
CRYPTOSAT
YAN MICHALEVSKY, CO-FOUNDER
CRYPTO-SATELLITES
- A CRYPTOGRAPHIC TRUSTED PARTY IN SPACE AND ITS APPLICATIONS

founders

Yonatan Winetraub

Aerospace

SPACEIL

WAYMO

2nd time founder. Founded SpaceIL - the first private moon-mission.

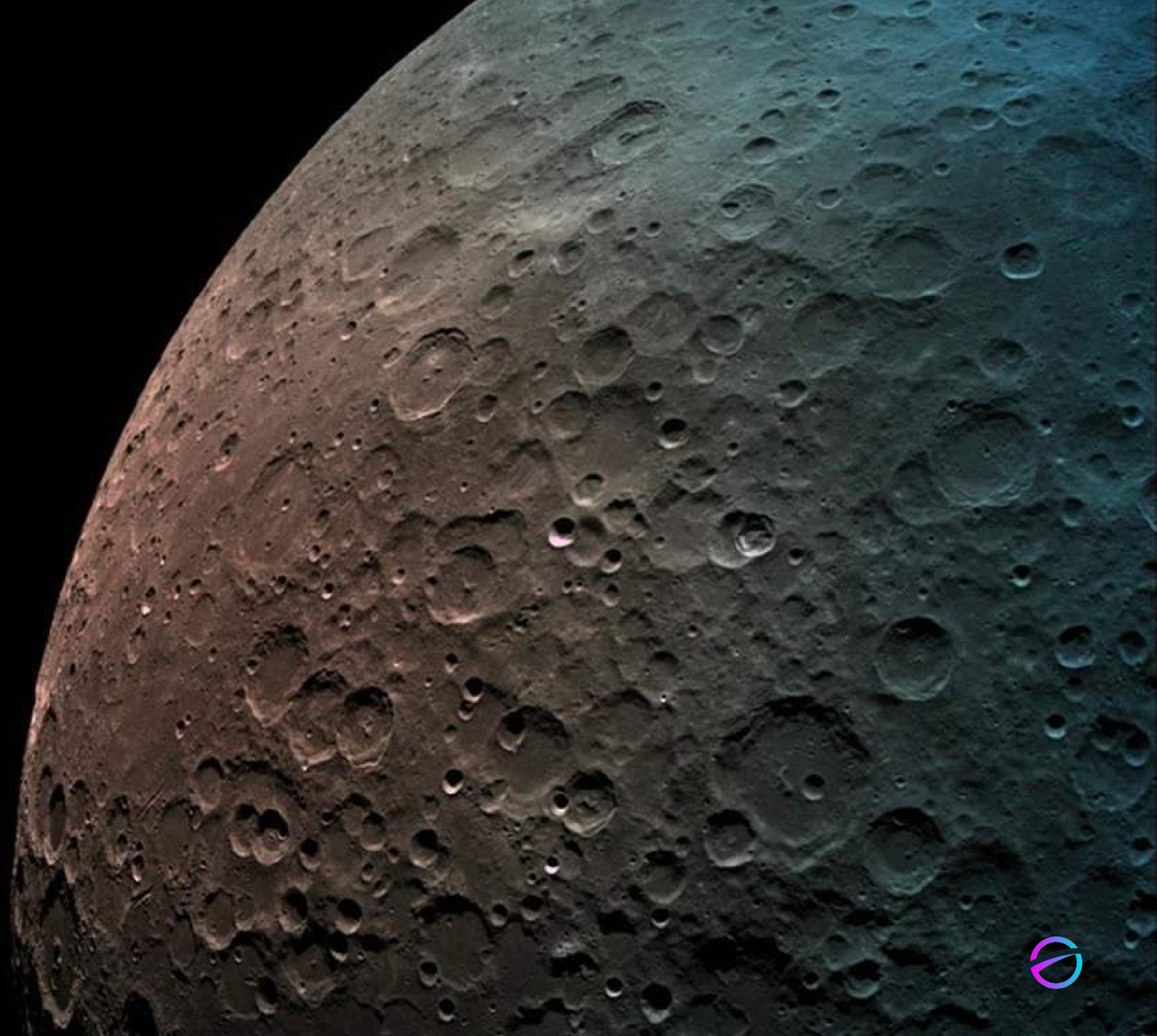
Yan Michalevsky

Crypto and Security

anjuna

2nd time founder. Founded Anjuna - an enterprise security company in Confidential Computing.


