



FALSE CALL REDUCTION FOR SMT AOI SERVICE DESCRIPTION

1. Scope of Services

The scope, quality, and technical specifications of the services ("Services") are defined exclusively in Annex 1 (Overview), Annex 2 ("FCR Commissioning Service") and Annex 3 ("FCR Operations Service").

2. Customer's special duties of cooperation

- Customer must provide a stable factory network. Outages of the factory network can adversely affect Performance of the Services.
- Customer must treat access credentials confidentially.
- Customer must instruct SISW staff regarding the health and safety and environmental protection measures to be applied on-site.
- Customer has to grant SISW remote access to the Edge device in order to report performance instabilities via an alarm signal (e.g. E-mail) from IE Device to the Cloud Setup.
- The Customer needs to deploy and run the latest versions of the IE Management software, the IE Runtime OS software, and the IE system apps in his Industrial Edge Eco System. If older or incompatible versions are used by Customer, the AI Software may not work properly.
- Substantial modifications on the IT/OT or production environment can affect the Key Performance Indicators (KPIs) and require reconfiguration or re-installation of the AI Software, which SISW can provide at additional costs. In any case SISW must be informed before modification of the production and IT/OT environment are carried out.
- Customer must provide a virus and malware free data sample as defined in detail in section 2.1.2 of Annex 2 to (i) initially train the pre-configured ML model, (ii) retrain (e.g. program changes), (iii) train for new products and (iv) assess KPIs. Customer must upload this data sample manually to the Cloud Setup, hosted by SISW. SISW and its affiliates and their subcontractors may use data samples provided by Customer during and after the contract term for internal business purposes (e.g. improvement of product and services).
- Data samples provided to SISW must not contain personal data.
- Changes to the VPN connection that affect SISW's capabilities to provide the Services must be communicated at least 4 weeks in advance.
- Customer is responsible for the connectivity of the SMT AOI machine to the IE Device and must detect and correct any events impacting the data flow.
- The Customers shall ensure that the bandwidth of data flow is limited by the maximum data input accepted by the southbound connector of the IE Device as per the Documentation of the IE Device.
- If the maximum bandwidth is exceeded and consequently the maximal acceptable time for a machine learning result is exceeded, the AI Software will not work properly.
- Customer shall support SISW in error investigation and data interpretation issues to fulfill the False Call Reduction for SMT Operations.

3. Exclusions

- Any recommendations that SISW provides will be based on information and data that SISW obtains from Customer. Accordingly, SISW makes no representations as to the accuracy or completeness of such recommendation. Such recommendations are provided as guidelines and estimates only, to be used at Customer's sole discretion.
- SISW warrants that the services included in this Offering will be performed in a professional and workmanlike manner. SISW does neither guarantee the achievement of specified KPIs (e.g. volume reduction, slip) nor the

