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RadioTrace: Enhancing the Traceability of Radioactive Sources Through Blockchain Technology

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RadioTrace is a proposed solution that employs blockchain technology to track the movement and custody of radioactive materials. Blockchain technology is a distributed ledger that grows a list of blocks that are held together by a cryptographic hash of the previous block. Participants in a blockchain distribute data in a decentralised manner and is therefore resistant to tampering or unauthorized alterations outside of the network. A prototype blockchain was developed as a proof-of-concept of RadioTrace.

Current Global Source Tracking State

Current inventory management systems involve storing items in a **centralised database infrastructure**. Centralised infrastructure lacks resilience against unplanned events such as natural disasters to political instability.

There is also a **lack of transparency** in current database systems for tracking radioactive source tracking. With security concerns being the **main excuse to mask the inadequacy** of these current management processes.

Multiple surveys have found that **only 6% of the world population is able to identify the black trefoil on a yellow background symbol** and associate it correctly with an ionizing radiation hazard.

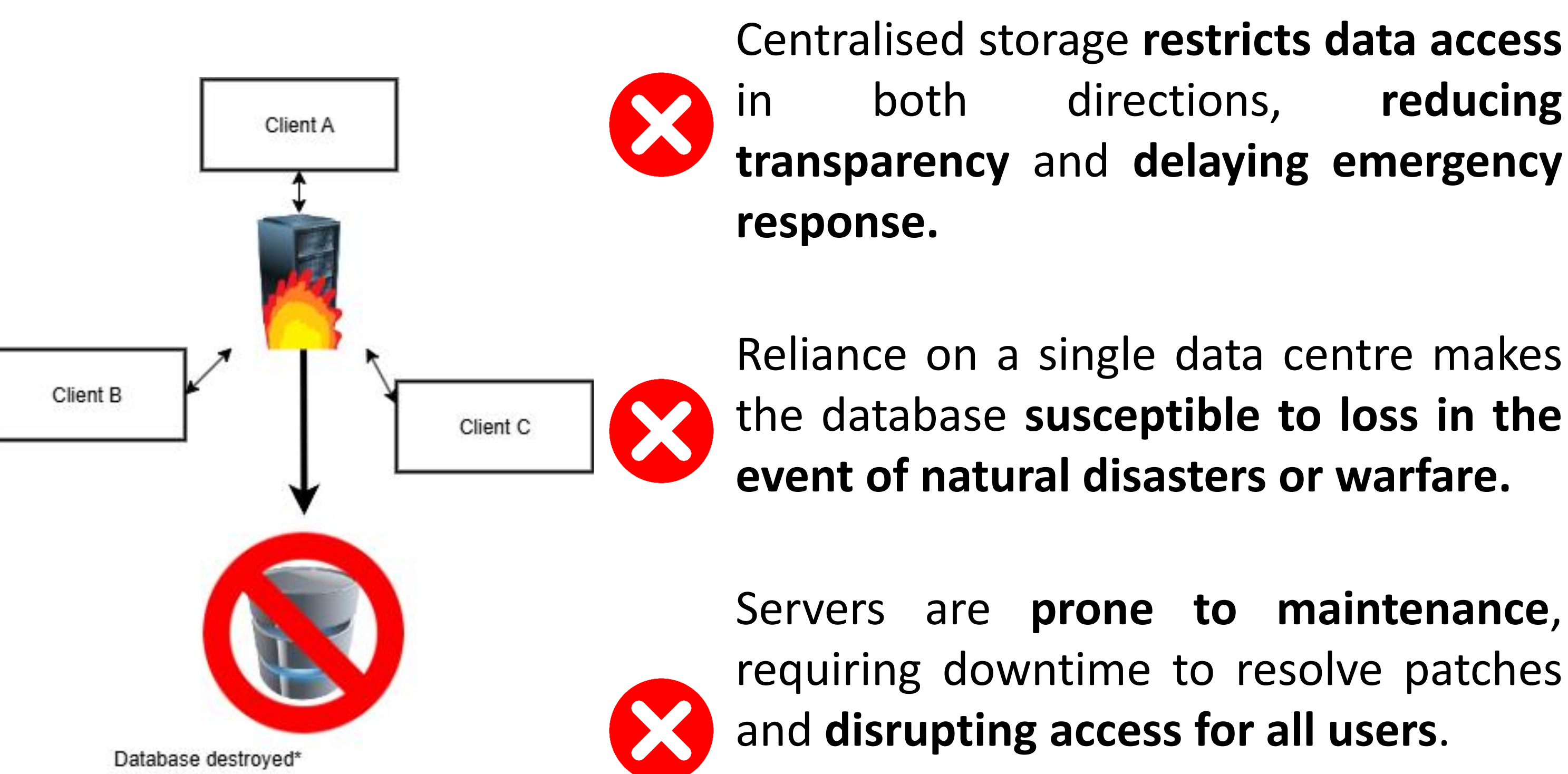
Case Studies

2023 - In **Australia**, a capsule containing **19 GBq of Cs-137** was lost during transport between the Gudai-Darri mine site and a storage facility in Perth, **with the loss remaining undetected for two weeks**.

