Test Project

Module D

Industry 4.0

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List of documents

NO.	DOCUMENT	DESCRIPTION
1	eInk_API.pdf	eInk API Description
2	Project.splx	Powerconfig configuration file for Siemens SENTRON PAC3220 power meter
3	InfluxDB3 and Grafana configuration.pdf	Documentation of the configuration of InfluxDB3 and Grafana
4	product_4500.json	Configuration file of product 4500 of the Central Factory, as exported in MES4 – Parts - Products

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Introduction

In this Module, your team is asked to implement means to analyse and supervise the production. One key aspect is to monitor the energy consumption of both the local prototype station and the Central Factory. Furthermore, system anomalies like E-Label display failures and falsified data in the central production must be detected and analysed to improve the security and robustness of your company's production.

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Description of project and tasks

This Module will be completed when the following tasks are executed:

1. Failures on the E-Labels are detected.
2. The energy monitoring system is implemented.
3. Energy data of the prototype station and of the Central Factory is logged to a time-series database.
4. Data falsification in the Central Factory is analysed and identified.

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1. Detection of E-Label Failures

In practical usage of the new E-Label, in rare cases there is a risk of display failures, e.g. due to damage or low battery. To ensure the quality of the new product information system you are asked to detect such situations using the ML CAM.

To simulate display failures for the training process of the machine learning algorithm, the endpoints "Set Overlay Image" and "Remove Overlay Image" of the eInk API can be used.

Here display failures are assumed if black pixels cover at least 30% of the display.



Figure 3.1: Example of simulated broken E-Label display.

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Your detection shall meet the following requirements:

NO.	ITEM DESCRIPTION
1.1	In the software of the ML CAM, a new region of interest (ROI) is configured to cover the display of the E-Label.
1.2	The new classes "Display ok" and "Display failure" are added.
1.3	A display without failure is classified as "Display ok".
1.4	A display with failure is classified as "Display failure".
1.5	On the "Product Information Dashboard" of Module A, in section "Product Data", a text is added with label "Display status".
1.6	If "Display ok" is classified, then • "Display status" shows "OK" as green text
1.7	If "Display failure" is classified, then • "Display status" shows "Failure" as red text, followed by the detection confidence in brackets, e.g. "Failure (99%)", and • the error message ("Display failure") appears on the HMI and prevents starting the CP Lab in "Automatic" mode. When a display without failure is classified, and the error message is closed, the CP Lab must be able to start. Acknowledging the error message manually or closing the error message automatically is both acceptable.

Files to be delivered:

- None.

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2. Energy Monitoring System

The energy consumption of the prototype station shall be measured and stored locally.

For this purpose, the EMB shall be integrated as sketched in Figure 1.1. The apprentice of your company has already started to configure the power meter and provides you with the file "Project.splx". He has not finished his work, nor done his work completely correctly. Use this file with Siemens Powerconfig to configure the power meter, and change the configurations where necessary.