SPACE
SPA
IA



Advisors

Prof. Dan Boneh

Ben Fisch

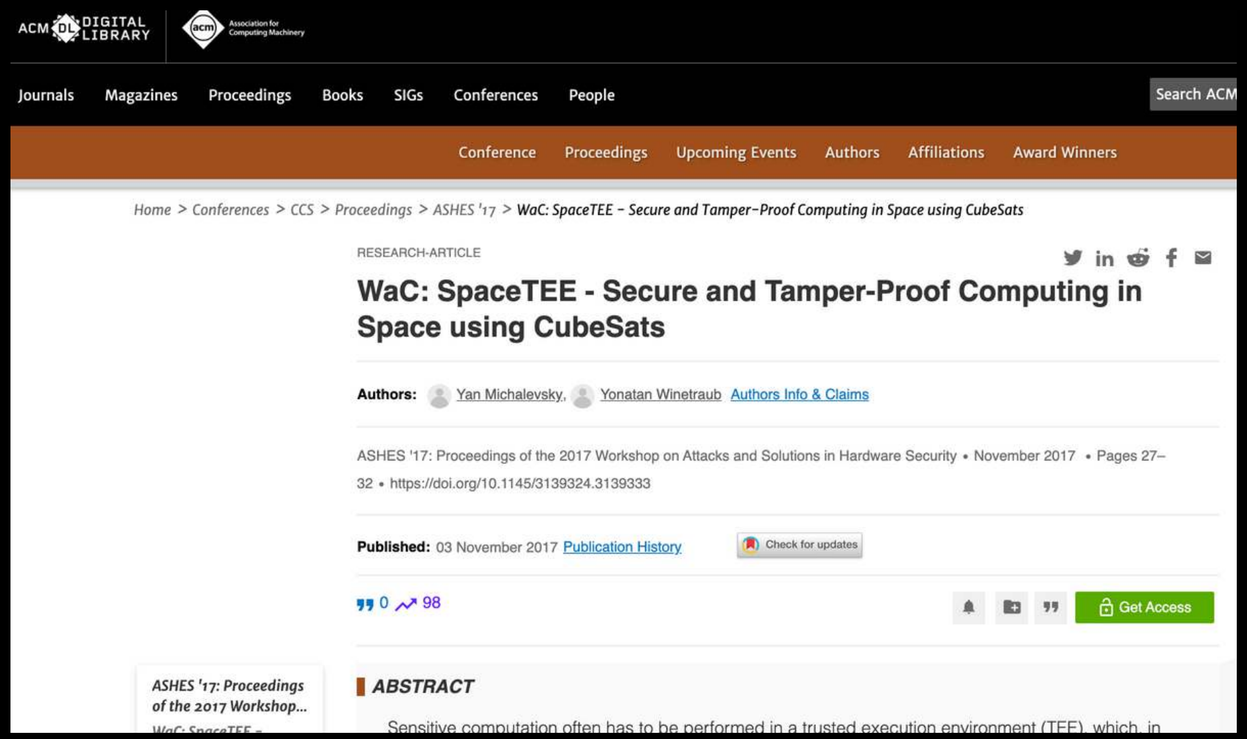
Juan Benet

Omer Shlomovits

mission

We build satellites that power cryptographic and blockchain applications. Our goal is to create the most secure cryptographic root-of-trust in space to protect protocols.

SpaceTEE



SpaceTEE: Secure and Tamper-Proof Computing in Space using CubeSats

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ABSTRACT

Sensitive computation often has to be performed in a trusted execution environment (TEE), which, in turn, requires tamper-proof hardware. If the computational fabric can be tampered with, we may no longer be able to trust the correctness of the computation. We study the (wild and crazy) idea of using computational platforms in space as a means to protect data from adversarial physical access. In this paper, we propose SpaceTEE – a practical implementation of this approach using low-cost nano-satellites called CubeSats. We study the constraints of such a platform, the cost of deployment, and discuss possible applications under those constraints. As a case study, we design a hardware security module solution (called SpaceHSM) and describe how it can be used to implement a root-of-trust for a certificate authority (CA).

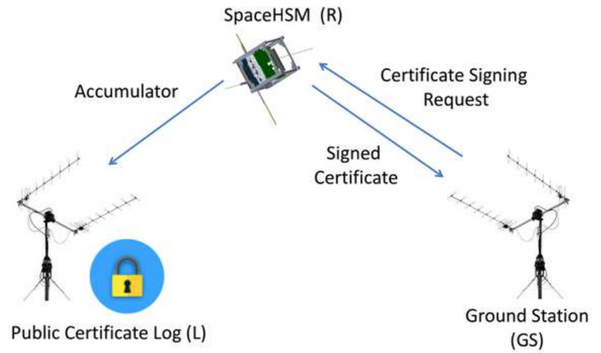
KEYWORDS

However, via physical access to the HSM it may potentially be possible to obtain its secrets. HSM vendors such as Safenet and Thales incorporate many precautions and preventative measures to secure their hardware and make it tamper-proof. One defensive measure is to protect them with sensors that identify an attempt to open the HSM enclosure in order to access the board. The FIPS 140-2 US government standard [9] specifies the requirements for cryptographic modules that protect sensitive (but unclassified) information for commercial uses.

FIPS 140-2 specifies 4 levels of security. The specification for Level 4 states

> "Physical security mechanisms provide a complete envelope of protection around the cryptographic module with the intent of detecting and responding to all unauthorized attempts at physical access."

1. SpaceHSM: Root-of-Trust (R) and crypto-accumulator
2. Ground-station (GS): delegates cert. sign. requests
3. Public, append-only certificate log (L)
4. Verifier (V): checks certificate validity



Use-cases

HARDWARE SECURITY MODULE (HSM)

Can we provide a better alternative to expensive and hard-to-operate HSMs that can still potentially be physically accessed and might be susceptible to side-channel attacks?

TRUSTED SETUPS

How to generate public parameters for cryptographic schemes securely?
zkSNARKs, Treshold Signature schemes, etc.

TRUSTED SOURCE OF ENTROPY

How to obtain random bits we can trust to be random?

TRUSTED PARTY FOR CRYPTOGRAPHIC PROTOCOLS

Privacy-preserving aggregation, private voting, sealed-bid auctions

Why satellites are a great solution?

PHYSICALLY INACCESSIBLE & TAMPER EVIDENT

No side-channel attacks, a satellite can be destroyed but not captured. Any physical attack will be easily noticeable by national monitoring (e.g NORAD)

ZERO INFRASTRUCTURE

Self-sufficient, no internet cables, no power source, anybody can set a personal ground station

TRANSPARENT

Satellites can guarantee that multiple parties see the same transmission. No split-world attacks.

