Griffith UNIVERSITY

Vacci-Chain: The Smart Contract Powered Vaccine Storage and Monitoring System

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Outline

- Introduction
- Limitations
- What is the Solution?
- The Proposed System
- Future Work
- Conclusion
- References

Vaccine Temperature

- ✓ Vaccine: a delicate biological substance
- ✓ Recommended temperature: 2 °C - 8 °C
- ✓ Sensitive: freezing temperature or exposure to heat

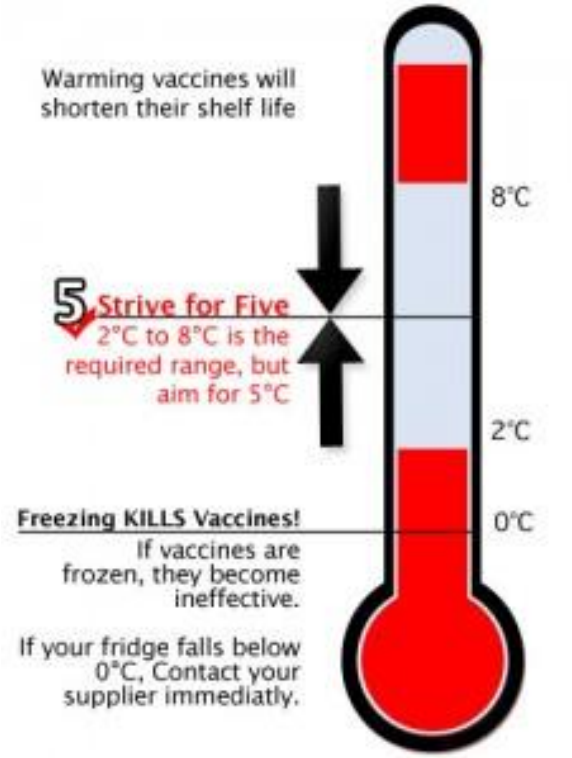
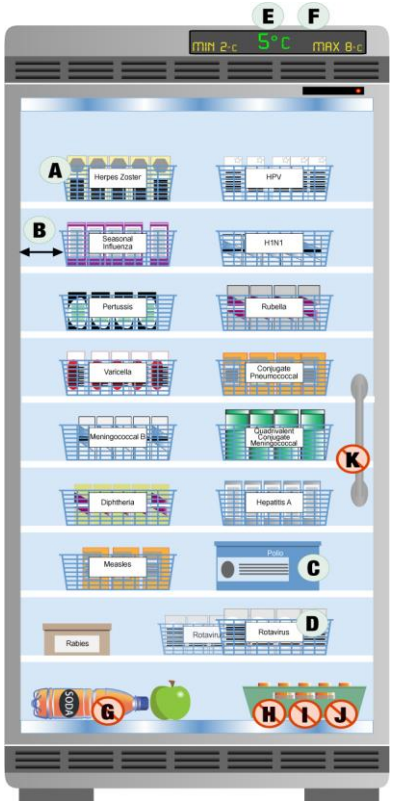


