Trustworthiness

- Jon Crowcroft 18/9/24

dependence

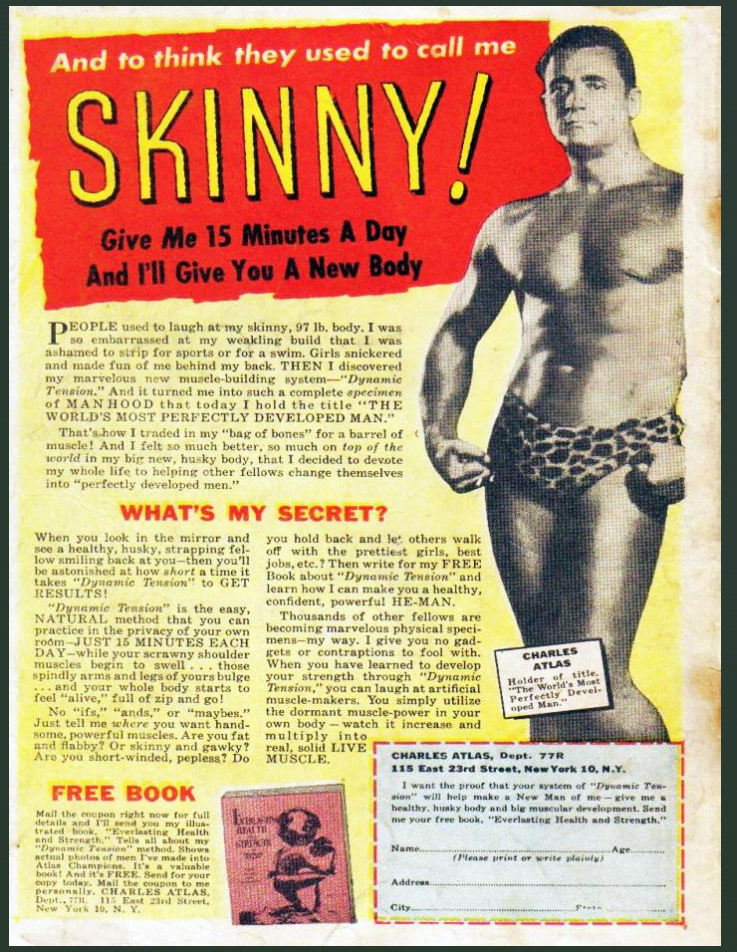
- Critical digital infrastructure
- Vulnerability

agency

- Who even knows what?

asymmetric power

- Redress

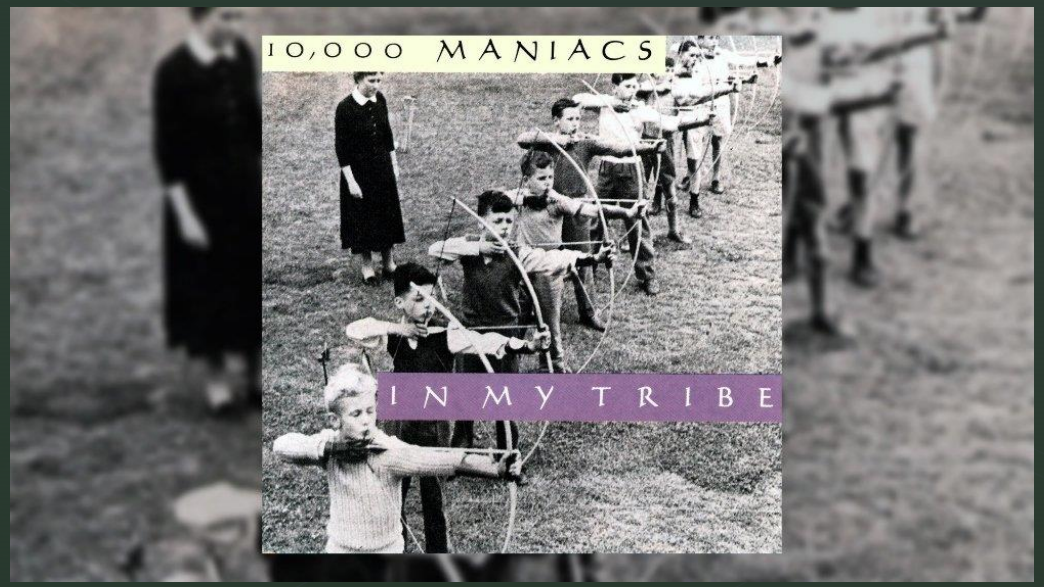


indistinguishable from magic

- Does anyone at all actually understand

10000 papers can’t even be wrong

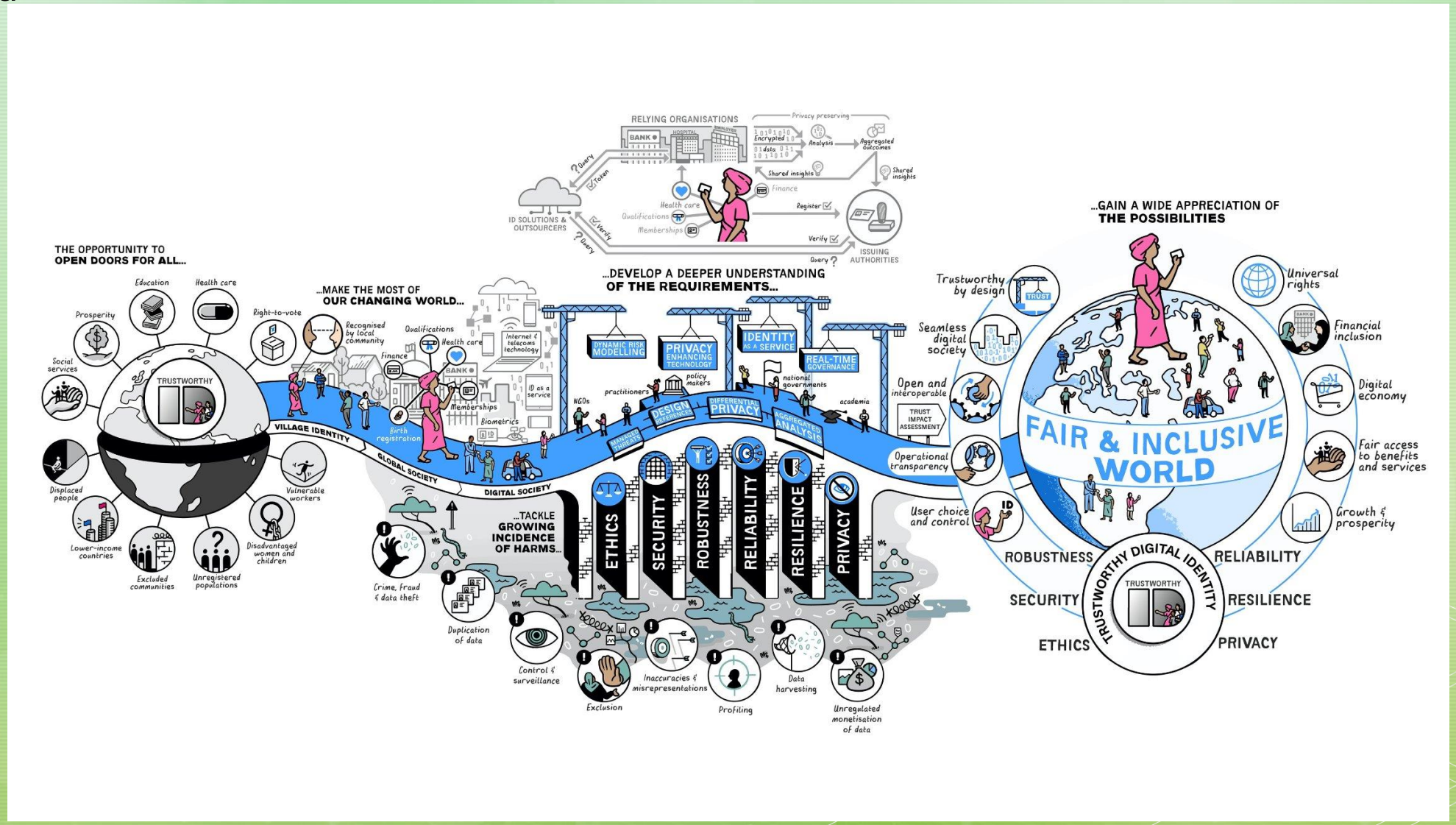
- How would anyone know?



why are we in such a rush anyhow?…

Past, present, future: Trustworthy Digital Infrastructure for Identity Systems – A worked example

- Looking
- Forward



Trustworthy Digital Identity

- $5M project on Trustworthy Digital Identity, led by Carsten Maple and Jon Crowcroft. Now $9M
- A large group of multidisciplinary researchers.
- Turing Interest Group one of key successes

- The incentives to misuse, commit fraud, breach or manipulate these systems are growing with their scope. We need to confront evolving risks & evocative issues

- Trustworthiness not trusted systems

Challenges

- Manyfold
  - Privacy
  - Security
  - Fairness
  - Explainability
  - Robustness

