Fraunhofer IZM

Fraunhofer Institute for Reliability and Microintegration IZM

Hardware Innovations for Cybersecurity & Industry 4.0

A trustworthy infrastructure for microelectronics production

Research Project SiEvEI 4.0

Assembly line at Fraunhofer IZM

The increasing proliferation of connected, digital, and automated technologies touches all aspects of business life including the manufacturing of microelectronic products. The collaborative project SiEvEI 4.0, funded by the BMBF, addresses the question of how to unite manufacturing, production environments, equipment, materials, safety, and products for industry 4.0 applications.

With the participation of Fraunhofer IZM, a consortium is working on solutions for the intelligent, flexible, and decentralized production of critical electronic systems, e.g. for use in power plant control rooms or the aerospace industry.

The SiEvEI 4.0 project aims to develop a concept for tamper-proof traceability along the production chain of electronic assemblies and components.

Chains of Trust (CoT)

The aim is to demonstrate how critical, trustworthy electronic assemblies can be realized within a suitable Public Key Infrastructure (PKI) by using anchors of trust (security certificates) in the form of Smart Secure Items (SSI), and how the product quality of such high-quality assemblies can be continuously improved by AI-supported data acquisition.

The focus of the research project is on introducing a »Chain of Trust« infrastructure (CoT) in an existing microelectronics production line, on collecting and processing data from manufacturing for ML-supported optimization, on refining the SSIs in terms of hardware technology, and on adding a protected certificate store.

Contributions of Fraunhofer IZM and TU Berlin:

- Implementing a trustworthy data collection and data processing infrastructure for collecting in-process data
- Producing Smart Secure Items (SSIs) and embedded SSIs (eSSIs) as containers of certificates for the proposed »Chain of Trust« (CoT)

Project partners

- Siemens AG (coordinator)
- Sensorik-Bayern GmbH
- WIBU-SYSTEMS AG
- Wagenbrett GmbH & Co. KG
- Fraunhofer IZM
- Technical University of Berlin
- University of Bielefeld
- atg Luther & Maelzer GmbH (associated partner)

Project volume

- € 4.78 million.
- 64 % Funding share

Duration & Funding code

- 03/2020 - 08/2023
- 16ME0005

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- Collecting process/training data to develop ML-based hybrid learning methods for process evaluation/optimization
- Preparing a 3D planning tool for the optimal arrangement of Edge Computing Modules (ECMs) in the distributed manufacturing environment with the visualization of radio reception qualities as a fundamental technology for lab planning in Industry 4.0

To ensure the security of intelligent, autonomous production systems in industrial plants, especially system-relevant infrastructures, each production step must be documented in a tamper-proof manner and be traceable at all times.

To this end, the supplier/manufacturer, machine, IT infrastructure, and all employees are provided with a security certificate. In addition, environmental and production data are recorded along the entire production chain, and eSSIs with a security chip are embedded in the assembly.

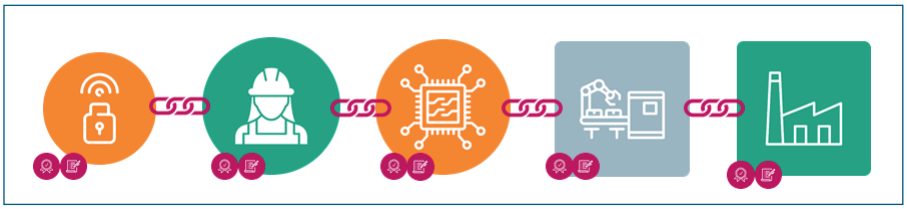
Data collection:

- Environmental data e.g. room temperature and humidity
- Process data, e.g. movement patterns, force effects, and temperatures within the machines
- Production data, e.g. information about individual production steps and the achieved production quality, authenticated by certificates assigned to machines or persons

By using certificates for each data block, a chain of trust (CoT) with tamper-proof manufacturing data is created. The CoT for each assembly is stored in the hardwired Smart Secure Item (eSSI). Security certificates are stored on the eSSIs to be able to check the CoT autonomously.

Once the trust anchors are present in all instances of the production environment, from machines and their operators to individual products, the CoT can be considered hardened and can be checked for tampering to identify e.g. when individual links in the chain are changed or replaced.

CoT extends beyond the actual production environment to include the entire value chain and the entire lifecycle of products, including the infrastructure in which they are manufactured, transported, and used.



Chain of trust with tamper-proof manufacturing data

Data processing:

Data from the SSIs and the eSSIs is passed to Edge Computing Modules (ECMs) via radio interfaces. Each production line is equipped with several ECMs where the collected data is pre-processed.

At the same time, the ECMs enable access to the certificate memory and the CoT of the products with Smart Secure Items. This affords a reliable and tamper-proof means to trace at any time by whom, when, how, and where the individual process steps were carried out.

Hybrid learning:

All information from the various sources is brought together in a cloud and processed further using machine learning. The project partners involved also provide important process knowledge to support the artificial intelligence in interpreting the data in the best possible way.

With the help of AI, potential improvements along the production chain are derived for each production site and the quality of production is ensured.

Areas of application:

- Marking for traceability of components
- Online monitoring of production processes
- Digitalization of manufacturing processes

Advantages:

- Tamper-proof recording of environmental and production data along the entire process chain
- Ongoing production monitoring and quality assurance
- Data source for AI-based manufacturing optimization
- Traceability against counterfeiting along the entire value chain
- Cost-effective modernization of existing production facilities for Industry 4.0

More information

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