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INTEROPERABILITY FOR PRODUCT LIFECYCLE MANAGEMENT

Reducing the Digital Threat in Smart Manufacturing

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About me

- Senior consultant at Engisis LLC and Research associate at the US National Institute of Standards and Technology (NIST)
- Oxford Blockchain Strategy Programme Tutor
- Focus on standard-based interoperability and data traceability
- Member of the US TAG for ISO/TC 307 (Blockchain) and TC184/SC4 (Product data)

About this project

- Collaboration with the US NIST
  - Research performed in collaboration with the US NIST System Integration Division (SID)
- Development of a Proof of concept with NATO
  - To support the NATO 3D printing capability
  - Integration of international systems

Agenda

- The Digital Transformation of Manufacturing
- The Digital Threat
- Reducing the Digital Threat
- Conclusion

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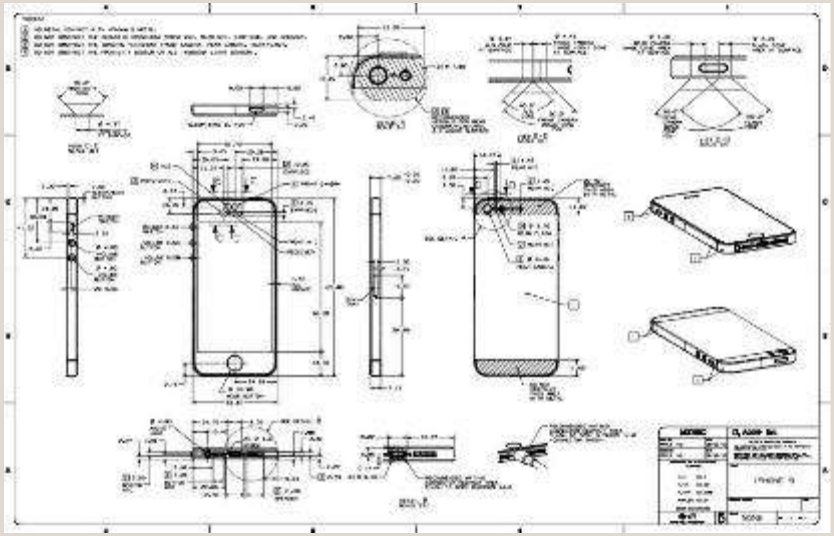
The Digital Transformation of Manufacturing

- Smart Manufacturing or Industry 4.0
- Moving from paper-based (business, engineering,…) knowledge to a digital representation
- Automated **data processing** (analysis, consistency checking and validation, exchange,…) using **modern techniques** (data mining, Machine Learning, High Performance Computing, …), thanks to **computational power and sensors**

The Digital Transformation of Manufacturing



The Digital Transformation of Manufacturing

Table 1. Processes within a smart factory

Process	Sample digitization opportunities
Manufacturing operations	• **Additive manufacturing** to produce rapid prototy • **Advanced planning and scheduling** using real-tim minimize waste and cycle time • **Cognitive bots and autonomous robots** to effecti minimal cost with high accuracy • **Digital twin** to digitize an op predictive analyses
Warehouse operations	• **Augmented reality** to assist • **Autonomous robots** to exec
Inventory tracking	• **Sensors** to track real-time m progress and finished goods, • **Analytics** to optimize invent
Quality	• In-line quality testing using • **Real-time equipment moni**
Maintenance	• **Augmented reality** to assist equipment • **Sensors** on equipment to dri
Environmental, health, and safety	• **Sensors** to geofence danger personnel • **Sensors** on personnel to mo other potential threats

Source: Deloitte Analysis.

