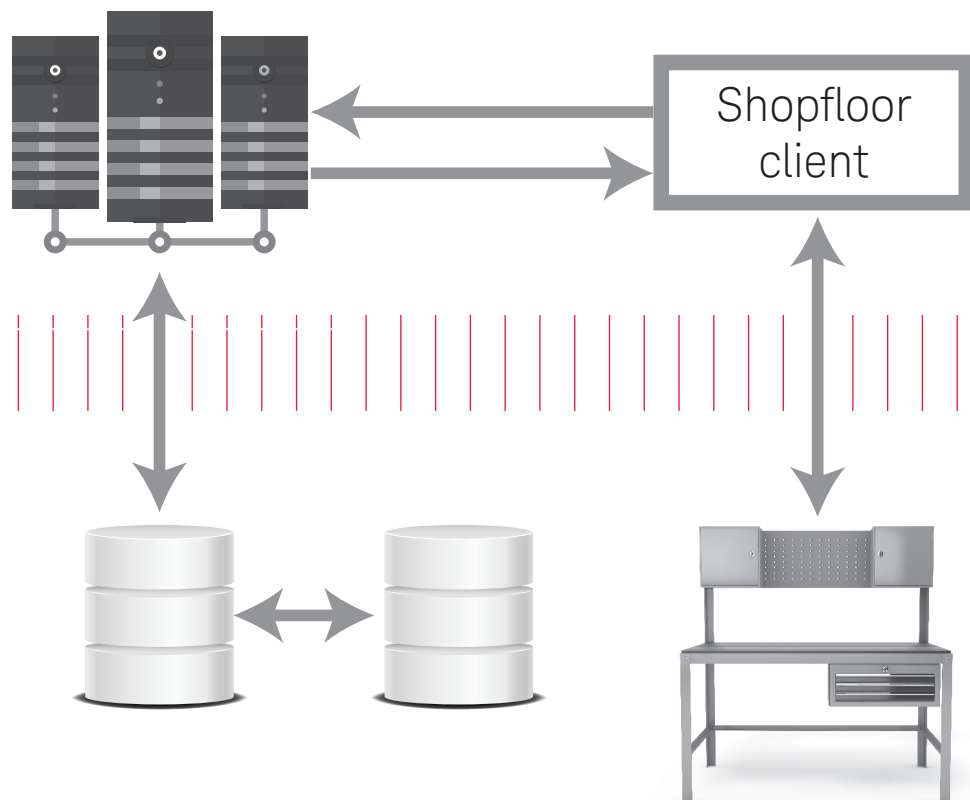


# Keysight Technologies

## Understanding the Operation and Usage of Manufacturing Execution Systems

### Technical Overview



# Introduction

The need to integrate an ICT Test system with the Manufacturing Execution System has become increasingly common as more businesses attempt to improve production management to achieve better operational efficiency and accuracy.

Manufacturing execution system (MES) is a software package that is usually server based and requires each element on the production line to upload or download information from its database. In doing so, the MES software gains knowledge of every single piece of product on the line and can assert restrictions so as to ensure that the product follows a particular production sequence. The most common restriction is to prevent a product from being processed at a particular station on the line if it has not completed the operation prior to this.

In order to achieve proper tracking and control, every piece of product on the line must be serialized. A common method will be to use barcode labels and have each station scan the labels and upload the information to the MES server for processing. Other method may include usage of RFID instead of barcode labels.

With the product serialized, each station on the line can now scan the ID of the product and check it against the MES server to determine if that product is legible for that station to process it. In other operations, the ID of the product may also be used to determine specific information to be downloaded from the server, which will be later programmed into the product itself. One example will be the MAC Address of a network board. MAC addresses are usually strictly controlled by the server to ensure that no two products will have the same address. Therefore, the blocks of MAC addresses are normally stored in the servers and assigned to specific product IDs upon request. This also allows the MES server to keep a record of the product ID and their assigned MAC address.

Another example of information download based on product ID will be product firmware. For product sites building multiple versions of the product, it is important to ensure that the correct firmware be programmed onto the product.

The manufacturing execution system controls the shop floor operation of a manufacturing facility. Therefore it is commonly referred to as the shopfloor control system or shopfloor server.