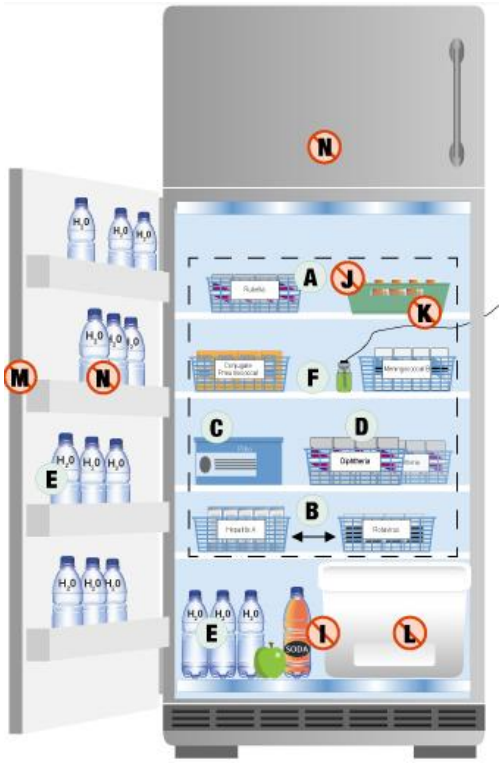
Figure: Vaccine Storage Temperature*

* http://vaccinetemperature.com.au/

Vaccine Storage



Purpose-built vaccine refrigerator‡

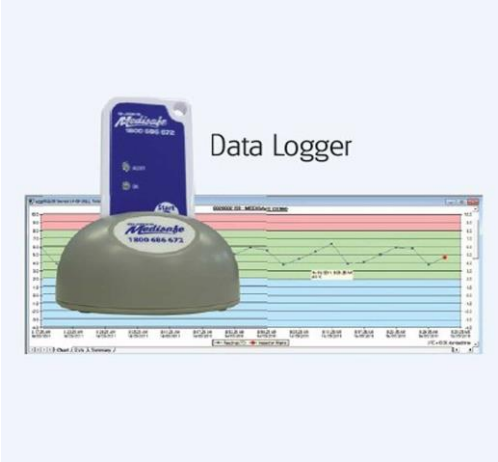


Domestic refrigerator‡

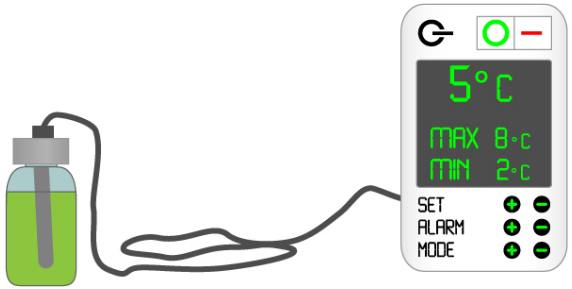
Portable vaccine refrigerator†

‡ https://www.canada.ca/en/public-health/services/publications/healthy-living/national-vaccine-storage-handling-guidelines-immunization-providers-2015.html
† http://www.labfreez.com/MPR-series-portable-refrigerator

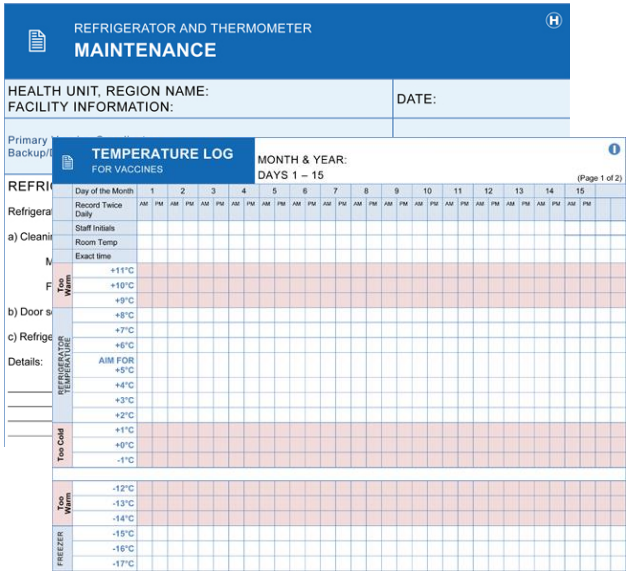
Data Collection and Monitoring



Data Logger†



Max/Min Thermometer‡



Manual Data Log‡

† https://www.bar-fridges-australia.com.au/medicine-vaccine-glass-door-fridge-medisafe-fkg-371g2-381l.html
‡ https://www.canada.ca/en/public-health/services/publications/healthy-living/national-vaccine-storage-handling-guidelines-immunization-providers-2015.html

Hardware Issues

- ✓ **Purpose-built vaccine refrigerators**
  - *No in-built monitor and/or logger in some models*
  - *No battery backup facility in some models*
  - *Need to use a min/max thermometer*

- ✓ **Domestic refrigerators**
  - *Temperature fluctuations*
  - *Non-uniform temperature*
  - *Must use a min/max thermometer & data logger*

Technical Issues

- ✓ **Purpose-built vaccine refrigerators**
  - *Manually reset thermometer*
  - *Compromise/Manipulate data downloaded to a computer*
  - *Compromise in-built system*

