Internet
of Things
World

How to Secure IoT with Blockchain

industrial internet®
CONSORTIUM

IoTeX

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Head of Cryptography
IoTeX

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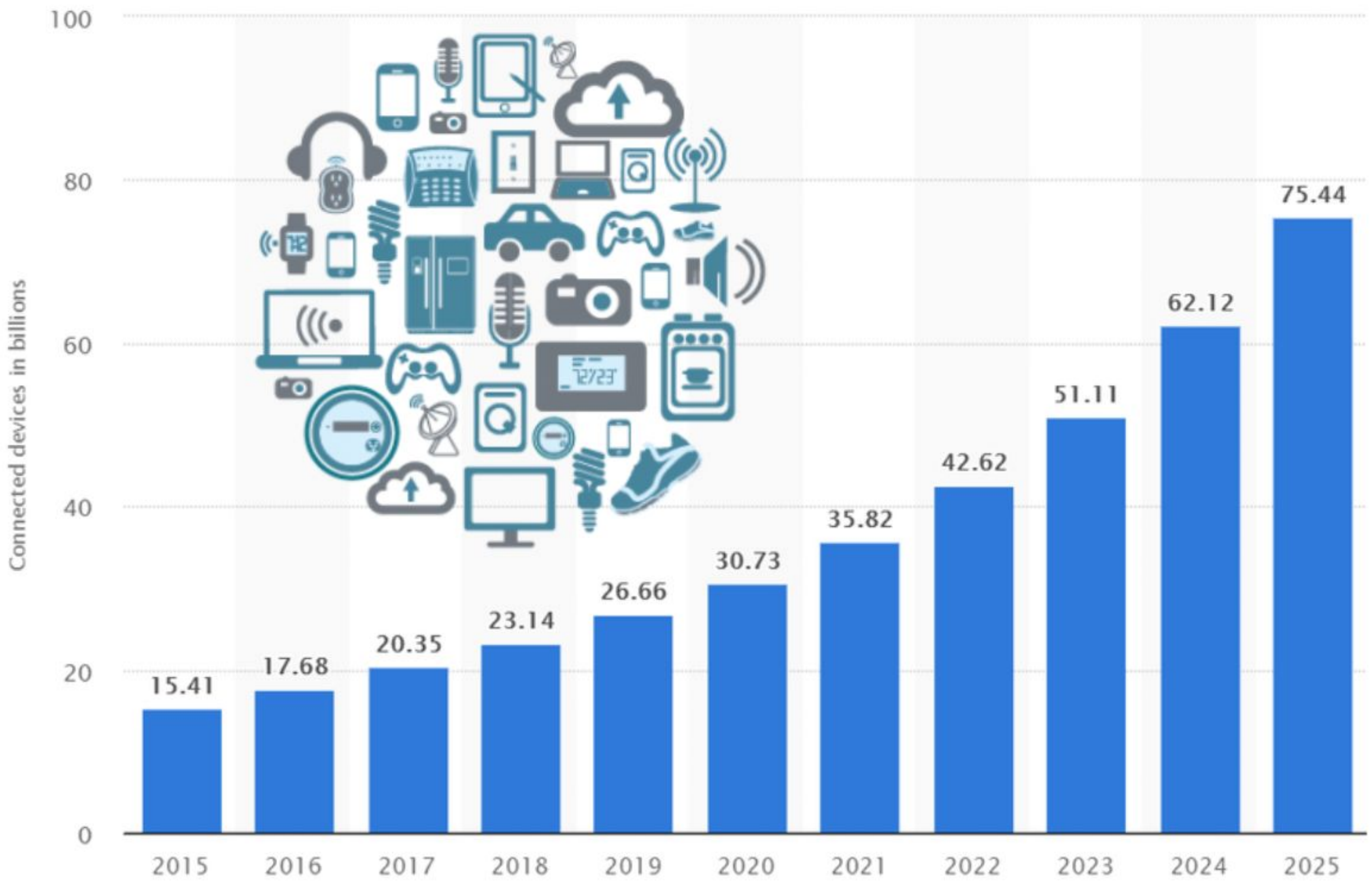
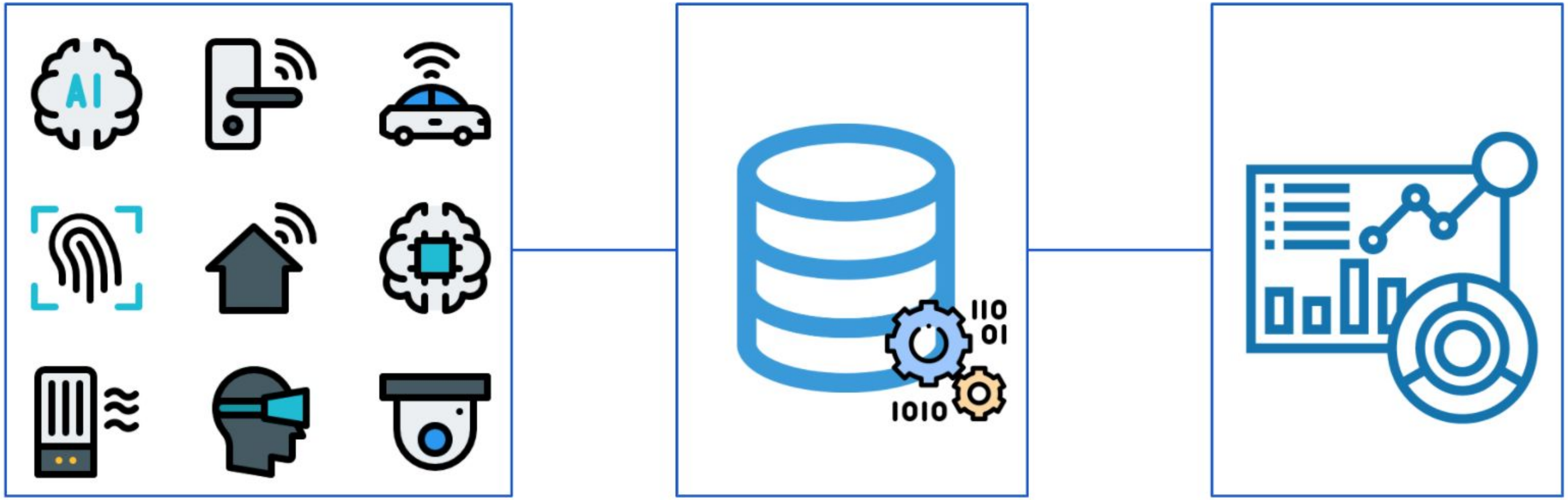
Size of the IoT Market Worldwide



