

MANUFACTURING ECONOMY

EDGE COMPUTING AND SECURE AUDIT TRAILS IN FINEBLANKING

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10.10.2018

ABOUT MYSELF

DANIEL TRAUTH

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HIGH SCHOOL GRADUATION 2002

(CO-)FOUNDER 2001 – 2008 (WEBDESIGN / HOSTING)

SKILLED-WORKER IN MECHATRONICS 2005

MECHANICAL ENGINEER 2010, MBA IN 2011

PHD IN TRIBOLOGY 2016

CHIEF ENGINEER 2017

MEMBER OF THE IOTA EVANGELIST NETWORK 2018

IOTA DATA MARKETPLACE MEMBER 2018

IOTA REGIONAL COMMUNITY LEADER 2018

(CO-)FOUNDER SENSEERING GMBH 2018



EMPLOYEES: ~1,300

BUDGET: 64 MIO. EUR (2016)

EST. 1906

WERKZEUGMASCHINENLABOR (WZL) OF RWTH AACHEN UNIVERSITY
FRAUNHOFER INSTITUT FOR PRODUCTION TECHNOLOGY (IPT)

New chair holder: Manufacturing Technology



Professor Dr.-Ing. Thomas Bergs takes over chair of Manufacturing Technology

After 23 years, on 01st of June 2018, Professor Dr.-Ing. Dr.-Ing. E.h. Dr. h.c. Dr. h.c. Fritz Klocke hands over the chair of Manufacturing Technology at the Laboratory for Machine Tools and Production Engineering WZL of RWTH Aachen University to Prof. Dr.-Ing. Thomas Bergs, MBA.

On **01st of June 2018** he was offered the chair of Manufacturing Technology at RWTH Aachen University and was appointed as a member of directors at the Laboratory for Machine Tools and Production Engineering WZL of RWTH Aachen and Fraunhofer Institute for Production Technology IPT.

INTERNET OF PRODUCTION

GERMAN UNIVERSITIES EXCELLENCE INITIATIVE

52 Mio EUR over 6 Years

25 Professors

9 Postdoctoral Researchers

85 Doctoral Researchers

„The vision is to enable a new level of **cross-domain collaboration** by providing **semantically adequate** and **context-aware** data from production, development and usage in **real-time**, on an **adequate level of granularity**“

INDUSTRIAL IOTA LAB AACHEN

Werkzeugmaschinenlabor WZL
RWTH AACHEN UNIVERSITY

WWW.SENSEERING.DE

SENSEERING

DECIDE BETTER. NOW!



