Test Project

Module C

Industry 4.0

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List of documents

NO.	DOCUMENT	DESCRIPTION
1	eInk_API.pdf	eInk API Description
2	iotgw-signature-ml.json	IoT Gateway signature file

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Introduction

In this Module, your team will use the new E-Label to make product and production data directly accessible on the product. Data will then be transferred to a central Cloud system through a secure network.

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Description of project and tasks

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

1. Live production data is written to the E-Label.
2. A tablet is integrated to supervise the E-Label integration.
3. The network of the prototype station is secured.
4. The IoT Gateway is integrated to transfer data to the cloud.

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1. Live Data Writing to E-Label

On the new workpiece data shall be written. Data writing is performed via a wireless access point, which is already connected to the E-Labels, and control software running on a central server. The server provides a REST API described in eInk_API.pdf and is accessible on

Host: 192.168.10.2
Port: 3001.

For authentication, the credentials provided must be used, and for writing the ID of the E-Label is required. The ID of the E-Label is printed in the footer of the display and encoded as a barcode.

A carrier with pallet and workpiece is assumed to be placed at the left end of the conveyor belt as in Module A. The CP Lab is switched to "Setup" mode. In "Parameters", "Application", "Mode", "Simulate application" is selected, so that the carrier stops in the stopper position. It waits until the simulation in CIROS is done, or until "Confirm" is pressed. Both alternatives are acceptable in this Module.



Figure 1.1: New workpiece on a carrier at the left end of the conveyor belt.

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The data writing functionality shall meet the following requirements:

NO.	ITEM DESCRIPTION
1.1	On the "Product Information Dashboard" of Module A, in section "Product Data", a button with label "Clear data on E-Label" and red background color is added.
1.2	If a carrier is detected at the left end of the conveyor, and the button "Clear data on E-Label" is pressed, then the "eInk API" is used to clear all writable data of the eInk display of the E-Label. Only the Logos in the header and the ID in footer shall remain, compare Figure 1.2. To identify the ID of the E-Label, the camera detection developed in Module A shall be used. As an alternative, it is allowed to provide an input field labelled "ID" on the dashboard which can be used to enter the ID manually in case the ID is not detected.
1.3	A button with label "Read next order data" and green background colour is added.
1.4	If the button is pressed, then the following information of the next order has to be requested from the MES: • ONo • OPos • OpNo • PartNo Next order means the waiting order position in the MES which will be executed next when the carrier arrives at the stopper. To request the data from the MES, the requests "GetOpForRsc" or "GetOpForCarrier" can be used. A fixed resourceID and the carrierID of the provided carrier can be assumed. The request can be implemented either in the PLC or with your dashboard application. However, later in this Module, the information will be required in the S7 PLC.
1.5	The order information is shown on the dashboard within 5 seconds after button press.
1.6	The order information is shown on the E-Label as follows: • title "Order {ONo}-{OPos}" • subtitle "Part {PartNo}"
1.7	The QR code on the E-Label references the Product Information Dashboard URL.
1.8	The "message" property of the response of the request "PUT labels/{{barcode}}" is shown on the dashboard for a limited time period between 3 and 7 seconds.
1.9	On the dashboard, a text informs about the presence of a carrier at the stopper position: • "Carrier at stopper position" in green text, if a carrier is present • "No carrier" in black text, if no carrier is present.

1.10	When the dispensing process has been finished – either by the CIROS simulation or by pressing "Confirm" on the HMI and selecting "finish step"/"finish step with error" in the MES manually – the result of the process step is displayed as property "message" on the E-Label as follows: • If the step finished successfully: "Successful" as white text on black background • If the step finished with error: "Error" as white text on red background In both cases, the other existing data remain.



Figure 1.2: Display of the E-Label after clearing the content (example ID).

Files to be delivered:

- None

2. Tablet Integration

A tablet is added as a mobile user interface to the system.

It shall connect to the system via the SCALANCE S615 and access selected services while being restricted from industrial control components.

The cloud system is available in the network 192.168.100.0/24 via DHCP and must remain accessible.