2001 - In **Lia, Georgia**, two **1.3 PBq Sr-90** cores were orphaned from Soviet radioisotope thermoelectric generators. They were found just off a dirt track road. **Three people were exposed to the source with 1 fatality after 893 days in the hospital**.



Centralised Database Systems - Issues



Since centralised database systems are problematic, a **decentralised database system is needed**

Acknowledgements

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Conclusions

- A prototype for RadioTrace was created as part of the NTR net pilot project scheme.
- A network of Raspberry Pi 5's were used to act as participants in the blockchain.
 - Blockchain consensus rules need to be further investigated
- Develop methods to encourage database updates from source owners.

The Proposed Solution - RadioTrace

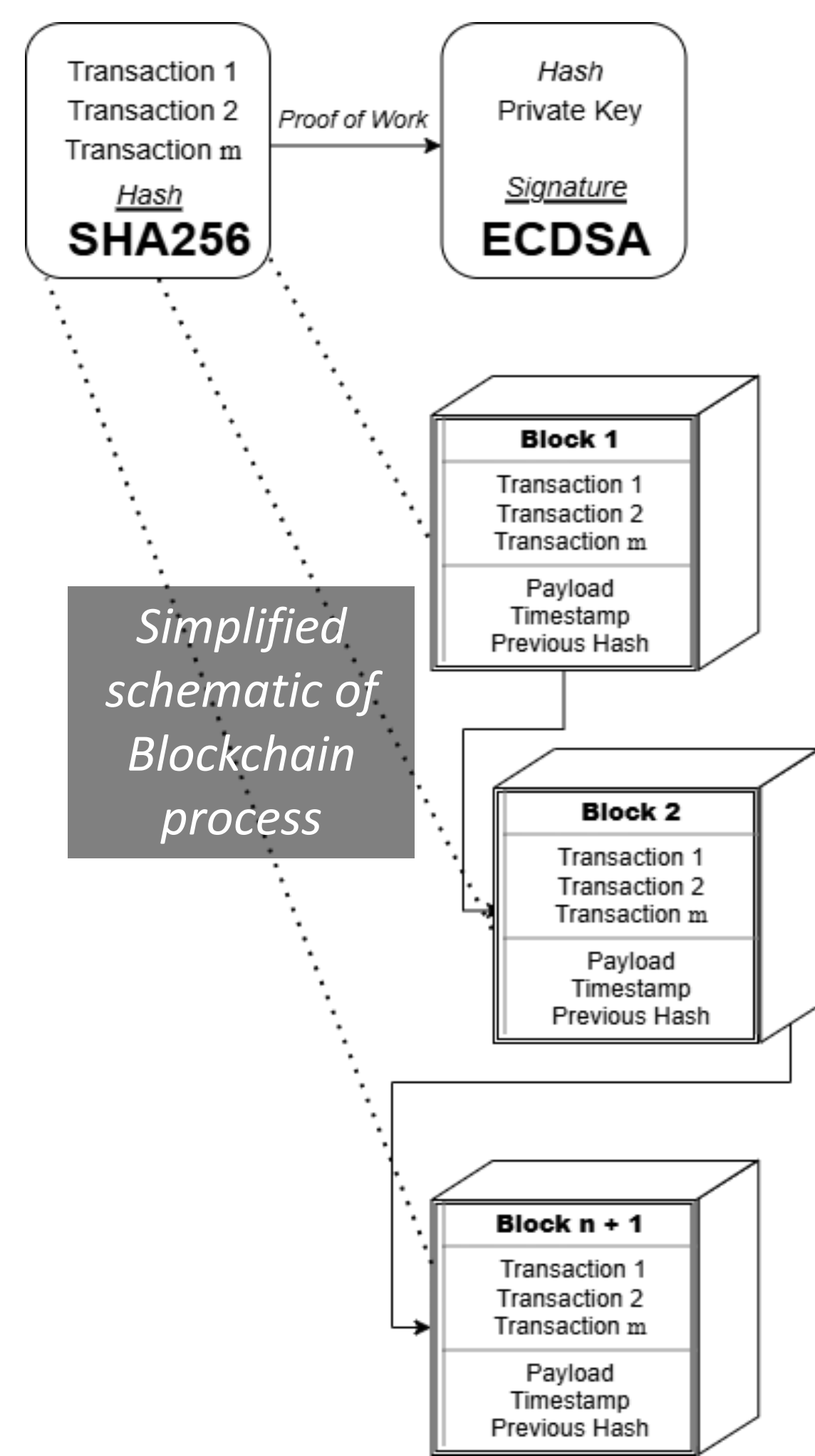
Blockchain is a decentralised ledger. Containing data in a sequence of data packets called “blocks”, which are tied together cryptographically through storing the previous hash, hence the “chain” part in the name blockchain. This is the backbone behind RadioTrace

