The Helium Network

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Helium

A Decentralized Wireless Network

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Abstract

The Internet of Things is an $800 billion industry, with over 8.4 billion connected devices online, and spending predicted to reach nearly $1.4 trillion by 2021 [1]. Most of these devices need to connect to the Internet to function. However, current solutions such as cellular, WiFi, and Bluetooth are suboptimal: they are too expensive, too power hungry, or too limited in range.

The Helium network is a *decentralized wireless network* that enables devices anywhere in the world to wirelessly connect to the Internet and geolocate themselves without the need for power-hungry satellite location hardware or expensive cellular plans. Powering the Helium network is a blockchain with a native protocol token incentivizing a two-sided marketplace between coverage providers and coverage consumers. With the introduction of a blockchain, we inject decentralization into an industry currently controlled by monopolies. The result is that wireless network coverage becomes a commodity, fueled by competition, available anywhere in the world, at a fraction of current costs.

Our secure and open-source primitives enable developers to build low-power, Internet-connected devices quickly and cost-effectively. The Helium network has a wide variety of applications across industries and is the first decentralized wireless network of its kind.

1. Introduction

The world is becoming decentralized. A multitude of platforms, technologies, and services are moving from centralized proprietary systems to decentralized, open ones. Peer-to-peer networks such as Napster (created by one of our founders Shawn Fanning) [2] and BitTorrent paved the way for blockchain networks and crypto-currencies to be built. Now Bitcoin, Ethereum, and other blockchain networks have shown the value of decentralized transaction ledgers. Existing Internet services such as file storage, identity verification, and the domain name system are being replaced by modern blockchain-based versions. While software-level decentralization has moved quickly, physical networks are taking longer to affect. These networks are more complicated to decentralize as they often require specialized hardware to function.

The Helium network is a wide-area wireless networking system, a blockchain, and a protocol token. The blockchain runs on a new consensus protocol, called the Helium Consensus Protocol, and a new kind of proof, called *Proof-of-Coverage*. The Miners who are providing wireless network coverage in a cryptographically verified physical location and time submit proofs to the Helium network, and the Miners submitting the best proofs are elected to an asynchronous byzantine fault tolerant consensus group at a fixed epoch. The members of the consensus group receive encrypted transactions submitted by other Miners and forms them into blocks at an extremely high transaction rate. In addition to the blockchain protocol, the Helium Wireless protocol, *WHIP*, provides a bi-directional data transfer system between wireless Devices and the Internet via a network of independent providers that does not rely on a single coordinator, where: (1) Devices pay to send & receive data to the Internet and geolocate themselves, (2) Miners earn tokens for providing network coverage, and (3) Miners earn fees from transactions, and for validating the integrity of the Helium network.

Note: This whitepaper represents a continuous work in progress. We will endeavor to keep this document current with the latest development progress. As a result of the ongoing and iterative nature of our development process, the resulting code and implementation is likely to differ from what is represented in this paper.

We invite the interested reader to peruse our GitHub repo at `https://github.com/helium` as we continue to open-source various components of the system over time.

1.1 Key Components

The Helium network is built around the following key components:

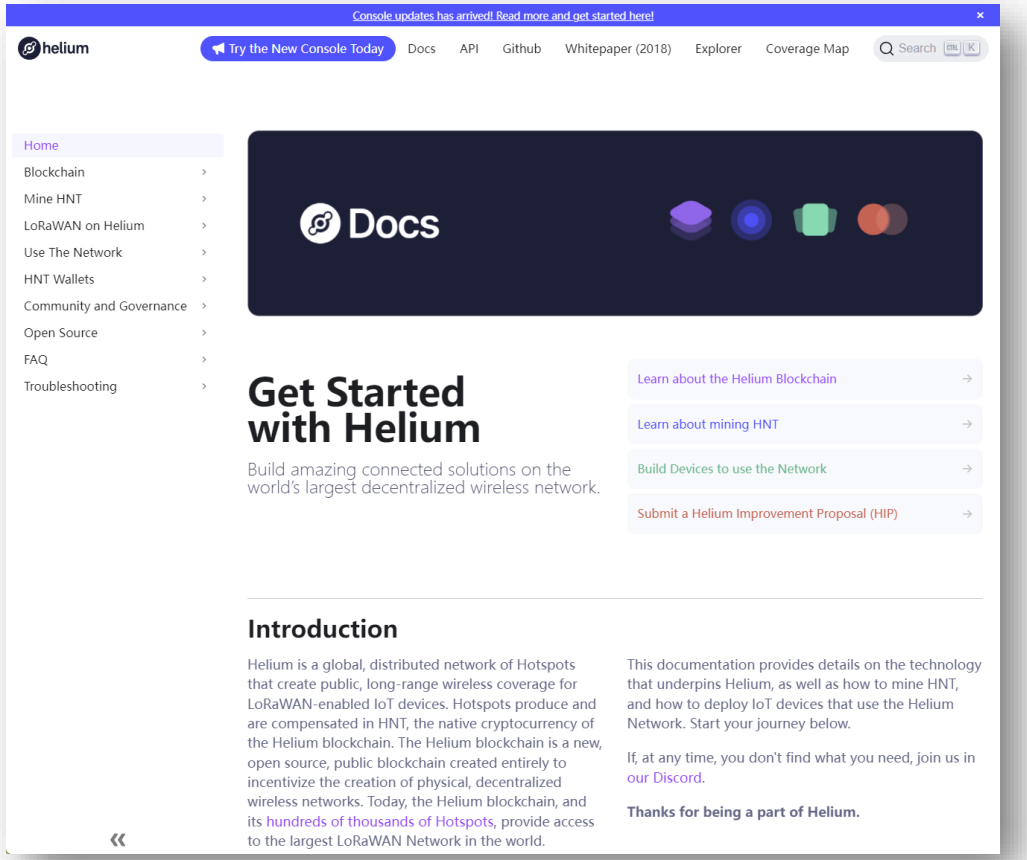
Proof-of-Coverage We present a computationally inexpensive *Proof-of-Coverage* that allows Miners to prove they are providing wireless network coverage. We anchor these proofs using a *Proof-of-Serialization* that allows miners

Haleem, A., Allen, A., Thompson, A., Nijdam, M., & Garg, R.