- ✓ **Domestic refrigerators**
  - *Very hard to deal with temperature changes*
  - *Use manual data log in most cases*

NEED A SAFE, TRANSPARENT and TRACEABLE SOLUTION FOR VACCINE STORAGE AND MONITORING SYSTEM

Vacci-Chain System

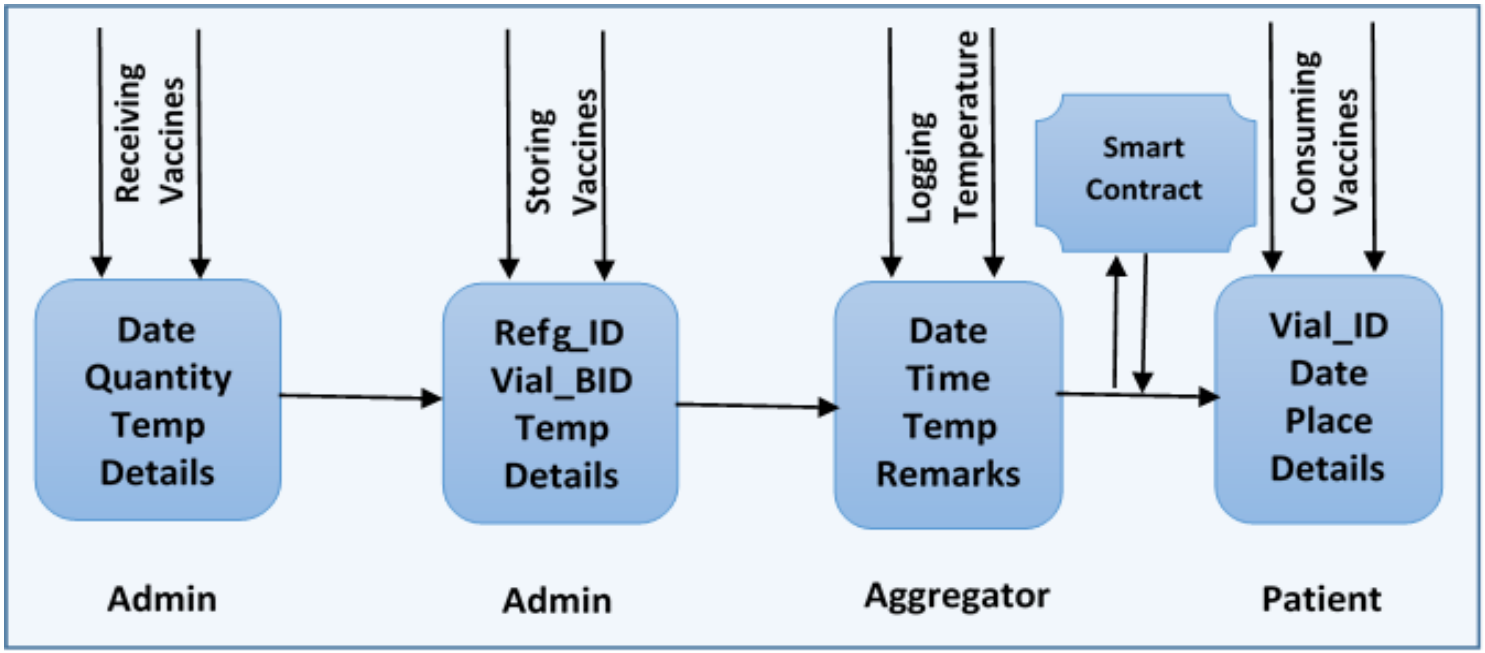
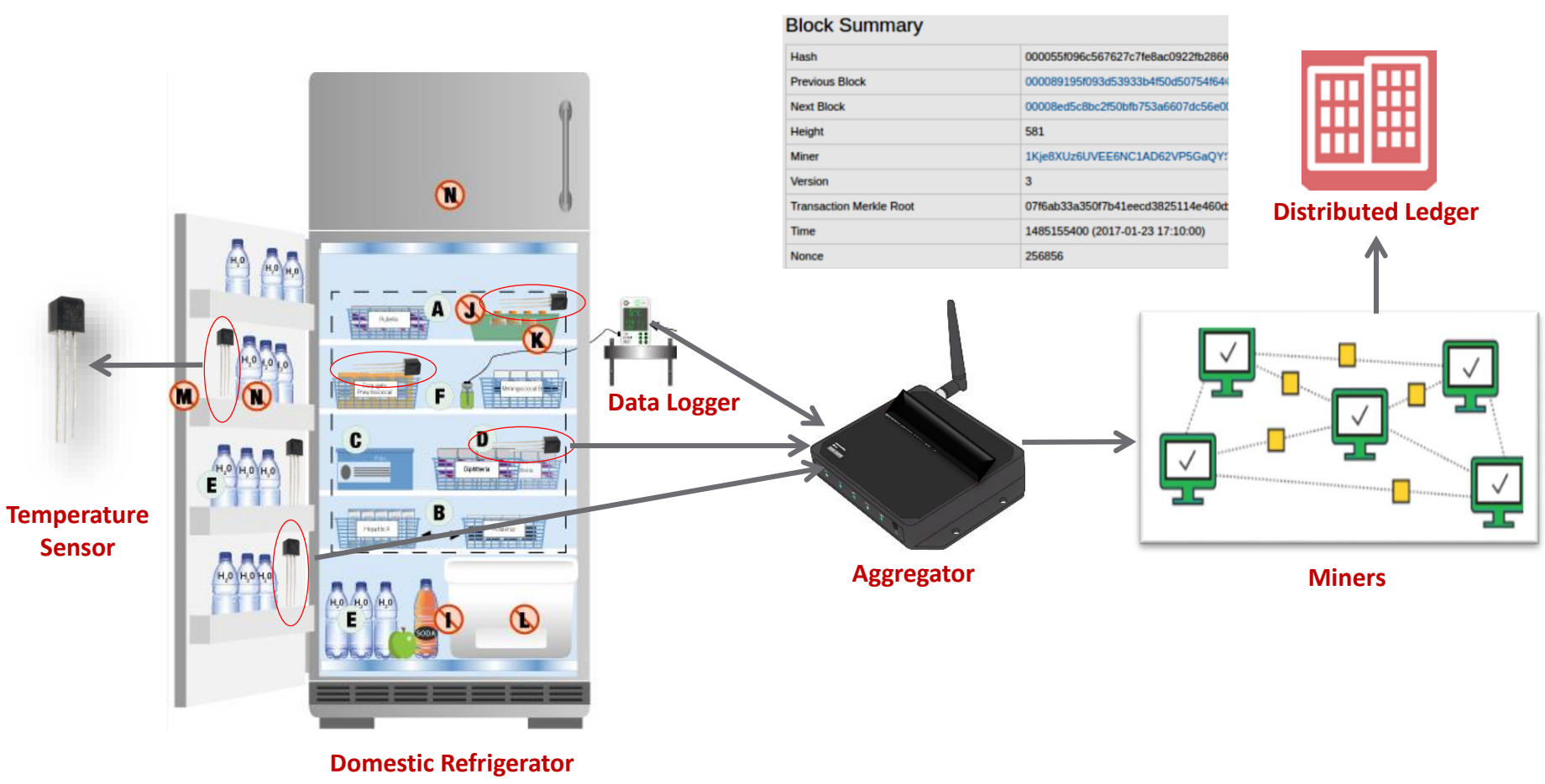
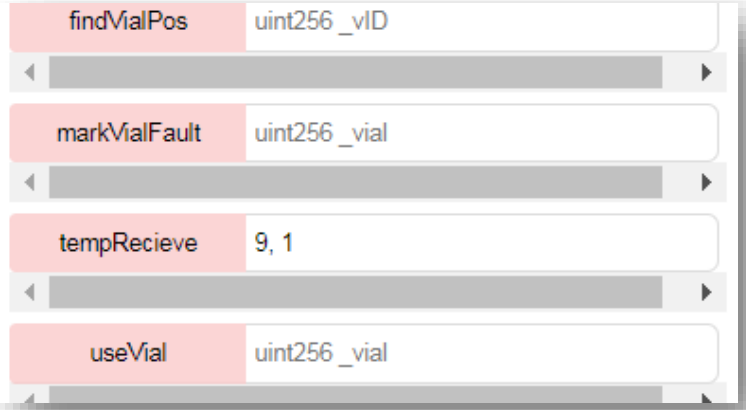


