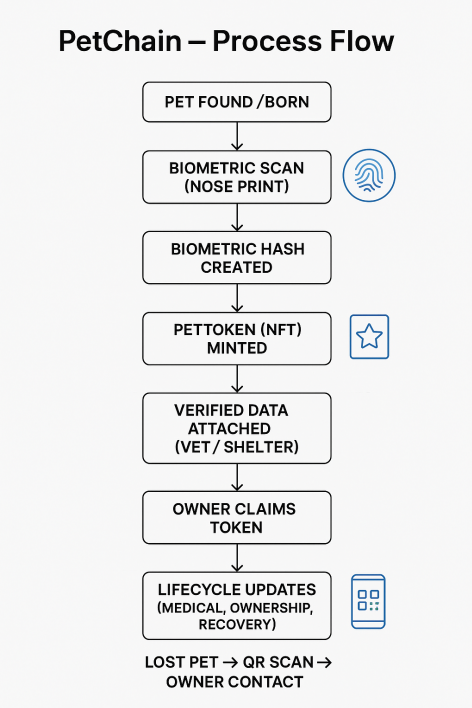
PetChain: A Biometric Digital Identity System for Pets

Stella Mulvihill, Molly Liu, Ethan O'Kelly, Johnson Ni

Abstract

PetChain is a pet verification and pet-specific information and storage system where an owner's pet information is stored on Ethereum's blockchain, with each pet having its own digital token (on the blockchain), containing information about breed, owner, and health history. A pet's unique nose print is scanned and then connected to a unique hash to ensure the individuality of the NFT (pet's digital identity).

Recent data has shown an increasing demand for an improved pet verification system that PetChain can address. Current pet reunification rates are 52% for lost cats and 63% for lost dogs. This demand is magnified by the rapid increase in pet ownership, with ownership increasing by 45% since 1996. Current systems like microchips have limitations, as there is a significant chance that the owners'/pets' information is outdated, and the microchips can be easily replicated. Petchain addresses these deficiencies, resulting in increases in rates of pet reunification, reducing animal shelter populations, and filling an ever-increasing need with the rise in pet ownership.



Obtaining the Biometric Hash

The identity layer of the system begins with the creation of a biometric hash. When a pet is first registered on PetChain, a licensed veterinarian scans the animal's nose using a specialized imaging device. A dog or cat's nose print will be scanned as it is unique, making it ideal for the

biometric scan. The system converts this image into a randomly generated, unique hash. This hash is then permanently stored on the blockchain. The hash also becomes the core identifier used to generate that animal's PetToken: the NFT identity.

Pet Profile Creation

Using the biometric hash, the vet or shelter creates the pet's public blockchain profile. The vet or shelter can start adding identifying data for the pet, such as name, breed, age, sex, and physical features. Veterinarians can also attach medical records: vaccination histories, procedures, microchip data, or adoption certificates. Since the pet profile is created before ownership of the token, all initial data comes from the vet (a verified source).

After the pet's public profile is created, the system issues a PetToken: an NFT that represents the pet's unique digital identity on the blockchain. This NFT is attached to the pet's biometric hash and serves as the unique identifier. Ownership of the PetToken is controlled through the private key of the owner after the token is claimed in their wallet. The owner's public key functions as the pet's public profile, while the private key permits any changes to the token, change ownership, or manage access permissions of who can update the token. Once the pet is registered by the vet, the owner links the PetToken to their personal wallet by claiming the hash created by the vet. This officially establishes ownership of their pet on the blockchain.

PetChain creates a unique QR code for each PetToken. The QR code can be printed onto a collar tag. When scanned, the QR directs the finder to the pet's public profile, where they also have the ability to message the owner. Owners may choose to reply directly within PetChain or voluntarily share personal contact information. Our PetChain solution offers a secure and simple alternative to traditional tags and microchips. If they begin messaging, PetChain will redirect them to a secure messaging platform. The finder does not need to have their own wallet; they only need to scan the QR code.

Smart Contract for Identity & Record Verification

PetChain aims to ensure accurate and consolidated medical and vaccination history. Every licensed veterinarian receives a PetChain verified wallet registered to PetChain's VetRegistry. When a pet's medical records need to be updated, the owner needs to grant the vet permission to modify the pet's records. This will then generate a smart contract. The owner will need to give specific access to the vet using their private key, allowing them to update their pet's token. This will make it so that only the vet specifically trusted by the owner has the ability to alter the token. The vet then uses their own private key associated with their wallet in the verified vet registry in order to submit medical updates. Each update is verified on the blockchain, and the system automatically checks:

1. Does the wallet submitting the update belong to a registered vet listed in the PetChains VetRegistry system?
2. Has the owner given access to the vet to update this specific token's (the pet's) information?

If both rules are met, the update to the token will be permanently updated on the blockchain. Another benefit to this is that the owners cannot alter medical data to prevent fraud and establish a trusted medical history.

Network Model

PetChain operates on a pre-existing public decentralized blockchain, which is either Ethereum or Solana. The system runs on a partially decentralized system. There is some centralization when it comes to scanning the biometric hash and updating the NFT, which happens at the vet. Other than that, PetChain is decentralized. Once data is written, it can be deleted. There is no way to alter or overwrite medical records. A pet's identity cannot be duplicated because it needs to have a unique hash. All records behind a pet, including things like microchip number, age, breed, ownership history, and more, are permanently shown on the blockchain and visible throughout the lifetime of the pet.

PetChain has a few key participants. Firstly, there are owners. Those who claim the hash and hold the wallet that has the private keys needed to transfer rights and access permissions for the unique NFT corresponding to the pet. They also have public keys, which can be shown to verify the identity of the pet and show its ownership history without any risk of losing access to the NFT. There are also trusted verifiers and updaters. The veterinarians and shelters have their own unique registered and verified wallets that are used to update the records and medical history of the pet. Veterinarians serve as the authoritative source for all information about the pet. Their signatures ensure that health records are authenticated and cannot be altered or forged by owners.

Revenues and Fees

PetChain, relying on a pre-existing blockchain, will have the fees that relate to the native token, as they will share their operating structure. Since the system will be run on Ethereum, each transaction will require gas fees. These fees will be paid in the native token, not PetChain itself. This means that if there is a transaction, there will be gas fees associated with it that will be paid either in ETH or SOL. These fees are paid by the owners as they are responsible for paying the fees for their transactions, such as claiming the NFT, transferring ownership, or granting permissions for the vet to update the NFT. These fees will allow the updates to occur on the pre-existing and secure blockchains such as Ethereum or Solana.

In addition to gas fees, PetChain will receive some revenues to remain profitable. PetChain will generate a small revenue for each transaction that is made in updating a pet's NFT through the

vet. Each time the vet updates the pet's information, such as vaccination history or medical information will come with a small fee, which is similar to a micro tax that is added to the smart contract, allowing the vet permission to update the NFT. While this fee is charged to the vet by PetChain, vet clinics may incorporate this additional cost into their appointment pricing, which would then pass the transaction fee to the pet owner. This allows PetChain to be profitable without having a subscription model or a different centralized billing system. This cost ensures that PetChain will update, verify, and ensure accuracy with their NFTs. Shelters also gain reliable identity matching, which can both reduce their errors and boost their credibility. Veterinarians also gain access to medical histories that are guaranteed free of fraud.

Another stream of revenue that PetChain will generate comes from the bounties placed for lost pets. When a pet is marked as lost by the owner, the owner can then place a bounty on their pet that will be paid out to the finder when the pet is successfully returned. The majority of this bounty will be given to the finder as a finder's fee, but a small portion of it will go to Petchain as a facilitator fee for connecting the finder and the owner. This will create an additional incentive for the community to help recover lost pets while also generating more revenue for PetChain.

Use Cases

1. Ownership Transfer: When the ownership of a pet changes, whether that be for adoption, fostering, or a sale, the current owner will sign a smart contract to give the pet. This will reassign the NFT to the new user's wallet. This transaction will be permanent. The new owner will immediately gain access to the pet's full profile, including ownership of the medical records and vaccination history. Each transaction is recorded, so every ownership of the pet will be shown, and this can not be falsified or deleted.
2. Updating Vet Records: Every time a vet updates a pet's medical history, the information is authenticated and verified through the vet's registered wallet and then permanently added to the blockchain. This eliminates problems that are often seen with outdated paperwork or even missing records associated with a pet. This makes it much more difficult to falsify information, as everyone can see the full medical history of a pet regardless of when and where the last treatment occurred.
3. Recovering Lost and Found Pets: The QR code generated from PetChain can be scanned by individuals or shelters who find the lost pet to return the pet. Scanning the code will show the public profile of the pet containing information name, breed, age, and more. The person who finds the pet will then get an opportunity to contact the owner. The owner can choose to accept this message, and they can then choose to exchange whatever information they would like. This will help increase the low rate of lost pets returned to owners, and also decrease the animal shelters' intake of lost pets.
4. Preventing Fraud: PetChain will reduce opportunities for fraud. There will no longer be forged vaccination records, fake breeding claims, or the ability to re-microchip a stolen animal. This is due to all transactions and updates being updated by a verified vet with all

information tied to the unique biometric hash. This leaves the data unable to be manipulated. Insurance providers, breeders, shelters, and clinics all benefit from the resulting transparency and authenticity.

Privacy

PetChain will separate your public profile of the pet from the private information of the owner. The owner's information will never be shown on the blockchain. This information includes the owner's contact information, address, and other non-public records will only be shown voluntarily by the wallet's owner. This information would only be shown if the owner chooses to exchange it with the finder of a lost pet, a veterinarian, or those purchasing a pet. Only verified veterinarians with permission from the owner can update the pet's information. The owner is unable to modify their own medical records. This structure ensures that updates are accurate and will not include any fraud from the owner falsifying information.

Threat Analysis & Challenges

Although PetChain solves many issues like lost pets and the consolidation of medical records, there are some risks associated with it. Private key loss is one of the risks. Losing a private key prevents an owner from managing the associated information with a pet's identity. Another threat is unauthorized individuals attempting to submit fraudulent or manipulated medical records. PetChain mitigates this risk by restricting record updates exclusively to wallets registered in the VetRegistry smart contract, combined with pet owner authorization for each update. However, a registered vet could perform fraud by using their vet registry wallet to update something they should not. In this case, the vet would get their wallet removed, and would no longer be able to be registered to update pet information. Duplicate identity creation is a threat to trust in any identity system. PetChain addresses this by binding identity to biometric hashing of the animal itself. Because biometric hashes are unique to the pet, generating multiple identities for the same animal is difficult.

Conclusion

PetChain is a consolidated information storage system with biometric security for pets. This new system provides a solution for today's faulty pet identification systems, easing the pet reunification and data storage process. By replacing outdated databases with shared, current public information, PetChain ensures the transparency and continuity of pet ownership and medical history.

Utilizing a blockchain will allow PetChain to promote verified ownership, storage of accurate pet information, and publicize essential data. These qualities enable PetChain to be the ideal pet information and identification system to support clinics, shelters, and most importantly, owners.

Sources

Bekoff, Marc. *"The Sad State and Fate of Lost Dogs and Cats in the U.S." Psychology Today*, 2 June 2025, https://www.psychologytoday.com/us/blog/animal-emotions/202505/the-sad-state-and-fate-of-lost-dogs-and-cats-in-the-us

Larkin, Malinda. *"Evolving Pet Owner Economics: What Data Reveal for Veterinary Teams."* American Veterinary Medical Association, 15 Oct. 2025, https://www.avma.org/news/evolving-pet-owner-economics-what-data-reveal-veterinary-teams