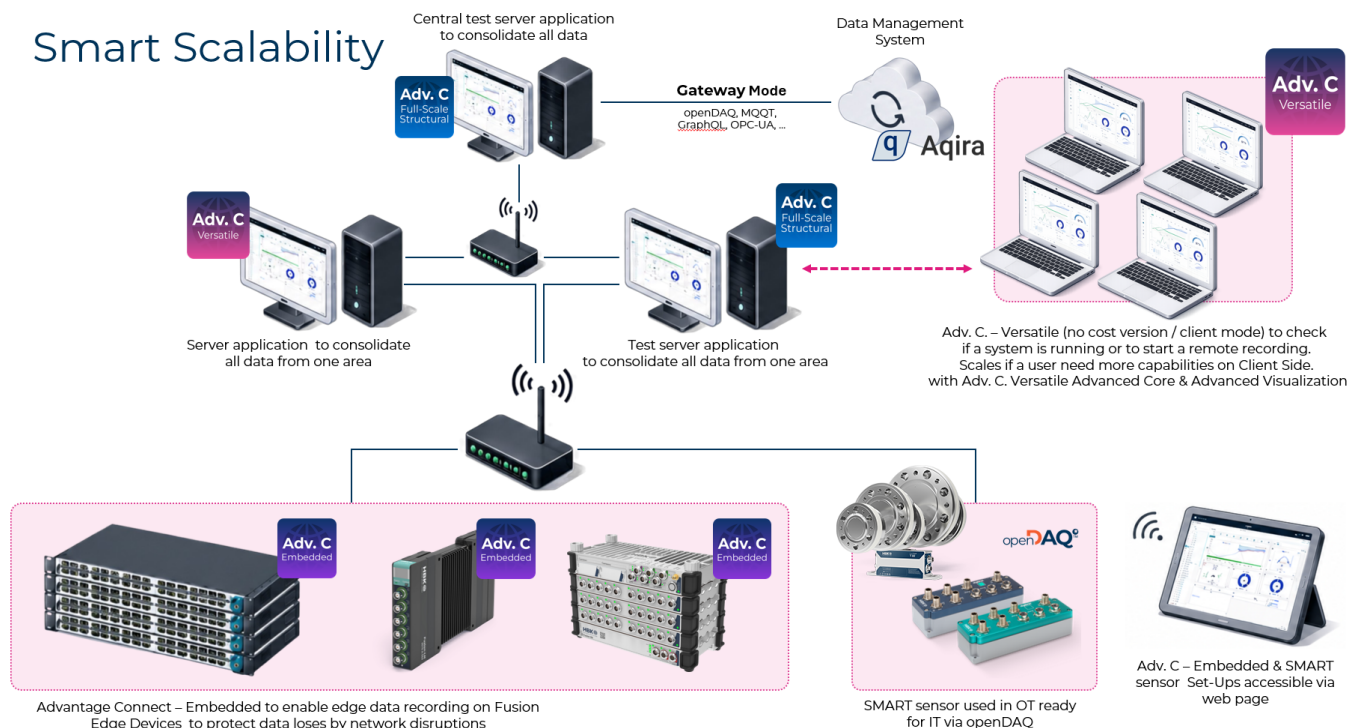


Figure 3: Smart Scalability – the power of the Fusion and Advantage platform

2.4 Smart Data

Smart Data closes the feedback loop between physical and virtual testing.

During acquisition, test data can be uploaded to HBK Aqira for test and information management. Engineers can then access analytics and engineering tools such as Advantage Insights and nCode.

The objective is not merely to centralise storage. It is to make trusted information and analytical capabilities available while the test campaign is still underway.

Measurement data can then be used to:

- Validate digital twins and simulation models
- Calibrate model parameters
- Improve prediction accuracy
- Reduce subsequent physical test iterations

Each physical test therefore provides evidence about the prototype while also improving the simulation models used for future development.

3. Potential Business Value for Customers

Smart Aerospace Testing is designed to deliver three primary customer outcomes:

- Fewer physical prototypes and test iterations
- Faster development
- Faster certification

Parallel development alone can reduce development time by approximately 30%. By combining the trends illustrated in Figure 1 with an integrated approach covering Smart Setup, Smart Acquisition, Smart Scalability, and Smart Data, organisations may achieve an additional reduction of approximately 20%.

