Internet-of-Things on Helium Network for Environmental Monitoring in an urban green space project in Nairobi, Kenya

BLOCKCHAIN-BASED INTERNET OF THINGS-NETWORKS IN ENVIRONMENTAL DATA PIPELINES - EXPLORING OPPORTUNITIES AND A USE CASE

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IAIA 2024

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Innovative data sharing and governance for a just transformation

IAIA 2024

DUBLIN

Impact is assessed (measured, analysed, reported, verified, valued, invested in) using data.

What role does data play in Environmental Impact Value Chains?

Environmental data pipelines are often multi-stakeholder efforts.

ENVIRONMENTAL DATA PIPELINE

ENVIRONMENTAL DATA SUPPLY CHAIN: DATA AS PRODUCT OR SERVICE

PILOT USE CASE FOR ENVIRONMENTAL MONITORING IN URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA:PARTNERS

de_plan proto

Philadelphia, US/India/Nairobi, Kenya

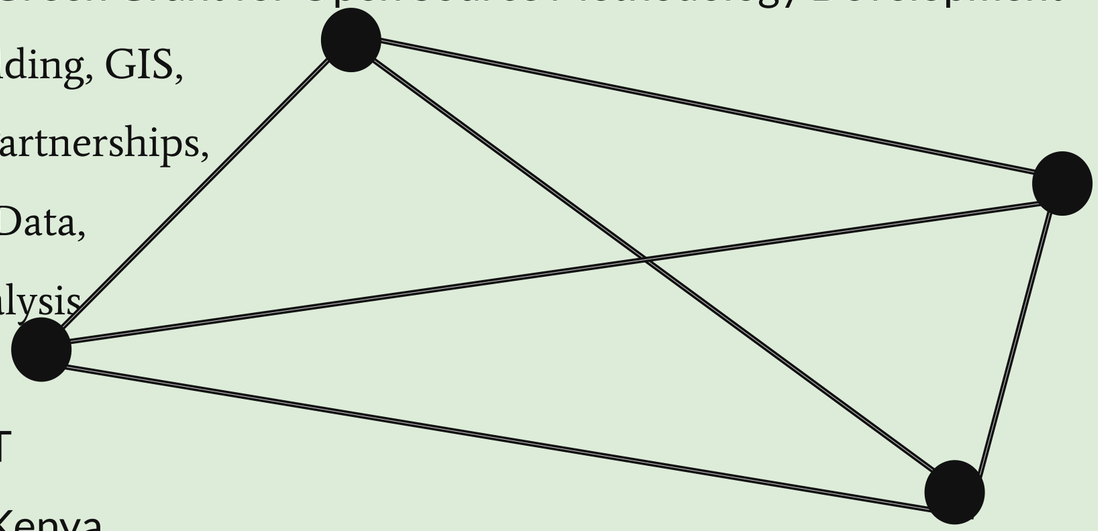
Filecoin Green Grant for Open Source Methodology Development

Map-Building, GIS,

Survey, Partnerships,

Satellite Data,

Data Analysis



Hanna

Leipzig University

Berlin, Germany

Research on Urban Metric, Survey Design,

Partnerships, Presentation

BLCK IOT

Nairobi, Kenya

Berlin, Germany

Gateway Deployment,

IoT on Blockchain

Sensor Installation

Kamukunji Environmental Conservation Champions

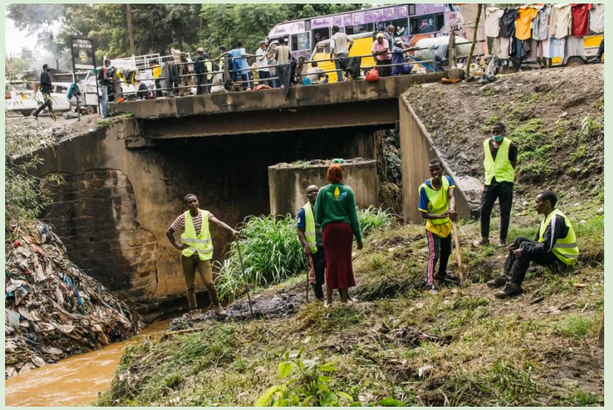
Public Space Network, Nairobi, Kenya

Restoration, Support with Sensor Installation, Data Beneficiary

PROJECT PARTNERS, Q1-Q2 2023

ENVIRONMENTAL MONITORING IN COMMUNITY-BASED URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA

- What is the project?
- Urban green space restoration project with community initiative of volunteers (KECC) in Nairobi, Kenya, Kamukunji Park (5 ha).
- Community initiative is part of the larger Public Space Network - community network of nature stewards around open spaces.
- Park is owned by the city, KECC are stewards.



