Industrial Edge 3rd Application Scenario

Example #1 - THT Close-Loop

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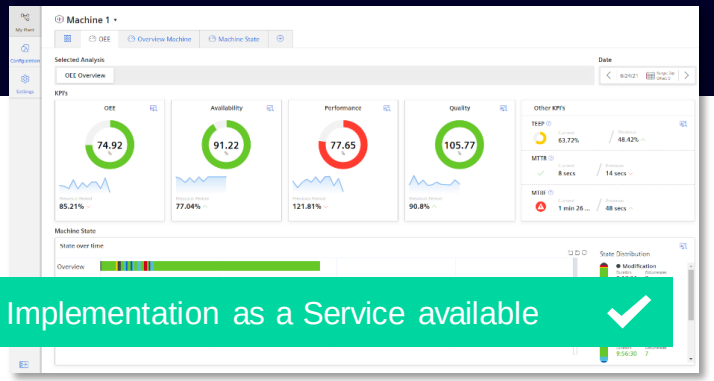
Industrial Edge Application Scenario Background

Start your Industrial IOT journey

Performance Analytics

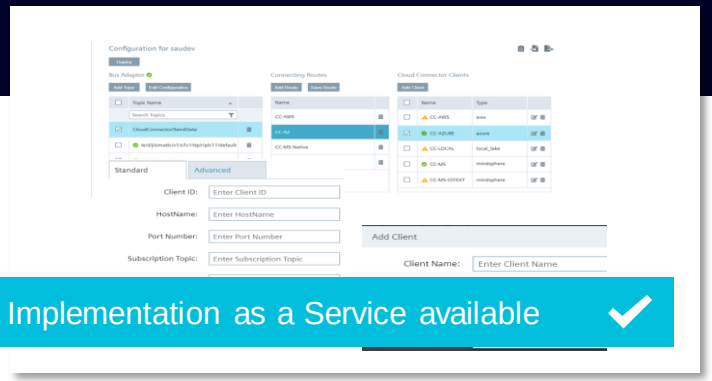
Detect and visualize root causes for efficiency losses in manufacturing



Implementation as a Service available

Shopfloor to Cloud Connectivity

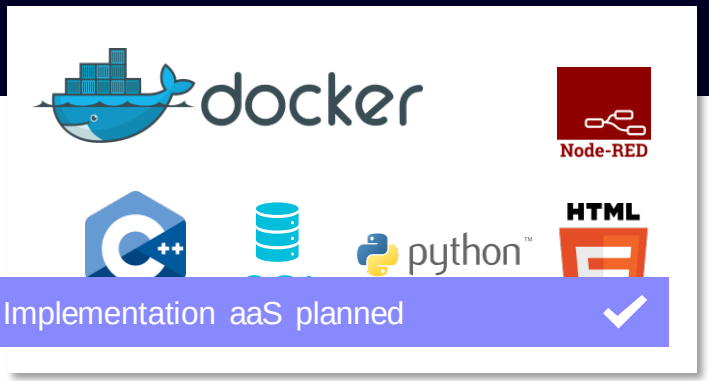
Integrate machine & production data securely into the company cloud



Implementation as a Service available

Bring own applications to shopfloor

Management and deployment of self-developed apps to the shopfloor



Implementation aaS planned

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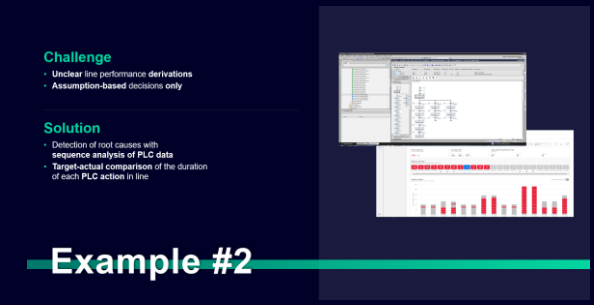
Industrial Edge Application Scenario Background

Application Scenario structure

Performance Analytics



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Shopfloor to Cloud Connectivity

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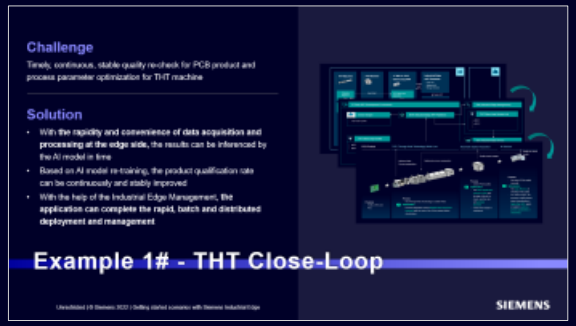
Bring own applications to shopfloor



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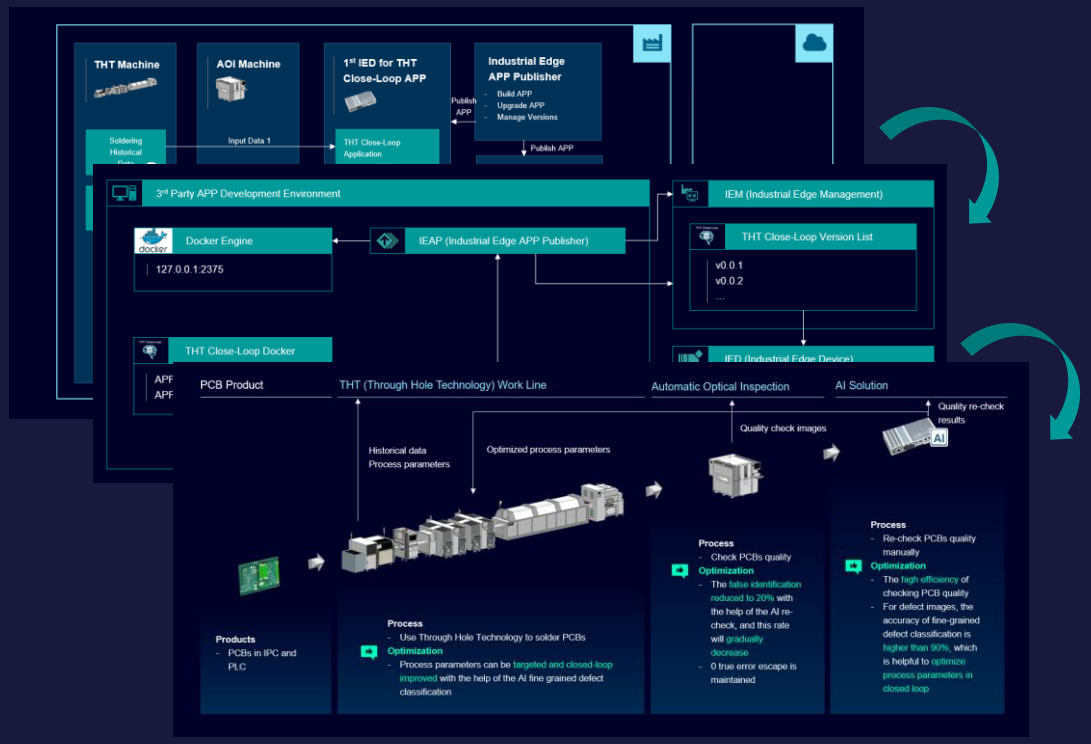
Challenge

