EXAM 4.0

THE EXCELLENT ADVANCED MANUFACTURING 4.0

AM 4.0 labs running I4.0 technologies

Technology 7: Machine To Machine (M2M)

7/15

Piloting the Advanced Manufacturing workshop 4.0

03

THE EXCELLENT ADVANCED MANUFACTURING 4.0

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EXAM 4.0 partners:

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0 Introduction

Following the piloting process of Advanced Manufacturing Labs for H/VET through the Collaborative Learning Factory (hereafter CLF), the EXAM4.0 partners we have piloted 16 technologies embedded in Industry 4.0

The following image shows the overall structure of the piloting process.

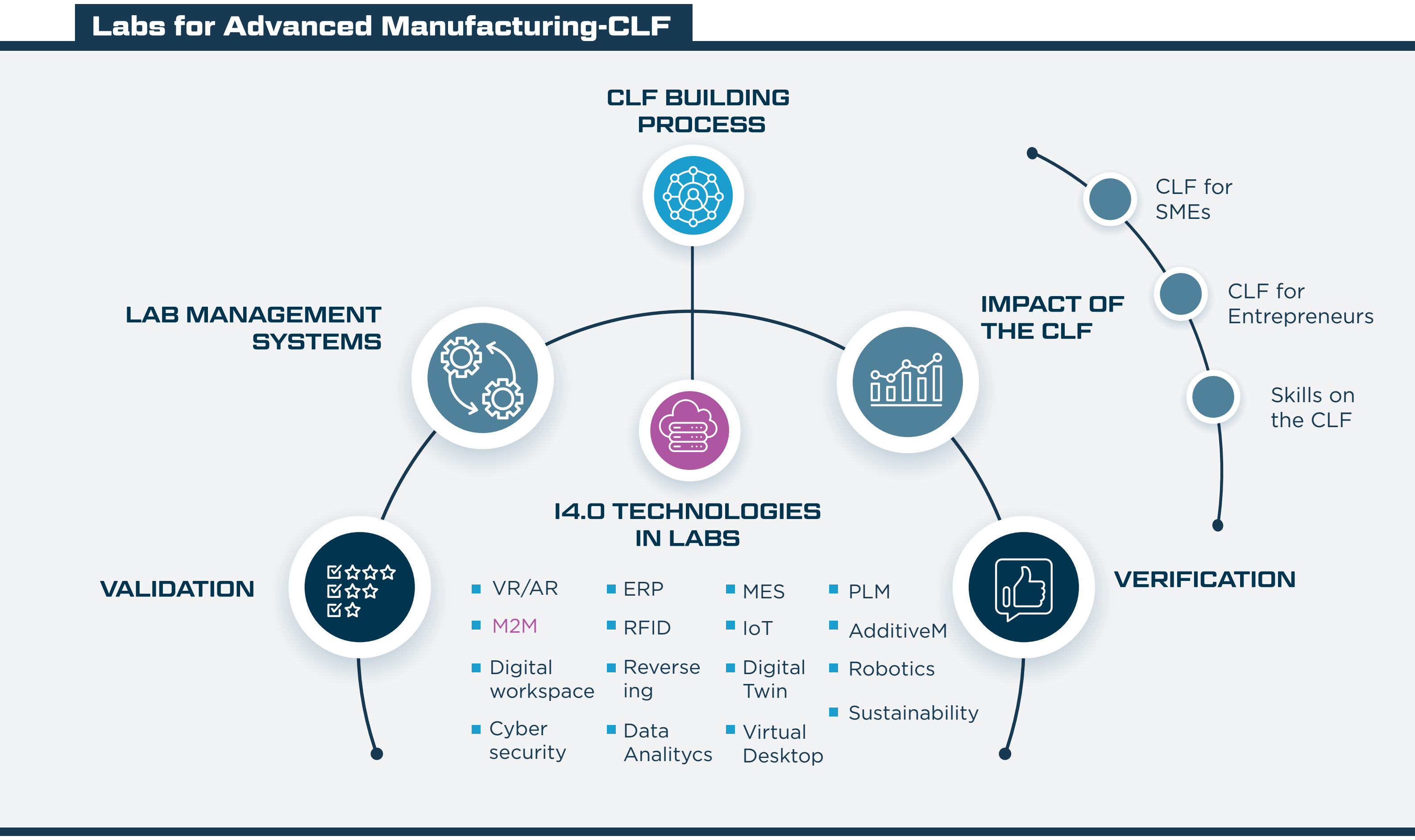

Figure 1: Overall structure of the EXAM4.0 labs piloting process. Source: EXAM4.0

The present report is the one out of 16 I4.0 technology described within the "Industry 4.0 technologies in labs" section, specifically #7 Machine to Machine Communication (M2M)

1 Definition and application of M2M in industry

M2M, central to the shop-floor, impacts Industry 4.0 and refers to technologies allowing for the automated exchange of information between the CPS, which constitute the Industry 4.0 production environment. M2M can be considered as the integral technology of the 'Internet of Things' (IoT). Through advanced embedded sensor and actuator applications technology, the entire production floor can relay meaningful information, forming the interface between the physical and the virtual worlds. This provides a level of transparency that enables huge improvements in manufacturing, from performance management to entire new business models. While the most evident usage forms of M2M will be in intra-company linking of production assets, M2M is also the key enabler when it comes to cross-company operations.