ENVIRONMENTAL MONITORING IN COMMUNITY-BASED URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA

- What is the project?
- Restoration activities and urban development

for some years now

- involved waste management in the park,

and the riverbed of Nairobi river, building

a playground for children, planting trees,

establishing site for urban agriculture and setting up

regular waste management with partners.

ENVIRONMENTAL MONITORING IN COMMUNITY-BASED URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA

- What for?
- Provide environmental measurements for community initiative to include in future grant and funding applications
- Enable baselining and continuous environmental monitoring (time and spatial analysis)
- Contribution to citizen science and data availability for a wider group of stakeholders

ENVIRONMENTAL MONITORING IN COMMUNITY-BASED URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA

- What was measured?
- Environmental parameters:

Air quality, Temperature/Climate, Rainfall, Water level, Soil, Leaf Moisture, Carbon Stock from Biomass

- Use and use values of the park through survey
- Tree species and abundance

Sensor	Parameter: Unit	Parameter: Unit	Parameter: Unit	Parameter: Unit	Parameter: Unit	Parameter: Unit	Parameter: Unit	Parameter: Unit
Particulate Matter	PM1: µg/m3	PM2.5: µg/m3	PM10: µg/m3					
Weather Station	Temperature: °C	Humidity: %RH	Pressure: Pa	Rainfall: mm/h	Light Intensity: Lux	UV Index: 0-12	Wind Direction: degrees	Wind Speed: m/s
Leaf Moisture	Moisture: 0-1	Temperature: °C						
River Level	Distance: mm							
Soil sensors	Temperature:°C	Moisture: %VWC	Electrical conductivity: dS/m					

Table 2 : Measured units by sensor

ENVIRONMENTAL MONITORING IN COMMUNITY-BASED URBAN GREEN SPACE RESTORATION PROJECT, NAIROBI, KENYA

- How?
- Field work (tree diversity and abundance)
- Survey on uses and use values of the park
- GIS analysis, satellite images
- IoT sensor data for environmental parameters

→ IoT devices using LoRaWAN on

Blockchain-based IoT Helium Network

Environmental data pipelines often involve multiple stakeholders.

Various challenges may arise from this collaborative effort.

CHALLENGES IN ENVIRONMENTAL DATA PIPELINES CAN BE TRANSLATED INTO REQUIREMENTS

Technical:

- Security, Reliability, Autonomy
- Quality of data
- Environmental Data Standards
- FAIR data (Wilkinson et al., 2016)
- Traceability of origin, transparency of processes
- Control over data, system interface

CHALLENGES IN ENVIRONMENTAL DATA PIPELINES CAN BE TRANSLATED INTO REQUIREMENTS

Contractual:

- Accountability (SMART targets), Transparency
- Independent Verification (MRV)

Distributive:

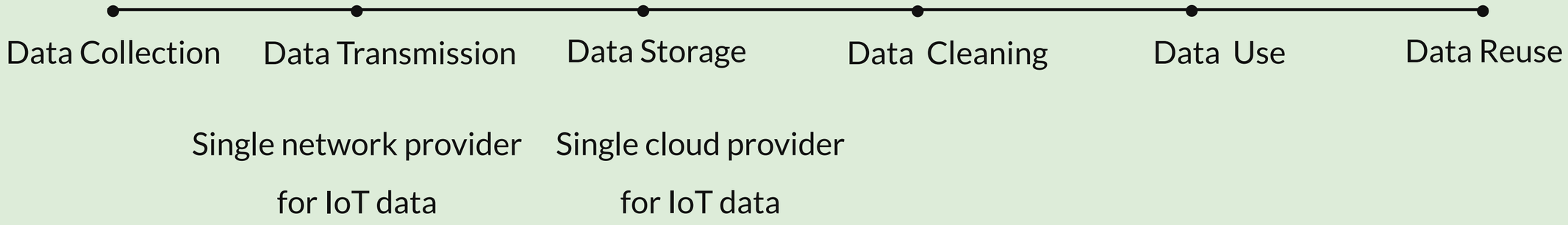
- Fair distribution of costs and benefits (De Lima et al., 2022), Equity

Procedural:

- Participation in governance and rule-making, shared control of system operation
- CARE principles: commitments to accessibility, responsibility, education, and engagement (GIDA, 2019)

MULTI-STAKEHOLDER ENVIRONMENTAL DATA PIPELINE

Centralization or domination of: control over data, system operation, rule making, governance, benefits, costs, verification, storage



Decentralization: Blockchain stores data in a distributed and immutable way and decentralizes verification processes through consensus among nodes.

Can Blockchain-based IoT networks help address challenges in environmental data pipelines?

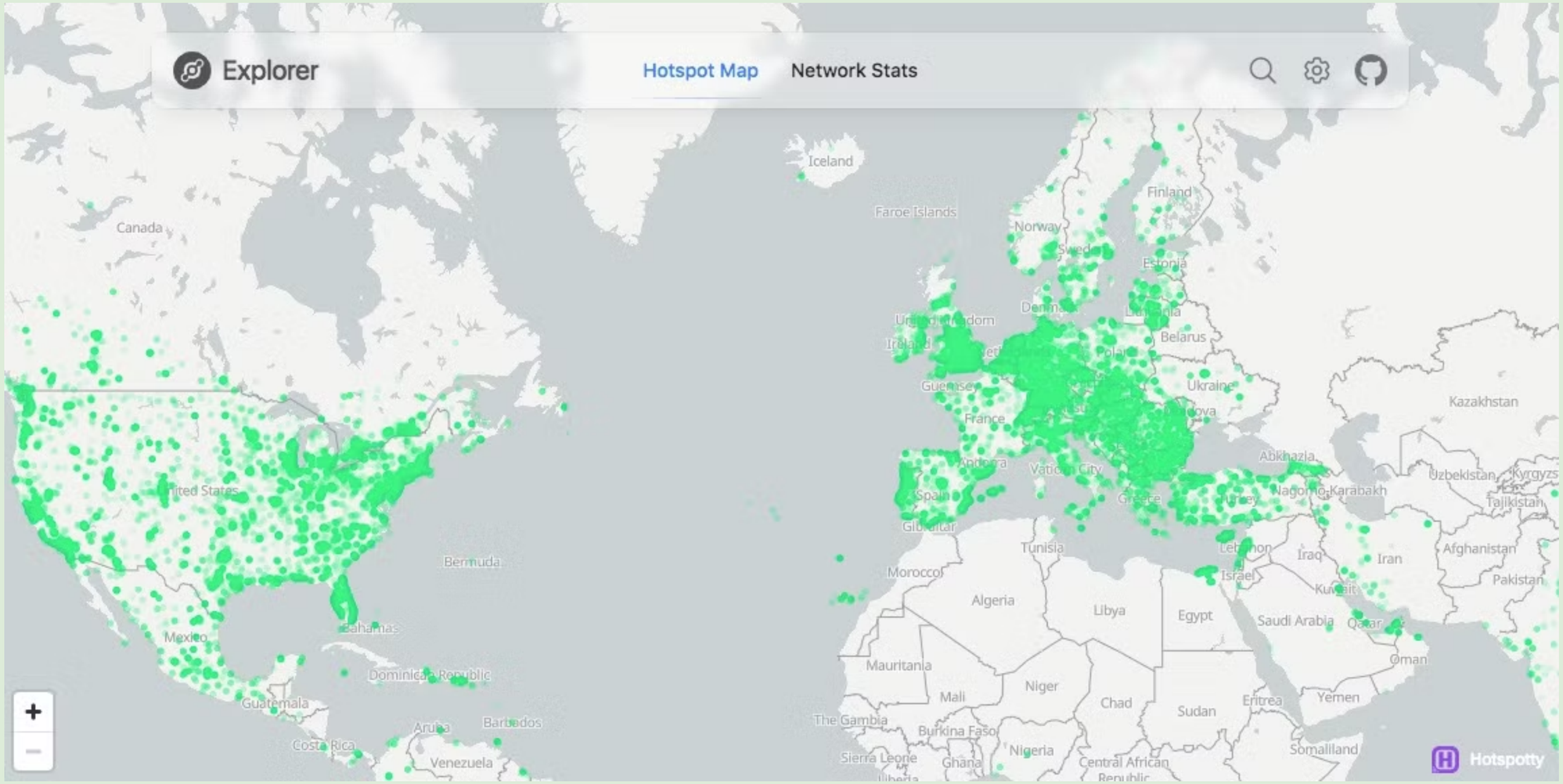
HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK

- What is it?
- Helium Network is a peer-to-peer decentralized blockchain-based IoT-network providing LoRaWAN coverage in its IoT-subnetwork
- since April 2023 on blockchain Solana
- just one possible model of an IoT + Blockchain combination (DePIN), but the largest network and it is public (everyone can participate)

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK

- How does it work?
- Participants (nodes) - anyone - can buy hardware and install and maintain a Hotspot (gateway) to provide LoRaWAN network coverage that they themselves and others can use
- Hotspot operators earn IOT tokens as rewards for data transmission and for witnessing other Hotspot's locations and their network coverage (Proof of Coverage) → Funding & Distribution of costs and benefits (participants pay each other)
- All transactions to use the network are paid for in Data Credits (transaction token)

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK



1.024.647 HOTSPOTS IN 195 COUNTRIES

HELIUM EXPLORER

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK

- How does it work?
- Public blockchain: It is continuously developed, built and governed by its community → Community Participation
- Development through Helium Improvement Proposals (HIP) on GitHub and Helium Documentation → Transparency of system operation
- Participants vote on HIPs, determine rules → More inclusive governance of technology

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK

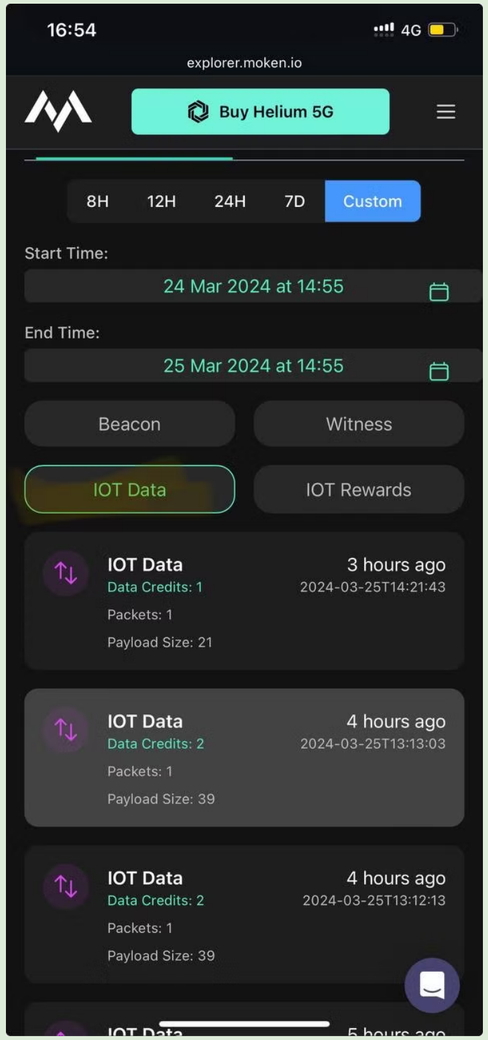
- How does it work?
- To any data transmission and Proof of Coverage, there is a transaction attached:

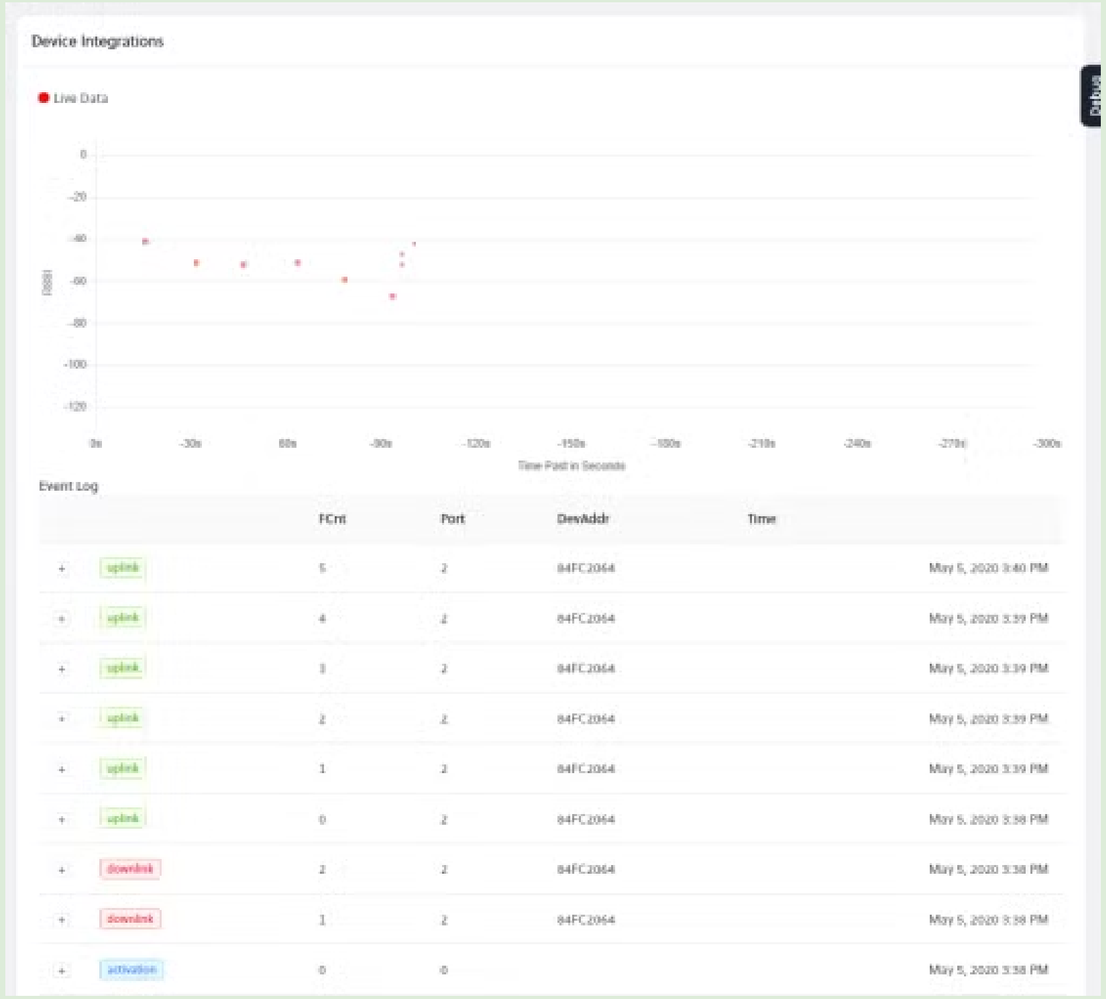
  Data transmissions and Proof of Coverage are verified and recorded on

  blockchain → Public traceability of data transmission, Transparency, MRV
- System is operated and maintained by distributed nodes: No single point of failure

  → Robust, increases system security
- Transactions are verified through consensus and immutable → Data Integrity
- All data that is transmitted is AES encrypted → Privacy

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK



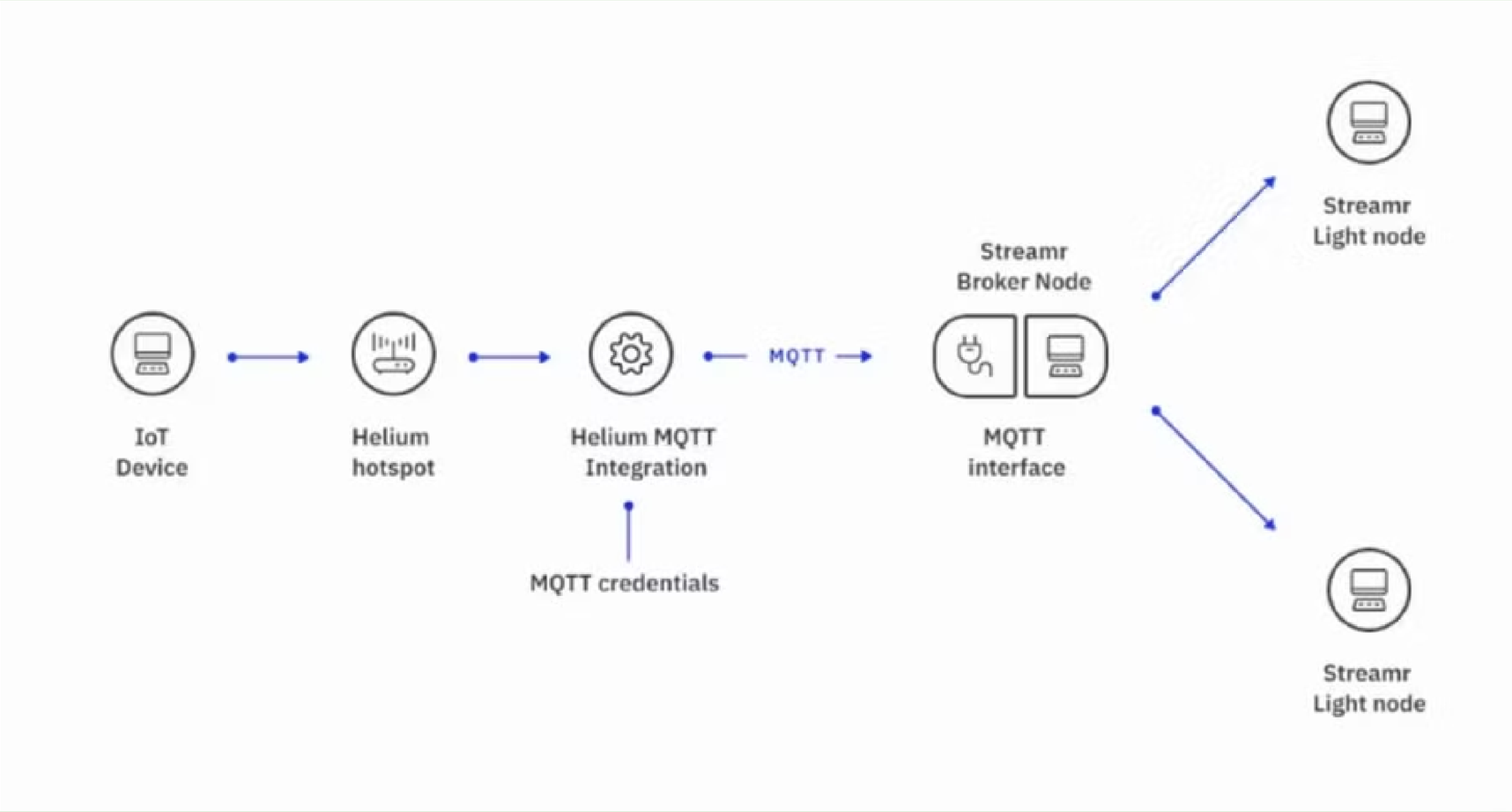


TRANSPARENCY: HOTSPOT ACTIVITY ON MOKEN AND IOT ON HELIUM CONSOLE

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK

- How does it work?
- Data is *not* recorded or tokenized on chain. Only **transactions** - data transmission, and Proof of Coverage (PoC) - and **identity** of devices are recorded and traceable.
- Technical Expertise is needed for installation of Hotspot hardware and IoT
- On-boarding and registering devices, however, is very simple and accessible.
- Data can be transmitted to server to further analyse it or to Web3 Data Exchange.

HELIUM NETWORK: DECENTRALIZED BLOCKCHAIN-BASED IOT NETWORK



FROM SENSOR TO DATA MARKETPLACE: TOKENIZE DATA

CONCLUSION

- Does it work?
- Pro: Reliability of network, security, community participation in network governance, active and supportive community, traceability and transparency of data transmission and transactions, low cost, pay-to-communicate.
- Con: Network traffic is low in areas with not much coverage such as in Kenya, as a consequence, there are not many rewards earned. Rewards increase in proportion to amount of network traffic (and number of Hotspots).
- HN is one DePIN (business) model among others. There can be customized solutions to respond to requirements of environmental monitoring and specific stakeholder needs.

Thank you!