Timely, continuous, stable quality re-check for PCB product and process parameter optimization for THT machine

Solution

- With **the rapidity and convenience of data acquisition and processing at the edge side,** the results can be inferenced by the AI model in time
- Based on AI model re-training, the product qualification rate can be continuously and stably improved
- With the help of the Industrial Edge Management, **the application can complete the rapid, batch and distributed deployment and management**



Example 1# - THT Close-Loop

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Application Scenario Background

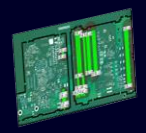
Original work process

PCB Product | THT (Through Hole Technology) Work Line | Automatic Optical Inspection | Manual Solution

Quality re-check results

Quality check results

Optimized process parameters



Products
- PCBs in IPC and PLC

Process
- Use Through Hole Technology to solder PCBs

Issue
- Process parameters cannot be inversely optimized with the help of the accumulated and classified historical production data

Process
- Check PCBs quality

Issue
- 80% false errors (true qualified) are identified as defective by AOI, such error recognition rate cannot be steadily reduced by the manual re-check process

Process
- Re-check PCBs quality manually

Issue
- The low efficiency of checking PCB quality
- The empirical value is difficult to solidify
- The accuracy and stability are difficult to be effectively guaranteed

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Application Scenario Background

Current work process

PCB Product

THT (Through Hole Technology) Work Line

Automatic Optical Inspection

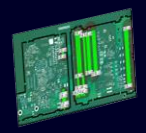
AI Solution

Historical data
Process parameters

Optimized process parameters

Quality check images

Quality re-check results



Products
- PCBs in IPC and PLC

Process
- Use Through Hole Technology to solder PCBs

Optimization
- Process parameters can be targeted and closed-loop improved with the help of the AI fine grained defect classification

Process
- Check PCBs quality

Optimization
- The false identification reduced to 20% with the help of the AI re-check, and this rate will gradually decrease
- 0 true error escape is maintained

Process
- Re-check PCBs quality manually

Optimization
- The high efficiency of checking PCB quality
- For defect images, the accuracy of fine-grained defect classification is higher than 90%, which is helpful to optimize process parameters in closed loop

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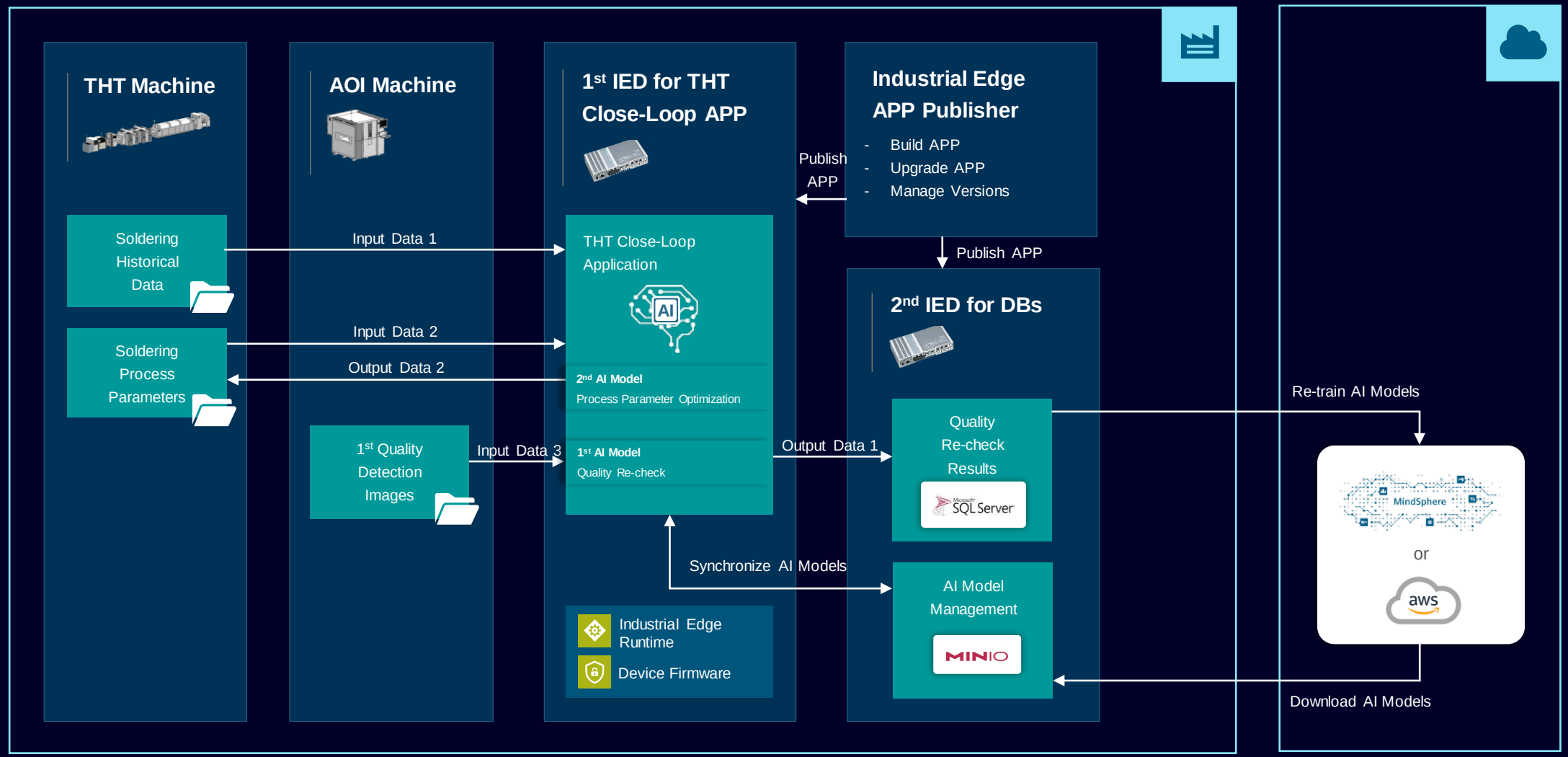
Reference Architecture



