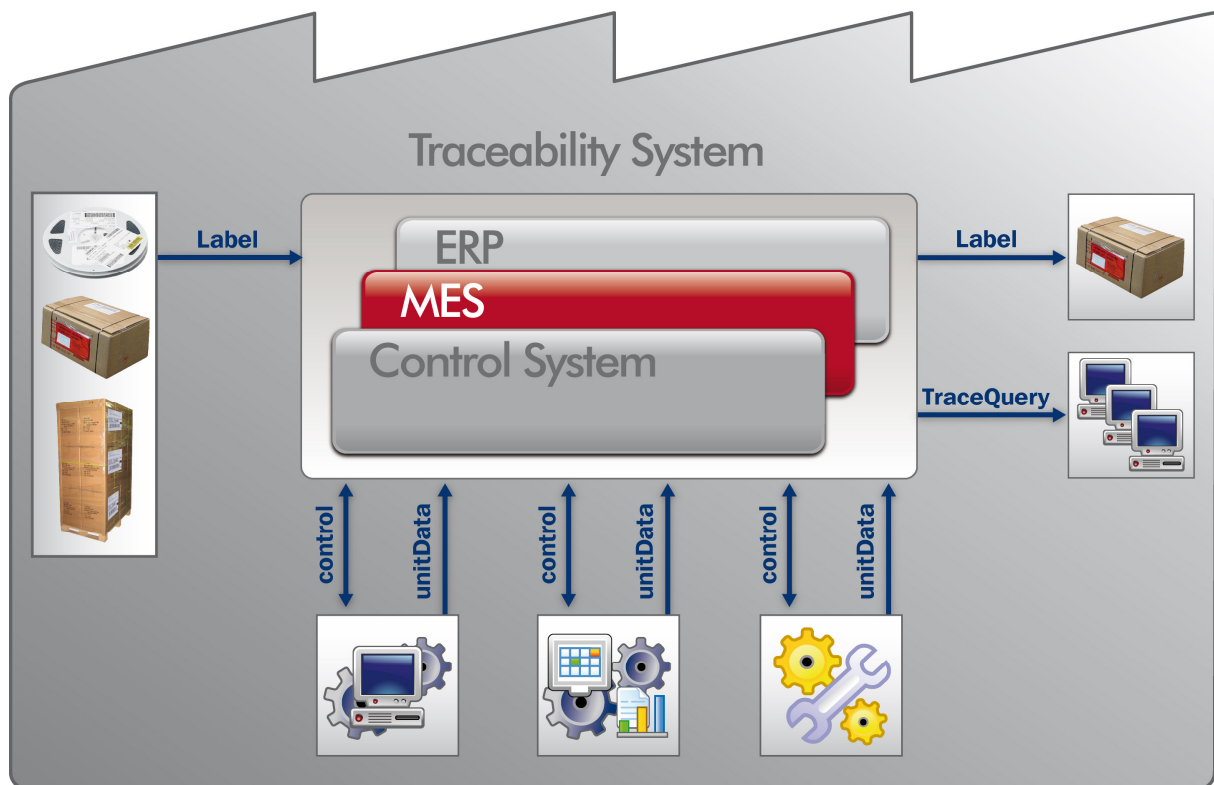


## Identification and Traceability in the Electrical and Electronics Industry



## ZVEI shop floor interfaces Manufacturing a product, overview

Version 1.1.0

## Preface

In line with the ZVEI guideline for the entire supply and value chain (see MIT-1 "Guideline for Identification and Traceability"), the Technology Working Committee III also designed a shop floor interface to connect machines, equipment and workstations.

The objective was to standardise this interface across all processes.

As a result, two XML-based interfaces were designed that are freely available and recommended by the ZVEI to connect the shop floor.

- **control** for the data transfer (requests and return messages) as part of the advanced process control during product processing.
- **unitData** for the data transfer to process a product

## History / changes

In MIT-2 "ZVEI-Interfaces-ChangeHistory" the history of changes of the interfaces **control** and **unitData** is described.



ZVEI – German Electrical and Electronic  
Manufacturers' Association e.V.  
Electronic Components and Systems  
Lyoner Str. 9  
60528 Frankfurt am Main

Phone: +49 (0) 69 6302 – 276

Fax: +49 (0) 69 6302 - 407

E-mail: [zvei-be@zvei.org](mailto:zvei-be@zvei.org)

[www.zvei-traceability.de](http://www.zvei-traceability.de)

# Contents

<b>Preface.....</b>	<b>2</b>
<b>History / changes.....</b>	<b>2</b>
<b>Contents .....</b>	<b>ii</b>
<b>1 Introduction .....</b>	<b>1</b>
1.1 Requirements.....	1
1.2 Prerequisites and limitations .....	2
1.2.1 Production type .....	2
1.2.2 XML interface.....	2
1.2.3 Error handling .....	2
<b>2 Equipment connection.....</b>	<b>3</b>
2.1 Participants .....	3
2.2 UseCase .....	3
2.3 Workflows.....	4
2.3.1 Job-related workflow .....	4
2.3.2 Serial number-related workflow .....	8
2.3.3 Scenarios with different equipment types and TraceabilitySystems .....	11
2.4 Interfaces .....	12
2.4.1 Operator - equipment interface.....	12
2.4.2 Equipment - TraceabilitySystem interface .....	12
2.4.2.1 [Optional specification of values and parameters] .....	13
2.4.2.2 [Optional process interlocking by verifying values and parameters] .....	14
2.4.2.3 Transfer of processing results .....	15
<b>3 Appendix.....</b>	<b>16</b>
3.1 List of relevant documents .....	16
3.2 List of illustrations.....	17
3.3 List of tables .....	17
3.4 List of relevant terms and abbreviations .....	18

# 1 Introduction

In addition to the operator and equipment, product manufacturing normally also involves a TraceabilitySystem to exchange data with the equipment to control production and to ensure internal traceability (across all equipment). This can either be a simple control, a line computer or an MES.

This specification describes the ZVEI standard interfaces for general product processing and provides details on the relevant workflows and interfaces required for connecting equipment to a TraceabilitySystem.

Product examples are:

- Electronic flat packs
- Mechanical assemblies
- Devices
- Material in general

In terms of equipment, examples are:

- Manufacturing systems
- Test systems
- Manual workstations
- Assembly lines
- Manufacturing cells
- Handling systems
- Scanners and readers
- Terminals (GUI)
- Signal devices (traffic light systems)

## 1.1 Requirements

The TraceabilitySystem supplies data to the ZVEI standard interfaces meeting the following requirements:

- Implementation of a bi-directional XML interface between the equipment and the TraceabilitySystem to transmit data and events
- Optional specification of values and parameters, (e.g. machine program)
- Optional process interlocking by verifying values and parameters, (e.g. testing the properties of the materials used)
- Product traceability  
Transfer of components and materials used
- Process traceability  
Transfer of process data
- Test and repair  
Transfer of test and repair data

## 1.2 Prerequisites and limitations

The following prerequisites and limitations apply when connecting equipment to a TraceabilitySystem.

### 1.2.1 Production type

Products can be processed on a job or serial number basis.

