Connecting Smart Devices to Smart Contracts with W3bstream

Xinxin Fan, Zhi Zhong, Dong Guo, Qi Chai and Simone Romano
IoTeX
Menlo Park, CA 94025, USA
Email: {xinxin, zhi, dong, raullen, simone}@iotex.io

***Abstract*—In this demo, we illustrate the process of creating a machine economy utilizing W3bstream - an emerging open-source framework designed for connecting smart devices to smart contracts. We will emphasize the flexibility and user-friendliness of W3bstream in empowering decentralized IoT applications.**

I. Introduction

With the increasing number of smart devices connected to the internet and the rapid development of Web 3.0 technologies, the machine economy is emerging as a new frontier in the digital transformation of the Internet of Things (IoT). [1]. Monetizing machine utility and generated data enables the machine economy to transform IoT businesses by creating new business models and customer engagement strategies. W3bstream [3], [4], as shown in Fig. 1, is an open-source framework developed by IoTeX [2] for connecting physical world to Web3. In short, W3bstream collects data from trusted smart devices, generates cryptographic proofs of real-world activities, and feeds them to a decentralized machine economy application to trigger state changes on a blockchain network. In this demo, we provide guidance for realizing decentralized machine economy applications using W3bstream. We expect this to stimulate interesting discussions among researchers and industry practitioners.

II. Building Decentralized Machine Economy Applications

A. High-Level Workflow

A high-level workflow of building a decentralized machine economy application with W3bstream is shown in Fig. 2.

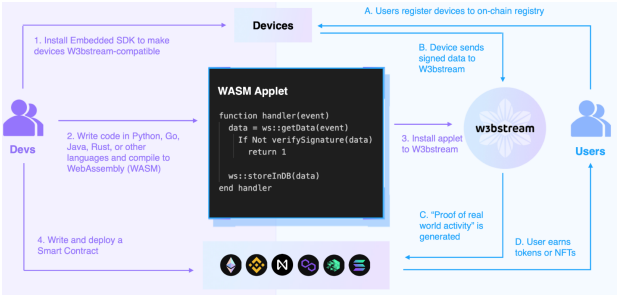

Fig. 2. A high-level workflow for building decentralized machine economy applications using W3bstream

For deploying a machine economy application, a developer needs to complete the following steps:

1) A developer installs the W3bstream embedded SDK on smart devices to enable communication with a W3bstream node;
2) The developer writes the business logic of a machine economy application in high-level programming languages such as Python, Go, Java, Rust, etc. and compiles it into a WebAssebmly (or *WASM*) [5] applet;
3) The developer installs the applet into a provisioned W3bstream node that contains a WASM rumtime;
4) The developer writes a machine economy dApp and deploys the smart contract(s) on a blockchain.

Once users receive the smart devices, they can join the machine economy application as follows:

1) A user registers their smart device(s) on an on-chain device registry;
2) The user's smart devices stream signed data to the W3bstream node;
3) The W3bstream node processes the data and generates cryptographic proofs of real-world facts based on the predefined business logic;
4) The user earns cryptocurrency tokens or NFTs based on the contributions from his/her smart device(s).

B. Building Components of a W3bstream Node

To support a wide range of applications and business requirements, a W3bstream node includes the following key components, as illustrated in Fig. 3, for interacting with IoT devices, blockchain, and node operators.

- *Service Endpoint*: The service endpoint communicates with IoT devices, blockchain, and node operators using various protocols (e.g. MQTT, HTTP, RPC);
- *Virtual File System*: The virtual file system stores the business logic;
- *Execution Engine*: The execution engine processes the time series data received from IoT devices and executes the pre-defined business logic;
- *Consensus*: The consensus module implements a number of consensus algorithms (e.g., Proof of Authority (PoA), Practical Byzantine Fault Tolerance (PBFT), etc.) for realizing a decentralized W3bstream network;
- *Database*: The database stores raw or encrypted data from IoT devices with a data retention policy;