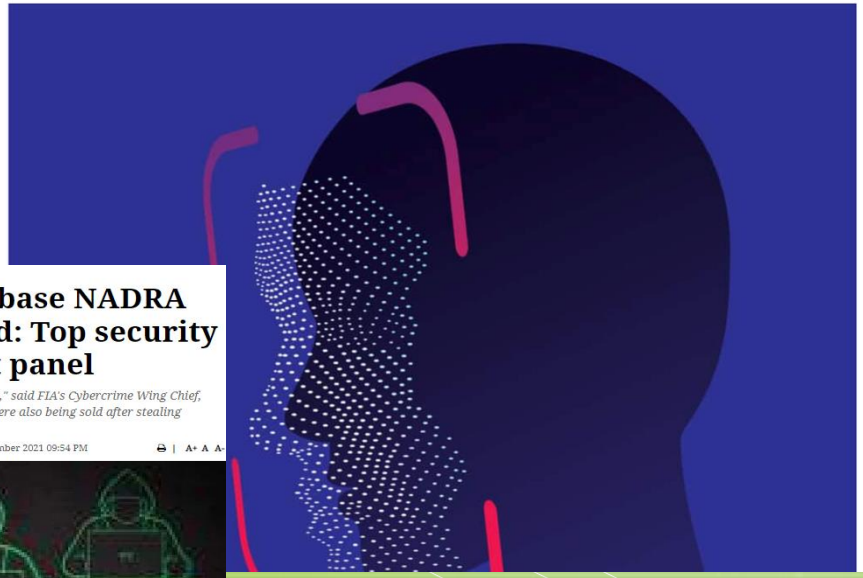
Privacy fears as India police use facial recognition at rally

In a first, Delhi Police use facial recognition software to screen crowds at Modi rally, raising surveillance concerns.

Pakistan ID authority shares data of 4K wanted people for biometric matching

Jan 11, 2023, 2:21 pm EST | Chris Burt

CATEGORIES Biometrics News | Civil / National ID | Law Enforcement



Home › World

Pakistan citizen database NADRA compromised, hacked: Top security agency to Parliament panel

"Nadra's data has been compromised, it has been hacked," said FIA's Cybercrime Wing Chief, Additional Director, Tariq, adding that fake SIM cards were also being sold after stealing biometric data.

Published: 25th November 2021 09:54 PM | Last Updated: 25th November 2021 09:54 PM

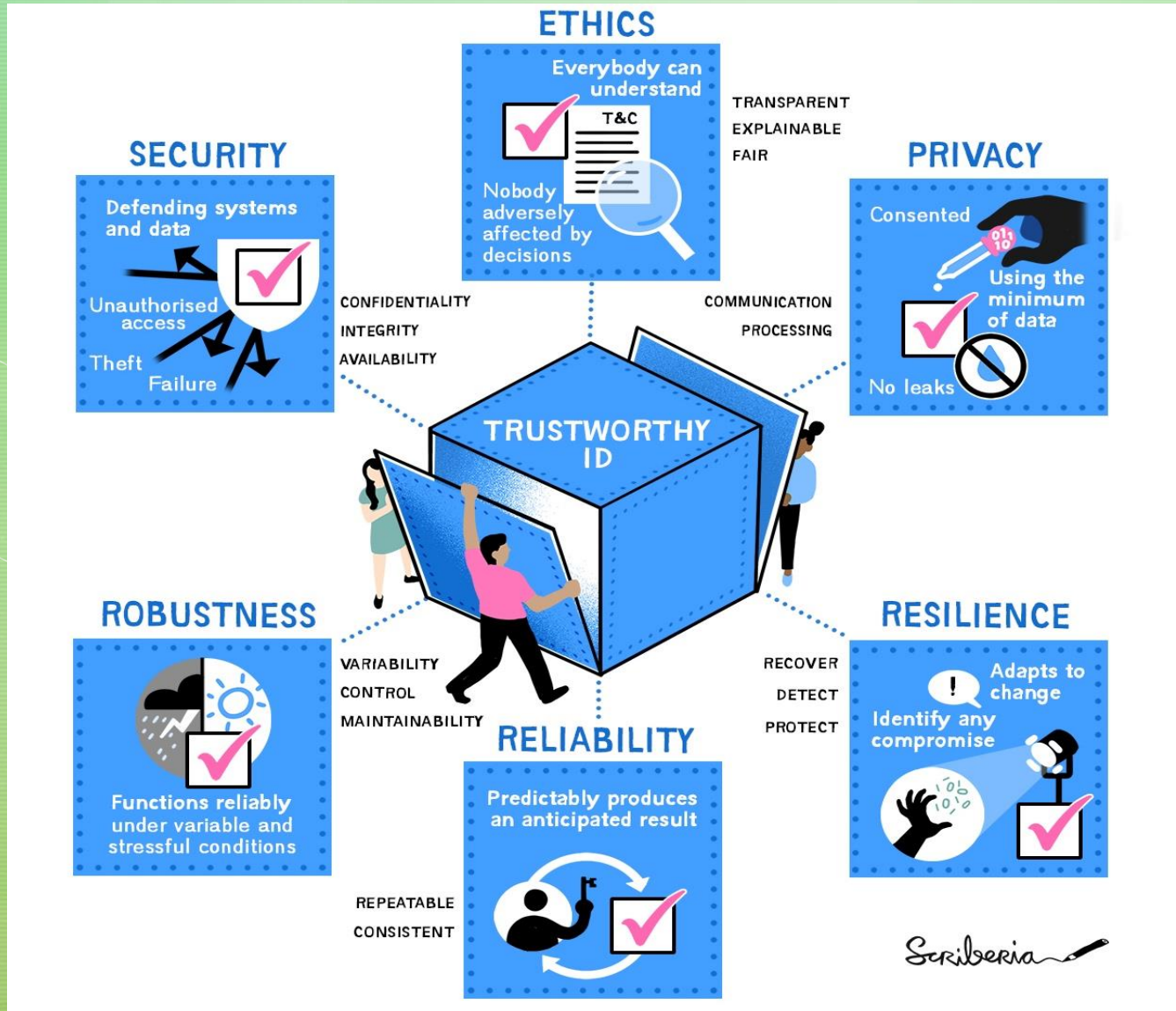
For representational purposes. (File Photo)

By PTI

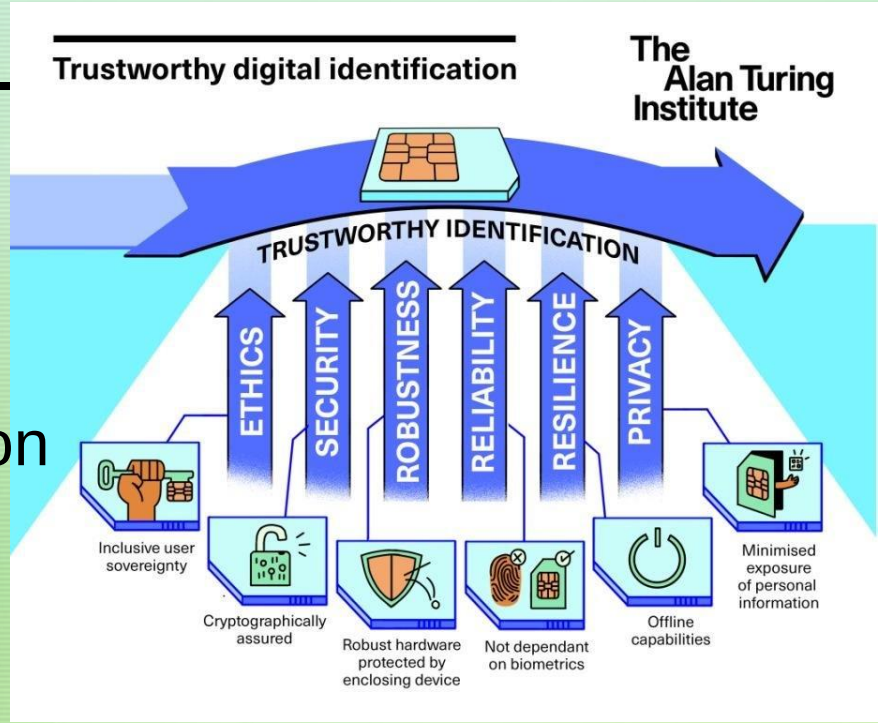
ISLAMABAD: Pakistan's main citizenry database has been compromised, the Federal Investigation Agency (FIA) informed a Parliament panel on Thursday, November 25, 2021, adding that the breach so far has been used to only issue illegal mobile SIM cards.

The Framework for trustworthy system design

Six facets
Measurable features & attributes
Creative Commons licence



A comprehensive framework for establishing the different assurance levels of an identity system in terms of its system components, information system flows, physical and logical processes, and information systems.



Accompanying assessment tool is ready for use.

