Industrie 4.0 Zwick Roell
on track for the 4th Industrial Revolution

testXpo 2017
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Internet of Things/ Industry 4.0

Zwick / Roell

At the core of the "Fourth Industrial Revolution" is the "Internet of Things".

INTERNET OF THINGS	INDUSTRY 4.0

"Internet of Things" is the expression applied to the far-reaching interaction between **human beings and technical systems** and of **technical systems with each other,** in which the systems themselves are equipped to an increasing degree with technological intelligence which enables autonomous action within a defined scope. Human-machine interfaces (HMIs) and artificial intelligence (AI) are therefore of particular importance for the Internet of Things.

At the core of the Fourth Industrial Revolution lies the **Internet of Things,** together with new ways of **networking** resources, services and people in production **in real time** on the basis of **cyber-physical systems**.
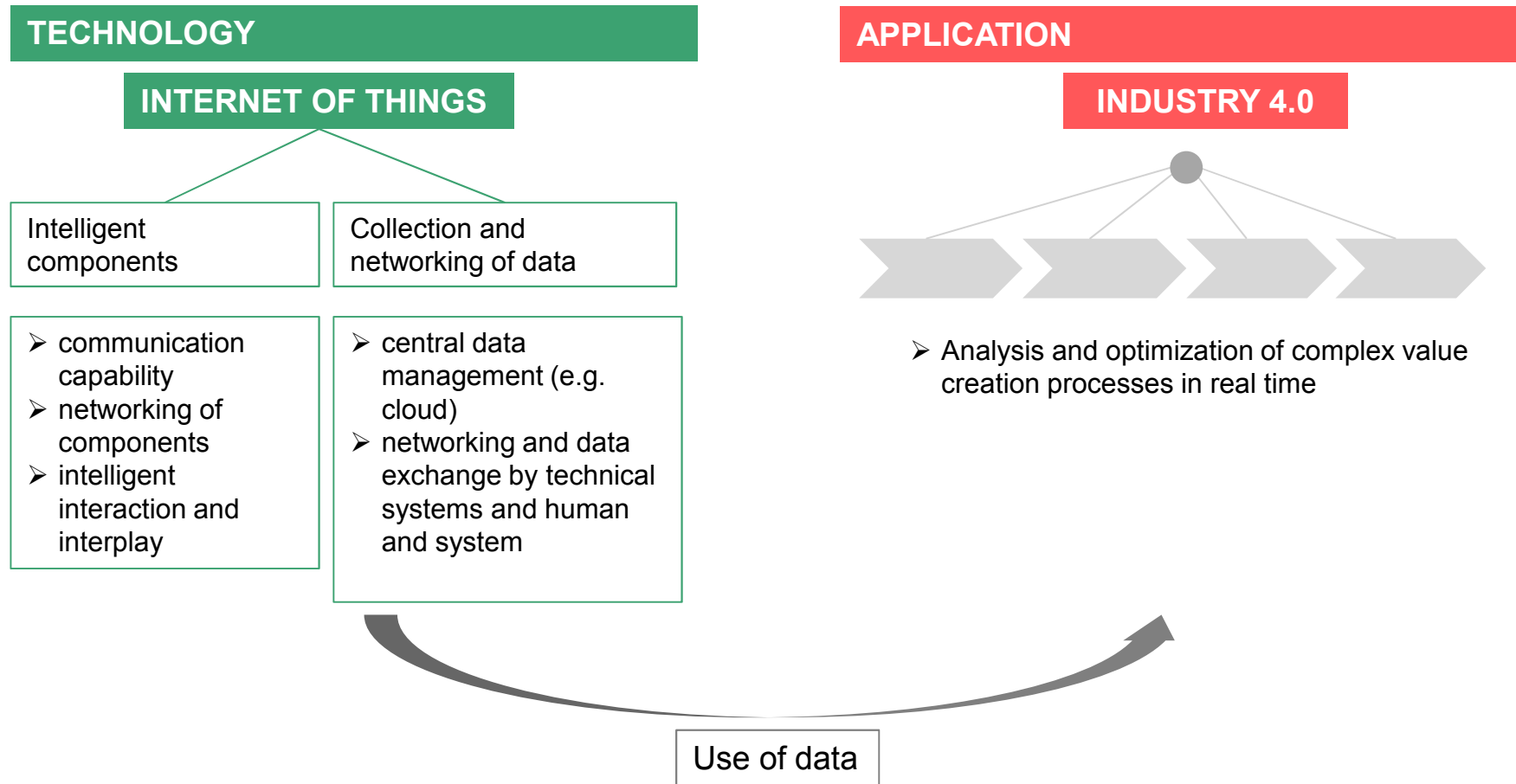
This is made possible by three technological developments:
- ➢ **horizontal networking**, i.e. using the **Internet of Things and Services** in value creation systems;
- ➢ **vertical integration** - the change in machine architecture, from mechatronic systems to **cyber-physical systems**;
- ➢ **real-time optimization** (based on the **processing of mass data**) of complex value-creation systems and of future forecasting based on this.

Source: VDI (Association of German Engineers)

Source: WGP (German Academic Society for Production Engineering)

Internet of Things/ Industry 4.0

Zwick / Roell

The networking of resources, services and people in production offers a means of optimizing value creation systems in real time.

TECHNOLOGY

INTERNET OF THINGS

Intelligent components

Collection and networking of data

- ➤ communication capability
- ➤ networking of components
- ➤ intelligent interaction and interplay

- ➤ central data management (e.g. cloud)
- ➤ networking and data exchange by technical systems and human and system

APPLICATION

INDUSTRY 4.0

- ➤ Analysis and optimization of complex value creation processes in real time

Use of data

Internet of Things/ Industrie 4.0

Zwick / Roell

Die Anbindung aber auch die Weiterverwendung der Daten zur Erbringung neuer, smarter Services wird die zentrale Herausforderung bei der Begleitung unserer Kunden hin zur Industrie 4.0.
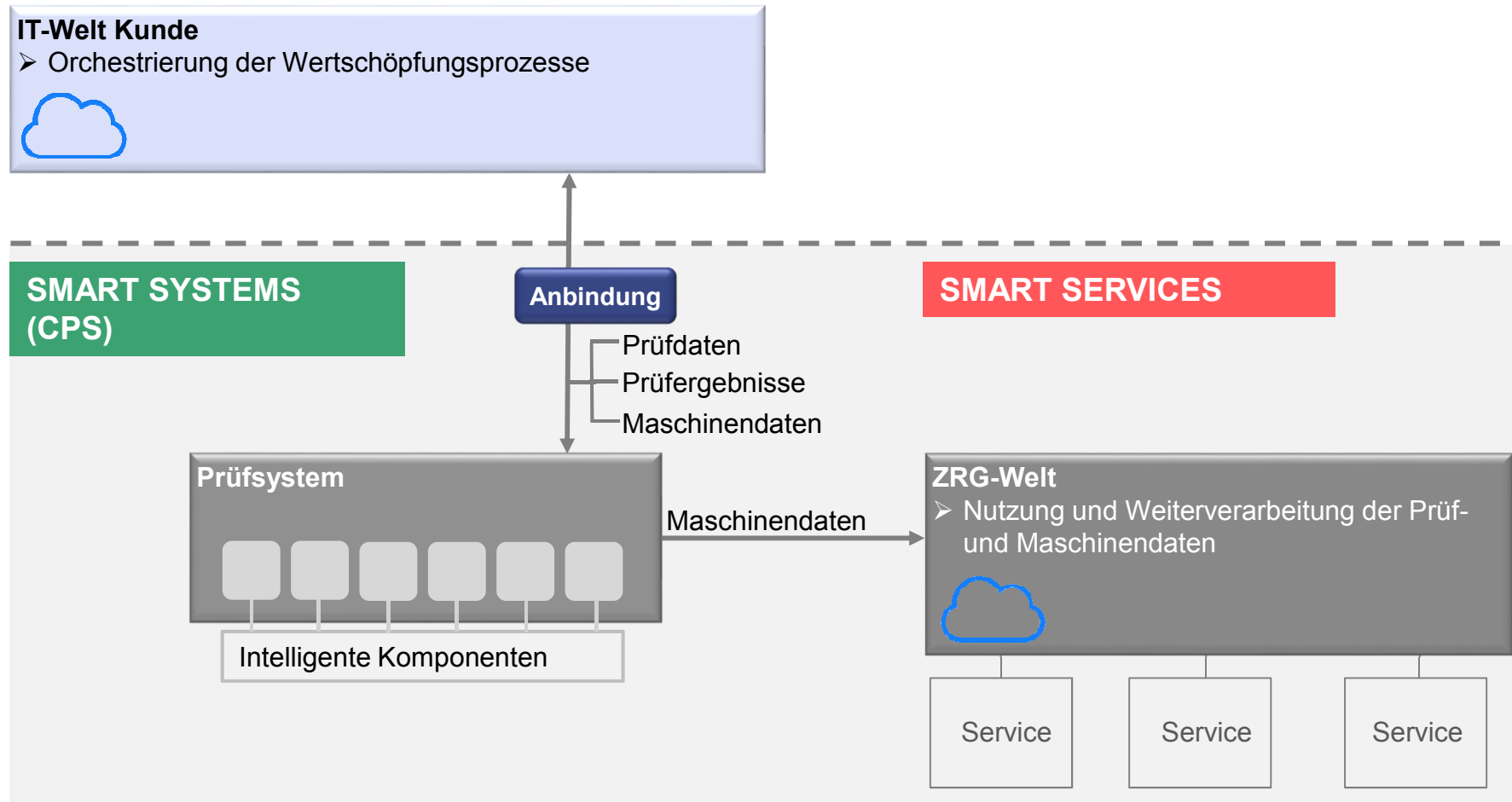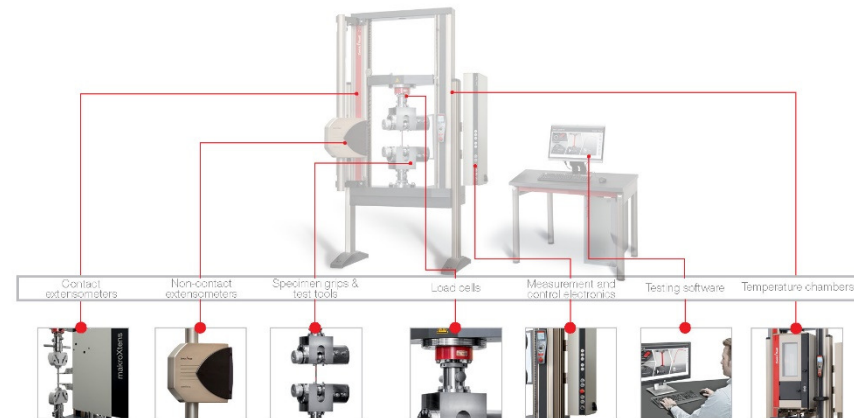
Intelligent components