Helium - A Decentralized Wireless Network

"The Helium Whitepaper"

Available at http://whitepaper.helium.com



Helium Systems Inc.

https://docs.helium.com/

"The Official Documentation"

Introduction

An open-source blockchain network

Running on consensus protocol

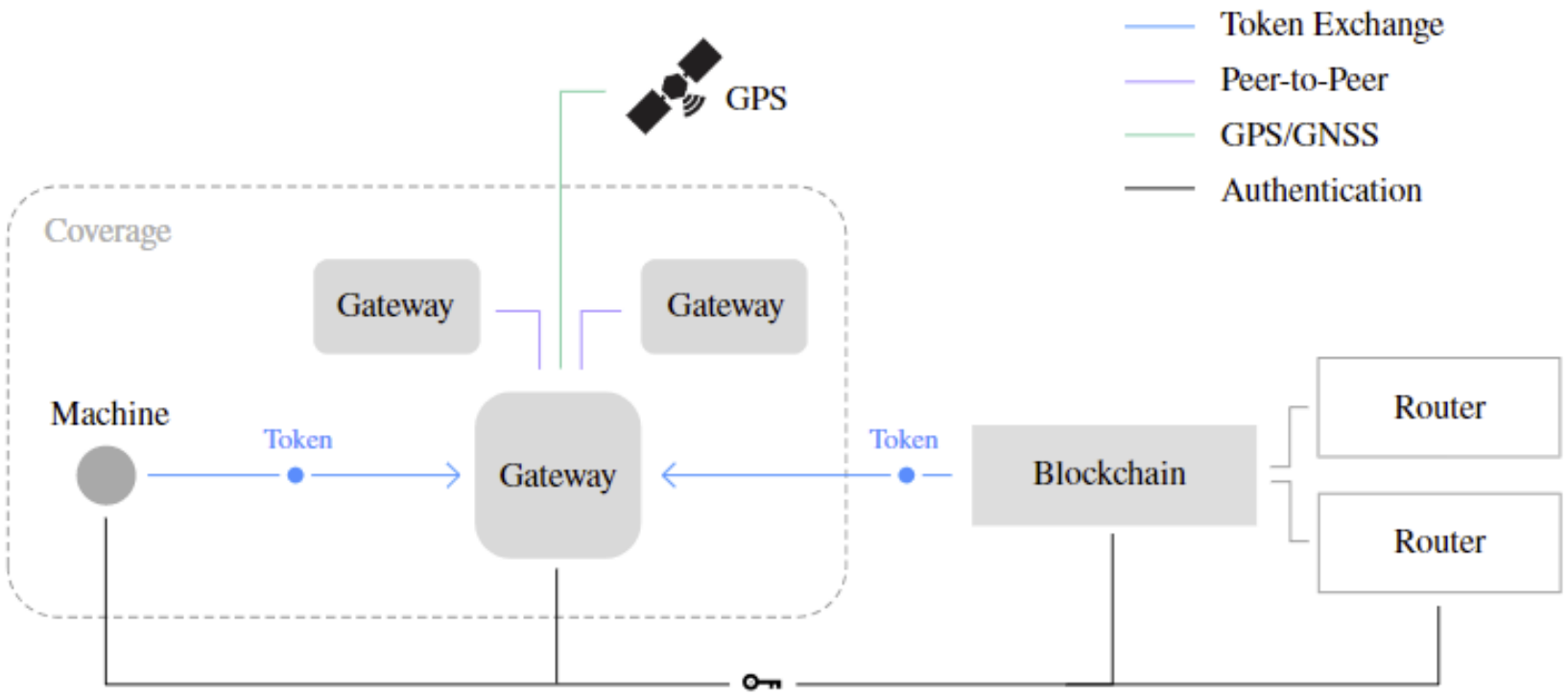
Deploy IoT Devices & Build global ubiquitous wireless network

Enable devices anywhere in the world to wirelessly connect to the Internet

Key Components

- Proof-of-Coverage
- Helium Network
- Helium Consensus Protocol
- WHIP
- Proof-of-Location
- DWN

Helium system overview



Source: http://whitepaper.helium.com/

LoRaWAN

A low-power, wide area networking protocol

Build on top of the LoRa radio modulation technique.

Wirelessly connects devices to the internet and manages communication between end-node devices and network gateways.

