BARRETT: BlockchAin Regulated REmote aTTestation

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Introduction – Problem Statement

- Today an increasing number of IoT healthcare devices connects to the Internet.
- They have low computational power; thus limited self-defense capabilities.
- One way to protect them is Remote Attestation (RA).
- However RA protocols can be used to attack these devices via:
  a) **Computational DoS (CDoS) attacks**
  b) **Deliberate Network Congestion**
- What do we do?

Our proposal: The BARRETT architecture

- Force the verifiers pay a fee for every Attestation Request (AR).
- CDoS and network congestion attacks become prohibitively expensive.
- The monetary cost deters the verifiers from maliciously using the RA protocol.
- The verifiers and provers are members of a Public Ethereum Network (PEN).
- Verifiers can send ARs to the provers only as Ethereum transactions.

Related Work

- In their RA design, Defrawy et al. proposed using timestamps to prevent CDoS.
- Brasser et al. used nonces to prevent CDoS attacks.
- SMARM allows interrupting RA so that the prover can perform its tasks.
- TM-Coin is the first RA design to combine an RA protocol with blockchain.
- Javaid et al. used Ethereum to counter Distributed Denial of Service (DDoS).

Our contribution

- We use Ethereum's fees and mining delays to protect the provers.
- A smart contract sets a limit to the number of ARs that reach a prover.
- Via Ethereum we provide nonrepudiation of actions and an immutable log.
- This log enables us to detect dishonest behavior from the verifier.

BARRETT's Assumptions and Threat model

- Healthcare IoT devices belong to a heterogeneous and dynamic network.
- We consider only adversaries that can interact only remotely with the prover.
- The adversaries are internal and use the RA protocol to harm the provers.
- Adversaries cannot physically interact with the device.
- Harming the prover by bypassing the BARRETT architecture is out of scope.

The BARRETT architecture

The BARRETT architecture comprises the following elements:

- The **PEN** which is the main component that protects provers.
- The **Verification Nodes (VNs)** which act as verifiers.
- The **provers**, which are IoT devices and the beneficiaries of BARRETT.
- A **smart contract** that regulates the number of ARs that reach a prover.

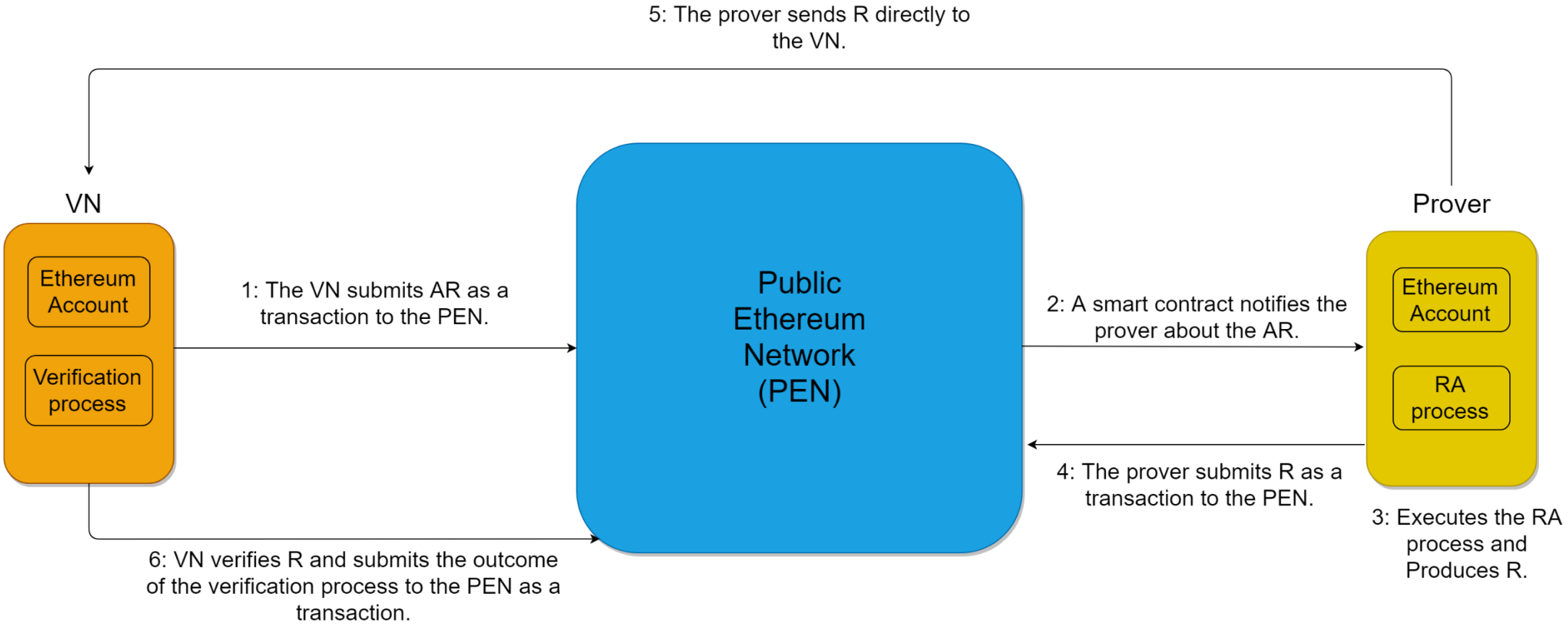
BARRETT – Components' features

Feature / Element	Ethereum Account	Ledger Copy	Shared Secret Key	Mining	Submits transactions
Full VN	✓	✓	✓	✓	✓
Light VN	✓	✗	✓	✗	✓
Prover	✓	✗	✓	✗	✓

Design Decisions

- We chose a PEN over consortium or private Ethereum because:
  a) It offers higher availability and robustness of data.
  b) Its mining delays are longer.
- BARRETT was not designed around an RA type for the following reasons:
  a) Compatibility with many types of RA.
  b) To protect provers in a variety of RA settings.

BARRETT – Flow of data



Performance Analysis

- The PEN imposes significant storage requirements to the **full** VNs.
- The mining process brings a considerable performance burden to the **full** VNs.
- Provers and VNs must dedicate 928 bits for storing information relevant to their Ethereum account.
- The above storage requirement is acceptable even for class-1 IoT devices.
- Mining can impose relatively long delays on the RA communication exchange.
- These delays may cause problems in RA scenarios that are not delay-tolerant.

Security Analysis

- Through the PEN BARRETT provides:
    a. Accountability and non-repudiation of actions.
    b. Data immutability.
    c. Constant data availability and single point of failure eradication.
- Ethereum fees and delays are **not enough** if ARs arrive from different verifiers.
- This is where the smart contract comes.

Conclusion and Future work

Conclusion:

- BARRETT is only suitable for RA scenarios that tolerate delays.
- In some cases, our architecture may become very expensive for honest VNs.

Future work will include:

- Expansion of the threat model's scope.
- A methodology that regulates fees for transactions that contain ARs.

Thank you!