The intelligent interaction of individual components forms the basis of the Internet of Things.

INTELLIGENT COMPONENTS

The starting point for the Internet of Things is [...] the ongoing development and use of a multitude of relevant enabling technologies from different technological fields, including electronics, RFID, sensors/actuators, energy supply, data transmission, data security etc. [...] The interplay and/or intelligent interaction of these technologies is crucial.[1]

These technologies ensure that components possess knowledge of their own state, knowledge of their own capabilities and are capable of self-description.[2]
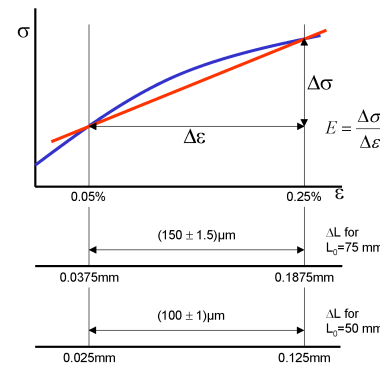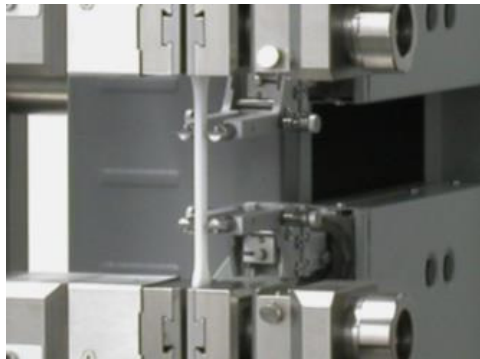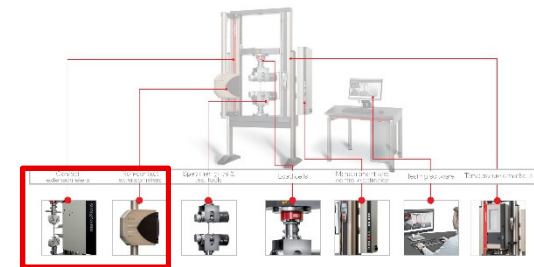

Intelligent components are the technological basis for intelligent Zwick testing systems and instruments.
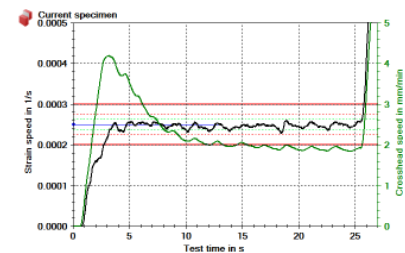
Source: [1] VDI / [2] based on WGP

Intelligent components

An intelligent sensor knows what measuring properties it possesses and can thus ensure standard-compliant test results.

- Automatic setting of gauge length to avoid operator error.

- For intelligent control purposes the system is familiar with possible gauge lengths and measuring ranges.

- Calibration data and date for test documentation and traceability.

- Knowledge of accuracy and resolution.

$$E = \frac{\Delta\sigma}{\Delta\varepsilon}$$

$(150 \pm 1.5)\mu m$ — ΔL for L_0=75 mm

0.0375mm — 0.1875mm

$(100 \pm 1)\mu m$ — ΔL for L_0=50 mm

0.025mm — 0.125mm

Accuracy requirement of ISO 527 with regard to Young's modulus determination

Accuracy requirement of ISO 6892-1 with regard to strain rate control
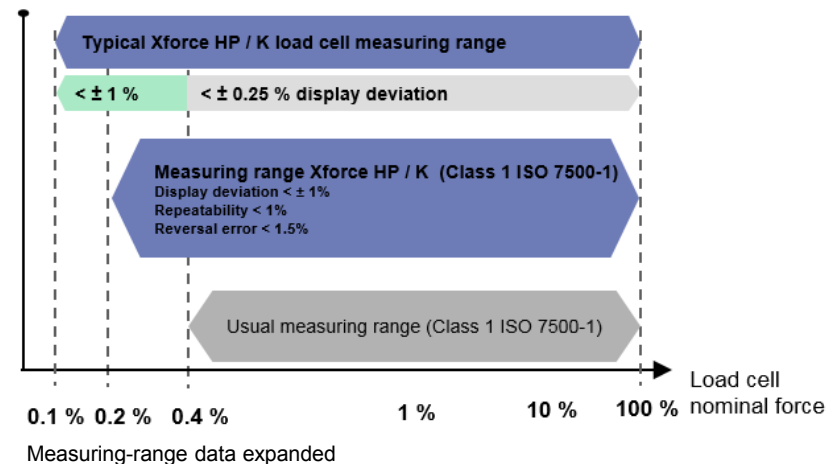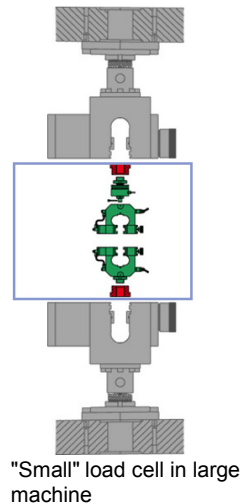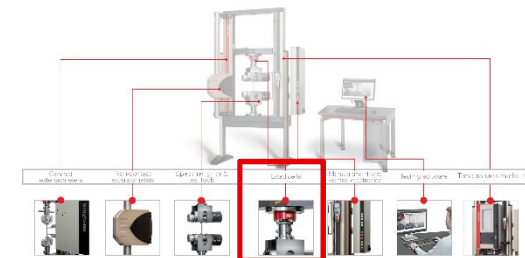
_i_ A Zwick testing system can determine from specific extensometer data whether the required accuracy and measuring range classes can be adhered to.

Intelligent components

An intelligent sensor identifies its operational status and availability autonomously, enabling it to guarantee reliable test results.

- Monitors calibration classes and data.

- Provides information on accuracy, resolution and measurement range.

- Registers any overloads which occur.

- Indicates maximum permissible force with reference to the weakest component.