Having a decentralised database means that each participant holds a copy of the blockchain. This allows for all parties to be **regarded as equals**.

Cryptographic connections between blocks enables the data to be **protected from tampering**.

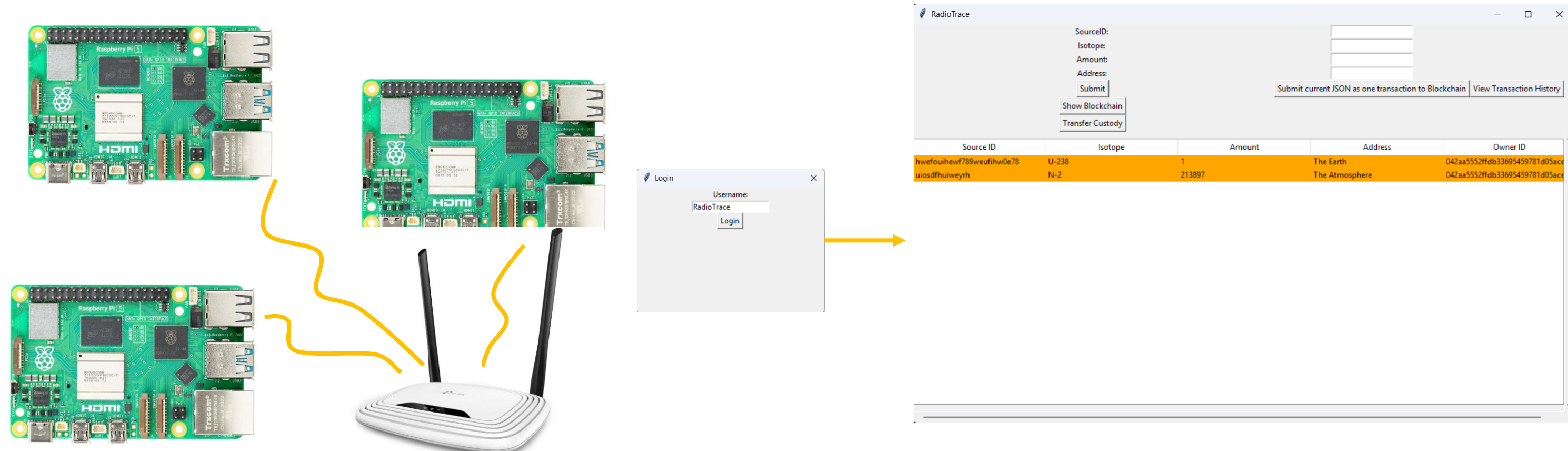
Data stored in blockchain is **immutable**, meaning it is permanent and is also protected from tampering.

Adding blocks to the blockchain are decided by **consensus by peers**, helping to **prevent rogue additions to blockchain**.



Prototype Deployment

- Raspberry Pi 5's** were connected to a network switch
 - Each acted as participants in the blockchain.
- Prototype code was written in **Python**
 - Python code outlined the blockchain protocols each participant must follow.
- All of the user's reported sources would be stored onto one block which is written to a database.



Future Steps going Forward

Add cryptographic protection to prevent unauthorised modification of stored files.

Automate database appending through a custom labelling workflow.

Investigate and address further into blockchain edge cases to allow RadioTrace to be robust.

Develop a mechanism to incentivize manufacturers and laboratories to update the RadioTrace database without reverting to current standard cumbersome infrastructure.

Further test the proof-of-concept with tracking sources within the University of Bristol IAC