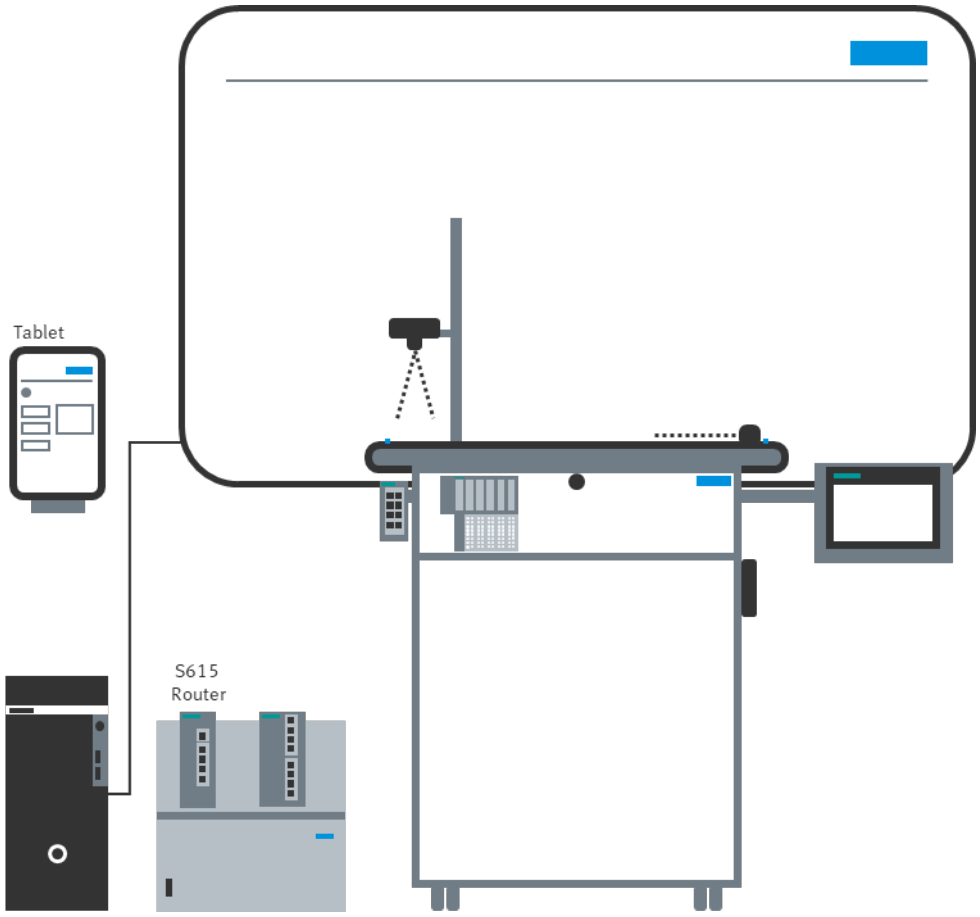


Figure 2.1: Tablet and S615 Router added to the system (network cables not shown).

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The tablet integration shall meet the following requirements:

NO.	ITEM DESCRIPTION
2.1	The tablet is connected to the SCALANCE S615 via Ethernet cable and provided adapters. It is placed on the tablet holder.
2.2	The tablet receives its IP address automatically via DHCP.
2.3	The tablet IP address must be in a separate subnet (not 192.168.100.0/24 and not 172.21.0.0/18).
2.4	The tablet can access the Product Information Dashboard on the MES PC.
2.5	Access from the tablet is not allowed • to the Webshop frontend on the MES PC, • to the web interface of the S7 PLC (172.21.1.1), • to the web interface of the IO-Link master. Access restrictions shall be implemented using the SCALANCE S615 firewall.

Files to be delivered:

- None.

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3. Network Security

The industrial communication system shall be restructured using the managed switch (XC208) and the S615 router to create a clear, robust, and maintainable network architecture.

The tablet remains connected to the SCALANCE S615 and is not modified in this task.

The network configuration shall meet the following requirements:

NO.	ITEM DESCRIPTION
3.1	The following devices are connected to the XC208 directly or via the unmanaged switch: • S7 PLC • HMI • IO-Link master • ML CAM • IoT Gateway (device side interface)
3.2	Port 0.3 of the XC208 switch is left unconnected, so that later devices can be connected.
3.3	If your tablet with your ethernet adapter (with its specific MAC address) is connected to port 0.3 in DHCP client mode, it shall: • receive a valid IP address from the DHCP server • be able to communicate with the MES PC (172.21.0.90) After verification, reconnect the tablet to the router.
3.4	If any other device is connected to port 0.3, it shall: • Not receive a valid IP address from the DHCP server • Not be able to communicate with the MES PC (172.21.0.90).
3.5	Changes in the cable connection (plugged/unplugged) on the ports of the XC208 switch are notified via email: • to the email server on the MES PC • via SMTP port 25 • to the recipient support@festo.systems • without authentication • without transport security The email account is already set up in hMailServer with password “Festo4.0”.
3.6	No other events of the XC208 switch are sent via email.
3.7	MES PC can access all industrial devices.
3.8	The PLC, HMI and IO-Link master can communicate with each other.
3.9	The IoT Gateway (device-side interface) can access: • S7 PLC (OPC UA)

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	• ML Camera data
3.10	The IoT Gateway (cloud side interface) is connected to the S615 router and can access the cloud network 192.168.10.0/24.
3.11	The MES PC allows access to the Cloud PC 192.168.10.2 on port 1880 and to the ports required to meet the previous specification. Other ports of the Cloud PC shall be blocked.
3.12	The created network infrastructure is documented in "3_network_documentation.pdf". The following items are required: • List of all network devices with name, IP address, subnet • Network topology diagram • Communication matrix showing which systems can communicate with each other

Files to be delivered:

- Solutions\Module_C\3_network_documentation.pdf

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4. IoT Data Transfer

The objective is to implement a system that collects, structures, and transmits product-related data across all system levels, from shopfloor devices to a cloud-based service.

