



An Introduction to IoT Use Cases With an Evaluation of Integration Possibilities with Blockchains

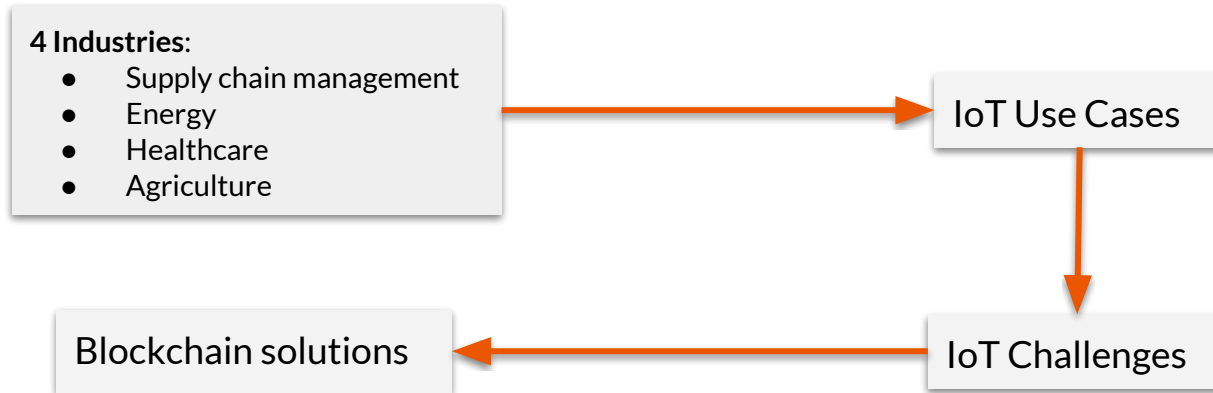
Communication Systems Seminar
Anna Götz & Cyrill Halter



Agenda

- IoT & blockchain basics
- IoT use cases & blockchain integration in four exemplary industries
- Discussion

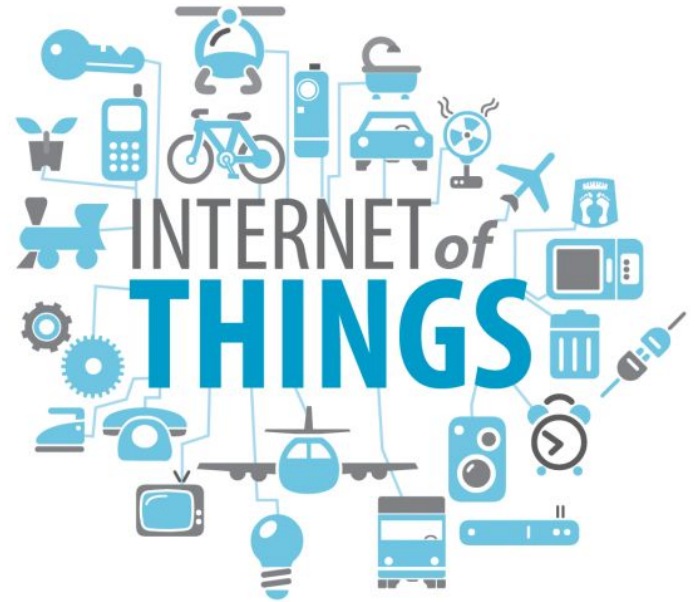
Methodology



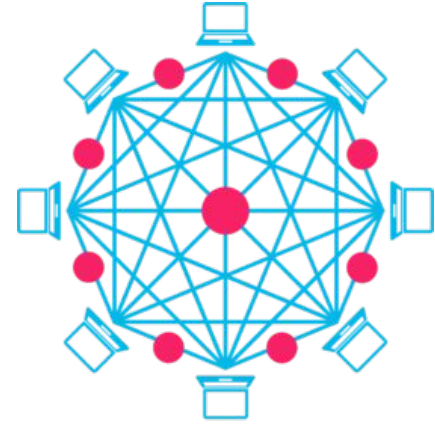
IoT and Blockchain Basics

A global network of machines and devices capable of interacting with each other and the internet

- Almost infinite range of applications
- Predictions of around 20 billion devices by 2020
- Vast amount of new data



Blockchain



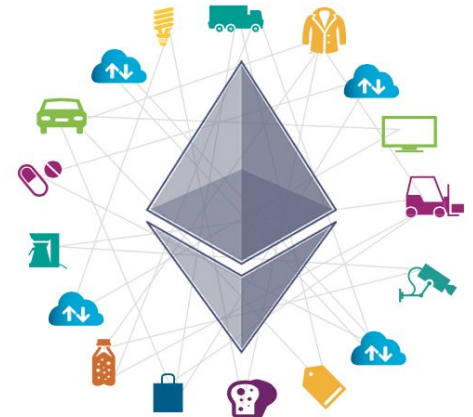
- Blocks build on top of each other
- Immutable
- Tamper-proof
- No need for intermediaries



Decentralized trust!