## Connections between Shopfloor Server and Clients

There is no standard protocol governing the communications between the production line equipment and the Shopfloor server. Every station on the production line has got its own function and data to upload. There are also different shopfloor software packages available in the market, each with their own method of transmitting information in and out of the production line. As such, there is no single universal application that can adapt to all equipment. Equipment will need to have a customized software application to handle the communications between the equipment software and the shopfloor server. This software application is known as the shopfloor client.

The shopfloor client works as the middle man between the equipment software and the shopfloor server. Therefore, it needs to handle two communication protocols; one between equipment software and the client and another between the client and the shopfloor server.

The communication of the shopfloor client to the shopfloor server will differ from case to case depending on the type of shopfloor software used. It will require detailed understanding of the shopfloor server in order to be able to develop a client application to handle the communication. Similarly for every station on the production line, the required information to transmit and receive is also different.

The physical link between the production stations and the shopfloor server is typically over local area network (LAN) given the fact that the server will be managing a significant number of stations located all over the manufacturing facility.

Equipment that links to the shopfloor server will require a shopfloor client application to handle the communication. The shopfloor client normally resides within the equipment itself and runs as a background process to monitor and transfer data between itself and the Shopfloor server.

### Shopfloor server

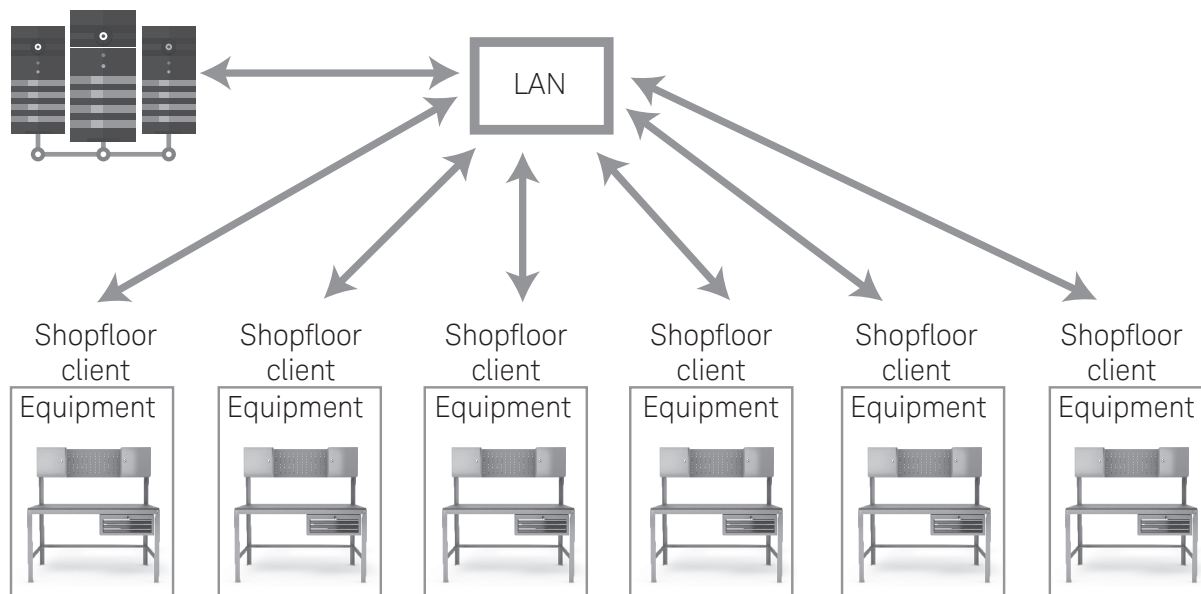


Figure 1. Communications can be in any form. It may be sending a string of commands and data between the systems or transferring of files with predefined formats that contain the required information.

## Example 1: General Users – Serial number validation

This is the most common setup in a shopfloor control system. The shopfloor server tracks all the products on the production line and tells the equipment if they are supposed to process the product or not. This prevents the product from getting mixed up and skipping any process along the production line.