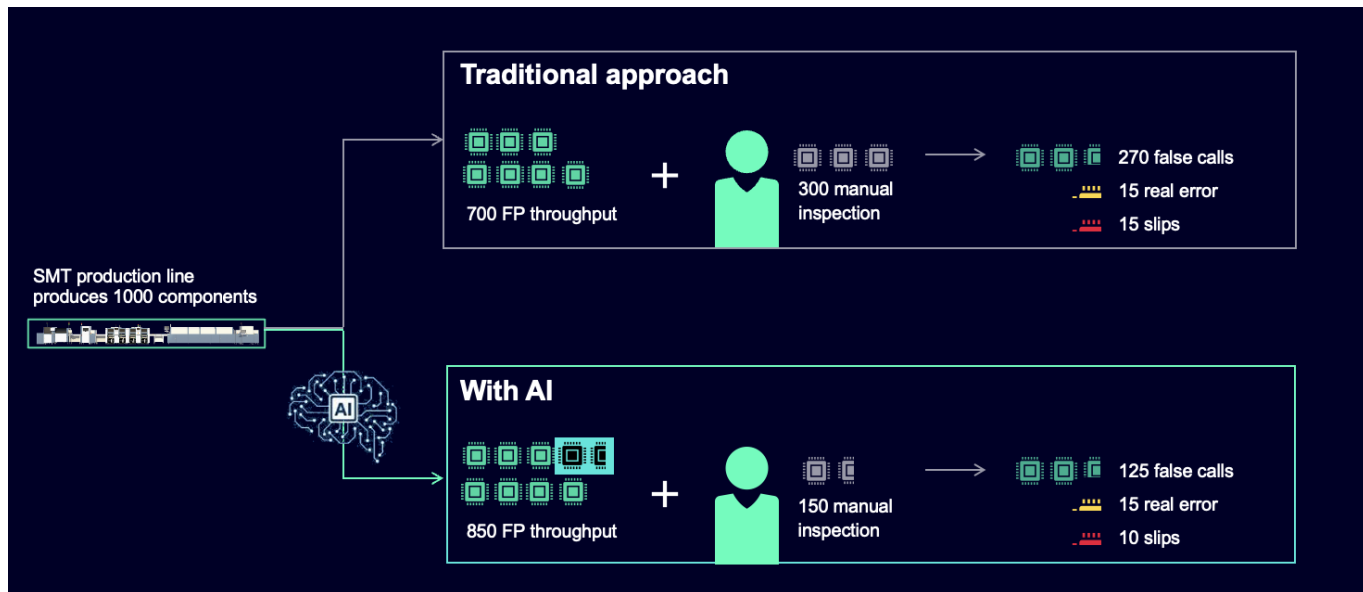
achievement of potential savings. Substantial modifications on the IT/OT or production environment can affect the KPIs. Therefore, any indicated potential savings are merely a rough estimation and highly dependent on many factors outside of SISW's control. EXCEPT AS PROVIDED HEREIN, SISW MAKES NO OTHER WARRANTY, EXPRESS, IMPLIED OR STATUTORY, WITH RESPECT TO THE SERVICES AND ALL SUCH WARRANTIES ARE HEREBY DISCLAIMED INCLUDING, BUT NOT LIMITED TO, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Attachments:

- Annex 1: Overview – False Call Reduction for SMT AOI
- Annex 2: Service description – False Call Reduction for SMT AOI Commissioning
- Annex 3: Service description – False Call Reduction for SMT AOI Operations

Annex 1: Overview – False Call Reduction for SMT AOI

With False Call Reduction for SMT AOI SISW supports its customers in reducing its manual inspections efforts for SMT AOI. This includes a recommendation for the operator whether a unit has a pseudo-error or not.



Graphic 1: Methodology of AI Software

The False Call Reduction setup (“False Call Reduction Setup”) requires the following hardware and software components to achieve the benefits for the Customer. The main components are:

- DI FA: Industrial Edge Eco System
 - Industrial Edge hub access
 - Industrial Edge Management
 - Industrial Edge (IE) device IPC427E
 - Industrial Edge system apps
- DI SW: SMT Connectivity Elements
 - Data Ingestion from AOI test system to Industrial Edge device
 - Data Upload from Customer shopfloor to Cloud Setup
- DI CS: AI Software and Cloud Setup
 - False Call Reduction Edge apps (= AI Software)
 - False Call Reduction cloud infrastructure for retraining (“Cloud Setup”)

The AI Software evaluates data of failed boards from the AOI test system and reduces the number of inspections and the effort by the operator at the repair station.

False Call Reduction for SMT AOI				
False Call Reduction for SMT AOI Commissioning				False Call Reduction for SMT AOI Operations
Assessment	Installation at factory and field level	Edge apps	Validation	
IT/OT Assessment	SMT Connectivity installation guidance	Configuration of False Call Reduction Edge apps	End-to-end system simulation	Monitoring
Machine learning assessment	Industrial Edge device installation guidance	Deployment of Industrial Edge System apps	Integration test at the shopfloor	Maintenance
	Industrial Edge Management installation guidance	Deployment of False Call Reduction Edge apps	Silent test parallel to production	Retraining
			Customer acceptance	AI Software License

Graphic 2: Content of the False Call Reduction for SMT AOI

The Graphic 2 gives an overview of the deliverables for False Call Reduction for SMT AOI Commissioning Service (Annex 2) and False Call Reduction for SMT AOI Operations (Annex 3).

Annex 2: Service description – False Call Reduction for SMT AOI Commissioning

1. Brief description and aims

With False Call Reduction for SMT AOI Commissioning (= Commissioning Services) the Customer benefits from the structured approach of Siemens to implement the AI based offering after the Automated Optical Inspection test system (AOI) at the Surface Mount Technology (SMT) production without specific knowledge in Data Science, Edge Computing, or IT Architecture.

