RE-MAIN

Co-funded by the European Union

REmote MAINtenance of Smart Industry Installations

RE-MAIN Technical Guidelines

Project Result 3

31/07/2024

The 'RE-MAIN' project is co-financed by the European Union. The opinions and views expressed in this document commit only the authors and do not necessarily reflect those of the European Union or of the Spanish Service for the Internationalisation of Education (SEPIE). Neither the European Union nor the SEPIE National Agency can be held responsible for them.

Content

PURPOSE OF THE TECHNICAL GUIDELINES

This document has a function of **methodological support** and works as a handbook to help educators/teachers to correctly use the training contents and tools developed within project result 2 (PR2), to effectively prepare and deliver the first pilot implementation of the training programme. It also aims at serving as a roadmap to facilitate the replication of this initiative by other entities outside the scope of the project after its completion, so that all the necessary aspects for successfully delivering the training are covered.

The document will guide trainers and teachers through all the stages of the process, namely the needs analysis of their target groups, the identification of the required equipment, the adjustment/preparation of this equipment according to the module to be delivered, the micro designing of the learning activities, the choice of teaching techniques and finally the assessment and evaluation tools

The document has the purpose of facilitating the diffusion and transfer of the educational material developed in Project Result 2, thus increasing the impact of it, which is extended far beyond the limited number of staff and students directly involved in the project activities.

This document serves as a comprehensive guide for educators and trainers delivering the combined training program on Remote Maintenance and Data Acquisition. It aims to:

- **Support effective delivery:** Equip educators with the necessary tools and methodologies to successfully implement the training program developed within the project.
- **Facilitate replication:** Provide a roadmap for other entities to replicate the training initiative beyond the project's scope.
- **Guide through training stages:** Offer step-by-step guidance on various aspects, including needs analysis, equipment identification, learning activity design, teaching technique selection, and assessment methods.
- **Promote knowledge transfer:** Facilitate the dissemination and utilization of the educational materials developed within the project, maximizing its impact beyond the immediate participants.

Target Audience:

This document is primarily directed towards trainers, educators, and lecturers responsible for delivering the training program.

Document Structure:

The document is divided into two parts:

- **Part A: Technical Guidelines for trainers/teachers.**
- **Part B: Technical Guidelines for students/learners.**

PART A Technical Guidelines for trainers/teachers

The main objective of the RE-MAIN Transnational training programme (PR2) is to equip teachers/trainers with a training programme methodology to transfer to learners a set of skills, competences and tools necessary to effectively monitor and maintain equipment remotely.
This main objective is reached through a defined, specific and measurable set of Learning ***OUTCOMES***, organized in 4 Modules.

Learning outcomes are fundamental in the definition of the Training programme, as they express measurable competences, knowledge and skills, mandatory for developing appropriate teamwork competencies in planning, design, problem solving and decision making exercises in the remote maintenance topics.
At European level[1], learning outcomes are defined as:
"statements regarding what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and responsibility and autonomy"
For all these purposes the learning outcomes approach strengthens the focus on the individual learner and the level of knowledge, skills and competence s/he is expected to achieve.

Following this approach, Partners have developed their training modules starting from the defined Outcomes, having in mind the real needs of the group target.

The primary goal of the **RE-MAIN Transnational training program (PR2)** is to equip learners with the knowledge, skills, and competencies necessary to effectively monitor and maintain equipment remotely. This objective is achieved through a set of specific and measurable learning outcomes organized into four modules:
MODULE 1 Corrective Remote Maintenance
MODULE 2 Remote Monitoring and Data Acquisition

[1] Council Recommendation EFQ of 22 may 2017 (2017/C 189/03)

MODULE 3 Remote Update of Programs and Functionalities (RE-MAIN_RUPF)

MODULE 4 Industrial Cybersecurity

Target Groups

In line with the development of the project activities, also the Guidelines addresses two different target groups, with particular needs and characteristics, which require dedicated approaches and tools. In particular:

- the direct addressee of this result is constituted by **trainers, educators and lecturers** who will deliver the training programme developed within Project Result 2;
- the secondary target group of the guidelines is represented by the **learners and students** who will attend the training programme itself.

The Part A of the present "Technical Guidelines" is dedicated to the first target group, as it will work as a handbook with the expected impact of develop and increase of their skill set in teaching, organising and micro designing training interventions.

The secondary target group will benefit of a dedicated, separated section of this document called part B Technical Guidelines for students which will present the Programme development and will not consist only of written text, but will be accompanied by a set of visual elements with the aim of making the document more user-friendly and accessible.

Structure of the training

Module Descriptions:

The document provides detailed descriptions of four program modules, including:

1. **Corrective Remote Maintenance:** This module focuses on using remote maintenance systems to troubleshoot and resolve equipment issues. Trainers delivering this module can leverage the information on guiding principles, planned competence acquisition, prerequisites, and course unit content to structure their lessons and activities.

2. **Remote Monitoring and Data Acquisition:** This module covers data gathering practices within factories and how to establish remote data collection systems. Trainers can use the learning outcomes and course content outlines to design lectures, labs, and assignments that teach students about Industry 4.0, data gathering infrastructure, and remote data collection techniques.

3. **Remote Update of Programs and Functionalities (RE-MAIN_RUPF):** This module focuses on updating programs and functionalities on remote machinery. Trainers responsible for this module can use the guiding principle, planned competence acquisition, prerequisites, and course content to deliver practical training sessions on update mechanisms and best practices.

4. **Industrial Cybersecurity:** This module covers cybersecurity principles and practices relevant to industrial control systems. Trainers delivering this module can leverage the course content outlines to teach students about cyber threats, secure communication protocols, network hardening techniques, and virtual private network (VPN) management.

Teacher Preparation:

- **Review module materials:** Thoroughly familiarize yourself with the learning objectives, content, activities, assessments, and allocated time for each module.
- **Prepare teaching aids:** Develop engaging presentations, handouts, and any necessary equipment for demonstrations throughout both modules.
- **Practice activities:** Personally test out the activities to ensure clarity, feasibility, and completion within the designated timeframes.
- **Review assessment methods:** Understand the grading rubrics and feedback guidelines for all assessments in both modules.

Following the PR 2 structure, involved partners will lead the development of the defined modules, following a specific, common structure, which guarantee the homogeneity of the programme. Each module should run independently, although there could be references to other courses and materials where appropriate.

Course descriptor of each Module

Skeleton of Units (example)

Delivery methodologies

IMOOX •

MODULE PLANS

SPECIALIST FIELD:

Module title:

General information

Module code:	
Scope:	
Semester when the module is delivered:	
Specialist field:	
Allocated course units:	

Guiding principle and planned competence acquisition

Guiding principle:	
Planned competence acquisition:	

Location within the curriculum

Prerequisites and corequisites:	
Sequential modules:	

Module assessment

The module is concluded with successful completion of the allocated course units.

Course unit title:

General information

Course unit code:	
Scope (ECTS; contact hours per week):	
Semester when the course unit is delivered:	
Type of course unit (compulsory/optional):	
Mode of delivery:	
Course unit language:	

Course contents and learning outcomes

Course contents	**Learning outcomes** Upon successful completion of the course unit, students are able to

Required and recommended reading*

Required reading:	

Recommended reading:	

*current editions

Course unit assessment

The course unit is concluded with final examination.