- Job-related production  
Only products of the released job are manufactured.
  - ➔ Set-up of the equipment to be used for a job
  - ➔ Process release for a job
  - ➔ Process interlocking effective for the duration of the job and for the valid serial number
- Serial number-related production  
Products (serial numbers) that do not necessarily belong to one job are manufactured irrespective of their sequence.
  - ➔ Every serial number might require the individual set-up of the equipment to be used.
  - ➔ Every serial number might require the verification of the production processing regulations in the event of process interlocking.

### 1.2.2 XML interface

The bi-directional XML interface between the equipment and the TraceabilitySystem is implemented with the **control** and **unitData** (see Section 3.1 "List of relevant documents") standard interfaces. The equipment must support these standard interfaces.

### 1.2.3 Error handling

The TraceabilitySystem connects the equipment. Any errors are handled autonomously by the equipment and TraceabilitySystem control. The TraceabilitySystem can operate as a service without a user interface. If the equipment has a user interface (terminal, traffic light), errors during the communication between the equipment and the TraceabilitySystem are reported via the equipment user interface (see also MIT-6 "ZVEI transfer protocol interfaces").

## 2 Equipment connection

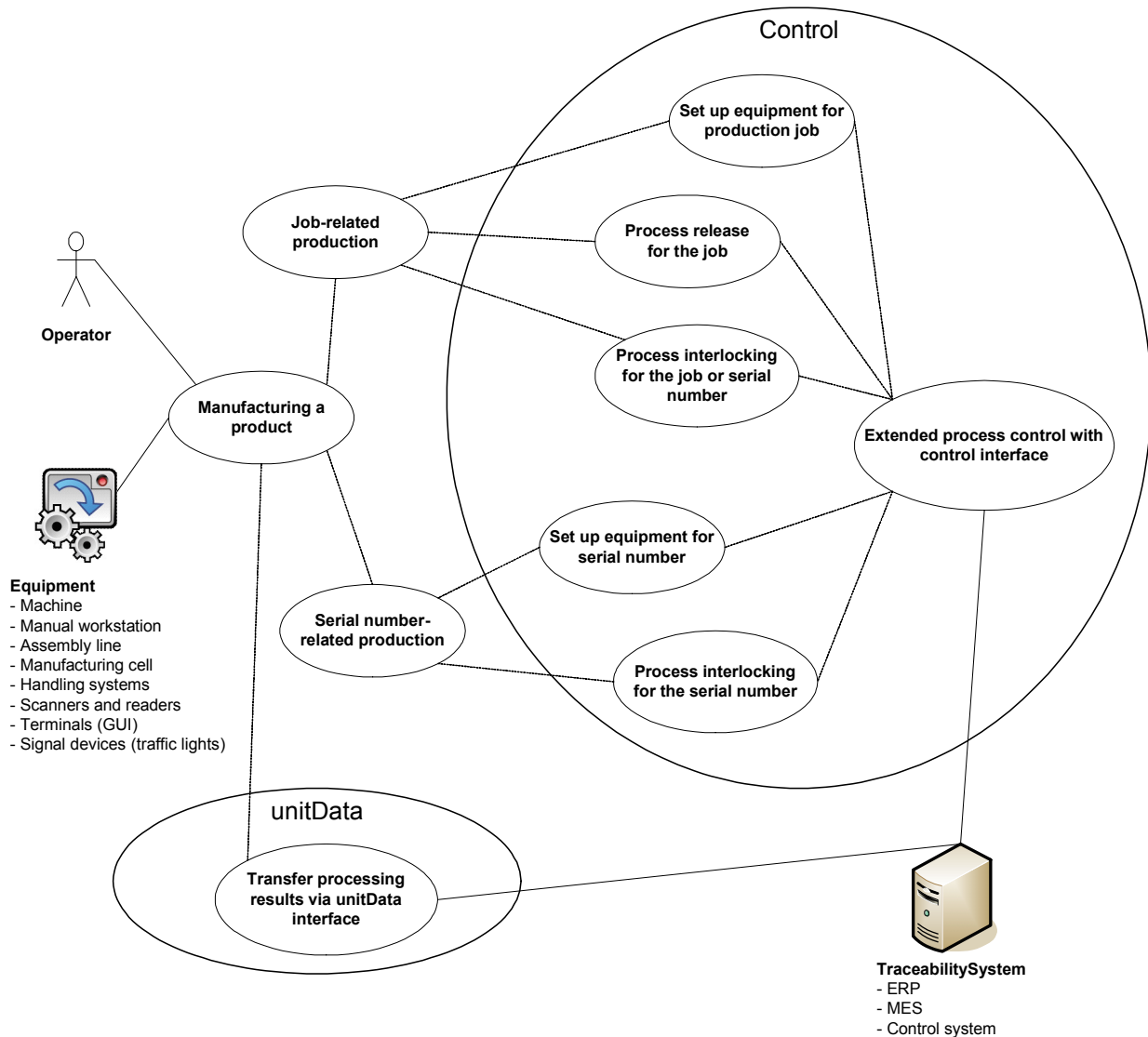
The workflows required to connect the equipment to the TraceabilitySystem are specified in the following.

### 2.1 Participants

- Operator
- Equipment
- TraceabilitySystem

### 2.2 UseCase

The following UseCase shows the general implementation of the control and unitData interfaces when manufacturing a product, differentiating between production based on jobs or serial numbers.



**Fig. 1: Manufacturing a product, UseCase**

The control and unitData interfaces can be used for any combination of participants and scenarios. A process can involve several TraceabilitySystems, (e.g. MES and line computer) and several equipment types, (e.g. scanner, handling system, machine).

## 2.3 Workflows

Products can be processed on job or serial number basis.

- Job-related production  
Only products (serial numbers) of the released job are manufactured.
  - ➔ Set-up of the equipment to be used for a job
  - ➔ Process release for a job.
  - ➔ Process interlocking effective for the duration of the job and for the valid serial number
- Serial number-related production  
Products (serial numbers) that do not necessarily belong to one job are manufactured irrespective of their sequence..
  - ➔ Every serial number might require the individual set-up of the equipment to be used.
  - ➔ Every serial number might require the verification of the production processing regulations in the event of process interlocking.

### 2.3.1 Job-related workflow

In the event of job-related production, the equipment is set up for a specific job.

- Optional set-up of equipment with tools
- Optional set-up of equipment with process parameters (machine program, target values)
- Optional preliminary set-up/re-set-up/set-up of equipment

After a process is released for a job, only products for the released job are manufactured. As long as the production processing regulations for the equipment (tools, process parameters, set-up) do not change, only the validity of the serial numbers, their reference and the job duration effective for the process interlocking must be verified.

The following illustration maps the general workflow of a job-related production with equipment. The workflow involves interactions of the operator and the dialogue between the TraceabilitySystem and the equipment.