Deployed IoT devices projected to be 75.44 billion by 2025

statista

Data-Driven IoT System



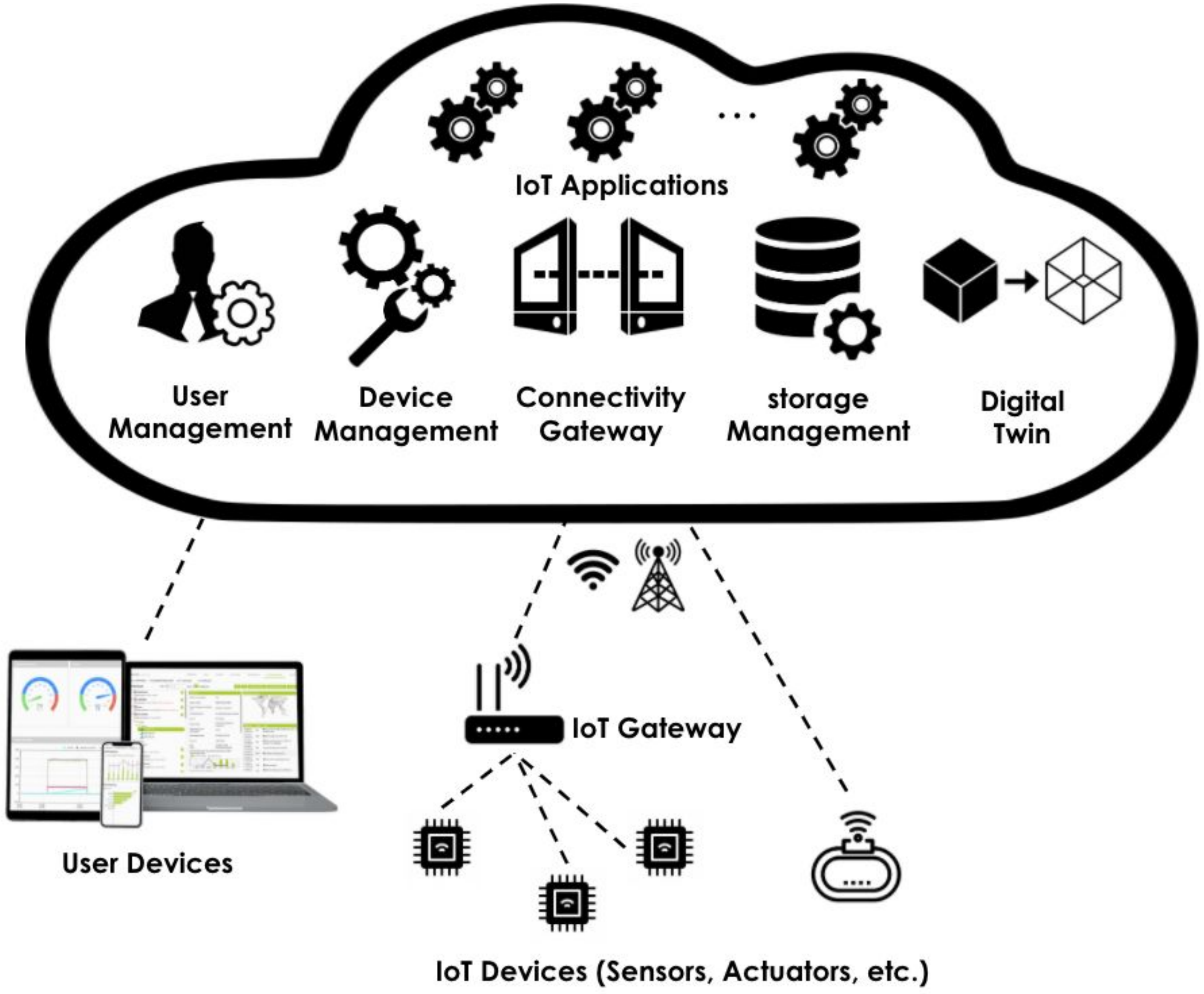
Data Collection & Transmission

Data Ingestion, Storage & Processing

Data Visualization & Analytics

IoT is all about making business decisions based on data collected by smart devices!

