

# Blockchain Meets IoT – A Research Perspective

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IoTeX  
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Blockchain Salon @ Technical University of Munich

# Agenda

- ✓ Overview of Machine Economy
- ✓ Blockchain Meets IoT – Research Challenges
- ✓ Blockchain Meets IoT – Research Tools

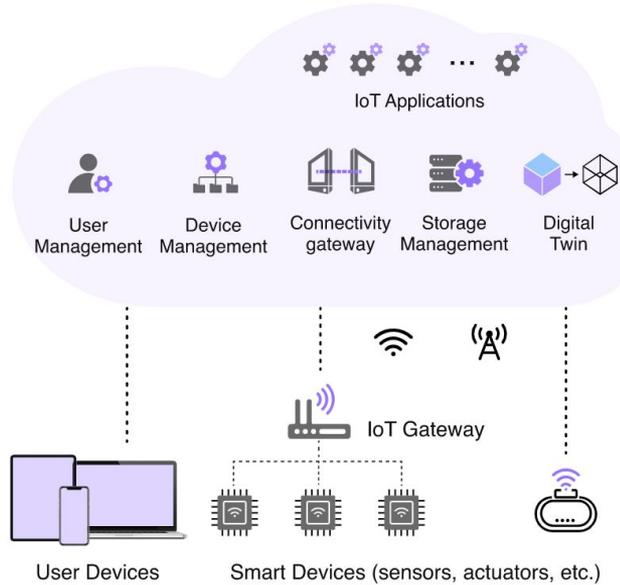




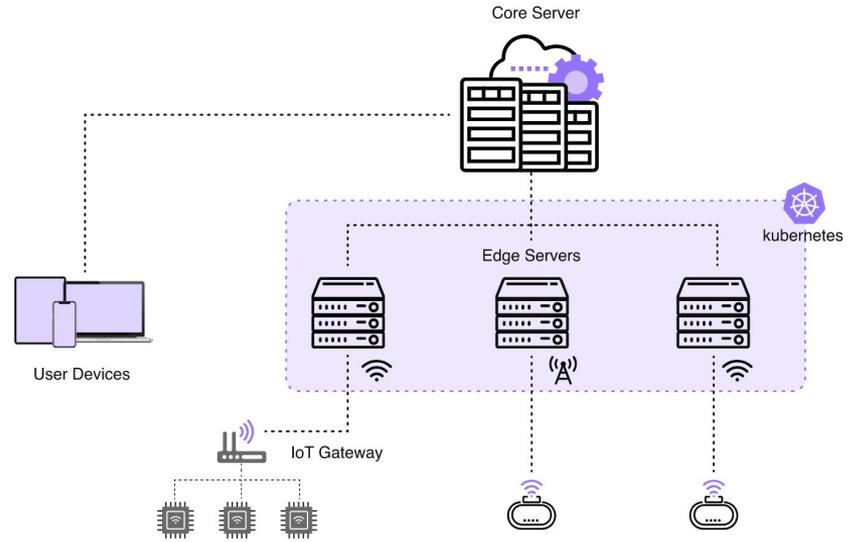
# Overview of Machine Economy



# Web2-Based IoT Systems



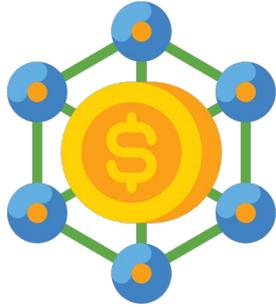
A Cloud-Centric IoT System