Considering manufacturing advancements supported by communication and networking technologies, manufacturing industries are ready to improve the production processes with big data analytics to take the advantage of higher compute performance with open standards and achieve the availability of industry know-how in advance. As a result of the penetration of manufacturing intelligence, manufacturers can be able to enhance quality and increase manufacturing output (Exam4.0, 2021).

M2M environments are usually made up of the following elements:

A. MACHINES TO MANAGE: Any machine that you want to control. In the industrial case, any machine involved in production.

B. M2M DEVICE: module integrated or connected to a machine that communicates with the server, which normally also consists of processing capacity. On the one hand it implements the protocol to be able to communicate with the machine and on the other hand it implements the communication protocol for sending information.

C. SERVER: Computer that manages the sending and receiving of information from the machines it manages. It is usually also integrated with the core business of the company (ERP, MES, Order system, etc.).

D. COMMUNICATION NETWORK: they can be either through cable (PLC, Ethernet, PSTN, ISDN, ADSL etc.), or through wireless networks (GSM / UMTS / HSDPA, Wifi, Bluetooth, RFID, Zigbee, UWB, etc.).

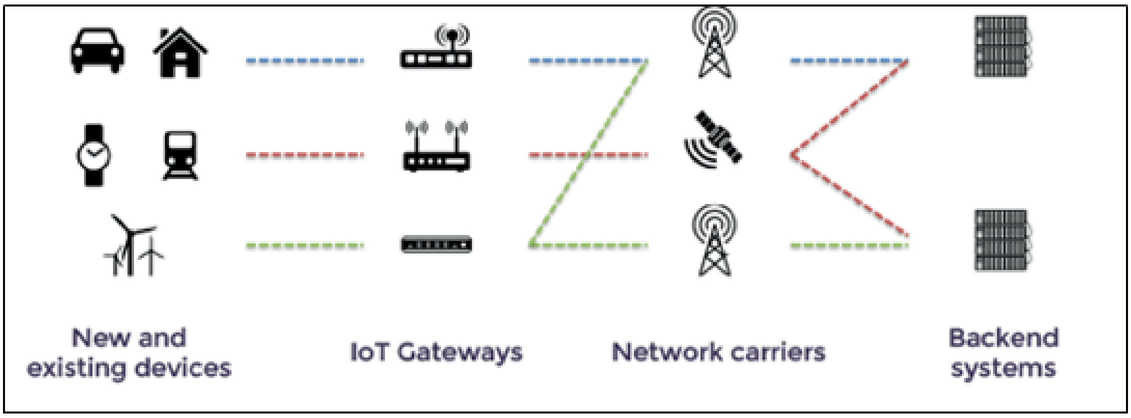

Figure 2: machine to machine communication architecture. Source: https://medium.com/predict/an-era-of-iot-machine-to-machine-communicati on-m2m-9a7861665b4c