DANIEL TRAUTH

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 *@DANIELTRAUTH*

Agenda

1 Introduction

2 Edge Computing

3 Secure Audit Trails

Agenda

1 Introduction

2 Edge Computing

3 Secure Audit Trails

LARGE-SCALE CYBER-PHYSICAL SYSTEM



DATA SPECS

VELOCITY: up to 7 Gb/s

VOLUME: up to 0,5 PB PER DAY

VARIETY: (un-)structured

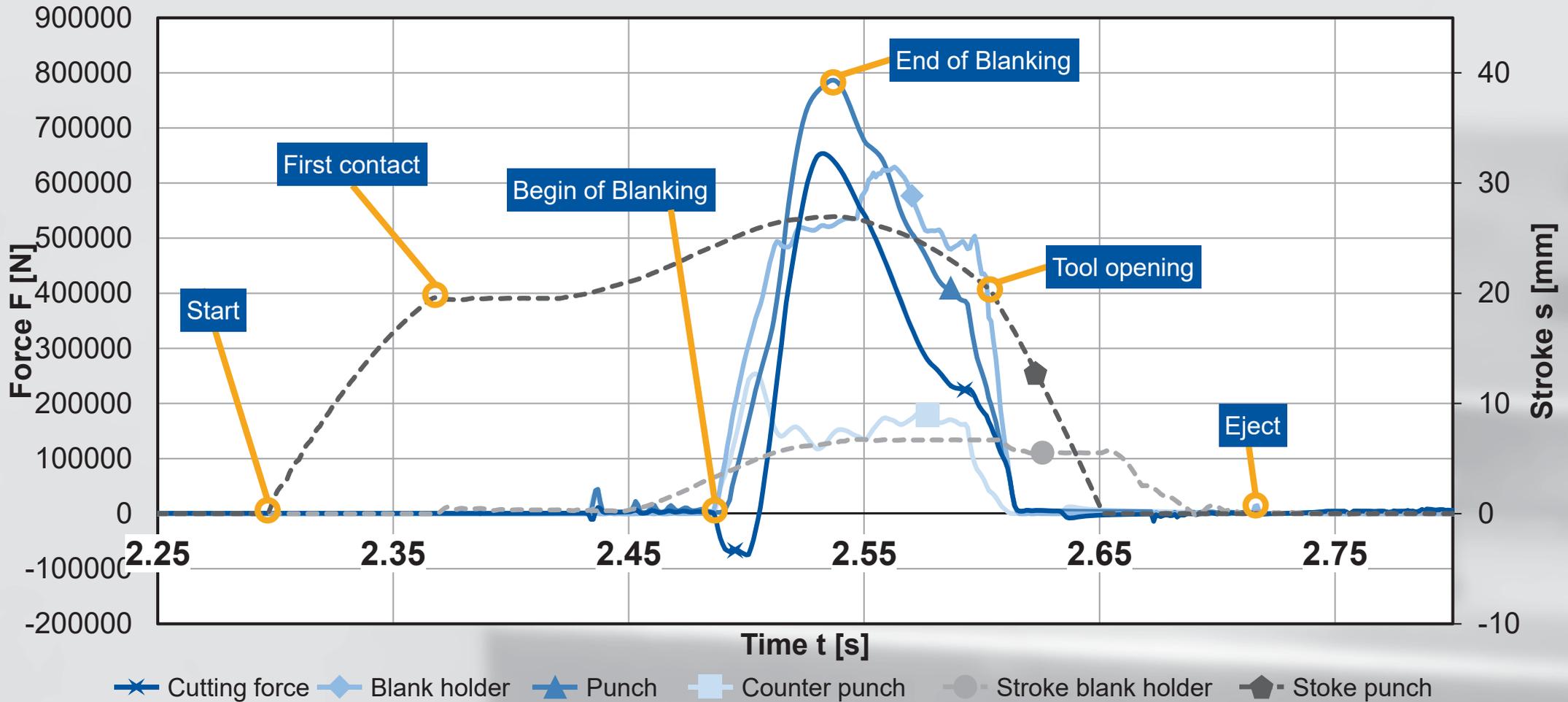
THE USE CASE

LARGE-SCALE CYBER PHYSICAL SYSTEMS



PROCESS FORCES

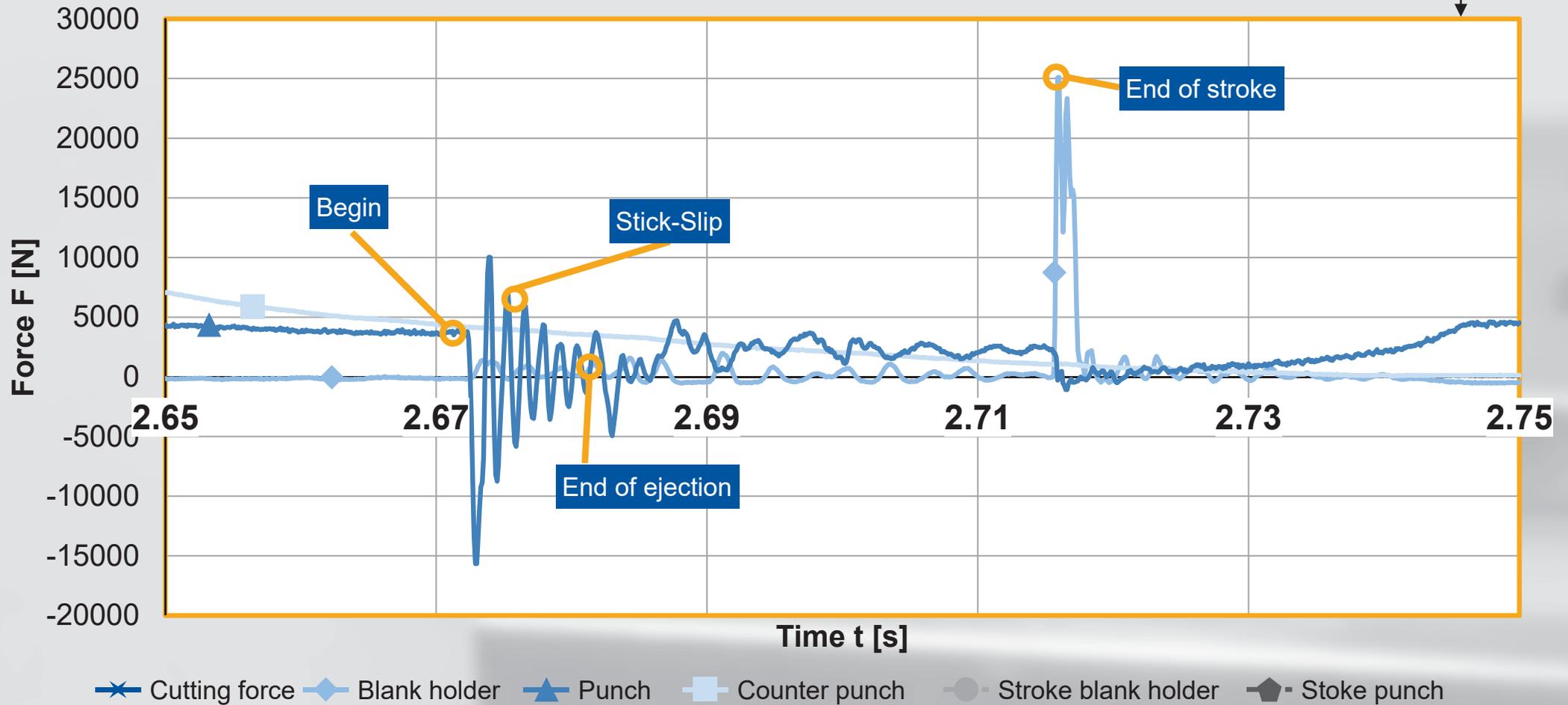
Forces and strokes during fine blanking



Force and stroke signals represent a characteristic process signature.

EJECTION FORCES

Forces during Ejection

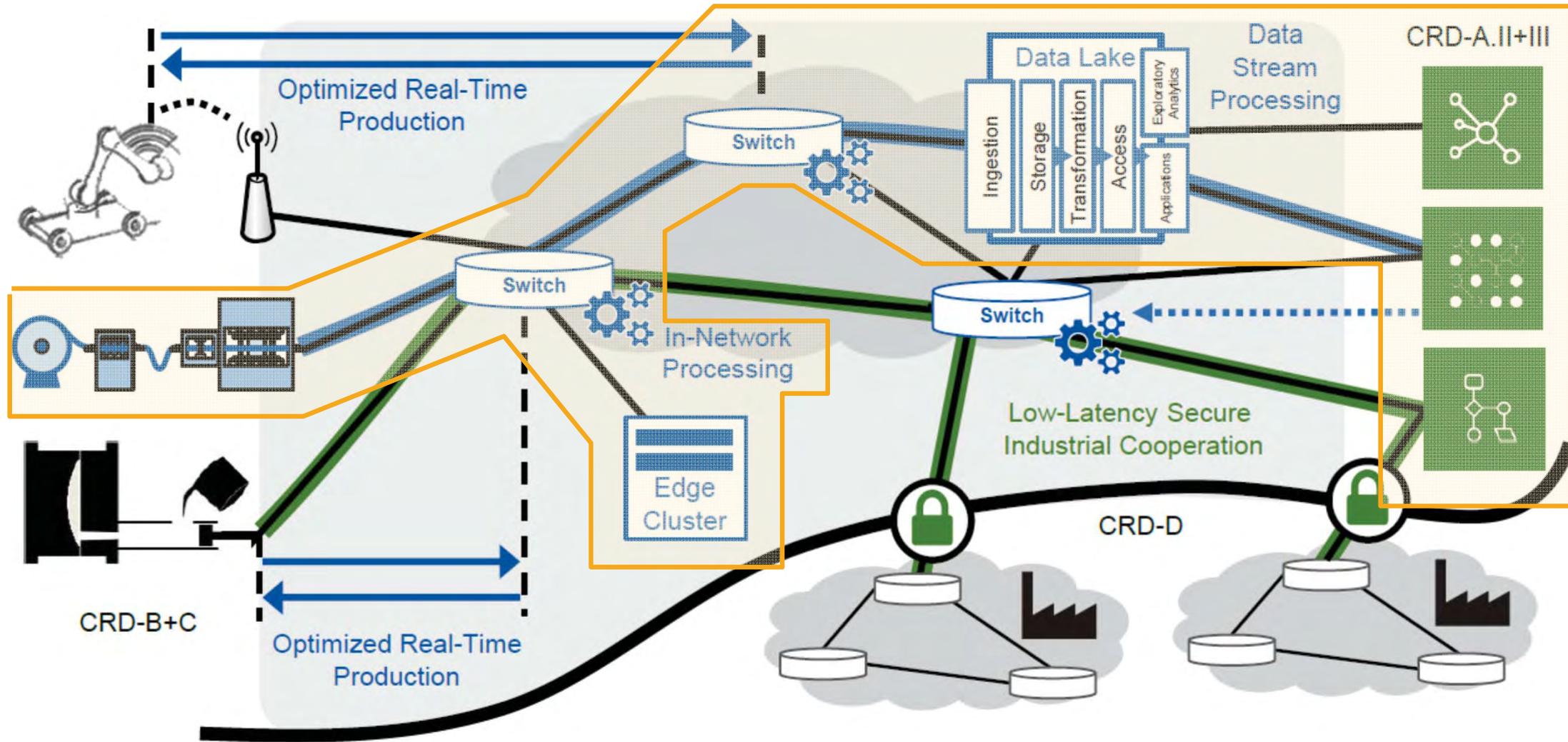


Force signature during ejection

USE CASE A.1:

EDGE COMPUTING NETWORKS FOR PRODUCTION ENGINEERING

INFRASTRUCTURE FOR FINE BLANKING



BATCH-LAYER

6 NODE

HADOOP / SPARK ECOSYSTEM

WZLRZ2-ESXi09



240 CORES

320 TB HDD

1,5 TB RAM

6 NVIDIA P100 GPU

SCALABLE (HORIZONTALLY)