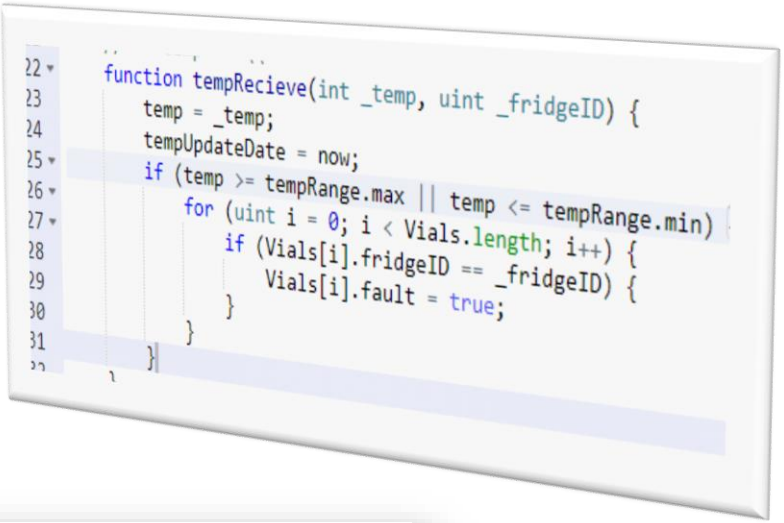
Fig: Vacci-Chain entities and their relationships