PRACTICAL

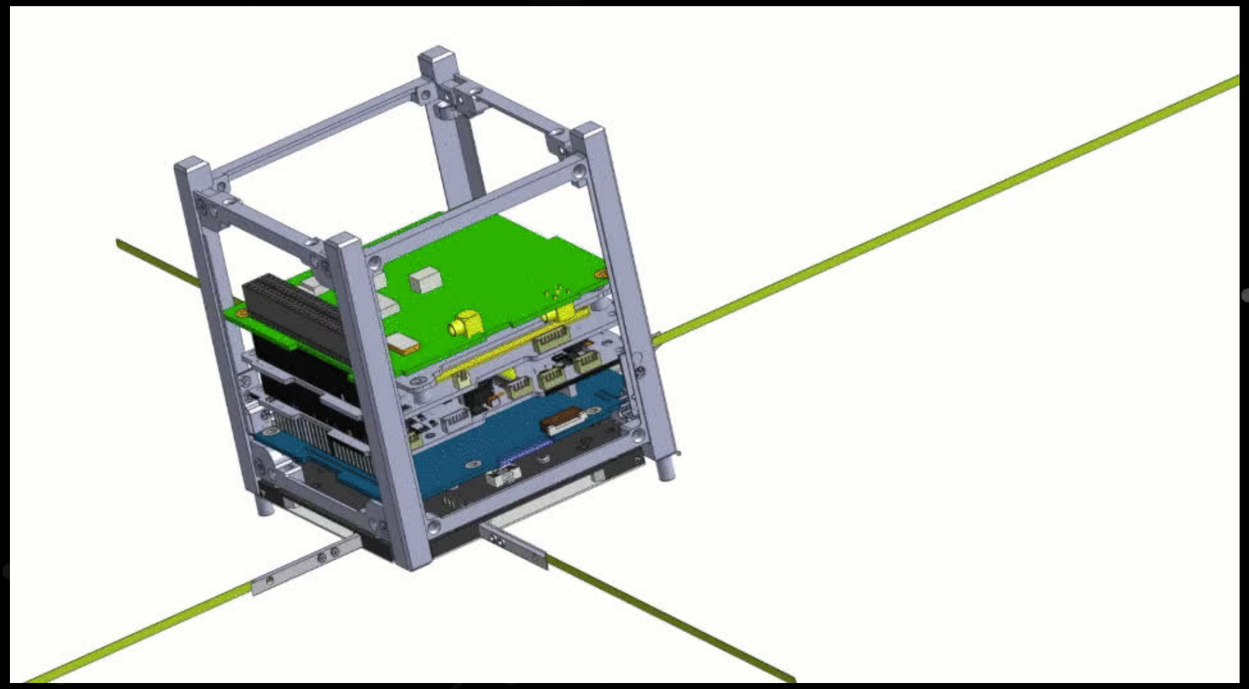
<$100k to build, launch and maintain a satellite

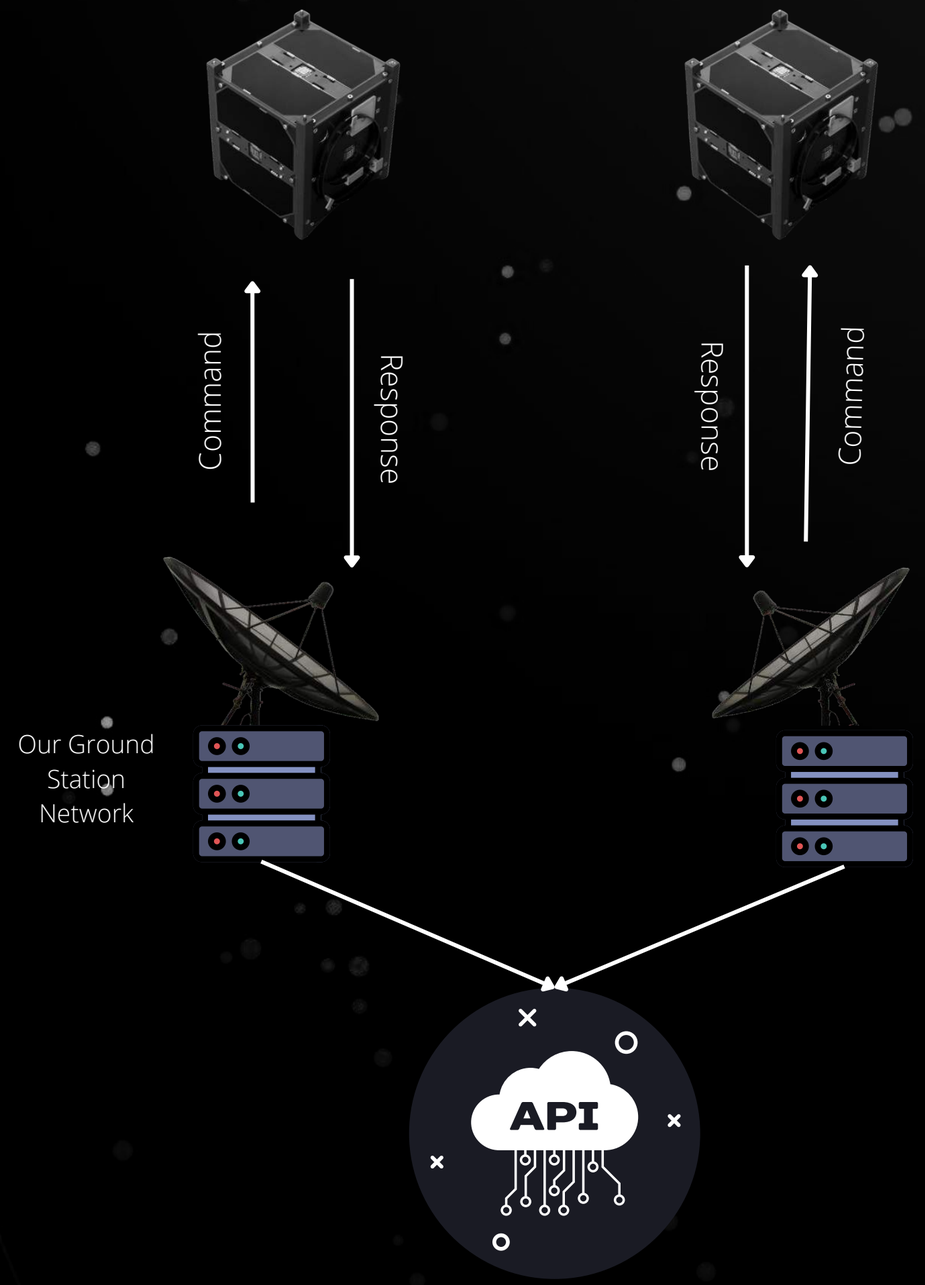
Cubesats

Cube satellites are miniature satellites made from off the shelf components. The costs of building cube satellites and launching them into space has dramatically declined in the past decades and will continue to do so as the technology gains more widespread adoption. We believe they are ideally suited for applications requiring trust.