Performance components at the first attempt			
Assessment methods		**Weighting**	**Minimum achievement per performance component for the positive completion**
Written test/practical testing	Attendance teaching	100.00 %	> 50.00 %
Total		**100.00 %**	**> 50.00 %**
Details on second attempt:	The second attempt is equal to the first.		
Details on third attempt:	The third attempt is a board examination (weighting 100 %) of the entire course contents.		

Planned learning activities and teaching methods

Attendance teaching		teaching sessions	12 hours
Teaching method:	Frontal lecture		
Social methods:			
Work assignments			5 hours
Teaching method:	Individual exercises and correction in plenary session		
Social methods:			
Self-directed learning			3 hours
Recommended learning methods:	On line reading		
Total		**teaching sessions**	**20.00 hours**

Equipment

Erasmus+ RE-MAIN

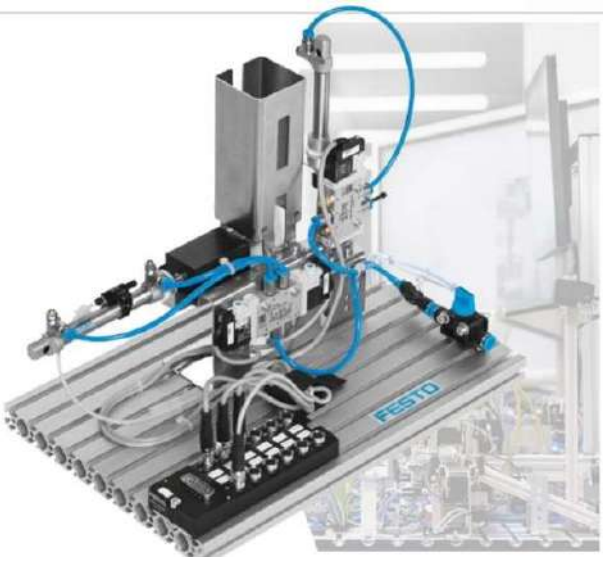
Material Provided By FESTO

Detailed components and Information:

MecLab:
Relevant parts:
- ✓ MecLab Storage Station→ 548704
- ✓ Workpiece→ 554301
- ✓ Cable to wire to CPX-E-PN → 8033586

→ More information of the equipment here

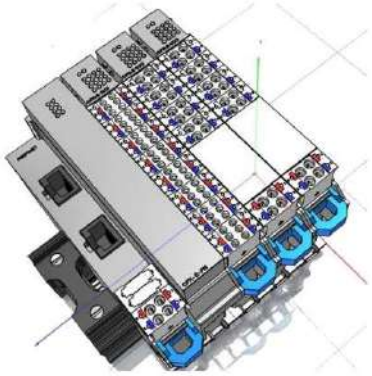
In any automated production line, workpieces must be stored and fed into the production process in an orderly way. In MecLab® that is the job of the Stacking Magazine station.



Erasmus+ RE-MAIN

Material Provided By FESTO

Detailed components and Information:



CPX-E-PN:
- ✓ Profinet Slave for bus communication with a Profinet Master
- ✓ 16 DI and 16 DO

→ More information here

CPX-E-PN

4080497	CPX-E-PN	Módulo de bus
4080492	CPX-E-16DI	Digital Input Module
4080491	CPX-E-8DO	Digital Output Module
4080491	CPX-E-8DO	Digital Output Module

Erasmus+ RE-MAIN

Material Provided By FESTO

Detailed components and Information:

IT- Cibersecurity:
- ✓ Pack SCE Scalance XC208
- ✓ Pack SCE IE Scalance 615

→ More information here

⚠ This Cybersecurity System is not assembled in an edutrainer so it will be delivered in the original packaging and the commisioning and integration on the system is responsability of the participant.

- **Stations (D:ML-S-VZ-M):** 1 unit is listed, a master station that controls communication on the network.
- **Parts (D:MPS-PA-SATZ-GH):** 1 unit is listed, likely a specific component or spare part for the system.
- **Cable (D:MP4-ET-LG-ST-2,0M):** This is a 2.0-meter long connection cable, possibly a Profibus cable (MP) with specific connectors (ET, LG, ST) for establishing communication between devices.
- **Bus Modules (CPX-E-PN):** 1 unit is listed, a Profibus network communication module.
- **Digital Input Modules (CPX-E-16DI):** This module likely receives digital signals (on/off) from sensors or other devices and transmits them onto the network.
- **Digital Output Modules (CPX-E-8DO):** 2 units are listed, these modules control external devices by sending digital on/off signals.
- **Scalance Profibus XC208 Pack:** 1 unit is listed. This is a network expansion module or a pre-configured package containing Profibus network components.
- **Scalance SCALANCE 615 LAN Pack** 1 unit is listed. This another network expansion module or a separate package containing components for connecting the Profibus network to an Ethernet (LAN) network.

Based on the equipment list, this setup creates an industrial automation system using a Profibus network for communication between various devices for

Centralized Control: The D:ML-S-VZ-M station acts as the central controller, coordinating communication and issuing commands to other devices on the network.

Data Acquisition and Monitoring: The digital input modules (CPX-E-16DI) are connected to sensors that monitor various aspects of the machinery (e.g., temperature, pressure, flow). They convert these physical signals into digital data and transmit them to the central station for monitoring and analysis.

Device Control: The digital output modules (CPX-E-8DO) receive control signals from the central station and activate or deactivate external devices like valves, motors, or actuators based on the received instructions. This allows for remote control and automation of various processes within the industrial setting.

Network Communication: The Profibus network cable and potentially the CPX-E-PN bus module facilitate communication between all the devices. The Scalance Profibus XC208 Pack is an expansion module to extend the network reach or a pre-configured package containing necessary Profibus network components.

Potential Ethernet Connectivity: The presence of the Scalance SCALANCE 615 LAN Pack creates the connection between the Profibus network and a larger Ethernet network. This enables communication with other control systems, monitoring software, or even remote access for maintenance purposes.

In essence, this equipment works together to create an automated system where sensors provide real-time data on the machinery's operation, the central station analyses this data and issues control

commands, and digital output modules activate or deactivate devices based on these commands. The potential Ethernet connectivity allows for integration with other systems for wider control, monitoring, and data management.