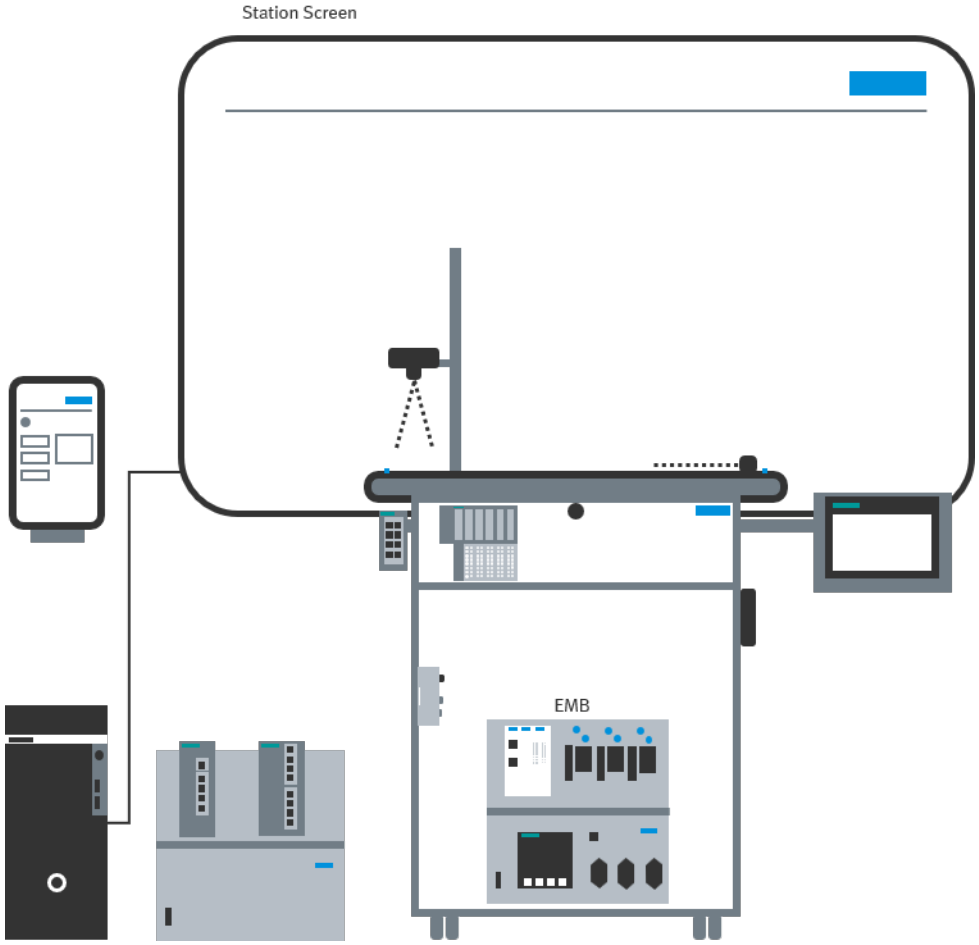


Figure 2.1: CP Lab prototype station with added Energy Measurement Box.

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The energy monitoring system shall meet the following requirements:

NO.	ITEM DESCRIPTION
2.1	The EMB has to be installed in the trolley of the CP Lab and the required connections must be made.
2.2	The power meter shall measure the electrical consumption of the following components on L2: • CP-L-CONV including S7 PLC, CP-L-SWITCH, IO-Link-Sensor, IO-Link master module • HMI • IoT Gateway
2.3	The Ethernet connection of the EMB is connected and the IP addresses are configured, so that the MES PC can communicate • with the Webvisu of the Codesys program running on the CPX-E controller of the Energy Measurement Box via its webserver (…"webvisu.htm") • with the PAC3220 power meter via its webserver. Links to the webservers are saved as • "Solutions\Module_D\2_webvisu" • "Solutions\Module_D\2_powermeter"
2.4	The configuration file "Project.splx" shall be loaded to the power meter.
2.5	In the Device Information of the PAC3220, the following information shall be set: • Location identifier: "Shanghai" • Installation date: (*Set to current date)*
2.6	The time zone must be set to UTC+8 and "No daylight saving" mode.
2.7	Settings must be corrected, so that the correct power values are measured.
2.8	All changes in the power meter configuration are saved in the file "Solutions\Module_D\2_Project.splx" and the file is encrypted with password "Shanghai4.0".
2.9	The flow and pressure sensor of channel 2 shall measure the compressed air of CP-L-CONV.
2.10	The display of the flow sensor of channel 2 shall indicate an unusual high air consumption of >10 l/min by changing the background colour from blue to red.

Files to be delivered:

- Solutions\Module_D\2_webvisu
- Solutions\Module_D\2_powermeter
- Solutions\Module_D\2_Project.splx

3. Data Recording and Visualization

The energy consumption of the prototype station shall be recorded in a time-series database for efficient storage and visualization.

In a second step the visualization shall be extended with measurements from the Central Factory and a clear supervision of the behaviour of the heating application modules shall be implemented.