An Edge-Centric IoT System

# From Financial Assets to Real-World Assets

2020 – The Year of DeFi



Financial Data

2021 – The Year of NFT



Tokenized Assets

2022+ – The Rise of MachineFi



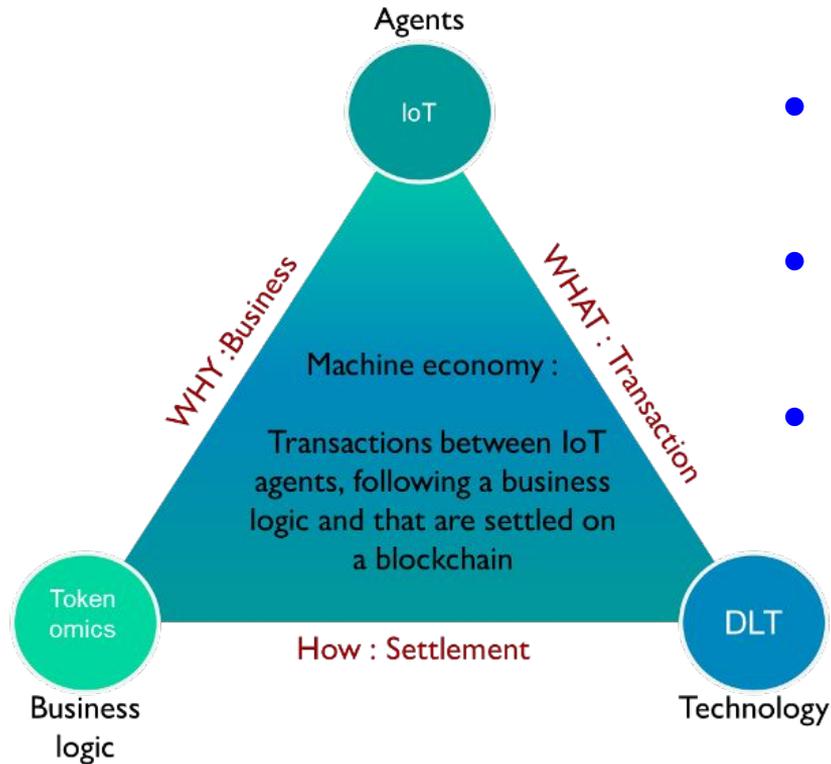
Machine Data & Utility

# What is Machine Economy?



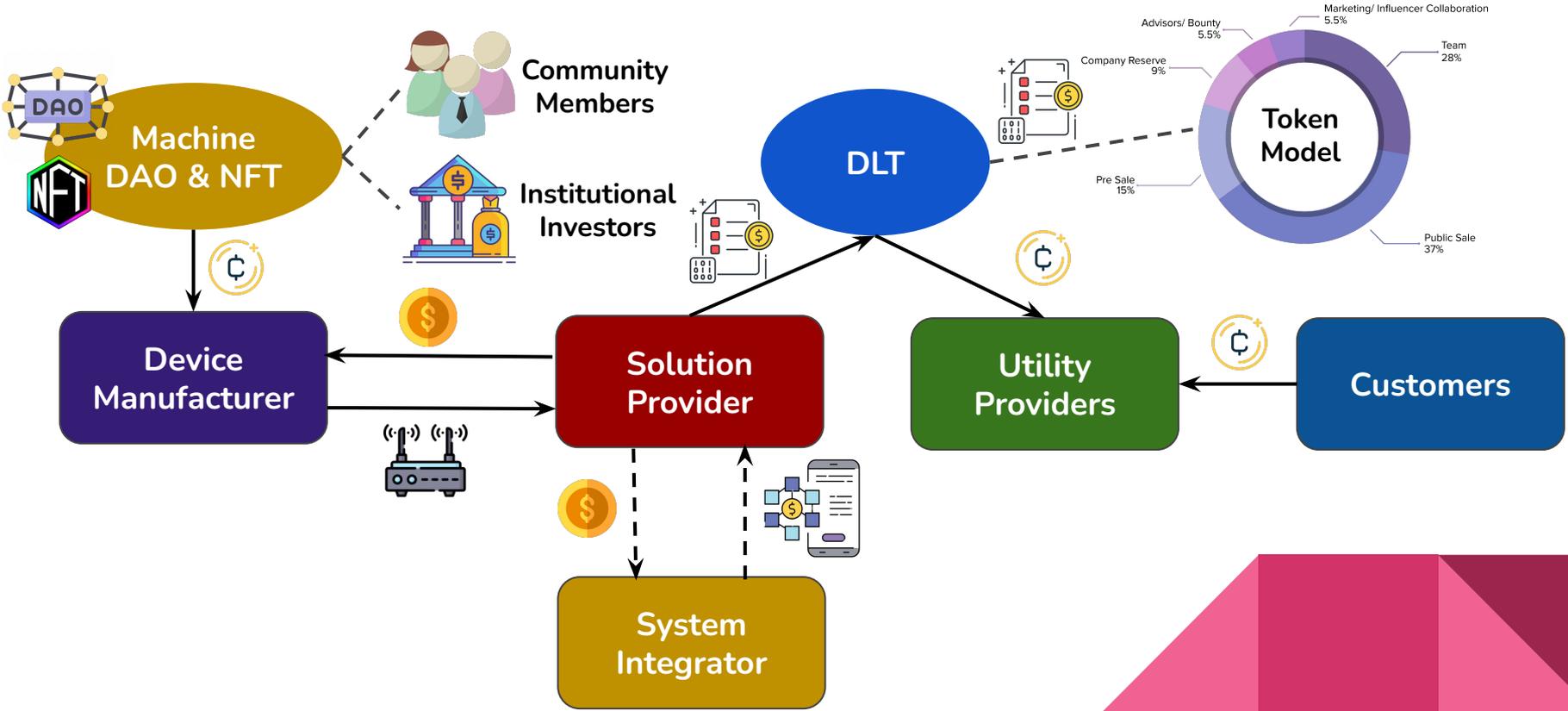
The machine economy is a network of smart, connected, and economically independent devices and machines acting as autonomous market participants, executing economic transactions and other activities with little to no human intervention.