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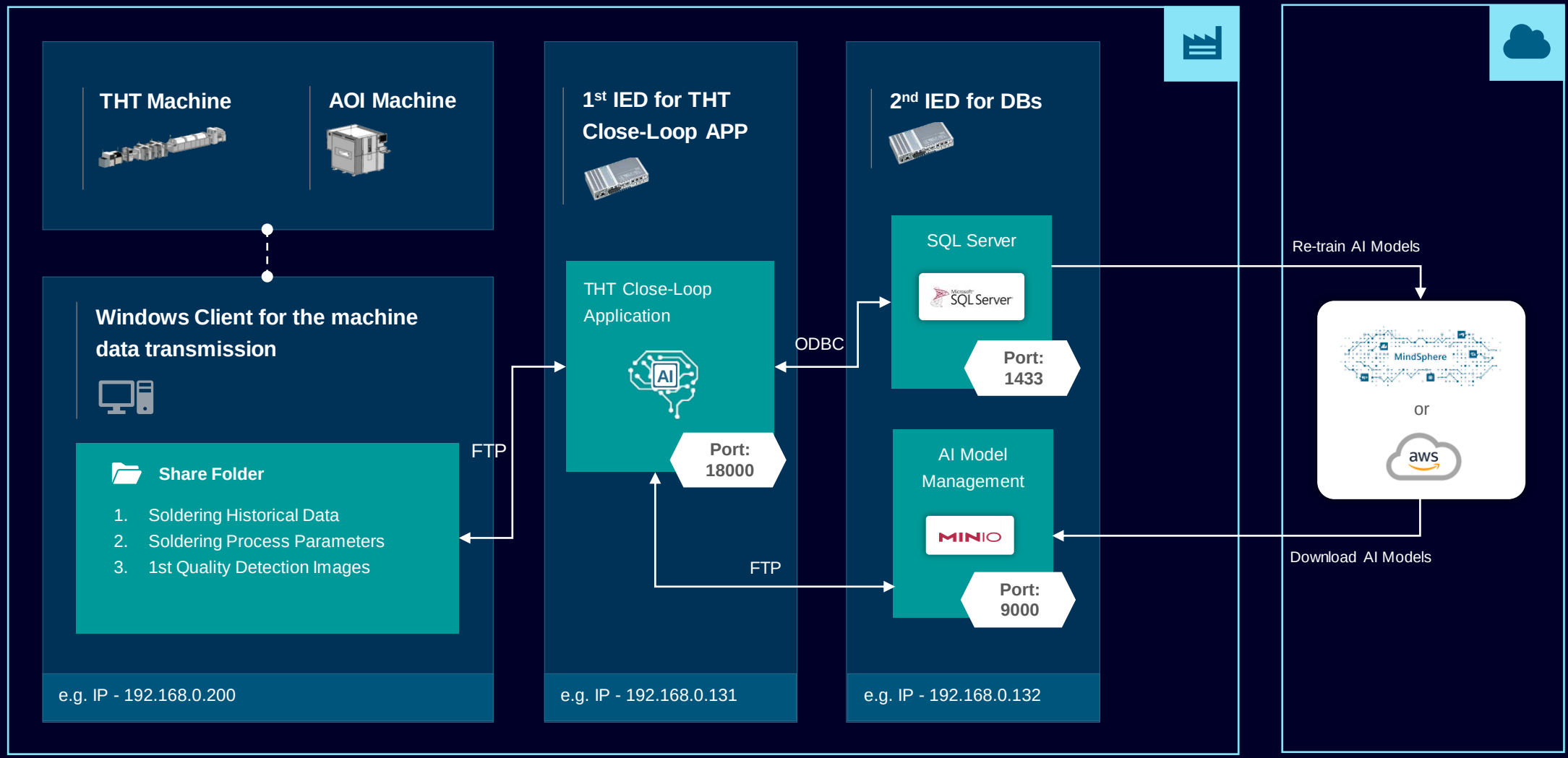
Network Architecture



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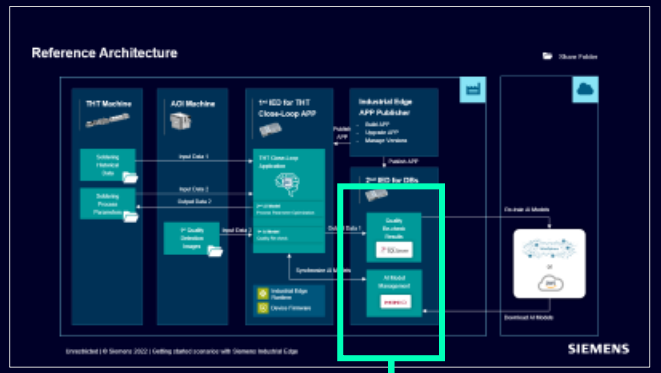
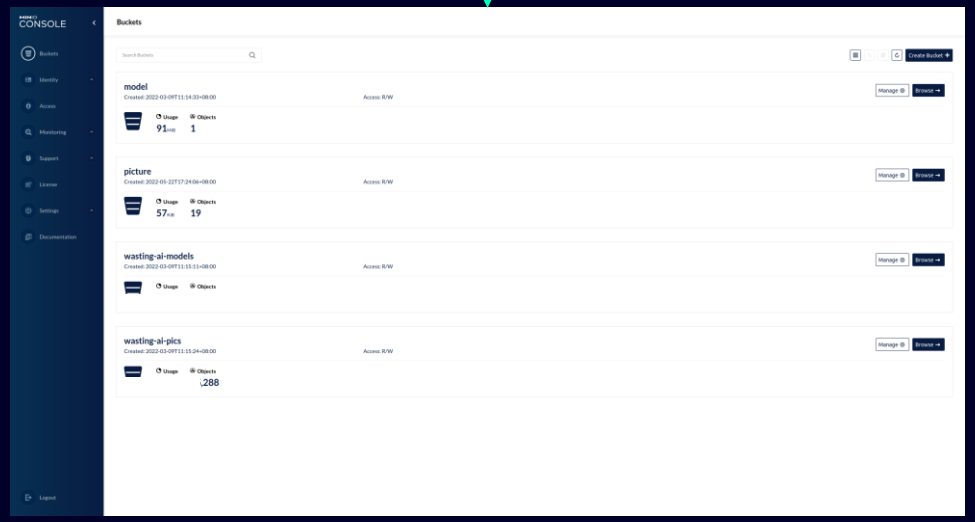
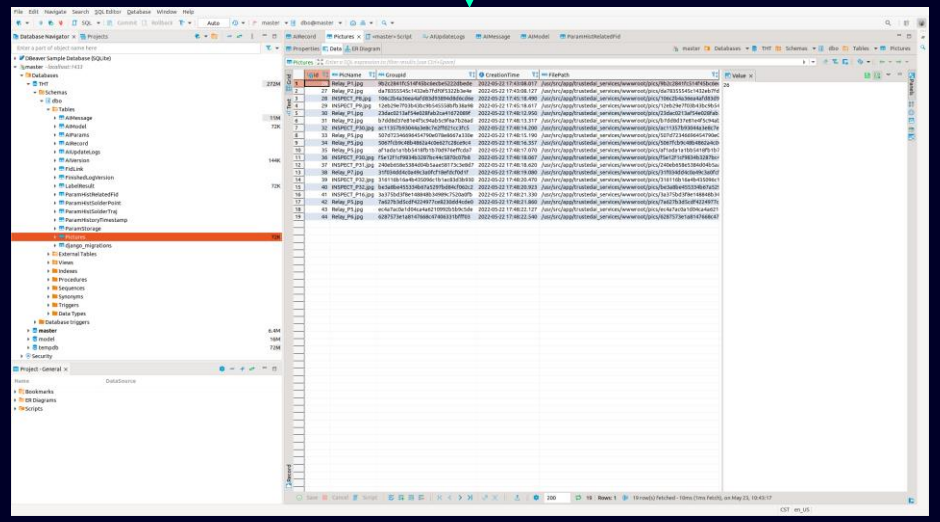
MinIO and SQL Server Features