Cloud-Centric IoT System Architecture



IoT Security Challenges

Device Security

- Secure Hardware
- Secure OS

Communication Security

- Secure Link

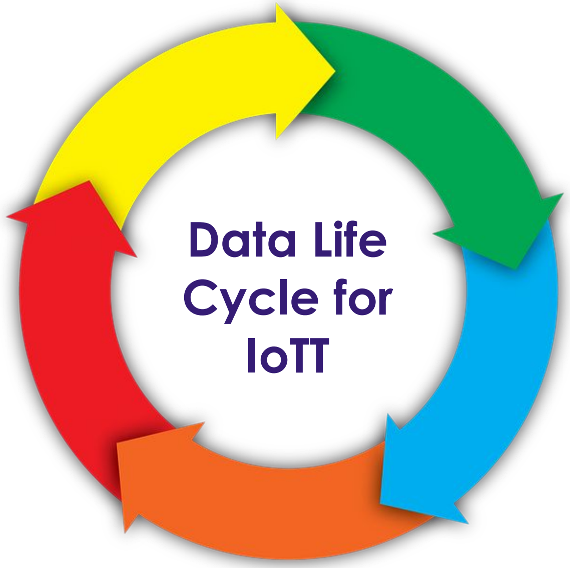
Cloud Security

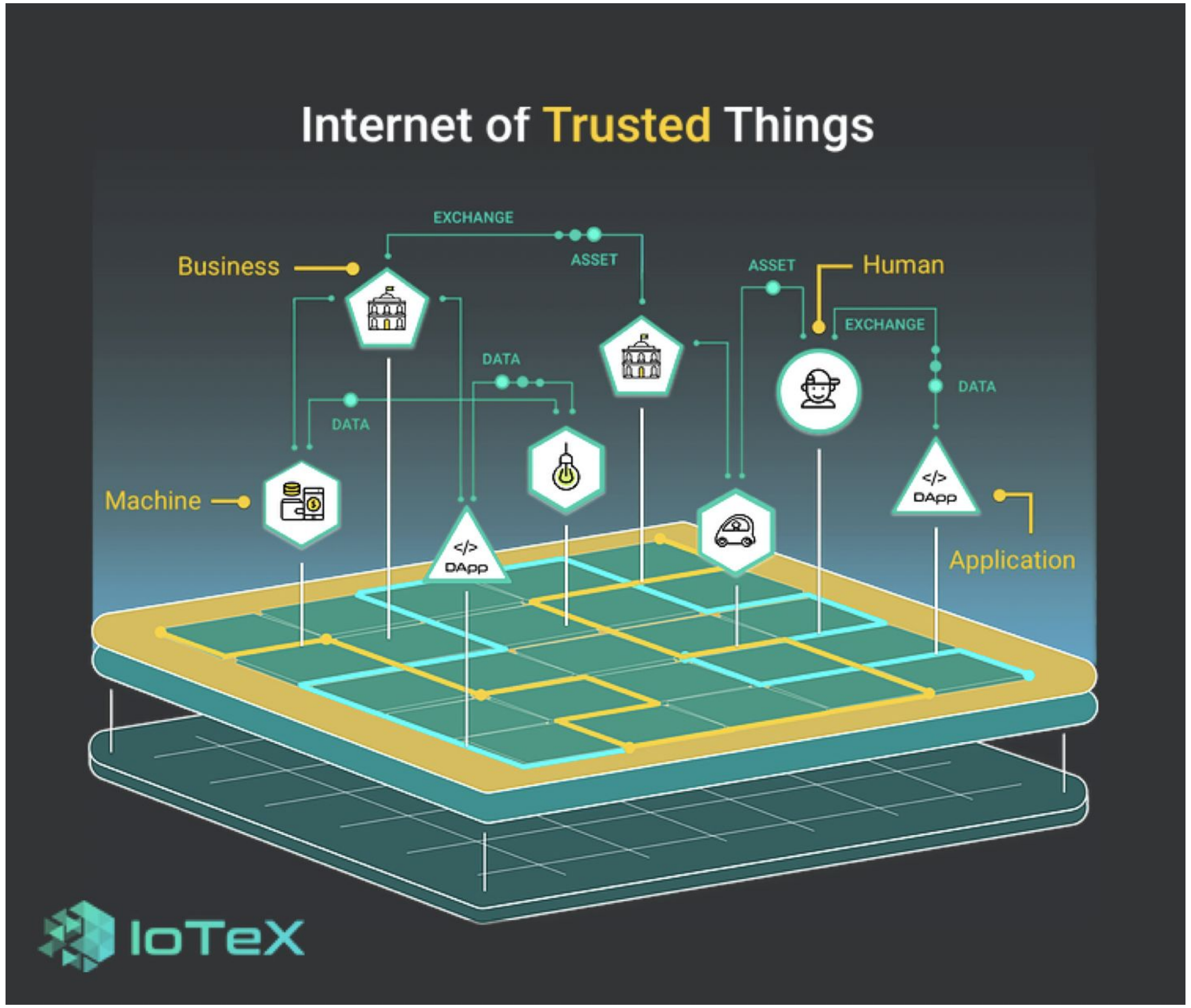
- Identity & Access Management
- Data Encryption
- Device Authentication
- Data Authorization
- DDoS Resilience
- Device Management

Data Trustworthiness in IoT Systems

Internet of Trusted Things (IoTT)

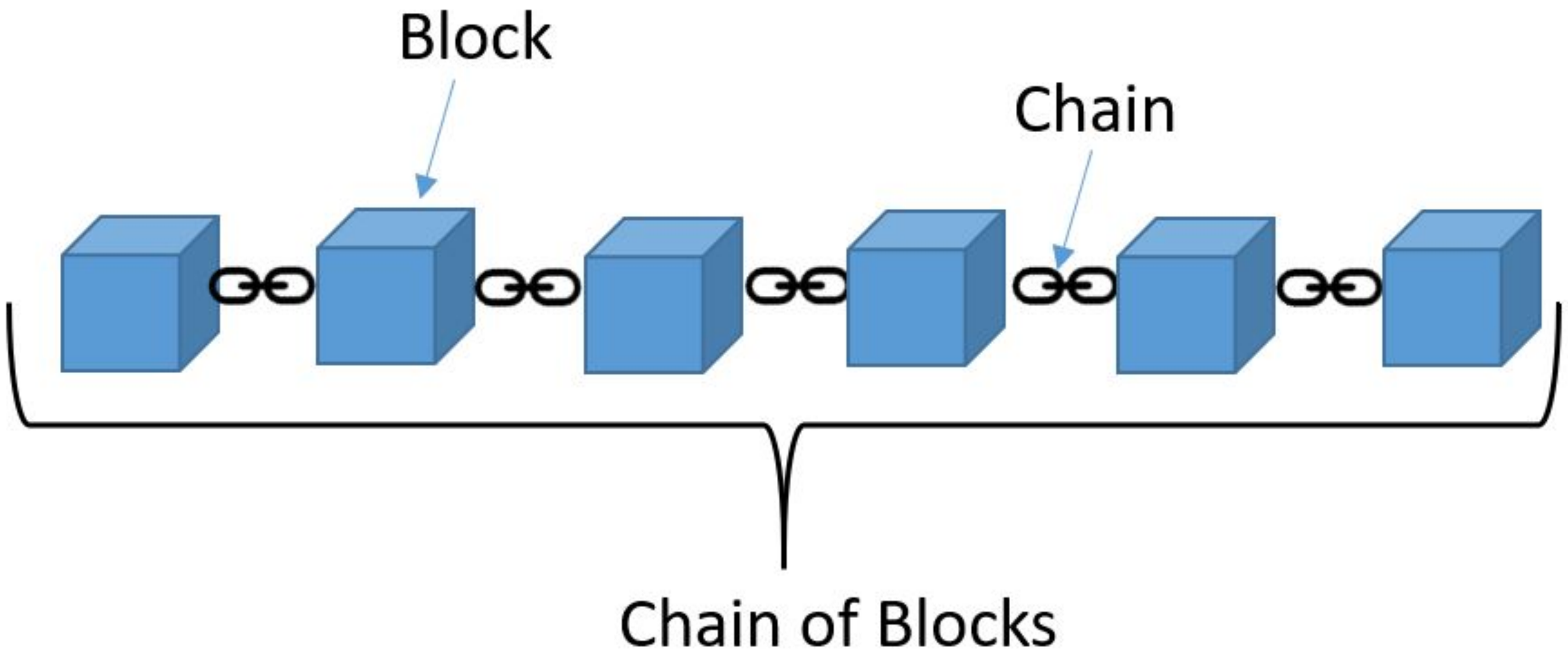
- Data collection
- Data in transit
- Data at rest
- Data processing
- Data retention





Blockchain in a Nutshell

Blockchains are tamper evident and tamper resistant digital ledgers implemented in a distributed fashion (i.e., without a central repository) and usually without a central authority (i.e., a bank, company or government).