# Key Enablers of Machine Economy

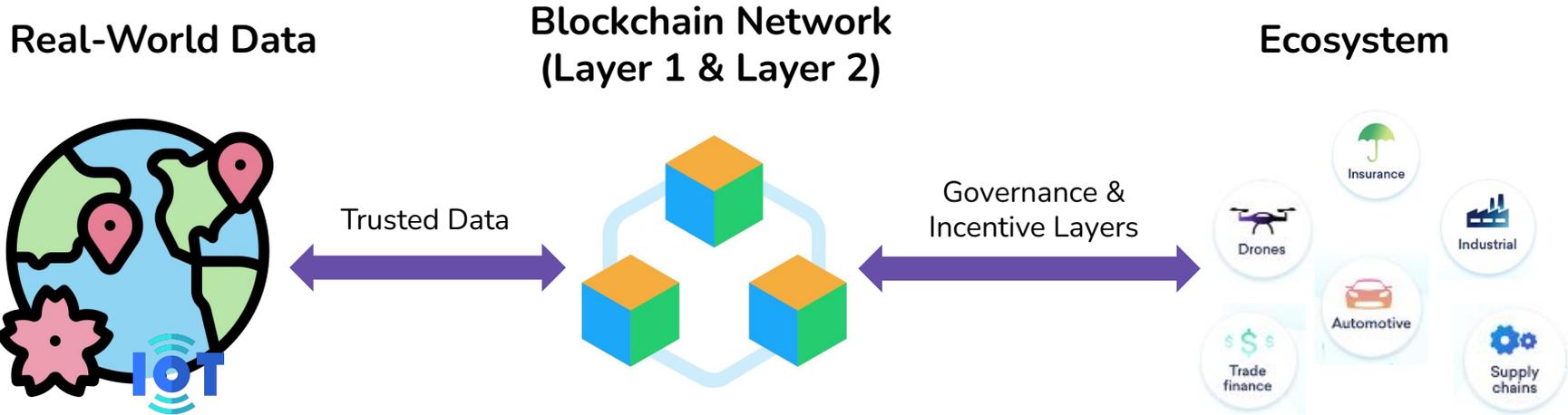


- **Internet of Things (IoT)**
  - Real-time information
  - Tokenized data/utility marketplace
- **Distributed Ledger Technology (DLT)**
  - Transactions without trusted intermediaries
  - Internet of value
- **Tokenomics**
  - Cold start problem
  - Long-term sustainability

# New Business Models



# High-Level System Architecture



# Learn More about Machine Economy



**iic** Industry IoT Consortium



## Machine Economy – The New Frontier of Digital Transformation in IoT

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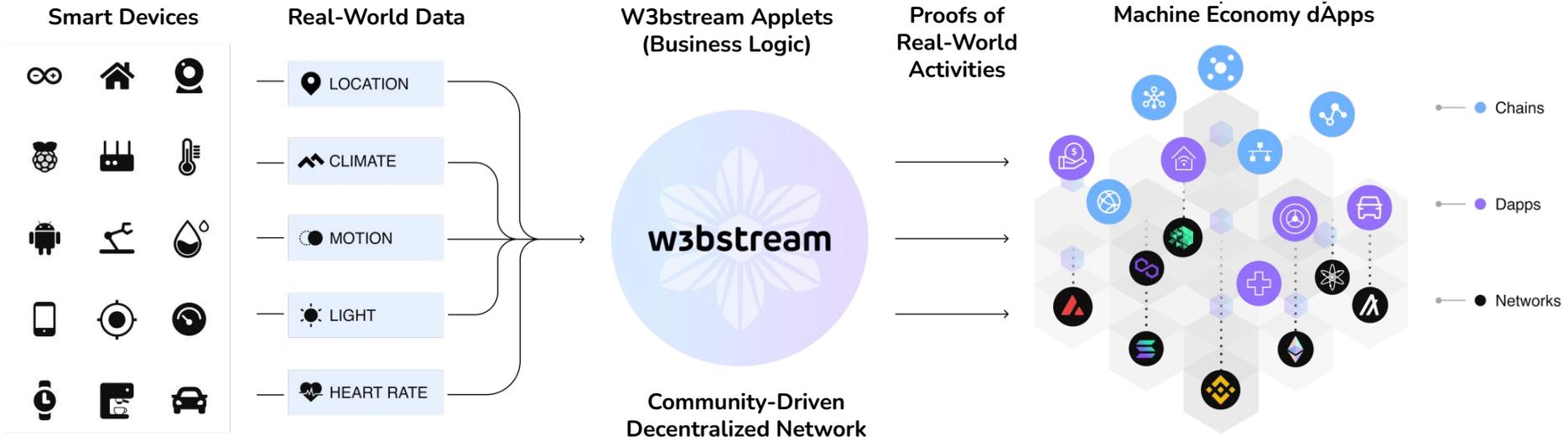