How Industry 4.0 is delivering revenue, cost and efficiency gains

Additional revenue from:	Lower cost and greater efficiency from:
Digitising products and services within the existing portfolio	Real-time inline quality control based on Big Data Analytics
	Modular, flexible and customer-tailored production concepts
	Real-time visibility into process and product variance, augmented reality and optimisation by data analytics
	Predictive maintenance on key assets using predictive algorithms to optimise repair and maintenance schedules and improve asset uptime
	Vertical integration from sensors through MES to real-time production planning for better machine utilisation and faster throughput times
	Horizontal integration, as well as track-and-trace of products for better inventory performance and reduced logistics
	Digitisation and automation of processes for a smarter use of human resources and higher operations speed
	System based real-time end-to-end planning and horizontal collaboration using cloud based planning platforms for execution optimisation
	Increased scale from increased market share of core products

Exhibit 25

We have identified the following big data levers across the manufacturing value chain

	R&D and design	Supply-chain mgmt	Production	Marketing and sales	After-sales service
1 Build consistent **interoperable, cross-functional R&D and product design databases** along supply chain to enable concurrent engineering, rapid experimentation and simulation, and co-creation	✓				
2 **Aggregate customer data and make them widely available** to improve service level, capture cross- and up-selling opportunities, and enable **design-to-value**	✓			✓	
3 Source and share data through **virtual collaboration sites (idea marketplaces** to enable crowd sourcing)	✓			✓	
4 Implement advanced **demand forecasting and supply planning** across suppliers and using external variables		✓	✓	✓	
5 Implement **lean manufacturing and model production virtually (digital factory)** to create process transparency, develop dashboards, and visualize bottlenecks			✓		
6 Implement **sensor data-driven operations analytics** to improve throughput and enable mass customization			✓		
7 Collect **after-sales data from sensors** and feed back in real time to trigger after-sales services and detect manufacturing or design flaws			✓	✓	✓

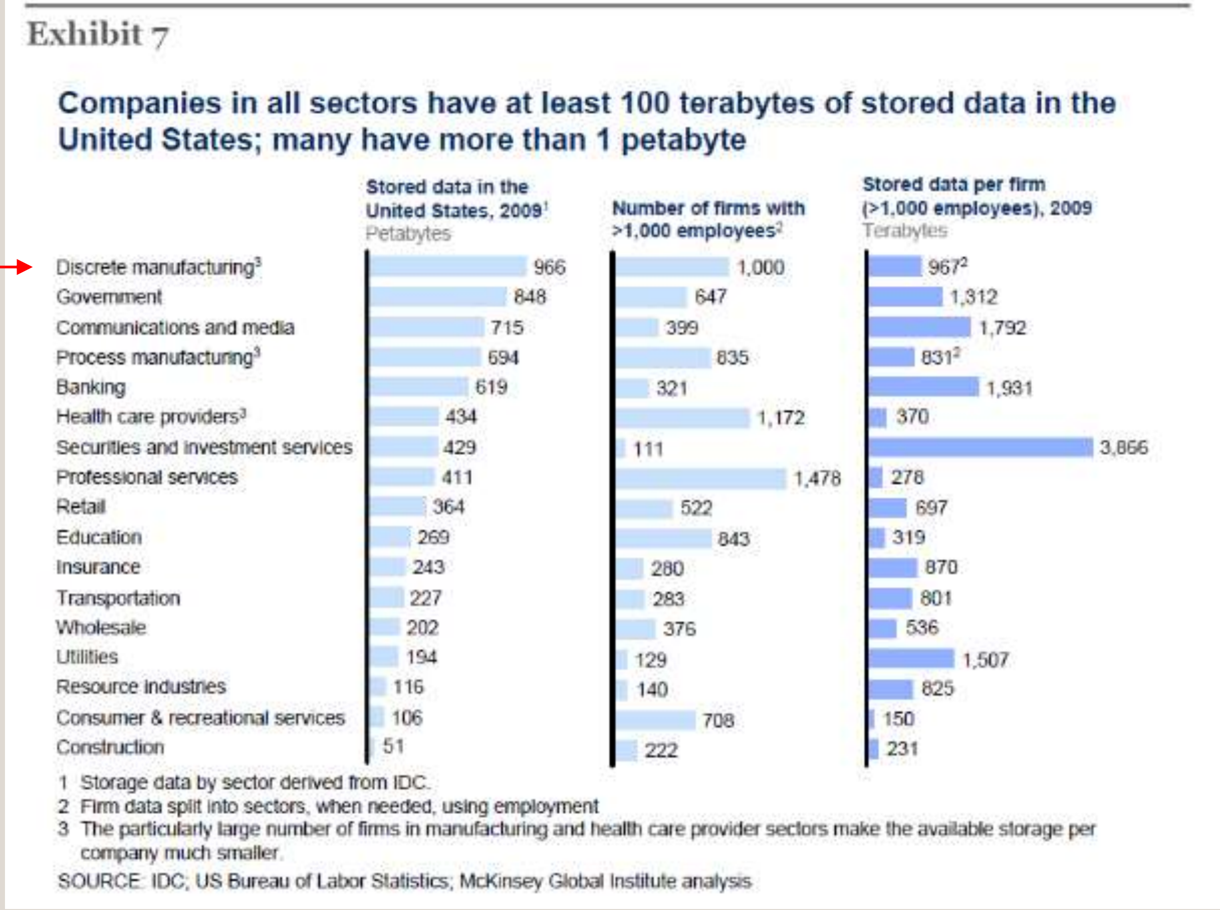
SOURCE: McKinsey Global Institute analysis