"Small" load cell in large machine

Typical Xforce HP / K load cell measuring range

< ± 1 %   < ± 0.25 % display deviation

Measuring range Xforce HP / K (Class 1 ISO 7500-1)
Display deviation < ± 1%
Repeatability < 1%
Reversal error < 1.5%

Usual measuring range (Class 1 ISO 7500-1)

0.1 % 0.2 %   0.4 %   1 %   10 %   100 %   Load cell nominal force

Measuring-range data expanded

> **i** A Zwick testing system automatically provides information on impending calibrations and draws the user's attention to any violation of the measurement range which may occur.

Intelligent components

The functional range of the testing system can be expanded by fully integrating external sensors and measuring devices.

- Balance for determining weight, volume or density.

- Camera recording for test documentation and traceability.

- Microphone for determining time of occurrence of acoustic events.

- Recording of temperature/humidity for documentation of adherence to test conditions.

- Compressed air monitoring as safety function.

- Position monitoring (open/closed) for actuators and test fixtures.
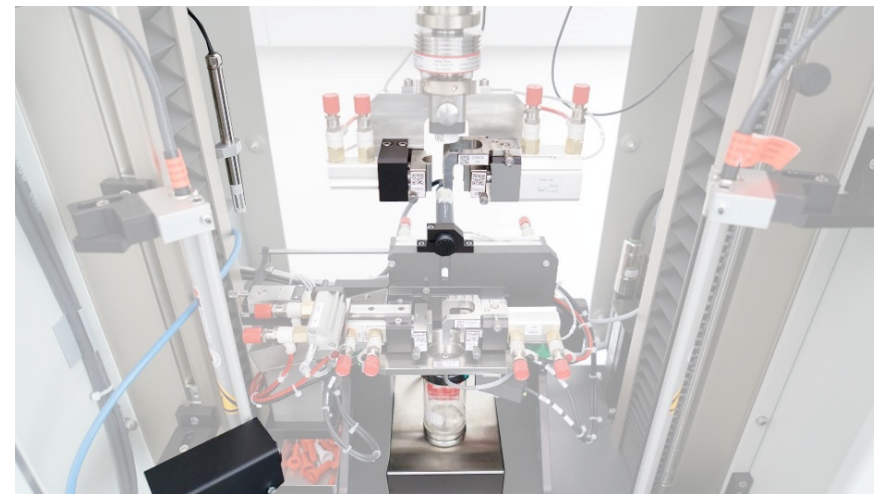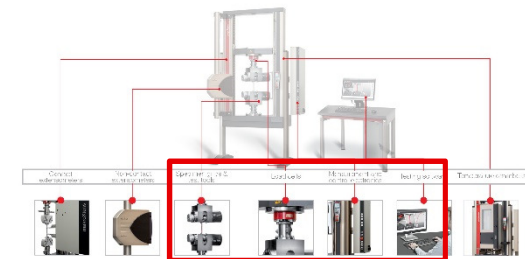
Various components for measurement and monitoring functions are merged into an intelligent system.

Intelligent components

Intelligent components ensure that the test arrangement is complete and correct.

- Machine-readable marking of fixtures/tools (e.g. barcode/RFID) for definitive identification of the test arrangement.

- Poka-yoke principle eliminates identification errors in installing fixtures/grip inserts.

- testXpert III checks for correct assembly (set/actual value comparison).

- Test cannot be started until authorized by system.

- Authorization can be expanded to include specimen (unique labeling).
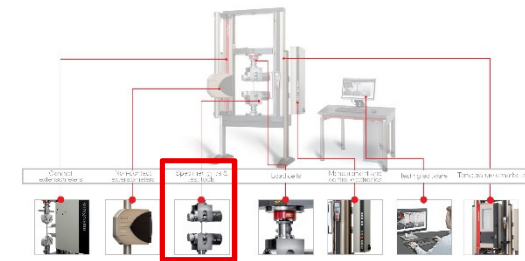
Vertauschungssichere Platzierung von Klemmbacken mittels Poke Yoke Prinzip

Eineindeutige Kennzeichnungen und Prüfstartfreigabe nach pos. Scan

> *i* Test arrangement and test method are checked and correspond exactly to the specification for the test.

Intelligent components

Zwick / Roell

Testing "intelligent" medical products calls for "intelligent" testing equipment also.

- Intelligent medical products are equipped with interfaces such as Bluetooth, WLAN, NFC or RFID which transmit information bidirectionally.

- Machine-readable codes, e.g. barcodes or matrix codes, contain important information which must be checked.

- The testing machine is equipped with suitable sensors and receivers and records both the mechanical properties of the specimen and the operational capability of the interfaces (e.g. conformity of transfer data).
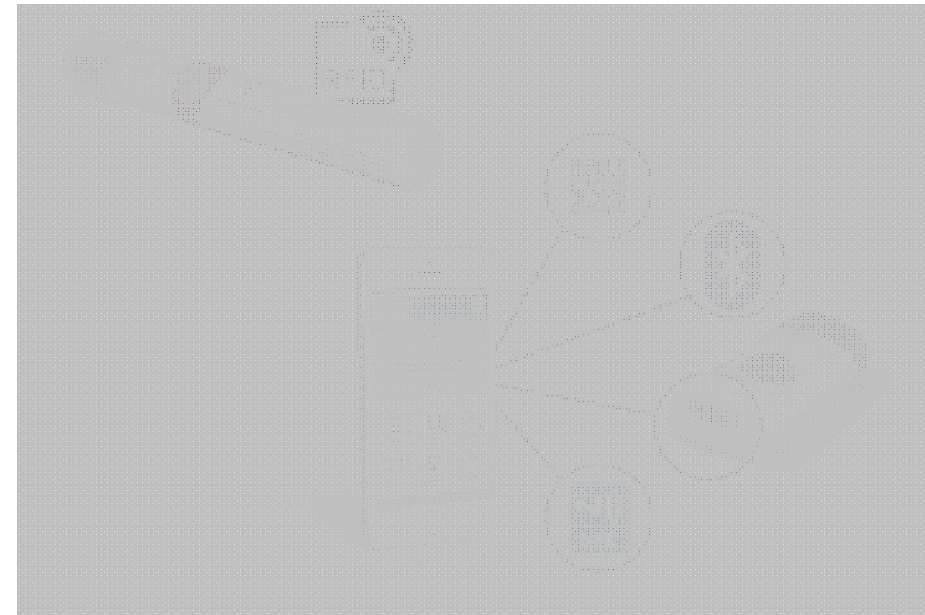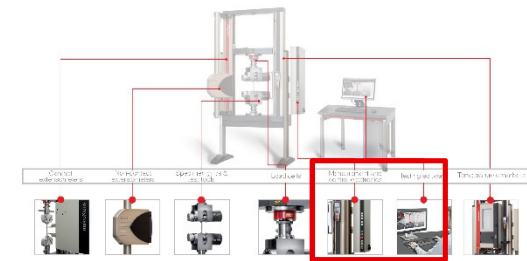
i The operational capability of the medical product is verified by checking mechanical functions and all existing electronic interfaces.

Intelligent components

testXpert III safeguards data against manipulation at all times and renders all changes and test results traceable.

- Access to testXpert III is restricted according to level of authorization.

- User management can be via testXpert III or Windows (LDAP) as desired.

- testXpert III logs all test and system-related actions and settings and renders them traceable.

- The "electronic signature" reliably safeguards test programs and test series against unwanted changes.
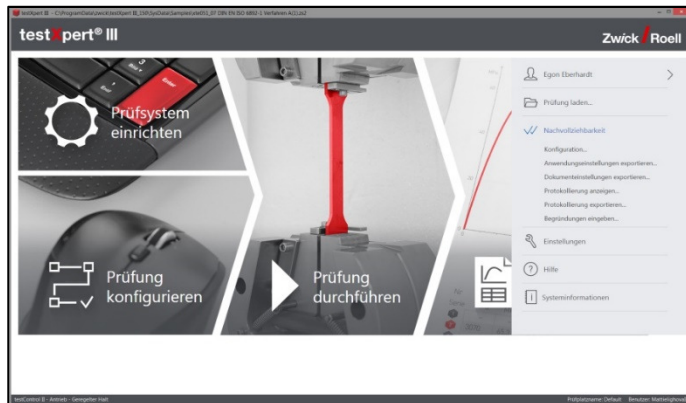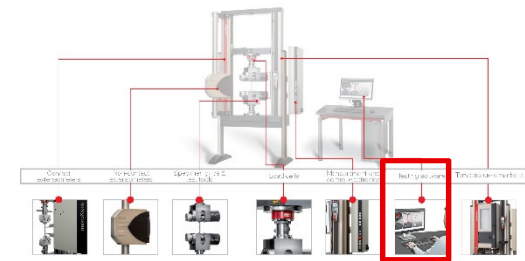
EU GMP Guideline Annex 11

