

GAIA-X and the Web3 Sustainability Loop

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GAIA-X, Aug 30, 2021
Slides: <http://trent.st/content/gaiax-wsloop.pdf>

@trentmc0 @oceanprotocol



GAIA-X is getting built. 

Now, how can GAIA-X
be self-sustaining over the decades?



GAIA-X Sustainability Goals

Here's the challenge.

Find a design to enable...

- GAIA-X ecosystem *sustainable and growing*, towards *ubiquity*
- Funding goes to teams writing code, doing outreach, over the long term (decades)
- GAIA-X funding grows as usage of network grows

Including:

- Basic design is simple to understand and communicate
- Can be implemented in a pragmatic fashion, over time
- Get people to do “work”
- Encourage skin-in-the-game by users

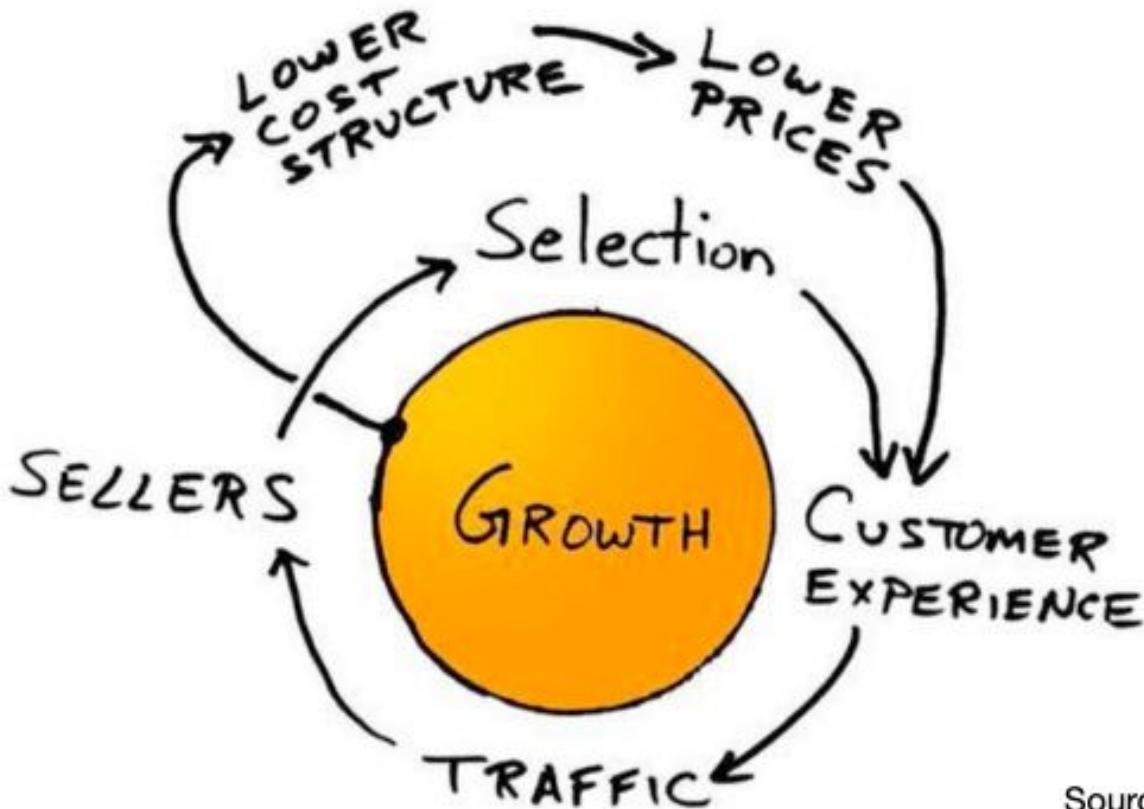
A choice of system-level design will lead to goals of sub-blocks in the system.



From Amazon to Web3 Sustainability



How does Amazon work?

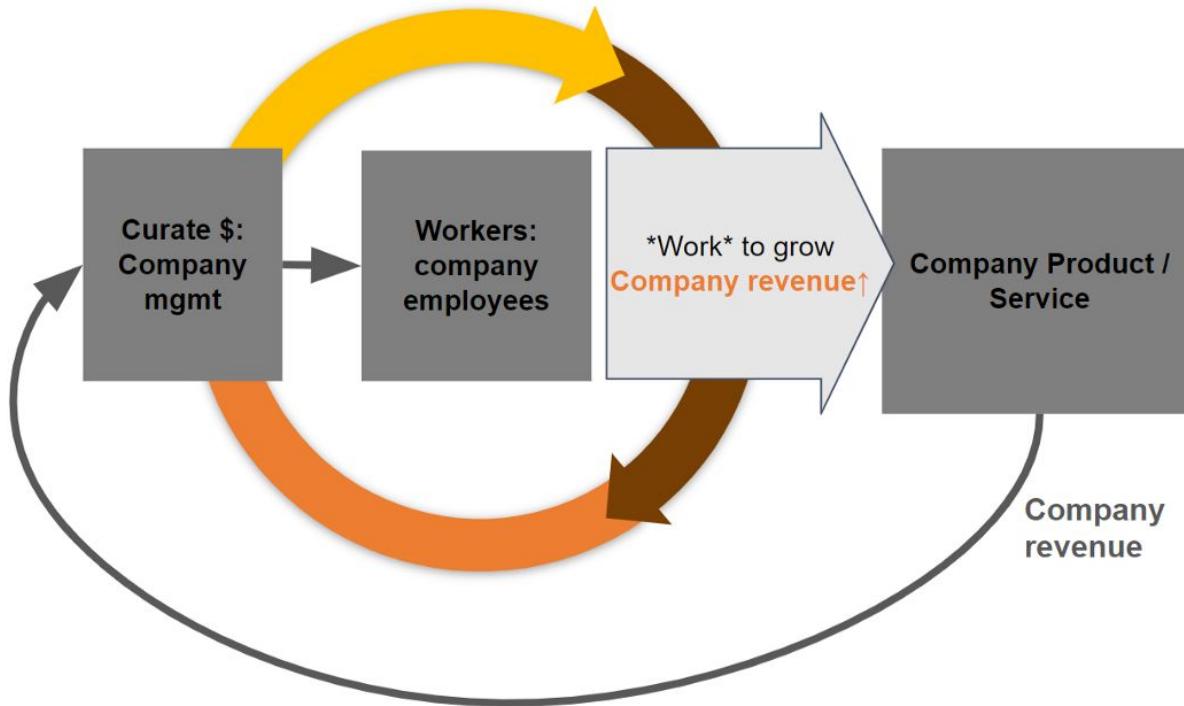


Source: Amazon



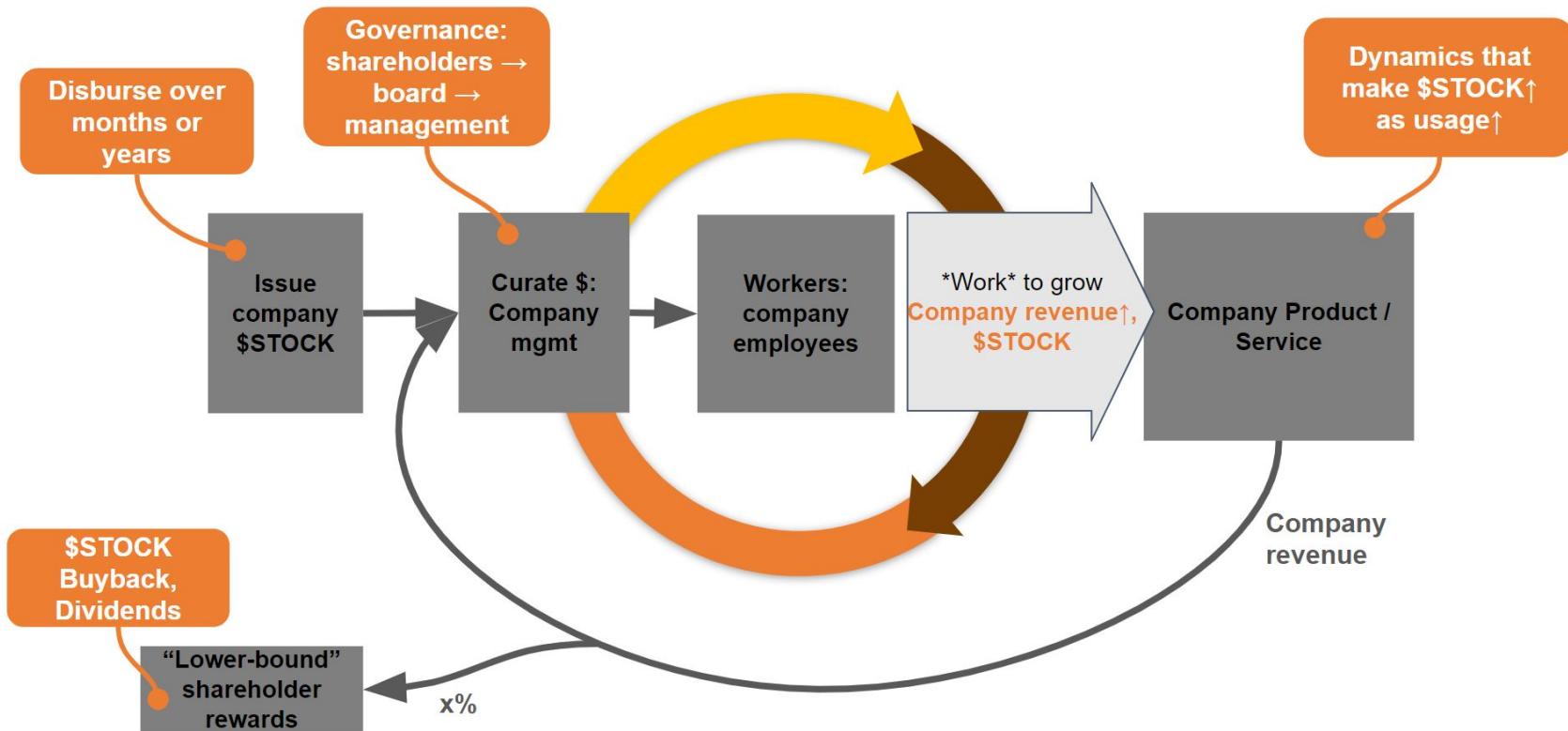
Company business model with a focus on revenue

Challenges: how to kickstart the company, how to grow fast enough to beat the competition



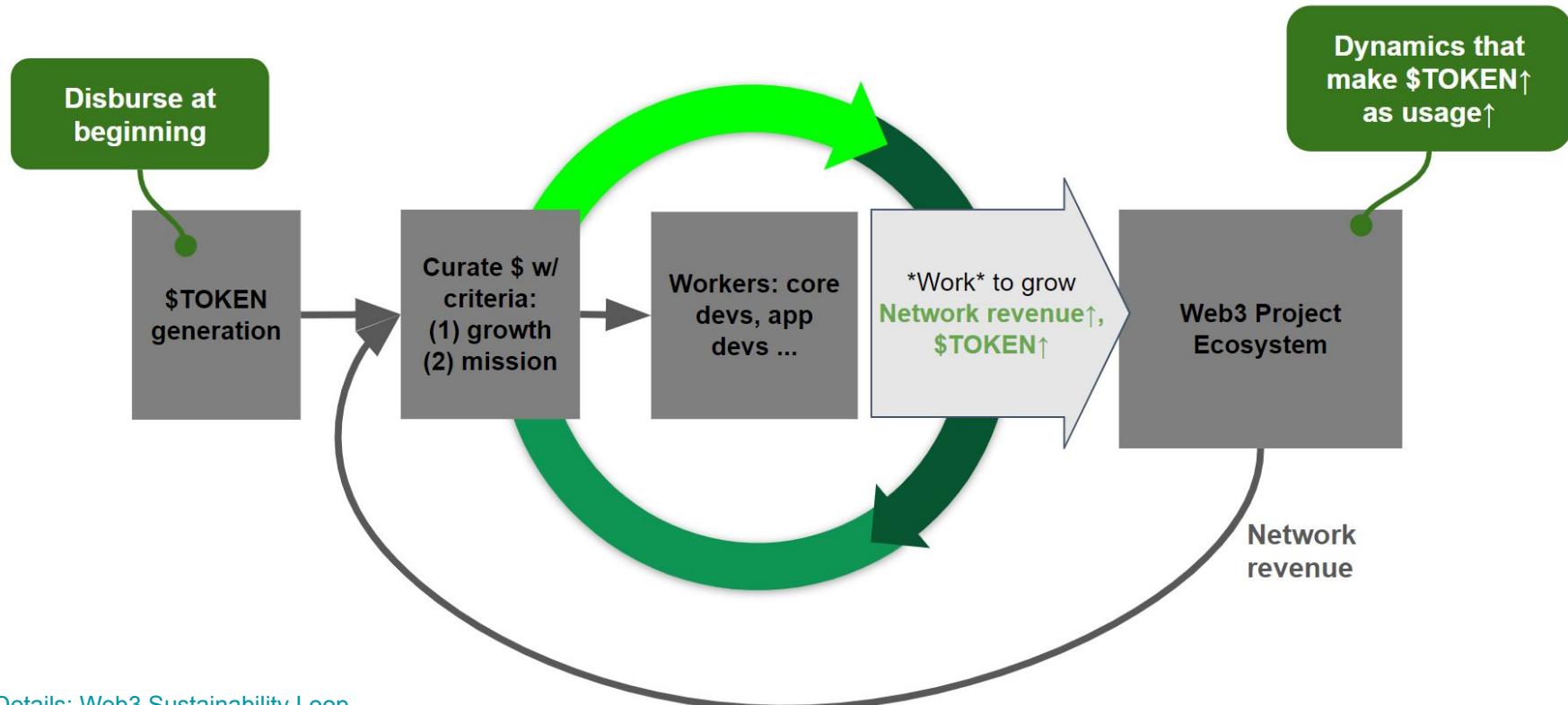
Company business model - full picture

Has an “outer wrapper” that uses stock as a tool, in addition to revenue.