Together, these improvements indicate the potential to reduce overall development time by up to 50%, as shown in Figure 4.

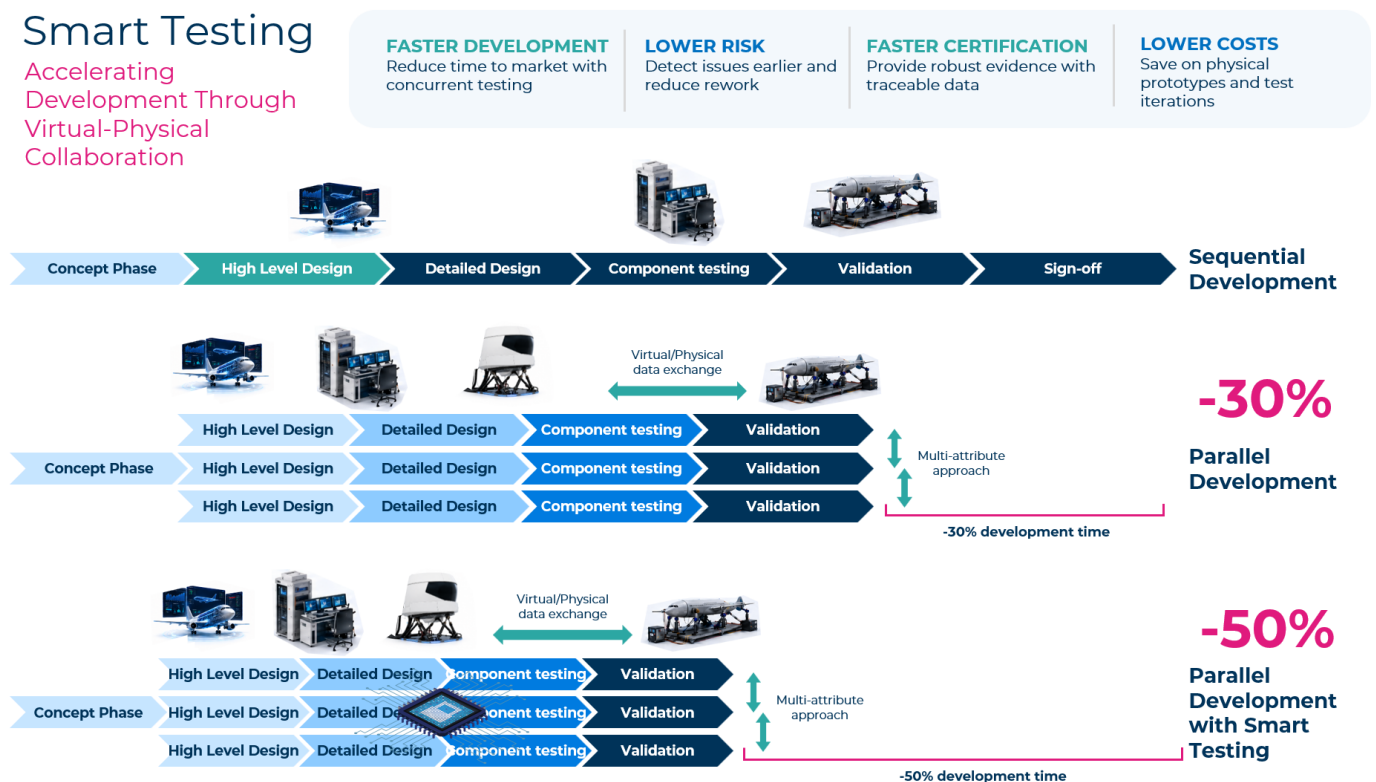


Figure 4: Accelerating development through virtual-physical collaboration

Conclusion

Smart Aerospace Testing positions physical validation as a connected component of the engineering lifecycle.

Its purpose is not to replace testing with simulation, or simulation with testing. Instead, it combines the two so that every physical measurement supports immediate test execution while strengthening the models used for future development.

Organisations can shorten feedback cycles and make better use of scarce testing resources by:

- Reducing setup effort
- Monitoring acquisition quality
- Recording and enriching relevant information
- Scaling consistently from edge devices to enterprise systems
- Returning trusted measurement data to simulation workflows

The central proposition is simple: accelerate aerospace development by connecting trusted measurement data with the models, decisions, and workflows that drive engineering confidence and certification readiness.

Let's work together
to make your
testing and data
smarter.