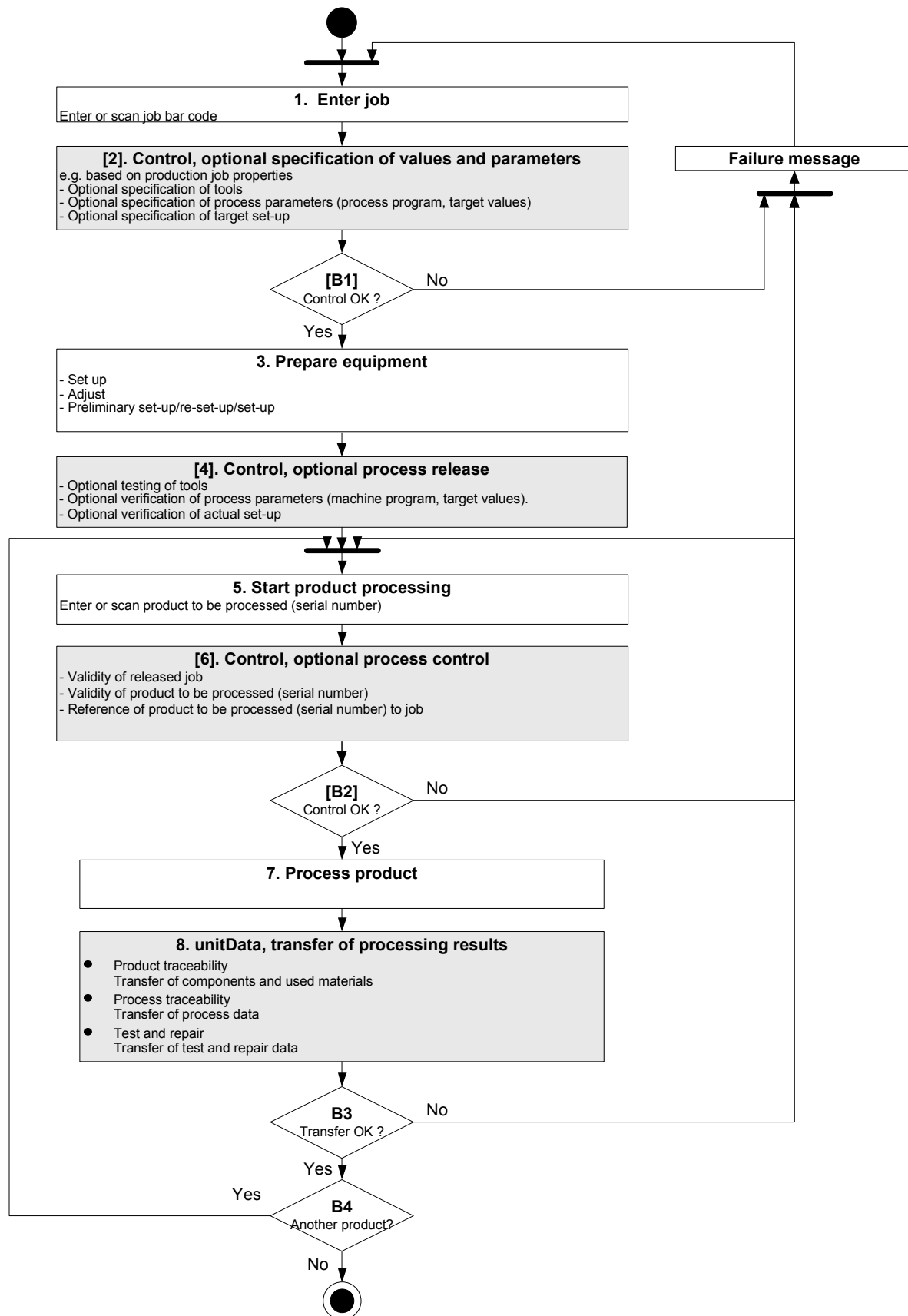


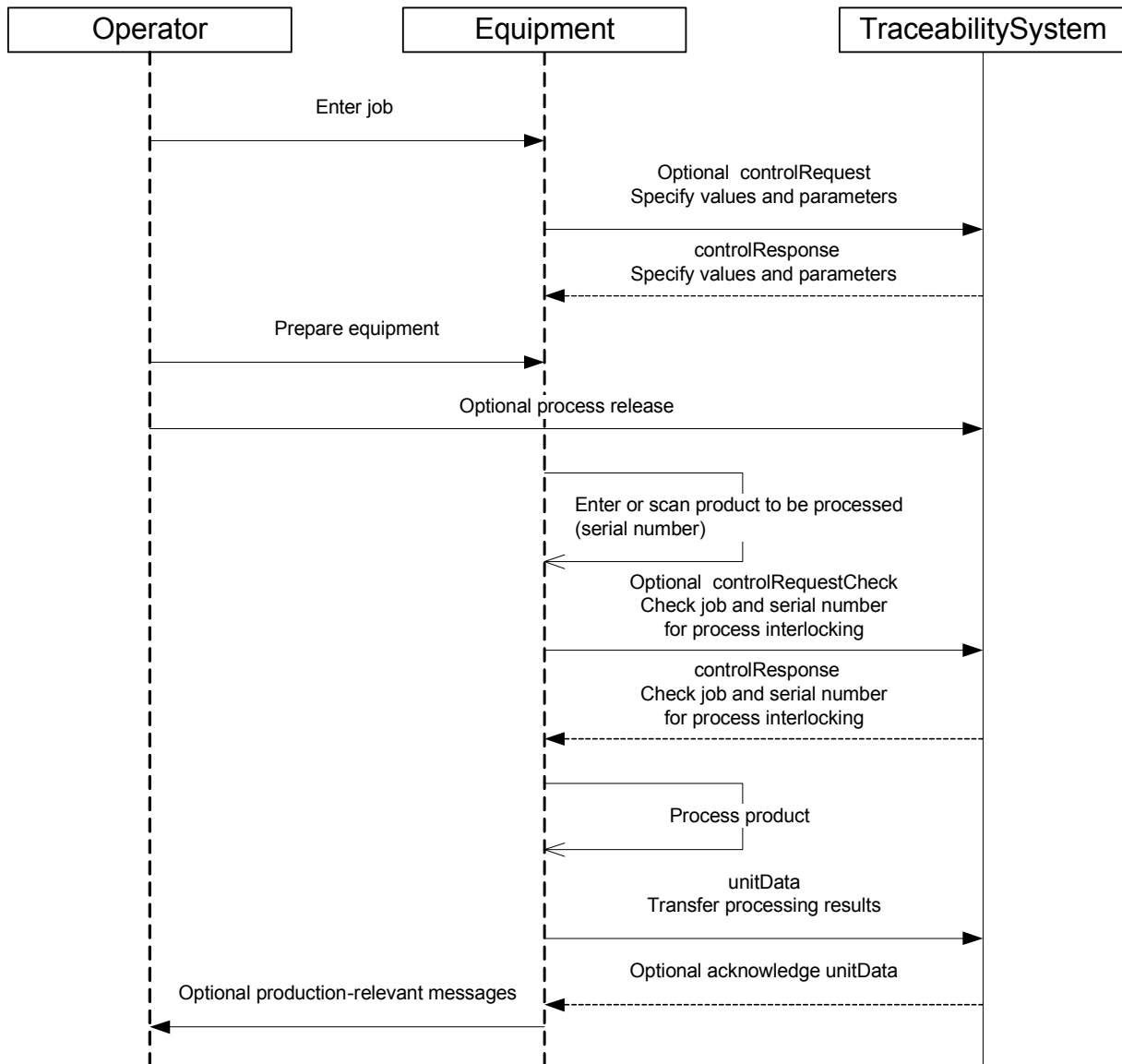
Fig. 2: Manufacturing a product, job-related workflow