Use for the unlicensed ISM radio bands for network deployments

Tokens

Burn-and-Mint Equilibrium(BME) model

The HNT

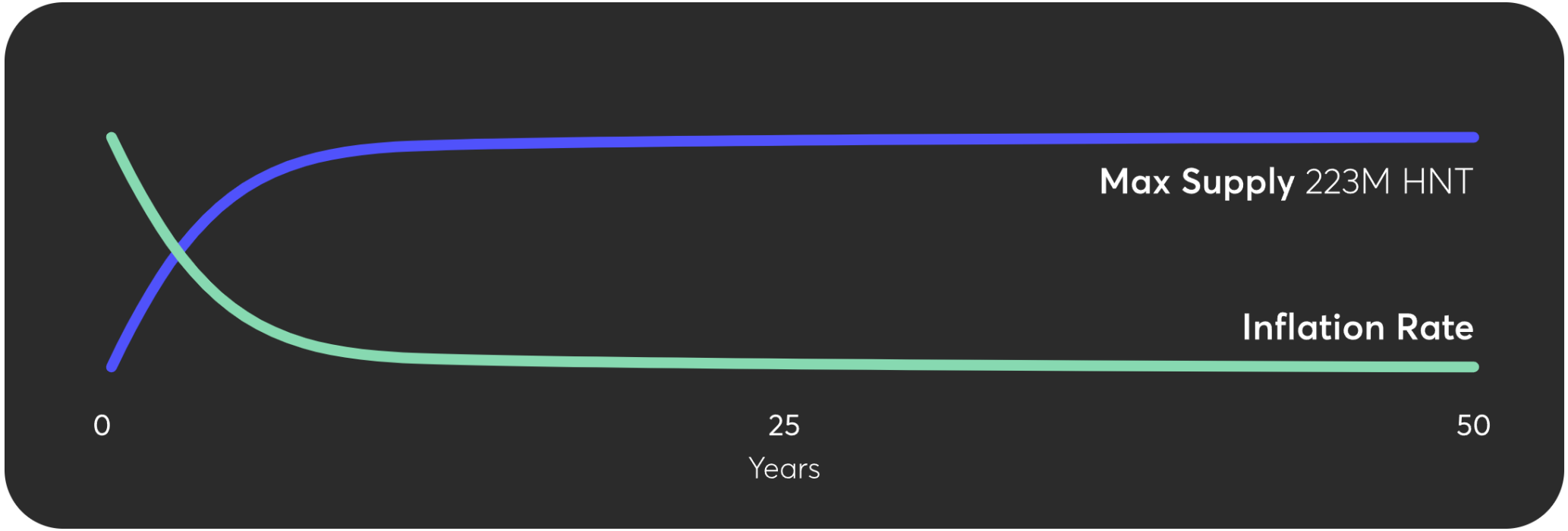
The Data Credits(DC)

HNT

- HNT is earned when Hotspots:
- Provide and validate wireless coverage
- Transfer device date over the network

HNT

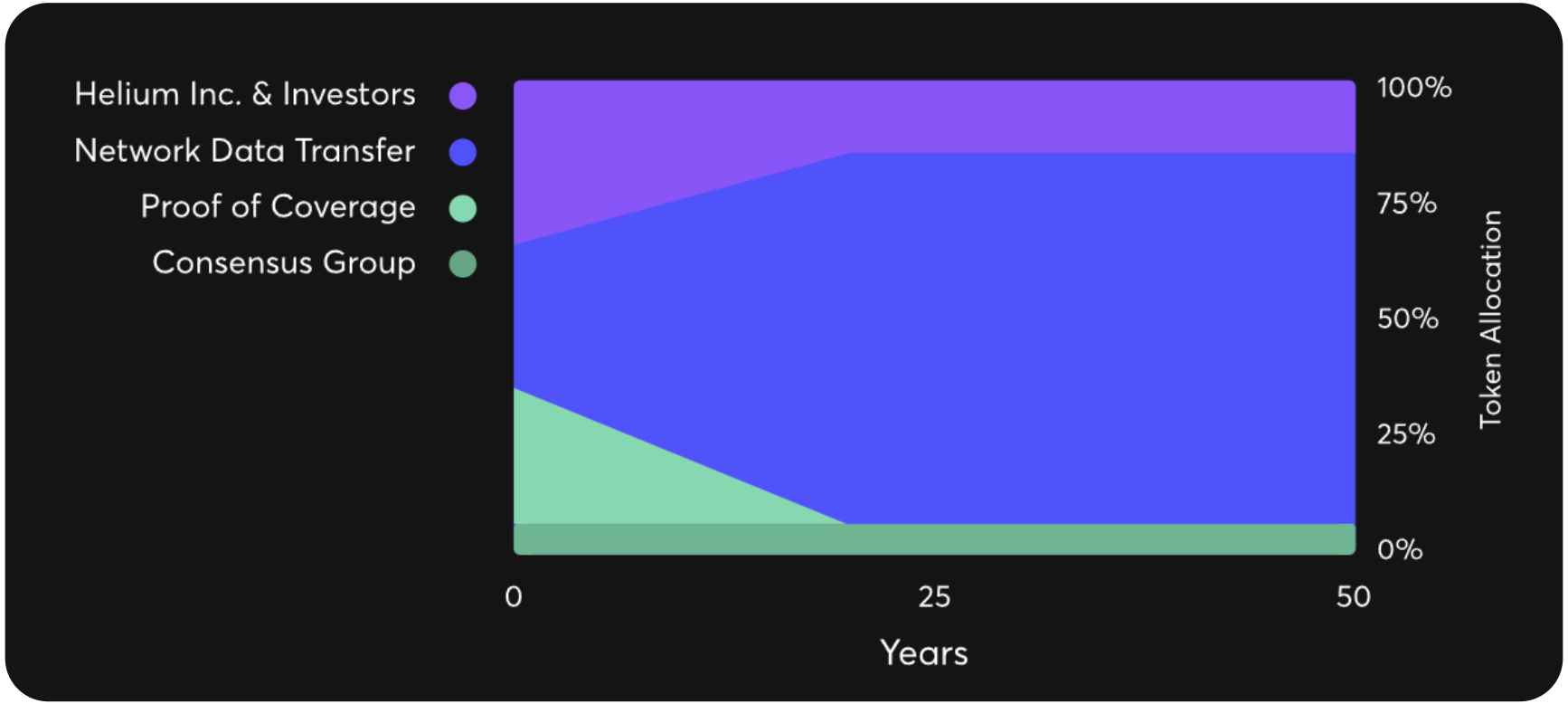
Theoretical Model: HNT Supply/Inflation Rate vs. Time



Source: https://www.helium.com/token

HNT

Theoretical Model: HNT Allocation vs. Time



Source: https://www.helium.com/token

Data Credits

HNT is burned

It is removed from the circulating supply and creates DCs.

DCs are created

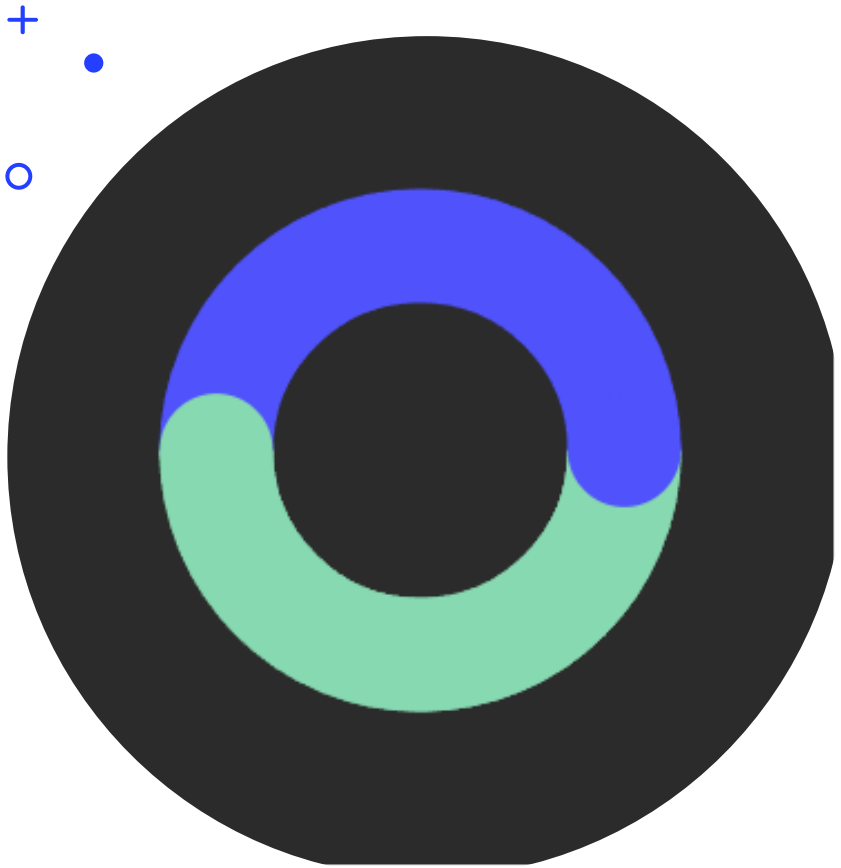
Data Credits are used by devices in order to use the network

Data Credits

Burn and Mint Equilibrium

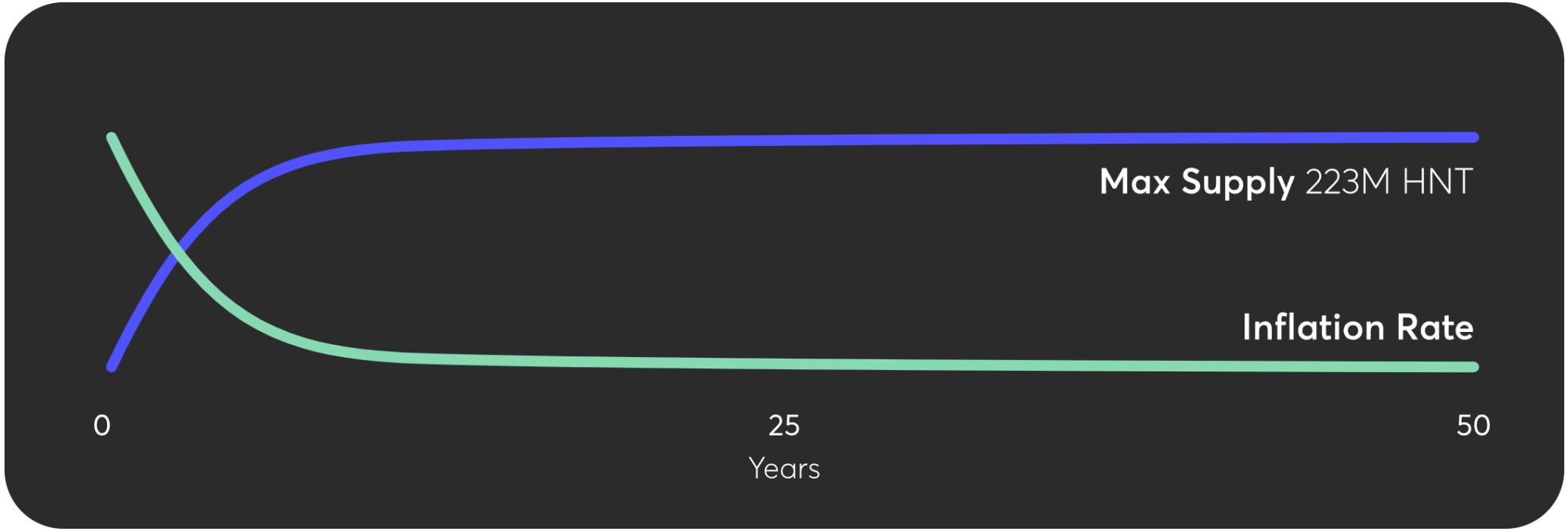
Net Emissions

WHAT HAPPENS WHEN MINTING ISN'T ABLE TO REWARD HOTSPOTS?



Net Emissions

Theoretical Model: HNT Supply/Inflation Rate vs. Time



Source: https://www.helium.com/token

Net Emissions

Current Schedule of HNT Emissions

Year	HNT at start of year	Total HNT Minted
1	0	60,000,000.0
2	60,000,000	60,000,000.0
…	…	…
45	239,999,943	14.3
46	239,999,957	14.3
47	239,999,971	7.2
…	…	…

Source: https://docs.helium.com/blockchain/helium-token

Net Emissions

Current Schedule of HNT Emissions

Year	HNT at start of year	Total HNT Minted	
1	0	60,000,000.0	← 2019
2	60,000,000	60,000,000.0	
…	…	…	
45	239,999,943	14.3	← 2064
46	239,999,957	14.3	
47	239,999,971	7.2	
…	…	…	

Source: https://docs.helium.com/blockchain/helium-token

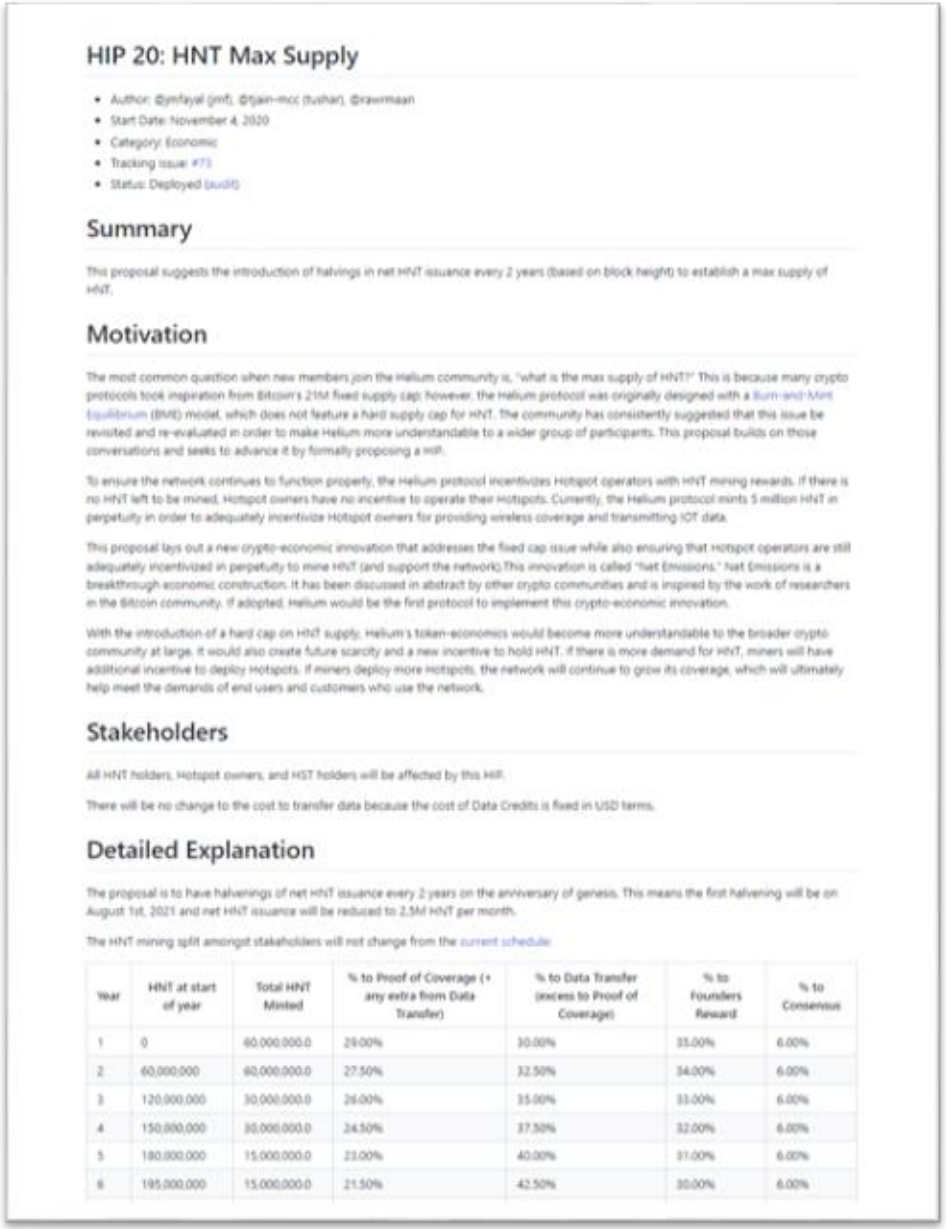
Net Emissions

@jmfayal (jmf), @tjain-mcc (tushar), @rawrmaan

HIP-20: HNT Max Supply

Recently deployed at 15 Sep. 2021

Available at https://github.com/helium/HIP



HIP 20: HNT Max Supply

- Author: @jmfayal (jmf), @tjain-mcc (tushar), @rawrmaan
- Start Date: November 4, 2020
- Category: Economic
- Tracking issue: #73
- Status: Deployed (audit)

Summary

This proposal suggests the introduction of halvings in net HNT issuance every 2 years (based on block height) to establish a max supply of HNT.

Motivation

The most common question when new members join the Helium community is, "what is the max supply of HNT?" This is because many crypto protocols took inspiration from Bitcoin's 21M fixed supply cap; however, the Helium protocol was originally designed with a Burn-and-Mint Equilibrium (BME) model, which does not feature a hard supply cap for HNT. The community has consistently suggested that this issue be revisited and re-evaluated in order to make Helium more understandable to a wider group of participants. This proposal builds on those conversations and seeks to advance it by formally proposing a HIP.

To ensure the network continues to function properly, the Helium protocol incentivizes Hotspot operators with HNT mining rewards. If there is no HNT left to be mined, Hotspot owners have no incentive to operate their Hotspots. Currently, the Helium protocol mints 5 million HNT in perpetuity in order to adequately incentivize Hotspot owners for providing wireless coverage and transmitting IOT data.

This proposal lays out a new crypto-economic innovation that addresses the fixed cap issue while also ensuring that Hotspot operators are still adequately incentivized in perpetuity to mine HNT (and support the network).This innovation is called "Net Emissions." Net Emissions is a breakthrough economic construction. It has been discussed in abstract by other crypto communities and is inspired by the work of researchers in the Bitcoin community. If adopted, Helium would be the first protocol to implement this crypto-economic innovation.

With the introduction of a hard cap on HNT supply, Helium's token-economics would become more understandable to the broader crypto community at large. It would also create future scarcity and a new incentive to hold HNT. If there is more demand for HNT, miners will have additional incentive to deploy Hotspots. If miners deploy more Hotspots, the network will continue to grow its coverage, which will ultimately help meet the demands of end users and customers who use the network.

Stakeholders

All HNT holders, Hotspot owners, and HST holders will be affected by this HIP.

There will be no change to the cost to transfer data because the cost of Data Credits is fixed in USD terms.

Detailed Explanation

The proposal is to have halverings of net HNT issuance every 2 years on the anniversary of genesis. This means the first halvening will be on August 1st, 2021 and net HNT issuance will be reduced to 2.5M HNT per month.

The HNT mining split amongst stakeholders will not change from the current schedule:

Year	HNT at start of year	Total HNT Minted	% to Proof of Coverage (+ any extra from Data Transfer)	% to Data Transfer (excess to Proof of Coverage)	% to Founders Reward	% to Consensus
1	0	60,000,000.0	29.00%	30.00%	35.00%	6.00%
2	60,000,000	60,000,000.0	27.50%	32.50%	34.00%	6.00%
3	120,000,000	30,000,000.0	26.00%	35.00%	33.00%	6.00%
4	150,000,000	30,000,000.0	24.50%	37.50%	32.00%	6.00%
5	180,000,000	15,000,000.0	23.00%	40.00%	31.00%	6.00%
6	195,000,000	15,000,000.0	21.50%	42.50%	30.00%	6.00%

Net Emissions

Recycle a pool of 'burned' HNT available for use in rewarding Hotspots.