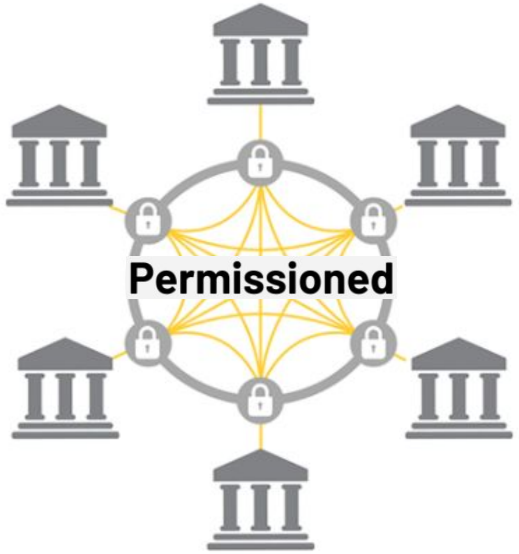


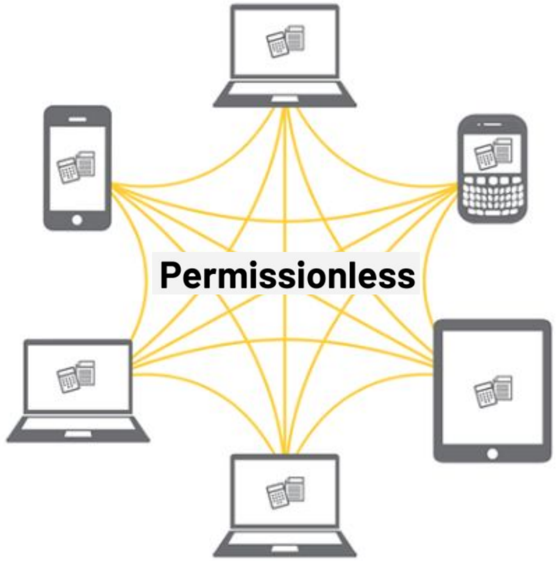
NIST
National Institute of Standards and Technology

Permissionless vs. Permissioned Blockchains

Permissionless blockchain

- Anyone can join the network
- Anyone can read the ledger data and validate transactions
- Ledgers replicate the high degree of trust





Permissioned blockchain

- Formed by a set of known transacting parties
- Validation is controlled by a selected set of nodes
- Ledgers replicate the high degree of transparency and accountability

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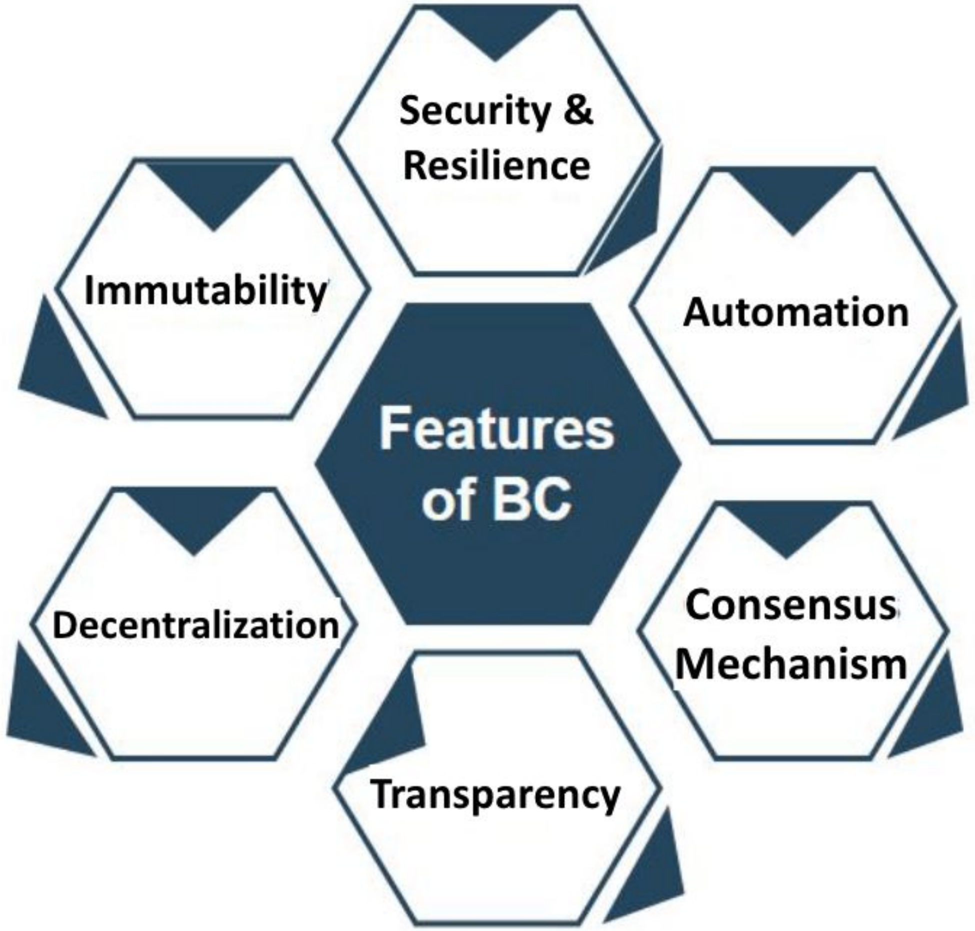
Salient Properties of Blockchains

- **Decentralization**: Remove the ‘single-point-of-failure’ embodied in a trusted central authority
- **Immutability**: Use cryptographic hashes
- **Transparency**: Provide a fully auditable and valid ledger of transactions
- **Security and Resilience**: Use public-key cryptography and digital signatures to prove ownership of data and allows the ownership to be transferred
- **Automation**: Streamline complex business processes that involve multiple intermediaries using smart contracts