PowerEdge R730

SXi10

Sensors
Bosch XDK

XDK1



XDK2



XDK3



XDK4



XDK5



XDK6



Hotspots
Raspberry Pis

TFPI-HST1



TFPI-HST2



TFPI-HST3



Data Cluster – Datalake
Batch-Layer 1/2



DLmaster DLnode01 DLnode02 DLnode03



4 TB



4 TB



4 TB



4 TB

Kafka Cluster – Filemanager



Kafka
Node01



Kafka
Node02



Kafka
Node03



Kafka
Node04



Data visualization – Speed-Layer



GUIPI



Force / stroke sensors



Machine control



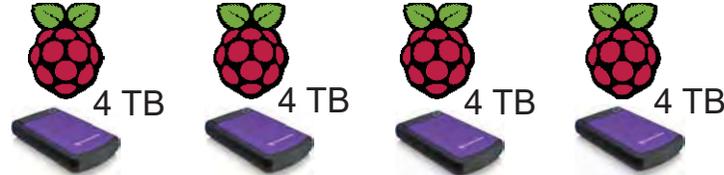
EXPANDING HORIZONS



Data Cluster – Datalake
Batch-Layer 1/2



DLmaster DLnode01 DLnode02 DLnode03



Batch-Layer 2/2



Kafka Cluster – Filemanager



Kafka Node01 Kafka Node02 Kafka Node03 Kafka Node04



Serving-Layer



Data visualization – Speed-Layer



GUIPI



PROBLEMS IN FINE BLANKING

TEARS ON THE SHEARING SURFACE

DIE ROLL

MOTIVATION

COMBINATION OF

PHYSICAL-BASED AND

DATA-DRIVEN MODELS



INTEGRATED STRUCTURAL HEALTH ENGINEERING
DAMAGE IN FINEBLANKING

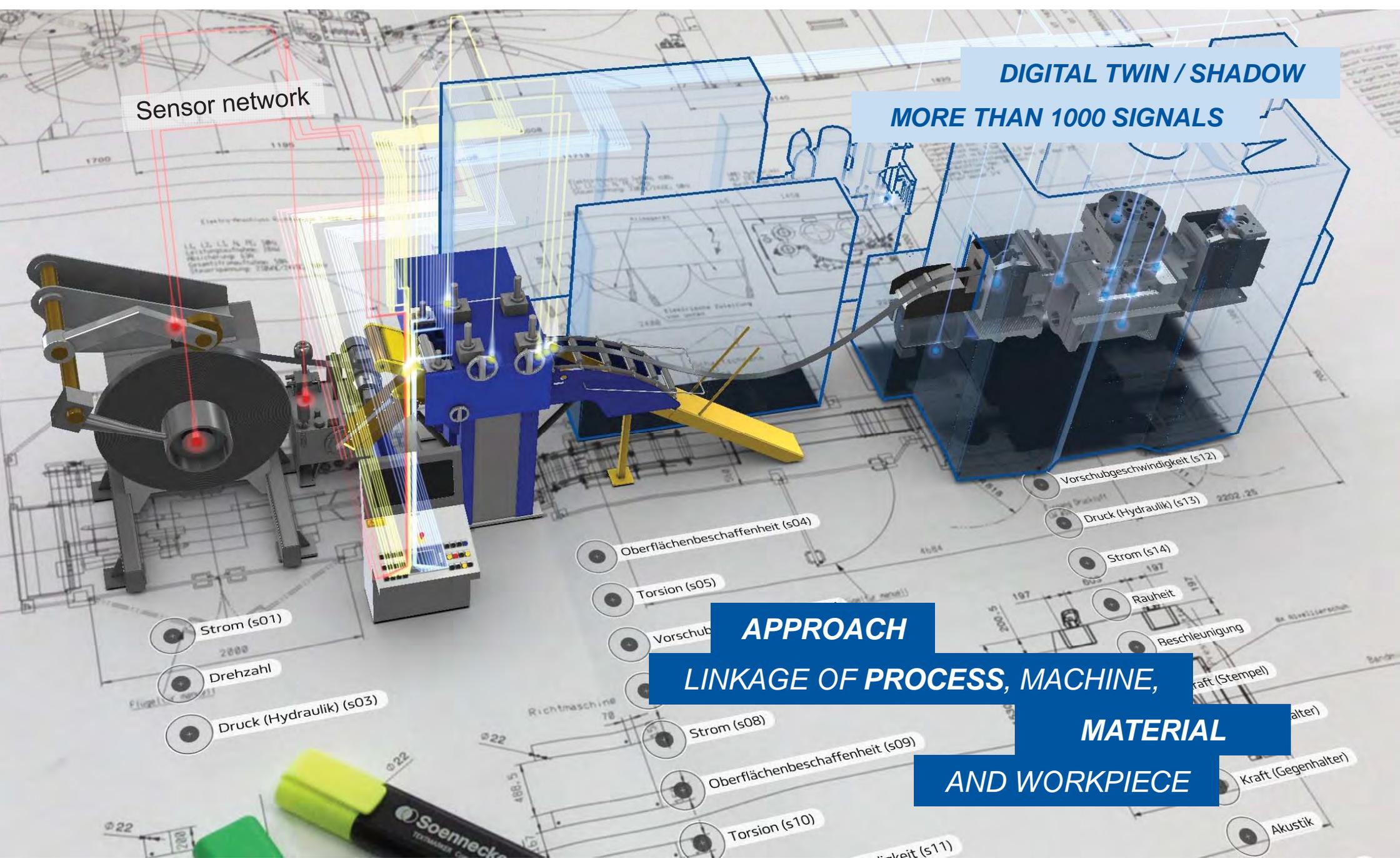


BELT STRAP



**BRAKE PAD
CARRIER**

Damage during fineblanking and damage during operation



Sensor network

DIGITAL TWIN / SHADOW
MORE THAN 1000 SIGNALS

Strom (s01)

Drehzahl

Druck (Hydraulik) (s03)

Oberflächenbeschaffenheit (s04)

Torsion (s05)

Vorschub

APPROACH
LINKAGE OF PROCESS, MACHINE,
MATERIAL
AND WORKPIECE

Strom (s08)

Oberflächenbeschaffenheit (s09)

Torsion (s10)

Vorschubgeschwindigkeit (s12)

Druck (Hydraulik) (s13)

Strom (s14)

Rauheit

Beschleunigung

Kraft (Stempel)

Kraft (Gegenhalter)

Akustik

Agenda

1 Introduction

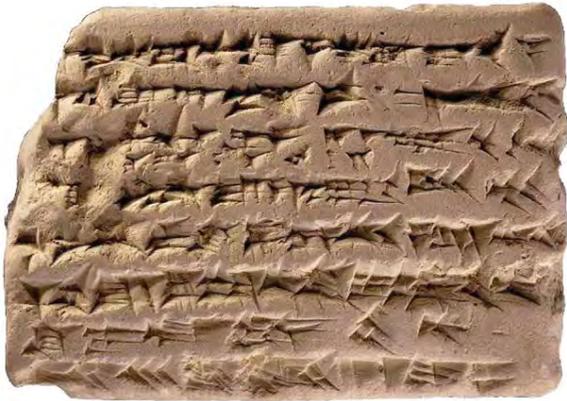
2 Edge Computing

3 Secure Audit Trails

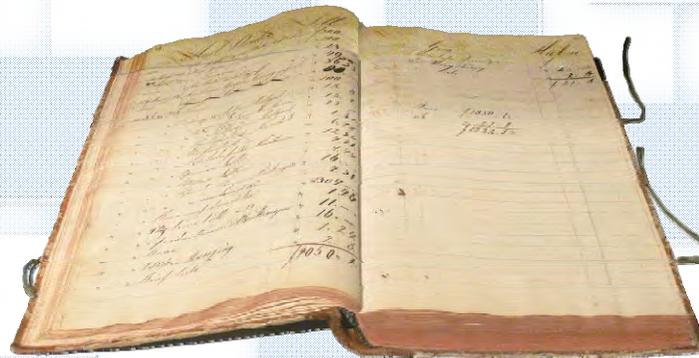
What is a ledger?

Ledger – a means for recording and storing of transaction data

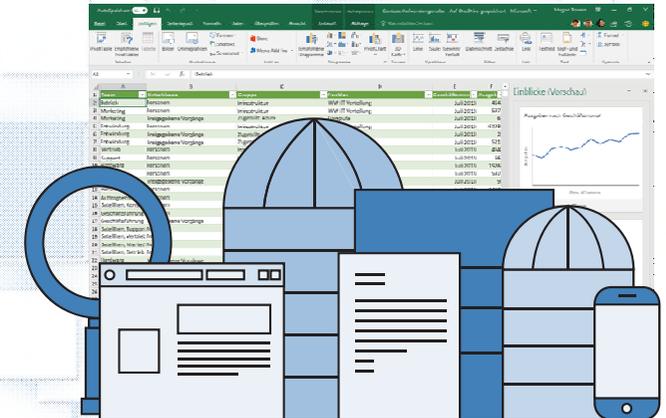
Cuneiform tablets
ca. 5000 BC



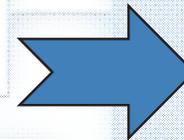
Accounting books
ca. 1300 AD



Data silos
present day



Data is stored in separate silos
within and across organizations



Obstacle for
machine economy

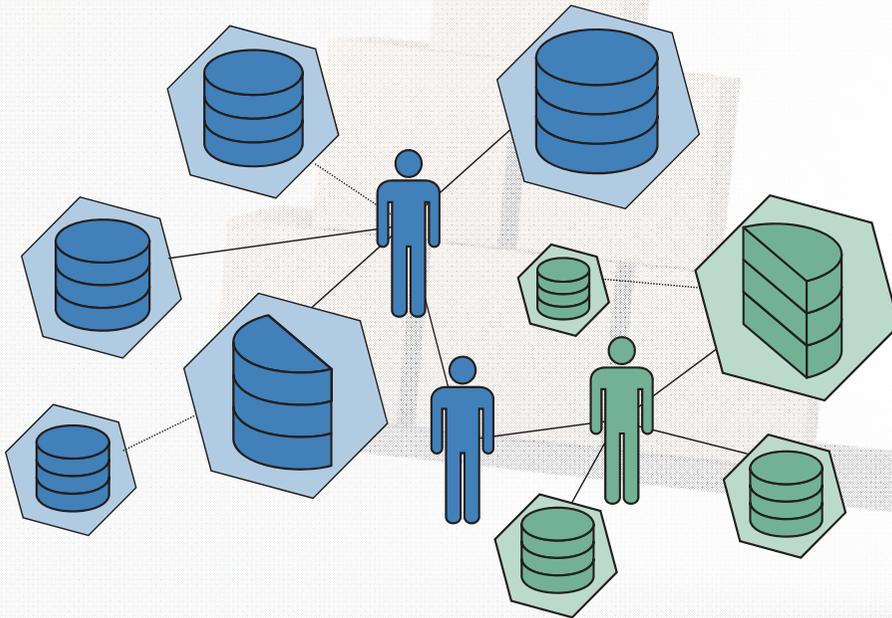
Source: wikipedia.com. Image source: wikipedia.com, microsoft.com

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Data silos vs. distributed ledger