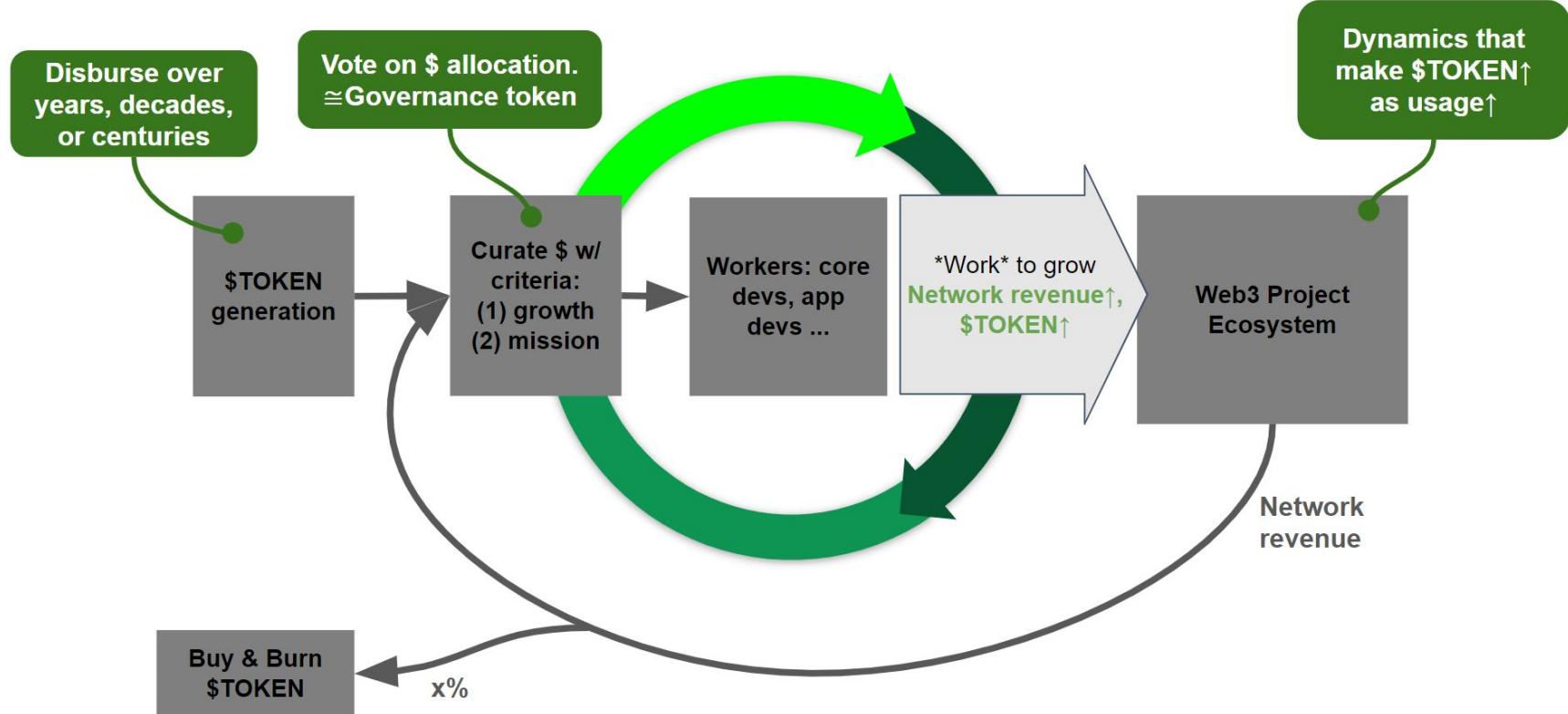
Web3 Model with a focus on revenue

But, challenges: how to kickstart the project, how to catalyze growth



The Web3 Sustainability Loop

Has an “outer wrapper” that uses tokens as a tool, in addition to revenue

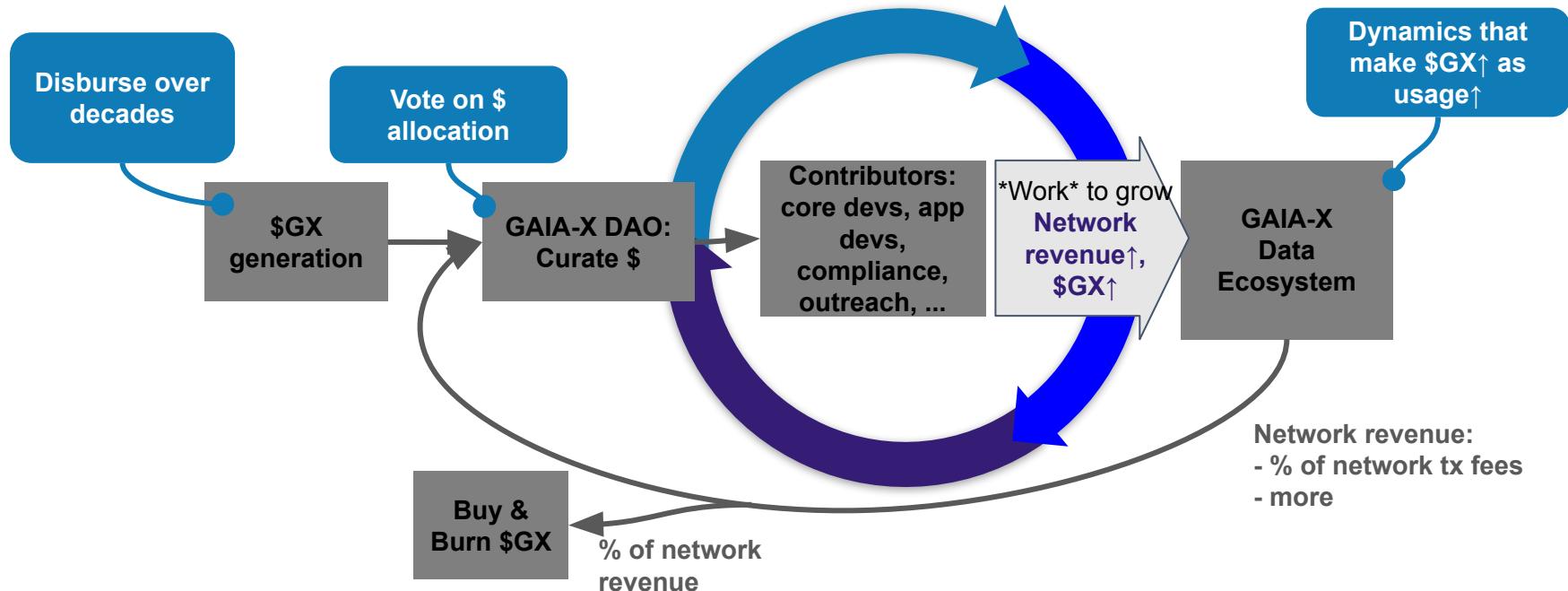


[Details: Web3 Sustainability Loop](#)



GAIA-X Sustainability Loop

Revenue for long-term sustainability, GX token to catalyze it



Will it work?

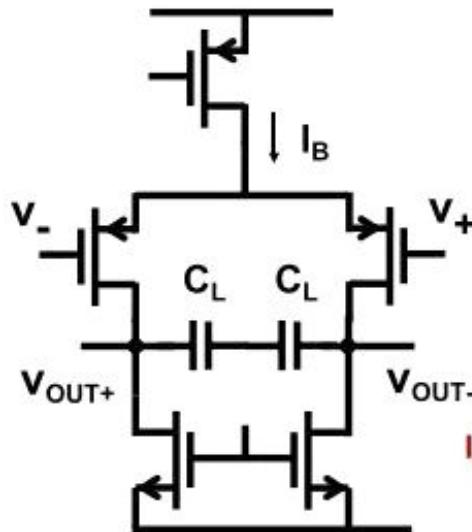
How do we verify the design?



Verification in Electrical Engineering



Pure Manual Analog Circuit Design



$$GBW = \frac{g_{m1}}{2\pi C_L} \quad g_{m1} = \frac{I_B}{V_{GS1}-V_T}$$

$$GBW_{max} = \frac{I_B}{V_{GS1}-V_T} \frac{1}{2\pi C_L}$$

0.2 V

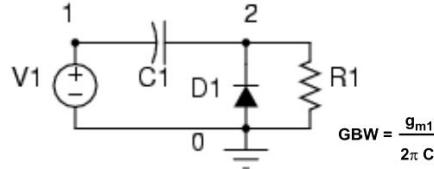
$$I_B = 10 \mu A \quad C_L = 1 pF \quad GBW_{max} \approx 10 \text{ MHz}$$

$$FOM = \frac{GBW \cdot C_L}{I_B} = 1000 \quad [800] \text{ MHz}\text{pF/mA}$$



SPICE workflow

Manual design

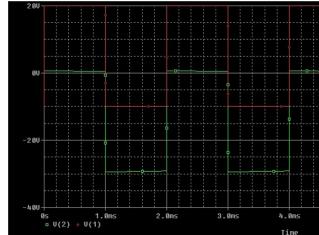


Enter netlist
(schematic editor, or write)

```
SPICE sample circuit - diode clamp
* sinusoidal voltage source with DC value, AC index, and
* AC frequency. The source has a peak-to-peak value of 20 V. I.e., it's 10V RMS over a period
* of 1 ms. The source is connected to node 1.
* capacitor for clamping
C1 1 2 1e-6
* diode for clamp - model name is diclamp
D1 2 0 diclamp
* load resistor - large enough that MC >> 2 ns
* model for diode is ideal (i.e., 1A)
* MC transfer function generated for this circuit
.MC V1=10 20 1
.MC V1=10 20 1
.MC frequency sweep - assumes circuit is biased with V1 =
.MC
```

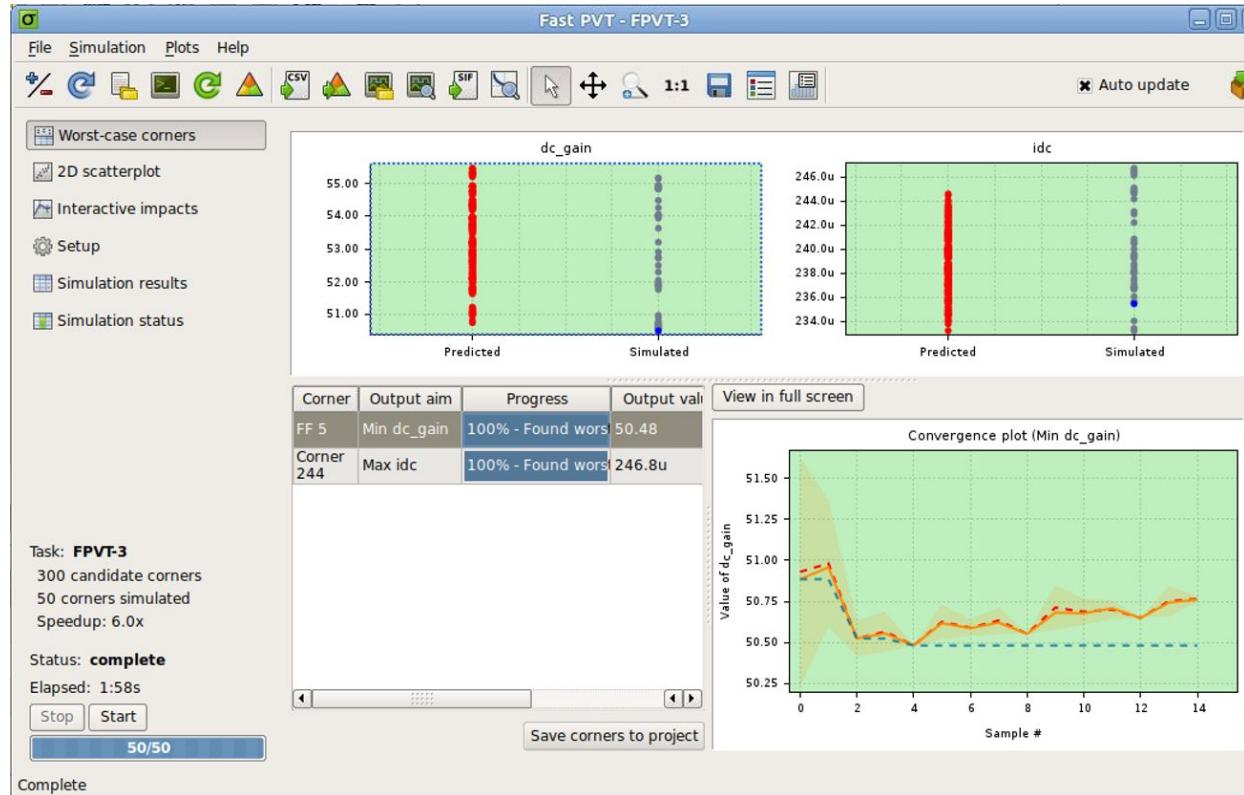


Run SPICE



Example: Verification with SPICE

Solido Fast PVT: Worst-case analysis via global optimization



Verification in Token Engineering



How To Verify

It's pragmatic to do verification in **phases** of increasing fidelity:

1. **Humans.** Subjective discussions, with increasing # people. 1 → 2 → key stakeholders
2. **Software modeling**, with increasing fidelity. Spreadsheet → **simulation**
3. **Economic (live)**. Can ratchet value-at-risk over time. People can choose risk/reward tradeoff. Phased approach.

Let's focus on simulation here...



TokenSPICE

<https://github.com/tokenspice/tokenspice>



TokenSPICE: EVM Agent-Based Token Simulator

TokenSPICE can be used to help design, tune, and verify tokenized ecosystems in an overall Token Engineering (TE) flow.

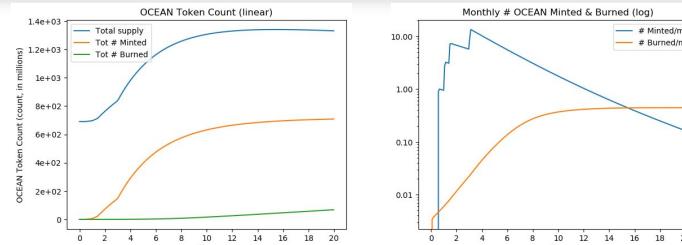
TokenSPICE simulates tokenized ecosystems using an agent-based approach.

Each "agent" is a class. Has a wallet, and does work to earn \$. One models the system by wiring up agents, and tracking metrics (kpis). Agents may be written in pure Python, or with an EVM-based backend. (The [original version](#) was pure Python. This repo supersedes the original.)

It's currently tuned to model [Ocean Market](#). The original version was tuned for the [Web3 Sustainability Loop](#). However you can rewire the "netlist" of "agents" to simulate whatever you like. Simply fork it and get going.

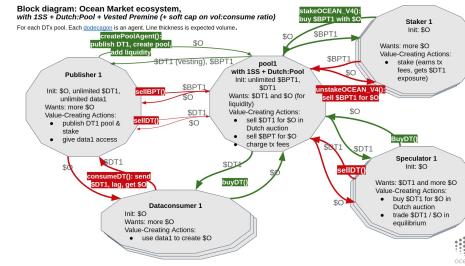
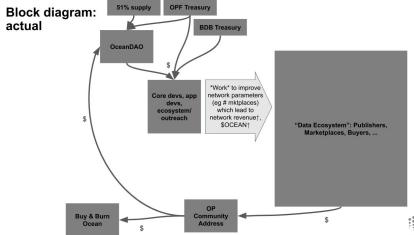
TokenSPICE was meant to be simple. It definitely makes no claims on "best" for anything. Maybe you'll find it useful.

[Documentation.](#)



TokenSPICE workflow

Manual design



Python

+ Solidity (EVM)

Enter netlist
(schematic editor, or write)



```
new_agent.addMarketplaceAgent();
    name = "marketplace";
    id = OCEAN+0;
    sell_agent_name = "ocean";
    receiving_agent_name = "marketplace";
    receiving_agent_id = OCEAN+1;
    time_step = 1;
    max_dt = 1;
}

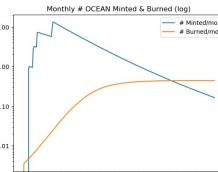
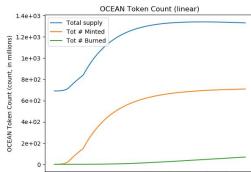
new_agent.addMarketplaceAgent();
    name = "ocean";
    id = OCEAN+1;
    sell_agent_name = "ocean";
    receiving_agent_name = "marketplace";
    receiving_agent_id = OCEAN+0;
    time_step = 1;
    max_dt = 1;

new_agent.addOBM();
    name = "OBM";
    id = OCEAN+2;
    sell_agent_name = "ocean";
    receiving_agent_name = "OBM";
    receiving_agent_id = OCEAN+3;
    time_step = 1;
    max_dt = 1;
```

```
new_agent.addOBM();
    name = "OBM";
    id = OCEAN+2;
    sell_agent_name = "ocean";
    receiving_agent_name = "OBM";
    receiving_agent_id = OCEAN+3;
    time_step = 1;
    max_dt = 1;

new_agent.addOBM();
    name = "OBM";
    id = OCEAN+3;
    sell_agent_name = "OBM";
    receiving_agent_name = "OBM";
    receiving_agent_id = OCEAN+2;
    time_step = 1;
    max_dt = 1;
```

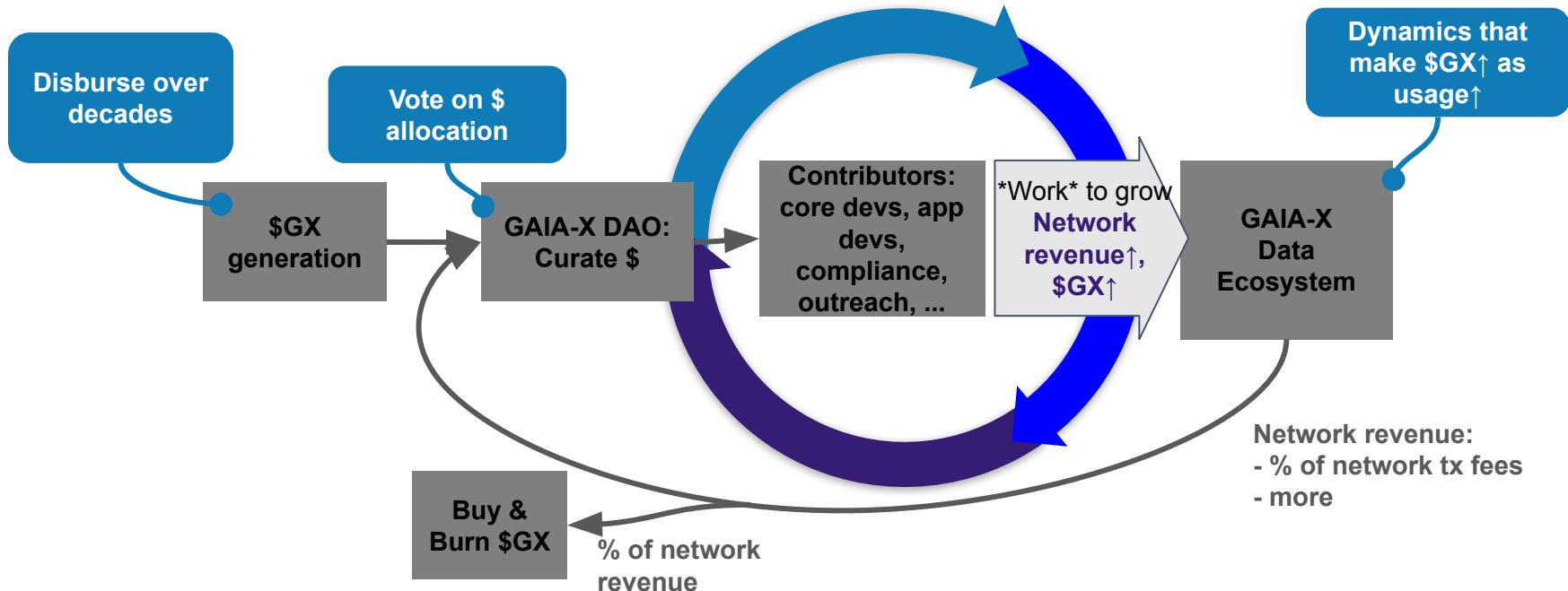
Run
TokenSPICE



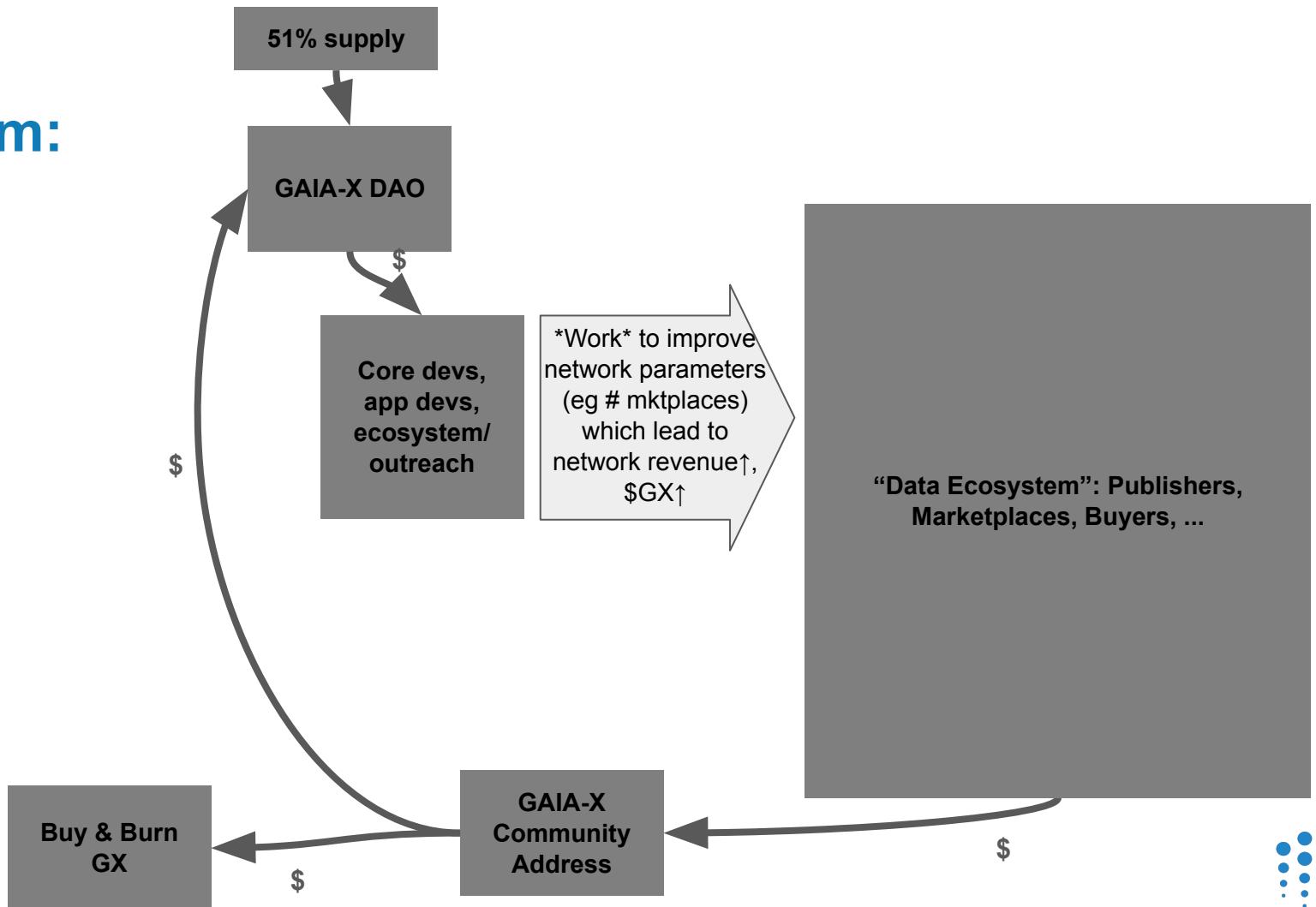
Agent-Based Simulation to Verify GAIA-X Ecosystem Sustainability



GAIA-X Ecosystem block diagram - simplified version

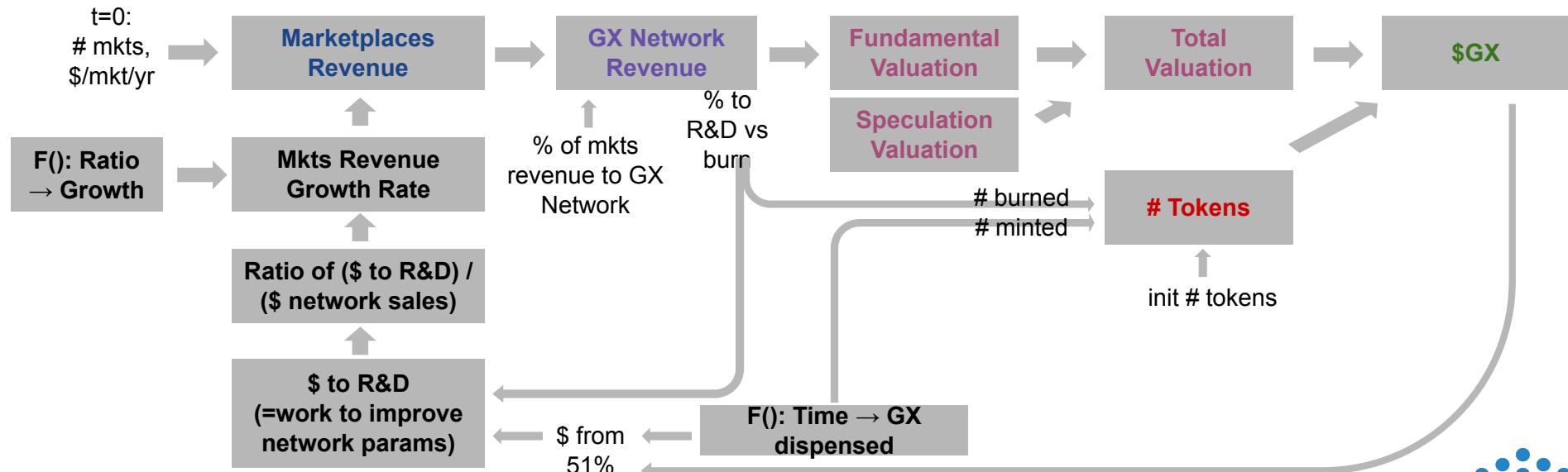


Block diagram: actual



Key variables being modeled

- We can model GAIA-X revenue and \$GX over time. This helps our decision-making.
 - We can model **marketplaces' revenue**. Depends on initial parameters, and \$ growth rates.
 - From that, we can model **GAIA-X network revenue**. Depends on % mkts revenue to GAIA-X network.
 - From that, we can model fundamental **valuation** of GAIA-X network (e.g. P/S). Can compare this to speculation-based component too.
 - We can also model **# tokens**, including effects of minting and burning
 - From valuation of GAIA-X network, and # tokens, we can model **\$GX**



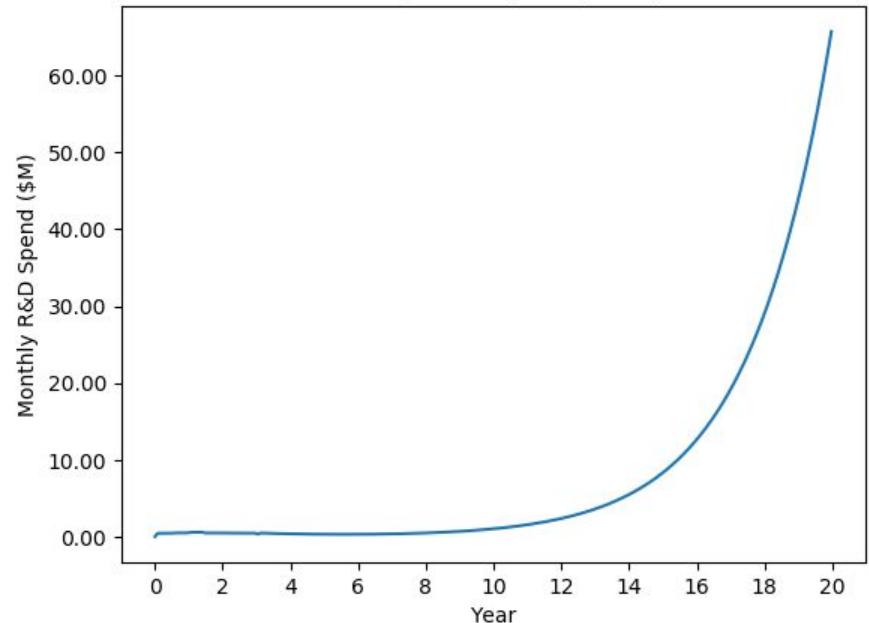
TokenSPICE Parameter Settings

- Simulation time 20 years
- Growth rate info:
 - `growth_rate_if_0_sales = -11.8%` (for total = -25%)
 - `max_growth_rate = 41.5%` (for total = 100%)
 - `tau = 0.6` (ie ratio needs to be 0.6 just for half the total range. MUCH higher than before)
 - `$ R&D = grantTakersMonthlyRevenueNow(); $ sales = gaiaXMonthlyRevenueNow()`
- GAIA-X toll from marketplaces revenue: 5%
- Speculation valuation at t=0: \$20M
- Growth rate of speculation valuation: 10% / year
- Fundamentals valuation approach: P/S = 30x
- % of revenue to burn directly: 10%
- Ramped exponential minting: like right side of 20200505: $H=4.0$, $T0=0.5$, $T1=1.0$, $T2=1.4$, $T3=3.0$, $M1=0.10$, $M2=0.25$, $M3=0.50$. Stop after 34 halvings (about 125 years)
- DAO is funded by: minting over time, some pre-mine

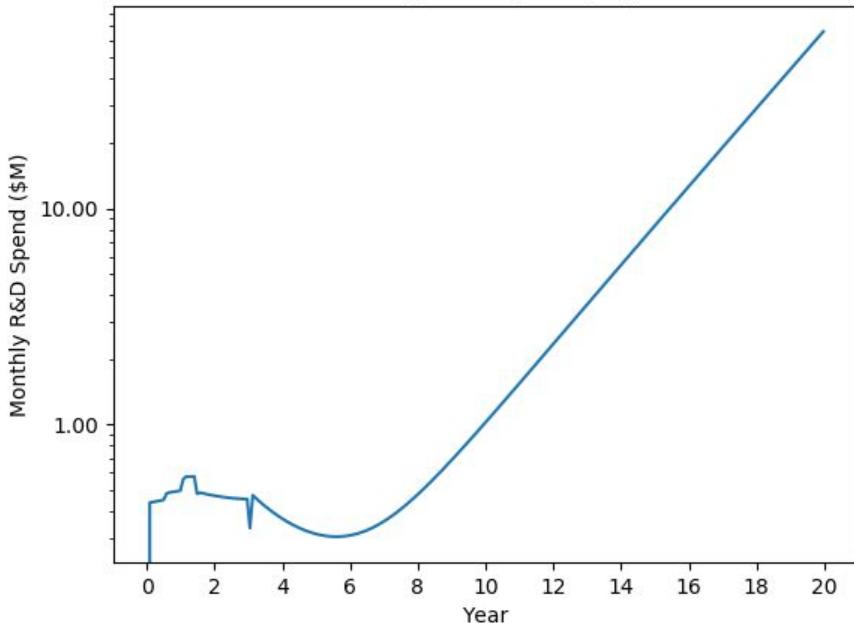


Monthly R&D Spend

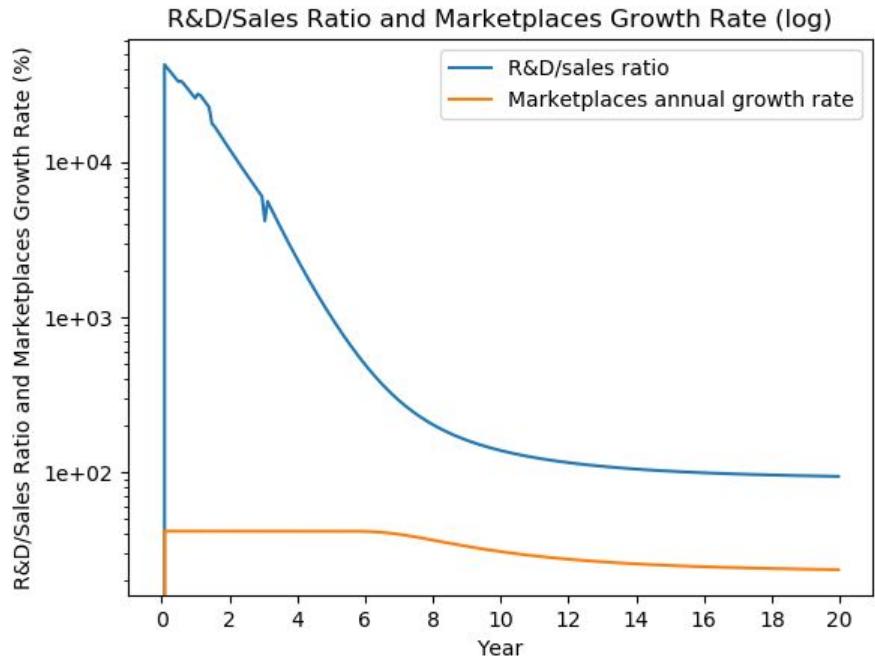
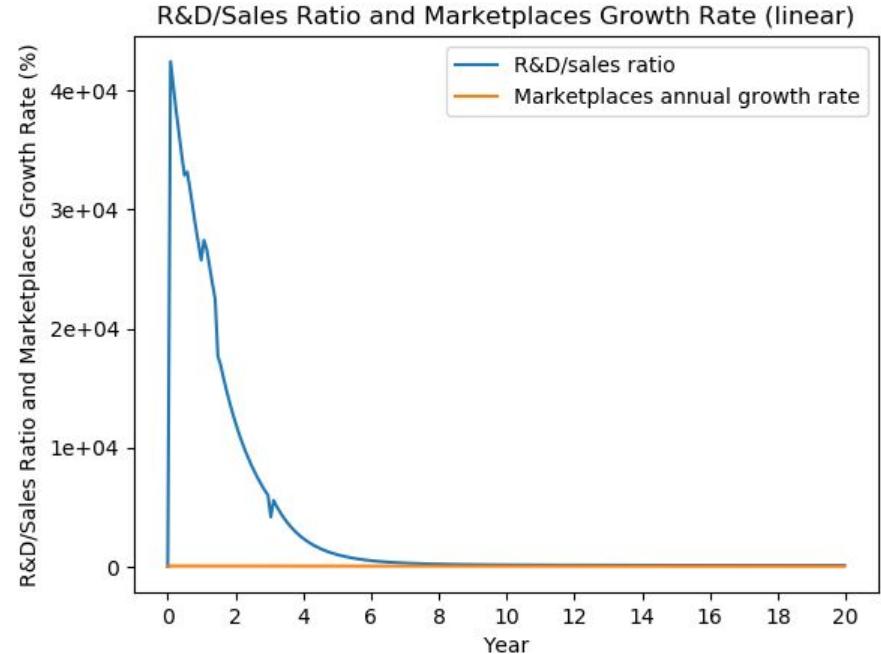
Monthly R&D Spend (linear)



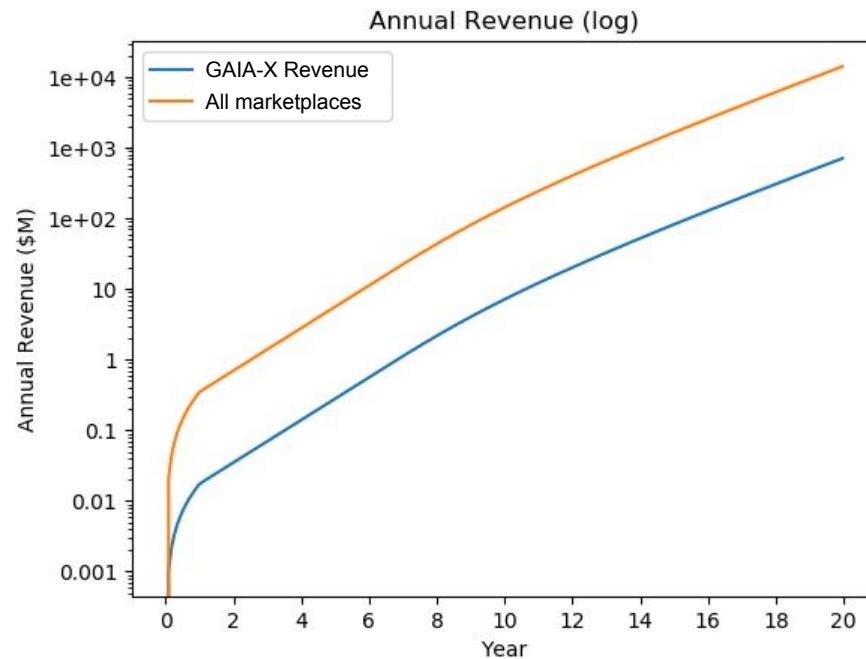
Monthly R&D Spend (log)



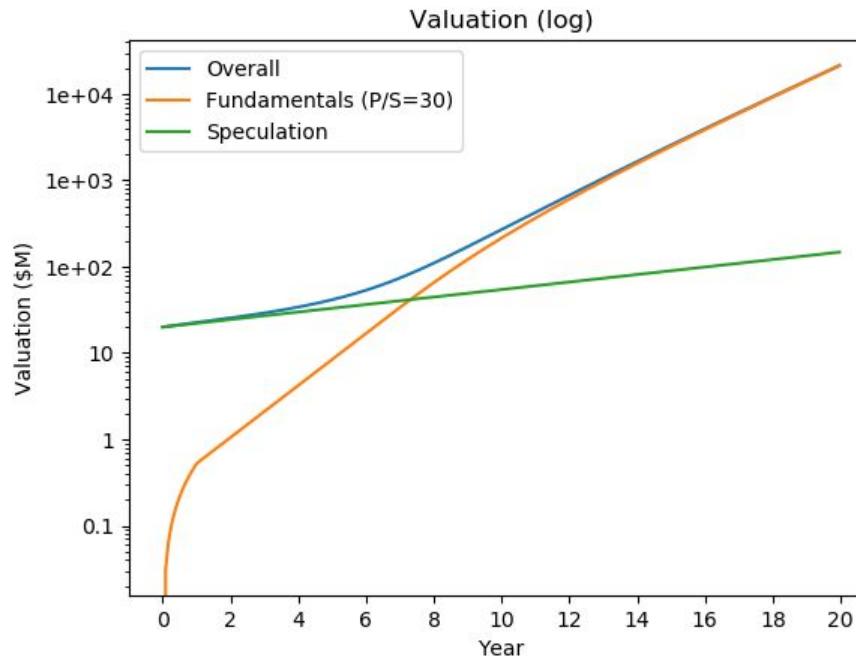
R&D/Sales Ratio, Marketplaces Growth Rate



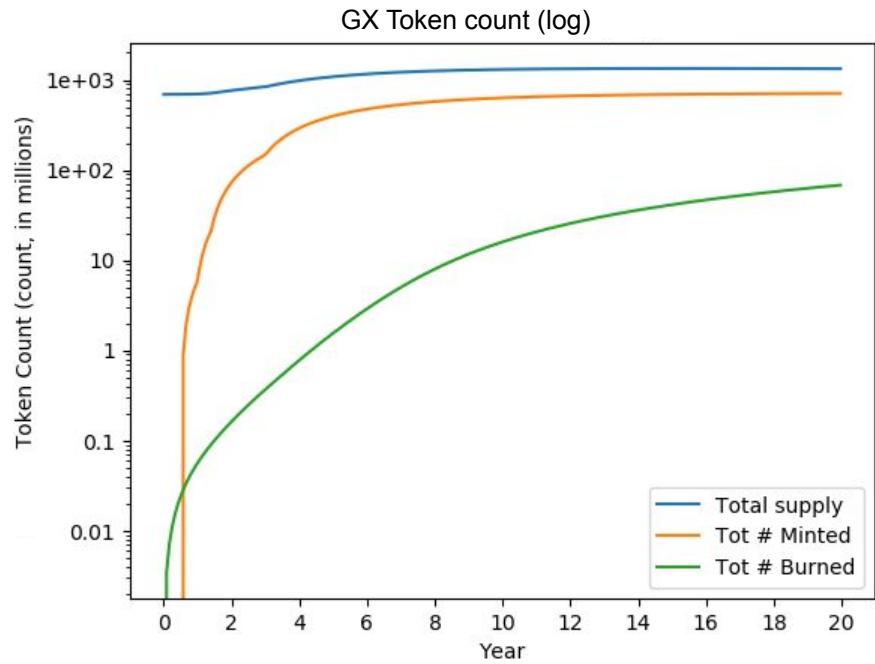
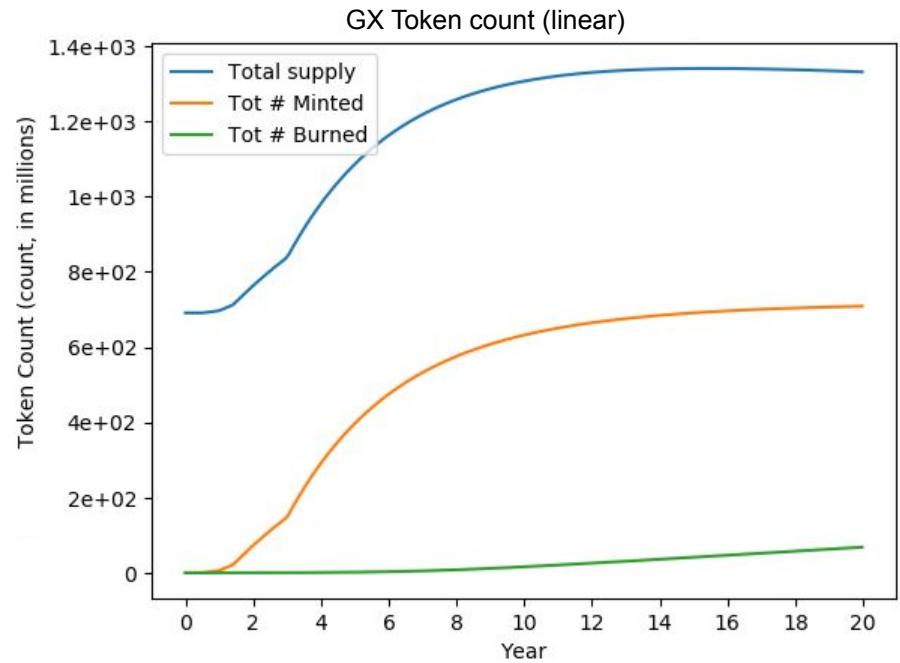
Revenue



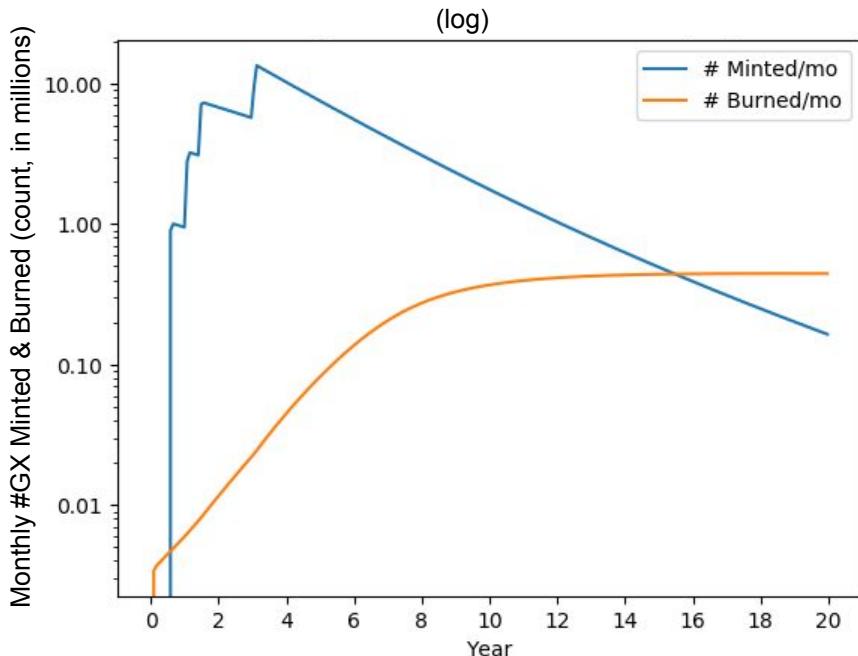
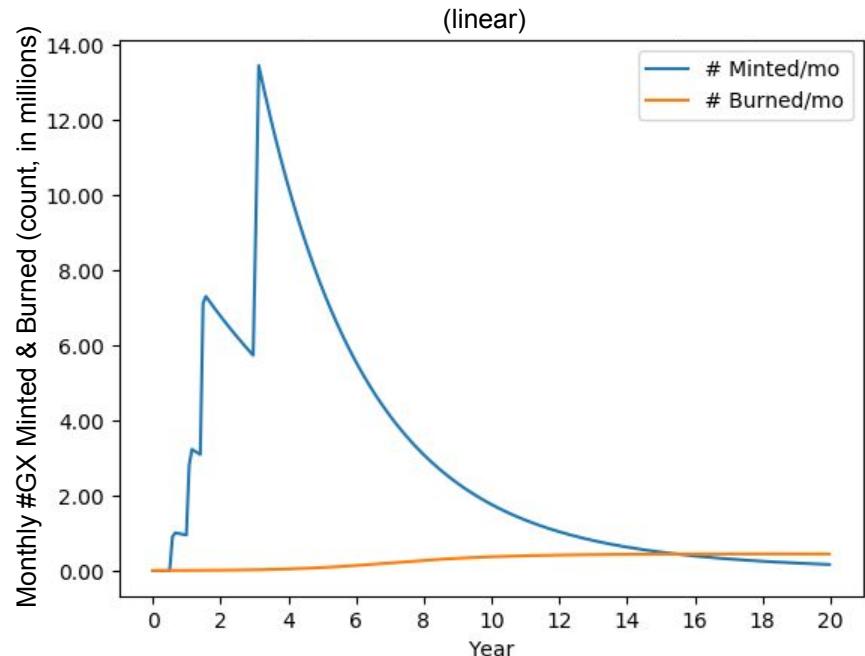
Valuation



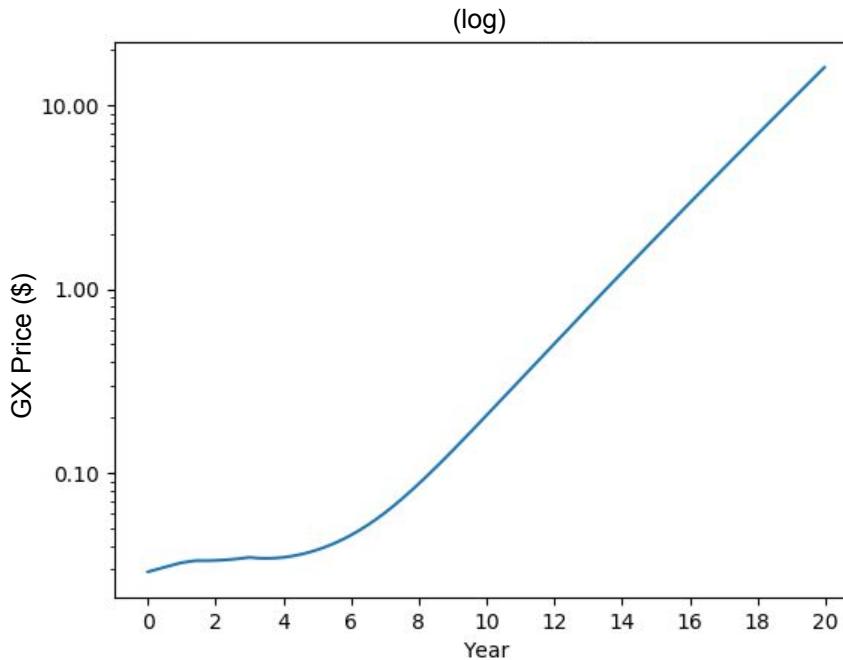
Token count



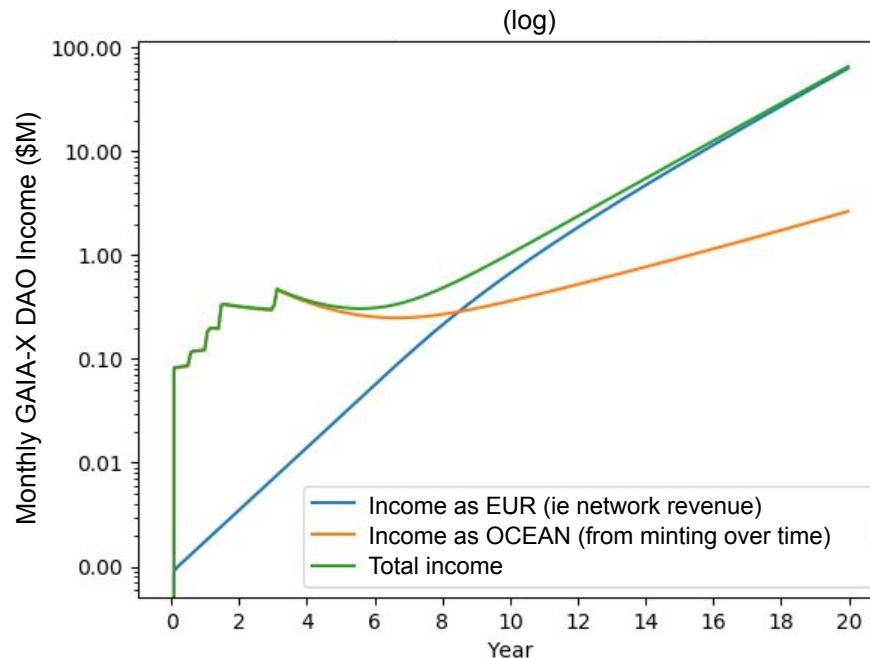
Monthly # GX minted & burned



GX price = valuation / (num tokens)



GAIA-X DAO Income



Revisiting System-Level Goals



On GAIA-X Sustainability Goals

Summary: The “GAIA-X Sustainability Loop” meets the goals.

- ✓ GAIA-X ecosystem *sustainable and growing*, towards *ubiquity*
- ✓ Funding goes to teams writing code, doing outreach, over the long term (10+ years)
- ✓ GAIA-X funding grows as usage of network grows

Including:

- ✓ Basic design is simple to understand and communicate
- ✓ Can be implemented in a pragmatic fashion, over time
- ✓ Get people to do “work”
- ✓ Encourage skin-in-the-game by users

Now, given that a choice of system-level design will lead to goals of sub-blocks in the system.

Let's zoom into sub-blocks.



**We have a system-level design.
What about the sub-blocks?**



GAIA-X Sub-block goals & how

A choice of system-level design leads to specific goals for sub-blocks, as follows:

- Data Ecosystem: Blockchain, smart contracts, and backend services
 - **Goal: meet GAIA-X specs for data sharing. (Many specs!!)**
 - How: pragmatic design & open-source implementation of smart contracts, backend services, libraries
 - **Goal: as tx volume goes up, it drives \$GX**
 - How: 10% of network tx fees go to GAIA-X community. A fraction of that is burned.
- Data Ecosystem: Marketplace apps:
 - **Goal: Get “work” and skin-in-the-game by curators, referrers, third-party marketplace owners**
 - How: pragmatic design & open-source implementation of marketplace app
- GAIA-X DAO:
 - **Goal: curation of projects (governance) encourages skin-in-the-game and long-term sustainability**
 - How: DAO where anyone can propose projects, GX token to vote. Funded by GX token minting & network revenues.



Sub-Block: GAIA-X DAO



GAIA-X and DAOs

4.1 Decentralized Autonomous Organization

Decentralized Autonomous Organization¹, DAO, is a type of governing model where:

- There is no central leadership.
- Decisions are made by the community's members.
- The regulation is done by a set of automatically enforceable rules on a distributed ledger whose goal is to incentive its community's members to achieve a shared common mission.
- The organization has its own rules, including for managing its own funds.

4.2 Gaia-X Association roles

Based on the objective and constraints to achieve those objectives, Gaia-X Association is creating a Gaia-X DAO.



How might GAIA-X DAO look?

GAIA-X DAO is a grants DAO to help fund GAIA-X community projects, curated by the GAIA-X community.

- Anyone can propose a project
- There is open discussion in forums and town halls
- Vote on proposals with GX token
- \$100K to \$1M+ per month funding available (see simulations)

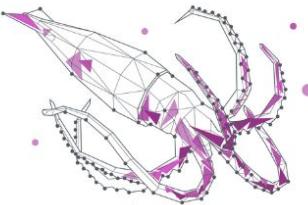
- Key constraint: expected ROI > 1.0 of grants over time



Example landing page - OceanDAO

Funding Rounds

Register & Vote on Proposals



oceanDAO

Round 9

\$300K USD available in grants
Submit your proposal by **Sept 7**
Vote from **Sep 9 - 13**

Builders

Create a Proposal, Submit it to port, and we'll take it from there.

SUBMIT PROPOSAL

Voters

Learn and vote on the best projects that deserve funding from the DAO!

View Proposals

Each Team can register one Proposal per Funding Round. Funding Rounds take place at the beginning of each month.

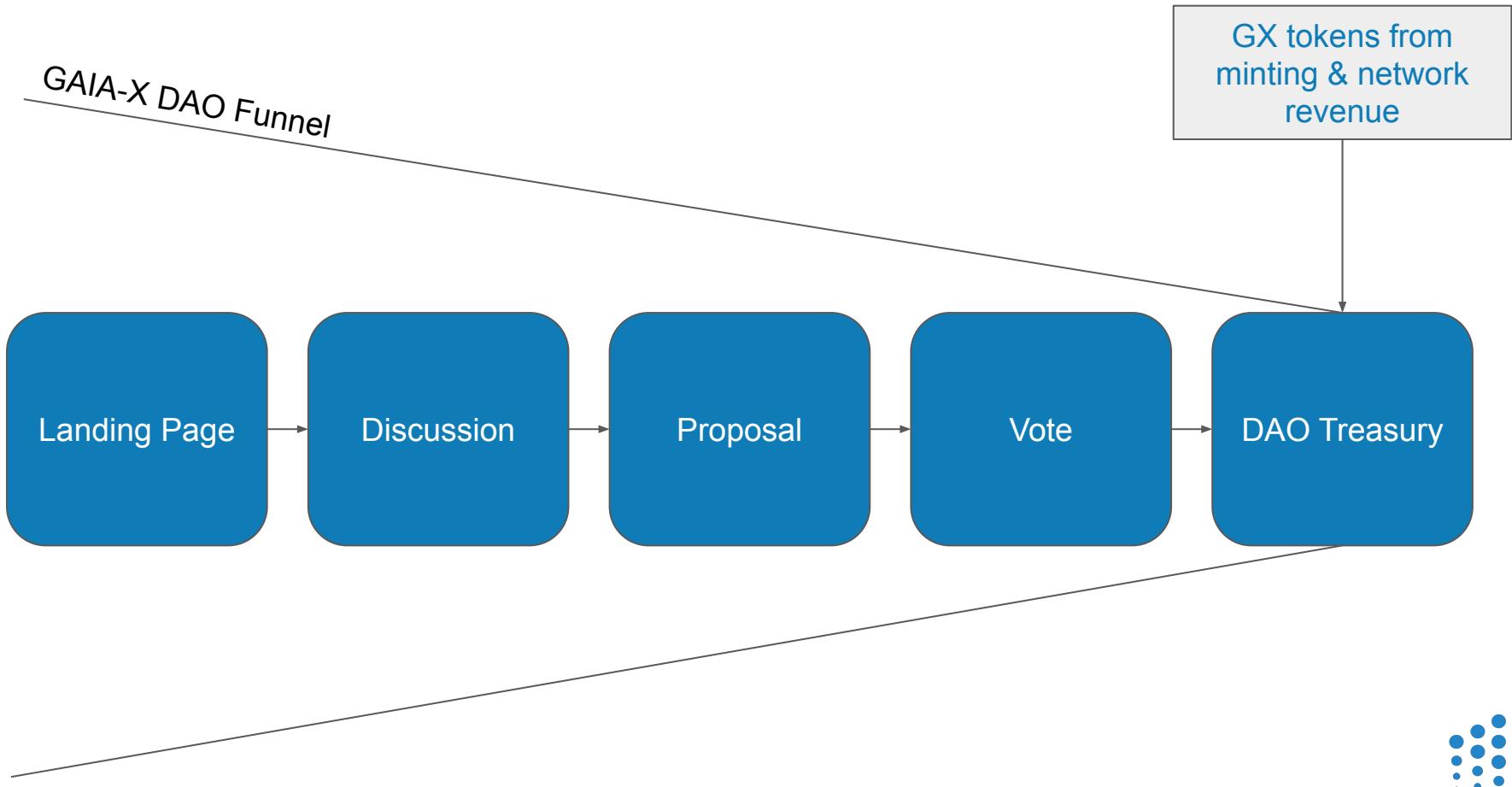
- Sep 2021 - Round 9 Proposals
- Aug 2021 - Round 8 Proposals
- Jul 2021 - Round 7 Proposals
- Jun 2021 - Round 6 Proposals
- May 2021 - Round 5 Proposals