The data recording and visualization shall meet the following requirements:

NO.	ITEM DESCRIPTION
3.1	A time-series database "energy-monitoring" is created locally on the MES PC in InfluxDB3. See "InfluxDB3 and Grafana configuration" for configuration information.
3.2	The electrical active power measured by the EMB on channel 2 is saved to the database with • measurement "powermeter" • field "activepowerl2" • sampling rate 1 Hz
3.3	In Grafana a dashboard with title "Production Monitoring" is created and a link is saved as "Solutions\Module_D\3_dashboard". The dashboard has to be optimized for the Station Screen. Don't change the Grafana password.
3.4	The dashboard shows the electrical power as recorded by the local time-series database of the last 15 minutes as line chart with sampling rate 1 Hz.
3.5	On the dashboard the last non-null value of 3.4 is shown as Gauge next to the line chart.
3.6	In Grafana, the database of the Central Factory is connected as second data source with the following connection parameters: • http://192.168.10.2:8181 • Query language: SQL • Database name: central-factory • Token: (as published on http://192.168.10.2:1880/ui) • "Insecure connection"
3.7	The dashboard is extended with the active power L3 of the Central Factory. The data is included in the table "energy" of the database central-factory. The information is visualized as a line chart of the last 15 minutes with sampling rate 1 Hz.
3.8	The line chart indicates values exceeding 400 W with red colour.
3.9	On the dashboard the last non-null value of 3.7 is shown as Gauge next to the line chart.
3.10	The Gauge 3.8 indicates values exceeding 400 W with red colour.

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3.11	The dashboard is extended with the state “xBusy” of the Heating. The data is included in the table “heating” of the database central-factory. The information is visualized as state timeline of the last 15 minutes with sampling rate 1 Hz.
3.12	The state timeline indicates the two states • “false”, coloured in green and labelled as “not active” in the chart • “true”, coloured in red and labelled as “active” in the chart.

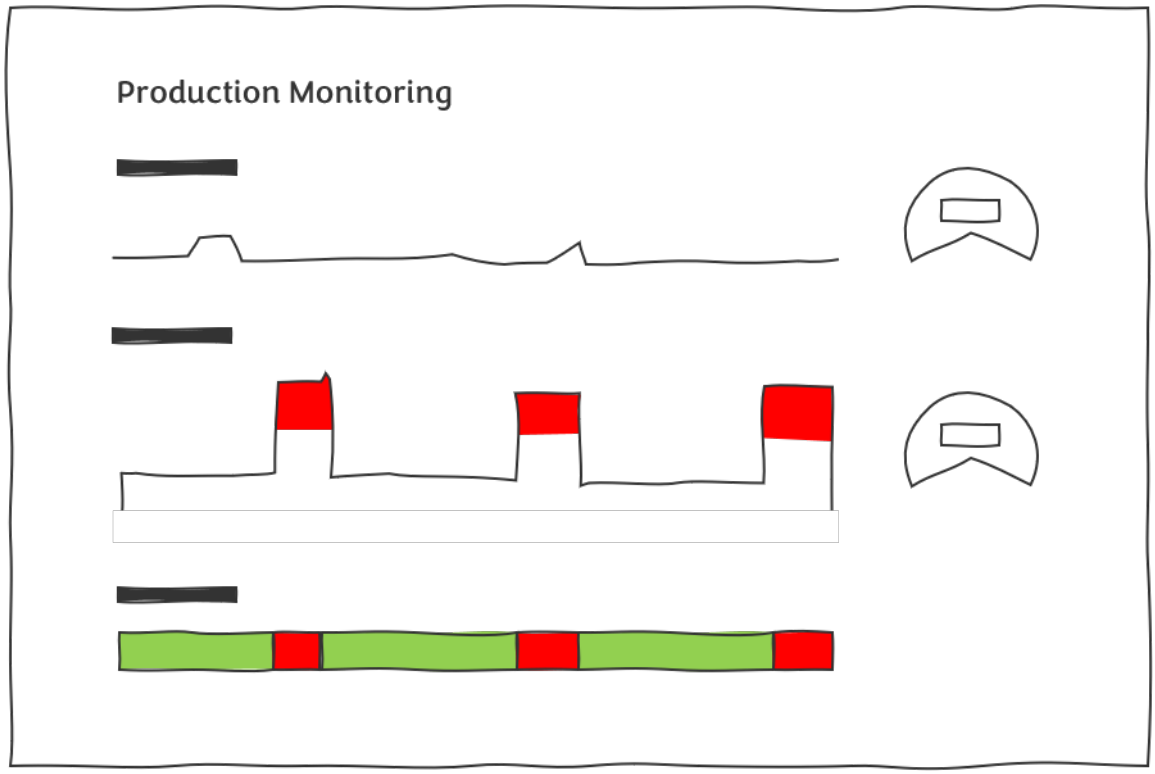


Figure 3.1: Sketch of the Production Monitoring dashboard.

