Vacci-Chain: A Safe and Smarter Vaccine Storage and Monitoring System

By

Kamanashis Biswas

Vallipuram Muthukkumarasamy

Wee Lum Tan

Introduction
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The Proposed System
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Outline

- ❑ **Introduction**

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Vaccine Temperature

- ✓ **Vaccine: a delicate biological substance**

- ✓ **Recommended temperature: 2 °C - 8 °C**
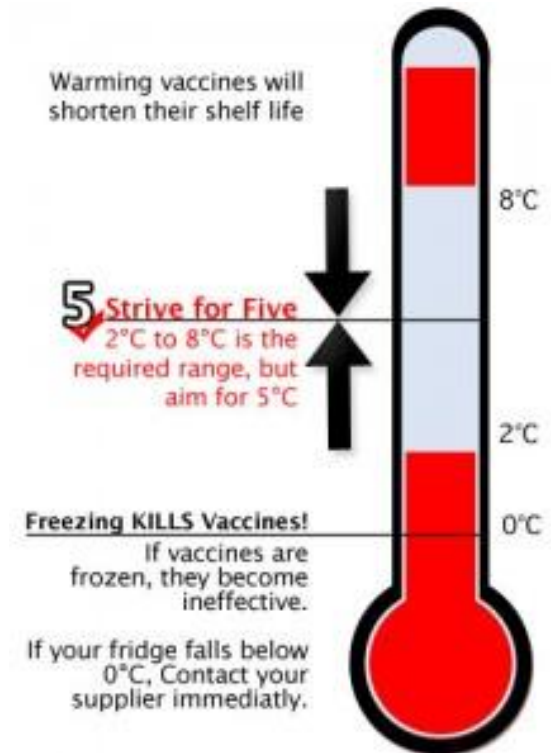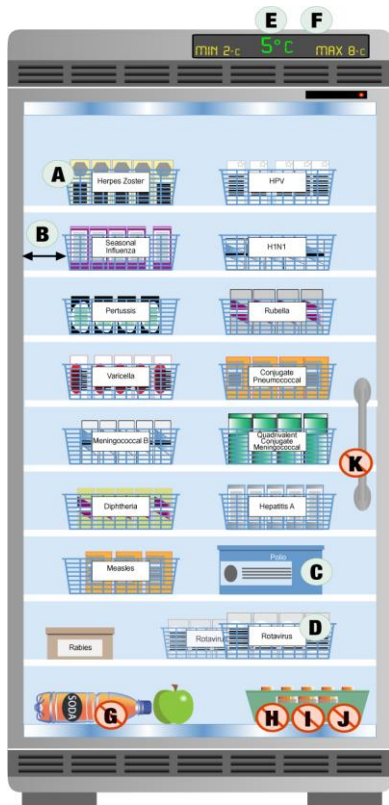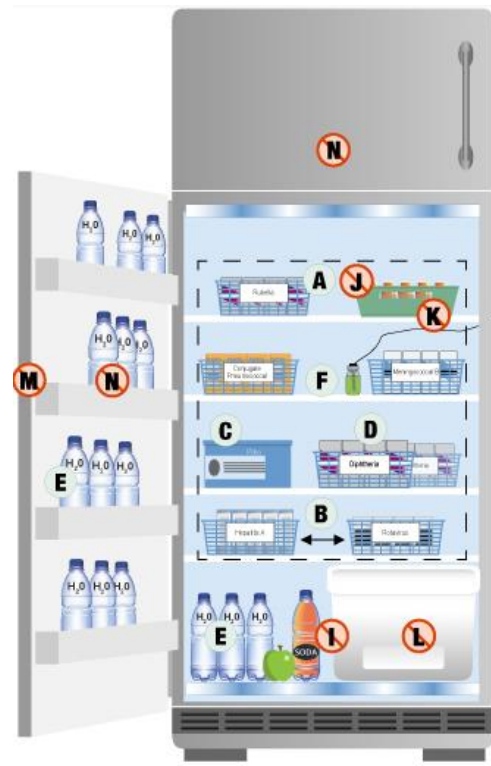
- ✓ **Sensitive: freezing temperature or exposure to heat**

Figure: Vaccine Storage Temperature*

* http://vaccinetemperature.com.au/

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Vaccine Temperature
Vaccine Storage
Data Collection and Monitoring

Vaccine Storage

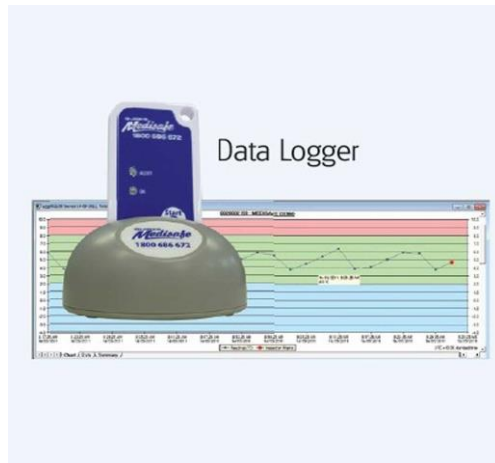**Purpose-built vaccine refrigerator‡**

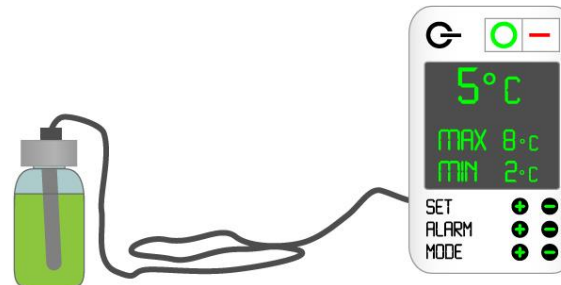**Domestic refrigerator‡**

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

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Vaccine Temperature
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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

Blockchain Technology
Why Blockchain?
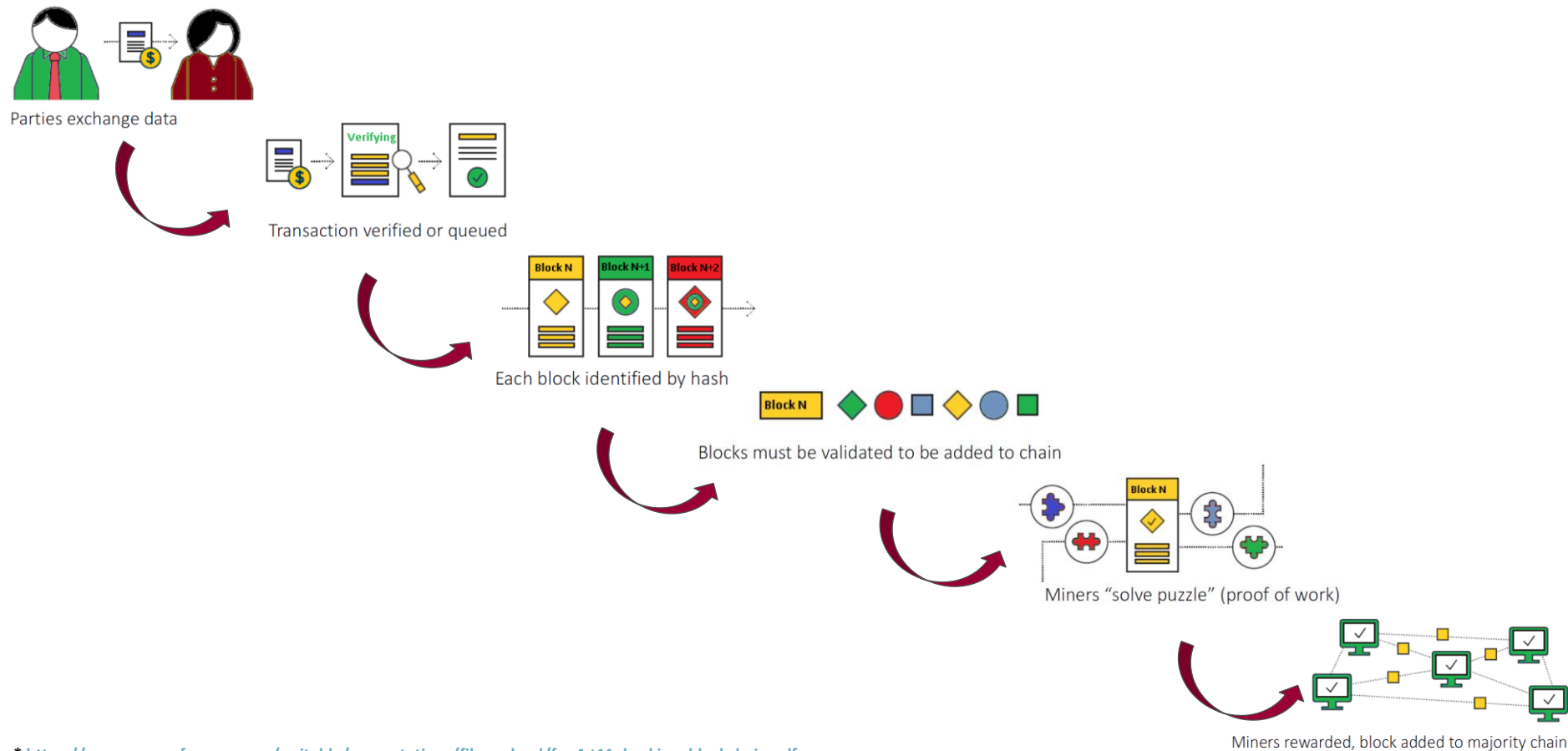
Blockchain Technology

Parties exchange data

Transaction verified or queued

Each block identified by hash

Blocks must be validated to be added to chain

Miners "solve puzzle" (proof of work)

Miners rewarded, block added to majority chain

* https://www.rsaconference.com/writable/presentations/file_upload/fon4-t11_hacking_blockchain.pdf

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Blockchain Technology
Why Blockchain?

Why Blockchain?