Data storage and bidirectional transmission between app and cloud







MinIO

- Download the AI models from the cloud and synchronize to the THT Close-Loop APP
- Collect the dataset from the THT Close-Loop APP and upload to the cloud for the AI models retraining

SQL Server

- Store all historical data and key results of the THT Close-Loop APP
- Provide data support for data interaction between MinIO and THT Close-Loop APP

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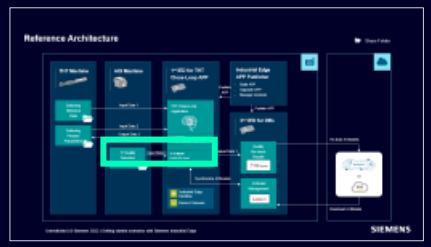
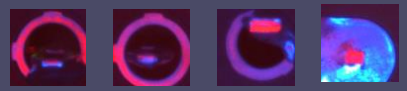
THT Close-Loop APP Feature - Quality Re-check

Quality re-check AI model



Input data

Unqualified results from AOI



Quality re-check model

Model content	Description
Name	ResNet (Residual Network) 50
Definition	The series of ResNet (ResNet50, ResNet101) are widely used in the fields of target classification, also regarded as a part of the backbone classical neural network for the computer vision tasks.
Layer amount	50
Parameter amount	25.5*10^6
Goal	Classify Quality re-check result into three types 1. OK 2. missing soldering 3. insufficient soldering

ResNet50 network structure

1. Convoluted the input
2. Enter the four residual blocks
3. Complete the full connection operation to facilitate the classification task

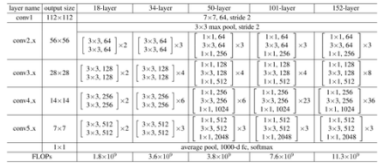
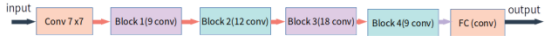


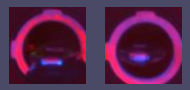
Table 1. Architectures for ImageNet. Building blocks are shown in brackets (see also Fig. 5), with the numbers of blocks stacked. Down-sampling is performed by conv3_1, conv4_1, and conv5_1 with a stride of 2.



Output result

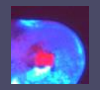
Classify unqualified results into three categories

Type 1 - Qualified



Type 2 – Unqualified in missing welding

Type 3 – Unqualified in insufficient welding



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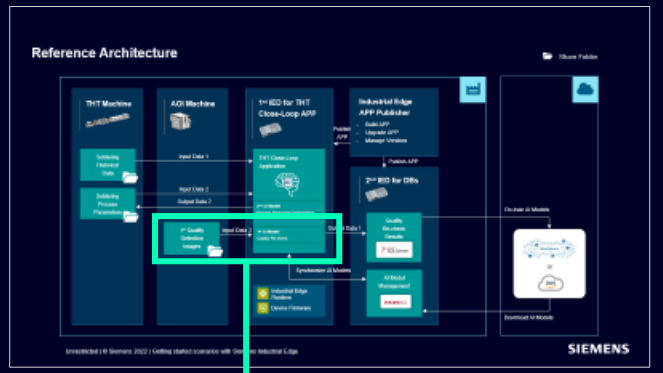
THT Close-Loop APP Feature - Quality Re-check