False Call Reduction for SMT AOI Commissioning Service (Product ID 9DE5110-4KA10) engages SISW to set up the False Call Reduction for SMT AOI Operations product (Product ID 9DE5110-6KA10) at the Customer shopfloor and comprises assessment, guidance for installation, data collection and training, configuration and deployment of the AI Software and validation of the False Call Reduction for SMT AOI Operations product.

False Call Reduction for SMT AOI **Operations** Service (Annex 2) can only be started after a successful completion of False Call Reduction for SMT AOI **Commissioning** Service.

The date for the False Call Reduction Commissioning will be subject to agreement. Duration approx.: 2 months from start of Commissioning until start of Operations.

2. Scope

2.1 Assessment

2.1.1 IT/OT Assessment

With the IT/OT Assessment Siemens understand the Customer's current framework and can align on the architectural requirements to implement the False Call Reduction Setup at the shopfloor. The assessment closes with identified action items.

The following main topics will be analyzed:

- Review of the relevant IT/OT elements
 - Industrial Edge device IPC427E on premise
 - Industrial Edge Management on premise
 - Industrial Edge hub access
 - SMT Connectivity Elements on premise
- Data Ingestion from AOI test system to Industrial Edge device
- Data Upload from Customer shopfloor to Cloud Setup
- Cloud connectivity setup
 - Network overview of the IT/OT elements
 - Remote access to the Industrial Edge device and Industrial Edge Management
 - Requirements towards firewall openings between the shopfloor/factory-network or factory/cloud-network
 - Alarming functionality for Monitoring of AI Software
- Security requirements
- Remote access regulations

2.1.2 Machine learning assessment

To run the AI Software successfully the inbuilt machine learning model needs to be configured to the Customer specific data. The machine learning model re-evaluates only the errors from the AOI test system and reduces the manual inspection efforts of these errors at the repair station.

Siemens trains one machine learning model per AOI inspection type and aims to cover at least 80% of all inspection errors of the AOI test system. A historic set of production data ("Data Sample") from the Customer's production needs to be provided into the Cloud Setup.

Where possible, example data samples will be provided for reference.

The Data Sample needs to fulfill the following requirements:

- It consists of the AOI measurement data and the corresponding operator labels
- It contains a data export of sufficient size with a distribution that is representative to the actual production process, therein at least 200 real errors and 200 false calls per inspection type (while typically the number of false calls is greatly exceeding the number of errors)
- It needs to include AOI inspection types that cover at least 80% of the lines' throughput.
- The real errors have been classified by an operator from the Customer
- It is stored in the format of AOI measurement data and operator labels for the supported AOI vendors listed in Annex 3.1 compatible with the AI Software (e.g. XML structure and necessary values (will be transparent through sample files provided)).

The period for the collection of data for the Data Sample depends on the production volume, first pass yield and real error rate. Data needs to be collected until at least 200 real errors have been recorded.

The listed steps will be conducted during the machine learning assessment:

- Alignment on required Data Sample prior to data upload to Cloud Setup.
- Review of the Data Sample to understand if the AOI test system is configured correctly. If deviations are found, guidance will be provided to reach alignment in order to match the data format with requirements of Siemens
- Agreement on customer specific test object unit (e.g. window, pin, board, panel, ...)
- Alignment on the expected Key Performance Indicators of the False Call Reduction Setup ("Key Performance Indicator" for the Service") (The verification takes place during Validation (2.4):
 - Volume Reduction
 - Slip
 - Average Processing Time
 - Maximal Supported Throughput
- Analysis of the Data Sample to understand which inspection type is generating AOI errors
- Training of one machine learning model per inspection type
- Result presentation of machine learning model training

2.2 Installation at factory and field level

2.2.1 SMT Connectivity installation guidance

Based on the installation guide of the Siemens SMT Connectivity team, Siemens will support the Customer remotely to install the SMT Connectivity Element. It must be installed on a Windows-based PC in the same network as the target AOI test system, the repair station, and the Industrial Edge device. The driver is responsible for the data ingestion from AOI test system to Industrial Edge device and enables the Customer to process the AOI measurement data.