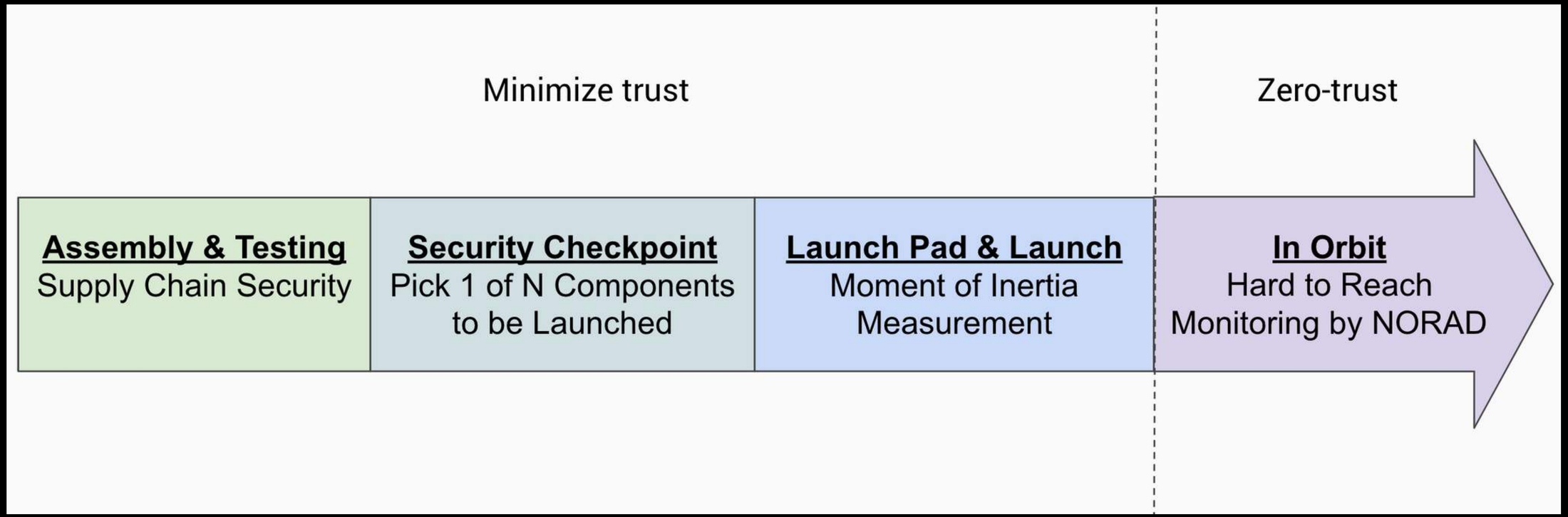
Architecture

(in a nutshell)





Trust model


Minimize trust
Zero-trust
Assembly & Testing
Supply Chain Security
Security Checkpoint
Pick 1 of N Components
to be Launched
Launch Pad & Launch
Moment of Inertia
Measurement
In Orbit
Hard to Reach
Monitoring by NORAD

Milestones

ISS Experiment
(March 2022)

Crypto1 Launch
(May 2022)

2nd ISS
Experiment
(December 2022)

Crypto2 Launch
(Jan 2023)
30x compute power

Crypto3
In Design

1st ISS Experiment

Cryptosat experiment aboard the International Space Station (ISS).

- DRAND (Distributed Random Beacon)
- Bitcoin transaction co-signing from space
- Tweets From Space
- and more...

Historic Experiment at ISS Takes Blockchain Technology to Space

One of your neighbors posted in Neighbor News. Click through to read what they have to say. (The views expressed in this post are the author's own.)