The Digital Transformation of Manufacturing

Different formats

Different sources

Different versions



Different purposes

Different frequency

Different recipients

[1] "Big data: The next frontier for innovation, competition, and productivity" J. Manyika et al.

The Digital Transformation of Manufacturing

- Most benefits are clear and obvious
- Most of the technical enablers have been proven
- Most companies (will) make decisions based on the digital information
  - 83% by 2021
- What are the challenges?

The Digital Threat

- CIA triad security model

Confidentiality

Prevent sensitive information from reaching the wrong people.

Integrity

Maintain the consistency, accuracy, and trustworthiness of data over its life cycle.

Availability

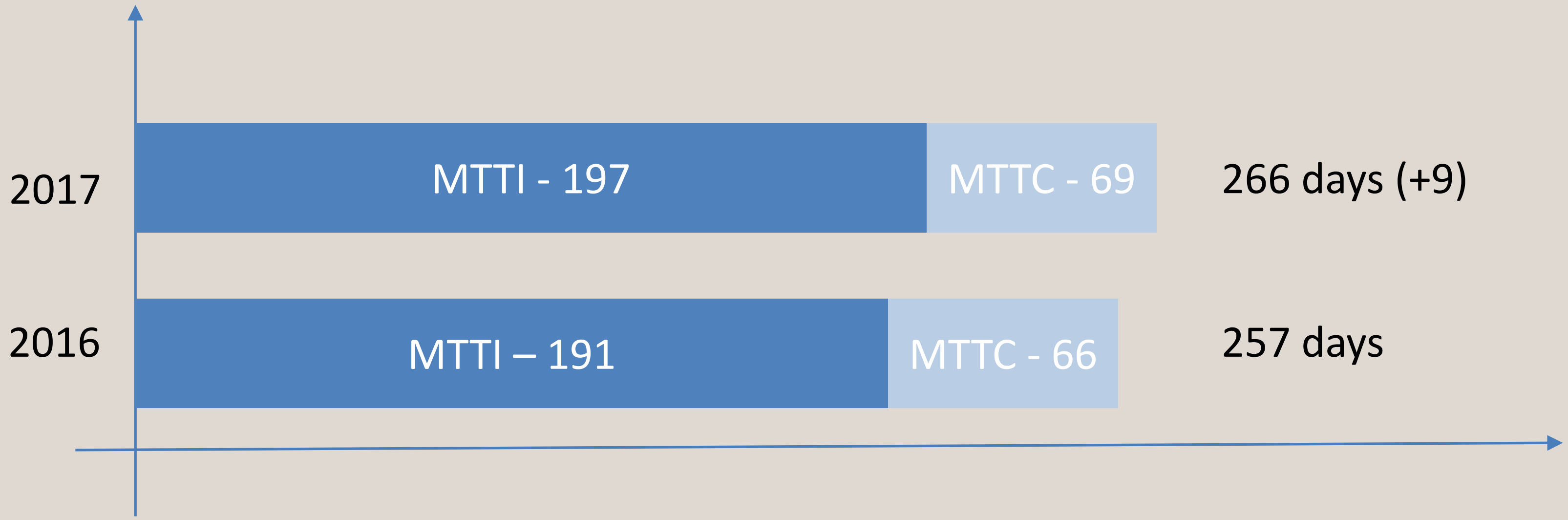
Ensure that the information concerned is readily accessible to the authorized viewer at all times.