The Data upload is done via the connectivity element which provides a function for loading a historic set of data into the Cloud Setup for machine learning model training. The Cloud Setup is currently located on the cloud infrastructure based in Europe (Frankfurt) "eu-central-1" and the backup infrastructure is based in Europe (Ireland) "eu-west-1". Siemens is free to change the

data center location at any time and will use reasonable efforts to notify Customer about such changes.

2.2.2 Industrial Edge device installation guidance

Siemens provides installation support for the whole architectural setup. The remote support team will assist the Customer's IT experts to install the Industrial Edge device and configure the IT architecture (e.g. ports) to provide data access.

2.2.3 Industrial Edge Management installation guidance

Siemens provides installation and configuration support for the Industrial Edge Management. The remote support team will assist to install the Industrial Edge Management and set it up according to the requirements.

2.3 Edge apps

2.3.1 Configuration of False Call Reduction Edge apps

The trained machine learning model is integrated in the False Call Reduction Edge apps (= AI Software). This AI Software runs during the Operations Services on the Industrial Edge device at the Customer shopfloor.

2.3.2 Deployment of Industrial Edge System apps

The Industrial Edge device at the Customer shopfloor needs system apps which need to be deployed once the Industrial Edge device and Industrial Edge Management is set in place. These apps are not False Call Reduction specific. Siemens will support the Customer with the selection of the right apps and its versions and guide through the deployment process. The Customer needs to purchase the Edge Management System including necessary apps separately.

The following Industrial Edge System apps need to be deployed:

- Industrial Edge MQTT Connector
- Industrial Edge Data bus
- Industrial Edge Flow Creator

2.3.3 Deployment of False Call Reduction Edge apps

Once everything is set in place, the preparation of the Commissioning Services completes with the deployment of the configured AI Software to the local Industrial Edge Management. Siemens installs the AI Software to the Industrial Edge device on the shopfloor.

2.4 Validation

2.4.1 End-to-end system simulation

The Validation starts with the end-to-end system simulation. This includes the test of all components of the AI Software and its interaction with the Industrial Edge device and Industrial Edge System apps at the Siemens test environment. The data ingestion will be emulated with AOI errors from the Data Sample. This test ensures shorter setup times at the Customer's shopfloor.

The following metrics will be determined:

- Volume Reduction

- Slip / False Delivery
- Average Processing Time
- Maximal Supported Throughput

The test object unit (e.g. window, pin, board, ...) can be different for each Customer and henceforth will be defined during the machine learning assessment (2.1.2)

2.4.1.1 Volume Reduction

The Volume Reduction VR is the weighted average of the Volume Reductions of each test object unit i , VR_i :

$$VR = p_1 \cdot VR_1 + p_2 \cdot VR_2 + \dots + p_n \cdot VR_n.$$

Equation 1

p_i is the ratio of the test object unit in the full sample. The aggregation level to a test object unit depends on the machine builder and corresponds to the unit the operator gives his feedback on (e.g., measurement window, component, pin).

The Volume Reduction of a test object unit is defined as the ratio of the counts of the correctly predicted false calls (FC) of the AI -algorithm compared to the total number of false calls¹:

$$VR_i = \frac{\#(AI_{FC}, TRUTH_{FC})(i)}{\#(TRUTH_{FC})(i)}.$$

Equation 2

Notably, an estimate of the Volume Reduction (also called the *estimated Volume Reduction* $\varepsilon(VR_i)$) is given by the ratio of the number of false calls of the AI algorithm to the number of real errors (RE) the AOI machine is predicting:

$$\varepsilon(VR_i) = \frac{\#(AI_{FC})(i)}{\#(AOI_{RE})(i)},$$

Equation 3

because the AOI test systems are usually operated with a great excess of false calls compared to real errors.

2.4.1.2 Slip

The Slip S is the weighted average of the Slip of each test object unit i , S_i :

$$S = p_1 \cdot S_1 + p_2 \cdot S_2 + \dots + p_n \cdot S_n$$

Equation 4

with similar meanings of the aggregation as for the Volume Reduction in Equation 1.

The slip rate of a test object unit is defined as the ratio of wrongly AI classified units (FP) and the total number of real errors by operator (OP_{RE}):

¹ The total population of the counts that are relevant for the $TRUTH$ is determined only by the errors that are reported by the AOI machine that can either be real errors (RE) or false calls (FC).

$$S_i = \frac{\#(FP)(i)}{\#(OP_{RE})(i)}$$

Equation 5

2.4.1.3 False Delivery

The False Delivery FD is the weighted average of the false delivery of each test object unit i , FD_i :

$$FD = p_1 \cdot FD_1 + p_2 \cdot FD_2 + \dots + p_n \cdot FD_n$$

with similar meanings of the aggregation as for the Volume Reduction in 2.4.1.1.