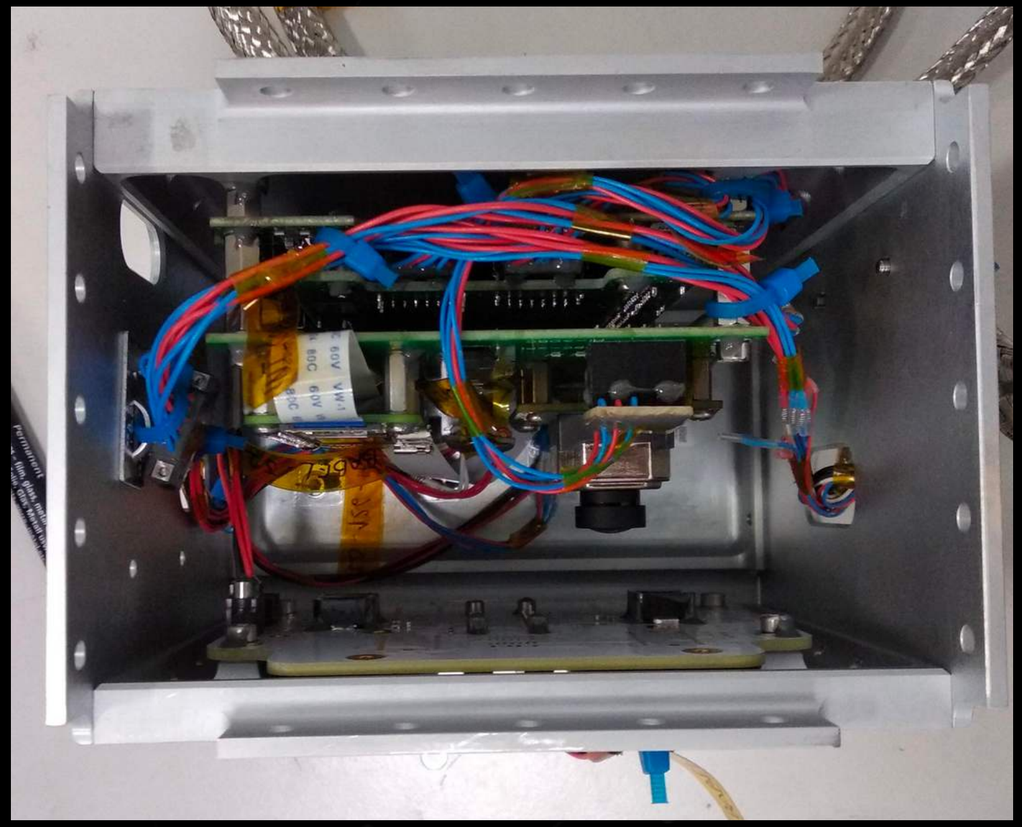
P Palo Alto / Mar 22, 2022

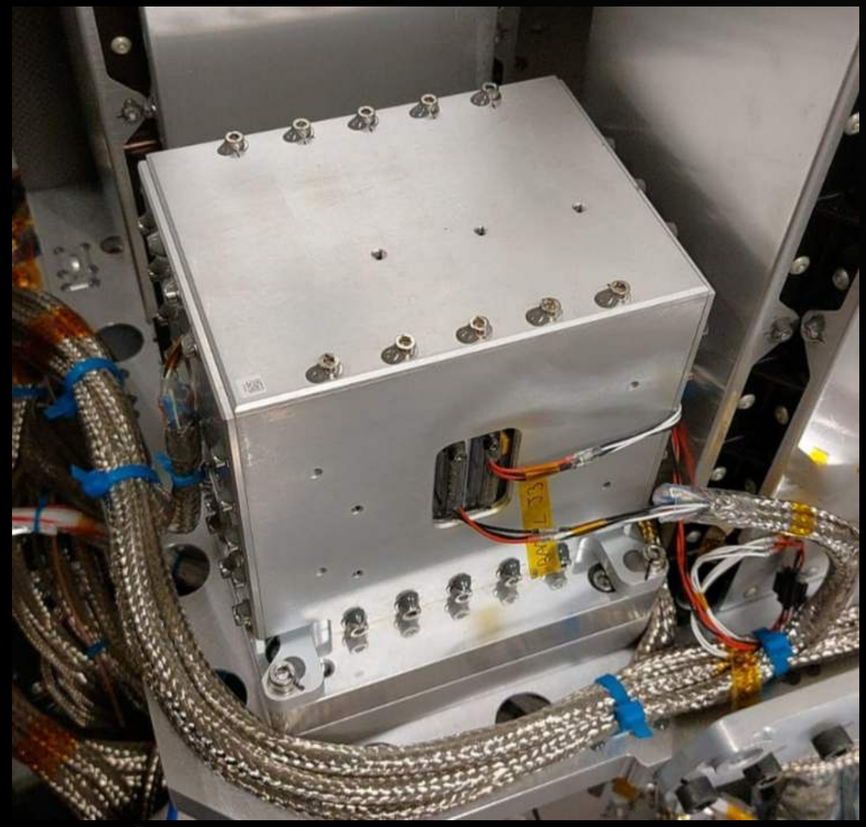
Tweets From Space

GET YOU TWEET SIGNED ABOARD THE INTERNATIONAL SPACE STATION (ISS)

Tweet at @cryptosatbot, and we send back a certificate digitally signed in space.