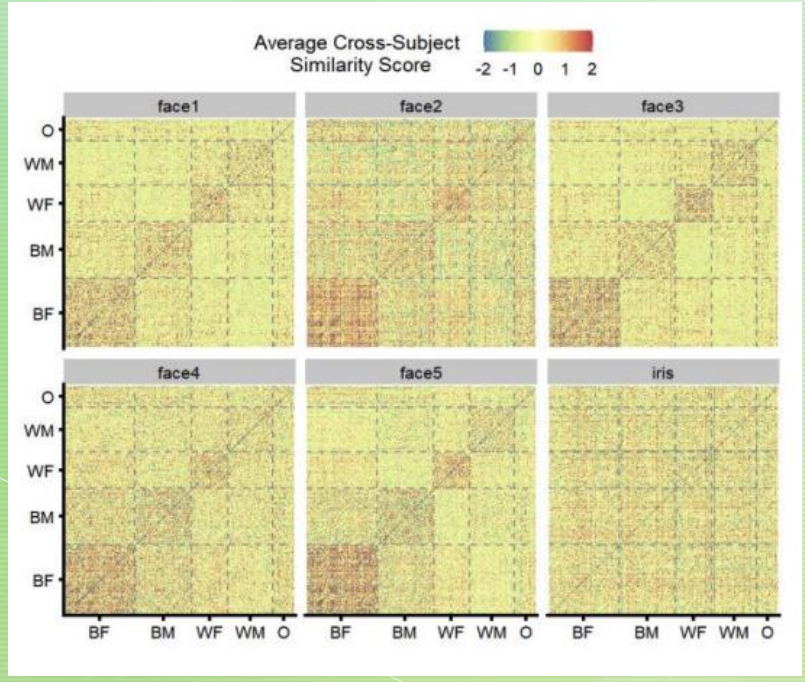
Comprises of 381 metrics across 65+ mechanisms amalgamated of standardisati documents, best practices, guidelines and codes, e.g. ISO27000x / NIST CFS/ NIST SP80xx family / ETSI 319411 / GDPR / ISO 29146 29115 / MAGERIT/ MITR

Reviewed by members of World Bank, ID4Africa and Aadhaar teams.

In-country testing and release to community expected over late 2024.

Fairness

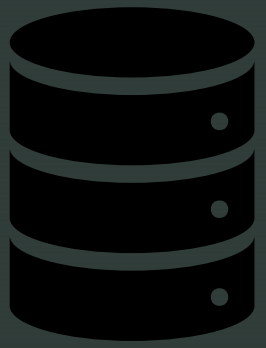
– Improving fairness of systems



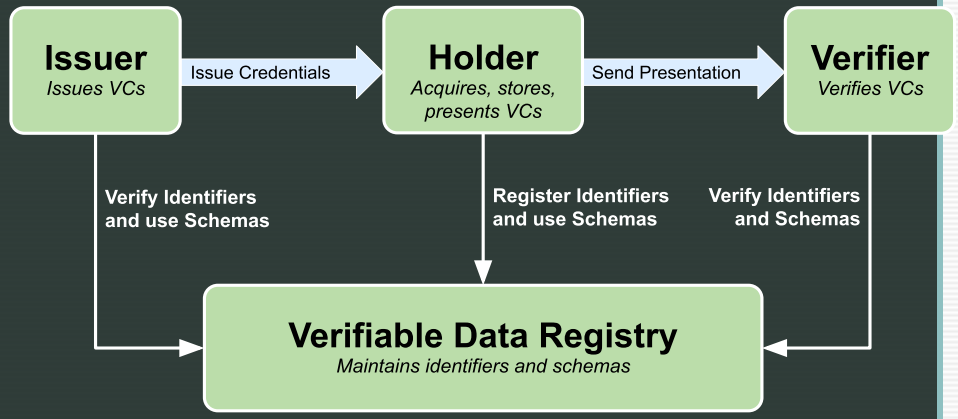
Howard, J.J. et al., 2020. Quantifying the Extent to Which Race and Gender Features Determine Identity in Commercial Face Recognition Algorithms. *arXiv preprint arXiv:2010.07979*.

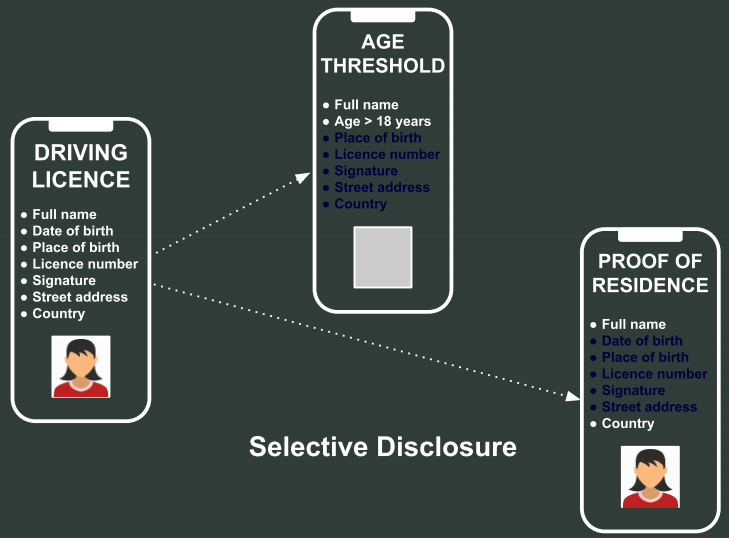
Trustchain: Trustworthy Decentralised/Federated Public Key Infrastructure – an example service prototype