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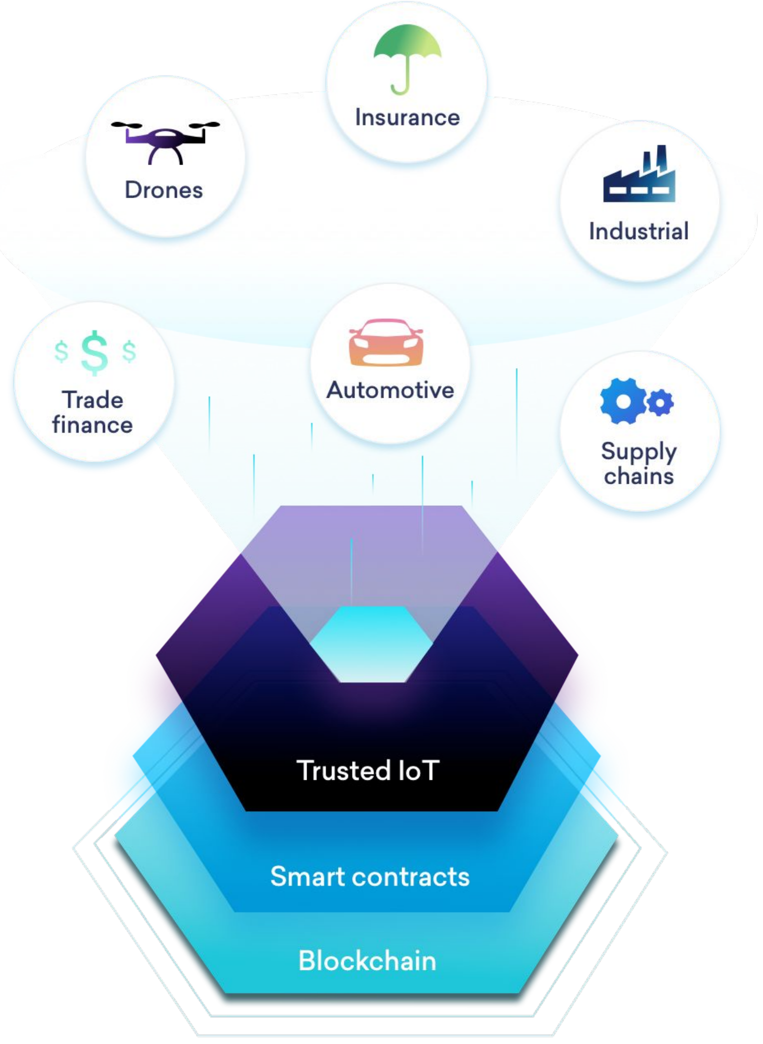
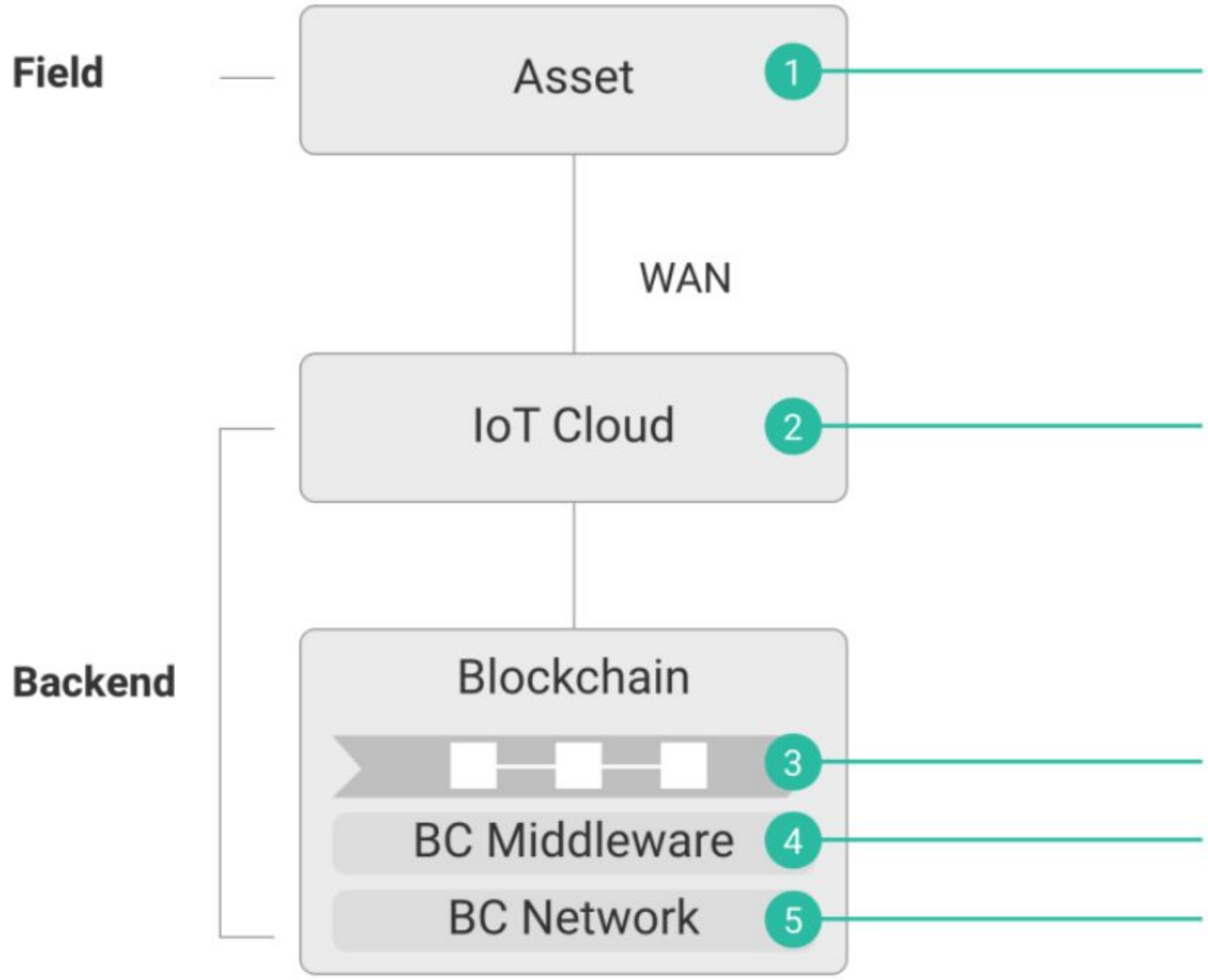
Security Implications for IoT Applications

- Remove single point of failure (decentralization)
- Ensure data integrity (immutability)
- Track status of connected devices (Transparency)
- Authenticate users and devices (Security & Resilience)
- Build trust among IoT processes (Smart Contract)



Blockchain & IoT Reference Architecture



Asset Layer

- Examples: Truck, Train, Machine
- Includes local and remote communication and processing (on asset, fog)