The European Telecommunications Standards Institute (ETSI) aims to create global standards for information and communication technologies. **Establishes the following requirements for machine to machine systems (IONOS, 2021):**

- **Scalability.** The system should continue to function efficiently even if other connected devices are added to it.
- **Anonymity.** The system must be able to hide the identity of the devices.
- **Protocols.** M2M systems must be able to record failed installations, defects or erroneous data and store these records for later reference.
- **Transmission methods.** Systems must support different transmission methods such as Unicast, Anycast, Multicast, or Broadcast and must be able to switch between these methods in order to reduce the load on M2M data transmission.
- **Planning of news transmission.** The system must be able to set times for data transmission and to regulate or delay communication according to priority.
- **Selection of the communication path:** The communication paths within the machine to machine system must be optimized through regulations regarding transmission errors, delays and network costs.

In general we can establish the following industrial applications (Innovation, 2021):

- Collection of data for processing by another team
- Traceability
- Intelligent stock control
- End of process notice
- Implementation of just-in-time systems
- Automated maintenance
- Procedure for requesting spare parts

2 M2M in HVET/VET labs

2.1Integration of M2M in Miguel Altuna's lab

This section deals with how M2M can be incorporated in VET centre labs by describing different options and applications.

The implementation of M2M communication obviously requires a set-up of machines and equipment, which is adapted for data acquisition and integrates in a communication architecture.

The communication of M2M is represented in different ways in VET labs:

(A) It can be replicated on a small scale in communication between different modules in didactic cells.

(B) in a limited number of machines in the Labs

(C) Scaled up to the set to all the machines to the system

It is important to highlight that when incorporating M2M into a VET Labs, the desired information from the machine and the way to exploit it could be different from industry as long as they are in learning processes instead of production.

It would be possible to get information from:

- Traceability of learners, machine usage, tools, performance indicators
- Machine use information for scheduling, planning and also maintenance
- Monitoring of student's performance, state of project's and task execution at real time
- Tools control
- other

The learning factories implemented in VET labs are a good way to reach the industrial applications of M2M solutions listed in the previous section in learning environments

- Collection of data for processing by another team
- Traceability
- Intelligent stock control
- End of process notice

- Implementation of just-in-time systems
- Automated maintenance
- Procedure for requesting spare parts

Figure 3: Miguel Altuna's student working on the machine's HMI.
Source: Author's creation

As for industry, in VET labs similar I4.0 technologies would be needed to implement M2M communication: The following paragraph describes how it is integrated at Miguel Altuna VET centre:

MACHINES TO MANAGE:	• 80 machines divided in 8 cells • 1500 tools managed by RFID	• 200 users (students & staff) managed by RFID • Users' PPEs control
SERVER:	• Local server	• Connected with ERP
M2M DEVICE:	• Groups of 6 machines are connected to a PLC. • Data is send form the PLC's to the server by wifi • HMI devices are installed in all the machines	• Cloud based Digital workplace: display information (learners documentation) Beacon displays that the machine is reserved
COMMUNICATION NETWORK:	• Different configurations are used depending the devices to be managed:	PLCs Ethernet HSDPA, wifi, RFID
BI & ANALYTIC	• Data analytic systems to exploit data	

All this is summarized in a simple scheme that can be seen in the following image.