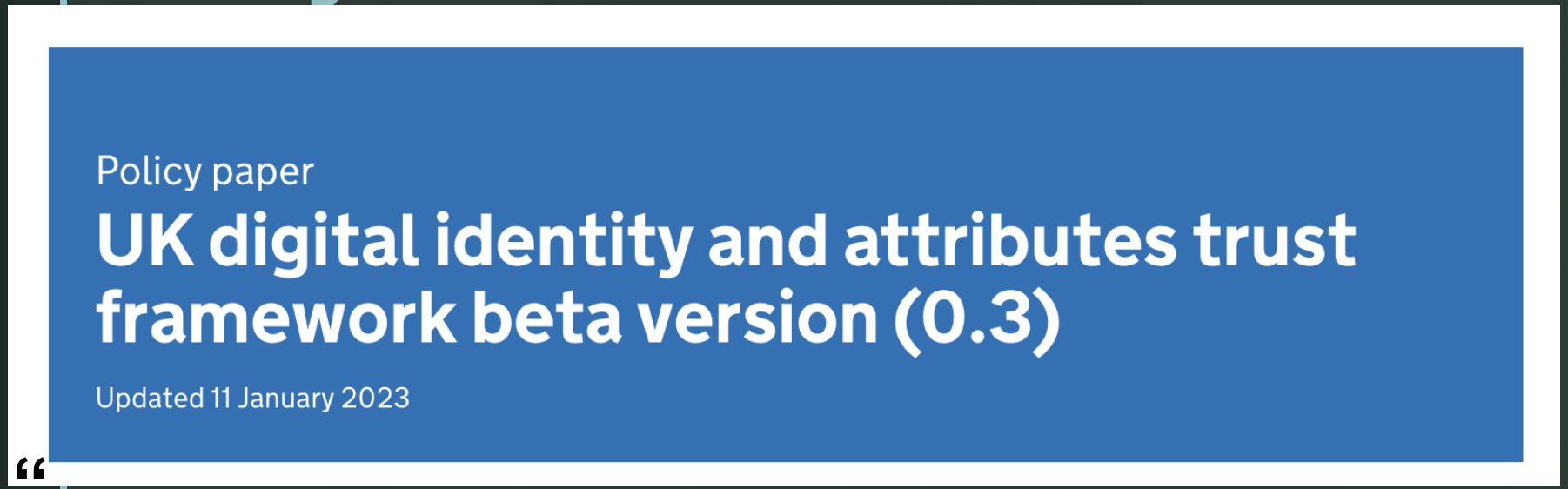
Digital ID



Credentials & Attributes



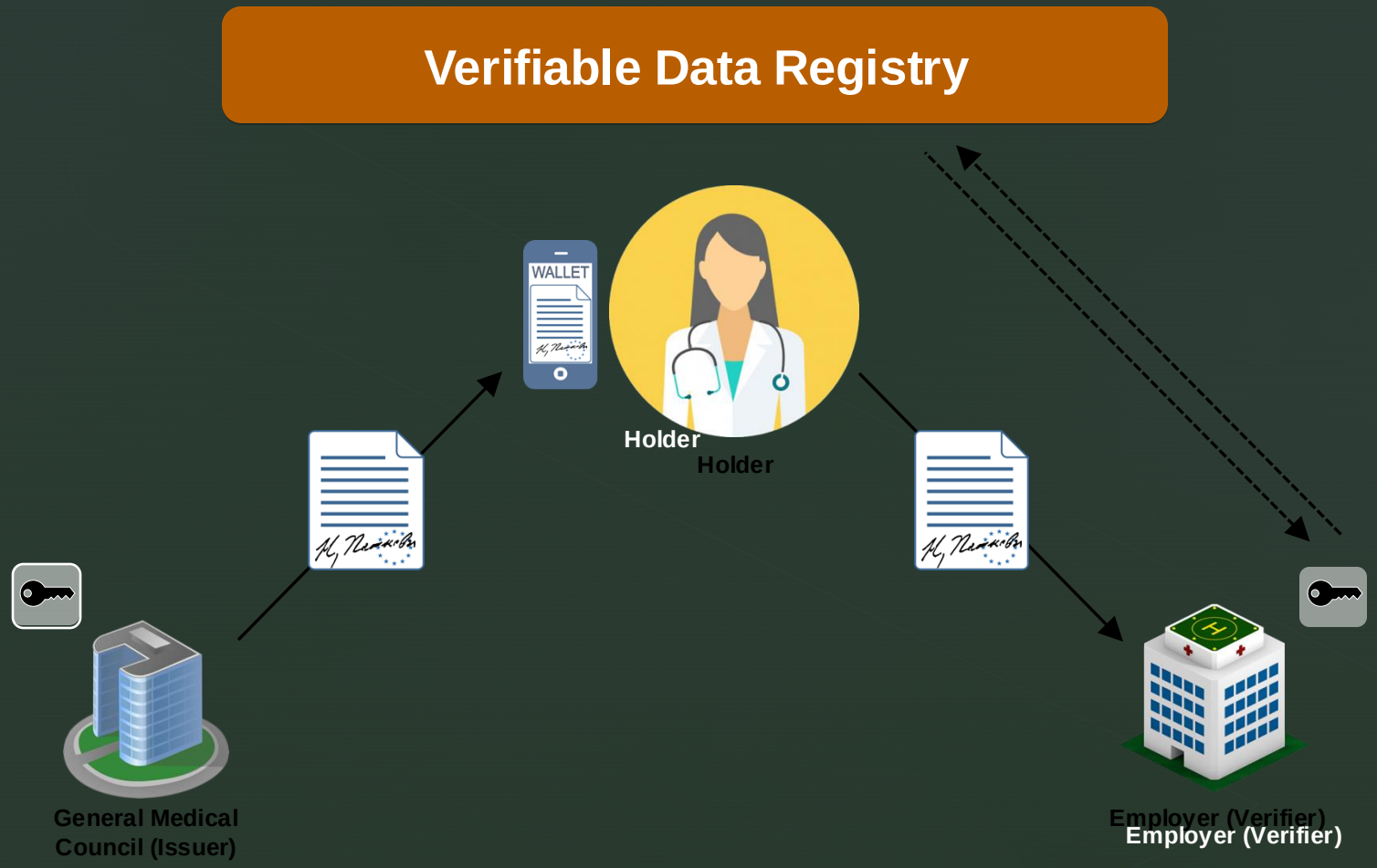




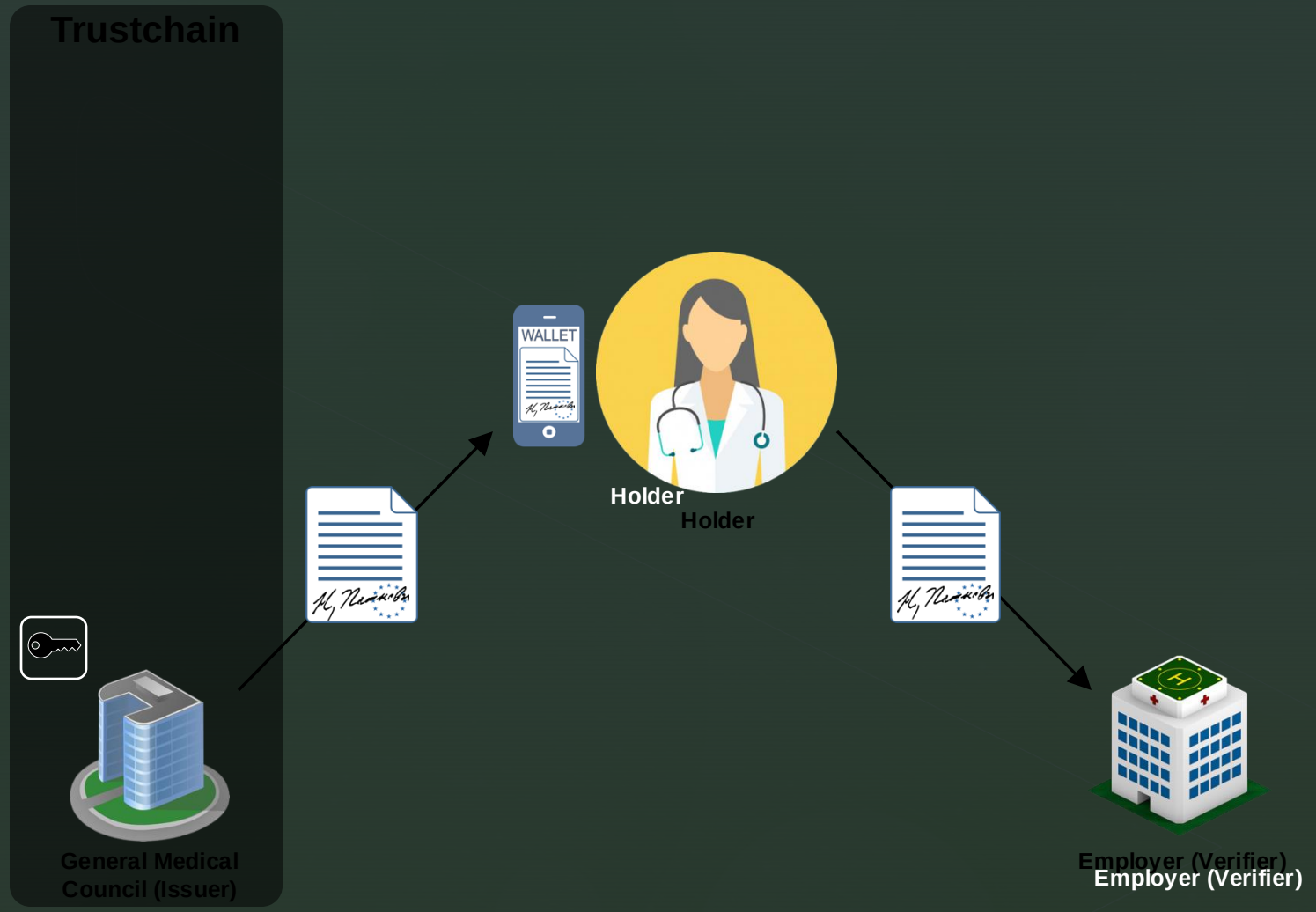
“The trust framework aims to make it easier and more secure for people to use services that enable them to prove who they are or information about themselves. It is a **set of rules** for organisations to follow if they want to provide secure and trustworthy digital identity and/or attribute solutions . […]

This document does **not** […] **provide a technical architecture** for digital identity and attribute.”