# Blockchain Meets IoT – Research Challenges

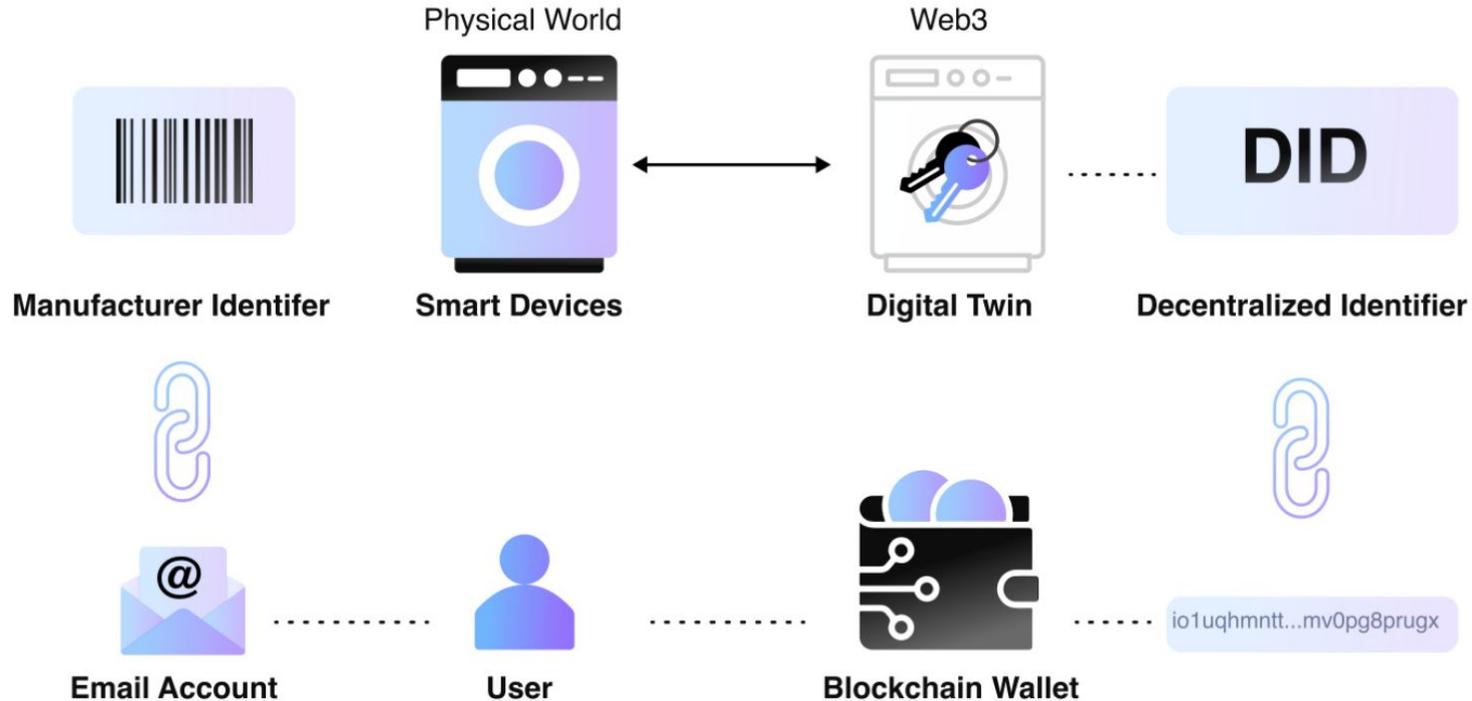


# W3bstream – Connecting Smart Devices to Smart Contracts

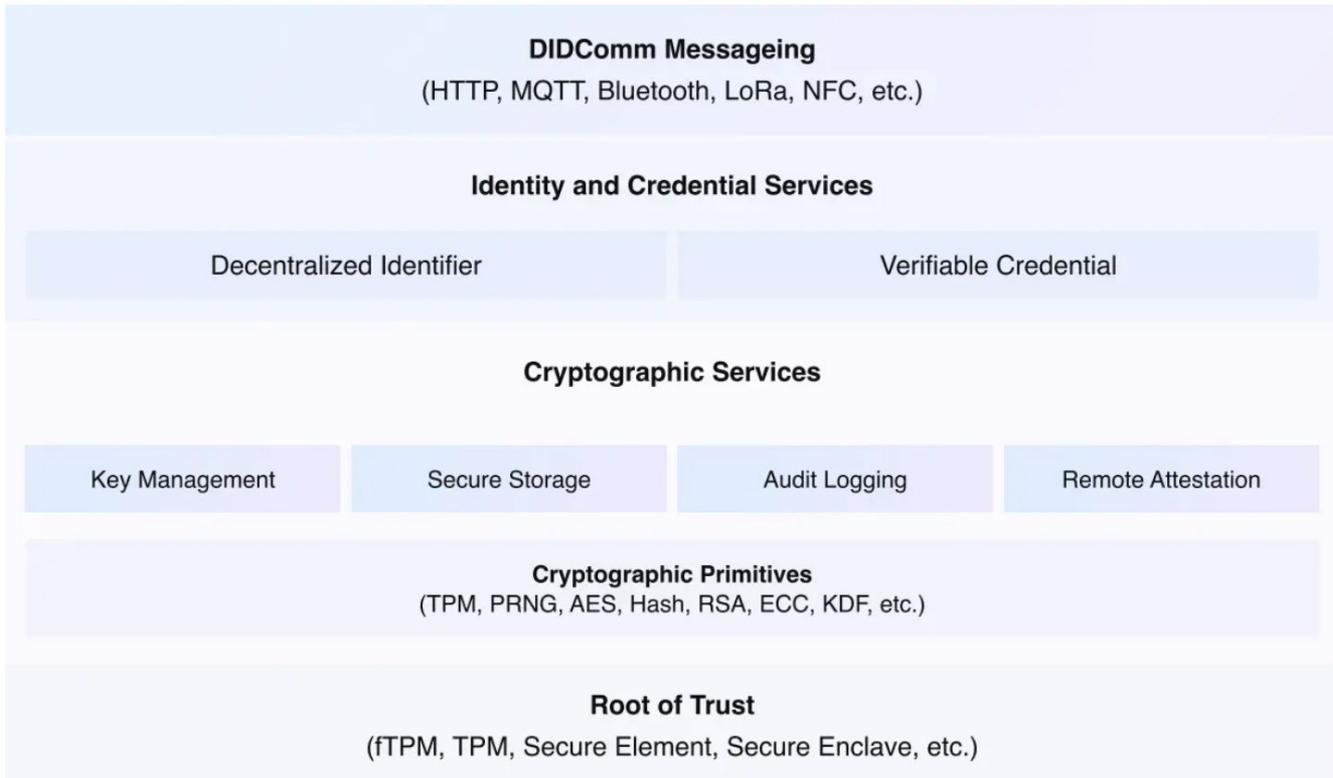


W3bstream is an off-chain compute infrastructure converting real-world data from devices into verifiable, chain agnostic, dApp-ready cryptographic proofs