Quality re-check AI model - inference

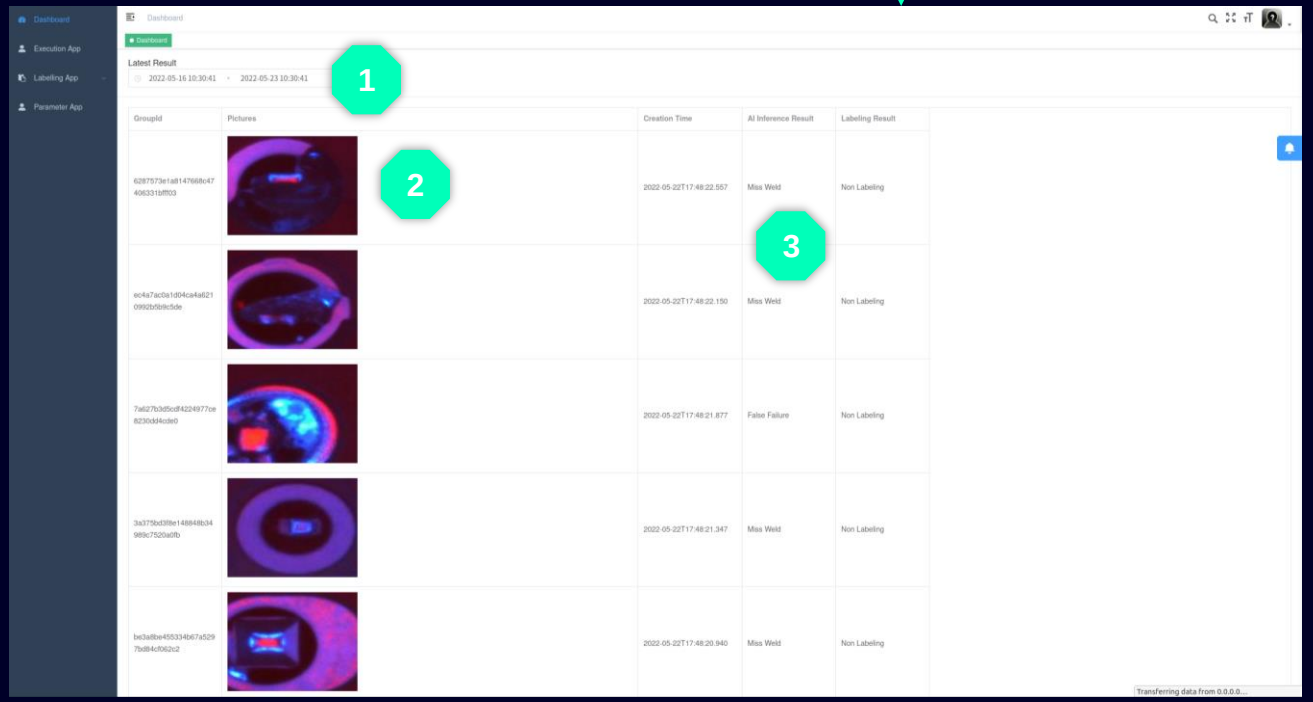


Description

- Based on the imported dataset and selected AI model, app can classify the quality issues and display the PCB quality re-check results in real time

Operation Step

1. Select a user-defined time range to view the PCB THT quality re-check results
2. Each line contains AOI check image, quality re-check result and other key information
3. AI model can classify the results into three categories: false failure (qualified), miss welding and insufficient welding. On the one hand, it can reduce the product waste caused by AOI misjudgment; on the other hand, it can provide help for the optimization of THT process parameters



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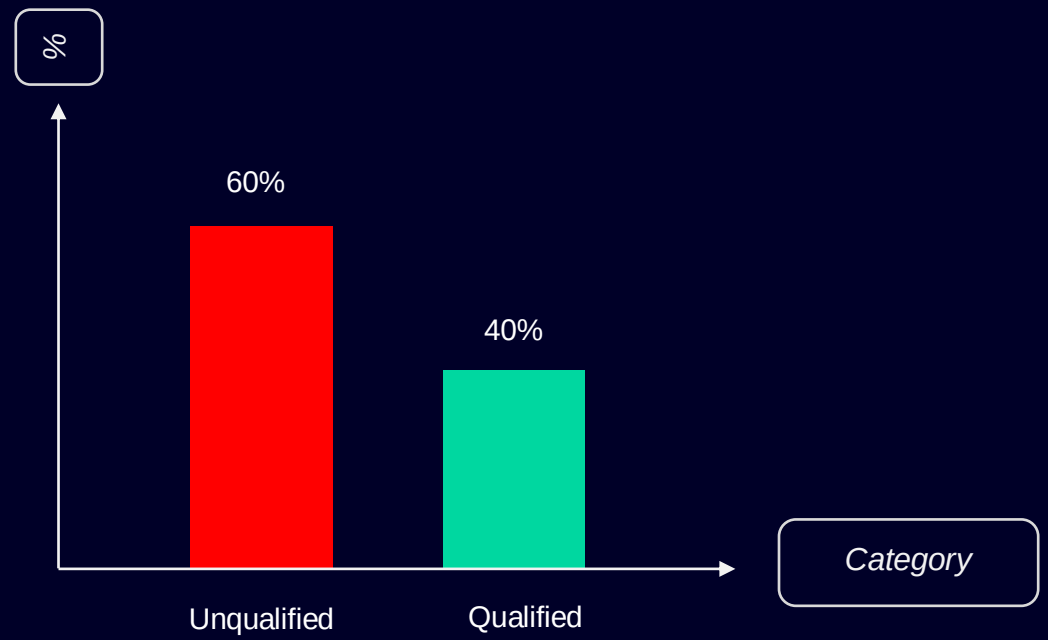
THT Close-Loop APP Feature - Quality Re-check

Quality re-check AI model – inference benefits

- Re-check the unqualified results from AOI and select qualified products, reduce product waste, and greatly reduce the false identification rate from 80% to 20%
- Classify the unqualified products into 2 types – missing welding and insufficient welding, provide direction for THT process parameter optimization

PCB quality check by AOI



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THT Close-Loop APP Feature - Quality Re-check

Quality re-check AI model – inference benefits

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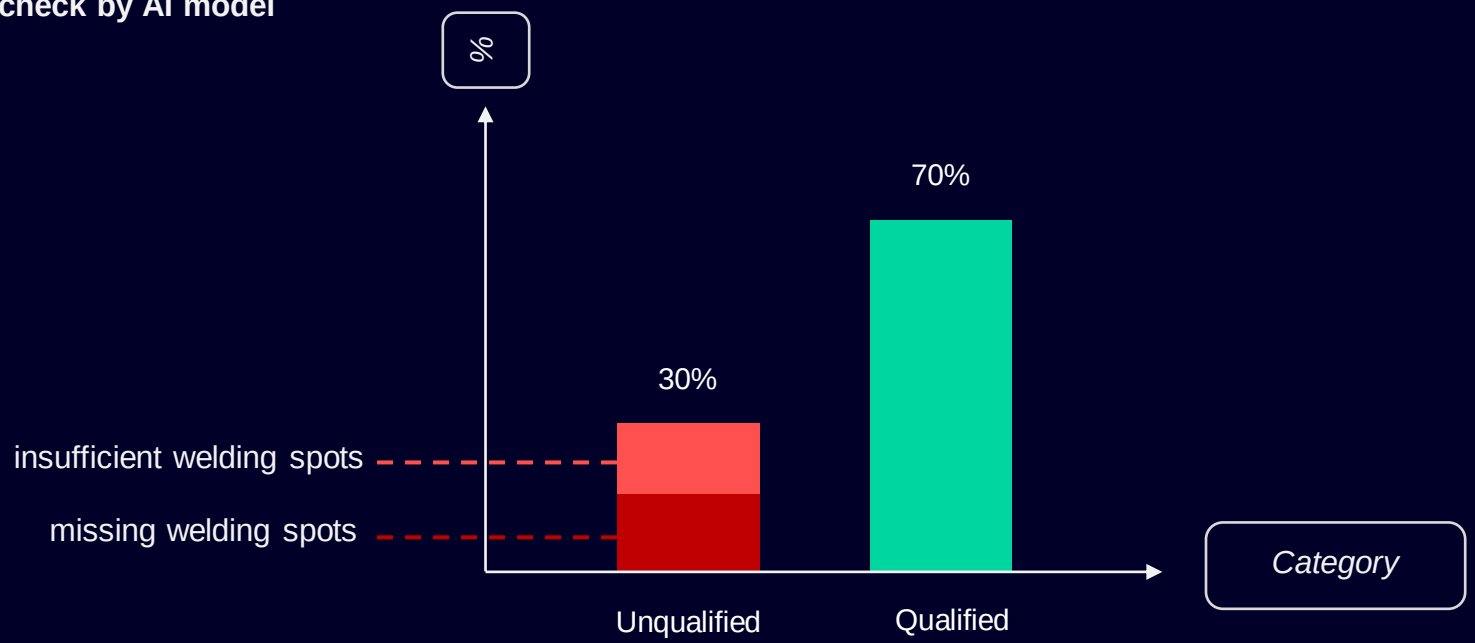
- Classify the unqualified products into 2 types – missing welding and insufficient welding, provide direction for THT process parameter optimization