Crypto1 and Crypto2



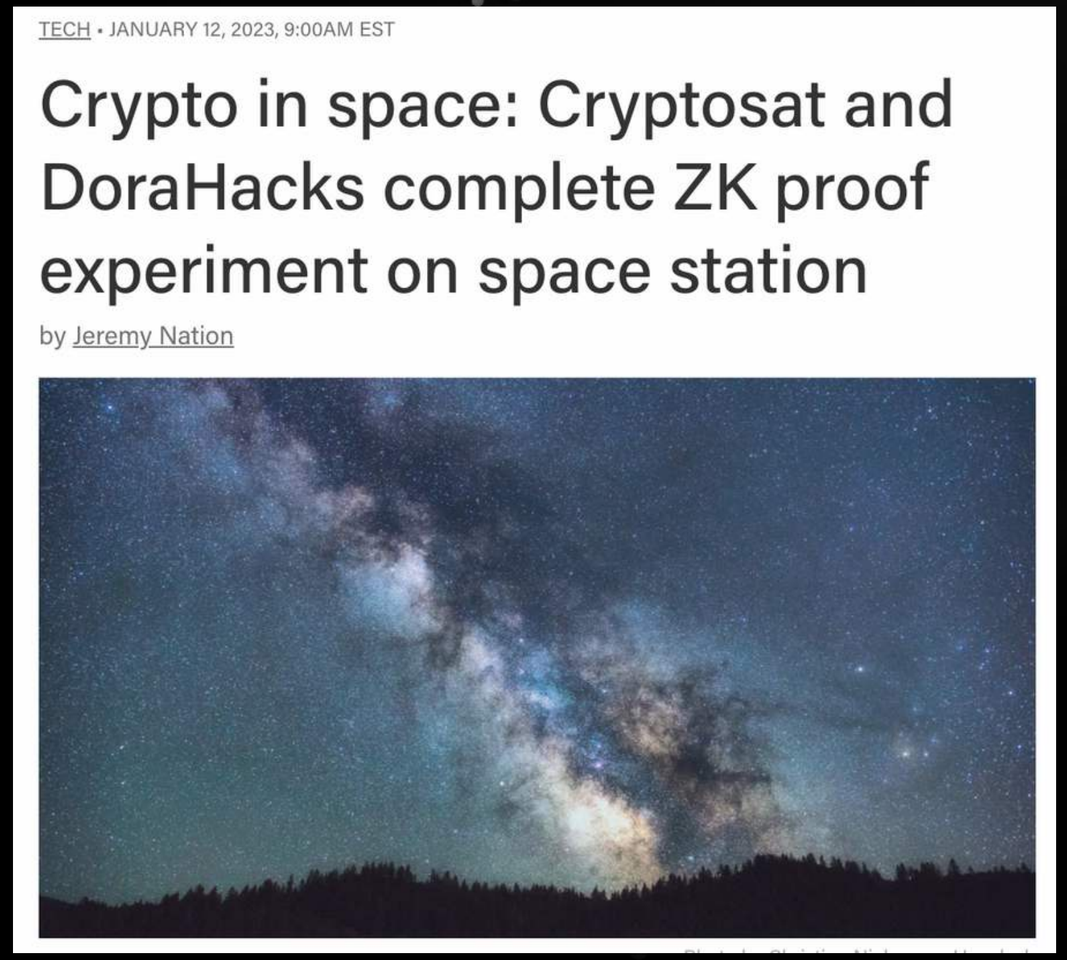


Crypto1 launch, May 25th 2022

Trusted Setup

TRUSTED SETUP IN SPACE FOR GROTH16 ZK-SNARKS

The proof system is used for collusion resistant voting in a DAO.