978-8-3503-1019-1/23/$31.00 ©2023 IEEE

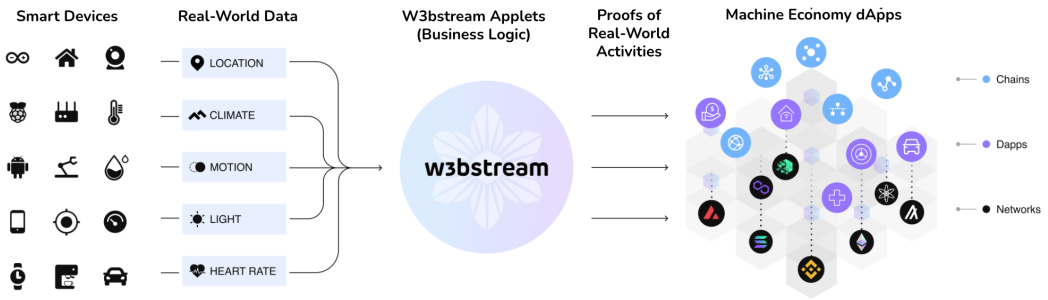

Fig. 1. W3bstream in a nutshell

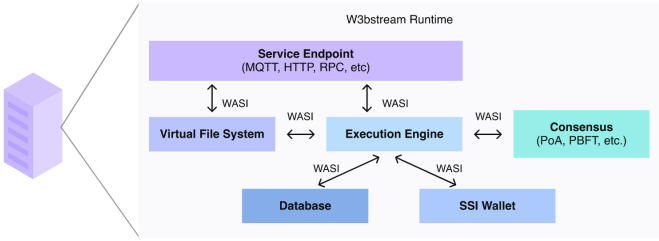

Fig. 3. A high-level architecture of a W3bstream node

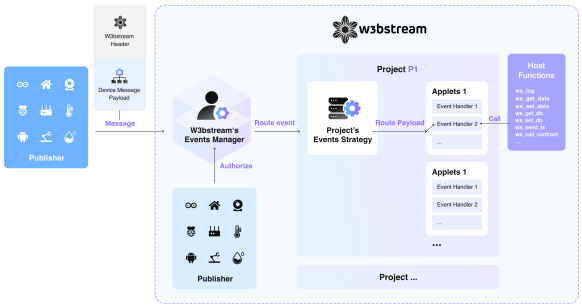

Fig. 4. Event-driven data processing in W3bstream

- *SSI Wallet*: The SSI wallet manages the identity of a W3bstream node using decentralized identifiers and verifiable credentials;

C. Data Processing in W3bstream

As shown in Fig. 4, W3bstream organizes machine economy applications as *Projects*. Each project consists of one or multiple WASM *Applets* that implement the business logic of a machine economy application. Data processing in W3bstream follows an event-driven approach, and each applet must export at least one function (called *Event Handler*) to handle a specific type of event message. By configuring a project's *Event Strategies*, one can define which event handler should be responsible for processing a particular event message. In W3bstream, an event message could be generated due to one of the following reasons:

- A data packet is received on an HTTP endpoint;
- A data packet is published to an MQTT endpoint;
- A smart contract event is detected by a blockchain monitor; and
- A certain blockchain height is detected by a blockchain height monitor.

Whenever an event message is generated, it will be routed to a specific applet for further processing, provided that a matching event strategy is defined for the project.

D. Blockchain Interaction in W3bstream

The W3bstream Virtual Machine provides host functions for applet developers reading the blockchain state and executing smart contract calls. This allows an applet developer to trigger on-chain logic based on machine data and business requirements, thereby creating powerful and decentralized machine economy applications built upon real-world data and blockchain technology.

E. Node Management in W3bstream

W3bstream Studio is a user-friendly web tool that enables W3bstream node operators to manage and configure their nodes, as illustrated in Fig. 5. Using W3bstream Studio, the node operator can complete several tasks such as creating projects, deploying applets, managing applets execution, adding publishers, creating strategies, and monitoring smart contracts and blockchain height.

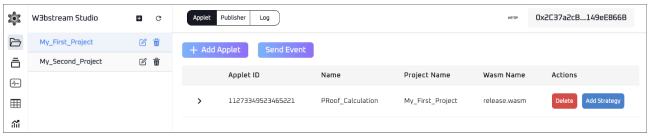

Fig. 5. Node management with W3bstream Studio

References

[1] X. Fan, S. Baudry, and S. N. Singh, Machine Economy - The New Frontier of Digital Transformation in IoT, Journal of Innovation, Industry IoT Consortium, https://www.iiconsortium.org/wp-content/uploads/sites/2/2023/01/IIC-JOI-Machine-Economy.pdf, January 18, 2023.

[2] IoTeX. https://iotex.io/.

[3] W3bstream. https://w3bstream.com/.

[4] MachineFi Lab. W3bstream - A Framework for Connecting Physical World to Web3, Volume I - Overview, https://docsend.com/view/twtxhbzvisdye2xj.

[5] WebAssembly. https://webassembly.org/.