Vote On Proposals

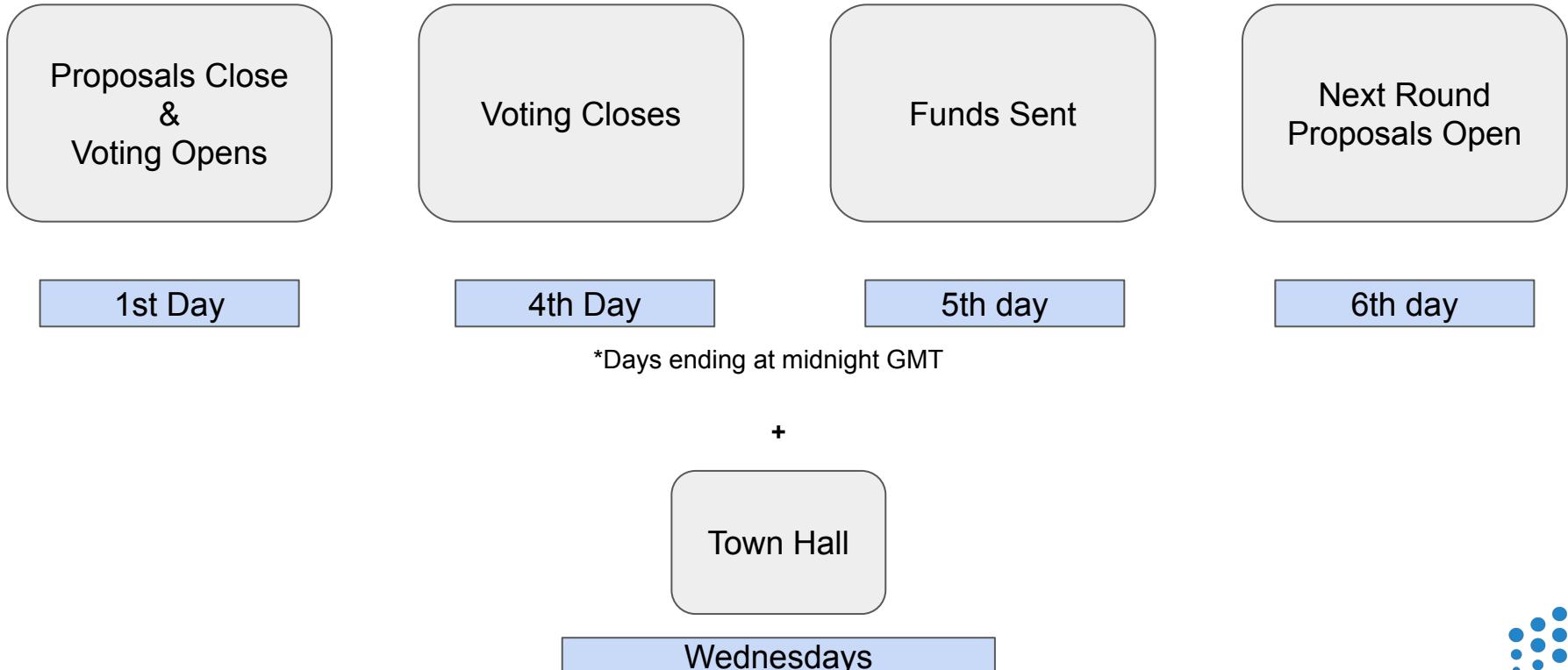
Support teams and projects across a wide range of categories! Vote on the best projects, and help Ocean grow!

- Sep 2021 - Round 9 Votes
- Aug 2021 - Round 8 Votes
- Jul 2021 - Round 7 Votes
- Jun 2021 - Round 6 Votes
- May 2021 - Round 5 Votes

GAIA-X DAO Component Stack



A monthly cadence of funding cycles



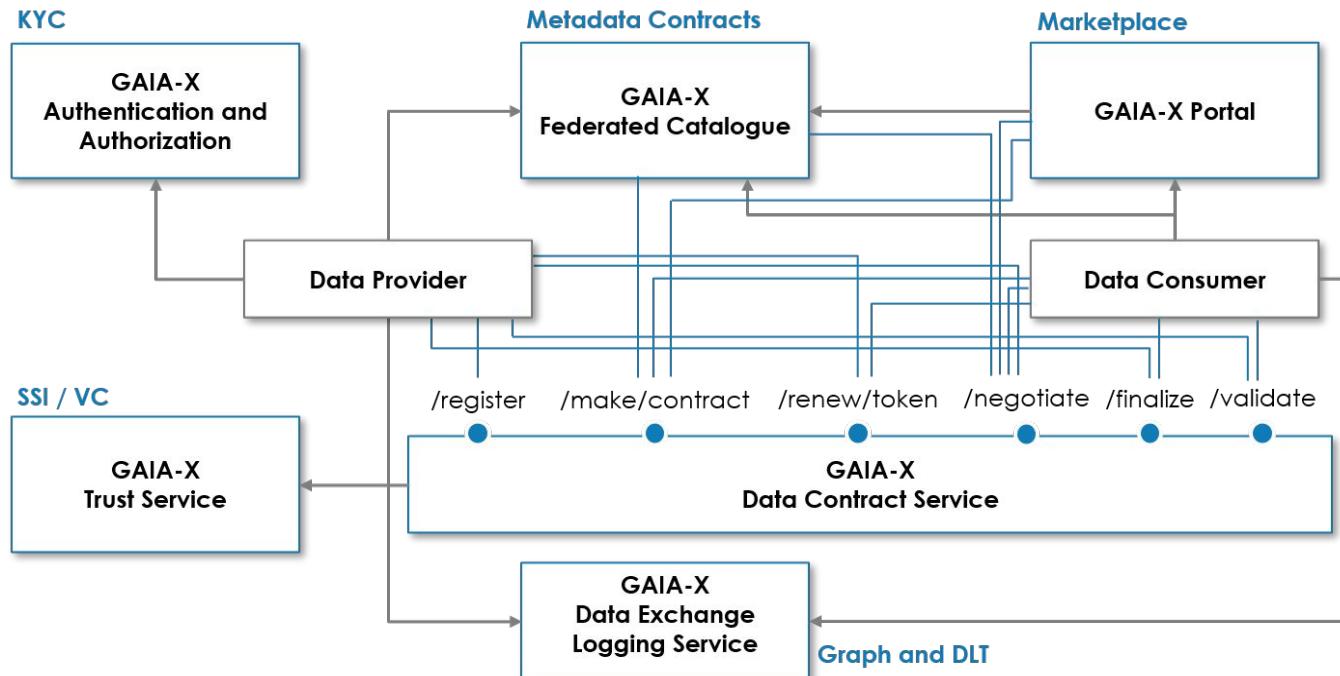
Sub-Block: Data Ecosystem



Q: How to implement a data ecosystem reconciling GAIA-X Sustainability Loop?

A: Support GX token at data ecosystem level, via DLT

Example: GAIA-X Reference Architecture with DLT components (ref. Ocean Protocol)



Source: Sovereign Data Exchange Data Contract Service
<https://www.gxfs.de/federation-services/overview-specification-documents/>

Image is licensed under a CC BY 4.0 license, Gaia-X, European Association for Data and Cloud, AISBL.
Remixed by deltaDAO AG for illustration purposes regarding the [Gaia-X architecture document 21.06](#).



Access Control

Tokenized data access control on DLT

Access to data services managed by smart contracts

If a consumer spends a [datatoken](#), access is granted.
More [conditions](#) in the SC are possible.

Data access rights in the form of datatokens can be transferred on-chain. Smart Contracts become a tool to pool data and conditionalize data sharing.



Access control

Token-based data access control on DLT.

Data Traceability and Integrity

Each access to data services is recorded on-chain

Results of computations can be registered on chain as well

Subsequent data uses can be tracked and traced



Ensure Data Traceability and Integrity
AI model and Data Lineage Tracking. Traceability
by design. Enabled by Smart Contracts.

Smart Contracts enable trustless traceability and auditability of data services, also for subsequent data use.

Data Portals

Buy & sell data services on data portals, enabled by Smart Contracts

Download, stream, or access data via [compute-to-data](#) enabled by Smart Contracts

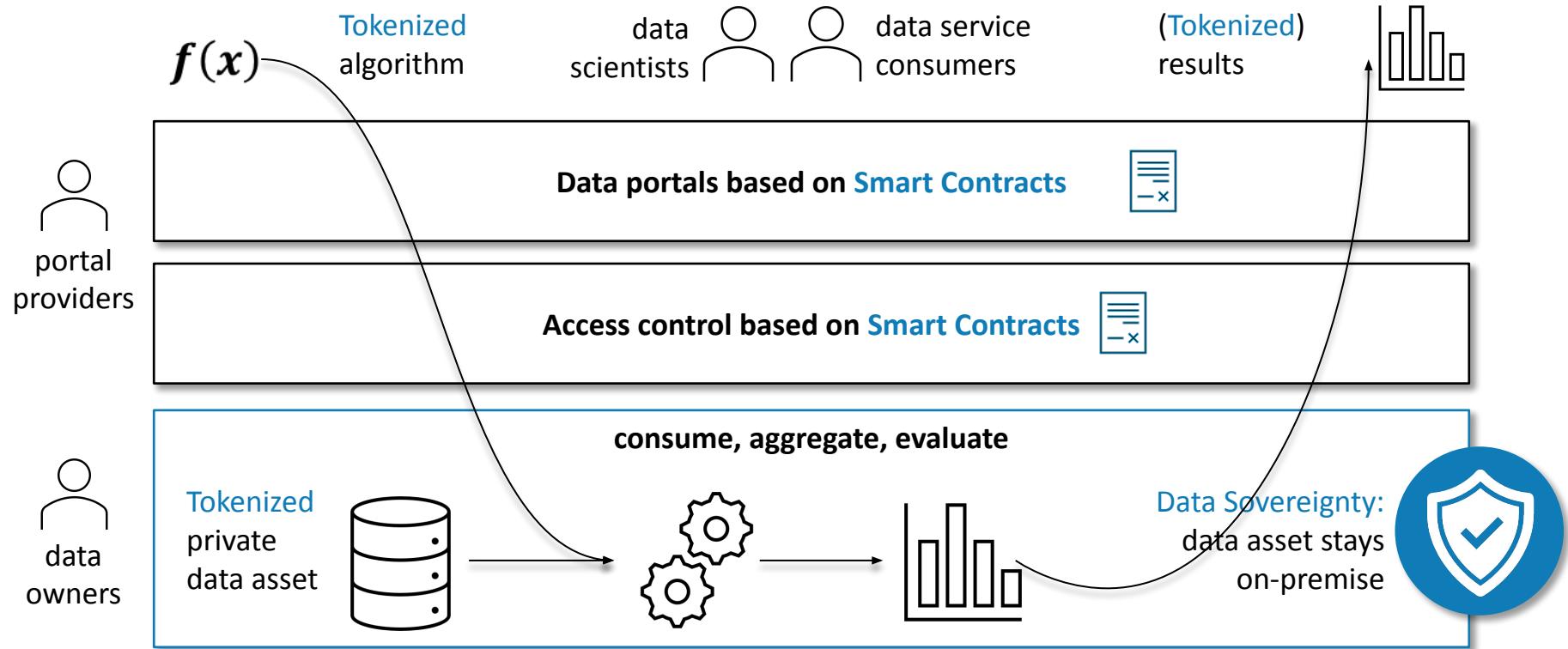
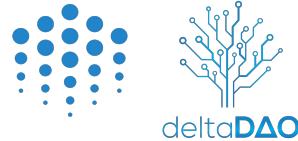
Smart Contracts enable on-chain datamarkets with integrated price discovery.



Simplify Data Exchange and Monetization

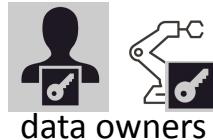
Easy to share, consume, sell and buy.

Layered design for privacy-preserving data sharing



GAIA-X Stakeholders per layer

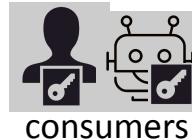
U
Users



data owners



data scientists



consumers



portal providers



analysts



governance

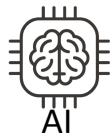
L3
Applications



portals



applications



AI

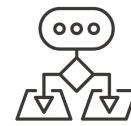
L2
Infra-
structure



(private) data assets



metadata caches



(private) algorithms



access controller



(private) CtD cluster

L1
DLT



validator nodes



metadata smart
contracts



data access &
exchange contracts



access records &
audit trail



Benefits of DLT-based implementations of GAIA-X

**Ecosystem sustainability
(our focus here)**

Sustainable
business models and
aligned incentives for
all participants

GDPR-compliance by
design

Data monetization with
automatic price discovery

Data owners always keep
full control

Accessibility and
Availability

Auditability, Provenance
and transparency by
design

Scaling: cross-listing
of datasets across
all datamarkets

No vendor lock-in



Sub-Sub-Block: GAIA-X Portal



MVG Portal Demo - Splash Screen

<https://portal.minimal-gaia-x.eu/>

The screenshot shows a web browser window for the URL <https://portal.minimal-gaia-x.eu/>. The page title is "MVG Portal Demonstrator". Below the title, it says "A platform to find, publish and consume Data Services in the Gaia-X Test Network." A note below that states "This demonstrator is powered by" followed by the Ocean logo. The main content area has a dark blue background with a network graph pattern. On the left, there is a large white text area asking "What is a Gaia-X Portal?". To the right, there are two cards: one for "CERFIS-7 Demonstrator Algorithm" and another for "BREOYS-75 Demonstrator Data". Both cards mention "deltaDAO AG" and "The Vision The future of data markets is embedded in the European Digital Single Market and the Gaia-X Test Network". The bottom right corner of the page features a small decorative graphic of blue dots.

gaia-x

Publish History Bookmarks Connect Wallet

MVG Portal Demonstrator

A platform to find, publish and consume Data Services in the Gaia-X Test Network.

This demonstrator is powered by

ocean

What is a Gaia-X Portal?

This demonstrator aims to bring to life a minimal viable Gaia-X Portal showing how the next generation of data infrastructure can look and feel like: An open, decentralized, transparent and secure digital ecosystem, where data and services are made available, collated and shared in an environment of trust.

CERFIS-7 Demonstrator Algorithm A European... deltaDAO AG The Vision The future of data markets is embedded in the European Digital Single Market and the Gaia-X Test Network.

BREOYS-75 Demonstrator Data A European Data Econ... deltaDAO AG The Vision The future of data markets is embedded in the European Digital Single Market and the Gaia-X Test Network.

1 OCEAN

1 OCEAN

MVG Portal - Browse Assets

<https://portal.minimal-gaia-x.eu/>

The screenshot shows a web browser window with the URL <https://portal.minimal-gaia-x.eu/> in the address bar. The page has a dark blue header and a white footer.

Header: The title "MVG Portal - Browse Assets" is at the top left. Below it is the URL "https://portal.minimal-gaia-x.eu/". The browser's toolbar is visible at the top right.

Main Content:

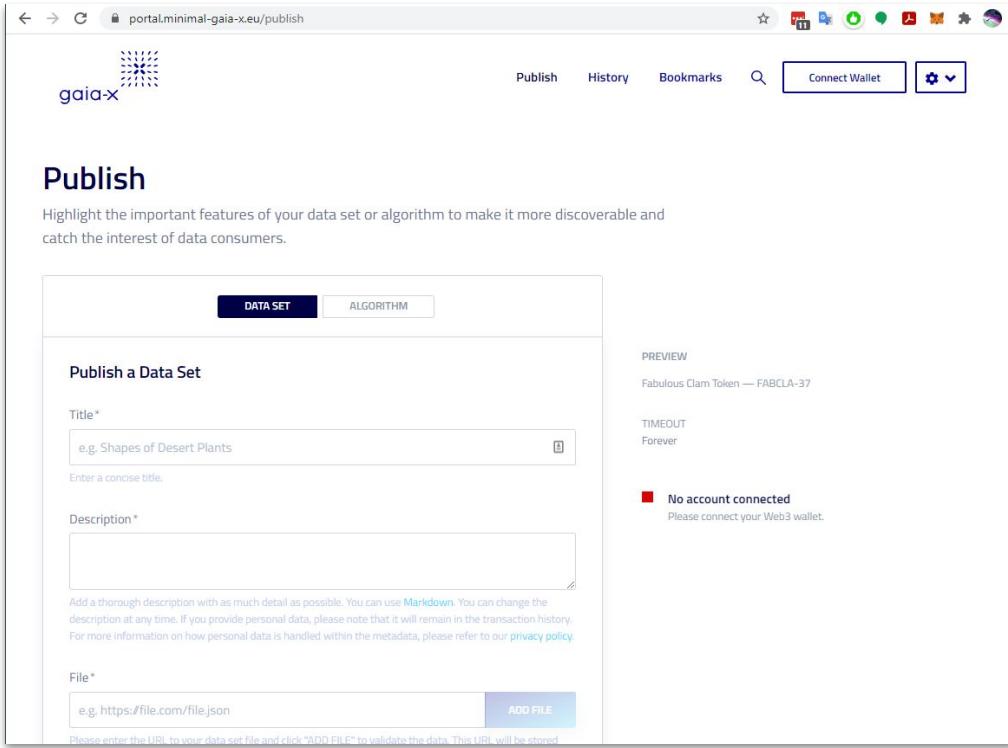
- Left Column:** A large section titled "How does it work?" contains text explaining the portal's architecture based on Ocean Protocol, emphasizing trustless, decentralized, and privacy-preserving data sharing.
- Right Column:** A section titled "Try it yourself" encourages users to explore assets to experience the European data economy. It includes a "TRY THE TUTORIAL" button.
- Bottom Section:** A "Recently Published" heading is followed by a grid of six dataset cards:

Dataset ID	Title	Description	Owner	Category	Action
INCORA-81	Sensor Data	Bill Gleim Test data for the hackathon	2 OCEAN	DATA SET	
DETMAC-1	Very useful data	Martin Swientek A picture of my cat.	1 OCEAN	DATA SET	
ZEAPEN-90	Sample Download Data Service	0x4265...901a Description: This is a quick sample to allow you to do download an asset.	1 OCEAN	DATA SET	
INSGRA-26	Shady's Brain	0xB6f4...20a0	DATA SET		
CHAHAD-63	Weather forged -- test	0xB6f4...EE58	DATA SET		
OBTSTA-1	My First Gaia-X Data Set	0x9D34...B7bA	DATA SET		



MVG Portal - Publish Flow

<https://portal.minimal-gaia-x.eu/publish>



The screenshot shows the MVG Portal's publish interface. At the top, there's a navigation bar with back, forward, and search icons, followed by the URL 'portal.minimal-gaia-x.eu/publish'. Below the URL is the gaia-x logo. The main menu includes 'Publish', 'History', 'Bookmarks', a search icon, 'Connect Wallet', and a settings icon.

Publish

Highlight the important features of your data set or algorithm to make it more discoverable and catch the interest of data consumers.

PUBLISH A DATA SET

DATA SET (selected) **ALGORITHM**

PREVIEW

Fabulous Clam Token — FABCLA-37

TIMEOUT
Forever

No account connected
Please connect your Web3 wallet.

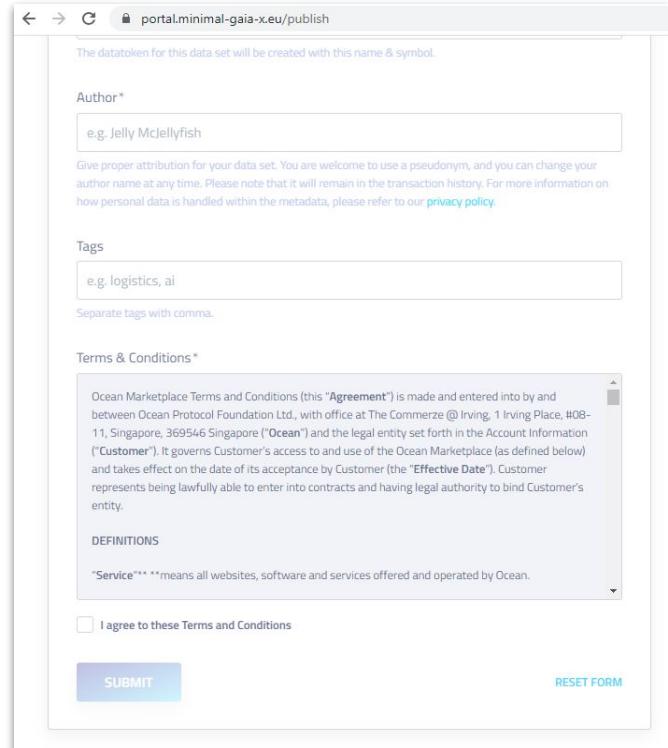
Description*

Add a thorough description with as much detail as possible. You can use [Markdown](#). You can change the description at any time. If you provide personal data, please note that it will remain in the transaction history. For more information on how personal data is handled within the metadata, please refer to our [privacy policy](#).

File*

e.g. <https://file.com/file.json> **ADD FILE**

Please enter the URL to your data set file and click "ADD FILE" to validate the data. This URL will be stored.



The screenshot shows the same publish interface with expanded fields for author and tags.

The datatoken for this data set will be created with this name & symbol.

Author*
e.g. Jelly McJellyfish

Give proper attribution for your data set. You are welcome to use a pseudonym, and you can change your author name at any time. Please note that it will remain in the transaction history. For more information on how personal data is handled within the metadata, please refer to our [privacy policy](#).

Tags
e.g. logistics, ai

Separate tags with comma.

TERMS & CONDITIONS

Ocean Marketplace Terms and Conditions (this "Agreement") is made and entered into by and between Ocean Protocol Foundation Ltd., with office at The Commerce @ Irving, 1 Irving Place, #08-11, Singapore, 369546 Singapore ("Ocean") and the legal entity set forth in the Account Information ("Customer"). It governs Customer's access to and use of the Ocean Marketplace (as defined below) and takes effect on the date of its acceptance by Customer (the "Effective Date"). Customer represents being lawfully able to enter into contracts and having legal authority to bind Customer's entity.

DEFINITIONS

"Service"*** means all websites, software and services offered and operated by Ocean.

I agree to these Terms and Conditions

SUBMIT **RESET FORM**

Example Data Asset: Fixed Pricing (ATOS data)

<https://portal.minimal-gaia-x.eu/asset/did:op:Dfa927A926481ce8Da68A9909785AD8d829804F2>

The screenshot shows a web interface for a data asset on the Gaia-X platform. At the top, there's a navigation bar with the Gaia-X logo, a search bar, and buttons for 'Publish', 'History', 'Bookmarks', 'Connect Wallet', and settings.

The main title of the asset is "QUICK - Copernicus Sentinel Data Fusion with CNES Orfeo toolbox (Dataset)". Below the title, it says "Published By ATOS SE".

Metadata QUICK ATOS dataset

Title: QUICK - Copernicus Sentinel Data Fusion with CNES Orfeo toolbox

Keywords: GaiaX, space, imaging, remote sensing, application, hackathon, demonstration, OTB, ESA, Copernicus, SAR

Timeout: 1 day

Description: Important:
This is the "quick" version for the 1st Gaia-X Hackathon. It runs much faster and only delivers a final result without the intermediate steps to illustrate the functionality of Compute-to-Data and the Data Exchange Logging Service and Data Audit Trails in Gaia-X.

About the use case

On the right side, there's a summary section:

- tar** 4.9 GB 1 OCEAN ≈ €0.70
- Select an algorithm to start a compute job
- Search by title, datatoken, or DID...
- QUICK - Copernicus Sentinel Data Fusion with CNES Orfeo toolbox (Algorithm) 1 OCEAN EFTTSA-0d | did:op:08C3C90d881105f4a735e34A1a10091fE8#2D76
- You will pay 1 OCEAN ⓘ
- BUY COMPUTE JOB**

At the bottom, a note states: "For using this dataset, you will buy 1 MANCOD-15 and immediately spend it back to the publisher and pool."

MVG Catalogue Demonstrator

<https://catalogue.minimal-gaia-x.eu/>

The screenshot shows a web browser window displaying the MVG Catalogue Demonstrator. The URL in the address bar is catalogue.minimal-gaia-x.eu/?sort=created&sortOrder=desc&text=. The page features a header with the gaia-x logo and a search bar. The main content area includes the title "MVG Catalogue Demonstrator", a subtitle "Browse and discover Data and their Self-Descriptions in the Gaia-X Test Network.", and a note "This demonstrator is powered by ocean". Below this, there is a section titled "18 results" with filters for "DATASETS", "ALGORITHMS", and "CATEGORIES". A sorting option "SORT Published" is also present. The main content area displays a list of datasets:

Name	ID	Action	Ocean Count
Demonstrator Data 📁 A European Data Economy in 2021	INCRA-81	DATA SET	2 OCEAN
A dataset published through the tutorial	DETMAC-1	DATA SET	1 OCEAN
Weather forged -- test	ZEAPEN-90	DATA SET	1 OCEAN
Sensor Data	INSCRA-26	DATA SET	1 OCEAN
FULL - Copernicus Sentinel Data Fusion with CNES Orfeo toolbox (Algorithm)	CHAHAD-63	DATA SET	1 OCEAN
QUICK - Copernicus Sentinel Data Fusion with CNES Orfeo toolbox (Algorithm)	OBTSTA-1	DATA SET	1 OCEAN
Random dataset	MANCOD-15	DATA SET	1 OCEAN



Conclusion



Conclusion

- Introduced an approach for GAIA-X sustainability
 - Drawing on a \$GX token
 - System-level design: Web3 Sustainability Loop
 - Sub-block: GAIA-X DAO for grants
 - Sub-block: Data ecosystem
- Verified with agent-based simulation (TokenSPICE)
- Provided an example DLT-based implementation (Ocean)