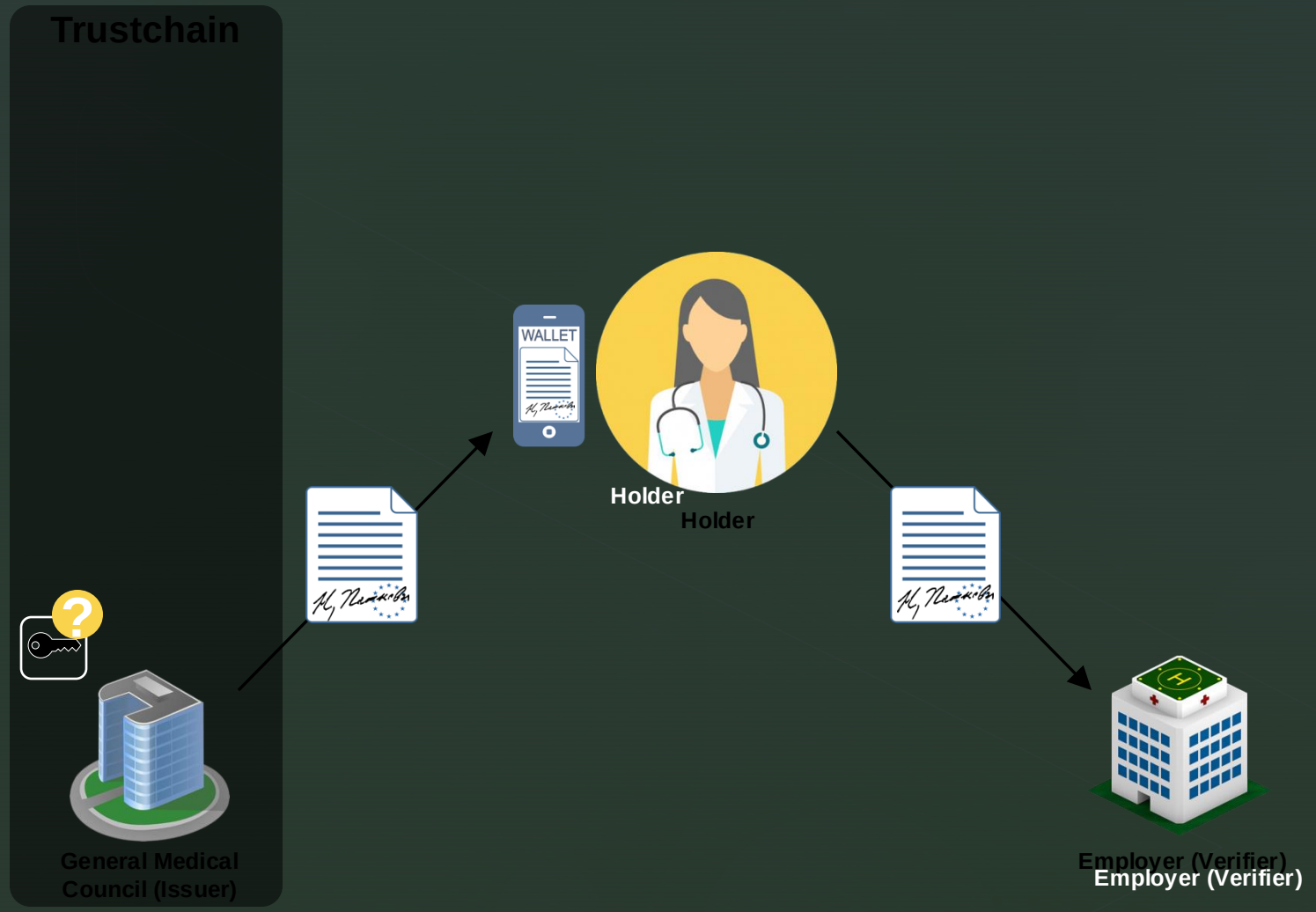
Use case: Medical licence



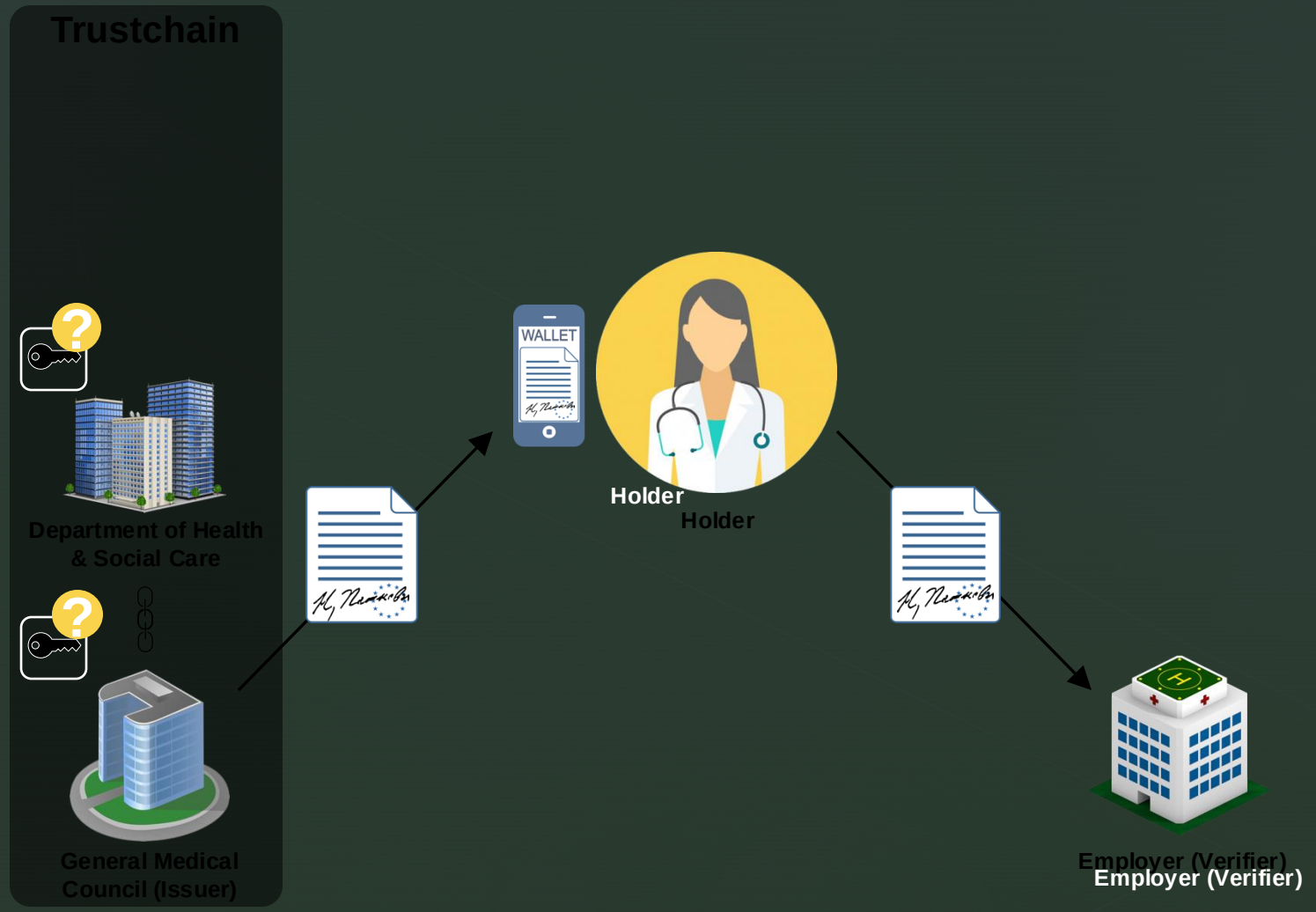
Use case: Medical licence



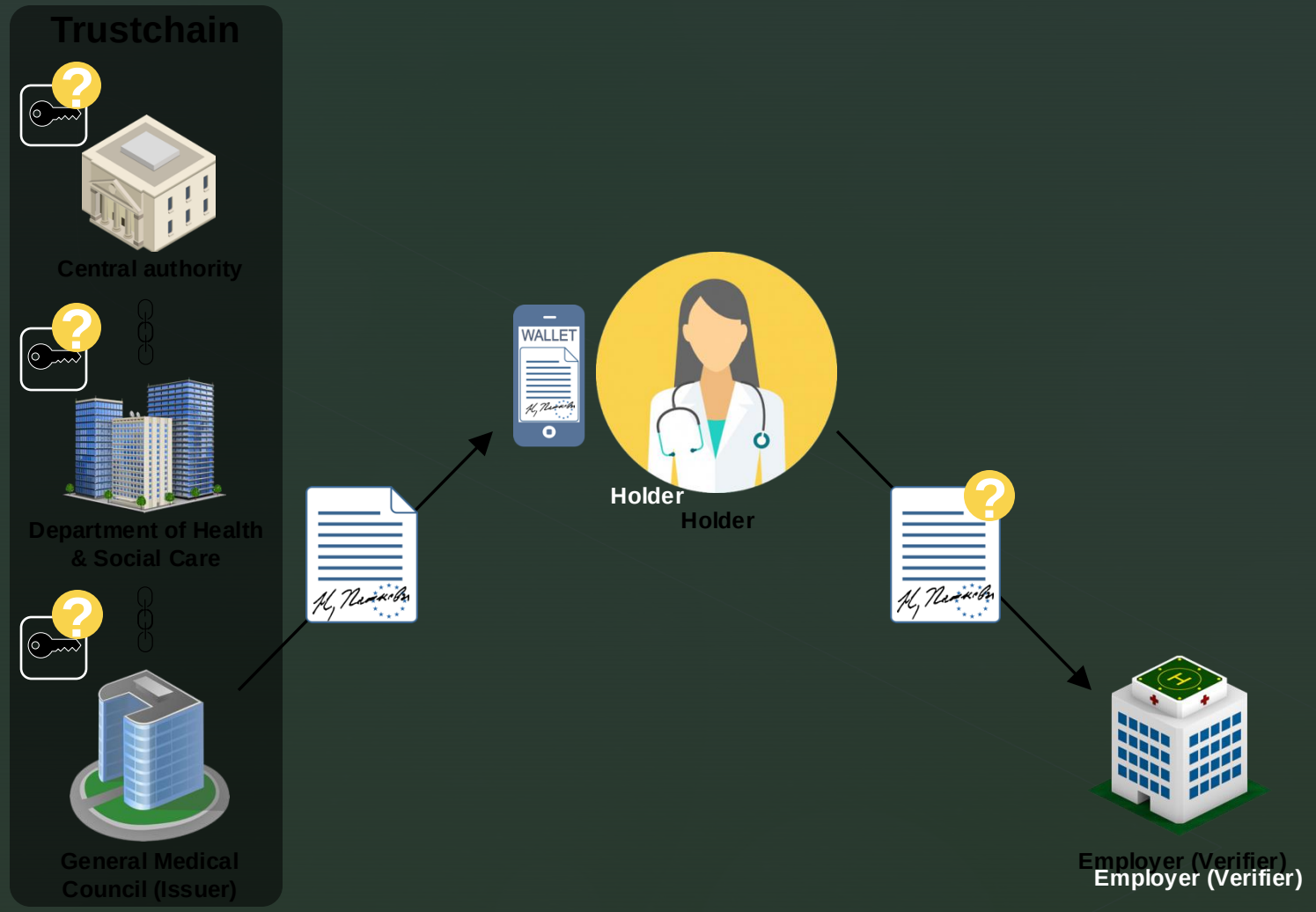
Use case: Medical licence



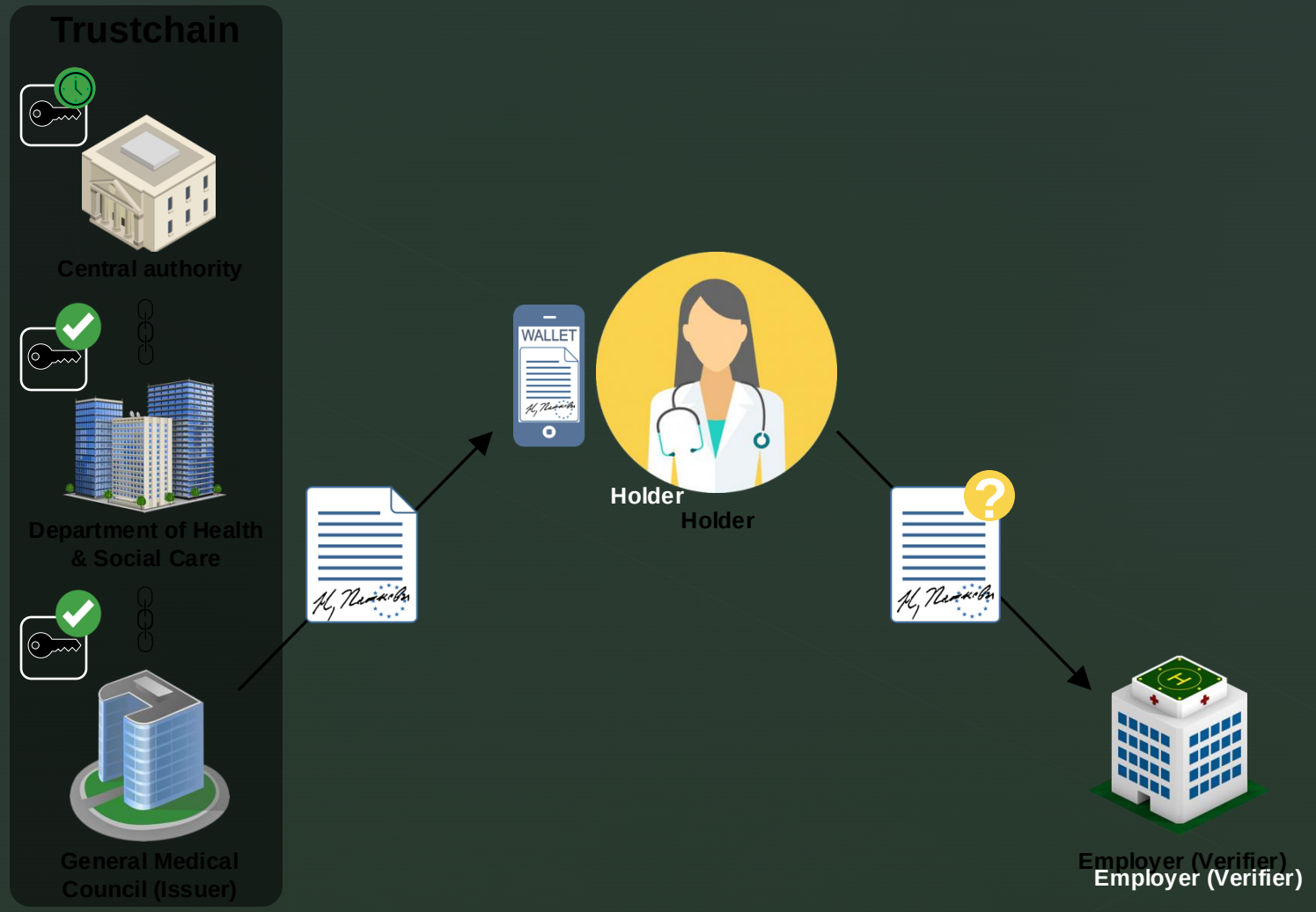
Use case: Medical licence



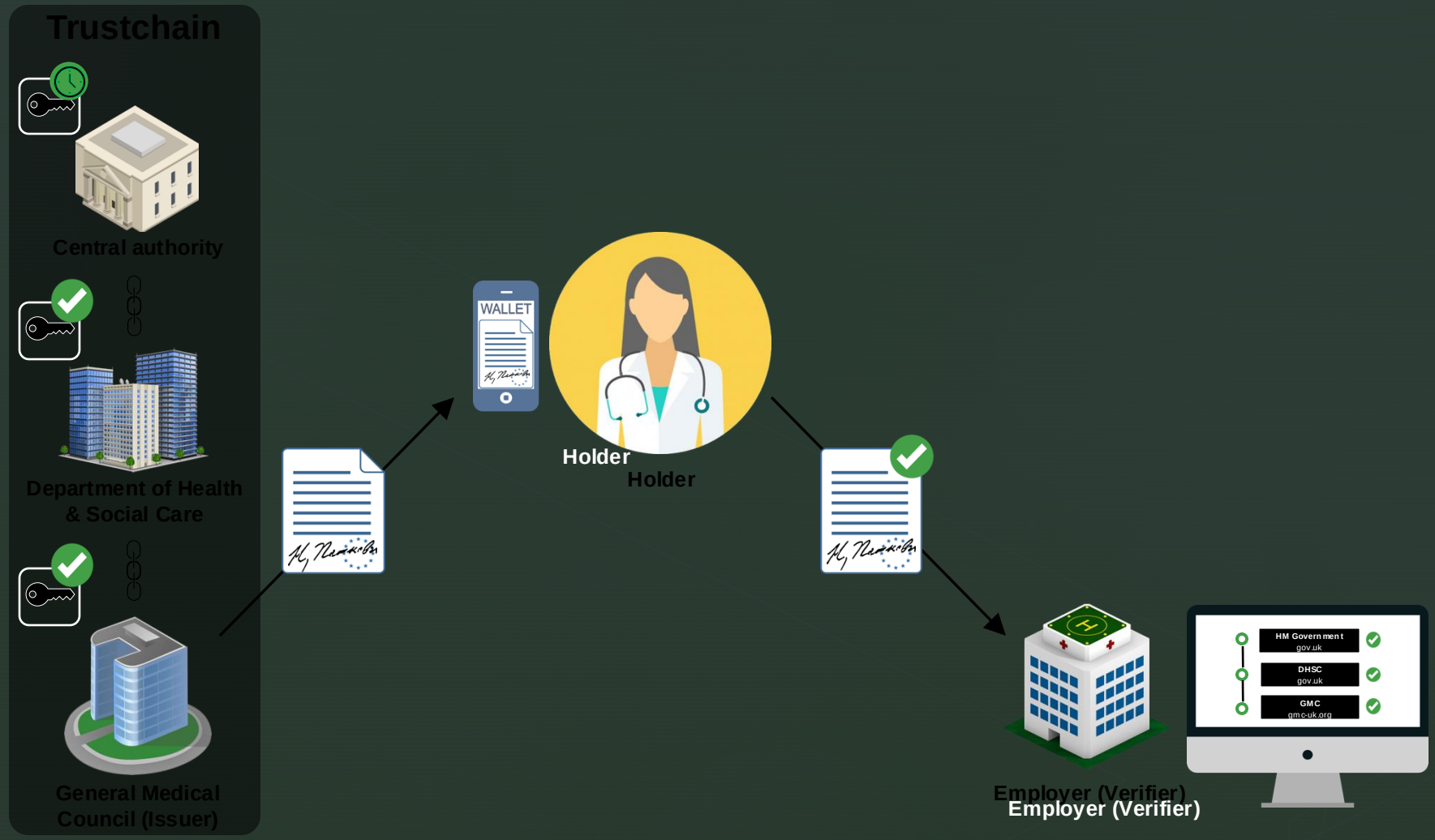
Use case: Medical licence



Use case: Medical licence