#	Step	Participants	Comment
1	Enter job	<ul style="list-style-type: none"> <li>Operator</li> <li>Equipment</li> </ul>	Enter or scan bar code
[2]	Control, presets Optional specification of values and parameters	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> </ul>	e.g. on the basis of the manufacturing job properties <ul style="list-style-type: none"> <li>Optional specification of tools</li> <li>Optional specification of process parameters (machine program, target values)</li> <li>Optional specification of target set-up</li> </ul>
[B1]	Branching/decision Control OK?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	Error message or continue
3	Prepare equipment	<ul style="list-style-type: none"> <li>Operator</li> <li>Equipment</li> </ul>	<ul style="list-style-type: none"> <li>Set up</li> <li>Adjust</li> <li>Preliminary set-up/re-set-up/set-up</li> </ul>
[4]	Control, Setfree Optional process release	<ul style="list-style-type: none"> <li>Operator</li> <li>Control terminal</li> <li>TraceabilitySystem</li> </ul>	<ul style="list-style-type: none"> <li>Optional testing of tools</li> <li>Optional verification of process parameters (machine program, target values)</li> <li>Optional testing of actual set-up</li> </ul>
5	Start product processing	<ul style="list-style-type: none"> <li>Operator</li> <li>Equipment</li> </ul>	Enter or scan product to be processed (serial number)
[6]	Control InterLock Optional process interlocking by verifying values and parameters	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> </ul>	<ul style="list-style-type: none"> <li>Validity of released job</li> <li>Validity of product to be processed (serial number)</li> <li>Reference of the product to be processed (serial number) with regard to the job</li> </ul>
[B2]	Branching/decision Control OK?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	Error message or continue
7	Process product	<ul style="list-style-type: none"> <li>Equipment</li> </ul>	
9	unitData Transfer of processing results	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> </ul>	<ul style="list-style-type: none"> <li>Product traceability Transfer of components and materials used</li> <li>Process traceability Transfer of process data</li> <li>Test and repair Transfer of test and repair data</li> </ul>
B3	Branching/decision Transfer OK?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	Error message or continue
B4	Branching/decision Another product?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	e.g. feeder status

**Table 1: Manufacturing a product, job-related workflow**

The following figure illustrates the sequence diagram of a job-related workflow.



**Fig. 3: Manufacturing a product, job-related sequence diagram**

### 2.3.2 Serial number-related workflow

In a production based on serial numbers, products (serial numbers) that do not necessarily belong to one job are manufactured irrespective of their sequence.

In this case it may sometimes be necessary to set the equipment up again for each serial number.

- Optional set-up of equipment with tools
- Optional set-up of equipment with process parameters (machine program, target values)
- Optional preliminary set-up/re-set-up/set-up of equipment

Every serial number might require the verification of the production processing regulations in the event of process interlocking.

The following illustration maps the general workflow of a serial number-related production with equipment. The workflow involves interactions of the operator and the dialogue between the TraceabilitySystem and the equipment.

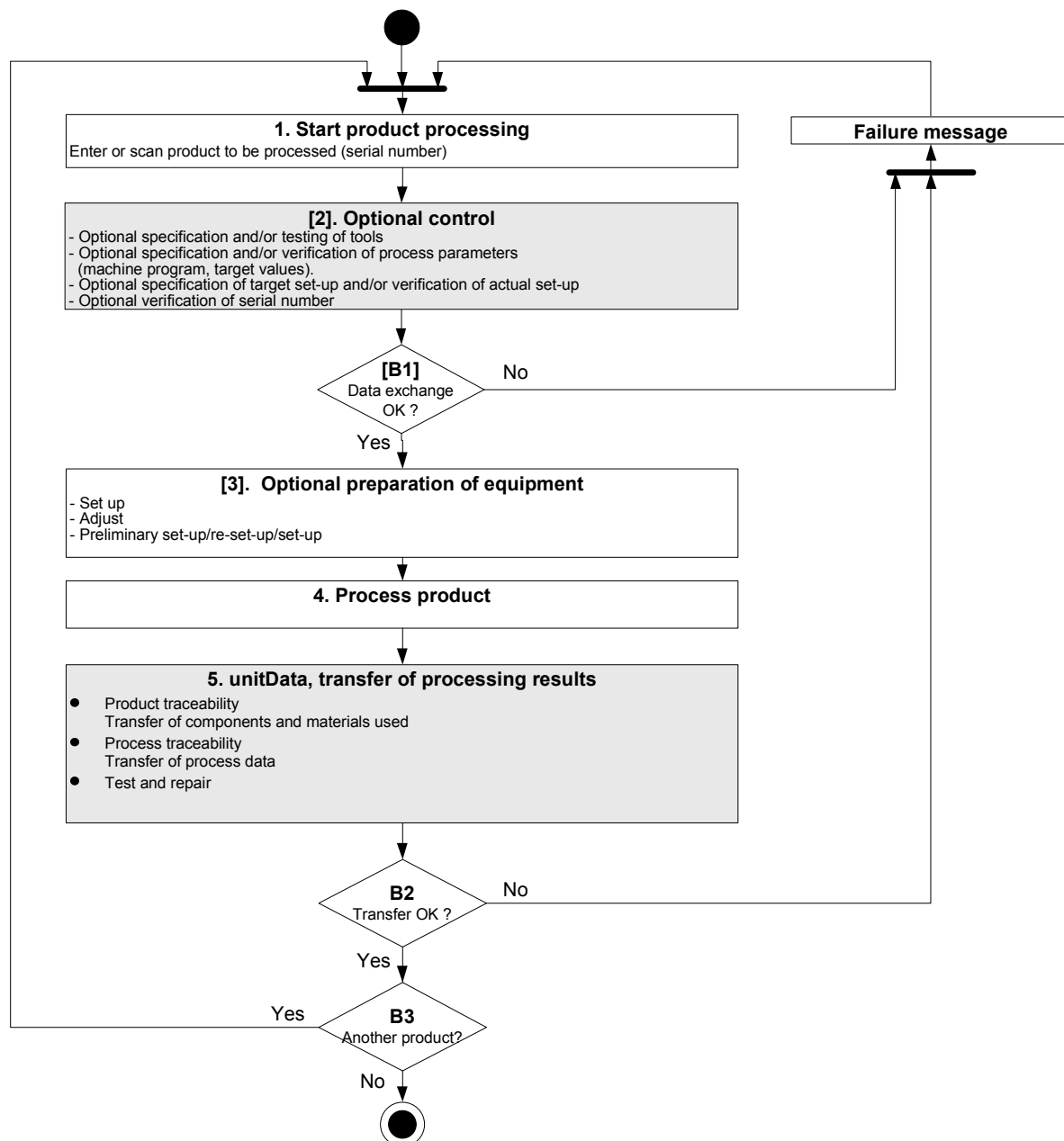
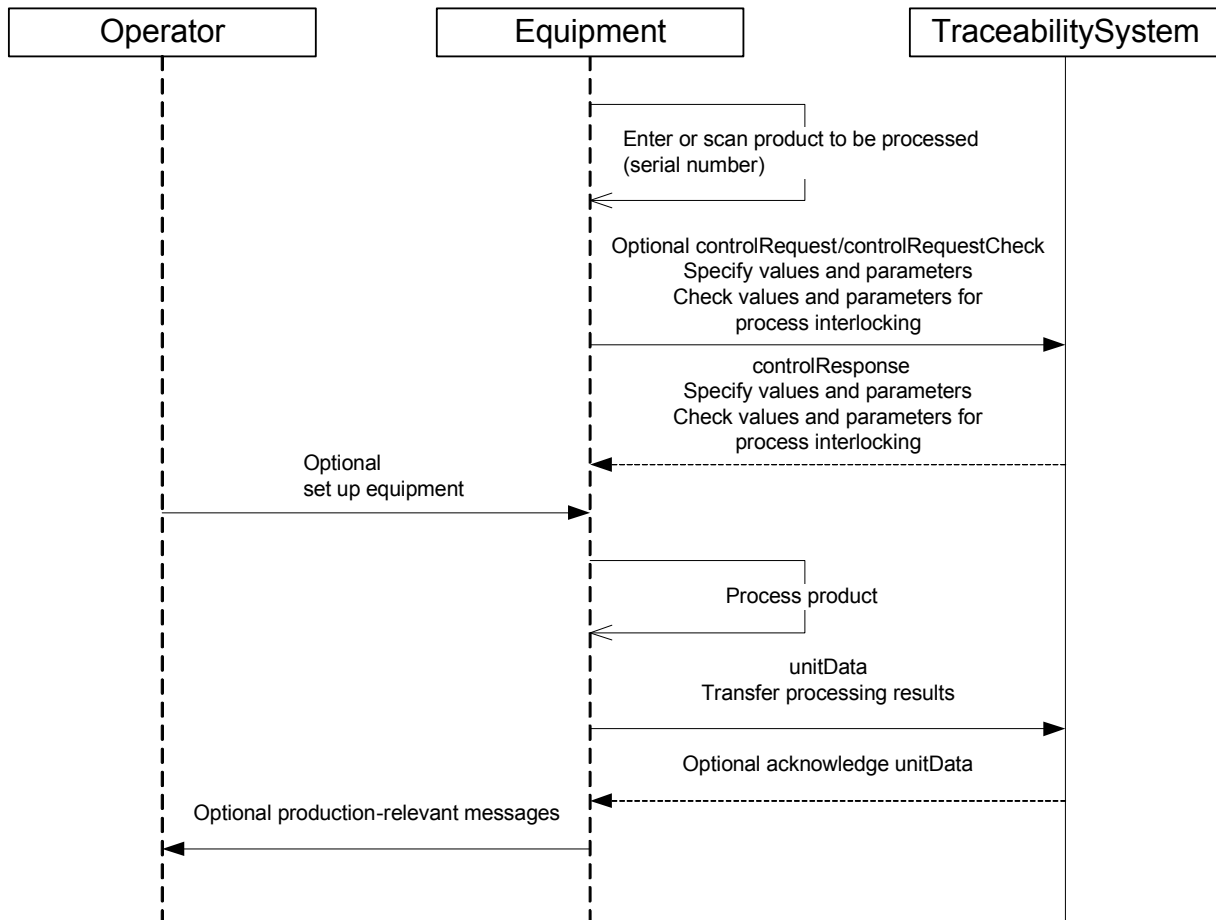