Description of the Equipment associated with the RE-MAIN Model - MTU

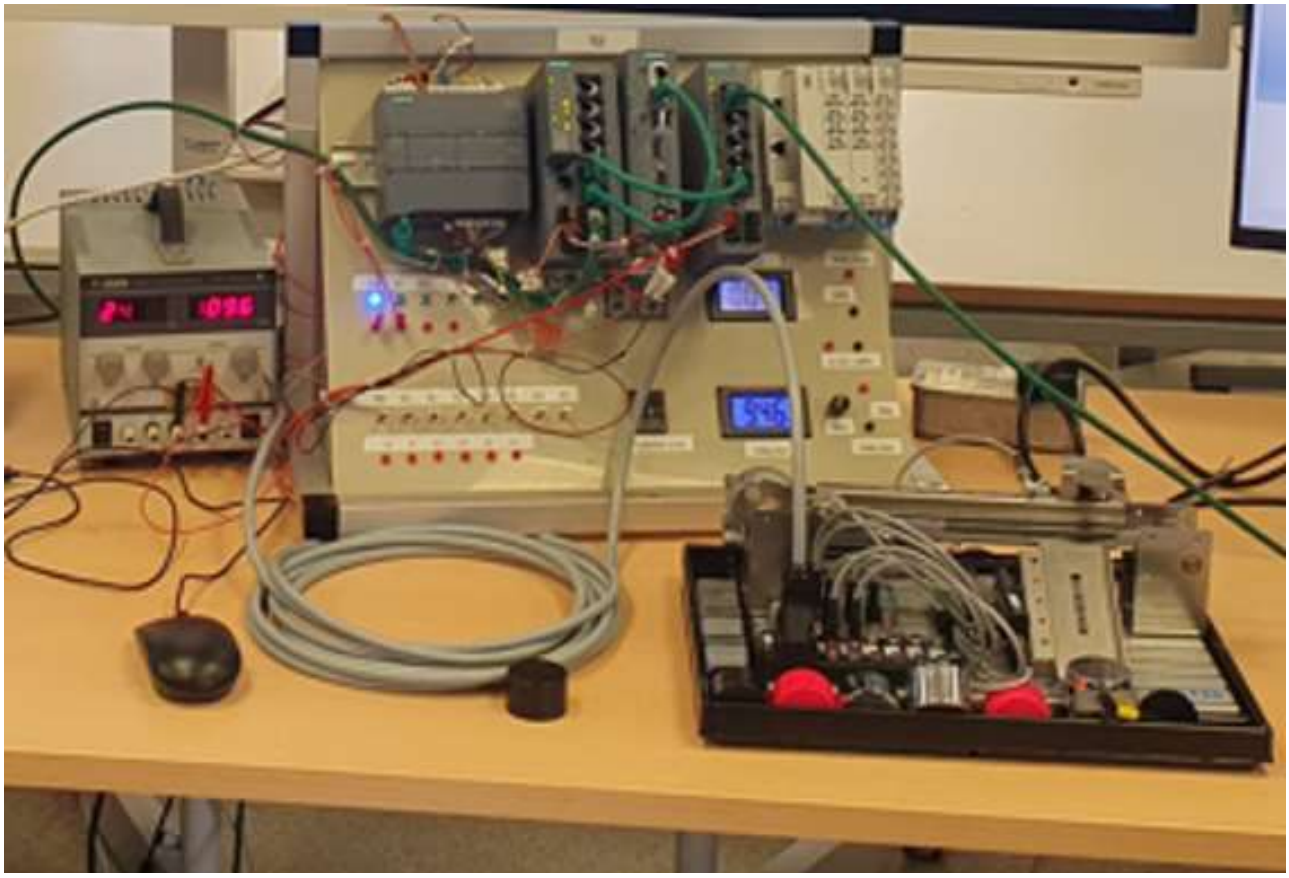


Figure 1 Complete RIG

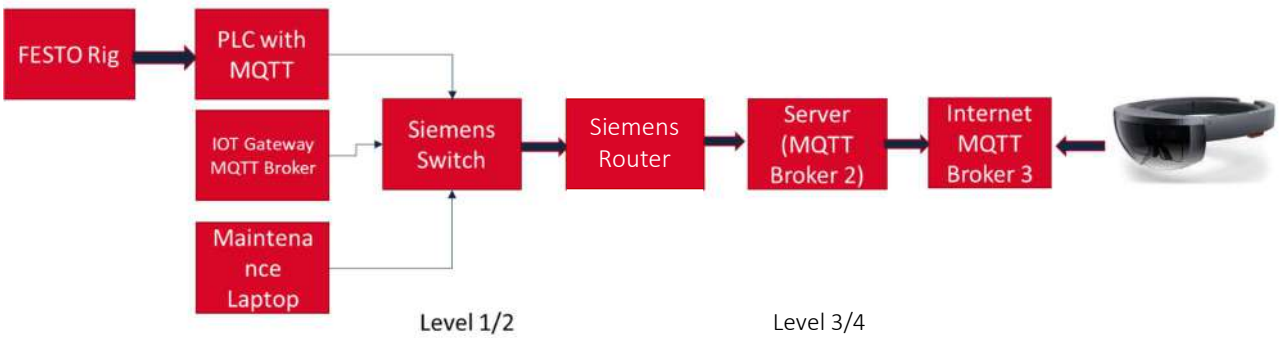


Figure 2 Block Diagram

ITEM

PLC S7-1200 Siemens

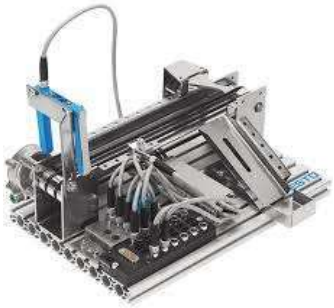
IOT2050 Siemens IOT Gateway

Router Siemens Scalance S615

Figure 3 S71200 PLC

Switch Siemens Scalance XC-208

FESTO MECLAB Conveyor station



Description of the Equipment associated with the RE-MAIN Model – CRN LEGANES

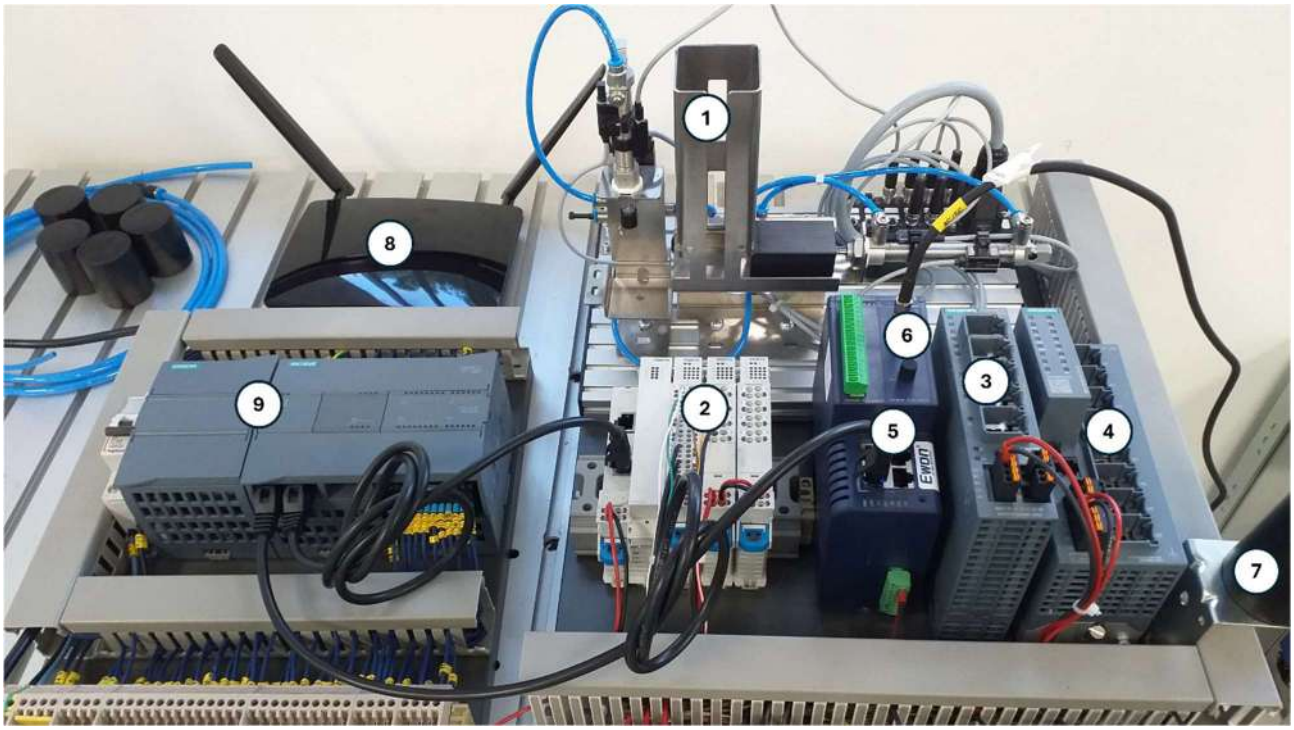


Figure 4 Setup CRN Leganes

The mockup supplied by FESTO for the REMAIN project consists of the following:

1. Electropneumatic installation
2. ProfiNet distributed I/O (Festo)
3. Scalance S615 OT Router (Siemens) + Key Plug
4. Switch OT Scalance XC208 (Siemens) + C-Plug

In addition, to complete it, the following has been added:

5. Ewon Flexy OT Router (HMS Network)
6. 4G Module (HMS Network)
7. Antenna (HMS Network)
8. IT 4G Router (TP-Link)
9. Simatic S7 1215C DC/DC/D programmable controller + SB AQ + 24VDC power supply (Siemens).

Ethernet cables of various lengths are also needed.

Everything must be properly wired and powered.

Required software:

- 16ince Pni o PST v4.2 (both from Siemens)
- WireShark (Wireshark.org)
- TIA Portal (Siemens)

Didactic material used for training in industrial cybersecurity:

- IT Security TP1333 (Festo), which includes:
  - Fundamentals of Networks and IT security (Festo didactic 8107694)
  - Network and IT security work manual (Festo didactic 8107694)
  - Network and IT security worksheets (Festo didactic 8107694)
  - Festo Netlab Toolkit (Festo)
  - NetLab Courseware Files V190801

Description of the Equipment associated to the RE-MAIN Model – FH CAMPUS 02

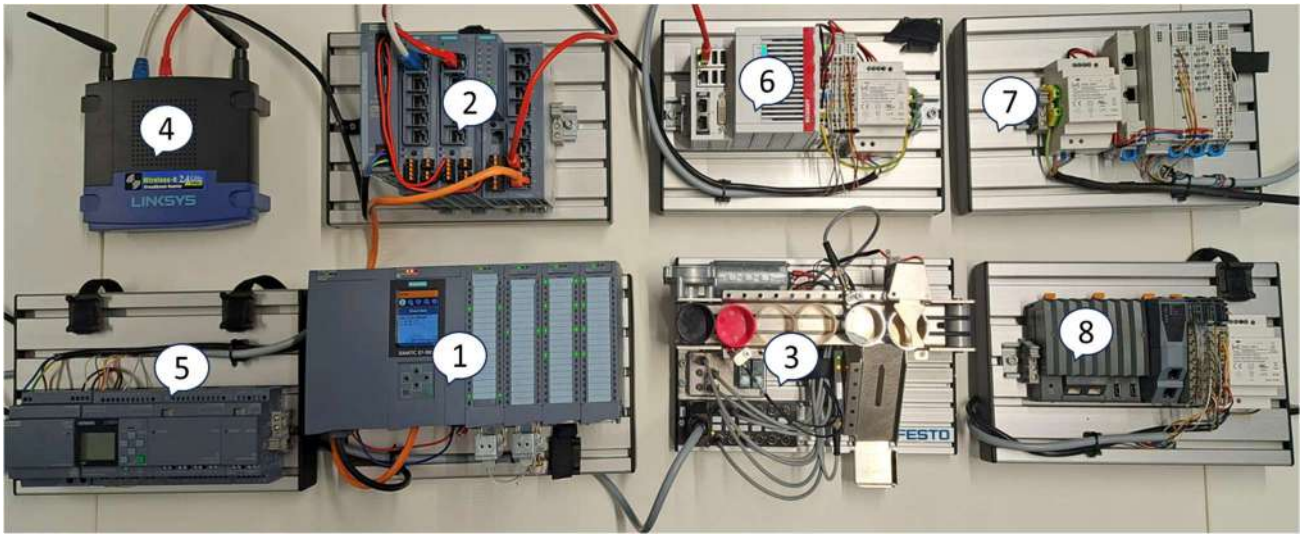


Figure 5: Operational setup with PLC Siemens Simatic S7 and additional PLC' s

The project setup module includes the Simatic S7 PLC, an update module, the Festo conveyor station, and a router to establish the internet connection, as shown in Figure 5, with points 1, 2, 3, and 4 highlighted. Additional modules include PLCs configured for educational purposes and validation of the project requirements. The module descriptions from Figure 5 are as follows:

1. Simatic S7 1500 PLC (featuring 32 digital inputs, 32 digital outputs, 8 analog inputs, and 4 analog outputs)
2. Siemens SITOP PSU6200 power supply, Scalance XC208 2-layer switch, and two Scalance S615 LAN Routers
3. Festo Conveyor Station
4. WLAN Router
5. Siemens Logo! PLC setup
6. Beckhoff CX5130 PLC
7. Festo CPX E PN Profinet Slave (16 digital inputs and 16 digital outputs)
8. B&R X20CP1382 PLC setup

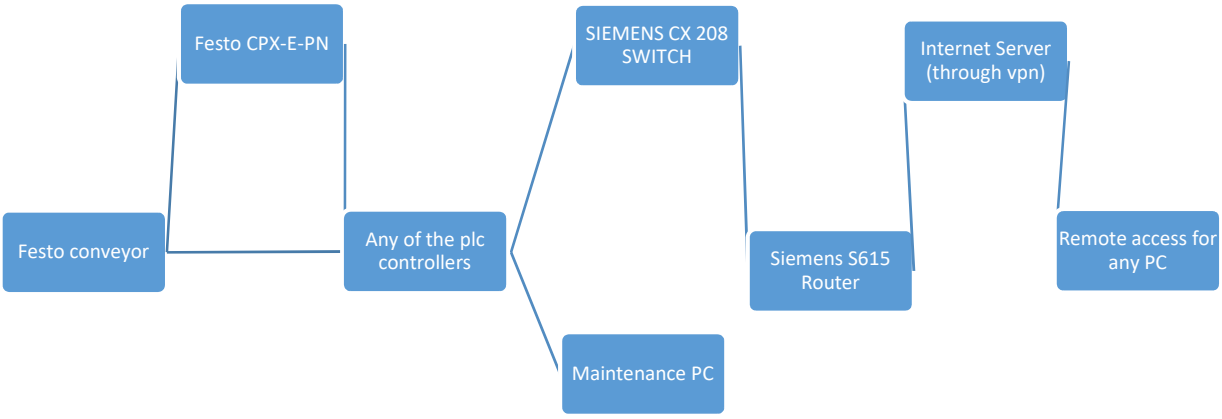


Figure 6: Block diagram of the set up

Figure 9:
Siemens SCALANCE XC208 2-Layer switch

Figure 8:
Siemens SCALANCE S615 LAN Router (two routers)