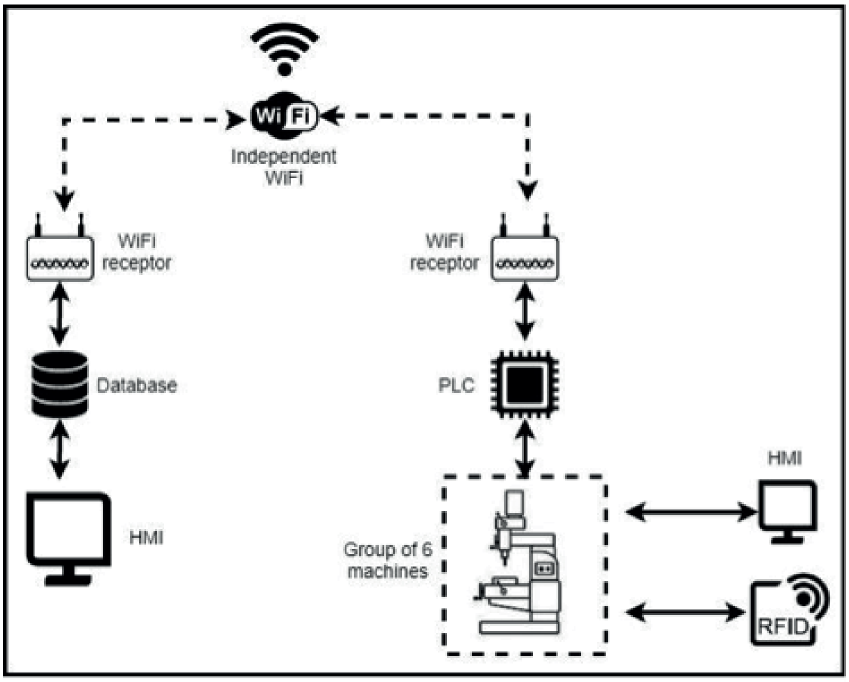

Figure 4: Miguel Altuna's M2M installation architecture. Source: Author's creation

2.2 Role of the M2M in the EXAM4.0 CLF

The CLF that is going to be launched has divided its production process into 4 stages (product design, process engineering, production and assembly) as can be seen in the following image. Within these stages, although the M2M could be incorporated in more than one of them, for now it will intervene in the production part.