The Digital Threat

- Digital tampering can have physical consequences:
  - Structurally weaker parts (failure)
  - Functionally different parts (physical hijack)
- Tampering has different origins
  - Intentional: cyber attacks, from outsiders AND insiders
  - Unintentional: mistakes (manual entry, file not saved properly, simple typos, …)

The Digital Threat

- Cyber attacks often take time to be identified (MTTI) and contained (MTTC)



[1] "2017 Cost of Data Breach Study: Global Overview" by IBM&Ponemon
[2] "2018 Cost of Data Breach Study: Global Overview" by IBM&Ponemon

Reducing the Digital Threat: Digital Trust

- Can we use the data without worrying about its integrity?
- Digital Trust is a key enabler to Smart Manufacturing
- Digital trust enables identifying the threat as soon as possible
  - The data itself is not enough

Reducing the Digital Threat: Digital Trust

- Reliable
  - If the data is altered after embedding information, trust is broken
- Flexible mechanism to embed Trust
  - Everyone has their own flavor
- Support standard formats for digital product data
  - Standards are interoperability enablers that support Smart Manufacturing

Reducing the Digital Threat

Different formats

Different sources

Different versions

Different purposes

Different frequency

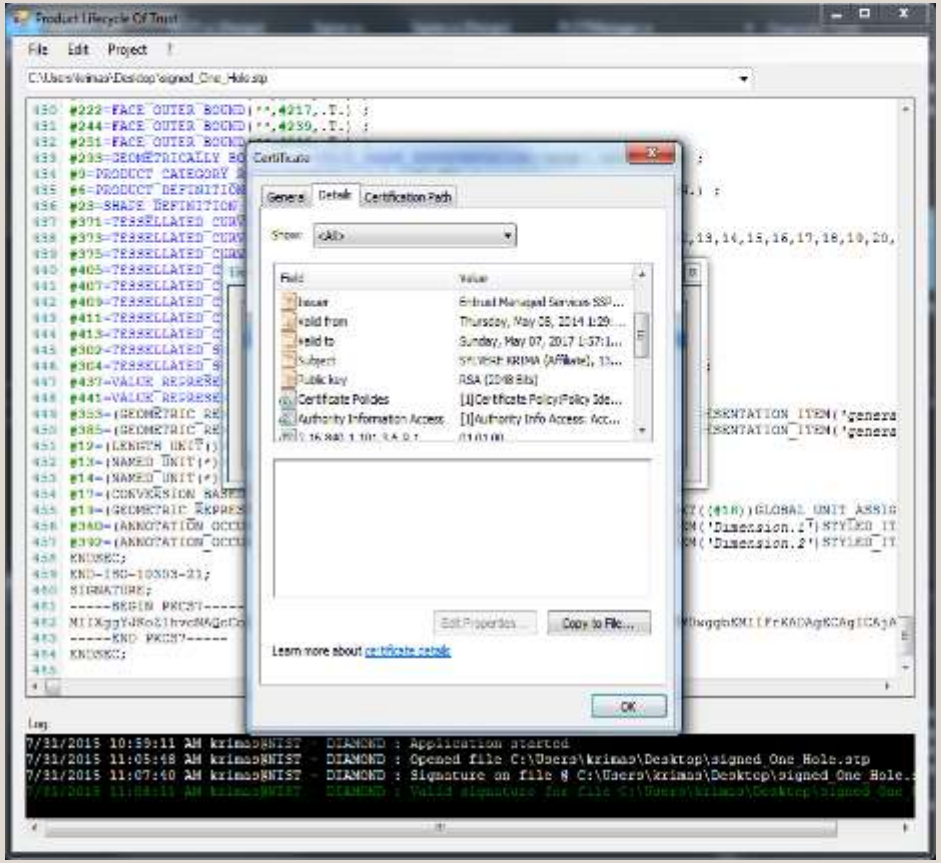
Different recipients

The digital signature acts as a glass container. You can look but can't touch.

