happiest minds
The Mindful IT Company

The need for a bespoke Testing and Validation strategy for Industrial Automation and Embedded Systems

www.happiestminds.com

Introduction

The last few years have seen tectonic shifts in technology and part of that narrative has been the evolution of Industry 4.0 and the emergence of a software driven approach. Traditionally, a bulk of the investment in the Industrial world would have been allocated to hardware, however that is changing rapidly with the advent of advanced software platforms. In fact, Industrial software is now witness to a blending of Information Technology (IT) and Operational Technology (OT) leading to the creation of new platforms that combine data generated at the corporate level and data received from the field.

The Industrial Automation segment has been bolstered by the rapid adoption of IoT which has resulted in reduced costs, flatter and open AI architectures, tighter integration of IT and OT and the ubiquity of edge devices and sensors.

As Industrial Automation continues to evolve, end users and IA suppliers are at the crossroads where they must walk the fine line between risk and reward. The risk is in being overly enthusiastic and adopting new technologies before they have been proven at scale. Alternatively, not adopting these technologies until the point of stability can result in other risk savvy competitors forging ahead to snare a large portion of the market.

A couple of years ago, we saw the emergence of open industrial system architectures with themes such as computing at the edge and multivendor interoperable open systems to name a few. Today, prominent industry initiatives like Industry 4.0 and Open Process Automation Forums are leading the transformation. It is quite evident that companies embracing this transformational shift will stay ahead of the technology curve and stand a real chance of differentiating themselves from the pack.

Testing has always been an afterthought in the grand scheme of things, however the emergence of a software driven approach necessitates a fundamental shift in the way testing is carried out. A lot of the older IA architectures aren't completely open due to gated ecosystems which poses a big challenge for multi-vendor integration. On the other hand, Open architectures bring an open thought process along with the application of advanced technology that tightly integrates the varied ecosystems of customers, suppliers, manufacturers and others. Therefore, creating a superior integrated IA system requires fully open source standards for communications, data definitions and frameworks.

With an increasing share of functionality in today's machine and plant automation systems being shifted from electronics to software, its quality becomes a crucial enabling factor in the overall automation systems. As a result, quality assurance methods need to constantly evolve in the development of industrial automation systems.

Testing for Industrial Automation Systems

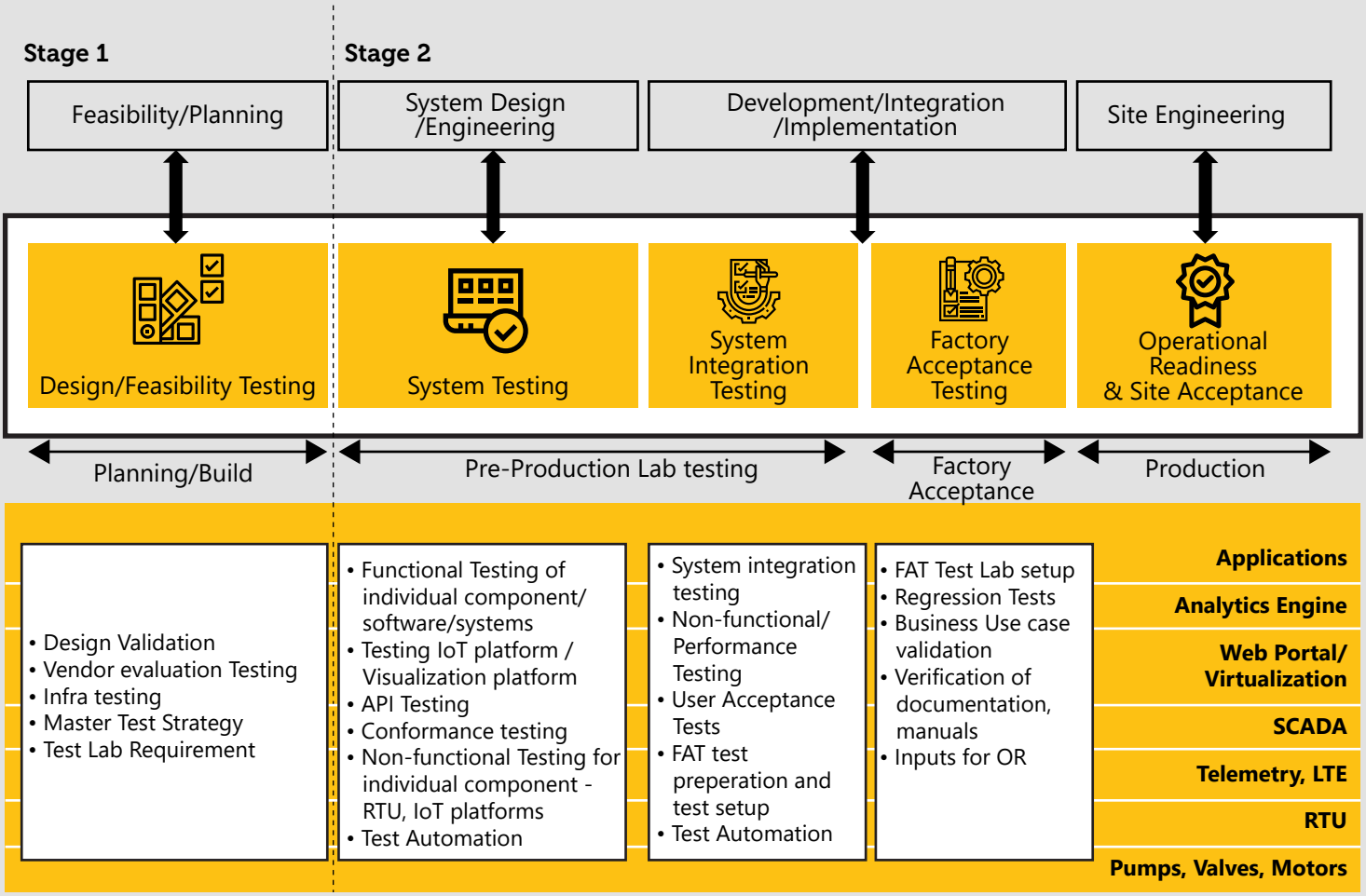
Traditionally, Industrial Automation systems comprise of an integrated solution involving different entities with a focus on mechanical, electrical, and software work products.