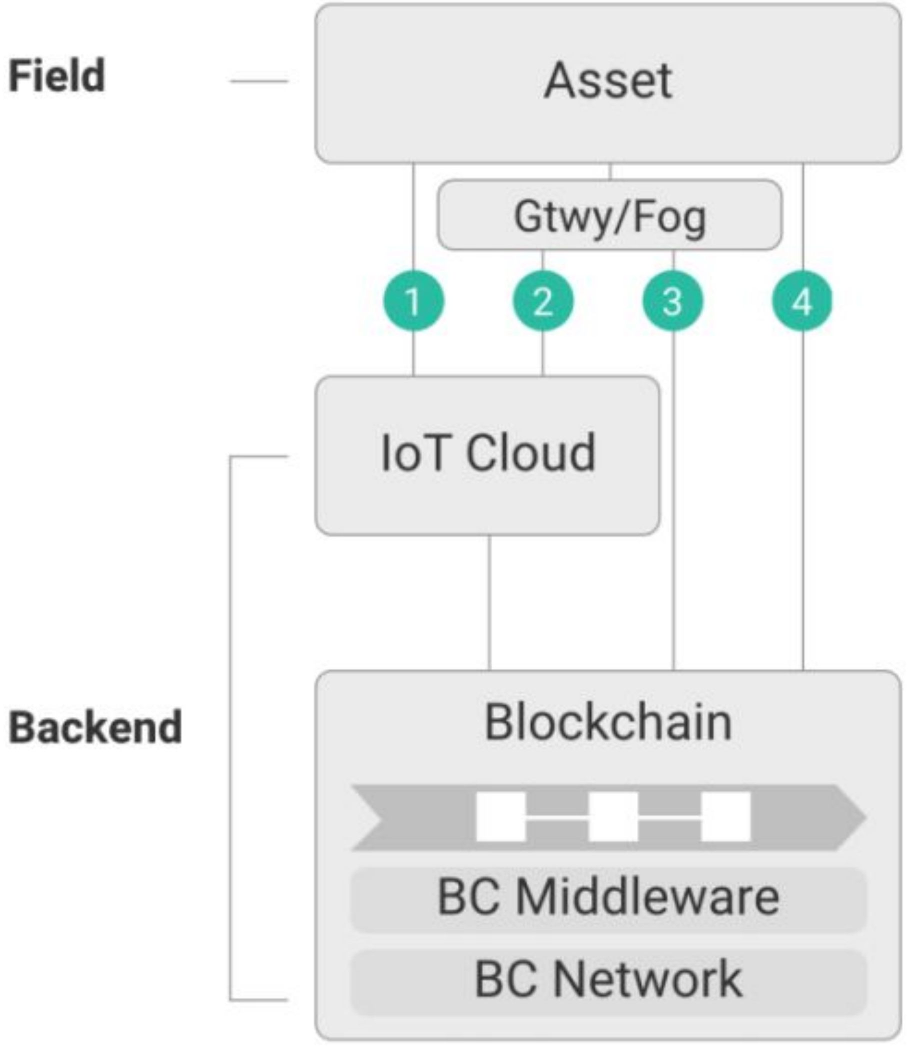
IoT Cloud Layer

- Asset connectivity & FOTA
- Asset-related data and event management
- Enterprise Application Integration

Blockchain Layer

- Asset-related ledger entries
- Peer-to-Peer Middleware for management of BCs
- Network of compute nodes for BC

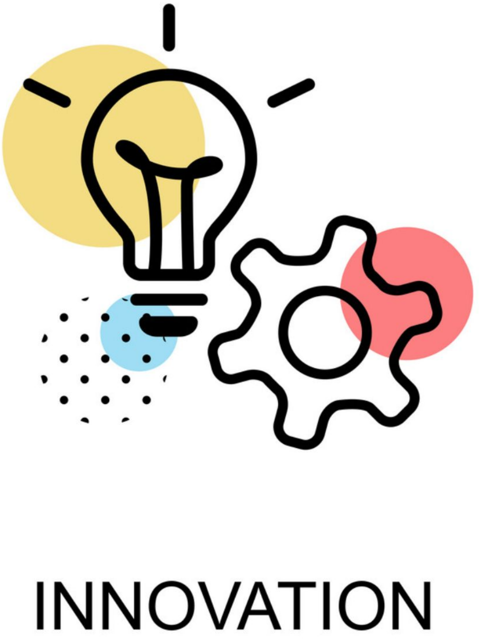
Four Blockchain & IoT Integration Patterns



1. **Asset → IoT Cloud → Blockchain**
2. **Asset → Gateway/Fog → IoT Cloud → Blockchain**
3. **Asset → Gateway/Fog → Blockchain**
4. **Asset → Blockchain**

https://hub.iiconsortium.org/portal/IndividualContribution/5db03a83f7679b000f0e762f

Case Study - When Home IP Camera Meets Blockchain



Can we enhance the security of home IP camera systems using blockchain?

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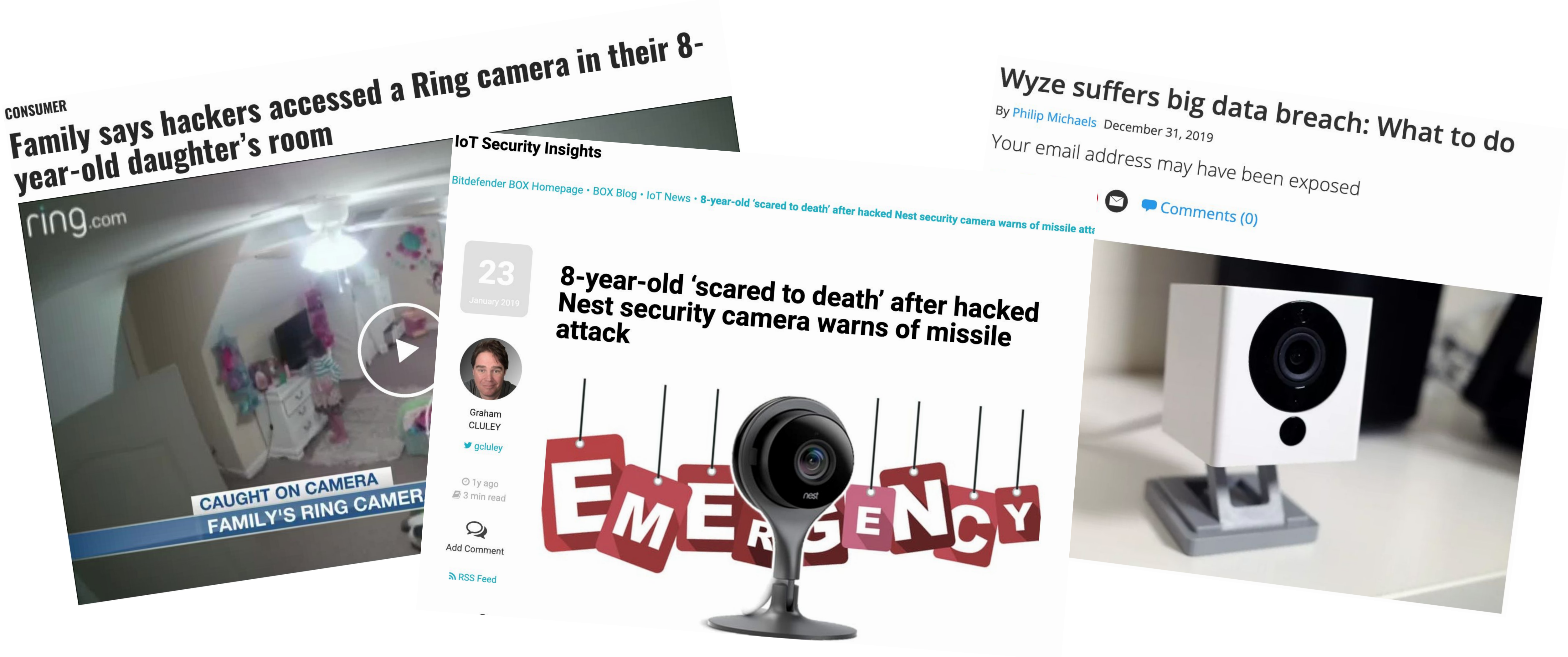
Security of Home IP Cameras