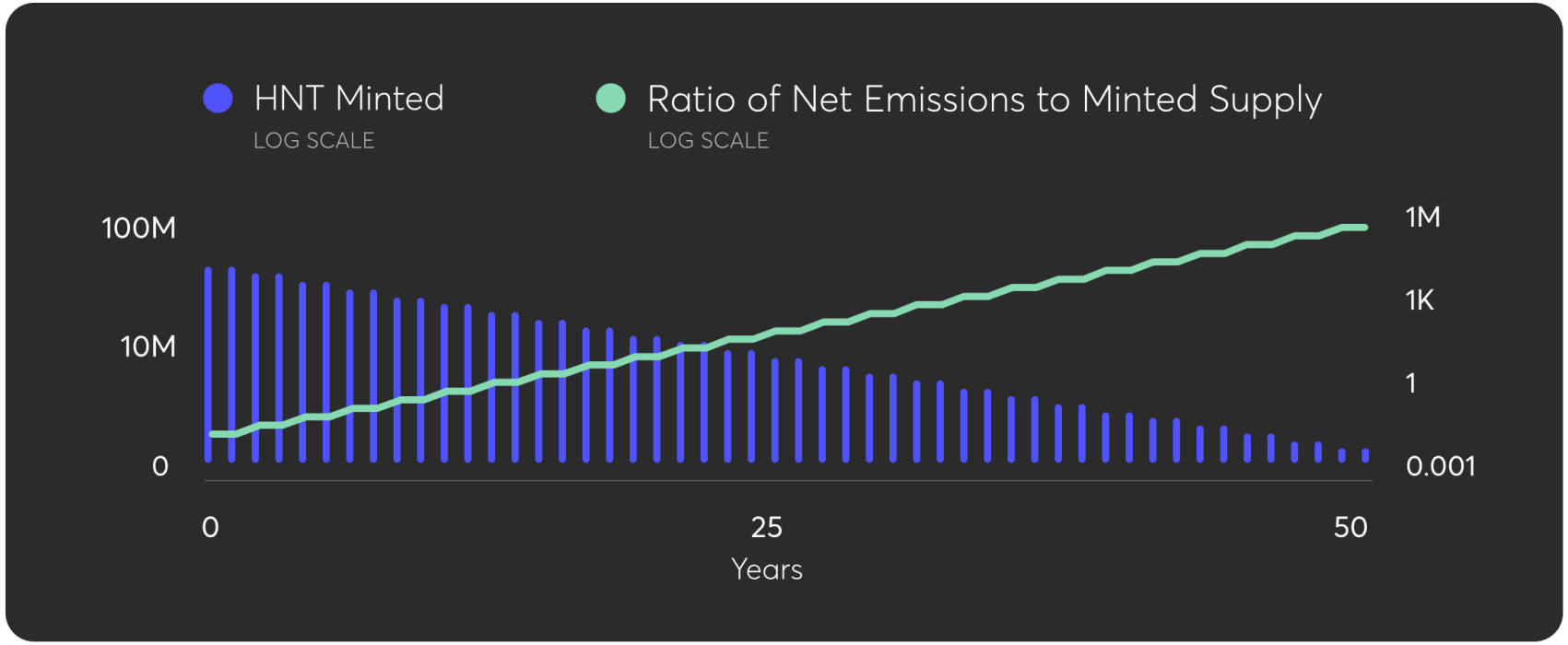
Net Emissions

Recycle a pool of 'burned' HNT available for use in rewarding Hotspots.

A cap of 34.24 HNT per epoch (1% of the current issuance)

Net Emissions

Theoretical Model: HNT Minted/Net Emissions Ratio vs. Time



Source: https://www.helium.com/token

Proof of Coverage

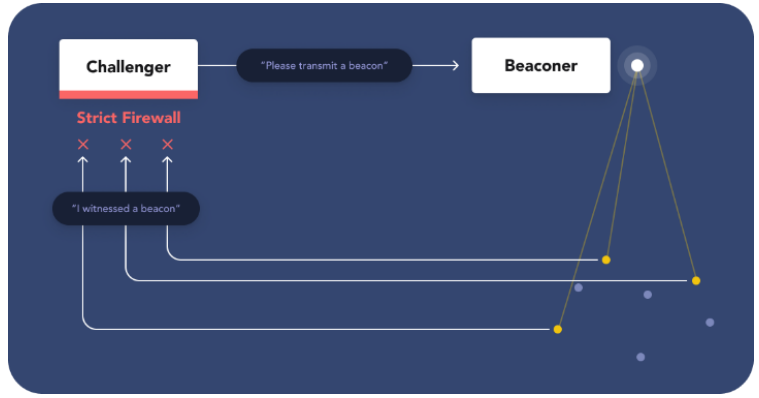
- **What’s Proof-of-Coverage(PoC)?**
- Helium's original consensus mechanism
- proves that the hotspot is real and working properly

PoC roles

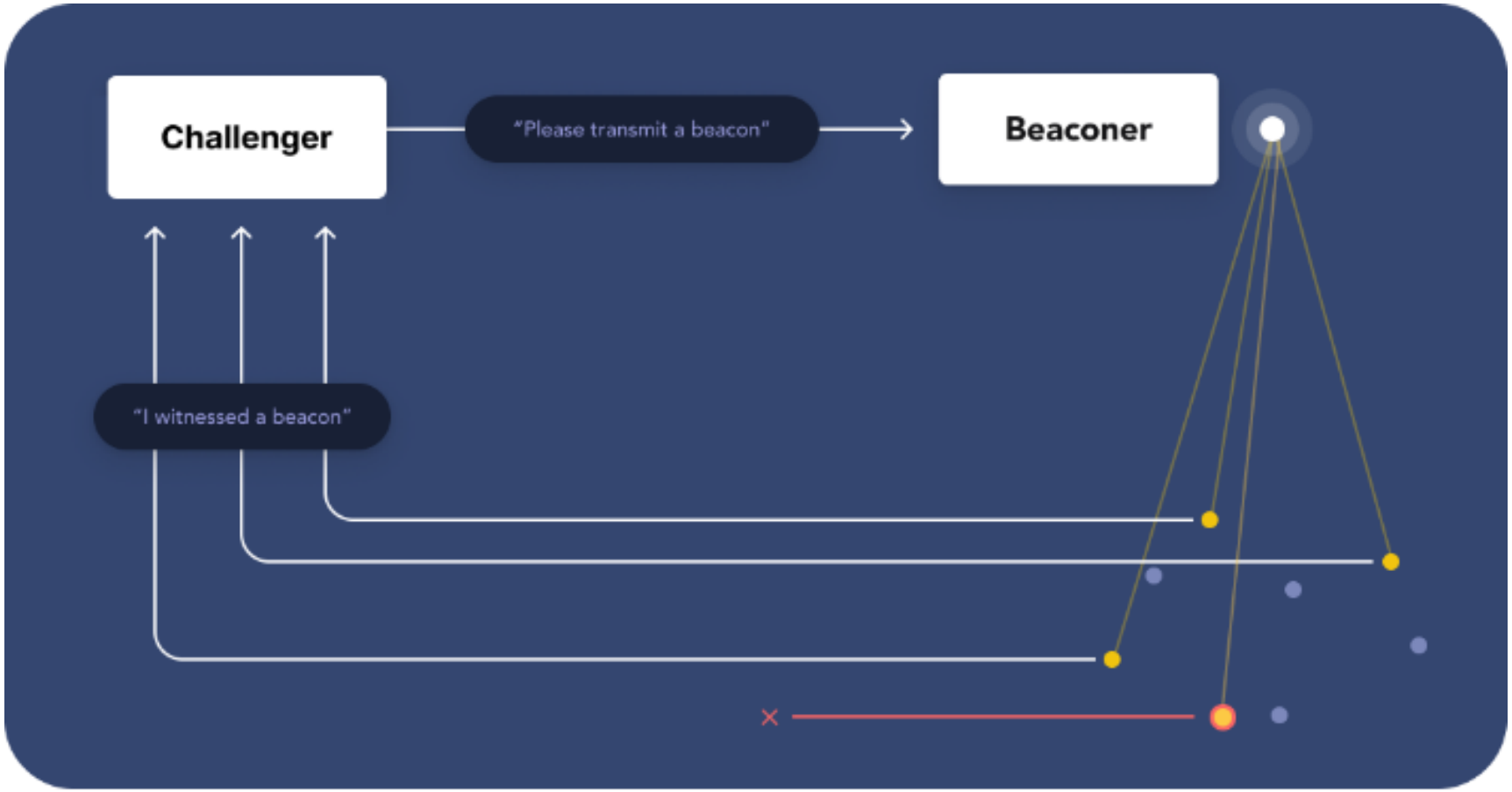
Challenger(0.9%):	Transmitter(5.02%):	Vitness(20.08%):
• Selected by the system; • Verifies the authenticity of coverage by sending commands to other hotspots in the vicinity;	• Sometimes called “Challengee”; • Used to prove that the peer’s own wireless coverage is real and valid;	• Monitor and report on proof-of-coverage activity at other hotspots; • The exact tokens rewarded depends on how much activity they witness and the percentage of rewards for proof of coverage;