# Research Challenge I – Device Management



# Research Challenge II – Self-Sovereign Identity for IoT



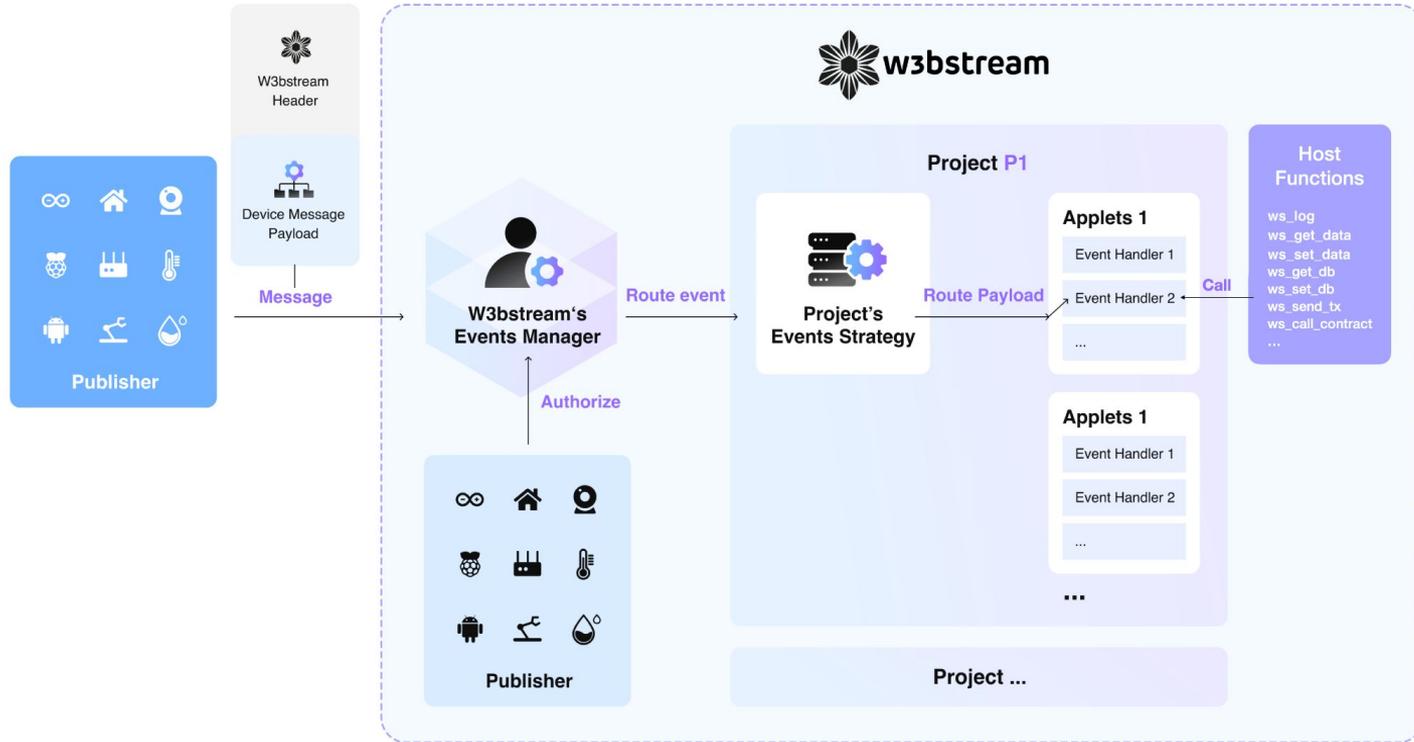
DIF W3C