Therefore, the traditional testing processes in Industrial Automation are aligned to multiple levels such as Component Testing, Integration Testing, Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) before the machine or plant is commissioned.

Developing a Testing approach that delivers value

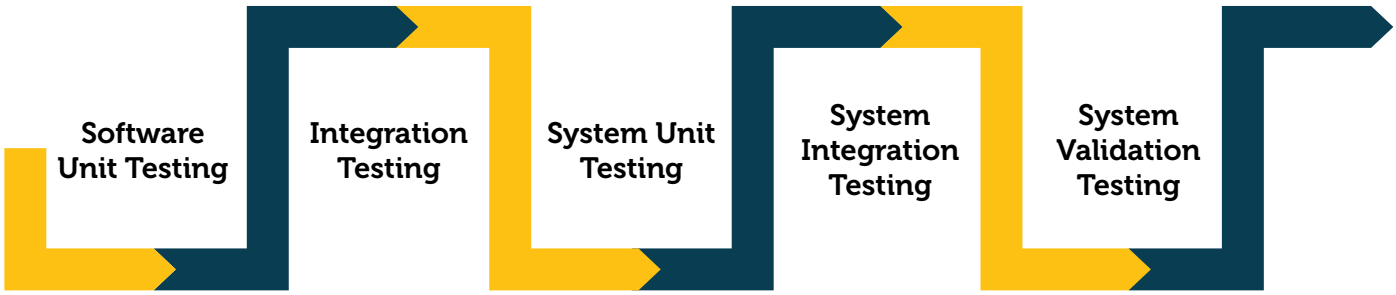
The Internet of Things and the rise of smart devices ushers in agile IoT platforms which are complex, scalable, and high-performance systems. This necessitates that testing strategies and practices evolve while both embedded and software components are closely integrated and grounded in automated testing. Also, the movement towards Open Architectures which are mostly open source and software driven are also an added fillip towards this change.

Integrated Testing Approach by Happiest Minds to address traditional as well as future needs



Types of Embedded Testing

As the scope of this whitepaper is IoT embedded systems, our test approach should be geared towards the different embedded test types and target areas for an IoT embedded system. This further compliments the application testing side which is already evolved.



Target areas for IoT embedded devices

01 Device Characteristics

These characteristics represent the data model of the device, presented by various data types, are saved to and fetched from the cloud, for validation of their integrity. Devices supports different data types. The tests validate the data as well as ensure that all the data types are saved properly and retrieved from the cloud.

02 Device Interaction Module

There are protocols like UART which support the reliable data exchange between the microcontroller and the module to test according to specifications. The test verified data is transmitted in sequence and further acknowledged.

03 Output Drive Tests

This test is normally at the edge and is generally responsible for other high-power entities, typically achieved via a GPIO interface.