Reducing the Digital Threat: Digital Trust

- Toolkit includes a User Interface and API for Reading, Writing, and Verifying digital signatures in models
- Supports G-Code (ISO 6983), QIF 2.0, PDF/PRC, and STEP P21 formats
- Toolkit and source code available at:

  https://github.com/usnistgov/DT4SM



Reducing the Digital Threat: Why Blockchain?

- Digital signatures are **not** supported by all data formats

- Authentication, authorization and traceability information are stored in the product data files and not shared
  - Validation of information can be complex in a large network
  - Auditing is cumbersome: how to retrieve the recipients?

- Making information easily available can reduce this complexity and shorten the MTTI (for all formats) and MTTC (consolidated diffusion data)

Reducing the Digital Threat: Why Blockchain?

- A replicated source of information that cannot be tampered
  - Secure: replication guarantees availability of the information
  - Trustworthy: data cannot be modified
- Data insertion is controlled by business rules randomly performed by peers
  - Lack of single source of authority
  - Customizable to different scenario

Reducing the Digital Threat: Why Blockchain?

- We focus on storing product data fingerprint
  - For IP and performance concerns, the product data is not stored or exposed

- We reuse our previous toolkit to generate that fingerprint
  - Our PoC manages STEP (ISO 10303) files and other common standards

- The fingerprint is the key to storing and retrieving information
  - Key-value pairs are stored in the blockchain

Reducing the Digital Threat: Why Blockchain?

Benefits

Secure data identity (MTTI)	+	Secure transactions (MTTC)
Protect data fingerprints in a tampering-free environment		Protect data transactions between the different actors

Reducing the Digital Threat: Why Blockchain?

- All open-source/free software and APIs
- Ethereum to implement the blockchain network
- Reuse of our Digital Manufacturing Certificate (DMC) toolkit
  - Generate data fingerprint
  - Digitally sign data using software and hardware (PIV/CAC) X.509 certificates
- Development of a client application to record and retrieve data on the blockchain (Node.js)

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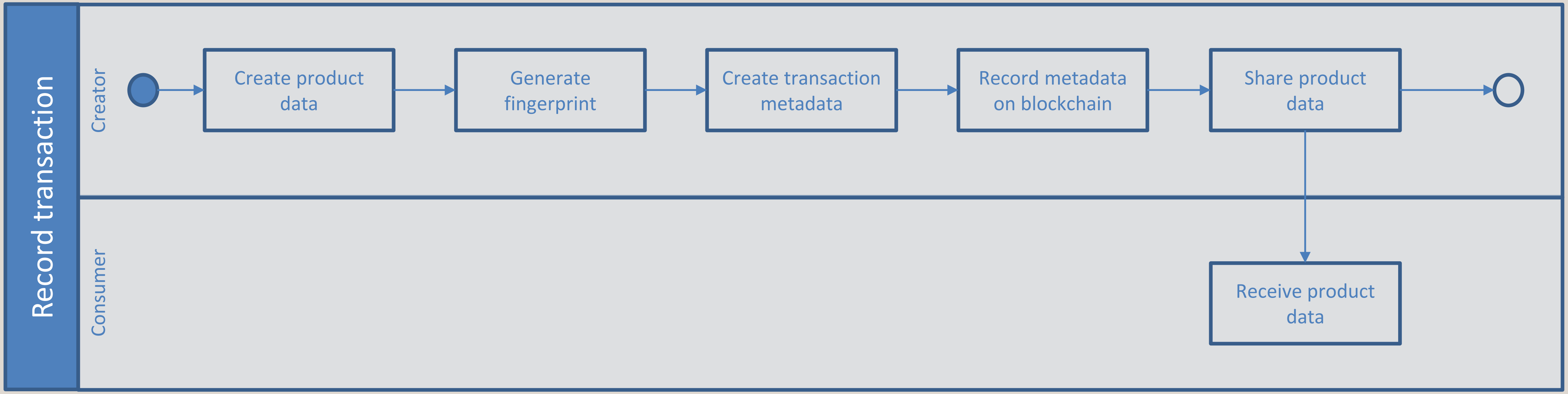
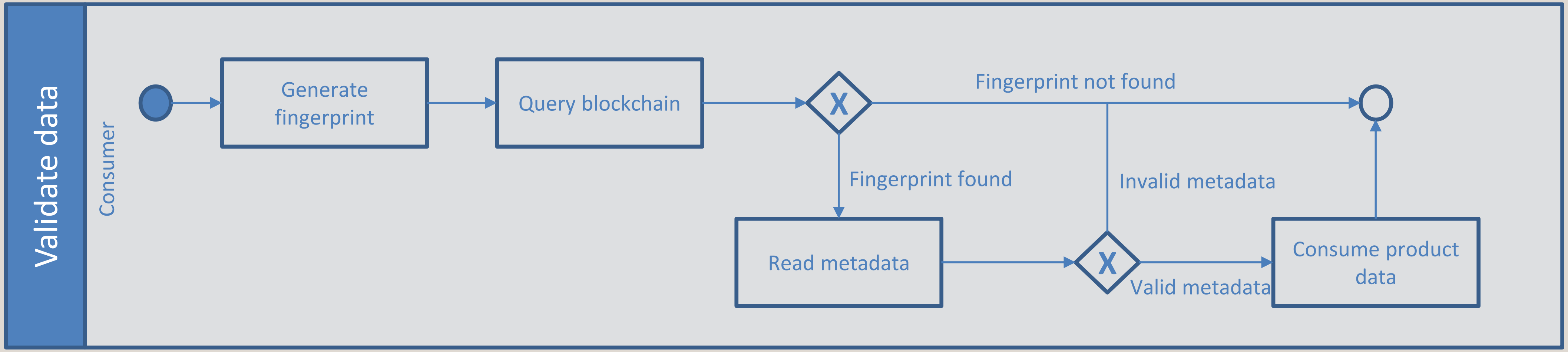
Reducing the Digital Threat: Why Blockchain?