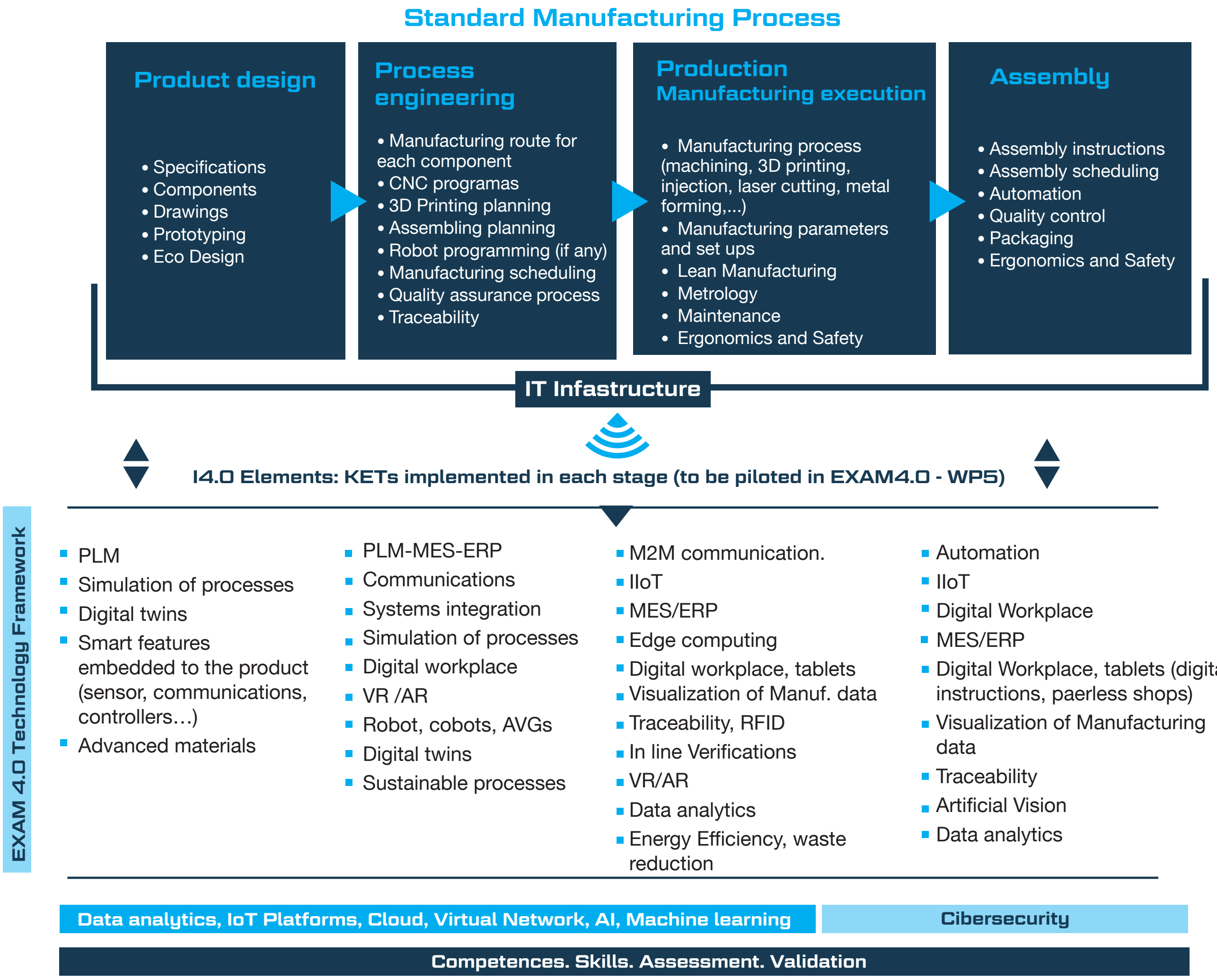

Figure 5: EXAM4.0 Collaborative Learning Factory's (CLF) Value Chain
Source: Author's creation

Within production, the use of the M2M technology will be made when manufacturing the intermediate plates of the robot. **In the production process of these plates, the following inaformation will be collected:**

- User who has reserved the machine
- Machine reserved hours
- Machine running/standby hours
- Drawing and CNC programs that are being used
- Tools the user is using

Figure 6: Miguel Altuna's machine booking dashboard. Source: Miguel Altuna

2.3 Benefits of using M2M in EXAM4.0's CLF

Among the benefits that we find when inserting M2M in EXAM CLF are:

- Massive remote control managed through the use of applications. All M2M equipment is visible at all times and in real time, being able to control its operation and detect or solve problems.
- Cost reduction promoting operational efficiency, lowering production and logistics costs.
- Automation of processes due to artificial intelligence. The processes will become more and more automatic, avoiding the errors of manual operators.
- Better monitoring by obtaining information (status, consumption, etc.) in real time.
- Maximum use of resources, making them more efficient.

Figure 7: Miguel Altunas's lab occupation dashboard. Source: Miguel Altuna

2.4 Competences addressed with M2M

The insertion of M2M technologies are going to help on developing competences such as:

- Schedule productions, production planning, quality control and measurement procedures, maintenance planning.
- Prepare the procedures for the assembly and maintenance of equipment, defining the resources, the necessary times and the control systems.
- Supervise and / or execute the machining, assembly and maintenance processes, controlling the times and the quality of the results.
- Supervise the programming and tuning of numerical control machines, robots and manipulators for machining.
- Determine the necessary provisioning through an intelligent warehouse.
- Ensure that manufacturing processes conform to established procedures. Applied metrology.
- Manage the maintenance of resources in their area.

3 Collaboration opportunities opened by M2M

The fact of incorporating the M2M technology in labs opens up possible collaborations with other labs.

First, you can monitor the data that comes up with this element. In this way, it is possible to work with the traceability of the parts from different labs.

All this data can be used to analyse the process and improve it using a digital twin. In addition, this digital twin with real data, can be a perfect structure; so that HVETs, that do not have enough economic capacity to be able to have certain machines, can work with them virtually through collaboration.

4 References

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