Crypto2 launch

Cape Canaveral, Florida

Jan 3rd 2023

Some of our partners

Protocol Labs

ethereum

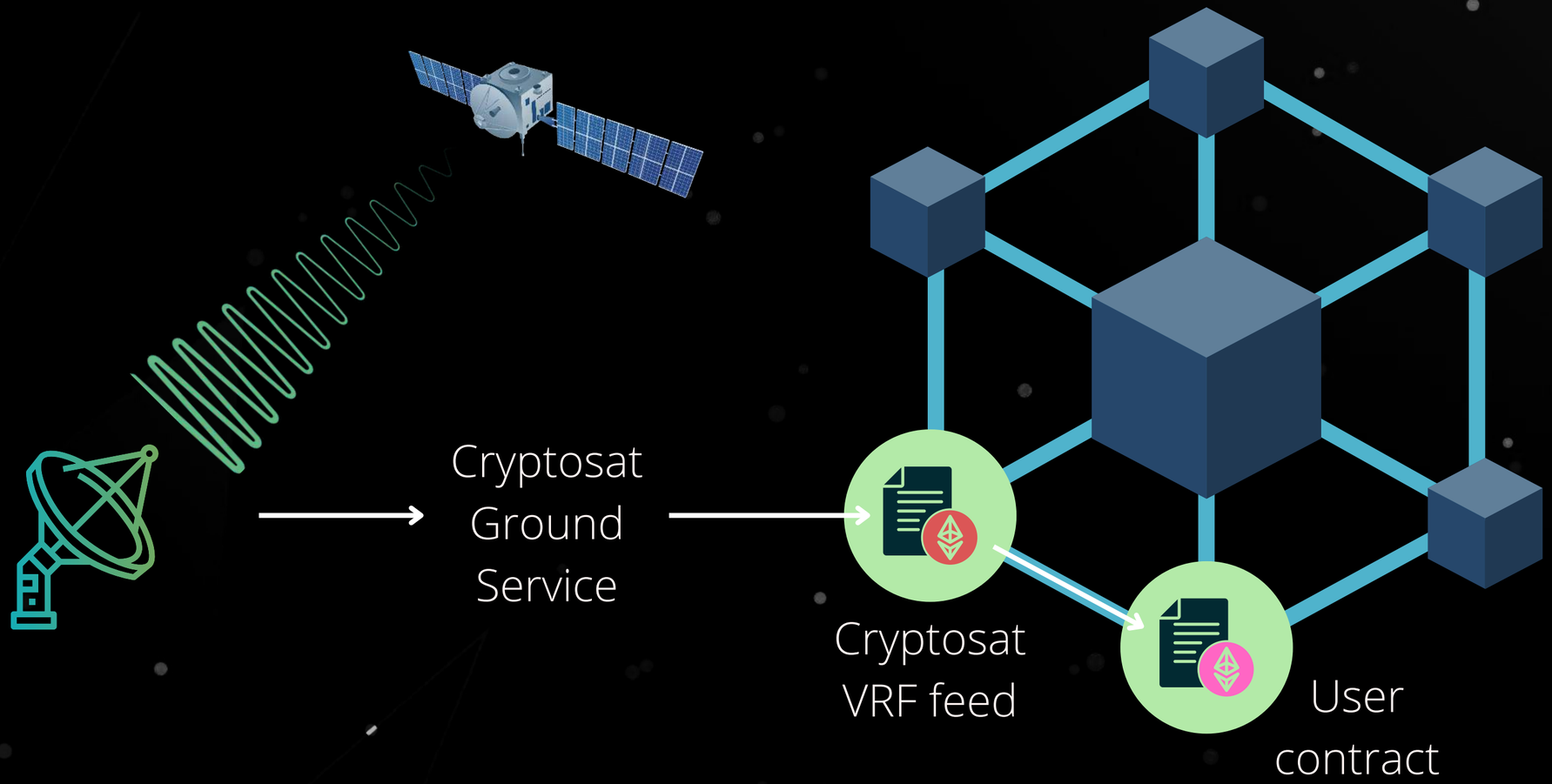
drand

DoraHacks

VELAS

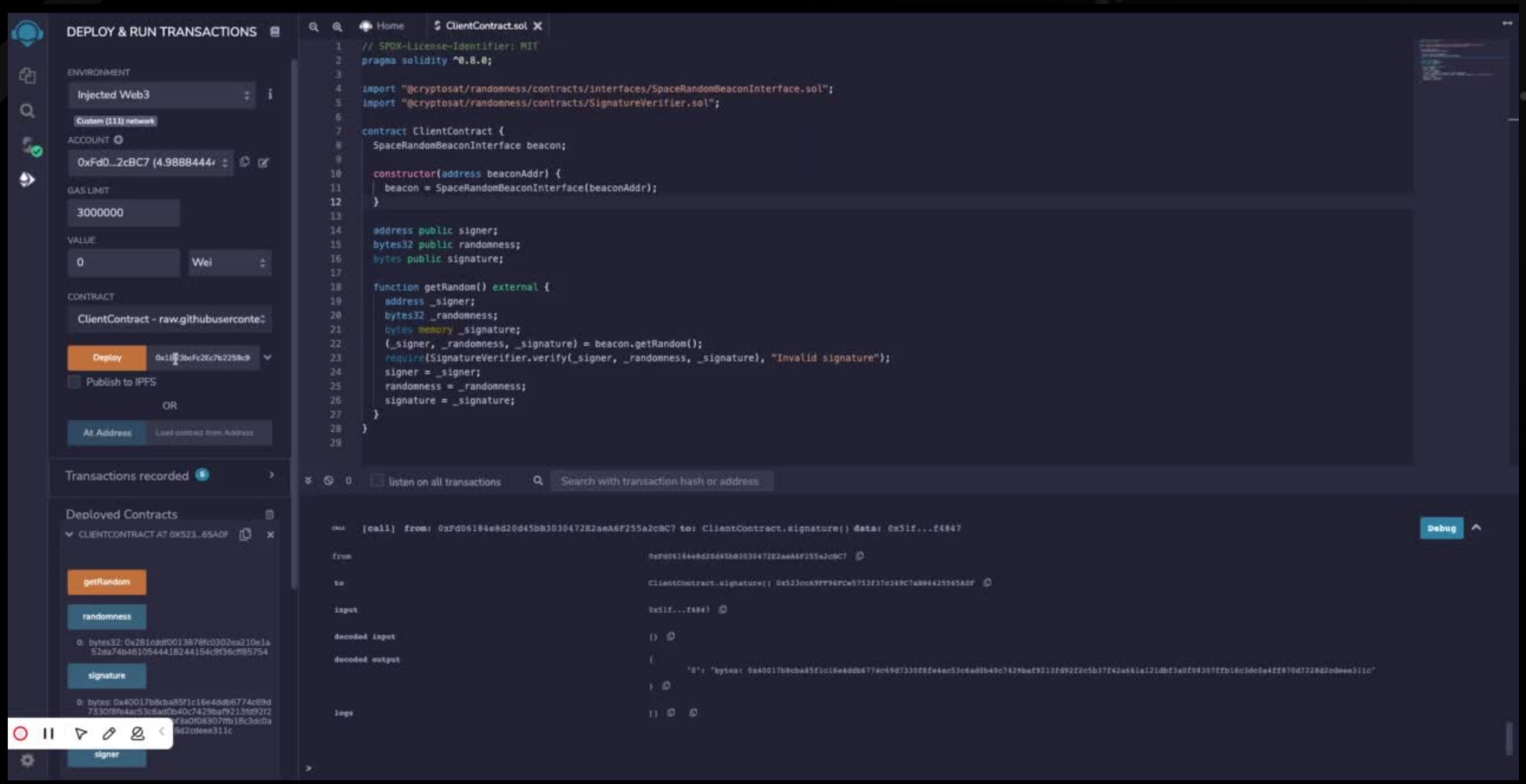
MPC ALLIANCE

CRYPTOSAT VRF ORACLE



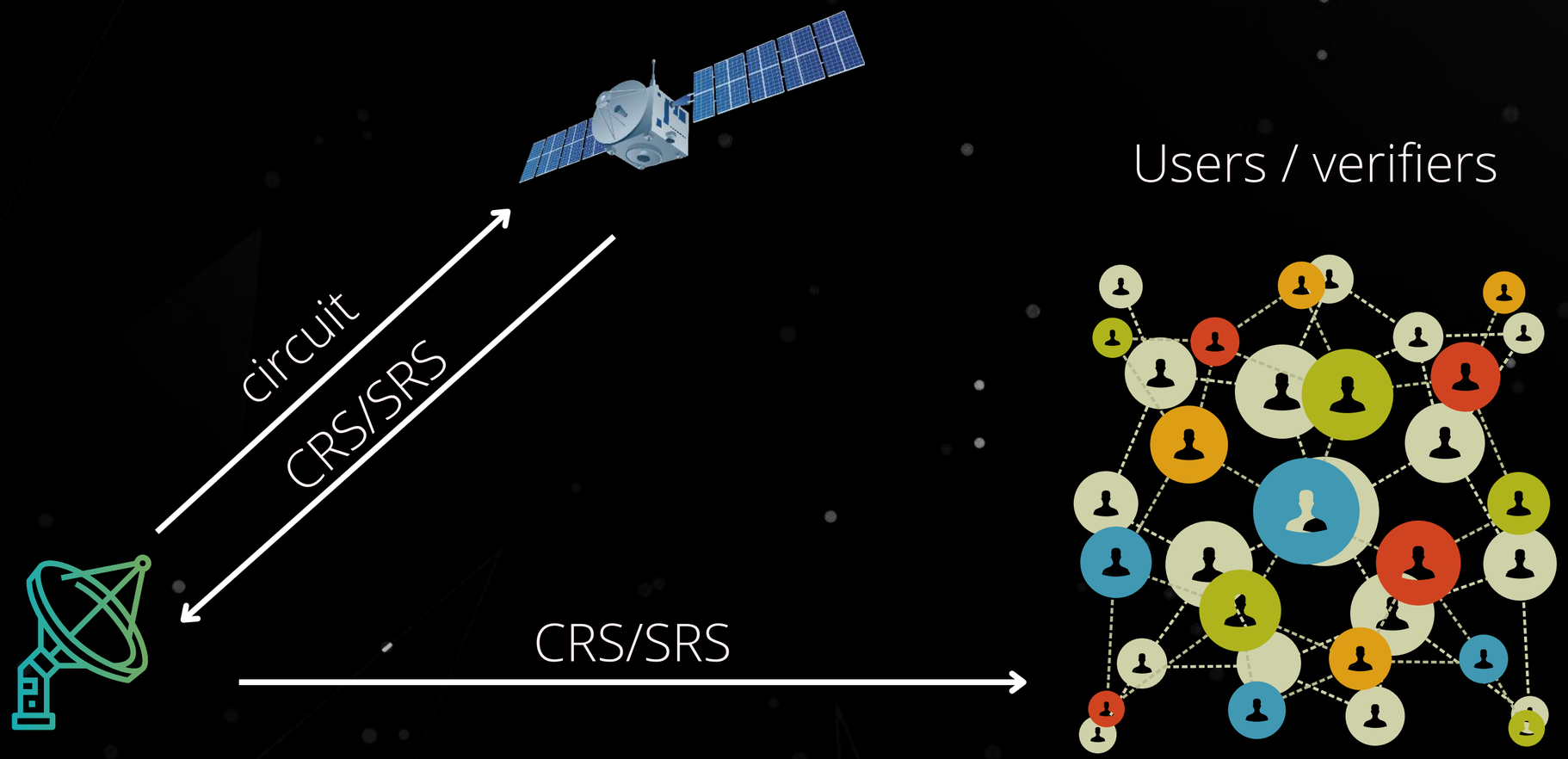
https://docs.cryptosat.io/cryptosat/random-beacon/verifiable-random-beacon