CONSUMER

Family says hackers accessed a Ring camera in their 8-year-old daughter's room

IoT Security Insights

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8-year-old 'scared to death' after hacked Nest security camera warns of missile attack

Wyze suffers big data breach: What to do

By Philip Michaels December 31, 2019

Your email address may have been exposed

Comments (0)

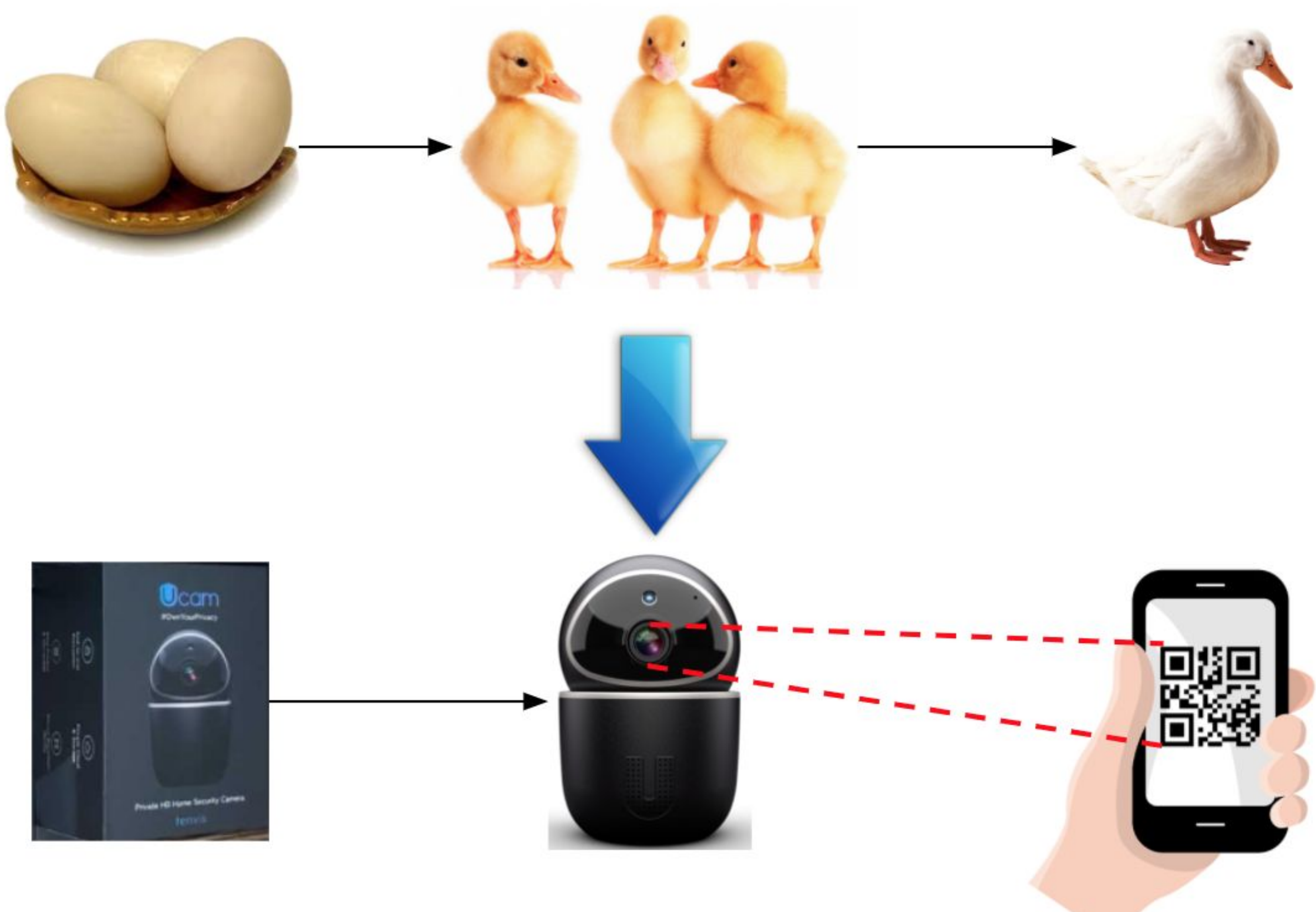
Major Security Concerns

- Username/password-based logins
  - Poor/leaked password w/o MFA
  - Buggy IAM systems
- Database breaches
  - Password leakage
  - Ownership compromise
- Insecure device binding
  - Ownership compromise
- Data integrity of local/cloud storage
  - Insert, delete, modify video clips

Passwordless User Authentication

- A blockchain wallet is generated on the mobile app
- The blockchain address is passed to the IoT cloud for user account registration
- Each user account contain a blockchain address and a random challenge
- The mobile app signs the random challenge to complete login after the user’s confirmation
- A JWT is issued to the user to access cloud storage or other cloud services
- The random challenge is updated after each login attempt