Files to be delivered:

- Solutions\Module_D\3_dashboard

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4. Data Falsification Detection

According to your company's security officer, the OT network of your Central Factory production is presumably hacked! Even though strong IT security measures have been implemented, the officer reported unknown network activity and possible data falsification in the heating application module. This might be caused by a so-called Man-in-the-middle attack of a suspicious device.

Your task is to investigate this case current production scenario in the Central Factory. You will have the following data available:

- Order information of new created orders in the MES with steps and parameters via MQTT
- PLC data with order information of station 6 (Heating) via MQTT
- A Wireshark network traffic recording of around 1 hour based on the mirrored port of the MES PC of the Central Factory, which will be provided via the WorldSkills Competitor Communication System (WSCCS) to your Team.
- An Address Resolution Protocol (ARP) table of the interface 172.21.0.90 of the MES PC of the Central Factory.

Important information:

The Wireshark recording will start 2 hours after the competition start, and it will take 1 hour. Make sure to receive the provided information via MQTT during this recording period so you can analyse all data later.
Start and stop of the recording will be announced via the WSCCS.

Your data analysis shall meet the following requirements:

NO.	ITEM DESCRIPTION
4.1	A new dashboard "Data Falsification Detection" is created and a link is saved as "Solutions\Module_D\4_dashboard".
4.2	Information about a new MES order is received on the MES PC via MQTT with the following specifications: • Broker: 192.168.10.2 • Port: 1883 • User and password: (see credentials) • Topic: public/mes/neworder/tblstepparameter • Data: The content of tblstepparameter of the new order The workplan of the production of PNo 4500 is provided for your information as an MES4 part export as "product_4500.json".
4.3	On the dashboard, in a table each new order positions is added as a row, with the following columns: • ONo • OPos • Heating Parameter 1 • Heating Parameter 2 Only order positions for PNo 4500 shall be listed.

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4.4	PLC data is received on the MES PC via MQTT with the following specifications:
	• Broker: 192.168.10.2
	• Port: 1883
	• User and password: (see credentials)
	• Topics:
	  • public/plc/heating/ONo
	  • public/plc/heating/OPos
	  • public/plc/heating/temperature (= parameter 1)
	  • public/plc/heating/time (= parameter 2)
	Each topic is only sent when its value has changed.

4.5	On the dashboard, in a second table each processed production step is added as a row, with the following columns: • ONo • OPos • Heating parameter 1 • Heating parameter 2 Only order positions for PNo 4500 shall be listed.
4.6	In both tables, the orders are sorted with the latest (highest) order numbers and positions on the top.
4.7	The Wireshark network traffic capture file "CF.pcapng" and the ARP table "ARP.txt" are received via the WorldSkills WSCCS and analysed.
4.8	A documentation is created and saved as "4_falsification_detection.pdf" with the following information: 1. List of analysed data sources 2. Example of falsified data 3. Identified foreign device which falsifies data (IP address, MAC address) **4.** Naming of three different potential measures to avoid this cyber-attack.

Files to be delivered:

- Solutions\Module_D\4_dashboard
- Solutions\Module_D\4_falsification_detection.pdf

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Instructions to the Competitor

The Test Project and related documents will be provided digitally.

Competitors may use personal computers during development. Final solutions must be deployed and executed on the provided MES Server PC with Station Screen. It is allowed to connect monitors, a keyboard, and mouse to the MES Server PC or to access it via Remote Desktop Connection**.**

Whenever a shared network infrastructure is used, any attempt to gain unauthorized access to network devices including servers, switches, routers or devices and systems of other teams, or to disturb data traffic, is prohibited, regardless of success.

Make sure to save and backup your work before leaving the workplace.

Files to be delivered are to be stored on the Desktop of the MES Server PC in the given directories.

Unless otherwise specified, all interfaces and signals may be implemented using appropriate engineering judgment, provided that the required system behaviour is achieved.

During the marking, only solutions running or saved on the competition system are evaluated, unless requested differently.