> With testXpert III, user-specific regulatory and safety requirements are satisfied reliably and traceably.
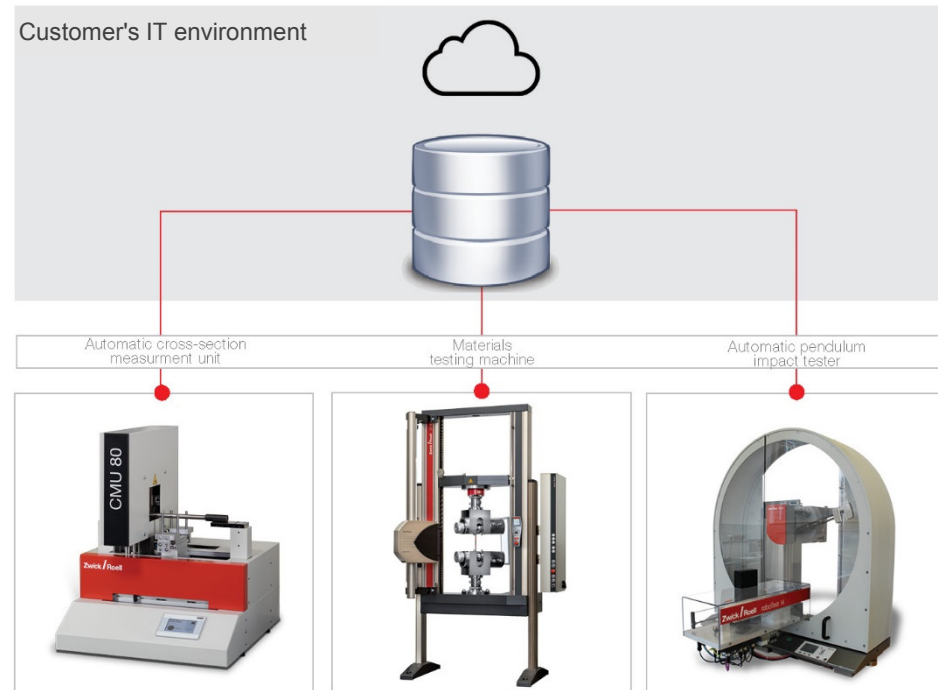
Cyber-physical systems

Zwick / Roell

Cyber-physical systems interact between the physical world and the digital world.

CYBER-PHYSICAL SYSTEMS

"Cyber-physical systems (CPS) are characterized by a linking of real (physical) objects and processes to information-processing (virtual) objects and processes via open, in part global, information networks which are always connected to each other (i.e. the Internet)."[1]

"Their interaction between the physical and digital worlds is of fundamental importance."[2]

"Their potential comes from [...] the continuous platform-based networking of integrated sensors and actuators via local and global networks with other CPSs ("System of Systems")".[2]
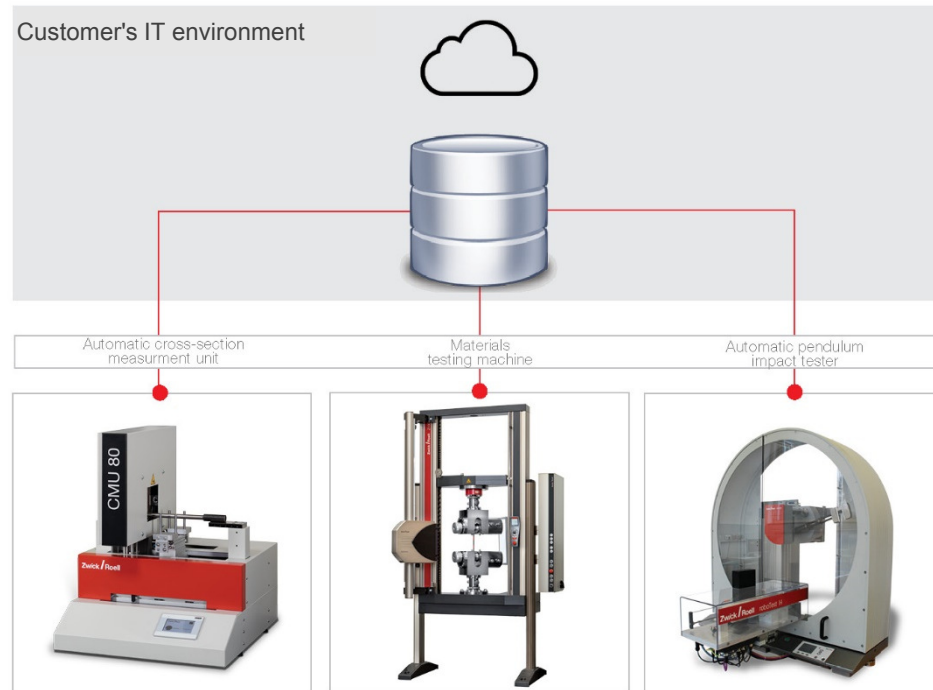

Customer's IT environment

Automatic cross-section measurment unit | Materials testing machine | Automatic pendulum impact tester

Sources: [1]VDI, [2]WGP

The smallest unit in a CPS can be the Zwick testing system or instrument itself.

The smallest unit of a cyber-physical system is the Zwick testing system/instrument itself.

Every Zwick testing system or instrument can be integrated into the customer's IT environment.

Customer's IT environment

Automatic cross-section measurment unit

Materials testing machine

Automatic pendulum impact tester

Smart systems

testXpert III communicates with each IT system in the customer environment through automated import and export.

Link to customer's IT environment
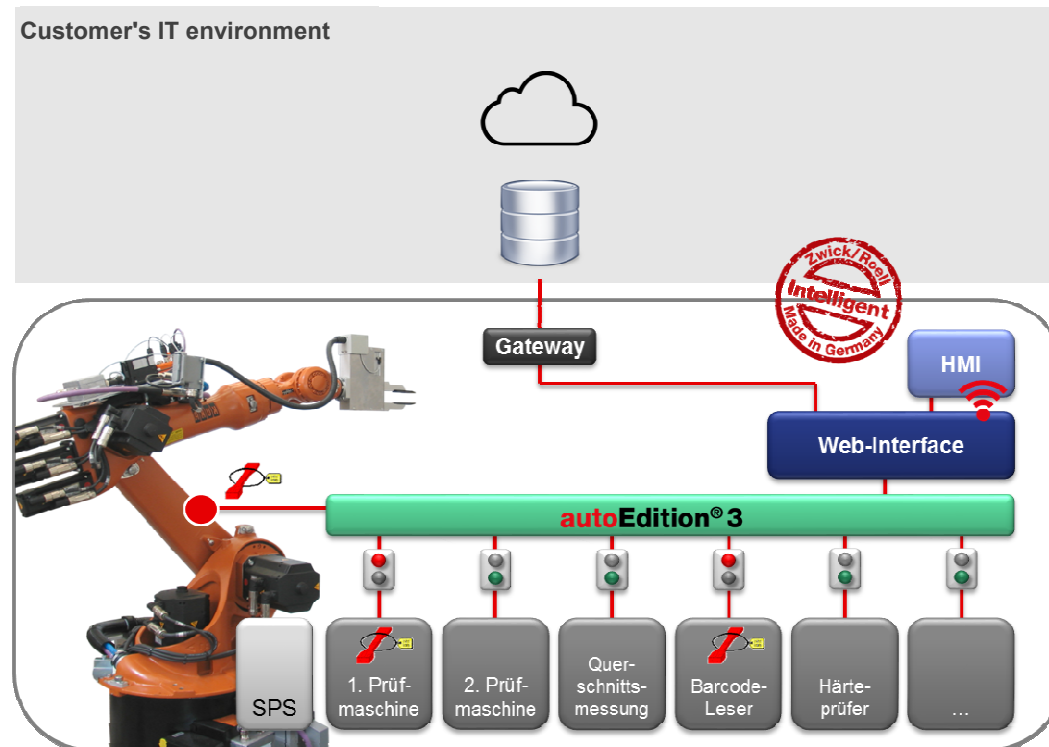
External devices