The IoT data transfer shall meet the following requirements:

NO.	ITEM DESCRIPTION
4.1	The IoT Gateway is mounted on a DIN rail in the CP Lab trolley and connected electrically.
4.2	The device side and cloud side interfaces are connected according to the specification in the previous task.
4.3	The gateway is configured with a valid IP address in the industrial network. The URL to the web interface is saved as "Solutions\Module_C\4_iotgw", and the password is set to "Shanghai4.0".
4.4	The provided signature file "iotgw-signature-ml.json" is loaded to IoT Gateway.
4.5	The ML CAM is onboarded.
4.6	An OPC UA server interface with name "s7productdata" is configured in the S7 PLC.
4.7	The OPC UA server interface provides access to the following data • ONo • OPos • PNo • ProductKey of type string: "team{team number}" identifying your device e.g. "team20" The order data has already been requested in requirement 1.4.
4.8	The signature file is extended for the new device type "s7productdata" to map the OPC UA variables to the following MQTT destination keys: • ONo → orderNumber • OPos → orderPosition • PNo → partNumber
4.9	The OPC UA server interface of the S7 PLC is onboarded as type "s7productdata" to the IoT Gateway and is sending the last data set every 5 seconds with via the MQTT topic "team/{id}/{deviceId}/IOTGW-RT", with {id} the number of the team, and {deviceId} the ProductKey, e.g. "team/20/team20/IOTGW-RT".
4.10	Additionally, the data set is sent on change of the ONo via the topic "team/{id}/IOTGW-CHANGE", with {id} the number of the team, and {deviceId} the ProductKey, e.g. "team/20/team20/IOTGW-CHANGE".
4.11	The data is sent to the MQTT broker with endpoint • Host: 192.168.10.2 • Port: 1883 • User/Password provided per team

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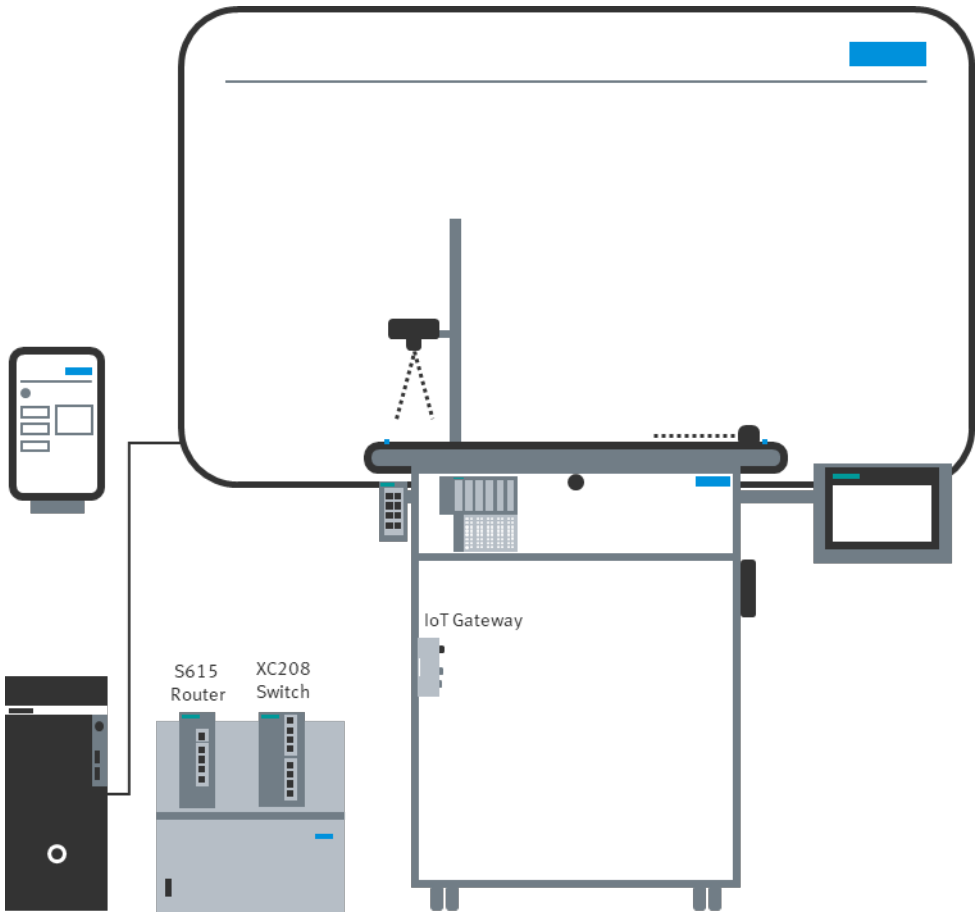


Figure 4.1: Prototype station with manageable network devices and IoT Gateway.

Files to be delivered:

- Solutions\Module_C\4_iotgw

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.