Reducing the Digital Threat: Why Blockchain?



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Blockchain for Industrial Applications

- Blockchain is often believed to be limited to cryptocurrencies/finance
  - Popularity, visibility, good and bad rep
- Transactions/exchanges of physical and digital assets are omnipresent in a lot/most of industries
  - Manufactured goods
  - Food
  - Medications/pills
  - …
- Identify and explore these use cases
  - Can they benefit from using a blockchain-based solution?

Blockchain for Industrial Applications

- Two parallel efforts

NIST

2016
- Use case
- Blockchain?

2017
- Design
- Implementation #1
- Implementation #2

2018
- Implementation #3
- Documentation
- Data management strategies

Today

Blockchain for Industrial Applications

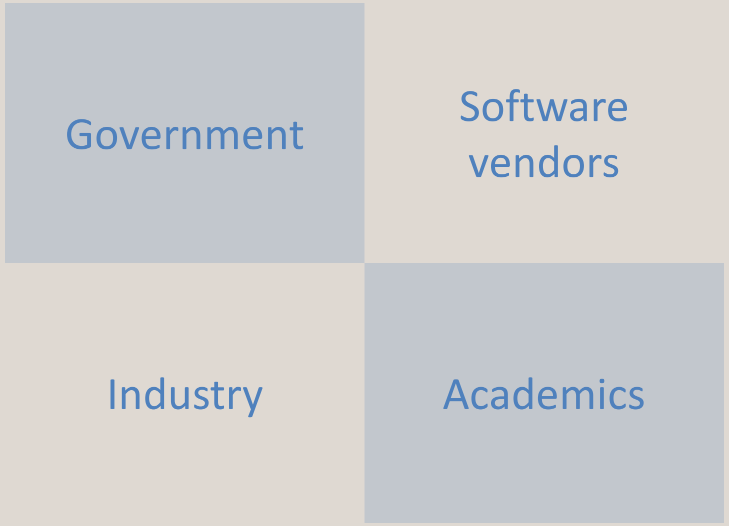
Phase 1
- Call for participants
- Brainstorming
- Documentation

Phase 2
- Planning
- Kickoff

Blockchain for Industrial Applications

- Objectives:
  1. Identify and document industrial use cases
  2. Identify, document and tackle threats and challenges

- Open participation



Conclusion

- Digital transformation = digital threat
- Different ways to provide digital trust (reduce MTTI and MTTC)
- A blockchain can provide digital trust without storing the data itself
- Our method can be applied to any type of information but requires domain-specific metadata
- Blockchain for Industrial Applications Community of Interest