PCB quality re-check by AI model



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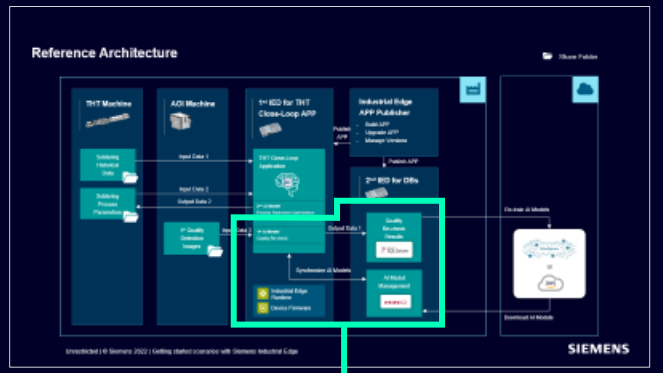
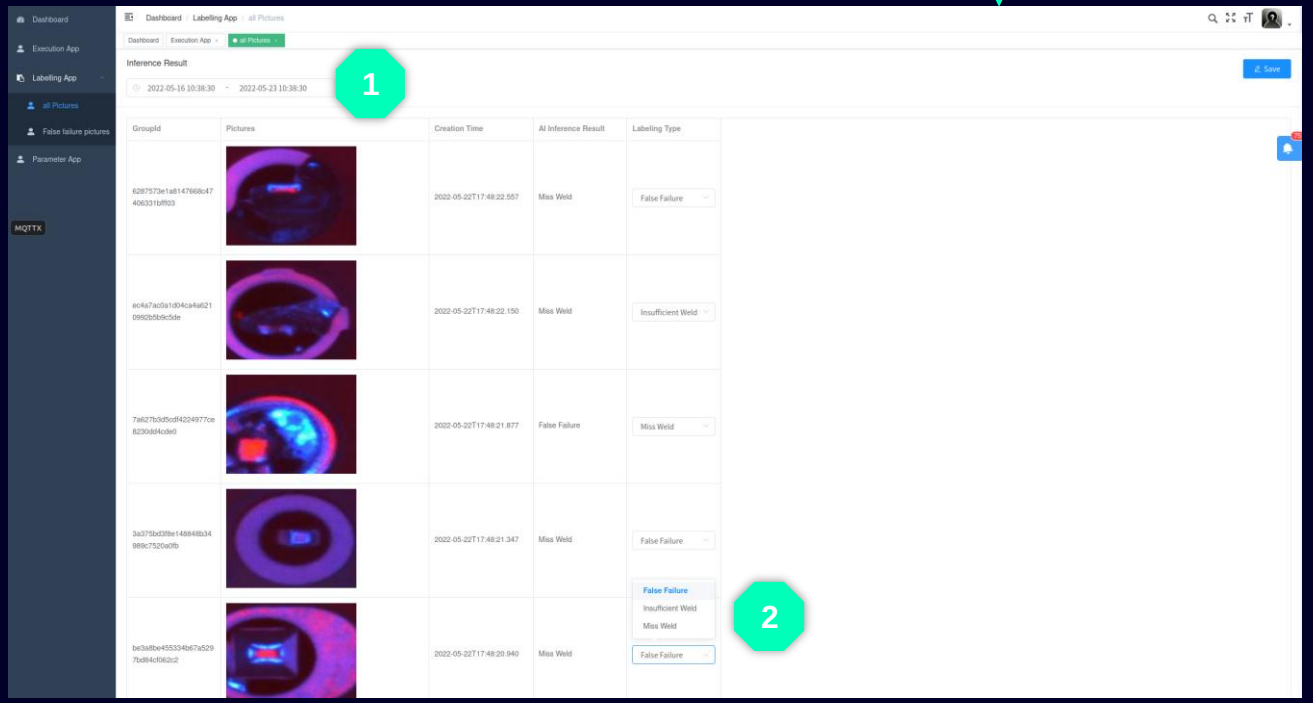
THT Close-Loop APP Feature - Quality Re-check

Quality re-check AI model - retraining





Description

- Not all re-check results are accurate, especially in the early stage of model deployment, which requires repeated training of the model through human intervention to make the model deduction results more accurate

Operation Step

1. Select a user-defined time range to view the PCB THT quality re-check results
2. Using the field experience to correct some of the AI re-check results, then save and upload the correction results to the cloud, so that the model can be further trained and optimized based on these corrected results

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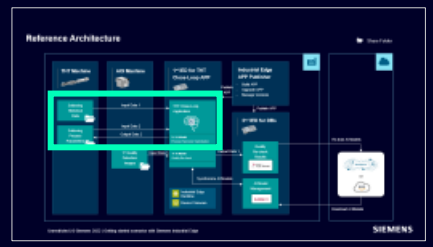
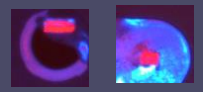
THT Close-Loop APP Feature - Process Parameter Optimization

Process parameter optimization AI model



Input data

Unqualified results from the quality re-check AI model



Production log data from THT

- w10_y2022
- w09_y2022
- …

Process parameters from THT

- A5E35520161.job
- A5E39579684.job
- …

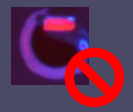
parameter optimization model

Model content	Description
Name	FC (Full Connection)
Definition	In the CNN (Convolutional Neural Networks) structure, after passing through multiple convolution layers and pool layers, one or more FC layers are connected, FC plays the role of classifier.
Layer amount	2 16 nodes in the first layer and 1 node in the second layer
Parameter amount	14
Goal	The parameter optimization is a Numpy Operation, which is a 10*10 matrix operation basically, based on the input data to optimize the process parameters of the THT machine.