04 Firmware upgrade/downgrade

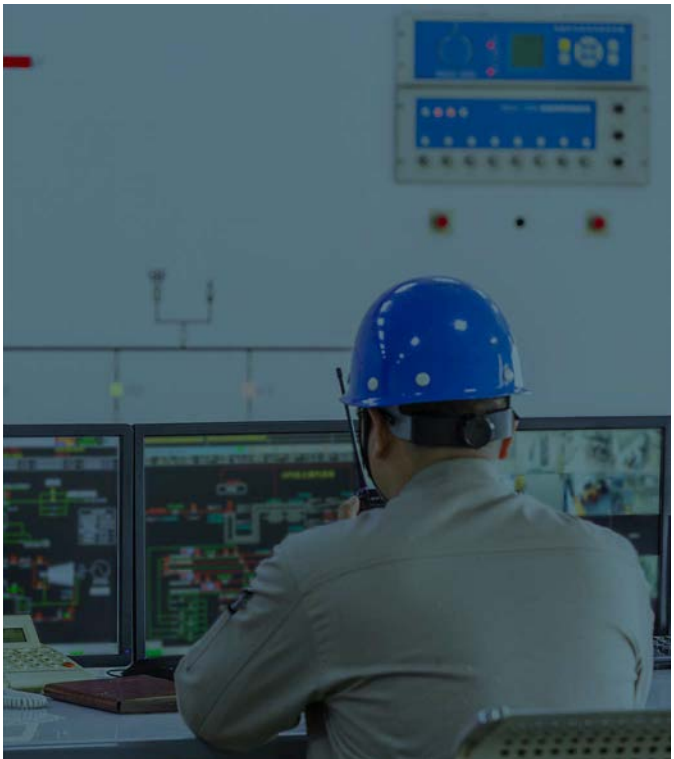
Customers may be using different releases of the firmware, so all upgrade-downgrade paths should be tested. This is normally tested Over the Air (OTA) i.e. between device to cloud for example, against a pre-defined compatibility matrix. This ensures all covered firmware releases are upgradable to the new release.

05 CPU, Memory Usage

This is related to RTOS and OS tests involving the monitoring of CPU and memory consumptions during different nodes of operation.

06 Power Modes

This test is always covered on the edge wherein there are different types of power modes available.



07 Connectivity

The testing focus here is on validating the wireless configuration for protocols like Bluetooth, BLE, Zigbee, 3G, 4G, LoRa, etc. For a WiFi system, this test validates the wireless configuration, the ability to switch between AP and station modes, and the ability to connect to the various WLANs with different security settings. These standards evolve rapidly and it's important to validate them.