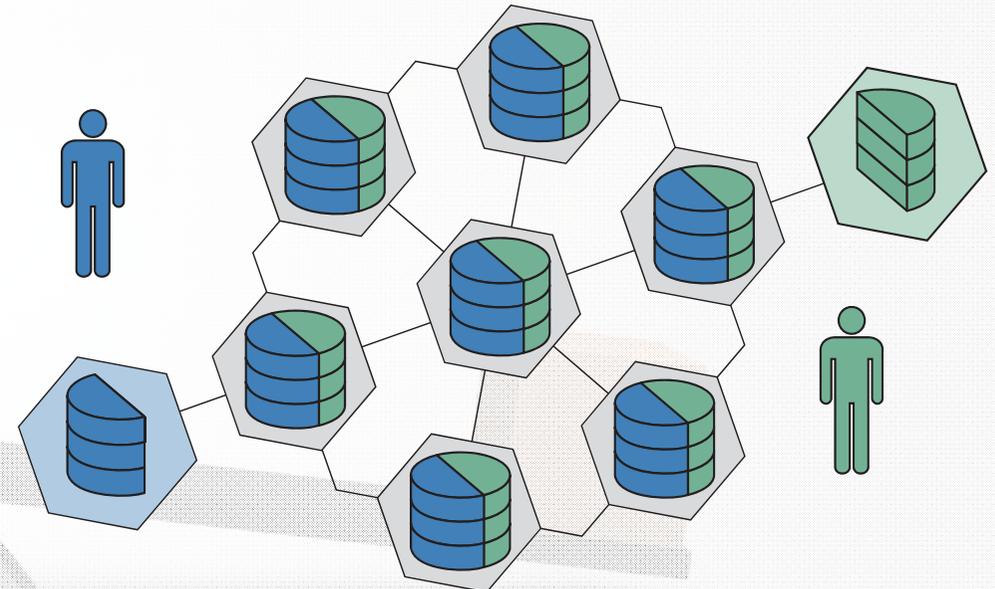
Distributed ledger – a consensus-based distributed system for immutable recording and storage of transaction data from a peer-to-peer network

Data silos



Using data silos gathering and communication of **distributed data is complicated** if even possible

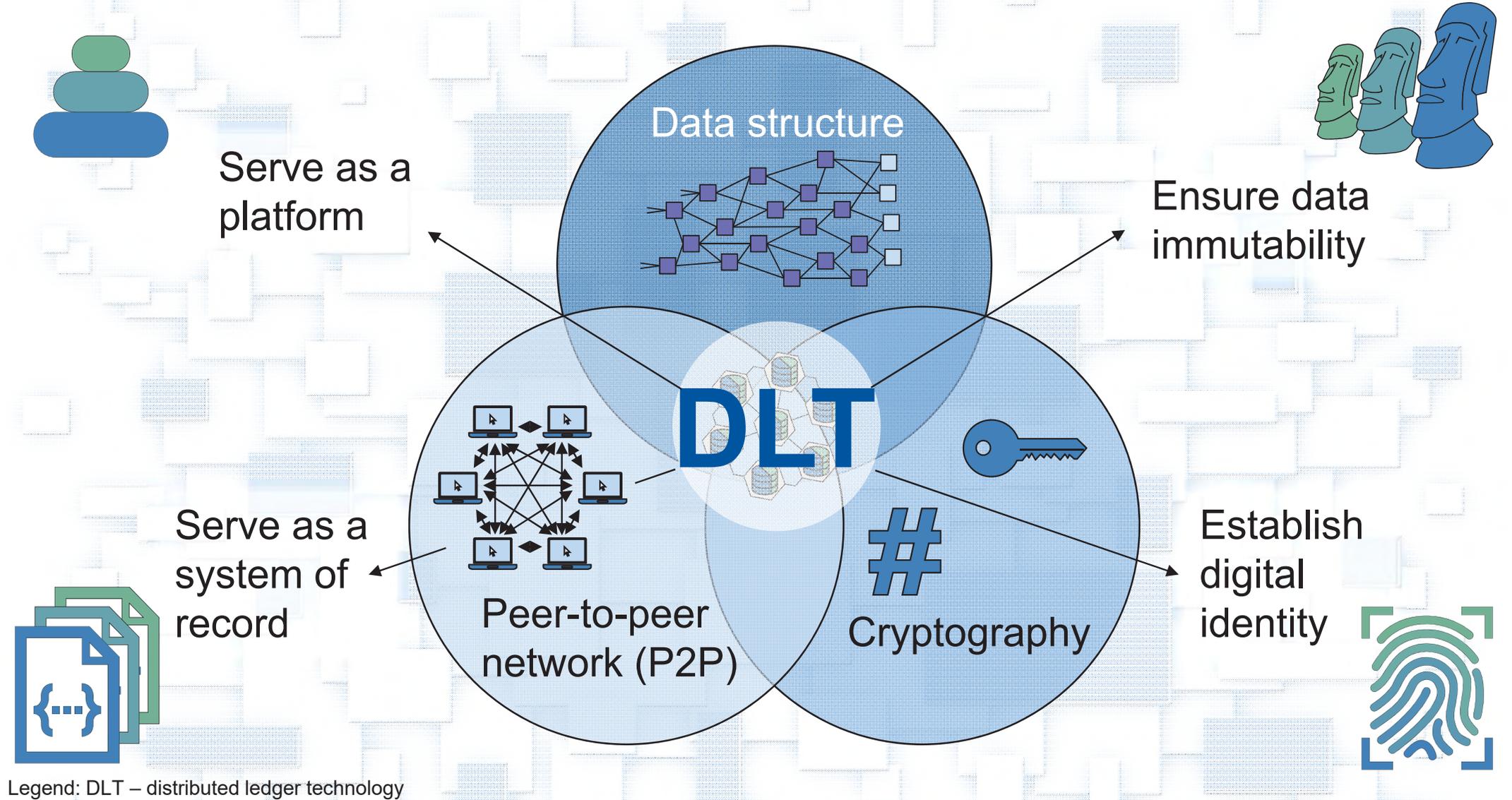
Distributed ledger



Distributed ledger provides a novel approach for **gathering and processing** of distributed data with some special features

Distributed ledger technology

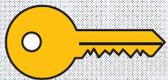
Special features and underlying technologies



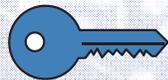
Legend: DLT – distributed ledger technology