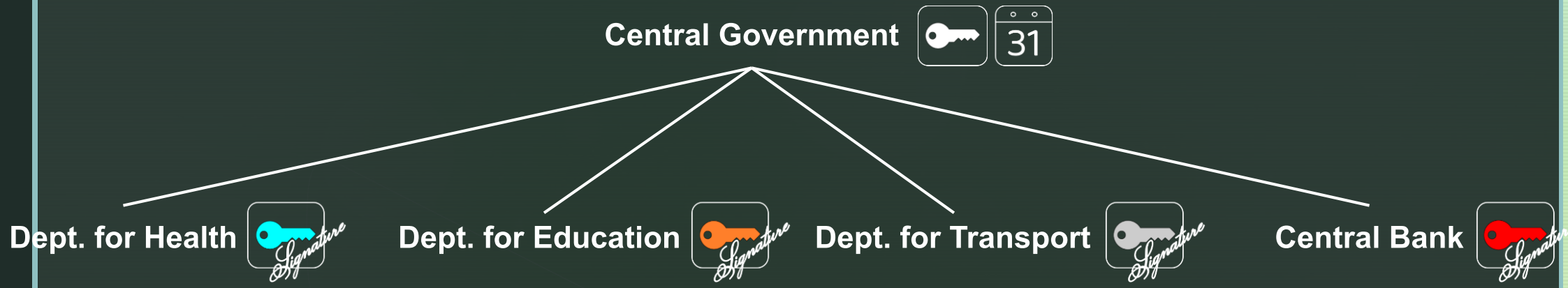


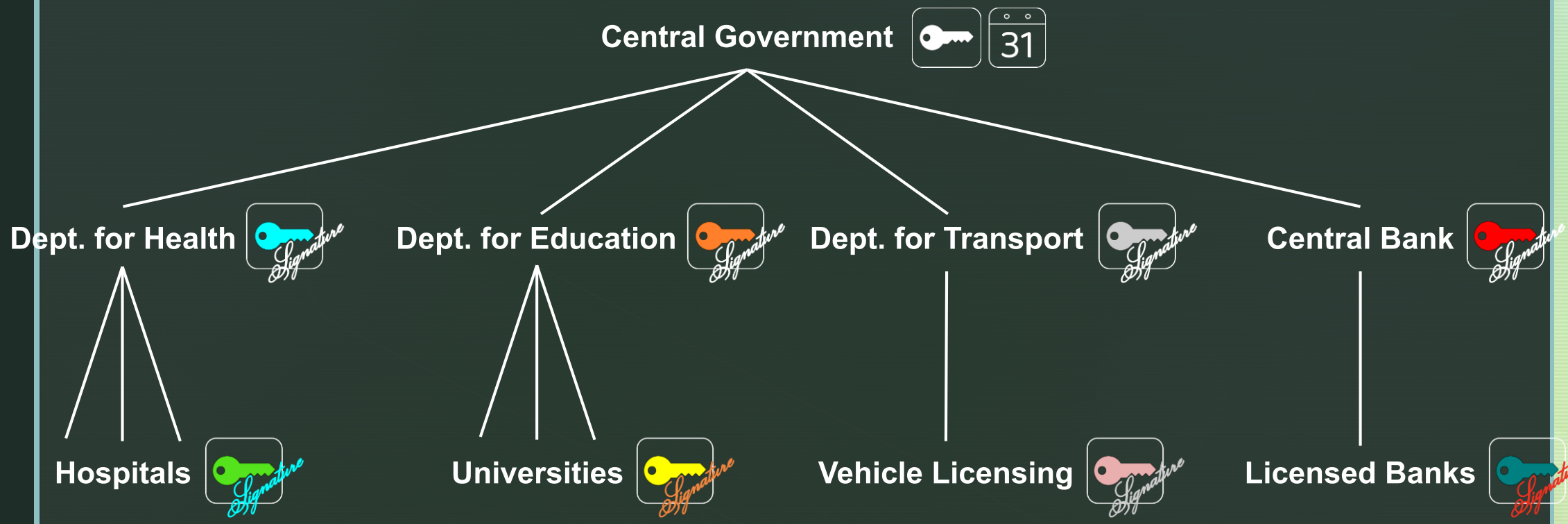
Use case: Medical licence



Decentralised Public Key Infrastructure

Trustchain employs decentralised networks and protocols to create a digital twin of existing hierarchical trust relationships.


Central Government
31
Dept. for Health
Signature
Dept. for Education
Signature
Dept. for Transport
Signature
Central Bank
Signature


Central Government
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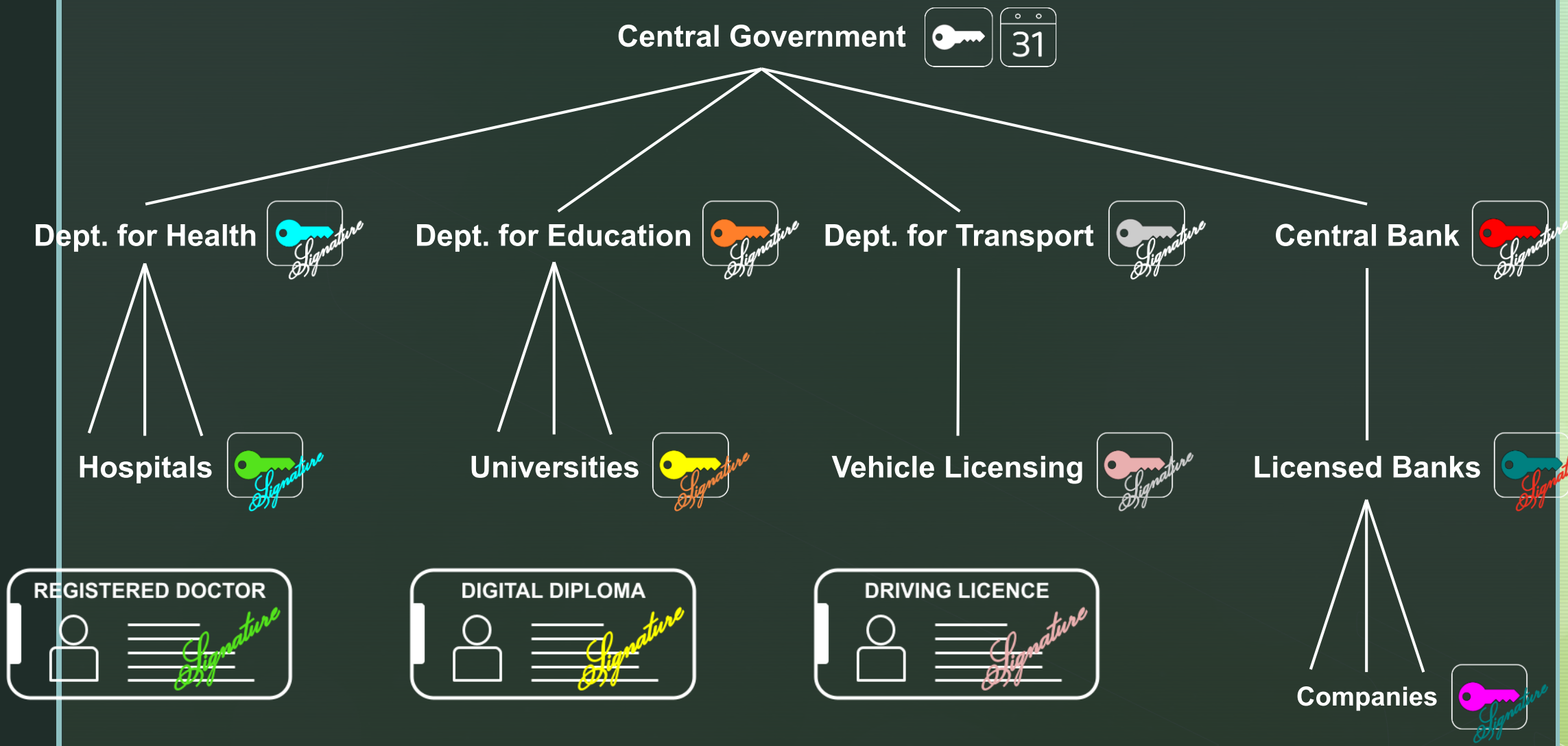
Dept. for Health
Signature
Dept. for Education
Signature
Dept. for Transport
Signature
Central Bank
Signature
Hospitals
Signature
Universities
Signature
Vehicle Licensing
Signature
Licensed Banks
Signature