Beacon

- **What's Beacon:**
- In the PoC progress, the challenged (Beaconer) verifies the message sent by the challenger and broadcasts the confirmation. The series of activities to broadcast the confirmation message are called beacons.



Beacon



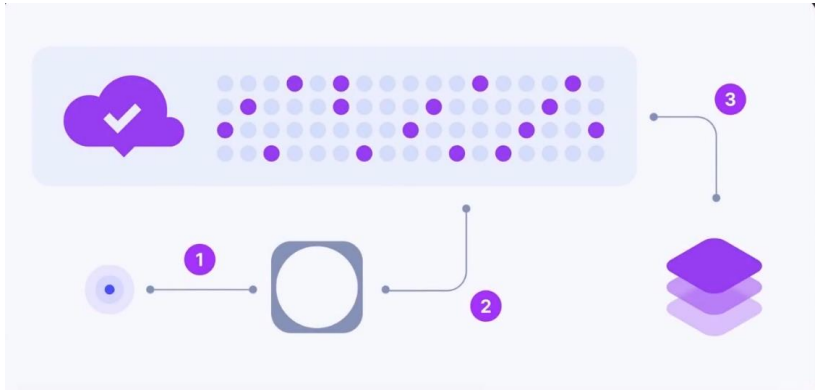
- **How it works**?
- The witness monitors and reports on the implementation of the beacon and sends the final message back to the challenger

Beacon

- If Any failure in any of these steps will result in no network rewards for the actors involved.
- Beacon occurs automatically and hotspots are witnessed automatically.

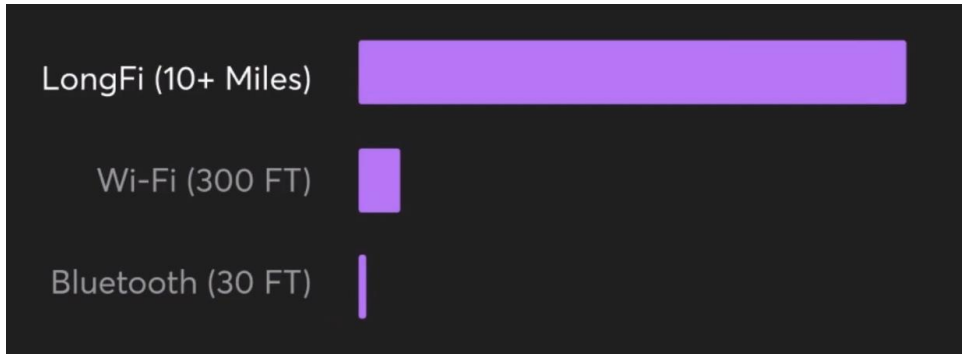
Consensus

- **The Consensus Group Election**
- The Consensus Group is elected by the system, the current consensus group consists of Validator validation nodes.
- **Validator(6%)**
- The main tasks performed by the validator include validating transactions and adding new blocks to the blockchain



Application Level

- LongFi
  - LongFi is a technology that mounts the traditional LoRaWAN wireless protocol to the Helium network.
  - LongFi signals generated by Helium hotspots can be transmitted to low power LoRaWAN devices. Such as GPS tacker、thermometers、hygrometers,etc...
  - LongFI supports a much a larger hotspot coverage compared to Wi-Fi and Bluetooth.



Application Level

- Console
  - Console is a web-based data management tool.

Future Works

- Helium announced a partnership with FreedomFi, a connectivity company producing open source 5G devices to develop its second wireless network.(https://freedomfi.com/helium5g/)
- 5G network deployment allows users to access Helium's 5G network directly through their cell phones.

THANK YOU!

QUESTIONS