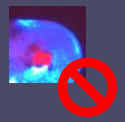
Output result

THT process optimized parameters for the specified jobs containing unqualified results

Optimized A5E35520161.job



Optimized A5E39579684.job



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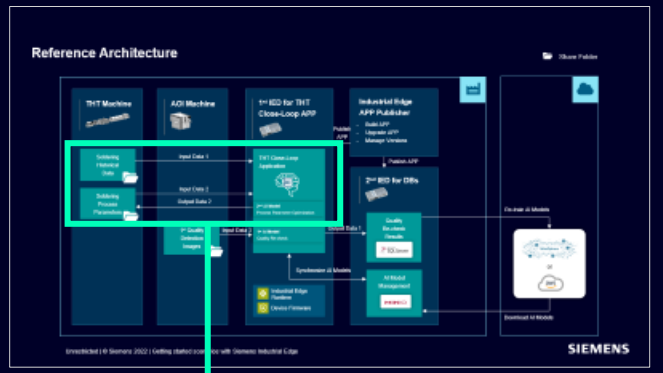
THT Close-Loop APP Feature - Process Parameter Optimization

Process parameter optimization AI model - inference

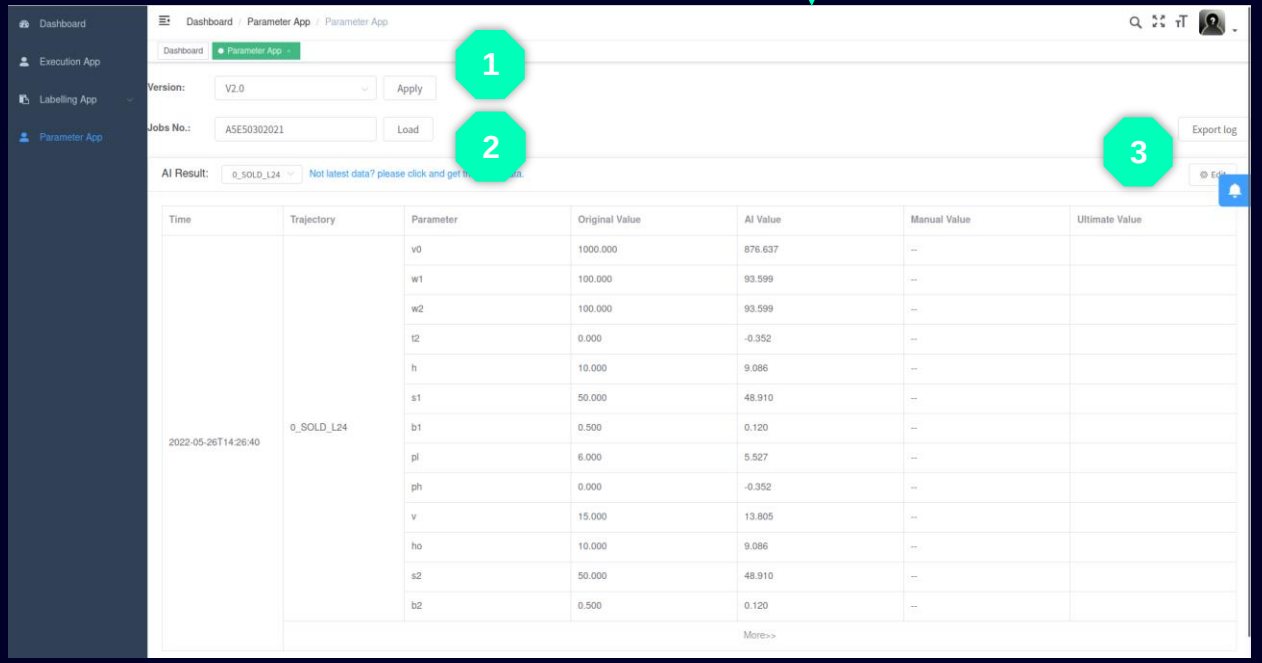


Description

- When the data imported to the process parameter optimization AI model, the app can inference and display the optimized parameters for the corresponding jobs and product, so that user can view the optimized results in real time

Operation Step

1. Select and apply a specified version of the AI model for the inferencing
2. The app can display the latest optimized parameters for the specified product
3. User can intervene the optimized parameters based on the operator experience so that the THT process can use the most accurate and correct parameters to solder the PCBs in the next batch



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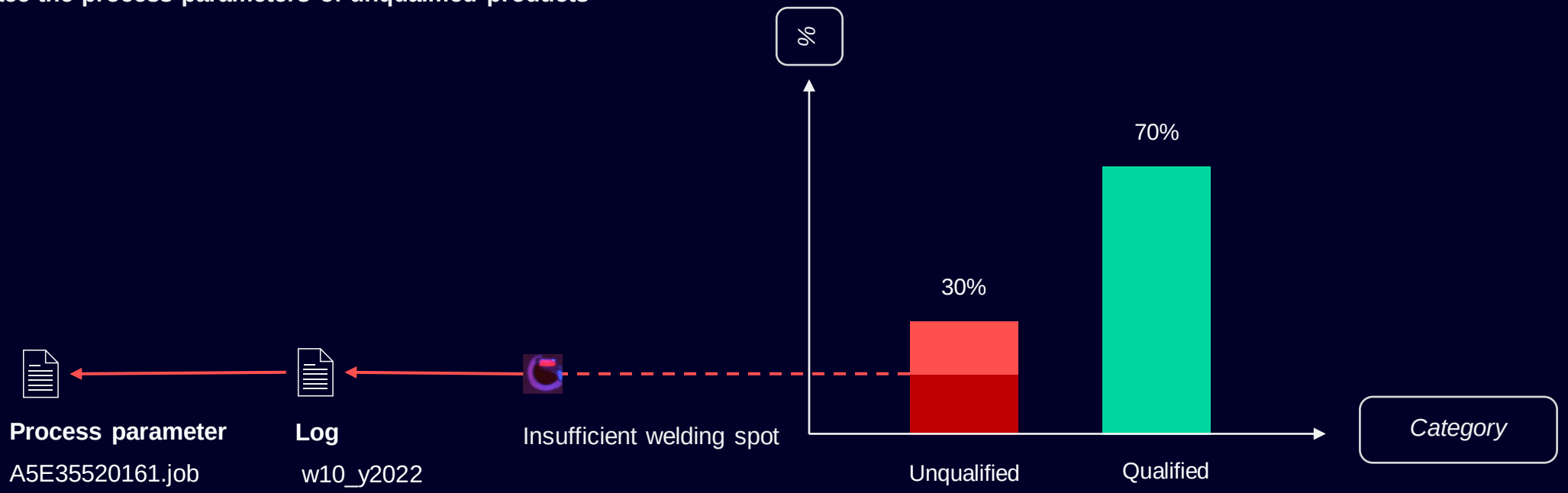
THT Close-Loop APP Feature - Process Parameter Optimization