CRYPTOSAT RANDOM BEA

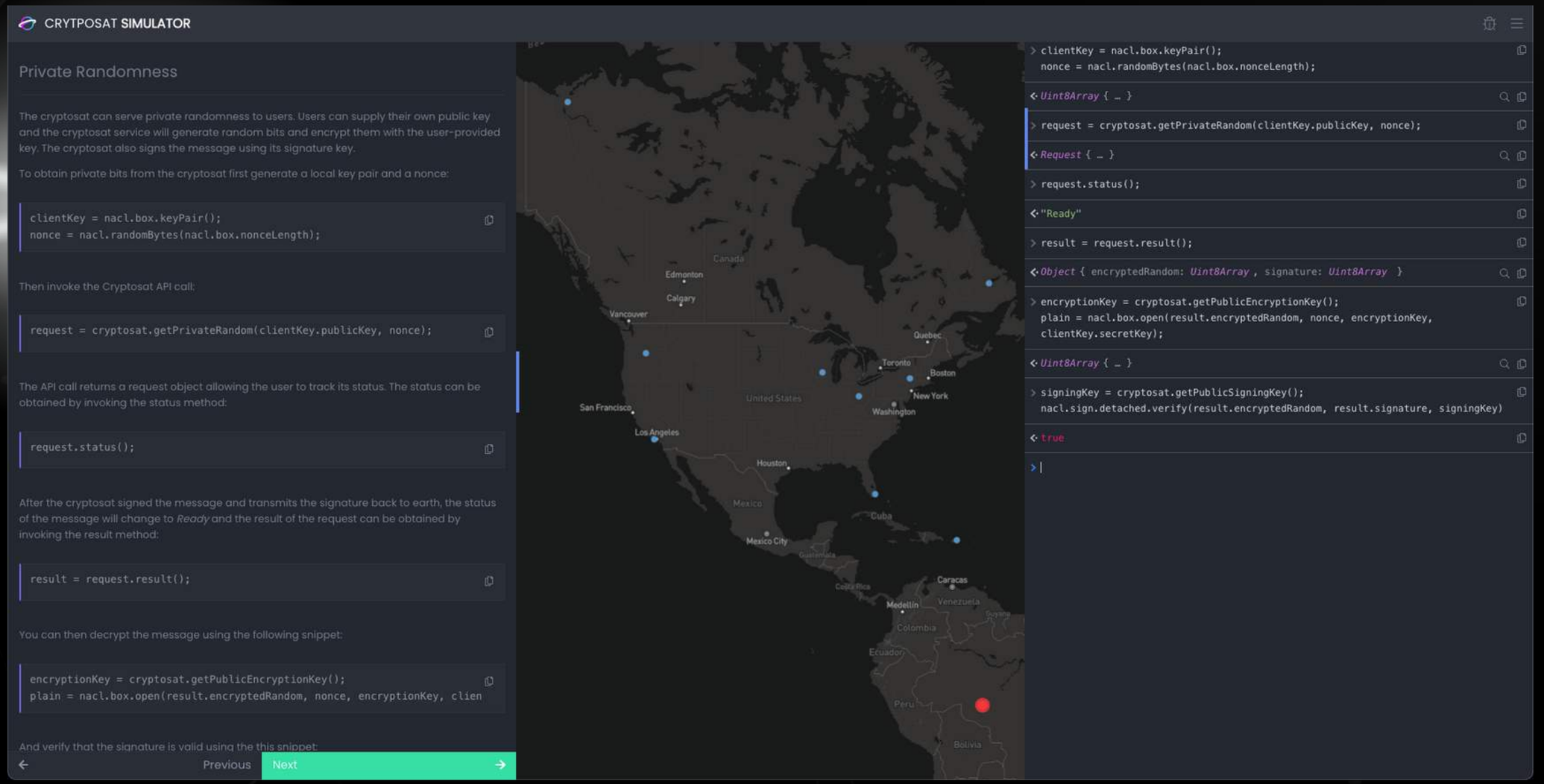


https://docs.cryptosat.io/cryptosat/random-beacon/verifiable-random-beacon

Trusted Setups for zkSNARKs



How Developers Interact with Cryptosat



https://simulator.cryptosat.io

Thank you

IN THE NEWS

Space Invaders

Crypto1 launch

TheBlock

Yahoo finance

PL + CRYPTOSAT

VDF announcement

VELAS + CRYPTOSAT

Random Beacon announcement

WHITEPAPER

SpaceTEE: Secure and Tamper-proof Computing in Space using Cubesats

WWW.CRYPTOSAT.IO