Figure 7: Siemens SITOP PSU6200

Figure 10:
PLC SIMATIC S7-1500 (Including 32DI, 32DQ and 8AI, 4DQ modules)

Figure 11:
Siemens Logo! Power supply 230/24V 4A

Figure 12:
Siemens SPS Logo! 12/24V

Figure 123:
Siemens LOGO! DM16 24 expansion module

Figure 114:
Festo CPX-E-PN

Figure 105:
Festo CPX-E-8DO (two of them)

Figure 13::
Festo CPX-E-16DI

Figure 157:
Beckhoff CX5130

Figure 148:
Beckhoff ES1018 DI and ES2008 DO Module

Figure 16:
B&R X20CP1382

Figure20:
B&R X20CP1382

Figure 17:
B&R X20CP1382

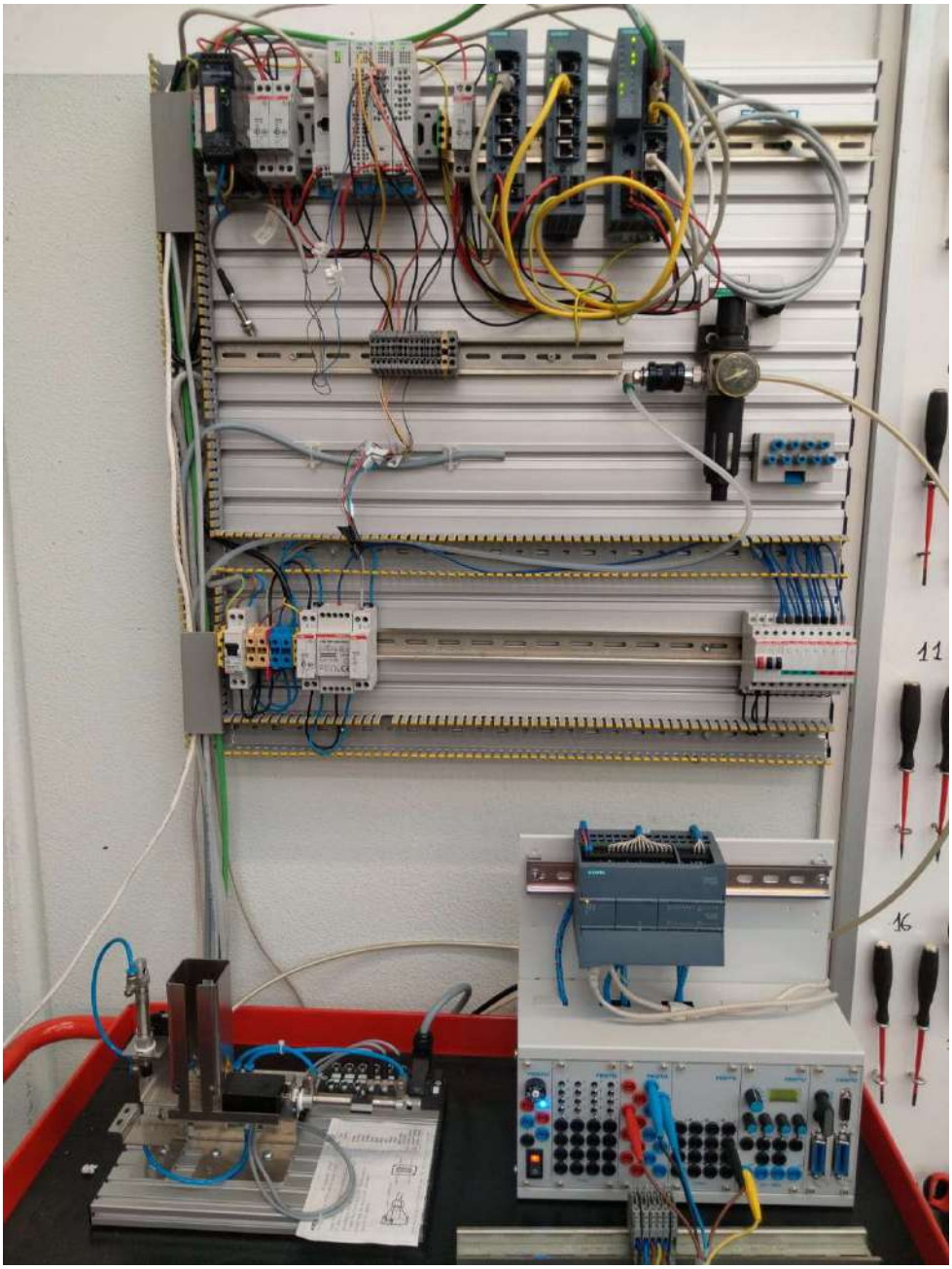


Figure 22: ENAIP VENETO CITTADELLA Prototype

Modules

1 - Corrective Remote Maintenance

This module focuses on equipping students with the knowledge and skills to diagnose and troubleshoot equipment issues remotely using dedicated maintenance systems.

Objectives: Equip students with the ability to diagnose and troubleshoot equipment issues remotely using dedicated maintenance systems.

Content:

- Guiding principles of remote maintenance
- Planned competence acquisition for remote maintenance tasks
- Different remote maintenance technologies and tools
- Fault diagnosis techniques for various equipment types
- Remote troubleshooting procedures and best practices
- Security considerations for remote maintenance connections

Trainer Use:

- Leverage this module to train students on systematically diagnosing equipment problems through remote access.
- Use the information on planned competence acquisition to tailor the course to the students' existing skill levels.
- Incorporate hands-on exercises with various remote maintenance tools for practical learning.

Learning Objectives:

- Understand and configure system operating parameters and alarm thresholds.
- Set up automatic alarm/malfunction messaging upon parameter deviations.
- Establish secure remote connections to automation systems.
- Analyze machine data history and modify parameters for continued operation.
- Develop troubleshooting procedures and provide remote support to technicians.

Learning Outcomes:

- Students will be able to Configure and troubleshoot data acquisition systems using protocols like TIA PORTAL.
- Students will be able to Secure remote data gathering infrastructure.
- Students will be able to Establish a complete remote data acquisition system (factory floor to cloud).

Attendance teaching		**Teaching sessions 20 hours**
Teaching method:	Contacts lecture, lab in-person and demonstration	
Social methods:	Team based work	
Work assignments		**5 hours**
Teaching method:	Individual exercises and correction in plenary session, group exercises in the lab	
Social methods:	Team based work	
Self-directed learning		**5 hours**
Recommended learning methods:	Recommended reading/videos	
Total	**10 teaching sessions**	**30.00 hours**

Recommended learning resources:

https://www.automation.siemens.com/sce-static/learning-training-documents/tia-portal/summary-sce-training-curriculum-s7-1500-en.pdf

RE-MAIn EBOOK https://remainproject.eu/ebook/

2 - Remote Monitoring and Data Acquisition

This module covers data gathering practices within factories and how to establish remote data collection systems.

Objectives: Provide students with the knowledge and skills to establish and manage remote data acquisition systems from factories and industrial facilities.

Content:

- Introduction to Industry 4.0 and its impact on data collection
- Designing and implementing data gathering infrastructure
- Various data acquisition techniques and sensors
- Real-time data monitoring and analysis methods
- Remote data security and integrity measures

Trainer Use:

- Utilize the learning outcomes to design lessons that teach students about the principles of Industry 4.0 and its relation to data acquisition.
- Structure lab sessions and assignments focused on designing data collection systems and using data acquisition tools.