PSA Cryptography API

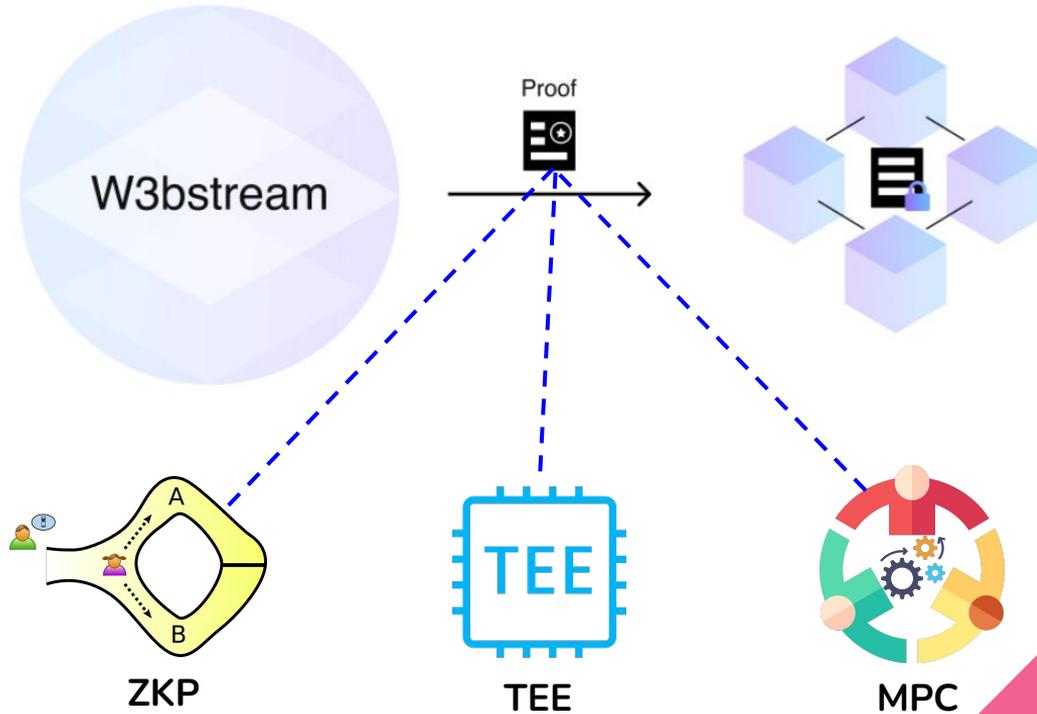
arm



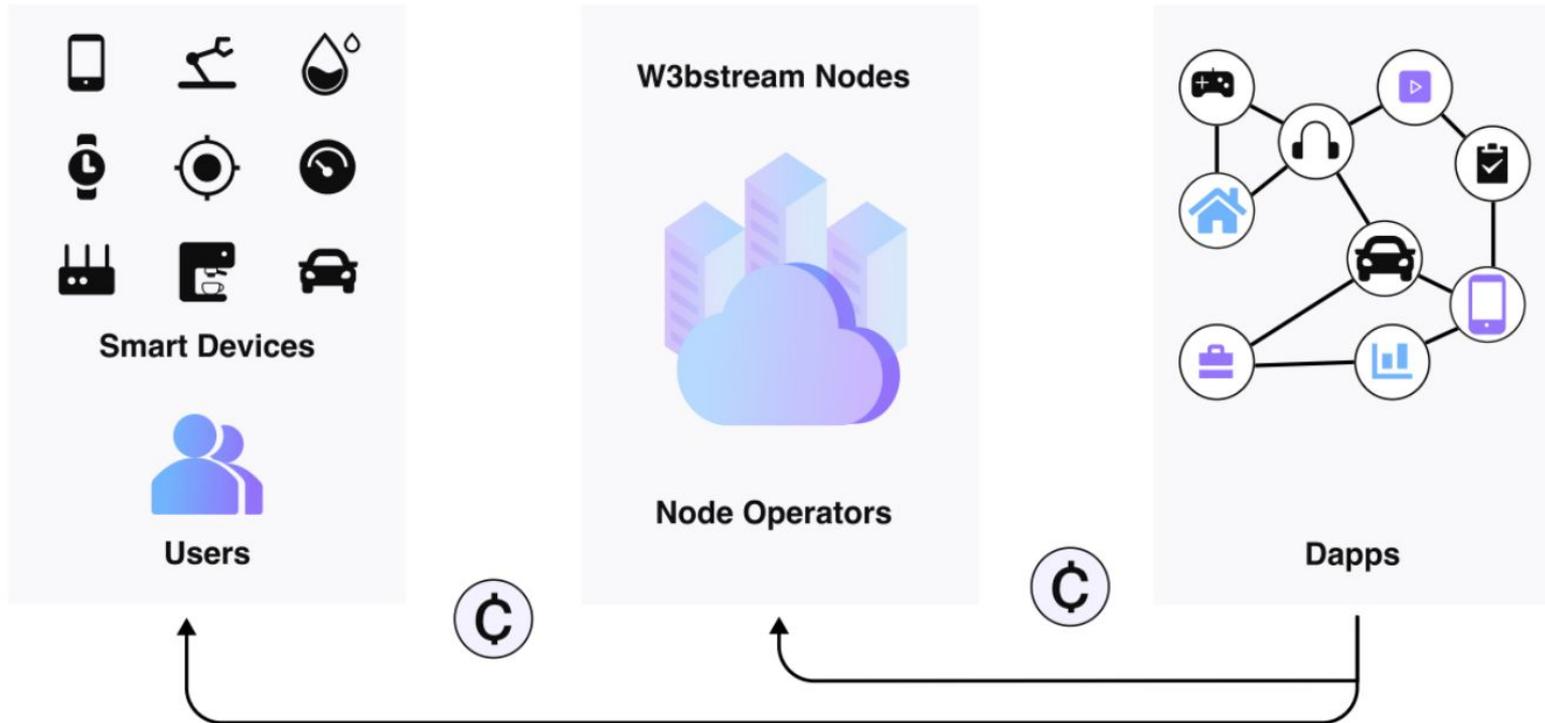
# Research Challenge II – Off-Chain Computing