Cryptography: public-key encryption and digital signature – analogies

Public key encryption



Private key:
physical mail box key



Public key:
mail box address

Digital signature



Private key:
seal

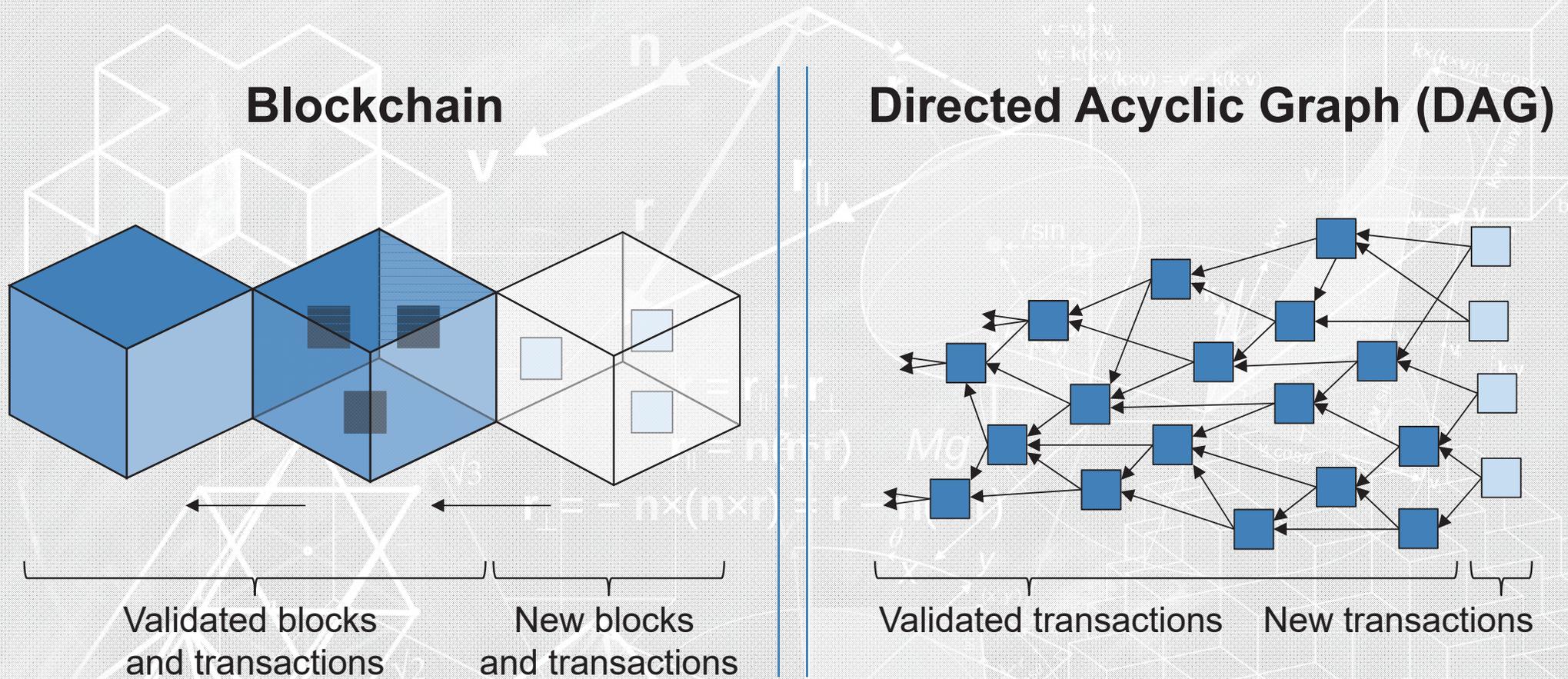


Public key:
knowledge of the seal

Source: tripwire.com

© WZL/Fraunhofer IPT

Data structure

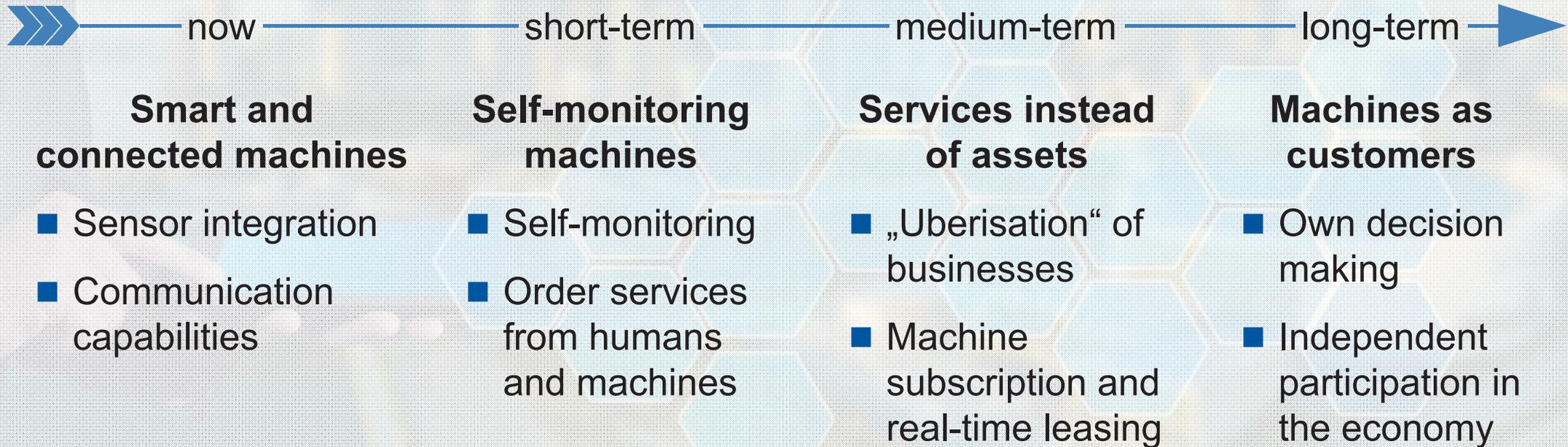


Every new portion of transactional data added to the blockchain or DAG validates the whole transaction history **ensuring the immutability of transaction records**

Machine economy definition and evolution

Machine economy

is the independent, economic operation of machines with the integration of modern technologies and the associated change of the economic system



Source: RAJA17

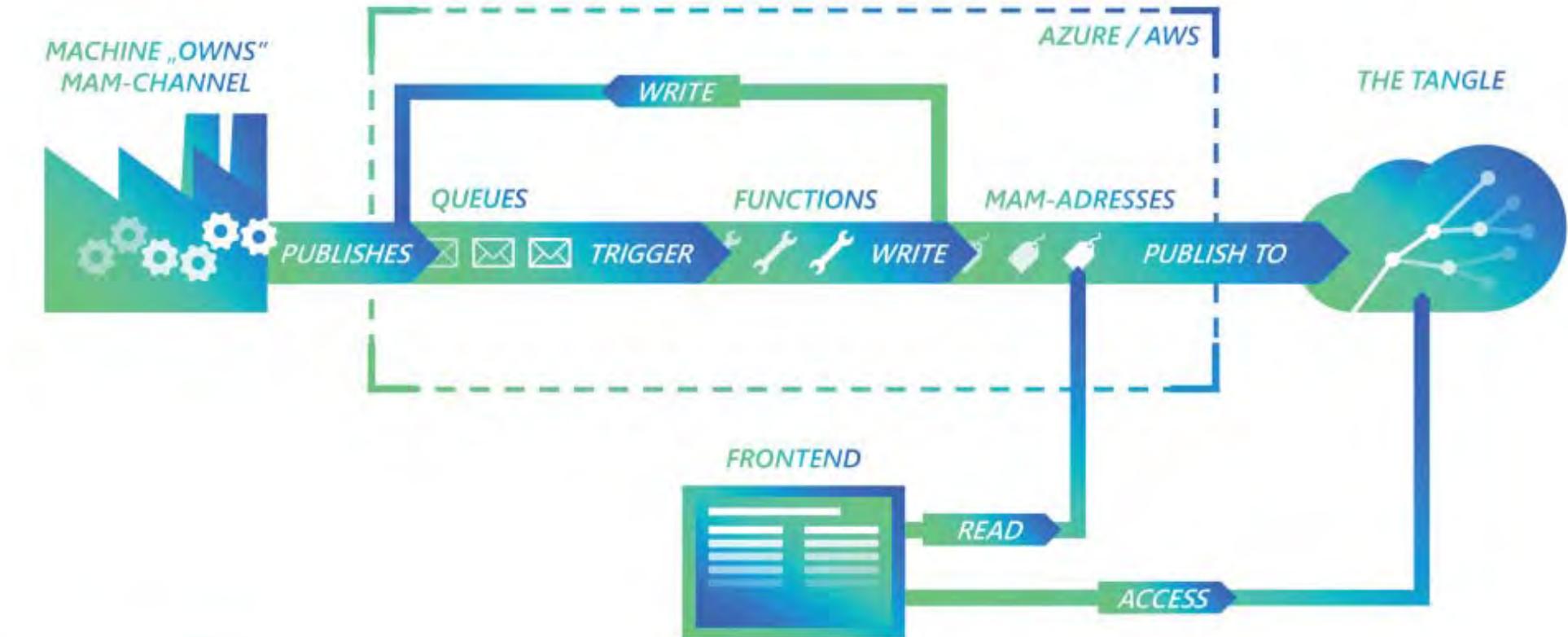
IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