In order for the product to be tracked, they will need to be given a unique ID. Serialization is the common method of identifying the products. Typical serialization methods use labels that are printed with machine readable barcodes to stick onto the products. Barcodes can be two dimensional or three dimensional. Equipment on the production line will need to be installed with a barcode reader that will be able to read the barcode labels and transfer the serial number to the shopfloor client application.

The shopfloor client then submits the serial number, along with other information about that station to the shopfloor server for validation. The shopfloor server records the information into its database and then decides if that particular serial number is expected to be processed by that station on the line. It then transmits the response to the shopfloor client which will either reject the product if the validation fails or proceed with normal operation if validation passes.

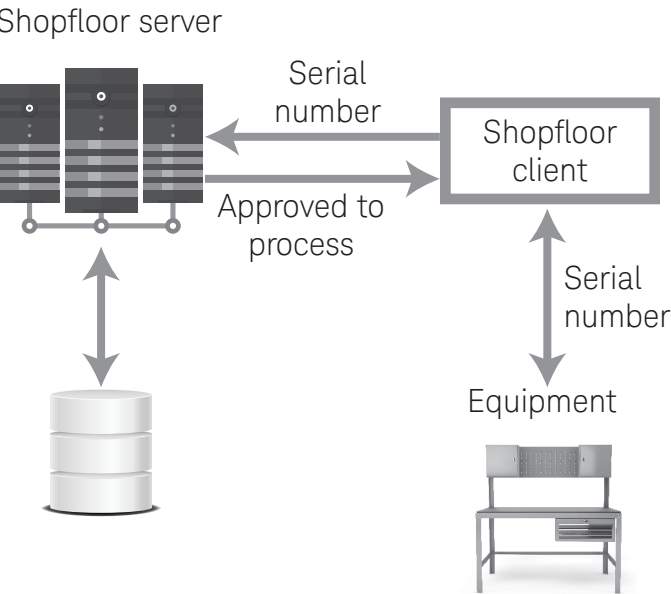


Figure 2. Setup for process approval

## Example 2: Computational Users – MAC Address download based on serial number

Taking a step further than just serial number validation, the shopfloor server can be also used to control the assignment and tracking of MAC addresses. This is essential for computational products that support networking features. MAC addresses are unique identification of a product in a network. Therefore it is important that there are no duplicated MAC addresses being programmed.

The shopfloor server holds a database which contains a range of MAC addresses. The shopfloor client sends the serial number of the DUT to the server for validation. The shopfloor server then assigns a new MAC address to this serial number from its database and records the assignment so that the particular address will never be assigned again to any other serial number.

The assigned MAC address is transferred back to the shopfloor client and then passed into the equipment software for processing. The common process will be to program this MAC address into a memory device in the DUT like an EEPROM or flash. Certain process may also require the shopfloor client to send the MAC address and serial number to a label printer. The operator will then paste the labels onto the DUT.

### Shopfloor server

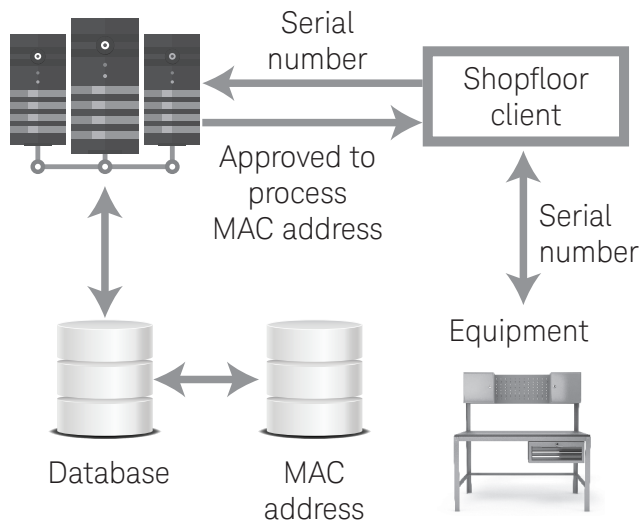


Figure 3. Setup for MAC addressing approval processing

## Example 3: Automotive Users – Test results verification by shopfloor server

Manufacturing electronic parts for automobiles requires strict controls and tracking of the production process. Small defects in these electronic parts of a car can cause catastrophic results and maybe even loss of life. Therefore, all major electronic parts used in the automobile are tracked during their production so that in the event of a failure in the field, investigations can be done all the way back to the production stage itself.