Learning Objectives:

- Explain the concept of Industry 4.0/5.0 and its practical application in factory environments.
- Understand common data gathering infrastructure used within factories.
- Configure and debug internal data gathering systems based on protocols like OPC-UA and MQTT.
- Set up and debug external data gathering infrastructure using protocols like MQTT and adhere to data security best practices.
- Design and configure an end-to-end data gathering system from the factory floor to the cloud for data collection, routing, and analysis.

Learning Outcomes:

- Students will be able to Explain the concept of Industry 4.0 / 5.0 and how that relates practically to the factory environment
- Students will be able to Explain common internal data architectures for factory automation and distinguish the different layers of the factory automation environment
- Students will be able to Configure and debug internal data gathering systems based on OPC-UA, MQTT and demonstrate basic networking competency
- Students will be able to Setup and debug external data gathering infrastructure, based on broker communication systems (such as MQTT), and apply data security, adhering to good namespace conventions
- Students will be able to Establish a remote data infrastructure starting from the internal factory communications system all the way to a cloud platform, collecting real data, routing it and managing it at a cloud level

Attendance teaching		**6 teaching sessions**	**12 hours**
Teaching method:	Lectures / labs and demonstrations		
Social methods:	Team based work		
Work assignments			**12 hours**
Teaching method:	Journals / projects		
Social methods:	Team based work		
Self-directed learning			**16 hours**
Recommended learning methods:	Recommended reading / videos		
Total	**2 hpw**	**6 teaching sessions**	**40.00 hours**

Recommended learning resources:

RE-MAIn EBOOK https://remainproject.eu/ebook/

3 - Remote Update of Programs and Functionalities (RE-MAIN_RUPF)

This optional module focuses on updating programs and functionalities on remote machinery.

Objectives: Train students on the proper procedures and best practices for remotely updating programs and functionalities on machinery.

Content:

- Guiding principles for remote program and functionality updates
- Planned competence acquisition for RE-MAIN_RUPF tasks
- Different remote update mechanisms for various equipment types
- Testing and verification procedures after remote updates
- Security considerations and version control during updates

Trainer Use:

- Deliver practical training sessions on using specific update mechanisms for different machinery types.
- Incorporate case studies or simulations to provide students with hands-on experience in managing remote updates effectively.

Learning Objectives:

- Explain the importance of secure and efficient remote updates for industrial machinery.
- Identify different mechanisms used for remote program and functionality updates.
- Describe various types of updates performed on remote machinery.
- Apply best practices for safe and reliable remote updates.

Learning Outcomes:

- Students will be able to compare and contrast different remote update mechanisms.
- Students will be able to distinguish between different types of updates for remote machinery.
- Students will be able to implement secure and efficient remote update procedures.
- Students will be able to troubleshoot common issues encountered during remote updates.

Attendance teaching		**8 teaching sessions**	**6 hours**
Teaching method:	Lecture		
Social methods:	Oral presentation, discussions, individual / group work		
Work assignments			**10.00 hours**
Teaching method:	Sample and code programming and exercises, practical experiments		
Social methods:	Individual / group work		
Self-directed learning			**14.00 hours**
Recommended learning methods:	Independent repetition, Internet research, manuals reading		
Total	**1.00 hpw (hours per week)**	**8 teaching sessions**	**30 hours**

Recommended learning resources:

RE-MAIn EBOOK https://remainproject.eu/ebook/

4 - Industrial Cybersecurity

This module covers cybersecurity principles and practices relevant to industrial control systems.

Objectives: Equip students with a strong understanding of cybersecurity threats and how to protect industrial control systems used in remote maintenance and data acquisition.

Content:

- Types of cyber threats targeting industrial control systems
- Secure communication protocols for remote connections
- Network hardening techniques for industrial networks
- Virtual private network (VPN) management for secure remote access
- Best practices for industrial cybersecurity incident response

Trainer Use:

- Utilize the course content outlines to deliver lectures on various cyber threats and mitigation strategies.
- Integrate assignments or projects where students design secure communication protocols or practice network hardening techniques.

Learning objectives

• Cyber Threats: Understanding the specific threats targeting industrial control systems (ICS) compared to traditional IT threats. This could involve exploring different attack vectors, malware types, and potential consequences of cyberattacks on industrial infrastructure.

• Secure Communication Protocols: Learning about secure protocols like PPTP, L2TP, SSL/TLS, SSH, and IPSec used to safeguard data confidentiality and integrity during communication over IP networks.

• Network Hardening Techniques: Building strong network defenses to minimize vulnerabilities. This could involve understanding network topologies, identifying network devices (routers, switches, firewalls), and learning about their configuration options for security purposes.

• Network Segmentation: Mastering techniques like subnetting, VLANs, and using network switches and routers to segment work networks and create additional security barriers.

• Virtual Private Network (VPN) Management: Learning how to install and configure OpenVPN servers on Linux PCs and VPN routers (e.g., EWON Flexy) and configure OpenVPN clients for secure remote access.

Learning Outcomes:

• Students will be able to differentiate between IT and OT threats, define cyber threats in the context of ICS, and identify the main risks and vulnerabilities associated with these systems.

• Students will be familiar with the key characteristics of various secure communication protocols used to protect data during remote connections.

• Students will gain foundational knowledge of network topologies, network devices, and their configuration options relevant to network hardening.

• Students will be able to explain the concept of network segmentation and gain practical skills in implementing techniques like subnetting and VLANs using network switches and routers.

• Students will acquire hands-on skills in installing and configuring OpenVPN servers on Linux PCs and specific VPN routers, as well as configuring OpenVPN clients for secure remote access.

Attendance teaching		**6 teaching sessions**	**12.00 hours**
Teaching method:	Lectures / labs and demonstrations.		
Social methods:	Team based work.		
Work assignments			**12.00 hours**
Teaching method:	Journals / projects		
Social methods:	Team based work.		
Self-directed learning			**6.00 hours**
Recommended learning methods:	Recommended reading / videos		
Total	**10hpw**	**6 teaching sessions**	**30.00 hours**

Recommended learning resources:

RE-MAIn EBOOK https://remainproject.eu/ebook/

Additional Information:

The main document includes details on assessment methods and recommended learning resources for each course unit. Trainers can use this information to develop effective assessments and guide students towards supplementary materials to enhance their learning experience.

By incorporating these modules and effectively utilizing the provided information, trainers can deliver a comprehensive Remote Maintenance and Data Acquisition program that equips students with the necessary skills to excel in this evolving field.

Assessment

General Assessment Methods:

The document might suggest some general assessment methods applicable across all modules. These could include:

Written exams: Testing students' theoretical knowledge and understanding of key concepts.

Lab assignments: Assessing practical skills acquired through hands-on activities in labs.

Projects: Evaluating students' ability to apply their knowledge and skills to solve complex problems or complete practical tasks.

Case studies: Analyzing students' critical thinking and problem-solving skills in the context of real-world scenarios.

Module-Specific Assessments (Possible Scenarios):

While the document might not prescribe specific assessments, we can consider potential methods suitable for each module based on the learning outcomes:

Corrective Remote Maintenance:

Written exams to assess understanding of troubleshooting techniques and remote maintenance procedures.