The false delivery of a test object unit is defined as the ratio of the counts of the wrongly predicted units (*False Positives, FP*) of the AI-algorithm compared to the total number of predicted false calls (*False Positives, FP, and True Positives (TP)*) of the AI algorithm

$$FD_i = \frac{\#(FP)(i)}{\#(AI_{FC})(i)}$$

2.4.1.4 Average Processing Time

The Average Processing Time of our False Call Reduction Setup is defined as the processing time starting with the completed test at the AOI with error measurement data until results of the AI Software are available at the export interface.

The Customer expectation of the required Average Processing Time will be aligned during the Machine learning assessment (2.1.2). During the End-to-end system simulation a load test will be performed to verify the Average Processing Time of the AI Software.

2.4.1.5 Maximal Supported Throughput

The Maximal Supported Throughput is defined as the average frequency of messages that are supposed to be processed by the AI Software, i.e. the AOI errors.

The Customer expectation of the required Maximal Supported Throughput will be aligned during the Machine learning assessment (2.1.2). During the End-to-end system simulation a load test will be performed to verify the Maximal Supported Throughput of the AI Software.

In case the AOI test system is exceeding the supported threshold of the Maximal Supported Throughput, it might have a negative impact on the availability of the False Call Reduction Setup. A faster cycle time of the AOI test system may lead to stability issues.

2.4.2 Integration test at the shopfloor

The integration test includes the test of all components required to fulfill successful Operations Services at the Customer shopfloor. It verifies that incoming data will be received, processed, and provided correctly. This test eliminates failures at the Customer setup and provides efficient execution of the silent test phase.

Components to be tested are:

- Data Ingestion from AOI test system to Industrial Edge device
- AI Software
- Deployment and remote access mechanism
- Data Upload from Customer shopfloor to Cloud Setup

2.4.3 Silent test parallel to production

After successful completion of the integration test, the AI Software operates on the Industrial Edge device parallel to the production process. During this test phase, no productive use is allowed. The results of the AOI test system have to be checked manually. During this phase the AI Software receives data from the AOI test system, the machine learning model evaluates the data sets continuously and stores it.

At the end of the silent test phase the results of the machine learning model with the Volume Reduction at a certain Slip can be compared to the results from the AOI test system and the labels of the Operator. Furthermore, the Average Processing Time and Maximal Supported Throughput of the AI Software as well as the Availability of the False Call Reduction Setup will be monitored.

The Availability is defined as:
$$\text{Availability} = \frac{\text{Uptime of False Call Reduction Setup}}{\text{Customer production time}}$$

All results of the silent test phase are summarized in the Validation test report.

2.4.4 Completion

The Commissioning Services will be completed with the issue of the Validation test report by SISW.

The report will contain following Key Performance Indicators :

- Volume Reduction (definition see Annex 2, Chapter 2.4.1.1)
- Slip (definition see Annex 2, Chapter 2.4.1.2)
- Average Processing Time (definition see Annex 2, Chapter 2.4.1.3)
- Maximal Supported Throughput (definition see Annex 2, Chapter 2.4.1.4)

3. Outcome

Installed False Call Reduction Setup:

- Industrial Edge hub access
- Industrial Edge Management and Industrial Edge device IPC427E on premise
- Industrial Edge system apps on Industrial Edge device
- SMT Connectivity Elements on Windows-based PC
 - Data Ingestion from AOI test system to Industrial Edge device
 - Data Upload from Customer shopfloor to Cloud Setup
- False Call Reduction Edge apps (= AI Software) on Industrial Edge device
- Connection to Cloud Setup for retraining

3.2 Validation test report

Annex 3: Service description – False Call Reduction for SMT AOI Operations

1. Brief description and aims

False Call Reduction for SMT AOI Operations” (Product ID [XXXXXX]) consists of a license for AI Software (including a Cloud Setup for data storing, data pipeline management and retraining) and a service to monitor, alert and retrain the AI Software to support Customer in reducing its manual inspections efforts for SMT AOI. This includes a recommendation for the operator whether a unit has a pseudo-error or not. Through constant monitoring services of KPIs (e.g volume reduction, slip) the Customer will receive notifications about performance deviations on Customers’ shopfloor.