Process parameter optimization AI model - inference benefits

- Trace and optimize the process parameters of unqualified products, solve the problem of unqualified products from the root, and further reduce the unqualified rate of products

Step 1 – Trace the process parameters of unqualified products



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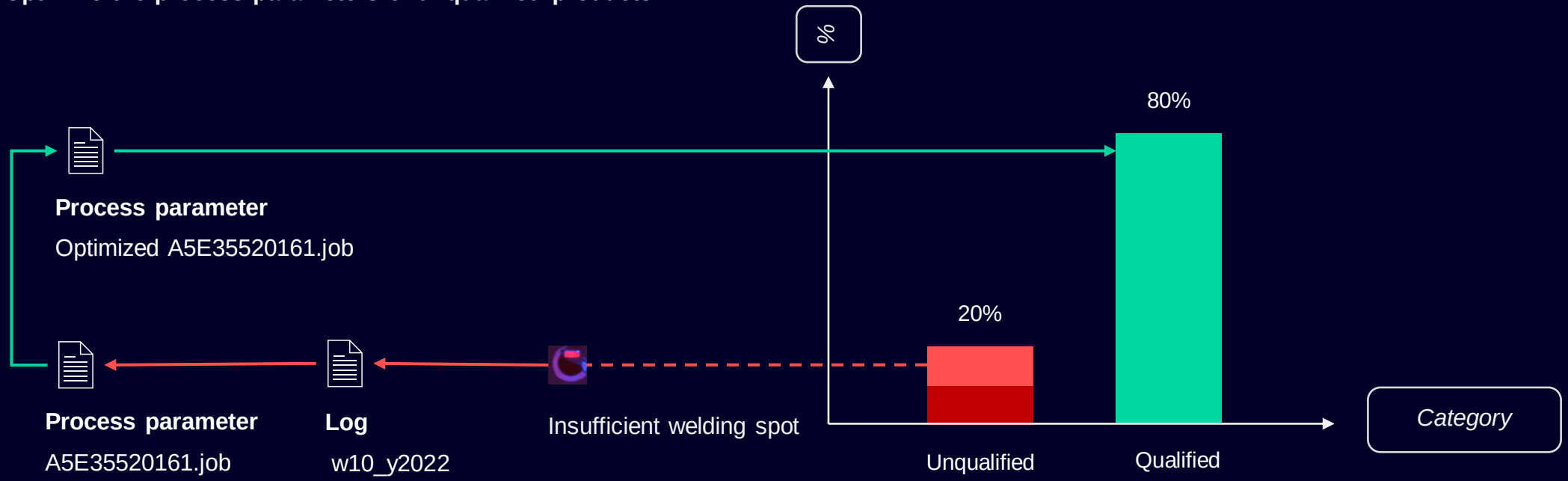
THT Close-Loop APP Feature - Process Parameter Optimization

Process parameter optimization AI model - inference benefits

- Trace and optimize the process parameters of unqualified products, solve the problem of unqualified products from the root, and further reduce the unqualified rate of products

Step 2 – Optimize the process parameters of unqualified products



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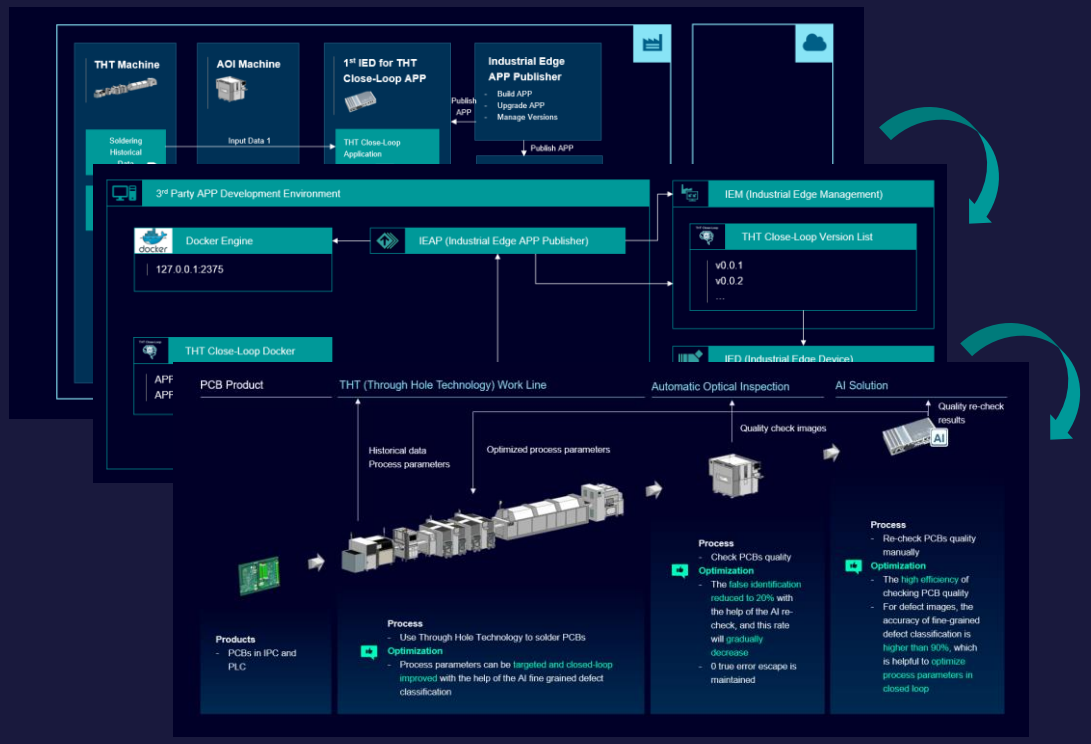
Challenge

Timely, continuous, stable quality re-check for PCB product and process parameter optimization for THT machine

Solution

- With **the rapidity and convenience of data acquisition and processing at the edge side,** the results can be inferenced by the AI model in time
- Based on AI model re-training, the product qualification rate can be continuously and stably improved
- With the help of the Industrial Edge Management, **the application can complete the rapid, batch and distributed deployment and management**



Example 1# - THT Close-Loop

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Thank you !

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