Lab assignments simulating remote maintenance scenarios for students to diagnose and resolve equipment issues.

Remote Monitoring and Data Acquisition:

Written exams to test knowledge of Industry 4.0 principles, data acquisition techniques, and security measures.

Projects where students design and implement a data acquisition system for a simulated industrial setting.

Remote Update of Programs and Functionalities (RE-MAIN_RUPF):

Written exams focusing on different update mechanisms, best practices, and security considerations.

Lab simulations where students practice updating programs and functionalities on remote machinery using specific update tools.

Industrial Cybersecurity:

Written exams to assess knowledge of cyber threats, secure communication protocols, network hardening techniques, and VPN management.

Lab assignments where students configure secure communication protocols, implement network segmentation techniques, or set up VPN connections.

Feedback template

By actively soliciting feedback from teachers and project partners, the project gains valuable insights into:

Learner Needs: The template helps identify areas where the training content might not be meeting student needs or expectations. This allows for adjustments to bridge knowledge gaps and ensure the content is clear and accessible.

Engagement and Effectiveness: Teacher feedback sheds light on student engagement during training sessions. This helps determine if the material is presented in a way that fosters active learning and facilitates knowledge retention.

Continuous Improvement: Feedback allows for continuous improvement of the training material. By identifying strengths and weaknesses, the project can refine the content, add new resources, or adjust teaching methods to optimize learning outcomes.

Purpose:

This feedback template is designed to gather valuable insights from teachers and project partners who participated in the RE-MAIN Project Training Material delivery.

The collected feedback is used to refine and improve the training content for future iterations.

By understanding the strengths, weaknesses, and areas for improvement identified by teachers, the project can ensure the training material is effective, engaging, and meets the needs of learners.

List of participants

Name	Surname	Role	Organization

Teams Call online **Date**

Answers to the following questions provide useful data and help Project Partners to improve the training.

Overall feedback of training content

Overall feedback of training goals

How engaged were the students?

Strengths & Weaknesses (trainer perspective)
S: **W:**

Do you think students had problems with the course content?

What did they appreciate mostly?

Proposals for improvement

Explanation of Questions for Teachers:

- Overall feedback of training content: This provides a broad perspective from the teacher on the overall quality and effectiveness of the training material.
- Overall feedback of training goals: This assesses how well the training content aligns with the stated learning objectives of the program.
- How engaged were the students? This evaluates the level of student participation and interest throughout the training sessions.
- Strengths & Weaknesses (trainer perspective): This offers a detailed analysis of the training material from the teacher's viewpoint. Strengths could be clarity of explanations, practical exercises, or engaging activities. Weaknesses might be gaps in content, confusing sections, or lack of resources for specific topics.
- Do you think students had problems with the course content? This identifies if there were specific areas in the training material that students found challenging to grasp.

- What did they appreciate mostly? This helps understand which aspects of the training material resonated most with the students and were valuable for their learning.
- Proposals for improvement: This gathers specific suggestions from the teacher on how to improve the training material for future use. This could involve revising specific sections, adding additional resources, or modifying teaching methods.

Benefits of Using This Feedback Template:

Enhanced Training Material: By incorporating feedback from teachers, the project can ensure the training content is up-to-date, addresses learner needs, and provides a more effective learning experience.

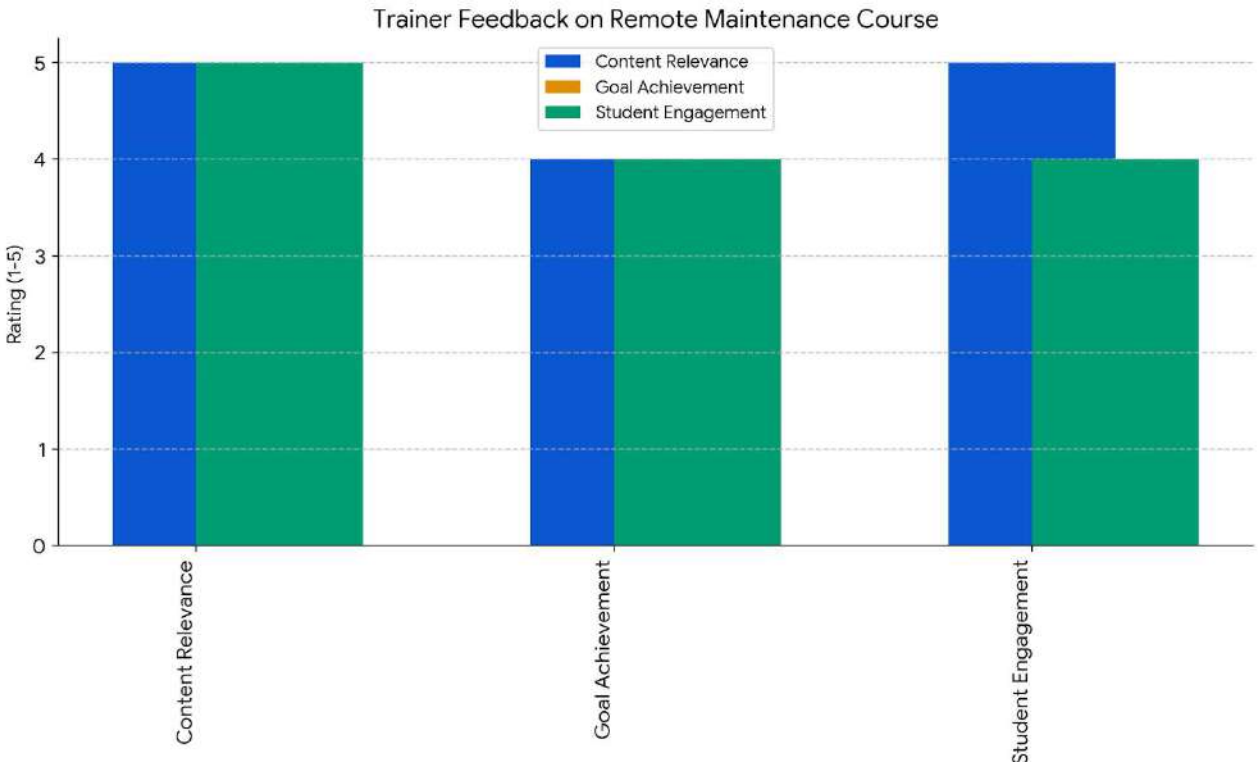
Improved Learning Outcomes: Understanding what students find valuable in the training allows for better alignment with their learning goals and ultimately leads to improved learning outcomes.

Collaboration with Project Partners: The feedback template fosters collaboration between teachers and project partners, leveraging their combined expertise to refine the training material.

Overall, this feedback template is a valuable tool for the RE-MAIN Project to continuously improve the quality and effectiveness of its training material, ensuring it remains relevant and impactful for students and future training sessions.

Synthesis of Trainer Feedback

The training was well-received by participants, who found the content relevant to future industry needs. While participants found the course engaging, achieving full autonomy in web server building requires additional training time. No significant challenges were reported as participants had prior PLC programming knowledge. The practical component, particularly the remote connection to Madrid (between ENAIP VENETO and CRN Leganes), was highly appreciated. Overall, the training was successful in generating interest and providing valuable experience. However, to fully meet the learning objectives, a significant increase in training hours is necessary.