# Research Challenge IV – Proof Generation



# Research Challenge V – Tokenomics

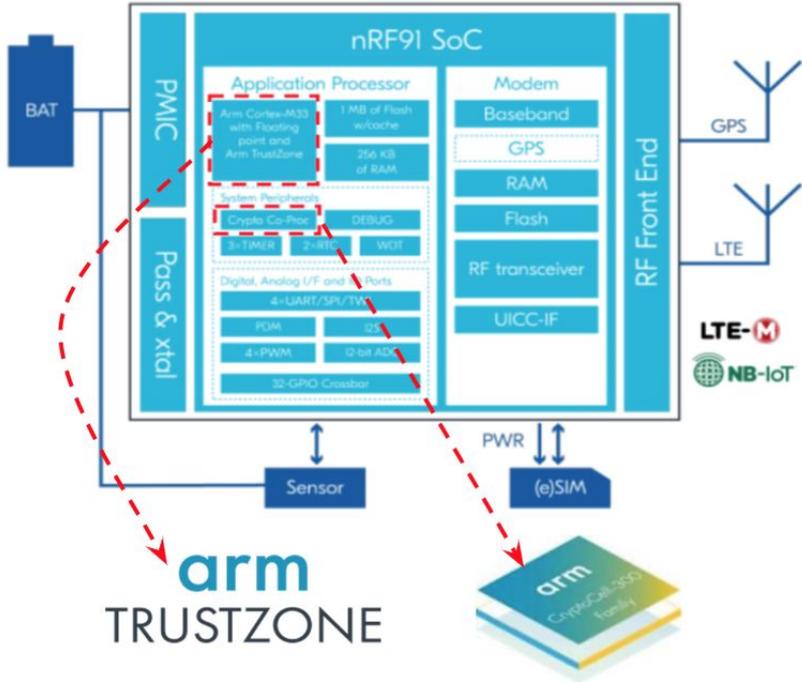




# Blockchain Meets IoT – Research Tools



# Open Hardware – Pebble Tracker



- Location
- NB-IoT/ LTE-M
- Temperature
- Humidity
- Pressure
- Gas
- Gyroscope
- Accelerator
- Light

## Tech Perspective

### Using a blockchain for secure asset tracking

IoTEx is combining the security built into Nordic's nRF9160 and its blockchain technology to protect the integrity of critical asset tracking data

The commercialization of cellular IoT asset tracking solutions such as IoTEx's Pebble Tracker has the potential to revolutionize supply chain applications. The product, powered by Nordic Semiconductor's nRF9160 SoP, uses mature, secure cellular infrastructure to provide location, environment and motion tracking data for global asset tracking. But more than that, Pebble Tracker promises to address problems such as the more than \$400 billion in annual losses that result from supply chain errors such as temperature excursions. Each year compensation for these losses and many others are sought, and payouts from penalty clauses and insurance claims rely heavily on asset tracking data. (See: [WJ Issue 2, 2020, p.2020](#))

Should there be any suspicion that asset tracking information has somehow been tampered with or falsified, claims could drag on for years. And worse, litigation could follow.

IoTEx is tackling the challenge by combining the Pebble Tracker's nRF9160 SoP's Arm TrustZone (for trusted execution) and Arm CryptoCell 320 (for application-layer security) protection features with the company's blockchain for large scale, decentralized and trusted asset tracking applications.

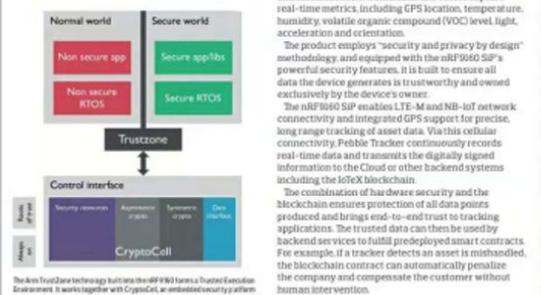
**Trusted on hardware and the blockchain**  
The Arm TrustZone technology built into the nRF9160 forms a Trusted Execution Environment (TEE). The TEE is a secure area inside the Arm processor that runs in parallel but is isolated from (and often invisible to) the main operating system. Code and data inside the TEE are maintained with the highest level of integrity and confidentiality. Such a system protects the valuable code and data while enabling less valuable code and data to run unencumbered on the main operating system. (See: [WJ Issue 2, 2020, p.2020](#))

But a truly secure IoT device requires more than a TEE; additional roots of trust (RoTs) and security mechanisms are demanded. That's the role of Arm's CryptoCell.

CryptoCell is an embedded security platform for devices using TrustZone, comprising a multi-layered architecture combining hardware data path, RoT management and operation control with a layer of security firmware. (See: [WJ Issue 2, 2020, p.2020](#))

Pebble Tracker sends its data to the IoTEx blockchain-based backend services to orchestrate large-scale, decentralized asset tracking applications. Blockchains are based on the concept of openly verifiable ledgers ensuring that all transactions are publicly confirmed and logged with an uncorruptible digital signature. (Only the transaction is visible, not the private data or content that triggered it.) Because of the use of open ledgers, tampering with blockchain data would quickly be exposed.