Extending the PoC: large-scale cyber-physical system



IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

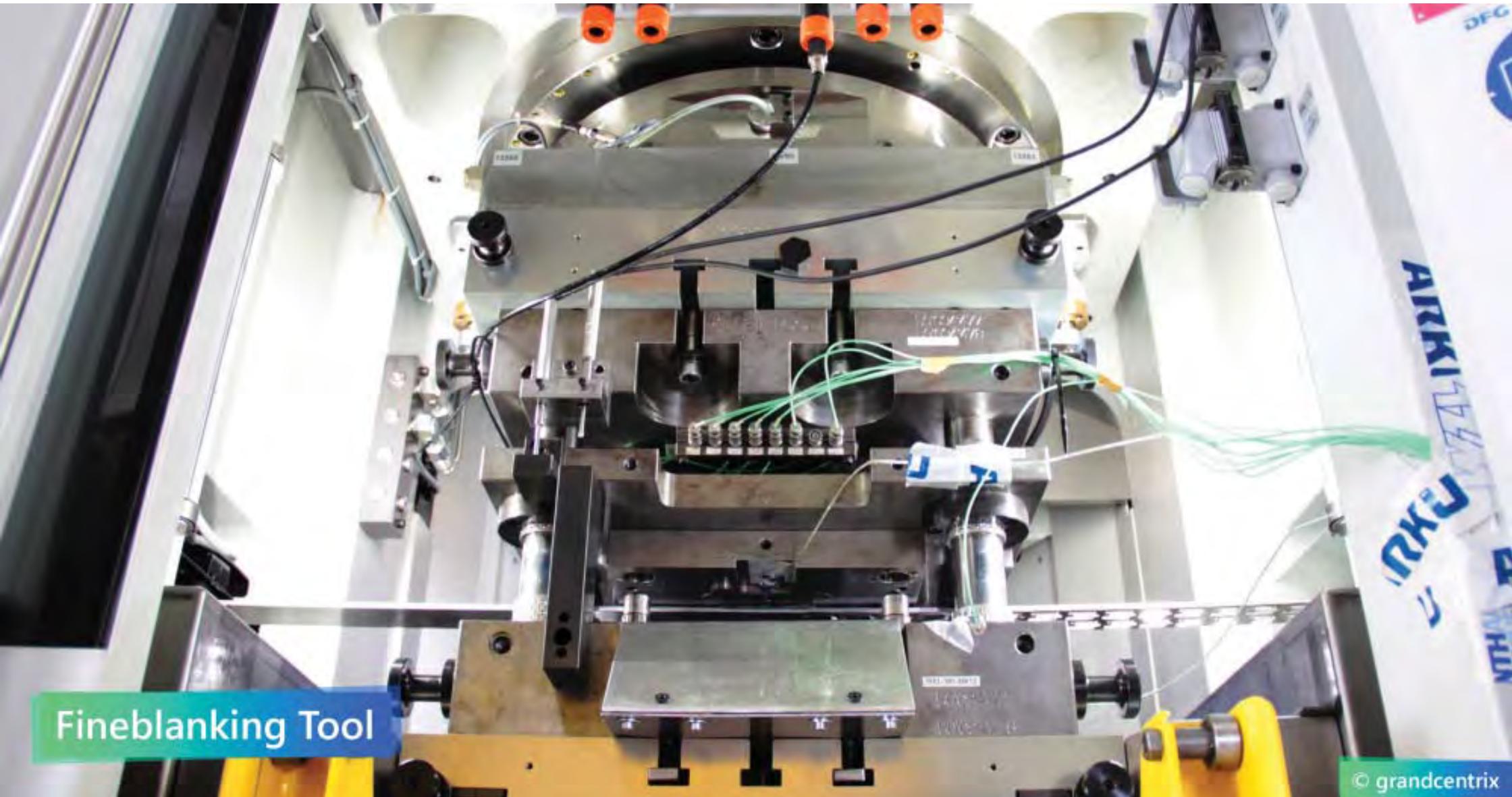
Secure Audit Trails in Fineblanking > Data Acquisition



Our Vision

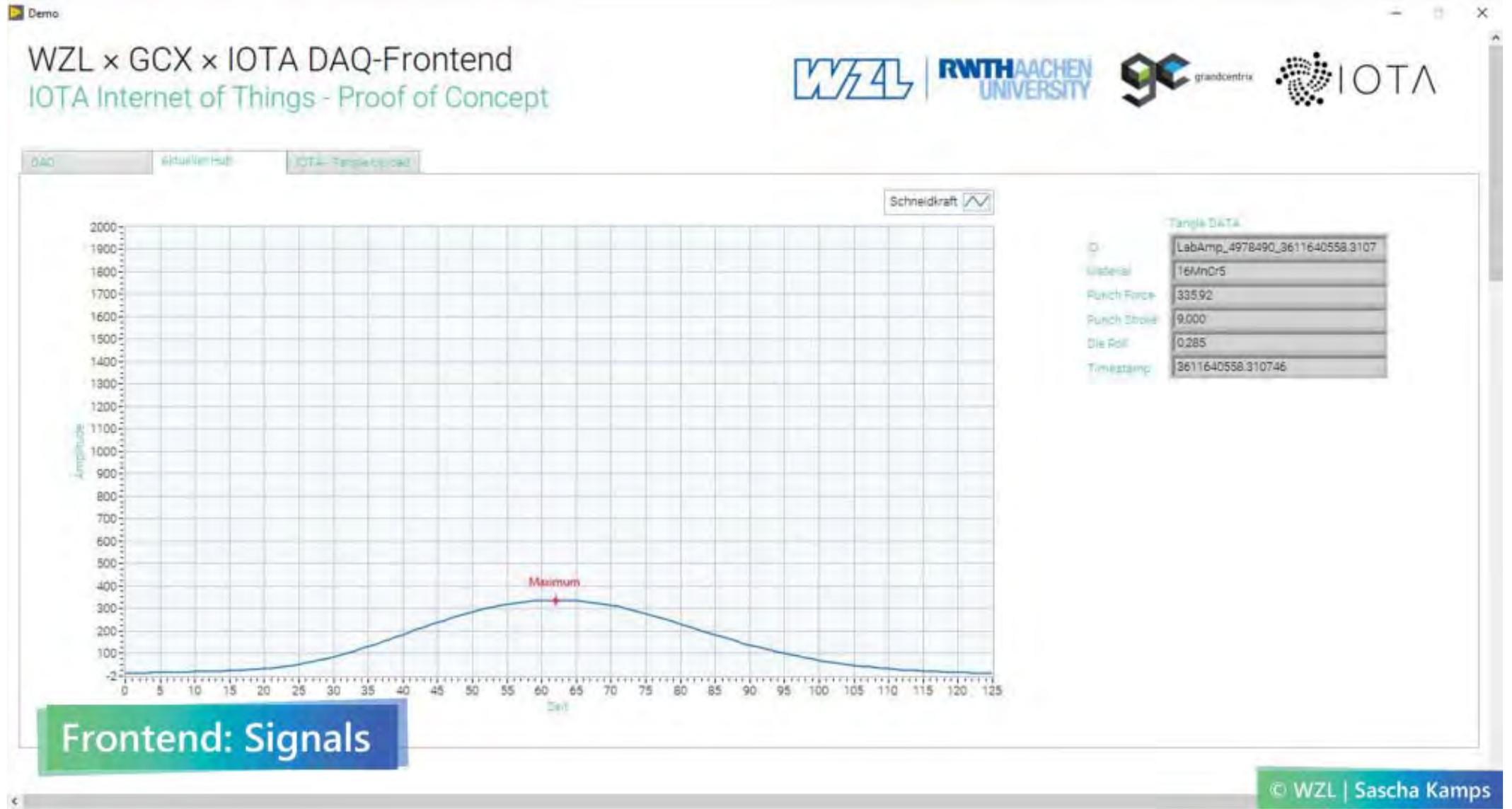
© WZL | Semjon Becker

IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE
Secure Audit Trails in Fineblanking > Data Acquisition



IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

Secure Audit Trails in Fineblanking > Data Acquisition



IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

Secure Audit Trails in Fineblanking > Tangle Explorer

The screenshot shows a web browser window with the URL `https://testnet.thetangle.org/tag/WZL9GCX9IOTA9POC9IIOT999999`. The page title is "Tag" and the address is "WZL9GCX9IOTA9POC9IIOT999999". A blue banner at the top says "YOU ARE ON THE TESTNET". The page features a search bar and a list of transactions. A green and blue overlay at the bottom left says "Testnet Transactions". A green and blue overlay at the bottom right says "© WZL | Sascha Kamps".