System Architecture

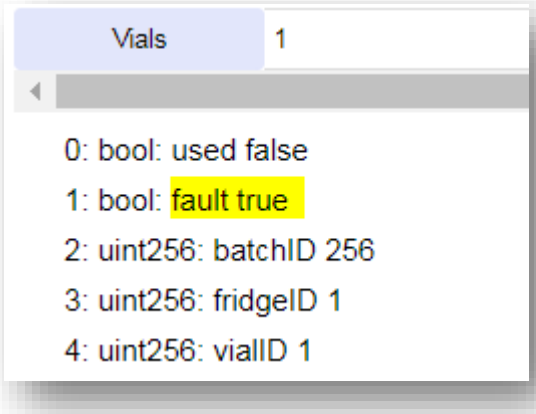


Smart Contract Powered Solution





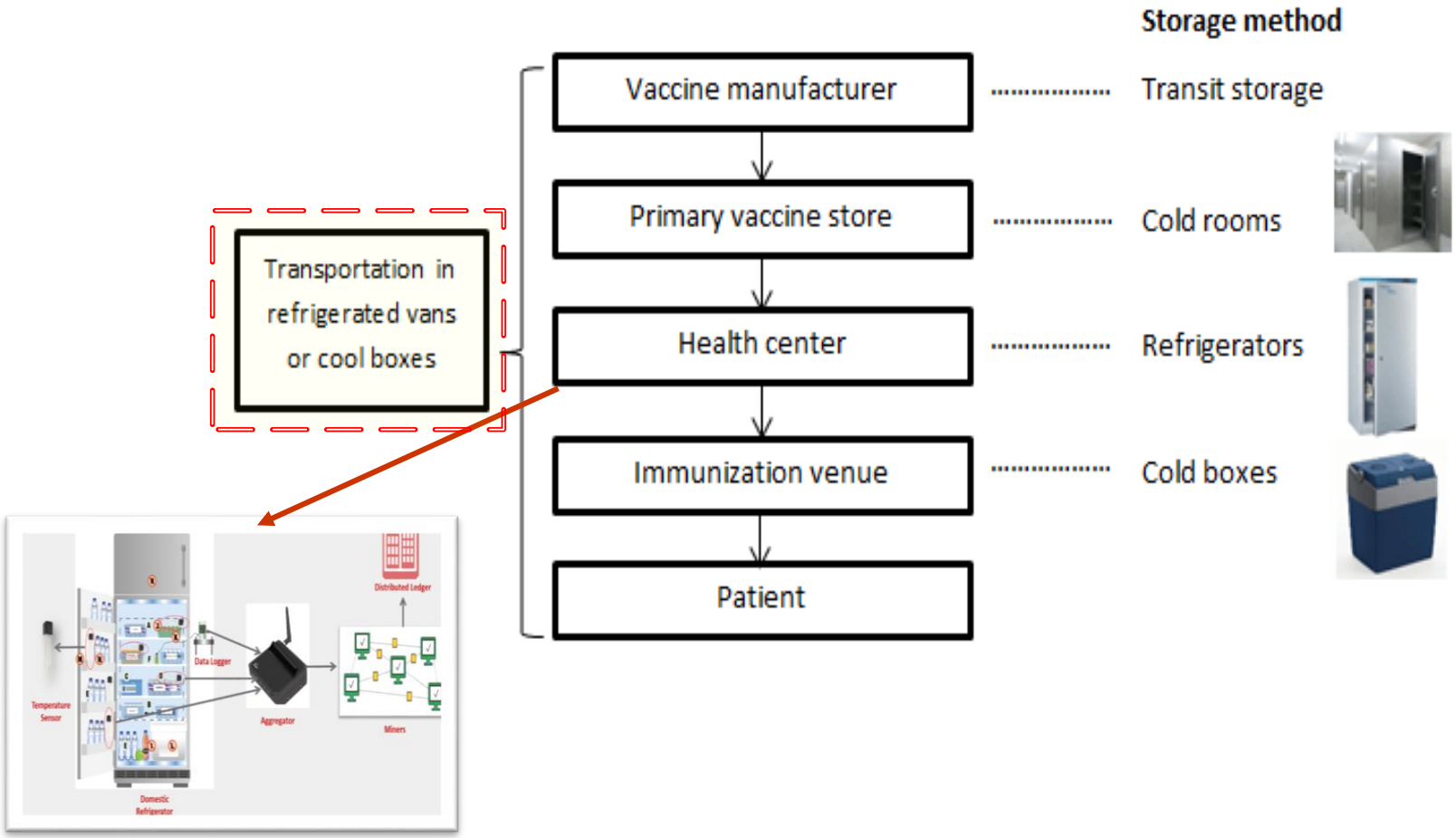
```
function tempRecieve(int _temp, uint _fridgeID) {
    temp = _temp;
    tempUpdateDate = now;
    if (temp >= tempRange.max || temp <= tempRange.min)
        for (uint i = 0; i < Vials.length; i++) {
            if (Vials[i].fridgeID == _fridgeID) {
                Vials[i].fault = true;
            }
        }
    }
```



Benefits

- ✓ **Transparency-** every block in the chain is visible
- ✓ **Traceability-** can trace the origin of vaccines, manufacturing & expiry date etc.
- ✓ **Accuracy-** temperature data is stored accurately
- ✓ **Fault Tolerance-** distributed ledger eliminates SPoF
- ✓ **Security-** blockchain is immutable and irrefutable
- ✓ **Ease of Access-** easily can check the history, availability etc.

Future Work


Storage method
Vaccine manufacturer
Transit storage
Primary vaccine store
Cold rooms
Health center
Refrigerators
Immunization venue
Cold boxes
Patient
Transportation in refrigerated vans or cool boxes
Distributed Ledger
Data Logger
Temperature Sensor
Aggregator
Miners
Domestic Refrigerator

Conclusion

- ✓ Safe, secure and transparent system
- ✓ Better traceability
- ✓ Cost effective solution

References

[1] Australian Government Department of Health and Ageing, National Vaccine Storage Standards, Strive for 5, 2nd Edition, 2013.

[2] R. Brandom, "UK hospitals hit with massive ransomware attack", https://www.theverge.com/2017/5/12/15630354/nhs-hospitals-ransomware-hack-wannacry-bit coin, 2017.

[3] J. Redman, "Nearly half the Internet temporarily incapacitated", https://news. bitcoin.com/blockchain-prevented-ddos-attack/, 2016.

[4] K. Karagiannis, "Hacking Blockchain", RSA conference, San Francisco, https://www. rsaconference.com/writable/presentations/file_upload/fon4-t11_hacking_block chain.pdf, 2017.

Thanks for your attention !!!