The provided feedback highlights a strong emphasis on the practical application of course content. While the core concepts were well-received, there is a consistent need for more in-depth training, particularly in areas like web server development and advanced automation networking.

Key Findings

Practical focus: Trainers universally emphasized the importance of practical application over theory.

Knowledge gaps: Participants with varying levels of IT and automation knowledge experienced different challenges.

Engagement: Practical elements, such as remote connections and web server development, significantly increased student engagement.

Resource constraints: High costs associated with materials and limited access to support resources were identified as challenges.

PART B Technical guidelines for students/learners

The Remote Maintenance and Data Acquisition program is designed for a diverse group of students/learners seeking to develop practical skills for a thriving field. By successfully completing the program, individuals can gain a competitive edge and unlock exciting career opportunities in various industrial settings.

Learning Outcomes and EQF Qualifications

This ambitious objective will be assured through a specific set of Learning Outcomes, organized in 4 Training Modules.

Learning outcomes are fundamental in the definition of the Training course, as they express measurable knowledge and skills that students/learners will gain by attending the course.

Partners have developed their training modules starting from the defined Outcomes, having in mind the real needs of the group target. Thus, they have been able to develop structured training modules which can be considered as interconnected. As a matter of fact, each Module will cover a specific topic, and it is structured according to the Learning Outcomes defined and shared with the other partners, as clearly presented in the section “MODULE” of this Guideline.

Thanks to this, there will not be any repetition of contents throughout the Modules, as each of them will deal with a specific topic and with a dedicated set of knowledge and competences to be developed.

With reference to the European Qualification Framework (EQF)[2] the 4 proposed Modules belong to a specific level, for a better identification of the most suitable user target and to help students/learners orientate throughout the contents.

More in specific, 2 are the EQF levels identified by the Remain course, as follows:

EQF 3: modules 1 and 4

[2] For more information, please visit: https://europass.europa.eu/en/europass-digital-tools/european-qualifications-framework

EQF 4: modules 2 and 3

Getting a little into depth, each EQF levels defines a specific level of knowledge, skills and responsibilities to be reached by attending the course. The table here below summarizes the main characteristics of the EQF levels identified in our training courses.

EQF LEVEL	KNOWLEDGE	SKILLS	RESPONSIBILITY
3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities

Table 1: details of EQF 3 and 4 - https://europass.europa.eu/en/description-eight-eqf-levels

LEARNING OUTCOMES METHODOLOGY

For defining learning objectives and learning outcomes all the partners worked on a **matrix**, which was fundamental for writing effective guidelines for the course development.

The matrix separates the big picture goals (Learning Outcomes) from the specific skills students will learn (Learning Objectives). This provides a clear distinction between:

- **What students should be able to achieve by the end of each module (Learning Outcomes).** (e.g., Students will be able to establish a complete remote data acquisition system (factory floor to cloud).)
- **The specific skills students will develop to achieve those outcomes (Learning Objectives).** (e.g., Configure and debug internal data gathering systems based on protocols like TIA PORTAL)

This structure creates a roadmap for the course content, ensuring all the necessary steps are covered for students to achieve the broader learning outcomes.

Effective Instruction:

- **Measurable Skills:** Learning objectives are action-oriented and measurable. This allows you to design assessments that accurately gauge student progress. (e.g., Students will be able to demonstrate setting up automated notifications for critical events.)
- **Content Development Guide:** The learning objectives become a blueprint for creating course materials like lectures, labs, and activities. You can ensure each element directly contributes to achieving a specific objective. (e.g., A lab activity could focus on configuring an OPC UA server on a PLC to transmit data to a monitoring system.)
- **Improved Student Learning:** Students can target their studying and focus on the key skills they need to learn by having clear expectations outlined.

Course Improvement: The matrix serves as a foundation for future iterations of the course. We can easily identify areas for improvement or adjust the objectives based on student feedback.

In The table below, an example of the template used for the MATRIX is presented: for each Module, partners identified the learning units, learning outcomes and objectives and the length of each unit/module.

N	CONTENT AREA	Unit	Learning Outcomes (Students are able to ...)	Learning Objectives/Goals (What the instructor, program, or institution aims to	Length (hours)	Responsible partner
1	CORRECTIVE REMOTE MAINTANANCE	Unit 1				
		Unit 2				
		Unit 3				
		Unit 4				
		Unit 5				
2	REMOTE MONITORING AND DATA ACQUISITION					
3	REMOTE UPDATE OF PROGRAMS AND FUNCTIONALITIES (RE-MAIN_RUPF)					
4	INDUSTIRAL CYBERSECURITY					

Program Goals:

This program equips individuals with the knowledge and skills necessary to perform remote maintenance and data acquisition tasks within industrial environments. It caters to a range of learners, including:

Entry-level technicians: Those with a technical background seeking to enter the field of remote maintenance and data acquisition.

Upskilling existing technicians: Experienced technicians looking to expand their skillset and stay current with advancements in remote maintenance and data acquisition technologies.

Professionals from other disciplines: Individuals from fields like process engineering, quality control, or operations who want to learn remote maintenance and data acquisition to broaden their career opportunities.

Target Audience Characteristics:

Educational Background: A high school diploma or equivalent is required. Prior coursework in electronics, automation, or computer networking is a plus.

Technical Skills: Basic understanding of electrical systems, computer hardware, and networking fundamentals is preferred. Familiarity with troubleshooting techniques and basic software usage is beneficial.

Industry Experience: No prior industry experience is required for entry-level technicians. Upskilling technicians may have some experience in related fields like maintenance, manufacturing, or automation.

Benefits of the Program:

Gain in-demand skills for a growing field: Remote maintenance and data acquisition are increasingly crucial for efficient industrial operations, making these skills highly sought-after by employers.

Career advancement opportunities: Completion of this program can open doors to new job opportunities in remote maintenance, automation, data analysis, and field support roles.

Increased earning potential: Technicians with expertise in remote maintenance and data acquisition are often compensated at higher rates compared to those with traditional maintenance skills.

Examples of Candidates:

Recent graduates with technical degrees (e.g., electronics, automation) seeking careers in maintenance or industrial automation (EQF 3-4).

Experienced technicians in maintenance, manufacturing, or similar roles looking to expand their skillset for career advancement (EQF 4-5).

Professionals from other disciplines (e.g., process engineering, quality control) wanting to add remote maintenance and data acquisition skills to enhance their qualifications and career prospects (EQF 5-6).

The program may offer optional tracks or modules to cater to specific sub-groups within the target audience. These might include:

A fundamentals track for those with limited technical background, providing a strong foundation in relevant electrical and computer concepts before diving into advanced remote maintenance and data acquisition modules.

An advanced track for experienced technicians, focusing on in-depth troubleshooting techniques, advanced data analysis tools, and potential specialization in specific areas like industrial cybersecurity.

The Remote Maintenance and Data Acquisition program on Imoox Platform

For the enrolment https://imoox.at/course/RE-MAIN

The 'RE-MAIN' project is co-financed by the European Union. The opinions and views expressed in this document commit only the authors and do not necessarily reflect those of the European Union or of the Spanish Service for the Internationalisation of Education (SEPIE). Neither the European Union nor the SEPIE National Agency can be held responsible for them.