Test logs & standardized reports
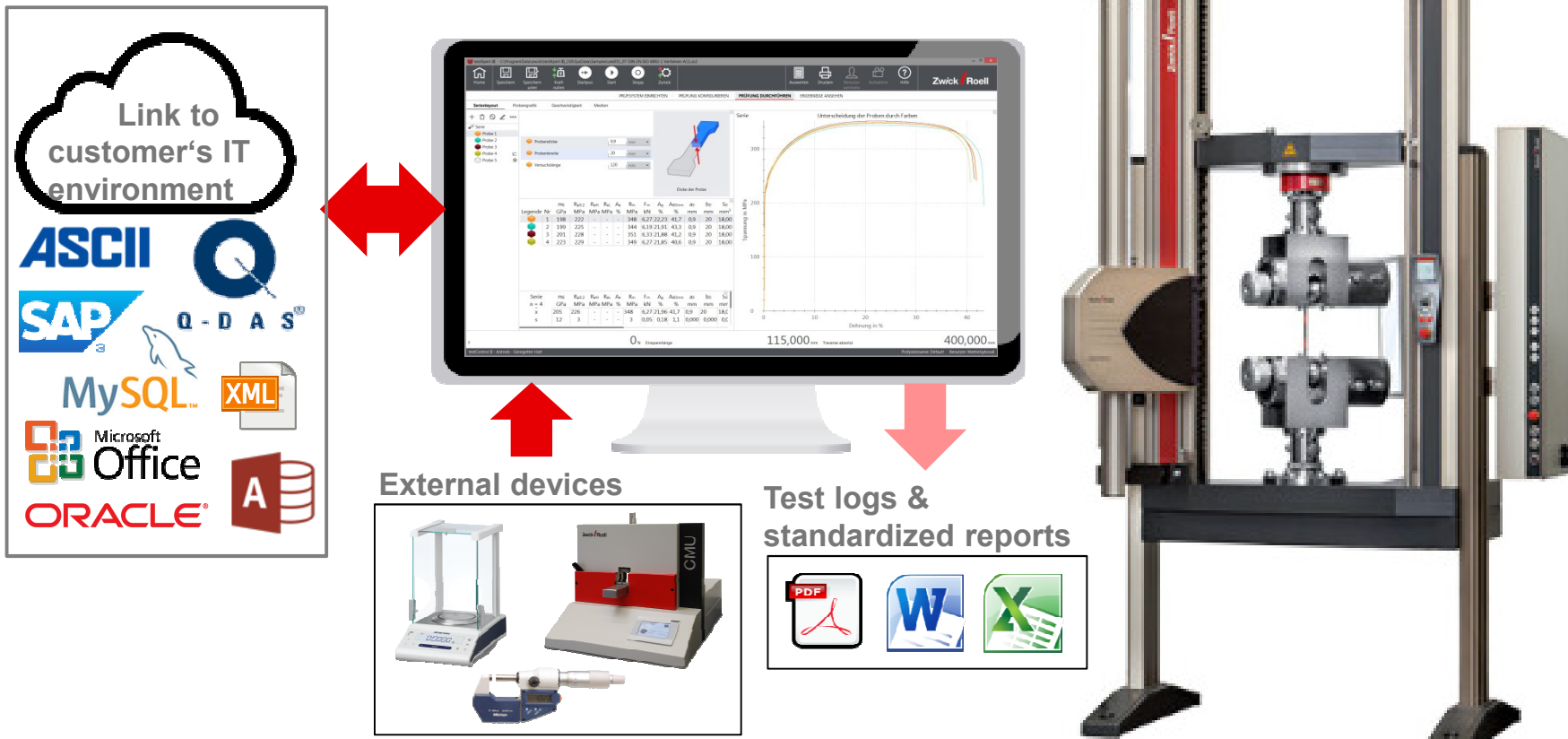
i testXpert III quickly imports, then automates all test-relevant data from ERP systems and databases in the customer's IT environment or directly from external devices.

Smart systems

autoEdition 3 automation software allows Zwick testing systems/instruments to be incorporated into a complete system with automatic specimen handling.

Zwick testing systems/instruments can be connected to a comperhensive system via autoEdition 3 automation software.

This automated system can in turn be integrated into the customer's existing IT environment.
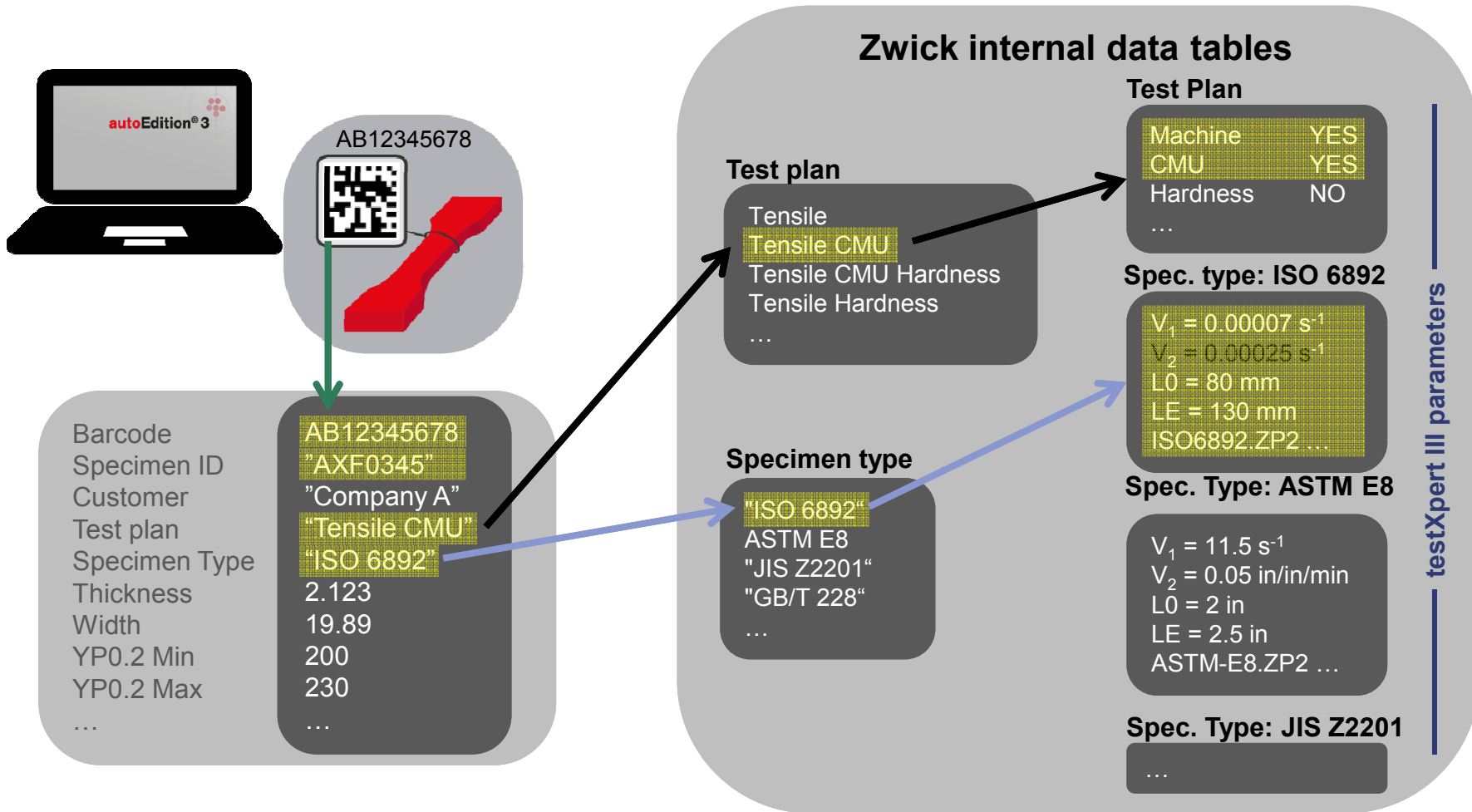

Customer's IT environment

Gateway

HMI

Web-Interface

autoEdition® 3

SPS | 1. Prüf-maschine | 2. Prüf-maschine | Quer-schnitts-messung | Barcode-Leser | Härte-prüfer | ...