The Blockchain's Real Potential with IoT

- Secure records (of sensor-collected data)
- Trust in devices (unaltered devices)
- Increased autonomy (also in critical situations through smart contracts)
- Eliminated single point of failure (centralized cloud is vulnerable, malware Mirai)



IoT Use Cases and Blockchain
Integration in

Supply Chain Management



The Supply Chain Management (SCM) Industry

Supply Chain Management

"..the [...] coordination of the traditional business functions [...] within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." - Mentzer et al.

IoT Use Cases in the SCM Industry

- **Fabrication:** Optimization of manufacturing processes through real-time monitoring of production facilities
- **Transportation:** Transparency, controllability and predictability through monitoring of objects in transit
- **Storage:** Efficiency, increased capacity and controllability of the warehouse through smart sensors and robotic assistants





IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>
Trust	Trust in correctness and integrity of shared information necessary
Reconciliation	No true end-to-end integration due to lacking standards
Effectiveness of the lowest common denominator	Effectiveness of information flow limited by weakest or most "wicked" link



IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>	<i>Blockchain Solution</i>
Trust	Trust in correctness and integrity of shared information necessary	IoT data stored in the blockchain is tamper-proof. No trust is necessary
Reconciliation	No true end-to-end integration due to lacking standards	Blockchain can serve as the standardized data backend.
Effectiveness of the lowest common denominator	Effectiveness of information flow limited by weakest or most "wicked" link	Centralized data backend eliminated as a single point of failure



Industry Example: Modum

- Zurich based company
- Pharmaceutical supply chain monitoring
- Leverage IoT and Blockchain technology
- Developed in collaboration with CSG



Industry Example: Modum



GDP: Goods Distribution Practice

IoT Use Cases and Blockchain Integration in **Energy**

The Energy Industry

... concerns itself with producing and supplying energy.

Energy sources:

- Fossil resources (oil, gas, coal)
- Nuclear fission
- Renewables (wind, sun, water, etc.)

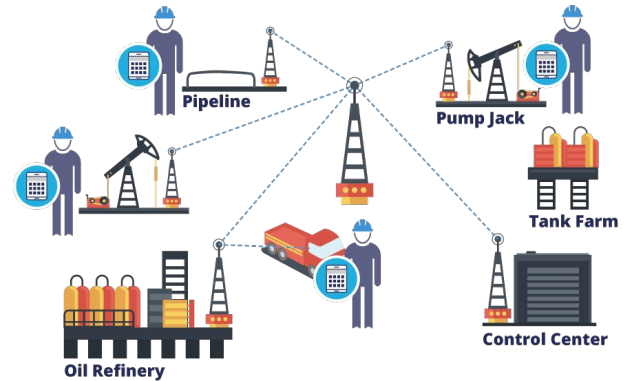


IoT Use Cases in the Energy Industry

- Remote Monitoring and Control
- Detection of Disturbances
- Smart pricing (based on supply & demand)
- Environment-Informed Behavior



Connected “things” in a smart home context



Remote locations in the oil industry connected with IoT technology

Industry Example: iEN

- Intelligent Environment Network Service (Chunghwa Telecom + Intel)
- Street lighting
 - Simplified maintenance
 - Then: Staff patrol or citizen reporting
 - Now: Automated monitoring of energy consumption and data output
 - Energy-efficient usage
 - Connected to Central Weather Bureau to determine on/off times
 - Informed by illumination sensor to adjust brightness





IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>
Single Point of Failure	Smart grid = central, internet-based system
Mismatch of Energy Production and Consumption	Energy storage is costly and inflexible
Lack of Consumer Choice	Where does my energy come from? Do I have a choice?



IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>	<i>Blockchain Solution</i>
Single Point of Failure	Smart grid = central, internet-based system	Decentralization, local energy production, peer-to-peer trading
Mismatch of Energy Production and Consumption	Energy storage is costly and inflexible	Peer-to-peer energy trading, smart contracts
Lack of Consumer Choice	Where does my energy come from? Do I have a choice?	IoT data stored in a secure blockchain, decentralized energy production



Industry Example: Exergy by LO3 Energy

- Based in New York
- Distributed ledger system
- Token system for distributed energy
- Supports communities who locally produce energy (solar panels etc.)
- Trade energy in a fast and secure way
- Buy and sell energy through a smartphone app

The Exergy logo consists of the word "EXERGY" in a red, sans-serif, uppercase font, centered on a dark navy blue rectangular background.The LO3 Energy logo features a green icon of three stacked squares to the left of the text "LO3 ENERGY" in a white, sans-serif, uppercase font, all on a dark navy blue rectangular background.

IoT Use Cases and Blockchain Integration in **Healthcare**



The Healthcare Industry

Healthcare

...a summarizing expression that refers to all products and services related to health and medical care.

Includes:

- Pharmaceuticals
- Medical Equipment
- Managed Healthcare
- Healthcare Facilities
- ...

IoT Use Cases in the Healthcare Industry

- **Personal Health Monitoring:** Telemedicine, detection of emergencies, preventive diagnostics through wearables
- **Disability Support:** Better quality of life through smart devices
- **Emergency Assistance:** Rapid response through IoT support
- ...





IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>
Security	Vulnerabilities may have fatal consequences. Security is crucial
Loss of Privacy	Very personal data. Protection may be mandated by law
Trust	Information must be trustworthy. May be used for life and death decisions



IoT Challenges and Blockchain Solutions

	<i>IoT Challenge</i>	<i>Blockchain Solution</i>
Security	Vulnerabilities may have fatal consequences. Security is crucial	Blockchains may be used for configuration management and access control
Loss of Privacy	Very personal data. Protection may be mandated by law	No solution
Trust	Information must be trustworthy. May be used for life and death decisions	IoT data stored in the blockchain is tamper-proof. No trust is necessary



Industry Example: IRYO

- Zero-knowledge health record storage platform
- Uses EOS blockchain
- Able to issue permission for IoT devices to write data

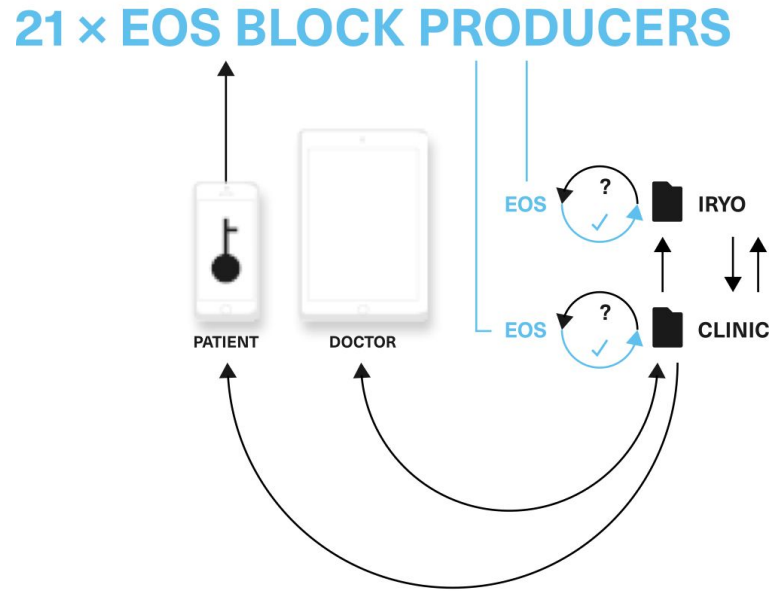


Industry Example: IRYO

Data stored in patient's mobile device, clinic and IRYO DB

EOS Blockchain Usage:

- Permission management
- Storage of timestamped data hashes



IoT Use Cases and Blockchain Integration in **Agriculture**

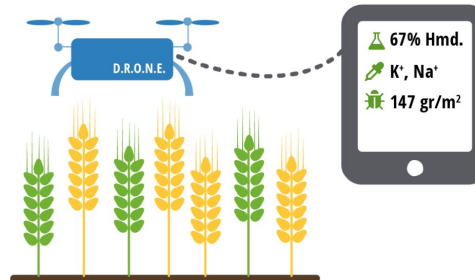
IoT Use Cases in the Agriculture Industry

Intelligent Monitoring:

- Temperature, humidity & illumination monitoring
- Pest detection
- Animal monitoring

Automated Control:

- Substance distribution
- Pest elimination
- Environment manipulation



Industry Example: FarmBot Genesis XL





IoT Challenges and Blockchain Solutions

	<i>(IoT) Challenge</i>
Food Waste	Lack of proper storage, wasteful behavior
Trust in Certification Compliance	Trust in fulfillment of the criteria for bio, organic, local, vegan, halal
Privacy Concerns	Cameras on drones → restrictive regulations on commercial UAVs



IoT Challenges and Blockchain Solutions

	<i>(IoT) Challenge</i>	<i>Blockchain Solution</i>
Food Waste	Lack of proper storage, wasteful behavior	Partly: Sell directly to consumer via decentralized marketplace
Trust in Certification Compliance	Trust in fulfillment of the criteria for bio, organic, local, vegan, halal	IoT data stored in the blockchain is tamper-proof. No trust is necessary
Privacy Concerns	Cameras on drones → restrictive regulations on commercial UAVs	No solution

Industry Example: AgriChain

- Based in New Zealand
- Mission: Increase availability of quality food for everyone
- Approach:
 - Historic data of produce gathered in smart farms (from farm to table - supply chain)
 - Decentralized produce marketplace incl. smart contracts (reduced transaction fees, resolution of trust deficiencies, faster coordination compared to a traditional marketplace)





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Discussion

Question 1:

Which of the industries mentioned here can benefit most from the IoT?

Question 2:

What do you think are the most pressing issues with the IoT?

Question 3:

In which of the presented sectors do you find blockchain technology most useful and why? Do you see any obstacles in any of the sectors?

Question 4:

What do you think about the industry solutions presented here? Do they leverage blockchain technology in a sensible way?

Question 5:

Would you be comfortable having your IoT health data stored in a blockchain?

Question 6:

Can blockchain be used as a solution for the problem of lacking standards in the IoT? How and where?

Question 7:

What do you think about decentralized energy trading facilitated by blockchain technology? Would you use it?



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