Blockchain-Based Ownership Management

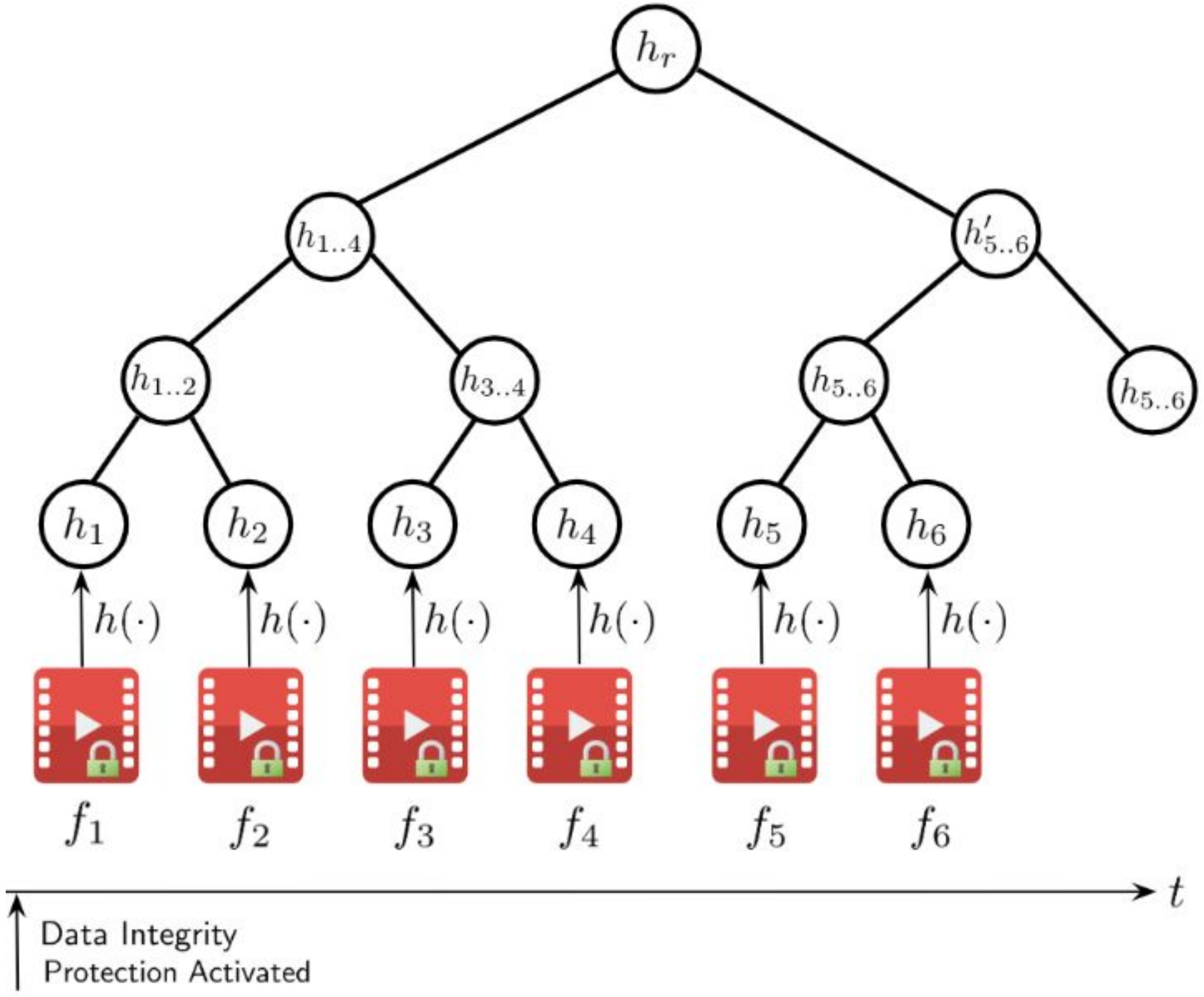


Resurrecting Duckling Security Model

- Device binding is conducted using the resurrecting duckling security model
- The camera associates its blockchain address with its owner’s one and invokes the ownership management smart contract on the blockchain
- Each device reset will restart the device binding process
- The blockchain serves as the ground truth regarding device ownership

Blockchain-Based Data Integrity Protection

- The user enables the data integrity feature on the mobile app and specify the time period in days for checkpoint commitments.
- The camera builds a Merkle tree dynamically for video clips received during the user-specified time period
- The camera invokes the checkpoint management smart contract for integrity checkpoint commitments.
- The user is able to verify data integrity of video clips retrieved from the SD card or cloud storage with the Merkle root.



Design Methodology Highlight

- Username/password based login is replaced by passwordless login using blockchain wallet
- Device ownership is managed by a smart contract in blockchain
- Data integrity of local/cloud storage is ensured by retrieving the Merkle root from blockchain

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CES Innovation Award for Cybersecurity & Personal Privacy

tenvis

Built in partnership with leading security camera manufacturer

Ucam

Powered by IoTeX

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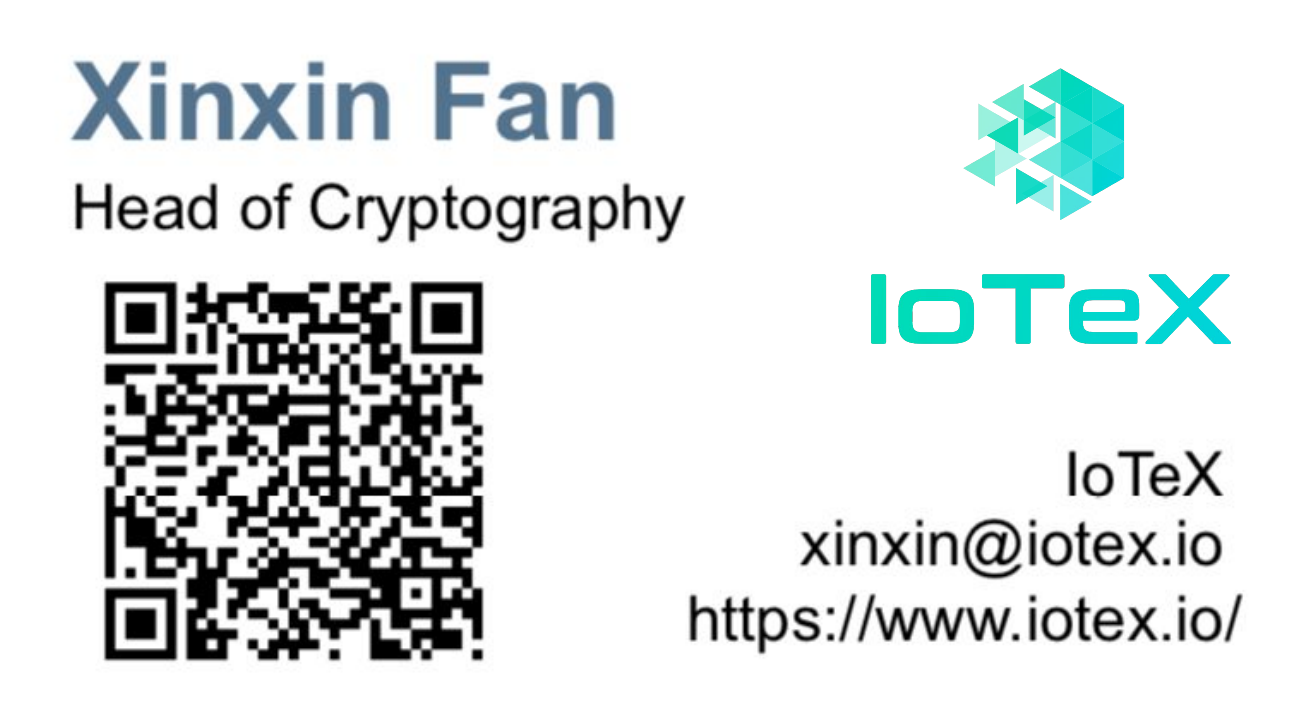

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