Smart systems

autoEdition3 forms the link between Zwick testing systems and the Industry 4.0 data flow of the customer's IT environment.
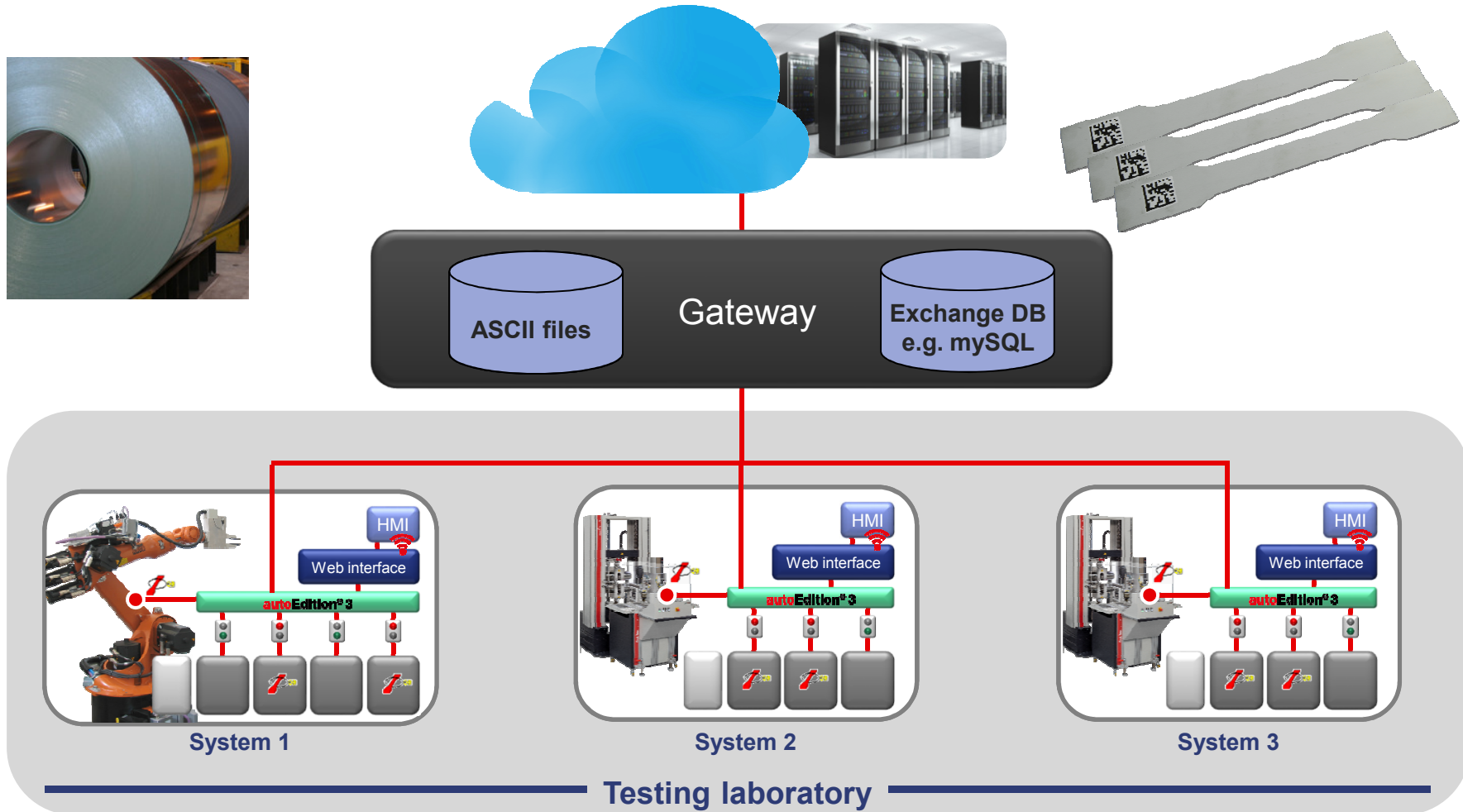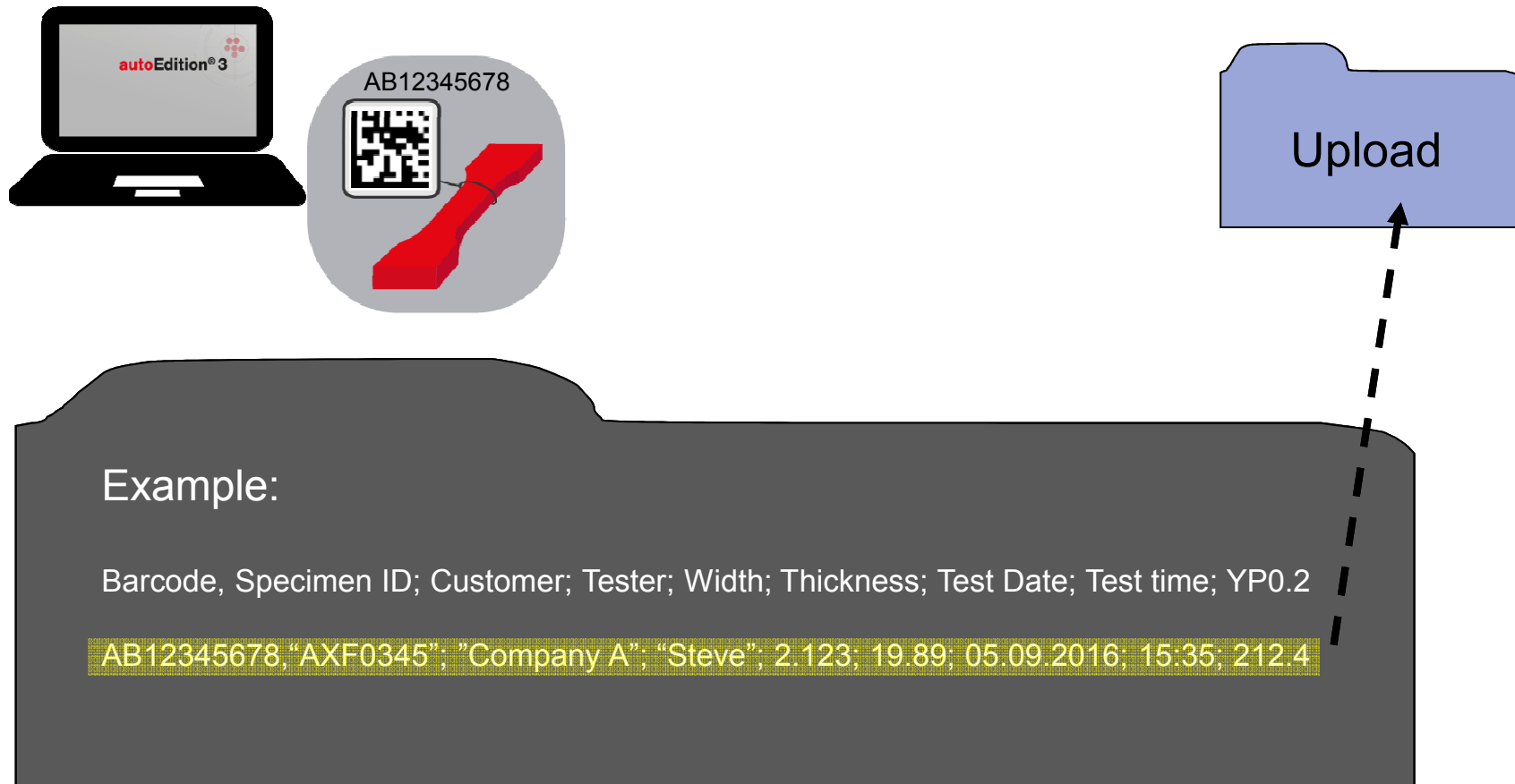
A machine-readable code identifies the download data for each specimen and guarantees the appropriate test sequence.


Zwick internal data tables

autoEdition® 3

AB12345678

Test plan

Tensile
Tensile CMU
Tensile CMU Hardness
Tensile Hardness
…

Test Plan

Machine	YES
CMU	YES
Hardness	NO
…	

Spec. type: ISO 6892

$V_1 = 0.00007\ s^{-1}$
$V_2 = 0.00025\ s^{-1}$
L0 = 80 mm
LE = 130 mm
ISO6892.ZP2 …

Specimen type

"ISO 6892"
ASTM E8
"JIS Z2201"
"GB/T 228"
…

Spec. Type: ASTM E8

$V_1 = 11.5\ s^{-1}$
$V_2 = 0.05$ in/in/min
L0 = 2 in
LE = 2.5 in
ASTM-E8.ZP2 …

Spec. Type: JIS Z2201

…

Barcode	AB12345678
Specimen ID	"AXF0345"
Customer	"Company A"
Test plan	"Tensile CMU"
Specimen Type	"ISO 6892"
Thickness	2.123
Width	19.89
YP0.2 Min	200
YP0.2 Max	230
…	…

testXpert III parameters

Smart systems

Uploading the test results for each individual specimen to the customer's IT environment guarantees traceable data.