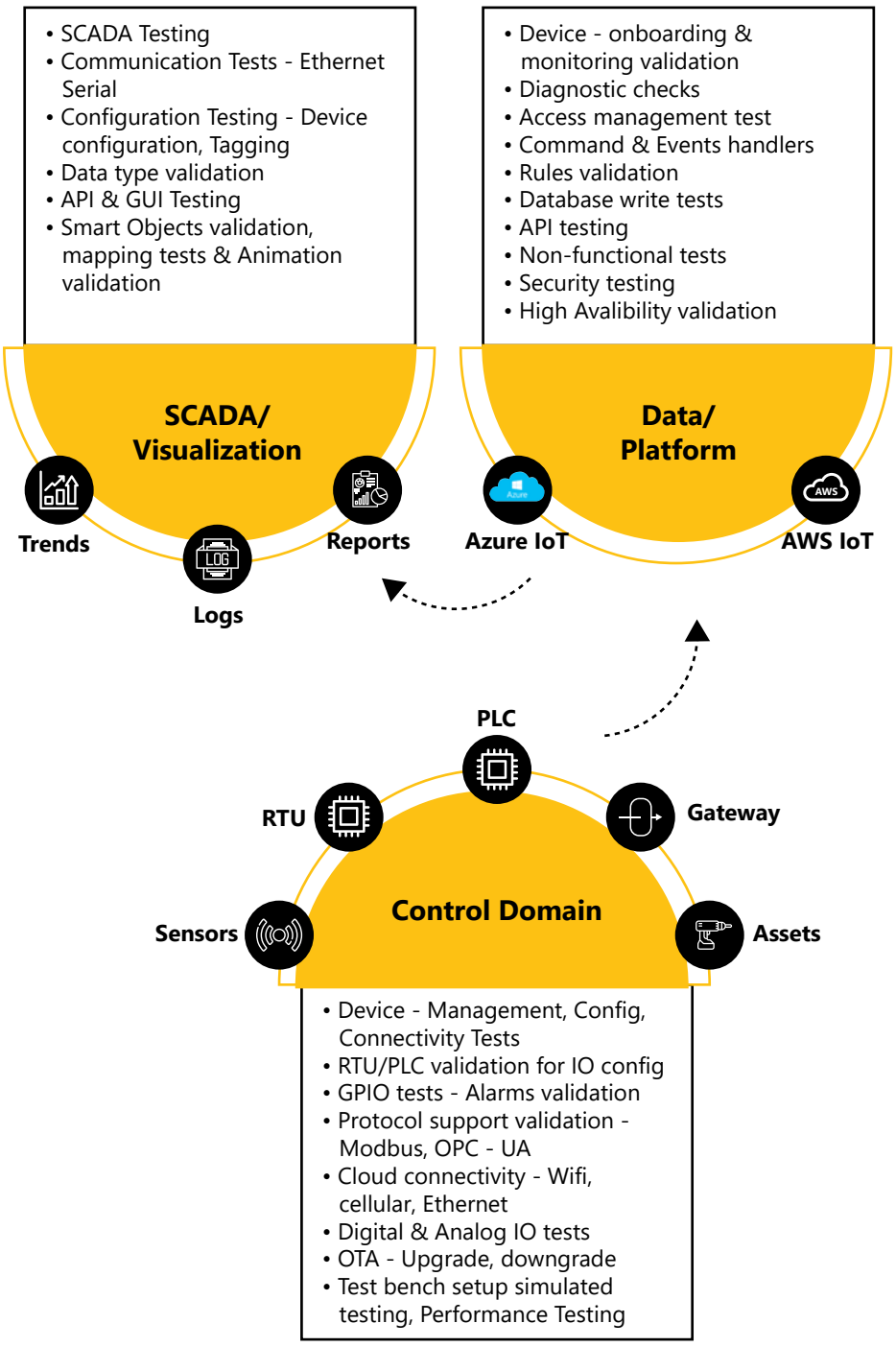
Skills required for
Embedded Validation

The skills of test engineers play a major role in ensuring that products are shipped with a high level of quality and assurance. In the world of industrial automation, test engineers need to have both product and automation skill-sets that can be collectively woven into the project. Some of the core skills needed for embedded testing are:

- Knowledge of Industrial Automation systems like a Smart Homes, Smart Buildings, Smart Utilities
- Ability to understand & ascertain Test requirements from Domain Use cases
- Experience with IoT Devices, Gateways, Hubs, Data Center, protocols (MQTT, CoAP, etc)
- Experience in test simulators, test tools like NI, etc
- Knowledge of Industrial Automation protocols - Modbus, BACnet, OPC UA and Wireless protocols – Zigbee, BLE, WiFi
- Python Programming
- Skills related to troubleshooting & debugging, triaging failure points

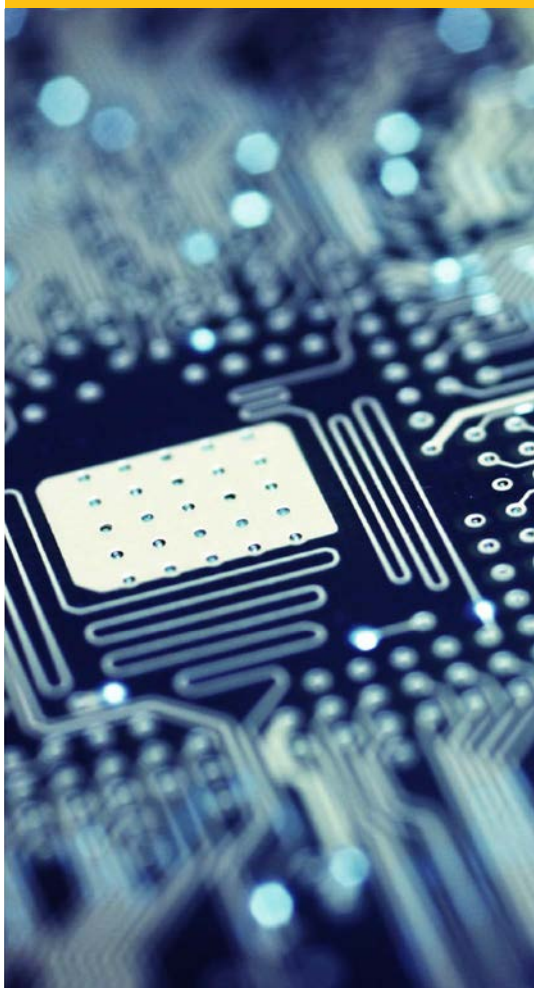
Verify, Validate and Automate with a Happy Mind

Happiest Minds Technologies has invested in creating test, validation and test automation frameworks and accelerators as part of the Industrial Automation Test offerings portfolio. A detailed overview of offerings and testing services are provided below.