IoTEx's blockchain and IoT technology stack, which includes sophisticated middleware to pair with Nordic's hardware, offers SDKs that developers can use alongside one of Nordic's preferred operating systems, the open-sourced Zephyr, to build the trusted applications of tomorrow.

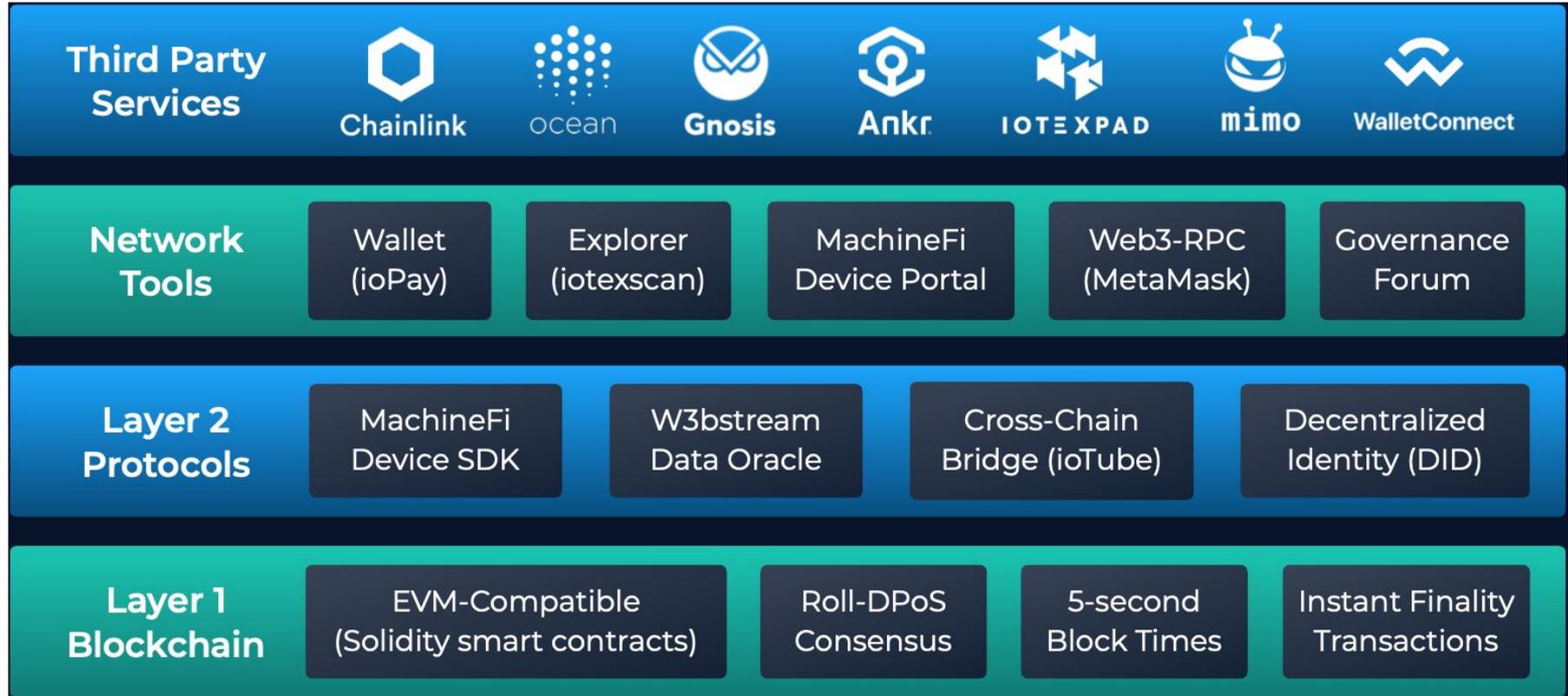


The combination of hardware security and the blockchain ensures protection of all data points produced and brings end-to-end trust to tracking applications



**Tech Check**  
Pebble Tracker uses a 750 mAh Li-Po battery, providing up to the week of battery life between recharges. For a top AI asset tracking application, the nRF9160 SoP has been re-engineered to minimize power consumption with, for example, support for eDRX and PSM power-saving modes.

# The IoTeX Platform



# IoTeX Developer Resources



<https://cdn.iotex.io/machinefi/loTeX%202.0.pdf>  
<https://docsend.com/view/twtxhbzvisdye2xi>



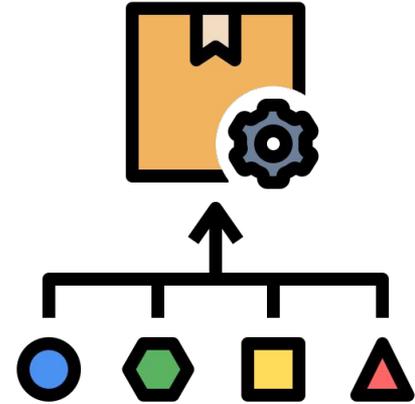
<https://docs.iotex.io/>  
<https://docs.w3bstream.com/>



<https://github.com/iotexproject/>  
<https://github.com/machinefi/>



<https://developers.iotex.io/>



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