Example:

Barcode, Specimen ID; Customer; Tester; Width; Thickness; Test Date; Test time; YP0.2

AB12345678;"AXF0345"; "Company A"; "Steve"; 2.123; 19.89; 05.09.2016; 15:35; 212.4

Zwick roboTest systems can be connected to a fully automatic test center and easily integrated into an Industry 4.0 environment.
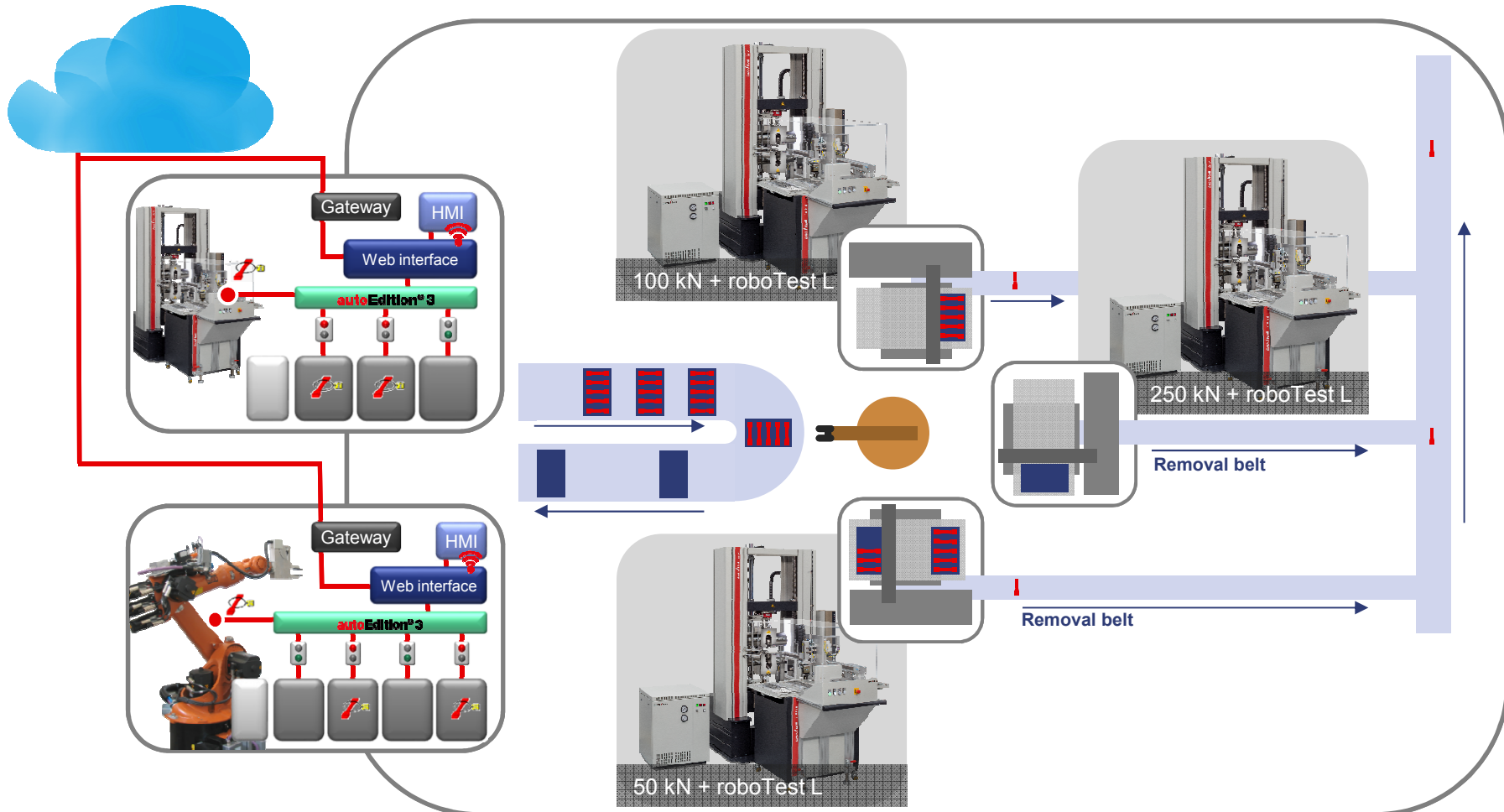
Smart systems

The entire laboratory can be integrated into the customer's IT environment.

The complete automated system plus all individual Zwick testing systems/instruments can be integrated into the customer's IT environment.
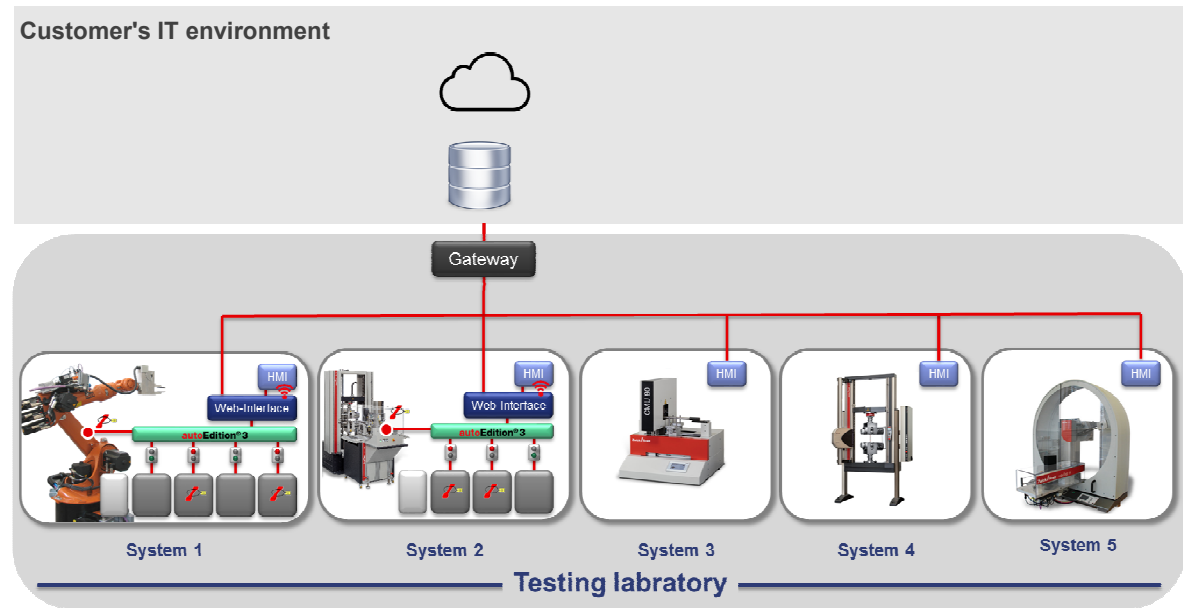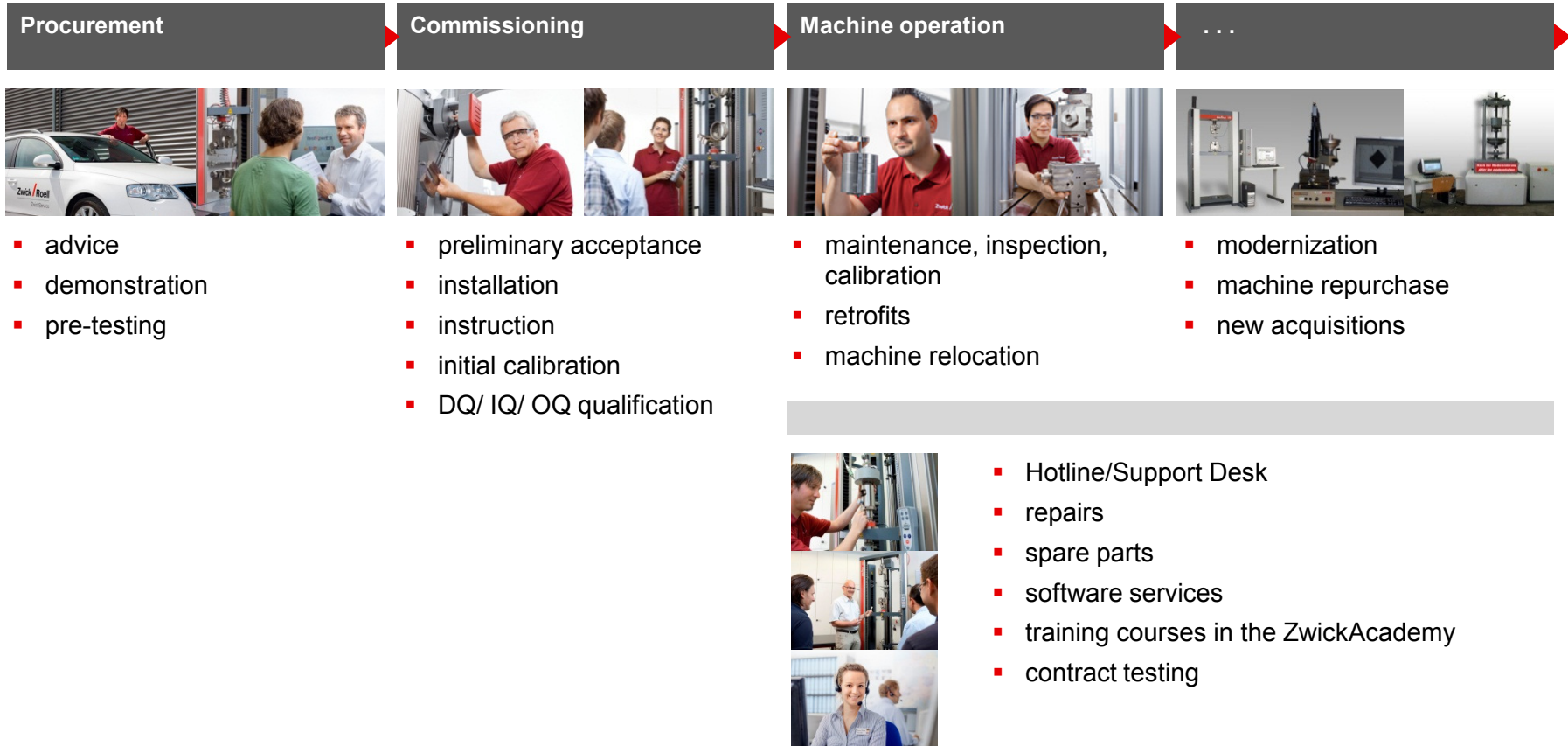
The Cobot – Your new lab-assistant