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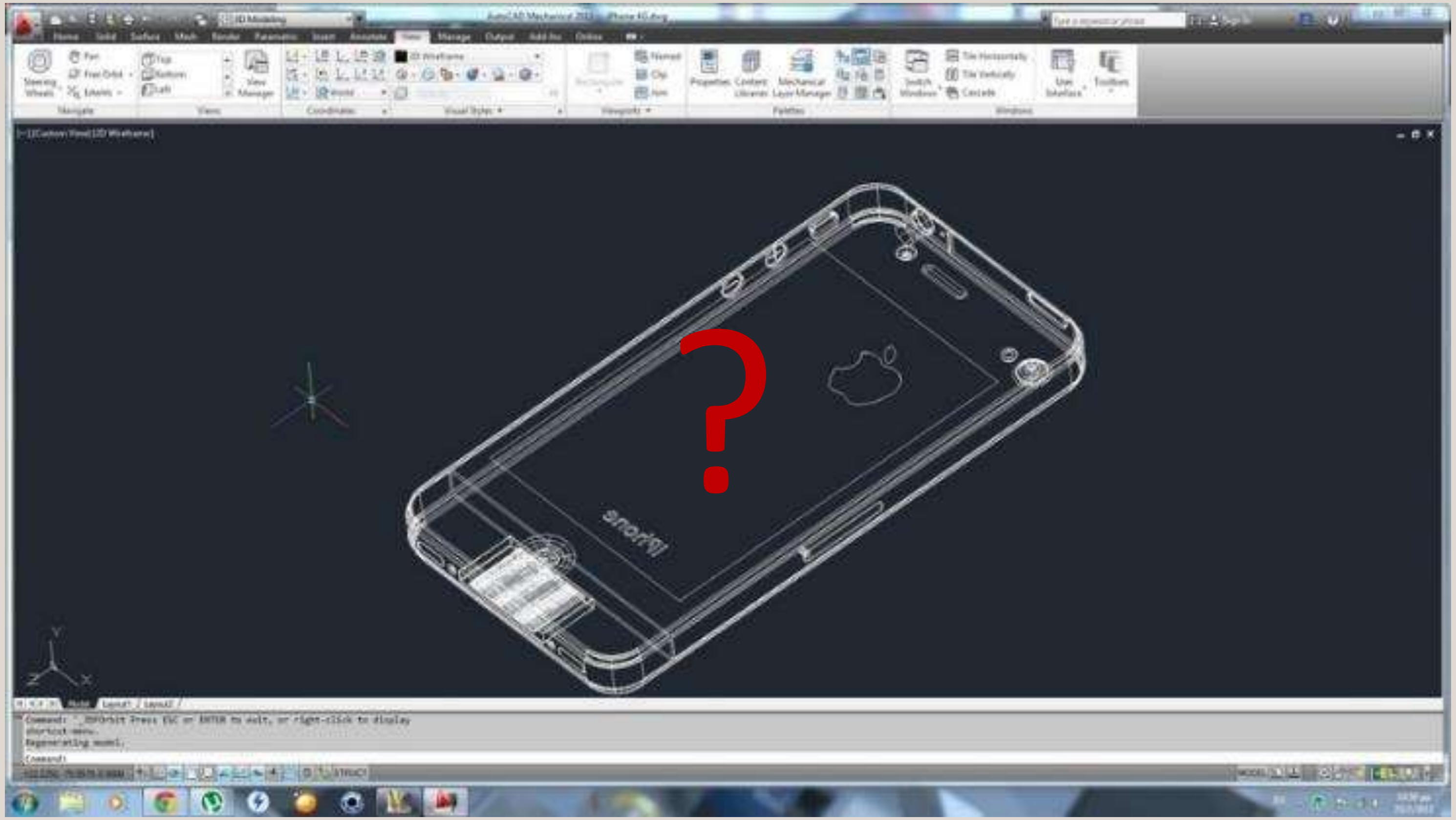
NIST AMS 300-6 "Securing the Digital Threat for Smart Manufacturing: A Reference Model for Blockchain-Based Product Data Traceability"

The Digital Transformation of Manufacturing



What's next?

- The investigation process: