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April 24, 2018

Erfahrungsbericht **Genesis of Things Project**

Ansätze und Herausforderungen bei der Integration von Blockchain in der additiven Fertigung und Geschäftsmodelle

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Genesis of Things

Genesis of Things is a

- trusted,
- encrypted and
- open

platform for the entire 3D printing supply chain.

Intellectual Property scales globally and stays protected. Each printed product has its own ID and digital product memory. Supply chain processes including trade finance are largely automated.

Key features include

- A digital product memory of each individual part printed
- Micro-royalties for designers
- Crypto-payments and escrow function

Lead User Interviews

BOSCH AIRBUS

BMW VW DHL

The solution will ultimately result in the print file "becoming" the business.

The print file would contain not only secure intellectual property but also the ability to negotiate terms and conditions, make payments and provide immutable documentation and authenticity for each part.

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The problem to be solved

Manufacturing closed shop: Customers cannot borrow a part of a plant – manufacturing assets are largely not shareable[1]

Manufacturing "Trust Tax": Huge effort to control, monitor and inspect the manufacturing process and the products (certifications, audits, ISO, TÜV)[2]

Supply Chain Transparency: Fraud, No proven authenticity/ownership, not optimal resource usage[2]
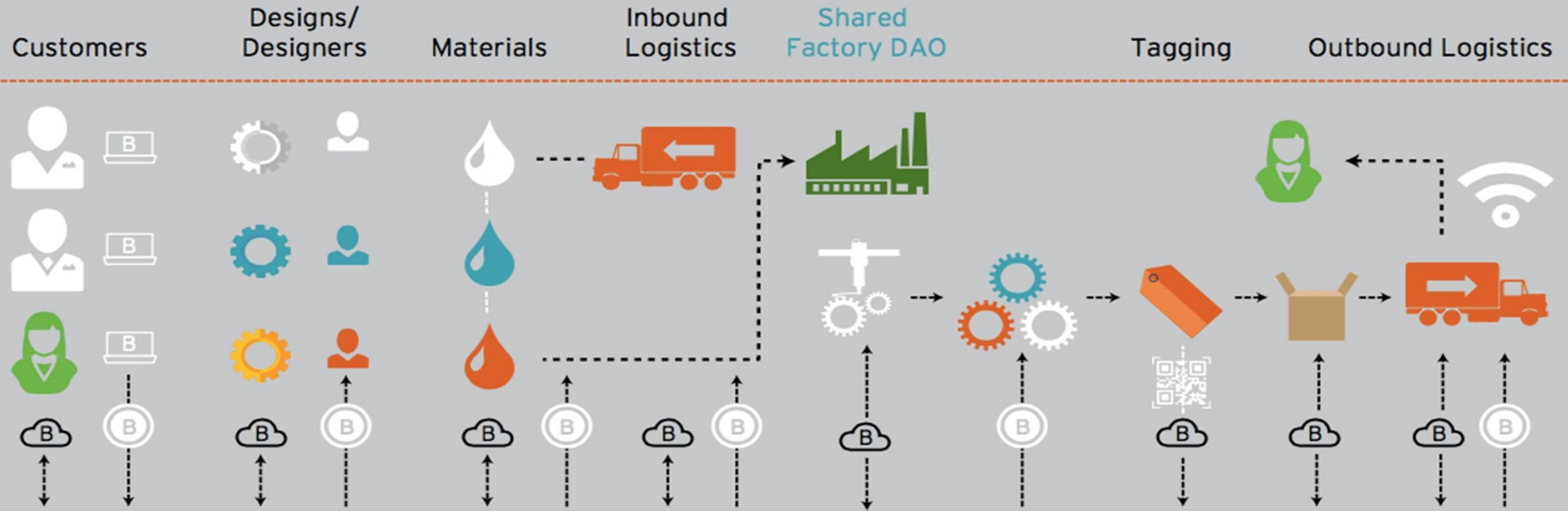
IP protection requirements for designs and production parameters prevent learning, innovation, growth[3]

1) Oliver Scalabre, BCG, May 2016
2) Stöcker/Blechschmidt: Applying Software-Defined Manufacturing and Blockchain Principles to Slash the "Trust Tax", Oct 2016
3) Salim Ismail, Singularity University, August 2016

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THE SHARED AUTONOMOUS FACTORY MODEL

Customers	Designs/Designers	Materials	Inbound Logistics	Shared Factory DAO	Tagging	Outbound Logistics

BLOCKCHAIN/SMART CONTRACTS

- User configures order.
- Unique product ID and "bill of process" is created.

- Encrypted design data on shared platform.
- Royalty accounting for designers.

Autonomously sourced material and services through smart contracts.

- Product produced in shared factory.
- Product lifecycle data stored in digital product memory.

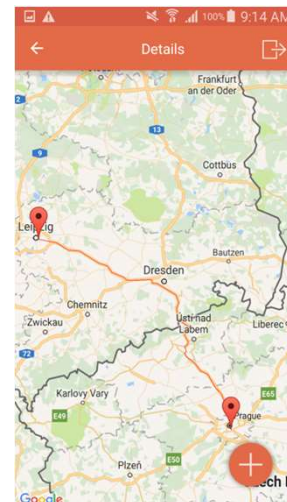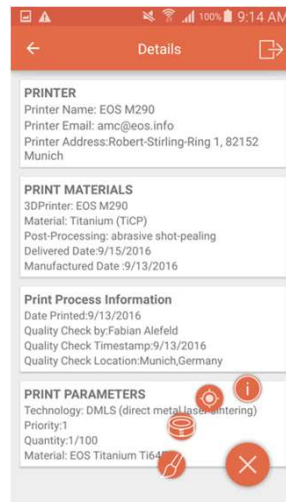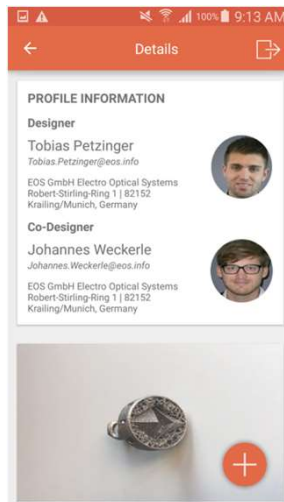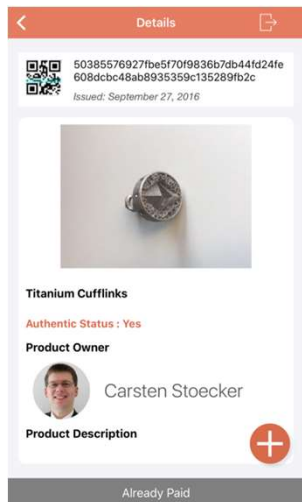Product is tagged with unique product ID on crypto chip/QRC.

Product is packaged & stored for shipping.

Product is shipped & tracked by telematics.

Source: innogy/Cognizant

Output: the printed product and its digital twin
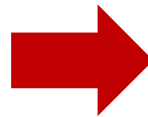
Digital Product Memory

- Stores all information starting at the birth of a product
- Provides Full supply chain transparency
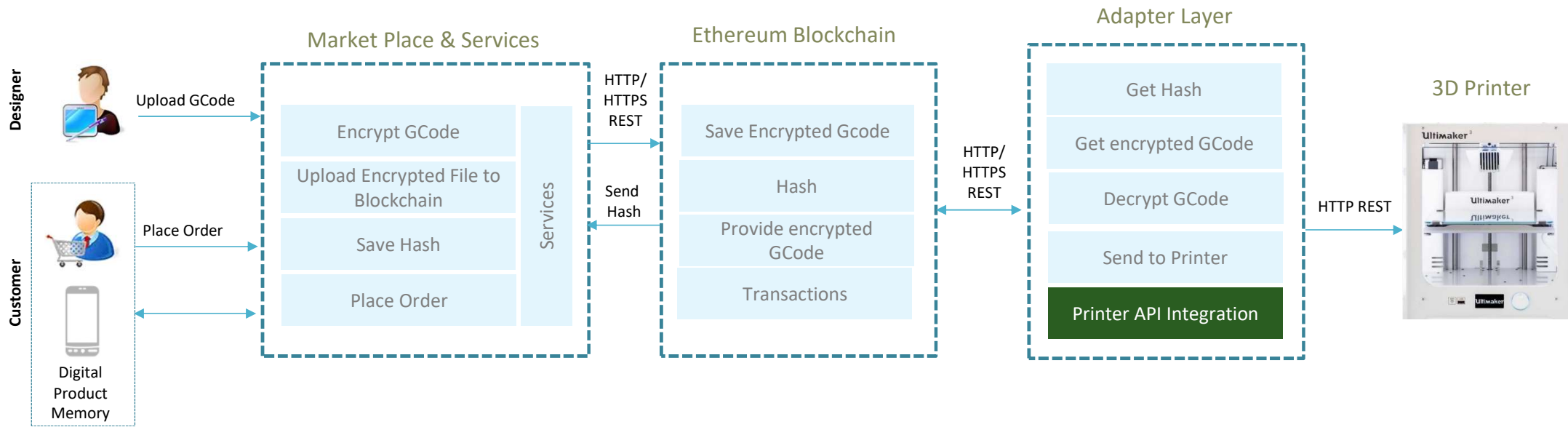- Endures interoperability among multiple stakeholders

New Use Cases

- Proof of Authenticity, Proof of Ownership
- Audit trails, paperless certifications
- Store of tokens

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Key Challenges

- IP Protection "last mile" – decryption taking place on the printer

- Inconsistent production quality and court disputes / liability questions

- Proof of certification of the 3D printing process quality (audit trail), Oracles for input data

- Ecosystem Innovation and Business models

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Building an adaptor to enable end-to-end encryption for an Industrial Company

Designer

Upload GCode →

Customer

Place Order →

Digital Product Memory

Market Place & Services

- Encrypt GCode
- Upload Encrypted File to Blockchain
- Save Hash
- Place Order

Services

HTTP/HTTPS REST →

Send Hash ←

Ethereum Blockchain

- Save Encrypted Gcode
- Hash
- Provide encrypted GCode
- Transactions

HTTP/HTTPS REST ↔

Adapter Layer

- Get Hash
- Get encrypted GCode
- Decrypt GCode
- Send to Printer
- **Printer API Integration**

HTTP REST →

3D Printer

Ultimaker

Encryption - While uploading

- Splitting GCode file into three chunks
- Encrypting each chunk with a random key (key size based on algorithm) and appending the key with the encrypted chunk and merging three chunks to one single file
- Store the encrypted GCode into blockchain layer.

Decryption at the Adapter Layer.

- Split encrypted file and isolating the keys
- Decrypting each chunks
- Merging it into single file

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Audit Trails and Digital Twins for Quality Management

Objectives

- **Data audit trail** for printed products produced by an additive manufacturing factory to prove consistent for QM processes and audits done by internal and external stakeholders
- Proof that at all times the AM process was executed in accordance to defined manufacturing parameters

Types of Audit Trails

1) Object Audit Trail
2) Design and GCode File
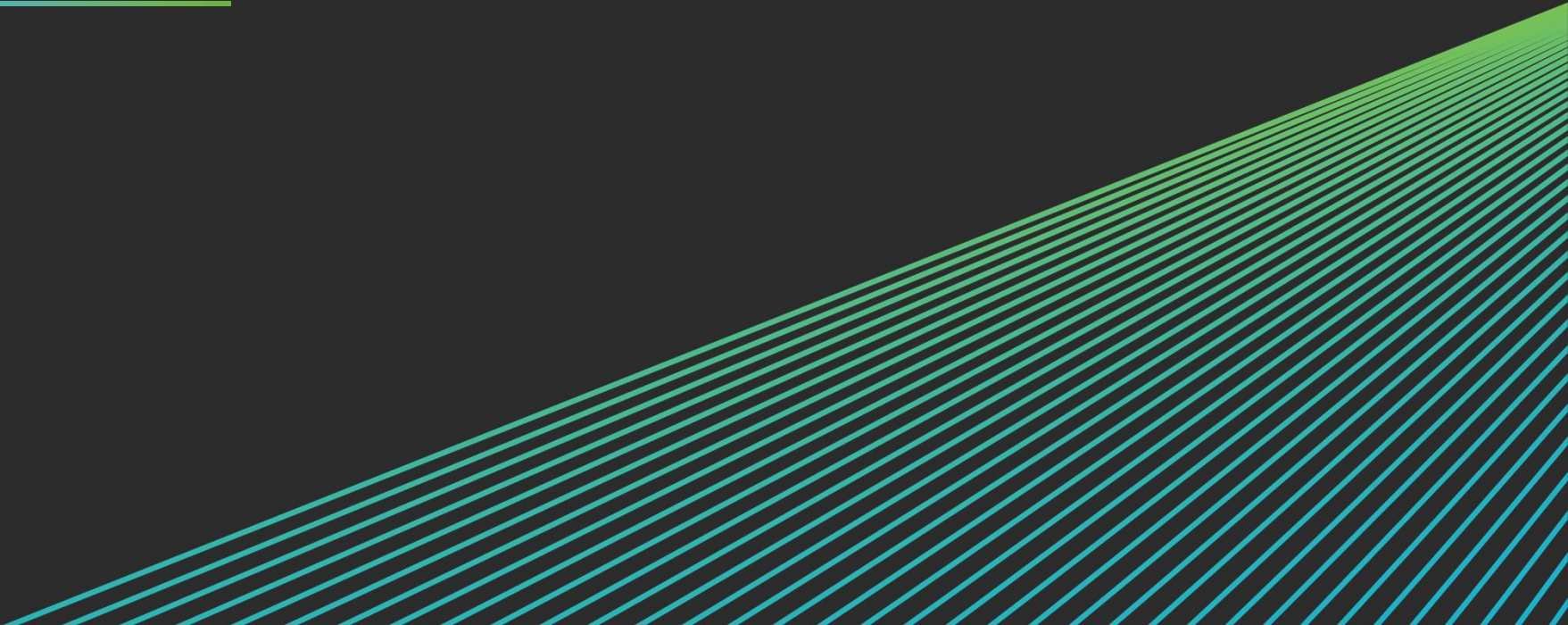3) AM System Provenance and Calibration

Key Features

1) Design, Machine, System and Object Identities
2) Data authenticity (signed data)
3) Data integrity (immutable storage of data hashes)
4) Time stamps and completeness of off-chain data (completeness compared to list of immutable hashes)
5) Meta data management, interoperability and decentral assets / ownership transfers

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Business Models

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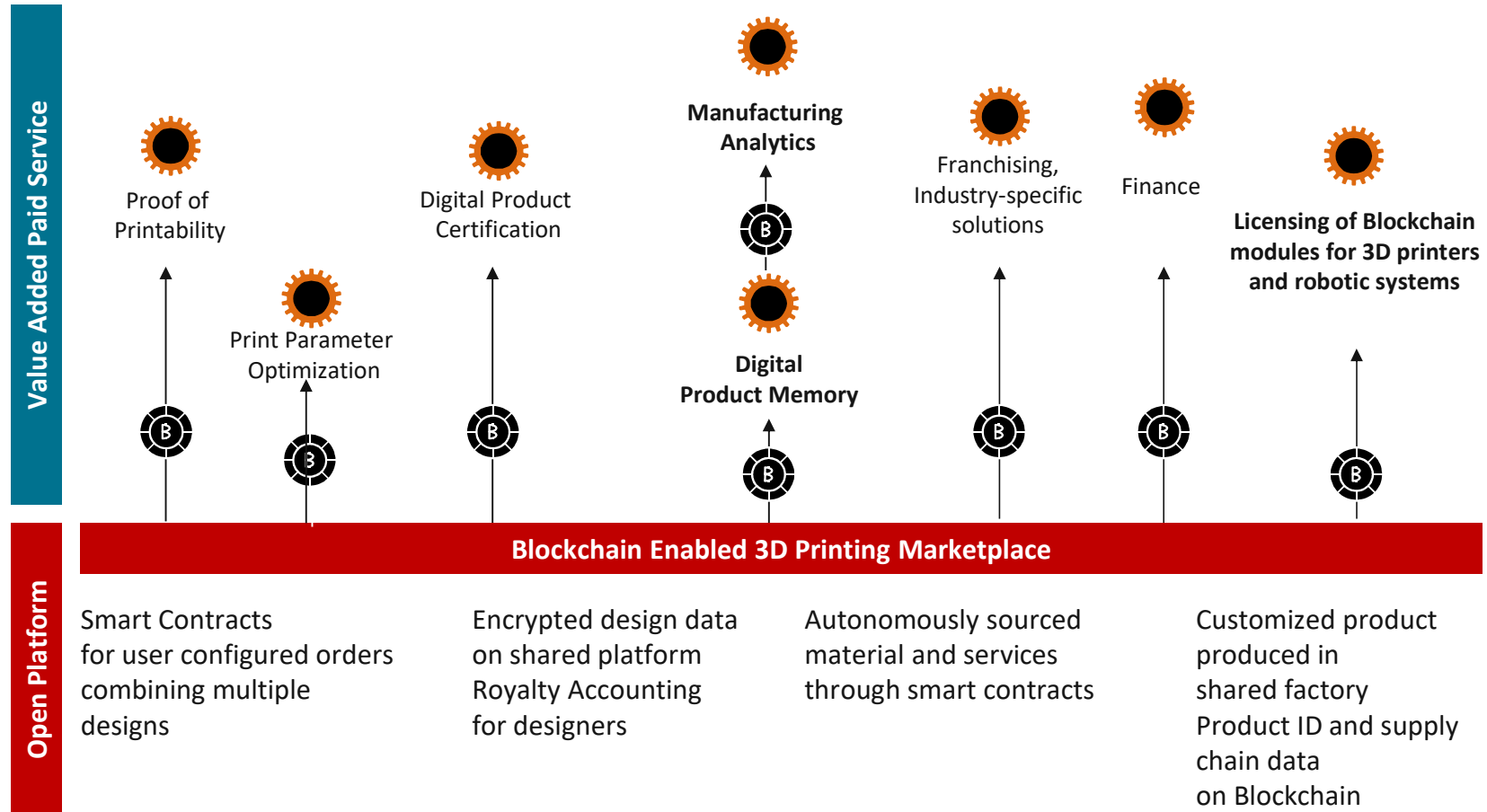
Thank you

Technical Architecture

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