Frameworks & Accelerators

Happiest Minds Technologies has invested in creating test automation frameworks and accelerators as part of the Embedded Testing offerings. This involves Test Automation frameworks for Devices, Gateways, configuration related Cloud API Tests, Pre-built Libraries, end device simulation, Modbus slave simulators & connectivity profile simulators.



Proof is in the Pudding

What we have done for our Clients

With a consultative approach that is backed by our deep expertise in embedded testing, we have worked with several clients across the world to understand their requirements and address their unique challenges.

Our work with clients spans the entire testing life cycle and provided below is a snapshot of some of the most interesting work we have executed recently.

Global Leader in Building Management Solutions

Scope
Responsible for Testing & Validation for BMS Controller portfolio as an extended team

Contribution
Test Plan preparation and Functional validation of the BMS controller Gateway Firmware (Lights, Energy Meters, Fire Alarms, etc). Protocols - Modbus, BACnet & Test Automation, System Testing

Technologies
Python

Tools
VTS Opensource, HMI

Leader in providing Smart Utility Solutions in US

Scope
Test Automation Framework development and enhancement

Contribution
Test Plan creation, enhancing the Python framework with new components. Test scripts for API, Database access, development of the device simulators, Scalability testing

Technologies
Python, Python-Selenium, RestAPI, JSON

Tools
Simulators, Sensors, Gateway

Leading Manufacturer of Industrial Products

Scope
End-to-End responsibility for Testing the Fleet Monitoring Platform for fuel tracks

Contribution
Complete QA ownership involving test plan, Functional & system testing covering Sensors, Gateway, CAN, MQTT Connectivity, IoT Hub, platform SW

Technologies
Python, RestAPI

Tools
Python, CAN simulators, endurance Test Scripts

Leader in Smart Systems and Thermal Systems

Scope
Improve the Regression Test cycle time across multiple products

Contribution
Complete Automation framework development using python to validate device commands handling, Configuration tests, Alerts handling and data validation on server using one click execution, development of components for UART, USB, I/O, etc

Technologies
Python

Tools
Sensors, Gateway, External simulators (GPS, CAN etc.), NI DAQ, Thermal chamber

TSP providing Smart Home solutions based in Europe

Scope
End-to-End ownership for validation of the CPI smart home solution

Contribution
Complete End-to-End QA, Test Bed Setup, Platform validation to support different IoT protocols (MQTT, CoAP, XMPP), Design of protocol simulators using the standard libraries, developed of API responder simulator for load testing & Performance bench marking of the Platform (TPS, response time)

Technologies
Python, Java, RestAPI

Tools
Various device models (Philips, Samsung, Belkin, Hubs, Gateway, routers)

Consumer Electronics and safety devices validation

Scope
Perform full E2E product testing of embedded safety device

Contribution
Test Plan, Device functional tests covering the connectivity of the WiFi & ZigBee connectivity, ZigBee HA profile validation

Technologies
Python, RestAPI, Appium (mobile)

Tools
TI Ember dev kit sniffer (ZigBee), Samsung Smart Things, Jmeter (API)

Integrated Testing Approach

Fulfilling the future needs in Industrial Automation systems

Testing is a critical success factor with the advent of new Open architecture and IoT driven Industrial Automation systems. A well thought out and holistic testing approach with both embedded and software components closely integrated and grounded in automated testing is an absolute necessity to ensure the much needed predictability and assurance.

Adopting a multi-layered and end to end approach provides significant benefits related to early detection of bugs, improved test cycles through automation, increase confidence levels and the required testing efficiency & sufficiency to ensure a smooth implementation.

If you are looking to work with a partner that combines industry expertise and unmatched attention to detail, please reach out to us at

business@happiestminds.com

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About Happiest Minds Technologies

Happiest Minds enables digital transformation for enterprises and technology providers by delivering seamless customer experience, business efficiency and actionable insights through an integrated set of disruptive technologies: big data analytics, AI & cognitive computing, Internet of Things, mobility, cloud, security, unified communications, SDN-NFV, RPA, etc. Happiest Minds offers domain-centric solutions applying skills, IPs and functional expertise in IT services, product engineering, infrastructure management and security. These services have applicability across industry sectors such as retail, consumer packaged goods, edutech, e-commerce, banking, insurance, hi-tech, engineering R&D, manufacturing, automotive and travel/transportation/hospitality.

Headquartered in Bangalore, India; Happiest Minds has operations in the US, UK, The Netherlands, Australia and Middle East.