Fig. 4: Manufacturing a product, serial number-related workflow

#	Step	Participants	Comment
1	Start product processing	<ul style="list-style-type: none"> <li>Operator</li> <li>Equipment</li> </ul>	Enter or scan product to be processed (serial number)
[2]	Control, presets Optional specification of values and parameters Optional process interlocking by verifying values and parameters	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> </ul>	<ul style="list-style-type: none"> <li>Optional specification and/or testing of tools</li> <li>Optional specification and/or testing of process parameters (machine program, target values)</li> <li>Optional specification of target set-up and/or verification of actual set-up</li> <li>Optional verification of serial number</li> </ul>
[B1]	Branching/decision Control OK?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	Error message or continue
3	Prepare equipment	<ul style="list-style-type: none"> <li>Operator</li> <li>Equipment</li> </ul>	<ul style="list-style-type: none"> <li>Set up</li> <li>Adjust</li> <li>Preliminary set-up/re-set-up/set-up</li> </ul>
4	Process product	<ul style="list-style-type: none"> <li>Equipment</li> </ul>	
5	unitData Transfer of processing results	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> </ul>	<ul style="list-style-type: none"> <li>Product traceability Transfer of components and materials used</li> <li>Process traceability Transfer of process data</li> <li>Test and repair Transfer of test and repair data</li> </ul>
B2	Branching/decision Transfer OK?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	Error message or continue
B3	Branching/decision Another product?	<ul style="list-style-type: none"> <li>Equipment</li> <li>TraceabilitySystem</li> <li>Operator</li> </ul>	e.g. feeder status

**Table 2: Manufacturing a product, serial number-related workflow**

The following figure illustrates the sequence diagram of a serial number-related workflow.



**Fig. 5: Manufacturing a product, serial number-related sequence diagram**

### 2.3.3 Scenarios with different equipment types and TraceabilitySystems

The control and unitData interfaces can be used for a random combination of participants and scenarios. A process can involve several TraceabilitySystems, (e.g. MES and line computer) and several equipment types, (e.g. scanner, handling system, machine).

Several equipment types of a line are involved in the following production example.

- An external scanner outside the machine reads the serial number of the product to be processed.
- The process is interlocked by the handling system outside the machine.
- The actual production is performed by the machine.

The control within the line is assumed by a TraceabilitySystem LineControl, which also centrally generates the messages for the operator.

The MES TraceabilitySystem has all the information for the production across all equipment types and production lines.

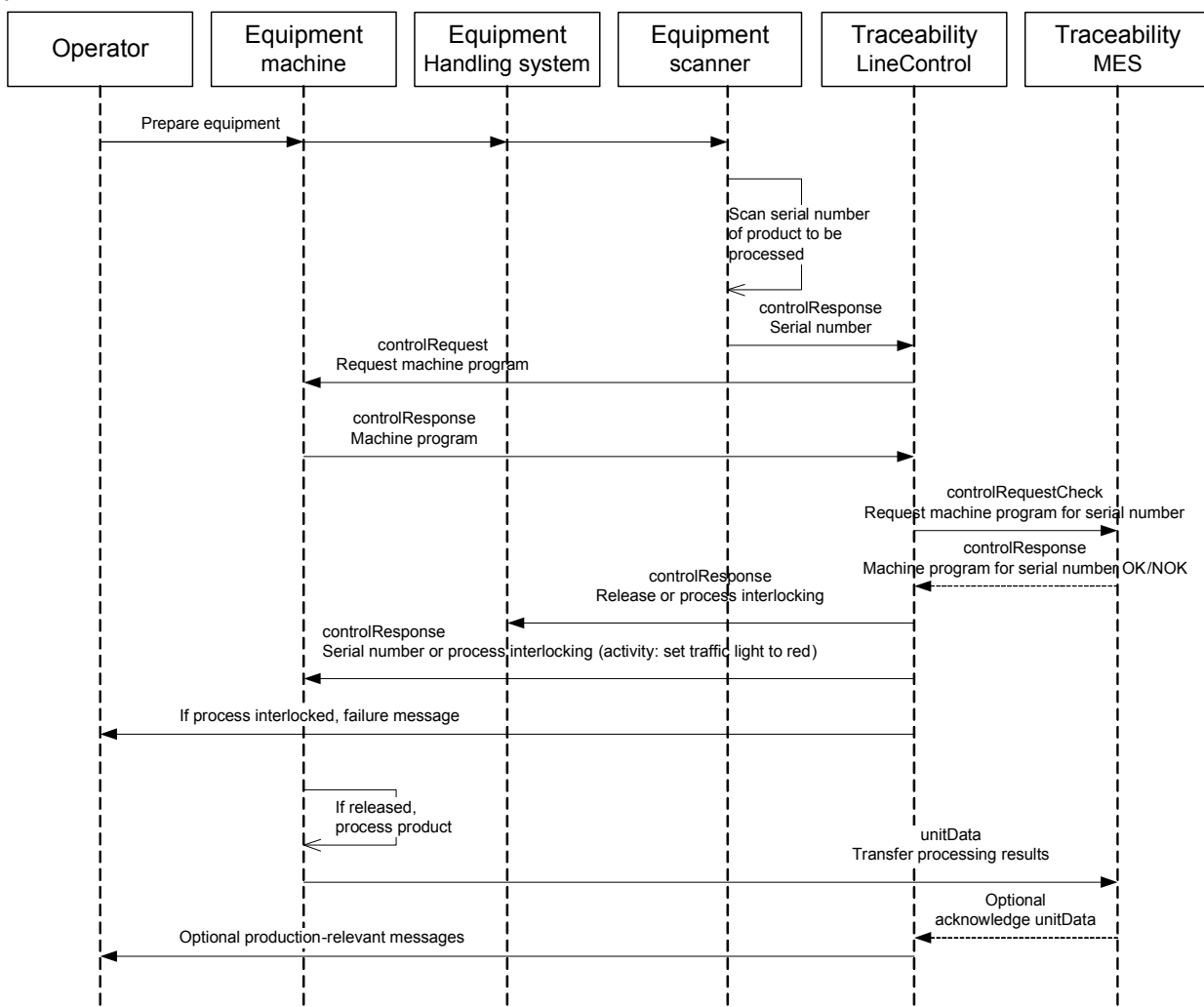


Fig. 6: Scenario with different equipment types and TraceabilitySystems

## 2.4 Interfaces

The following interfaces are involved in the overall workflow.

### 2.4.1 Operator - equipment interface

A job-related production must provide a GUI between operator and equipment to record the job, optionally to select the machine program and record the material information (actual set-up).

If the equipment has a user interface (terminal, traffic light), errors during the communication between the equipment and the TraceabilitySystem are reported via the equipment user interface (see also MIT-6 "ZVEI transfer protocol interfaces").

The equipment GUI is not part of this specification.

### 2.4.2 Equipment - TraceabilitySystem interface

The bi-directional XML interface between the equipment and the TraceabilitySystem is implemented with XML structures using the **control** and **unitData** standard interfaces; see:

- MIT-3 "ZVEI control interface"
- MIT-4 "ZVEI unitData interface"

MIT-6 "ZVEI transfer protocol interfaces" specifies the XML structures.

### 2.4.2.1 [Optional specification of values and parameters]

Example: Request and transfer of the product material number

The **control** standard interface specified in MIT-3 "ZVEI control interface" is used to request and transfer the material number of a product applying the following sample files:

- Product\_Request.xml
- Product\_Response\_ok.xml
- Product\_Response\_nok.xml

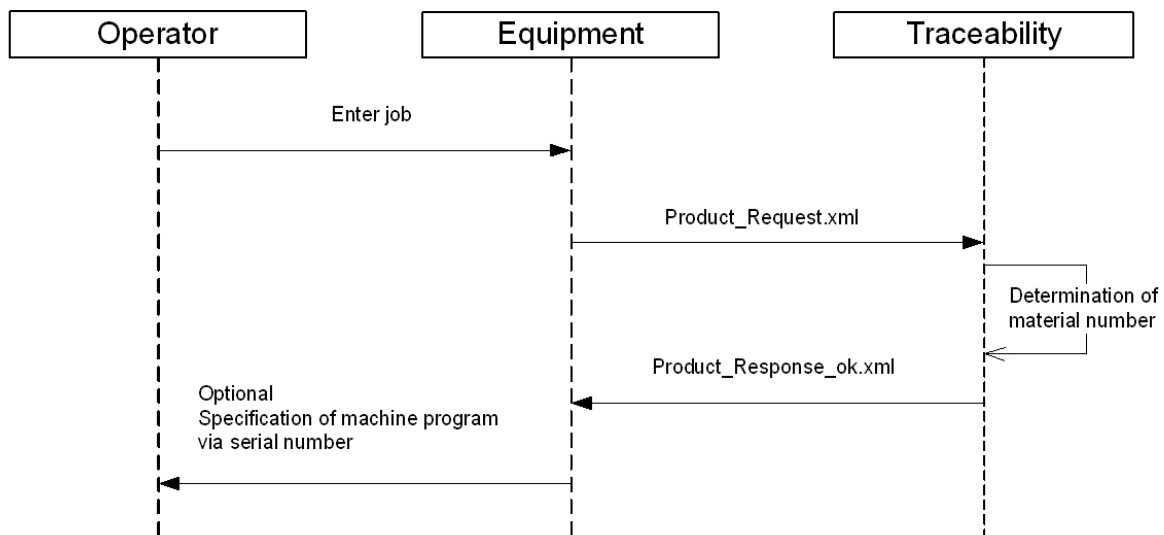


Fig 7: Sequence diagram: Material request of a product OK

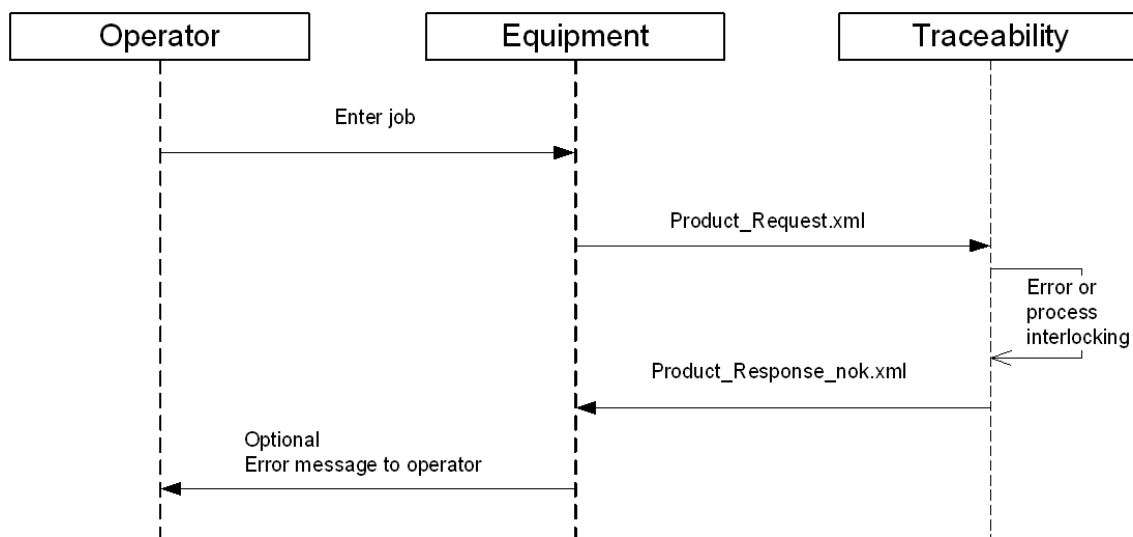


Fig 8: Sequence diagram: Material request of a product NOK



### 2.4.2.2 [Optional process interlocking by verifying values and parameters]

Example: Request and validation of trading unit number for process interlocking

The **control** standard interface specified in MIT-3 "ZVEI control interface" is used to request and transfer the trading unit number applying the following sample files:

- MaterialLot\_Request.xml
- MaterialLot\_Response\_ok.xml
- MaterialLot\_Response\_nok.xml

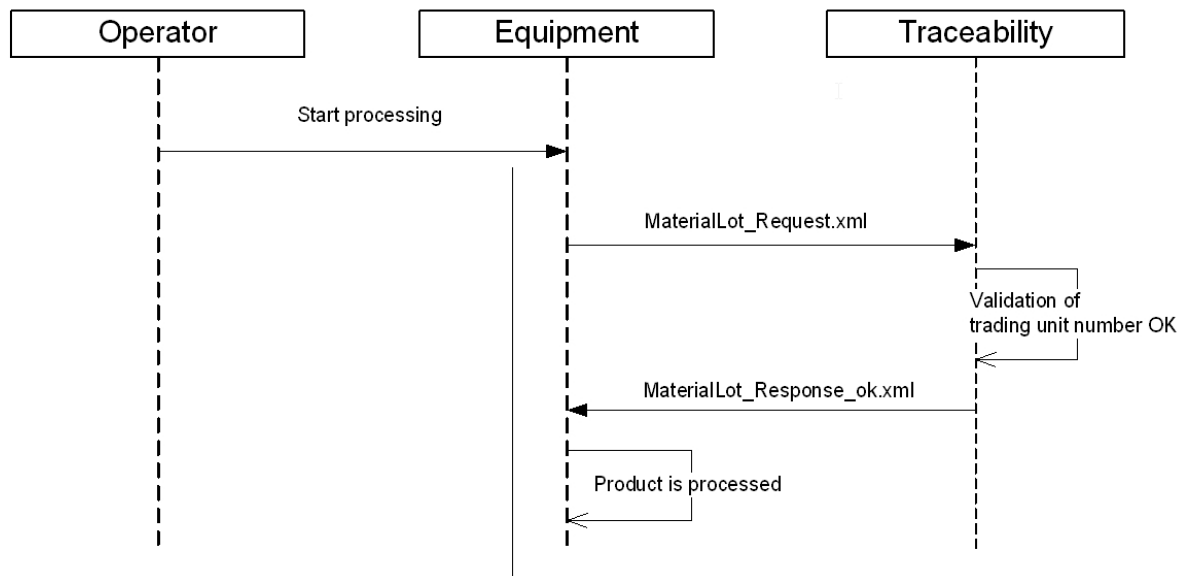


Fig 9: Sequence diagram: Request of trading unit number OK

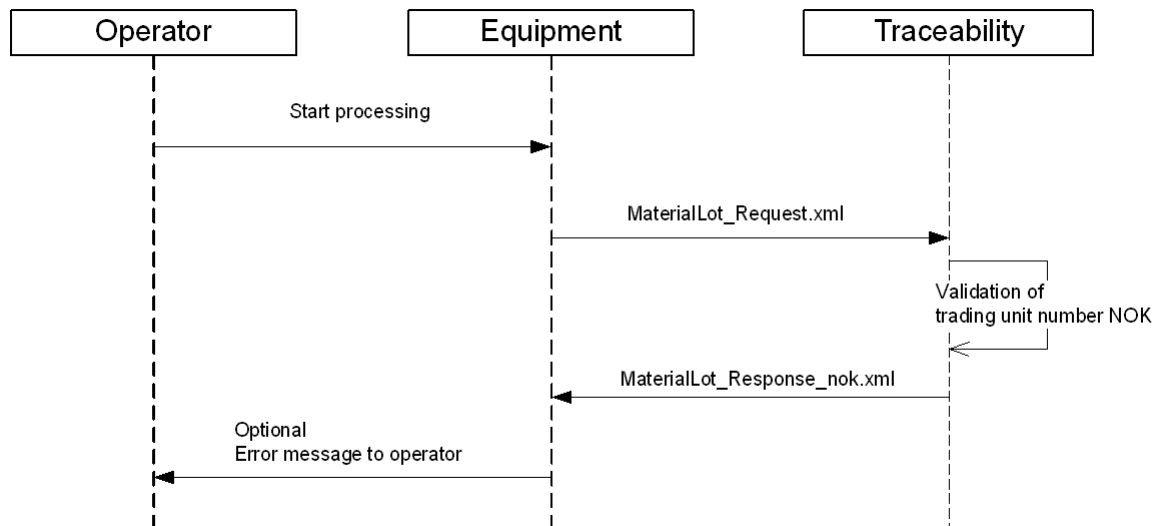


Fig 10: Sequence diagram: Request of trading unit number NOK

### 2.4.2.3 Transfer of processing results

The **unitData** standard interface specified in MIT-4 "ZVEI unitData interface" transfers the processing results using the ProcessingResults.xml sample file.

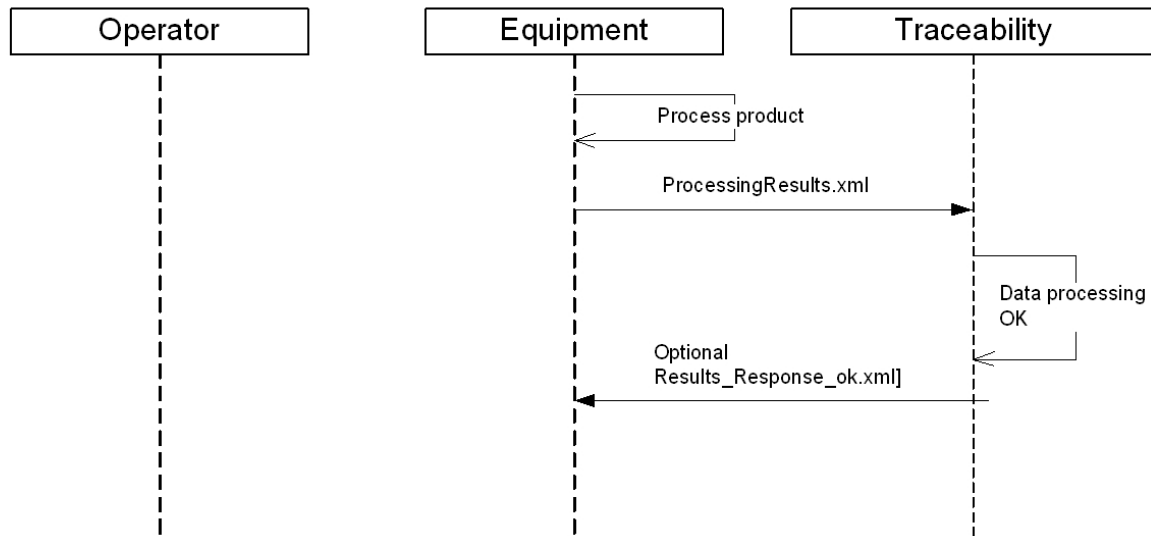


Fig 11: Sequence diagram: Processing results, data processing OK

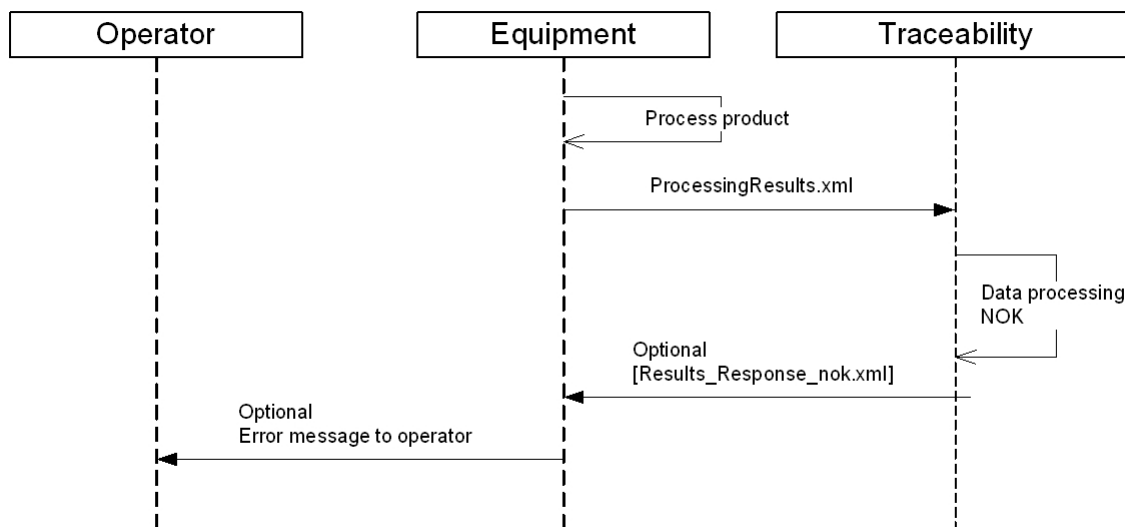


Fig 12: Sequence diagram: Processing results, data processing NOK

## 3 Appendix

### 3.1 List of relevant documents

MIT-1 " <a href="#">Guideline for Identification and Traceability</a> "	ZVEI guideline for the entire supply and value chain
MIT-2 "ZVEI-Interfaces-ChangeHistory"	This document describes the history of changes to the interfaces control and unitData.
MIT-2 "ZVEI interfaces overview"	This document provides an overview of possible applications of the ZVEI control and unitData interfaces during the manufacturing of a product
MIT-3 "ZVEI control interface"	This document describes the structure of the <b>control</b> standard interface for transferring data (requests and return messages) for the process control (advanced process control) during product processing
MIT-4 "ZVEI unitData interface"	This document describes the structure of the <b>unitData</b> standard interface for transferring data to process a product
MIT-5 "ZVEI TestAndRepair interface"	Description of the substructures of ZVEI standard interfaces for transferring test and repair data
MIT-6 "ZVEI transfer protocol interface"	Description of the standard interface transfer protocols to transfer XML structures
MIT-7 "control-1.1.xsd"	File with XSD diagram for ZVEI control standard interface
MIT-8 "unitData-1.1.xsd"	File with XSD diagram for ZVEI unitData standard interface
MIT-9 "ZVEI-common-1.1.xsd"	File with XSD diagram for common types that are used in various ZVEI standard interfaces
MIT-10 "ZVEI-testRepair-1.1.xsd"	File with XSD diagram for common types to forward test and repair data, which is used in various ZVEI standard interfaces
MIT-11 "control_Request-1.1.xml"	File with sample request for the ZVEI control standard interface
MIT-12 "control_Response-1.1.xml"	File with sample return message for the ZVEI control standard interface
MIT-13 "unitData-1.1.xml"	File with example of the ZVEI unitData standard interface

### 3.2 List of illustrations

Fig. 1: Manufacturing a product, UseCase .....	3
Fig. 2: Manufacturing a product, job-related workflow.....	5
Fig. 3: Manufacturing a product, job-related sequence diagram .....	7
Fig. 4: Manufacturing a product, serial number-related workflow.....	8
Fig. 5: Manufacturing a product, serial number-related sequence diagram .....	10
Fig. 6: Scenario with different equipment types and TraceabilitySystems .....	11
Fig 7: Sequence diagram: Material request of a product OK .....	13
Fig 8: Sequence diagram: Material request of a product NOK.....	13
Fig 9: Sequence diagram: Request of trading unit number OK.....	14
Fig 10: Sequence diagram: Request of trading unit number NOK.....	14
Fig 11: Sequence diagram: Processing results, data processing OK .....	15
Fig 12: Sequence diagram: Processing results, data processing NOK .....	15

### 3.3 List of tables

Table 1: Manufacturing a product, job-related workflow.....	6
Table 2: Manufacturing a product, serial number-related workflow .....	9

### 3.4 List of relevant terms and abbreviations

Term	Description
Product	Definition according to the German Equipment and Product Safety Act/Product Liability Act Description of a material that is manufactured. Examples: <ul style="list-style-type: none"> <li>• Electronic flat pack</li> <li>• Mechanical assembly</li> <li>• Device</li> </ul>
Bill of material	Description of component type and number contained in a product
Work sequence	Description of a work plan specifying the production steps required to manufacture a product
Work process	Description of a single production step (work step, process step) that is part of a work sequence required for manufacturing a product. The work process must not necessarily be assigned to a specific piece of equipment.
Equipment	Resources applied to manufacture a product, such as: <ul style="list-style-type: none"> <li>• Manufacturing systems</li> <li>• Test systems</li> <li>• Manual workstations</li> <li>• Assembly lines</li> <li>• Manufacturing cells</li> <li>• Handling systems</li> <li>• Scanners and readers</li> <li>• Terminals (GUI)</li> <li>• Signal devices (traffic light systems)</li> </ul>
PCB	Unpopulated independent circuit
Flat packs	Populated independent circuit
Panel	A combination of independent circuits to form a board (virtual workpiece carrier); single or multiple panels depending on the number of independent circuits.
Panel blank	Unprocessed single or multiple panel
Serial number	Unique number of a manufactured part
Component	A component (component, assembly, bulk material) is used for a product (for example mounted, populated)
Trading unit	Physical combination of individual parts, e.g. roll, rod or tray per smallest packaging unit.
Batch	Number of components with attached barcode (trading unit). There are two different types of batches, supplier batches and incoming goods batches. Supplier batches can be divided into smaller incoming goods batches.
MaterialLot (batch number or trading unit number)	Unique number of a batch or trading unit. The number of a supplier batch is already assigned by the supplier on delivery. The numbers of incoming goods batches can be (re)assigned in incoming goods. If incoming goods batches are combined per smallest packaging unit this is equivalent to a trading unit.
SI unit	Abbreviation for "Système International d'Unités" SI units are part of the International System of Units for Natural Sciences. In most countries, it is the legal standard system specifying seven SI basic units: <ul style="list-style-type: none"> <li>• Length: metre (m)</li> <li>• Mass: kilogram (kg)</li> <li>• Time: second (s)</li> <li>• Electric current: ampere (kg)</li> <li>• Temperature: kelvin (K)</li> <li>• Amount of substance: mole (mol)</li> <li>• Luminous intensity: candela (cd)</li> </ul> Numerous other units are derived from these basic units, for example Newton, Pascal or Joule.