YOU ARE ON THE TESTNET

TheTangle.org Live Statistics Services

Search address, transaction, bundle, tag

Tag

WZL9GCX9IOTA9POC9IIOT999999

Transactions **513** Only 100 transactions can be displayed

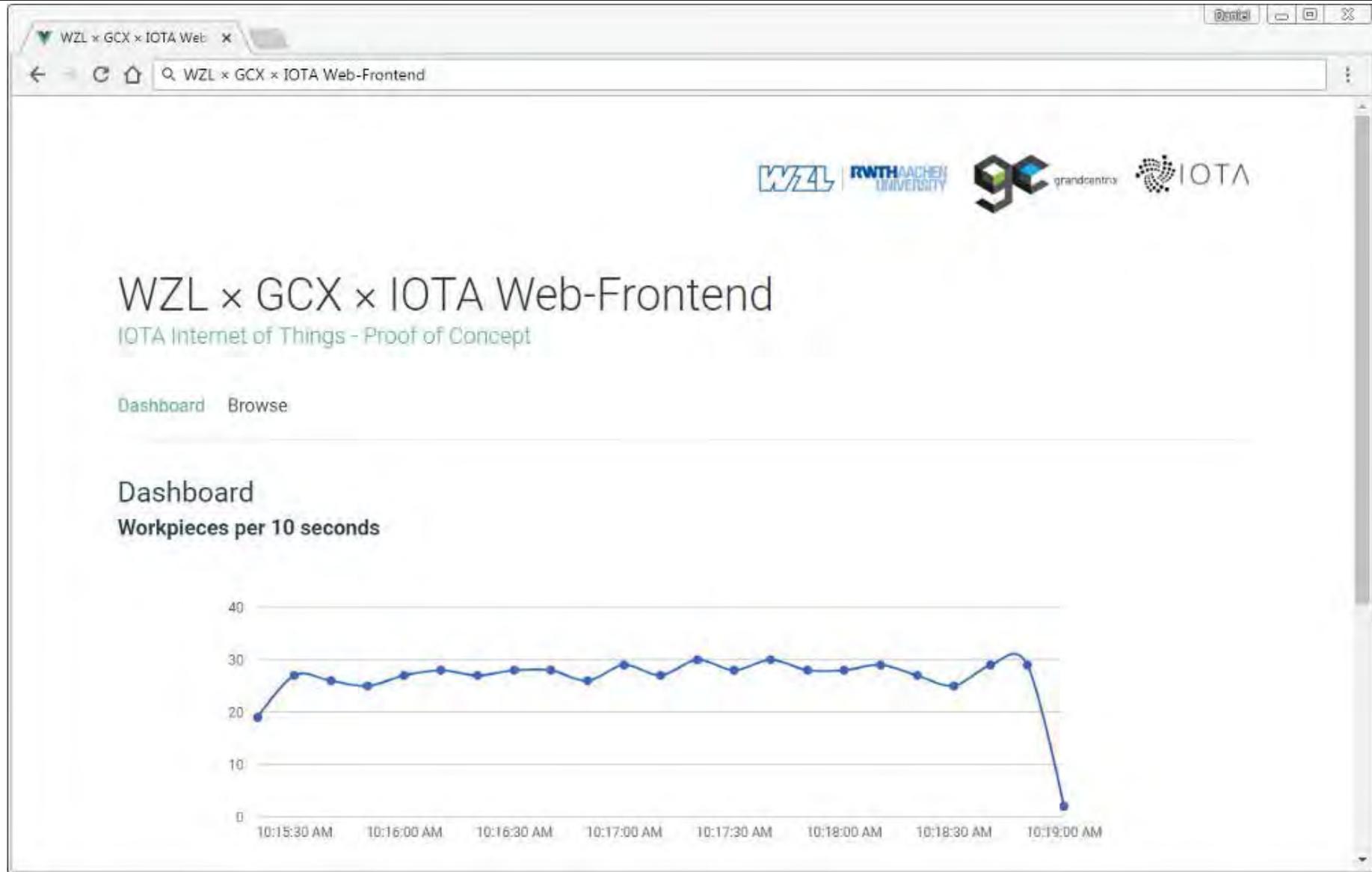
- QQSZEPGCBIVFJGAKTECIHVDPGKGAAILQLARBSLWSENULB9WFTWKSAMIHL9XKXW9TBYPEWKYGUAB999999
- KSL9LWRWDAEMVYCDVSNANINMUVRVIXRIKDDXEILYJ00HYTZS0SKIQSXHGDFDIJSNHXCUI0FKIMBV999999
- DWHMHXZMAIUNXLXPHSUBPWDRLOFN9JCTDV9XUPEGGXSGLLPM9BGKJQZNTPRIKZPOGOTTGPJJCVRX999999
- EUIXBRENNYXQXRDS9UF9GHKQWSJYGZQHZCT9XKELVYED9FPDZMGRGETAJVICGV99CXRCKATPYUBZ999999
- CABFNPZZNQJAVWBVOFEZPOAFQW9SOSXOAFJVFNDLVAPMNCHD9FEJMRVCMGUMHPLX9BWBXWBLDTAQA999999
- BKUHSTPHICOVLCVSTFBXJGDYIXRMA0GLELVP9HUKDNJLTKHUBEEHEEQKNREHNBEPTROIIESKQQA999999
- HFGVMUSMROYCGQAWZQSCXCRQOYOPCDCKASYEHJ9ABJQVEPNHVUIWHIENYXWIEFZZXKCDTYWRUDQZ999999
- UKHBOYXUULKYHSEMIF99QMY9DBTNPVYSUJNJCLWWCKEWPNYXC9TJMNQMR0WUKNRNKDTWAJD9JRZG999999
- MIO99AQK0XHUHAA9XYRTMJ8DFUJGMMZQZCEI9GXGYMWMLSY9QVLNDH9M2999999
- IPJRDMPFLXYTPOOVGEKQDXLBGZMAUUPGQTOPBCQRAMYNHNXMBHL9JLA999999
- VJKQHSYUEKRYAUDFVMYNZN0TF99M0WIPZNAQTHH9DJTXZH0QALYTJKYGDYPVYWKM9QBHSTLG9URL999999

© WZL | Sascha Kamps

IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE
Secure Audit Trails in Fineblanking > Tangle Explorer



Secure Audit Trails in Fineblanking > Data Visualization



Secure Audit Trails in Fineblanking > Data Visualization



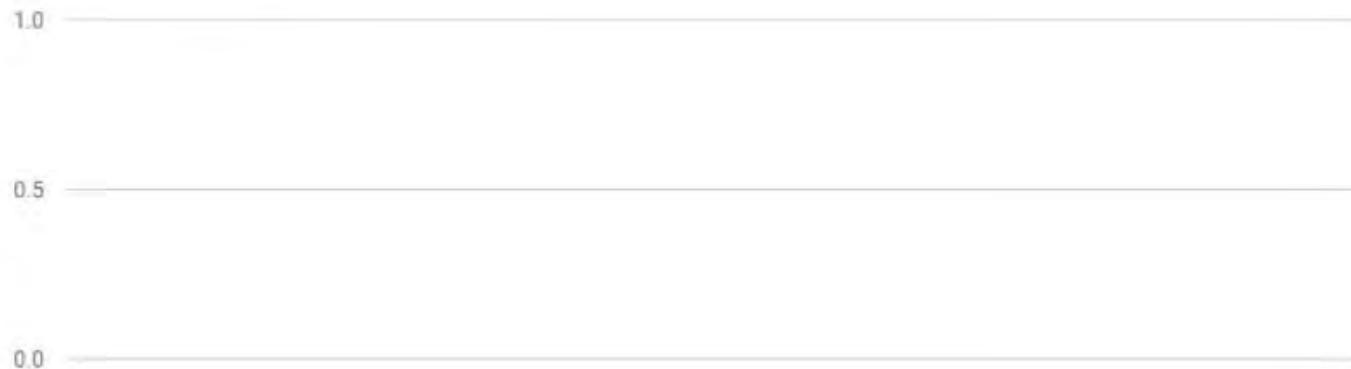
WZL x GCX x IOTA Web-Frontend

IOTA Internet of Things - Proof of Concept

[Dashboard](#) [Browse](#)

Dashboard

Workpieces per 10 seconds



Secure Audit Trails in Fineblanking > Data Visualization



Verification successful

© WZL | Daniel Trauth

IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

Secure Audit Trails in Fineblanking > Data Visualization

The screenshot shows a web browser window with the URL 'WZL x GCX x IOTA Web-Frontend'. The page features logos for WZL, RWTH Aachen University, GCX, and IOTA. The main heading is 'WZL x GCX x IOTA Web-Frontend' with the subtitle 'IOTA Internet of Things - Proof of Concept'. Below this, there are navigation links for 'Dashboard' and 'Browse'. The 'Browse Workpieces' section includes a search prompt and a filter bar with dropdowns for 'Aachen', 'XFT_2500_speed', and 'All', along with a 'Filter workpieces...' input field. A table displays workpiece data with columns for 'Unique Workpiece ID', 'Date', 'Stored', and 'Access Data'. The table contains five rows, each with a unique ID, a date and time, a checkmark in the 'Stored' column, and a 'Buy Data' button. A blue 'Overview' button is visible in the bottom left corner. The footer of the page reads '© WZL | Felix Mönckemeyer & Semjon Becker'.

Unique Workpiece ID	Date	Stored	Access Data
e650d9b4-c314-11e8-a93a-0050568e6107	28.09.2018 13:51:56	✓	Buy Data
e640d3d2-c314-11e8-b340-0050568e6107	28.09.2018 13:51:56	✓	Buy Data
e6207a42-c314-11e8-871c-0050568e6107	28.09.2018 13:51:56	✓	Buy Data
5a714e4a-c314-11e8-9b42-0050568e6107	28.09.2018 13:48:01	✓	Buy Data
...

IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

Secure Audit Trails in Fineblanking > Data Visualization

WZL x GCX x IOTA Web-Frontend

IOTA (Internet of Things - Proof of Concept)

Dashboard Browse

Workpiece Details

Payment

© WZL | Felix Mönckemeyer & Semjon Becker

IOTA use-cases in manufacturing > WZL x GCX x IOAT x SE

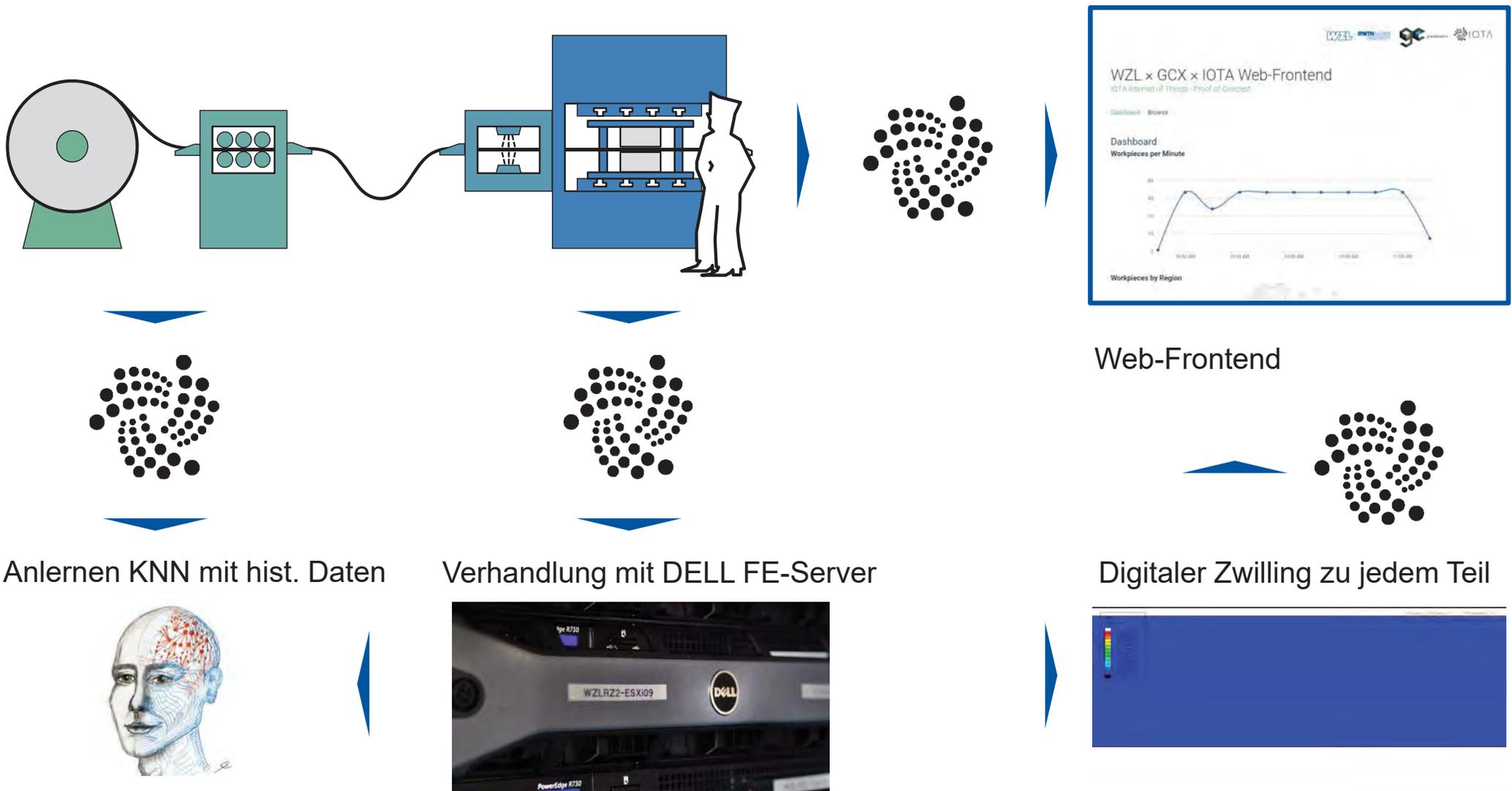
Secure Audit Trails in Fineblanking > Data Visualization

The screenshot shows a web browser window with the following content:

- Workpiece Details**
 - Identifier: e658d9b4-c314-11e8-a93a-0050568e6107
 - Timer: 23:30:55 (You can only see the data for a limited amount of time!)
 - Alert: Integrity check failed: Signature does not match public key and data.
- Classification Data**

Name	Value	Description
Material	16MnCr5	Name of the blanked material according to eurocode
Punch Force	2464.2925 kN	Maximum punch force in kN/Newton used to cut the workpiece
Punch Stroke	14.7351 mm	Moving distance of the punch from upper to lower dead center in mm
Die Roll	0.9034 mm	Depth of the die roll measured at one edge of the workpiece in mm
Timestamp	28.09.2018 13:51:56	Assigns a specific point in time to the moment the fine blanking of a workpiece is started
- Channel Reference**
 - Root: VHSLDLNQGCDYNNRYENZHPZUCHLIEYSKGEVDYNNWPP1IID9QCKARPRFGLQWNIYNIOWYXWQIINFJNGJUNTXE (The address of the MAM Channel where the Workpiece Information is persisted)
 - Verify Tangle Entry button
 - VERIFICATION SUCCESS! message
- Hash**
- Verification** (blue button)
- Footer: © WZL | Felix Mönckemeyer & Semjon Becker

Secure Audit Trails in Fineblanking > M2M with FE-Server



Anlernen KNN mit hist. Daten

Verhandlung mit DELL FE-Server

Web-Frontend

Digitaler Zwilling zu jedem Teil

Data is the new oil



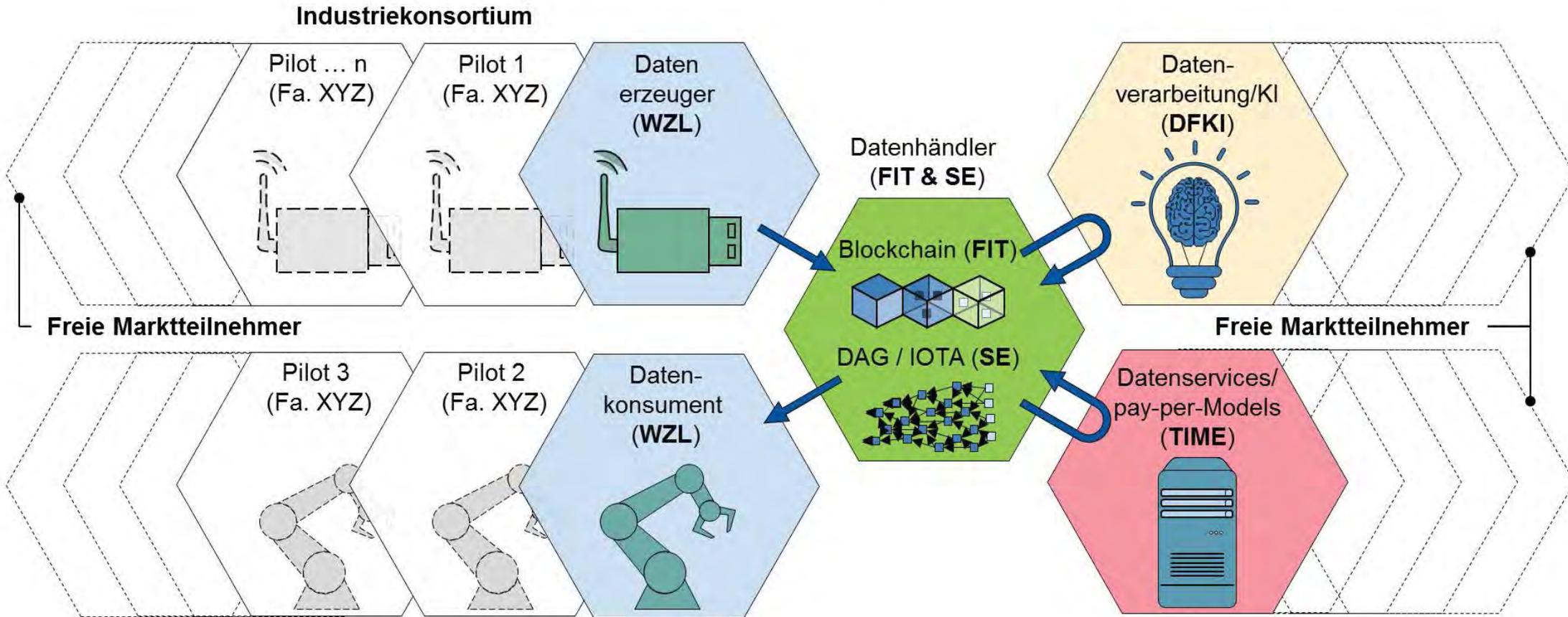
Distributed ledger technology is the data-backbone of machine economy

Source: The Economist

Outlook

Data is the new oil

Datenökonomie für industrielle Güter und Produktionsanlagen





AWK AACHENER
WERKZEUGMASCHINEN
KOLLOQUIUM

May 2020

THANK YOU FOR YOUR ATTENTION

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@DANIELTRAUTH