UK hospitals hit with massive ransomware attack

Sixteen hospitals shut down as a result of the attack

Nearly Half The Internet Temporarily Incapacitated

Blockchain Could Have Prevented Last Week's DDoS Attack

A Second Internet, Coming Soon, Courtesy of the Blockchain

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System Architecture
Benefits

System Architecture

Block Summary

Hash	000055f096c567627c7fe8ac0922fb2866
Previous Block	000089195f093d53933b4f50d50754f644
Next Block	00008ed5c8bc2f50bfb753a6607dc56e00
Height	581
Miner	1Kje8XUz6UVEE6NC1AD62VP5GaQY5
Version	3
Transaction Merkle Root	07f6ab33a350f7b41eecd3825114e460d
Time	1485155400 (2017-01-23 17:10:00)
Nonce	256856

Temperature Sensor

Domestic Refrigerator

Data Logger

Aggregator

Distributed Ledger

Miners

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System Architecture
Benefits

Benefits

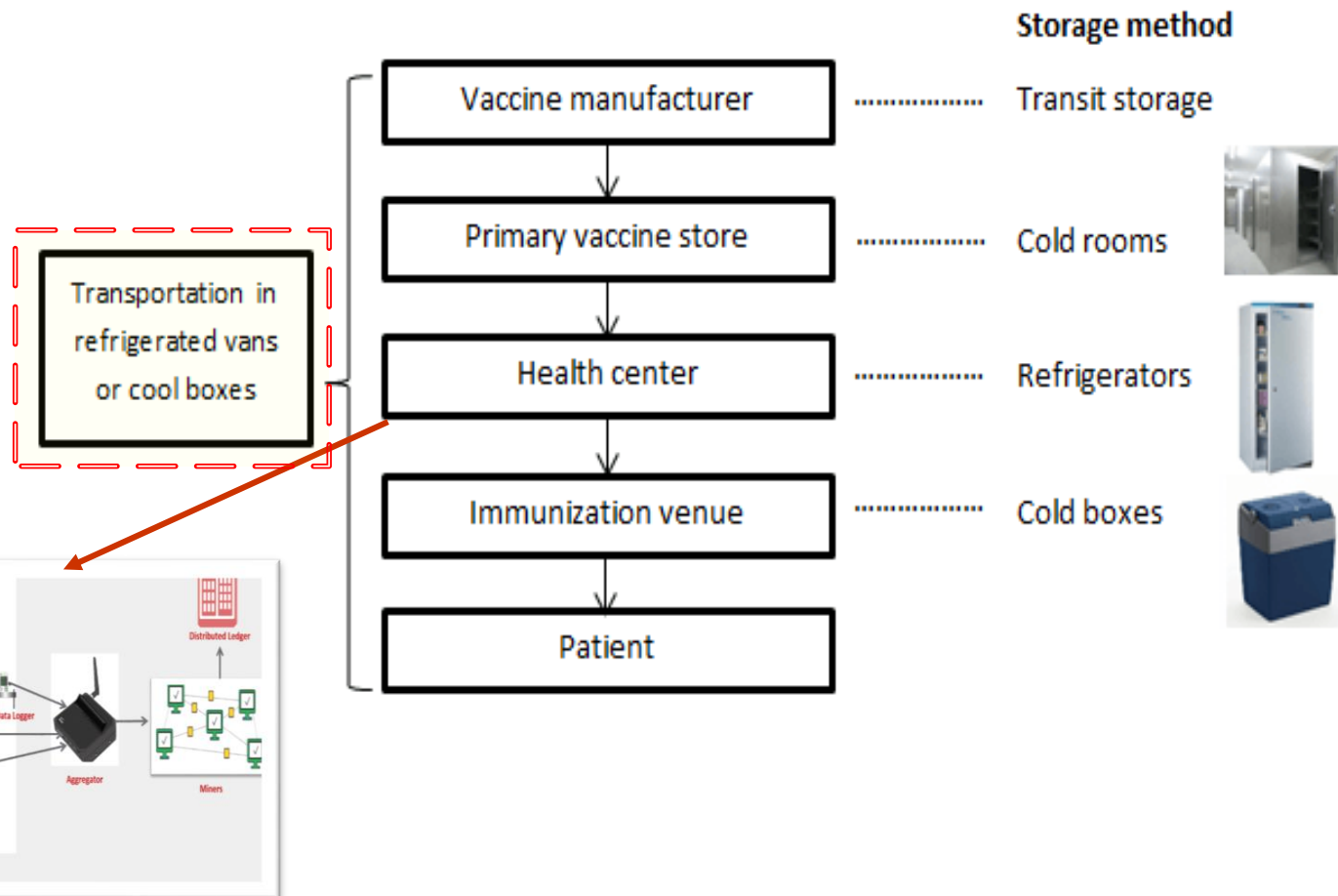✓ **Transparency-** every block in the chain is visible

✓ **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

Transportation in refrigerated vans or cool boxes

Health center .... Refrigerators

Immunization venue .... Cold boxes

Patient

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 !!!