Smart Systems

Zwick / Roell

Zukünftiges Datenmanagement - Wichtigstes Erfolgskriterium für eine erfolgreiche Digitalisierungsstrategie sind Daten. Diese Struktur (CPS) ermöglicht neue Services.

Services

benötigt

Export / Import · Ergebnis- algorithmen · Remote- Access · Predictive Maintenance · Visualisierung · Material- datenbank · Prüfplanung · Externe APPs · Etc.

Datenhaltung & -anzeige

Datenhaltung   **Datenanzeige**

Web Client

liefert

Datenquellen

testXpert III · testXpert Research · autoEdition® 3 · AutoEdition · Peripheriegeräte

Services

Zwick / Roell
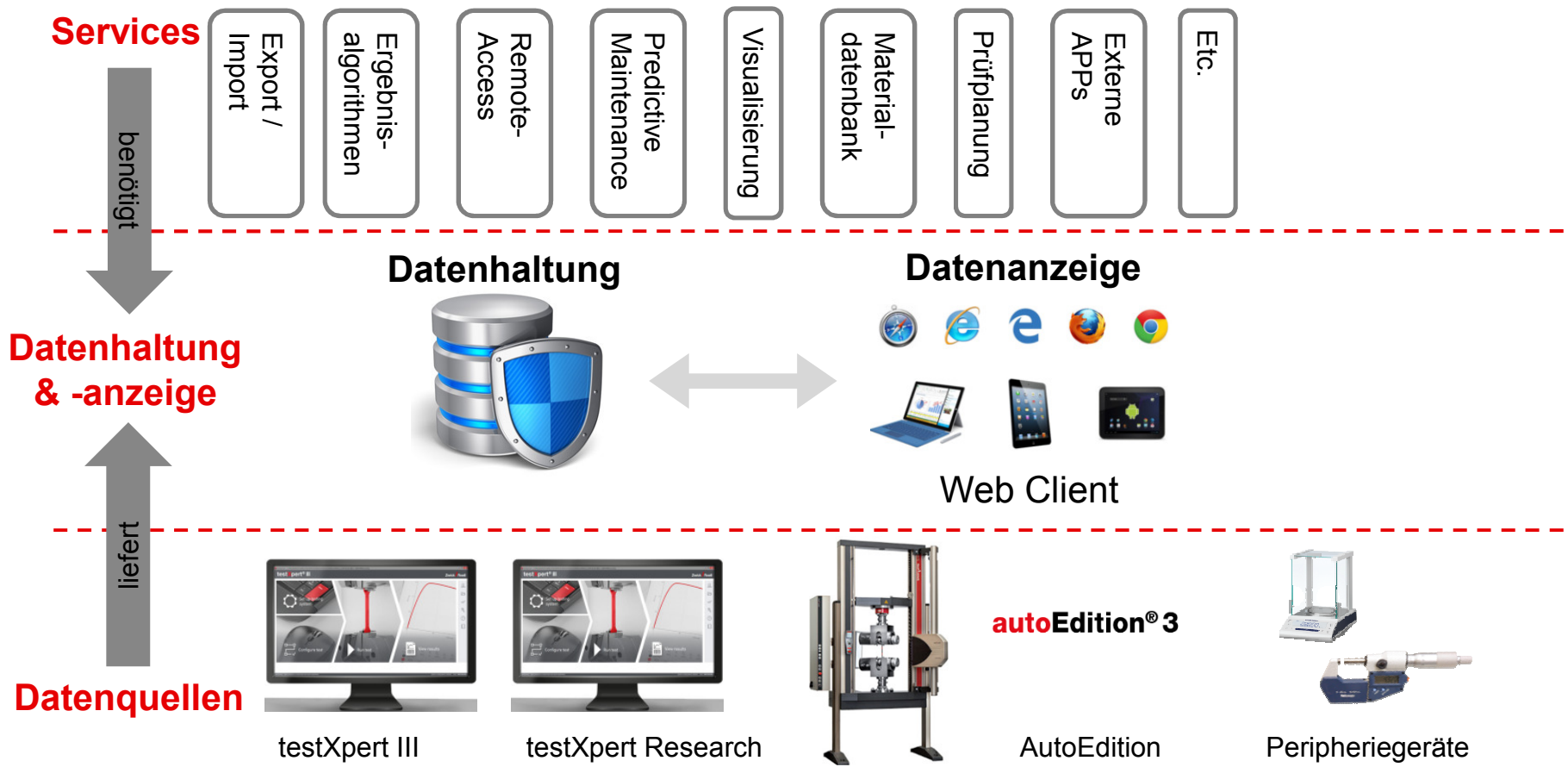
Zwick offers individually tailored services and provide support through the entire life-cycle of your materials testing machine.

Procurement	Commissioning	Machine operation	. . .

Procurement
- advice
- demonstration
- pre-testing

Commissioning
- preliminary acceptance
- installation
- instruction
- initial calibration
- DQ/ IQ/ OQ qualification

Machine operation
- maintenance, inspection, calibration
- retrofits
- machine relocation

. . .
- modernization
- machine repurchase
- new acquisitions

- Hotline/Support Desk
- repairs
- spare parts
- software services
- training courses in the ZwickAcademy
- contract testing

Smart services

Smart services include data-based and service-based offerings such as mobile applications, online portals and sharing services.

SMART SERVICES

The expression "smart services" refers to data and service-based offerings such as mobile applications, online portals and sharing-services. Smart services rely on the increasing intelligence of machines and an end-to-end digitalization of work processes. Companies' own value chains are linked to external value chains via the Internet. This allows companies to offer their customers higher-quality services more closely focused on target groups. At the same time, cloud-based platforms simplify the development, delivery and monitoring of services.

Source: https://www.iao.fraunhofer.de/lang-de/veranstaltungen/eventdetail/303/-/smart-services-digitalisierung-und-dienstleistungen-als-innovationstreiber-fuer-die-wirtschaft.html

Smart services

Zwick / Roell

Our services portfolio will in future be expanded to included smart services on the basis of the data generated.

SMART SERVICES

Zwick testing systems and instruments are in themselves intelligent products which are able to provide data for further processing via the connection to internal or external systems and platforms.

The Zwick Roell Group's services portfolio will be expanded to included smart services on the basis of test and machine data.

Operations management
- fleet management
- usage behavior
- trend analyses
- …

Servicing & maintenance
- remote diagnoses
- preventive/predictive maintenance
- …

Operator/ service technician
- machine data / history
- operational status
- …

Smart Services

The new customer portal offers our customers direct 24/7 access to relevant data of their testing systems.

Smart Services

Zwick / Roell

Remote standard demos or individual customer test are increasingly important and are offering fantastic new possibilities.