In an effort to ensure the accuracy and adherence to approved test limits, the security of the test program is often scrutinized. Most productions do not allow their operators and technicians to edit and modify the test programs. Some manufacturers may go a step further to control the test limits within the shopfloor server and make it inaccessible to the production floor. So even if the test programs are modified on the test system, the test limits in the shopfloor server remain unchanged and the test will never be allowed to pass.

In this setup, the administrator creates a list of test limits for each test programs and stores it the shopfloor server. On the production floor, the test program is loaded to the test system and the DUT is engaged for testing. The shopfloor client is triggered to scan the serial number and then transfer the serial number along with other information like product type to the shopfloor server. The shopfloor server validates the serial number and approves the test to continue.

At the end of the test cycle, the test system outputs the test measurements to a log file, which the shopfloor client will import and then extract the test values of each test. The shopfloor client then sends these values to the server for Pass/Fail verification. The shopfloor server then returns the PASS/FAIL results back. Shopfloor client then update the Pass/Fail results to the test system and resets for next cycle.

### Shopfloor server

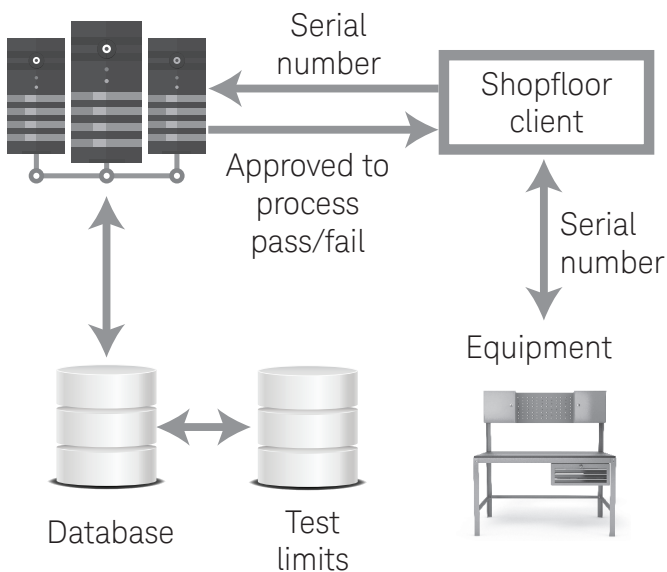


Figure 4. Setup for test results verification

## Conclusion

The usage of Manufacturing Execution System is limitless. It is a monitoring and control system that will ensure strict control of the manufacturing process. What we discussed in this document are real life examples of how the MES is used.

It is often a headache for the users to setup the communication link between the MES and the equipment on the production line because these are software that are independent of each other. The equipment will not support the exact format that the MES requires, nor can the MES support the various formats for all the different equipment on the line.

To bridge the gap between the MES and the equipment, a shopfloor client application is required.

Shopfloor clients are customized and unique to each type of equipment. Information within the equipment may not be readily available or even readable. Therefore, users often have to rely on the equipment suppliers to develop the application at a cost. And if there are changes to the MES requirements in the future, there will be added costs involved in getting the client application updated.

For the equipment supplier, shopfloor client development is not too difficult. However, it is challenging to maintain the support for it in the long term. The supplier may spend a few weeks to develop the shopfloor client and install it for production. Once installed, the client will usually work for many years to come until there is a request to modify it, such as to add information and features. This means that the supplier needs to maintain the knowledge and codes for that particular shopfloor client application for an extended period of time.

There will be multiple copies of the client application developed for different customers by the supplier. Therefore, it becomes increasingly difficult and tedious for the equipment supplier to be able to support the shopfloor client applications.

Equipment needs to provide a simple and effective method of data transfer and control so that it will allow the users to be able to manage the shopfloor client application themselves. Minor changes can then be handled directly by the users and in so doing users can grow their knowledge and be even more efficient in handling future changes. This will minimize the cost needed to engage the equipment supplier again to make modifications to the shopfloor client application.

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