The AI Software supports the data structure of the following AOI machine vendors:

- Viscom SI XML, by Viscom
- Further AOI vendors can be supported on request.

Data collected by Customer and provided via the Cloud Setup will be evaluated and processed by SISW personnel during SISW’s standard working hours in Germany, which are Monday to Friday (on working days excluding public holidays), 8 hours per day, between 08:00 and 17.00 hrs CET. SISW will use commercially reasonable efforts to meet short reaction times after receipt of an alarming incident. Customer will inform SISW as soon as any malfunction is detected.

An overview of the Third-Party Technology can be found in provided readme OSS files.

Successful Operations Services can only be started after a completion of False Call Reduction for SMT AOI Commissioning Services.

2. Scope

2.1 License to AI Software

SISW grants Customer a nonexclusive, nontransferable, non-sublicensable, limited license to use Documentation and to install and to use the AI Software for Customer’s internal business purposes during the applicable Subscription Term solely in accordance with the Entitlements and this Agreement.

2.2 Monitoring of AI Software and Cloud Setup

2.2.1 The Operations Services include the Monitoring of the AI Software running on the Industrial Edge device at the Customer shopfloor. Monitoring consists of the following services:

- If required, daily manual monitoring per remote access to the AI Software
- The following Key Performance Indicators will be monitored:
 - Volume Reduction (definition see Annex 2, Chapter 2.4.1.1)
 - Slip (definition see Annex 2, Chapter 2.4.1.2)
- SISW informs the Customer per mail in case significant deviations are detected during manual monitoring
- If no channel from the Industrial Edge device to the Cloud Setup is possible, the Customer shall take the responsibility to monitor the status of the False Call Reduction Setup and notify SISW about events or alarms via email to the SISW mailbox.

2.2.2. The Operations Services include the Monitoring of the Cloud Setup and consists of the following services: SISW will use commercially reasonable efforts to make the Cloud Setup available to Customer up to 24 hours per day and 7 days a week excluding downtime resulting directly or indirectly from any previously announced maintenance work. The Cloud Setup is available to Customer if its user interface is

accessible by login at the exit of the wide area network of the data center used by Siemens to provide the Cloud Setup.

If the Maximum Supported Throughput (defined in phase 2.1.2 of Annex 2 ML assessment) is exceeded, it may lead to stability issues and will have a negative impact on the availability and performance of the False Call Reduction Setup. SISW will not texcake any responsibility for performance issues.

2.3 Maintenance of the AI Software and machine model

The Operations Services include the Maintenance of the AI Software and the machine learning model running on the Industrial Edge device at the Customer shopfloor and the Cloud Setup. Maintenance will be provided in compliance with the General Maintenance Service Terms for Software and Hardware of Siemens Digital Industries Software

<https://assets.ctfassets.net/17si5cpawjzf/7xwz7Mlf8AzFQObbKcqLBL/95e10683b237d30221f05b7ebed47135/SISW-GEN-MNT-V1-4-English.pdf>

Siemens uses commercially reasonable efforts to meet short reaction times after an alarming incident or Customer individual notification.

2.4 Retraining of the machine learning model

The Operations Services include Retraining of the machine learning model running on the Industrial Edge device at the Customer shopfloor. Retraining consists of the following services:

- Retraining of the machine learning model for existing inspection types due to daily adjustments of thresholds of the AOI causing Key Performance Indicator to drop (as defined in 2.1.3 of Annex 2) are provided at no additional cost.
- However, if the Key Performance Indicators decline due to major changes in the Customer's environment (e.g. new products, changes to hardware Setup), retraining will be provided at additional costs.
- Training of new inspection types if sufficient data is available. The definition of data requirements can be found in Annex 2, Chapter 2.1.2.
- Deployment of the AI Software with the retrained machine learning models on the Industrial Edge Management with remote access. Siemens installs the AI Software to the Industrial Edge device on the shopfloor.
- In case the machine learning model cannot be retrained with commercially reasonable efforts, Siemens will switch off the affected inspection types from the machine learning model. A reason to use this fallback strategy could be lack of data for re-training.