Central Government
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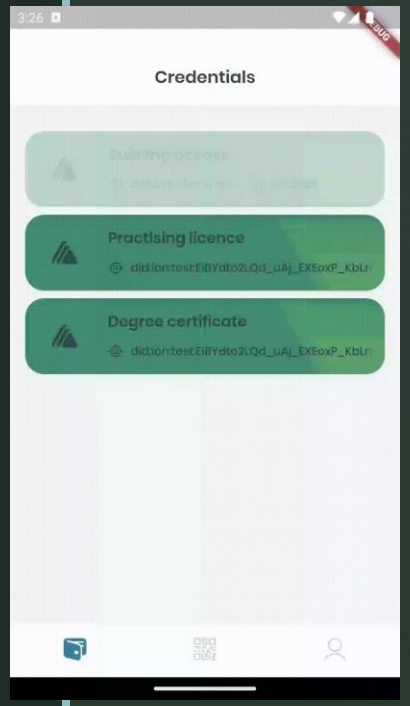
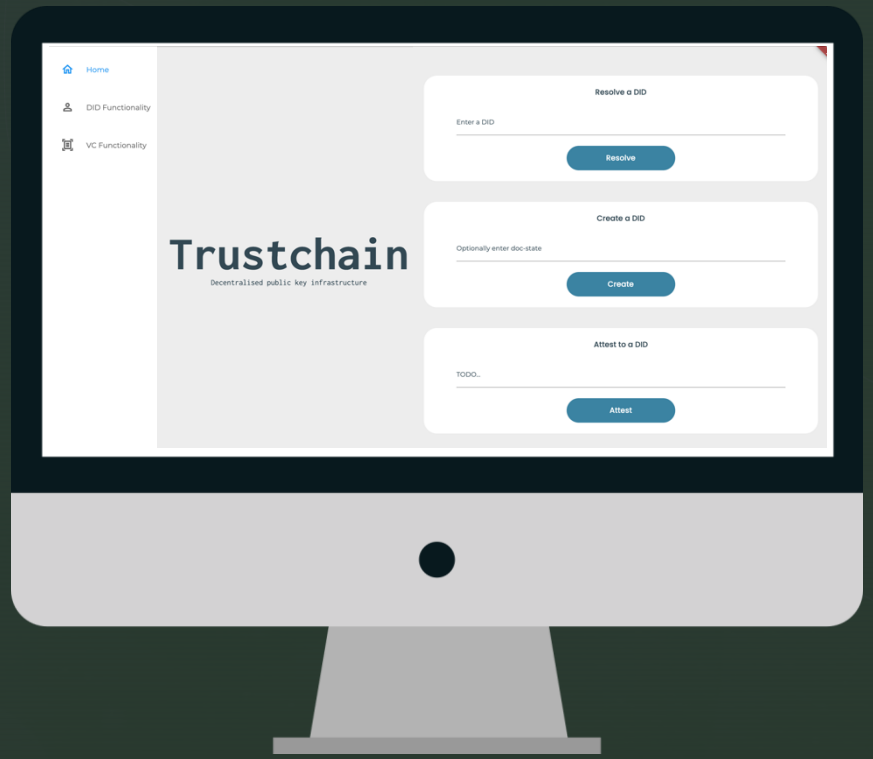
Dept. for Health
Signature
Dept. for Education
Signature
Dept. for Transport
Signature
Central Bank
Signature
Hospitals
Signature
Universities
Signature
Vehicle Licensing
Signature
Licensed Banks
Signature
REGISTERED DOCTOR
Signature
DIGITAL DIPLOMA
Signature
DRIVING LICENCE
Signature
Companies
Signature

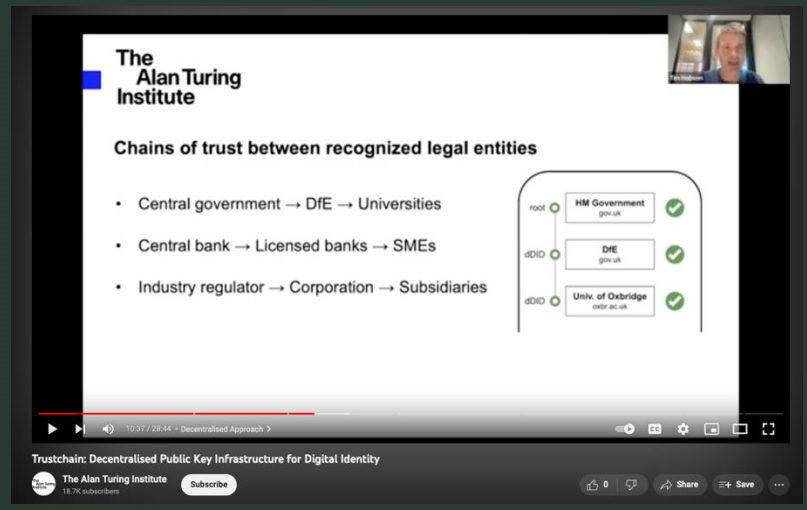
Trustchain resources

Open-source code: mobile and desktop apps





Demo video



Articles & technical notes

Trustchain – Trustworthy Decentralised Public Key Infrastructure for Digital Credentials

Tim Hobson[1], Lydia France[2], Sam Greenbury[3], Luke Hare[4], and Pamela Wochner[5]

The Alan Turing Institute, London, UK
thobson[1], lfrance[2], sgreenbury[3], lhare[4], pwochner[5]@turing.ac.uk

Abstract

The sharing of public key information is central to the digital credential security model, but the existing Web PKI with its opaque Certification Authorities and synthetic attestations serves a very different purpose. We propose a new approach to decentralised public key infrastructure, designed for digital identity, in which connections between legal entities that are represented digitally correspond to genuine, pre-existing relationships between recognisable institutions. In this scenario, users can judge for themselves the level of trust they are willing to place in a given chain of attestations. Our proposal includes a novel mechanism for establishing a root of trust in a decentralised setting via independently-verifiable timestamping. We also present a reference implementation built on open networks, protocols and standards. The system has minimal setup costs and is freely available for any community to adopt as a digital public good.

1 Introduction

Digital identity systems come in many guises, each design making a different set of trade-offs between diverse and com-

lective disclosure", a process by which a derivative Verifiable Presentation (VP) is used to disclose the minimum amount of information necessary to meet a given purpose.

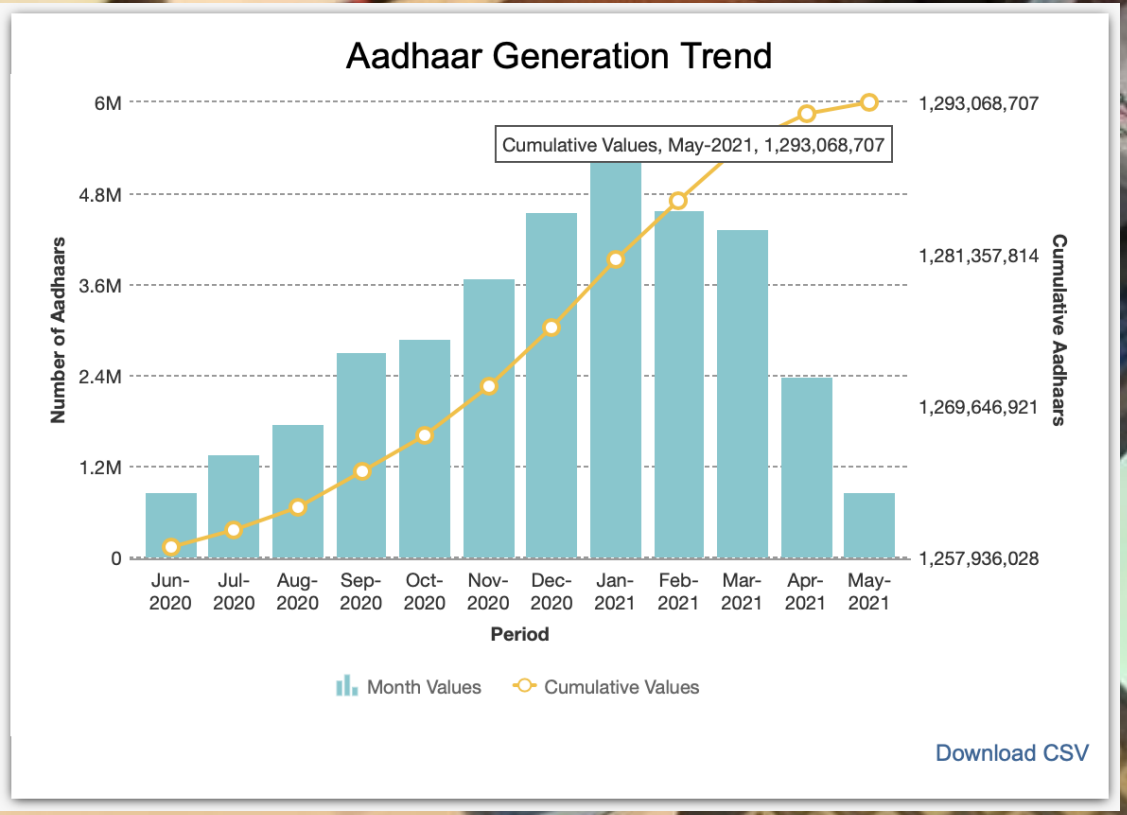
The VC mechanism is predicated on the idea that verifiers

Trustchain: Possible Next Steps

- Replace verifiable time stamp source.
  Current use of bitcoin net isn't good for optics.
- Fabric Time Use.
  But would depend on permissioned Hyperledger, whic
  turn depends on verified id☹ oops…
- Scale consensus for ledger to deal with net outages.
- New work using DAGs and Mysteci platform promising…

SIMple ID

basic mobile phones QR codes for digital id? example of a (verified) client-side app for inclusivity/simplicity – SIM as Enclave/TEE



Total Authentication Transaction **55,050,306,429**

Daily Authentication Trend for Transactions

Demographic Authentication Trend

Total Transaction	11,432,955,673

Biometric Authentication Trend

Total Transaction	41,772,861,733
Fingerprint Authentiction	40,857,370,044
Iris Authentications	909,900,669

OTP Authentication Trend

Total Transaction	1,538,732,976

04 June 2021

Fair Price Shops


Photo: Reuters

- Resident visits FPS, presents Aadhaar UID, provides a fingerprint scan and specifies her order.
- The FPS submits Resident's authentication and authorisation data to UIDAI.
- FPS receives yes/no response.

The Alan Turing Institute

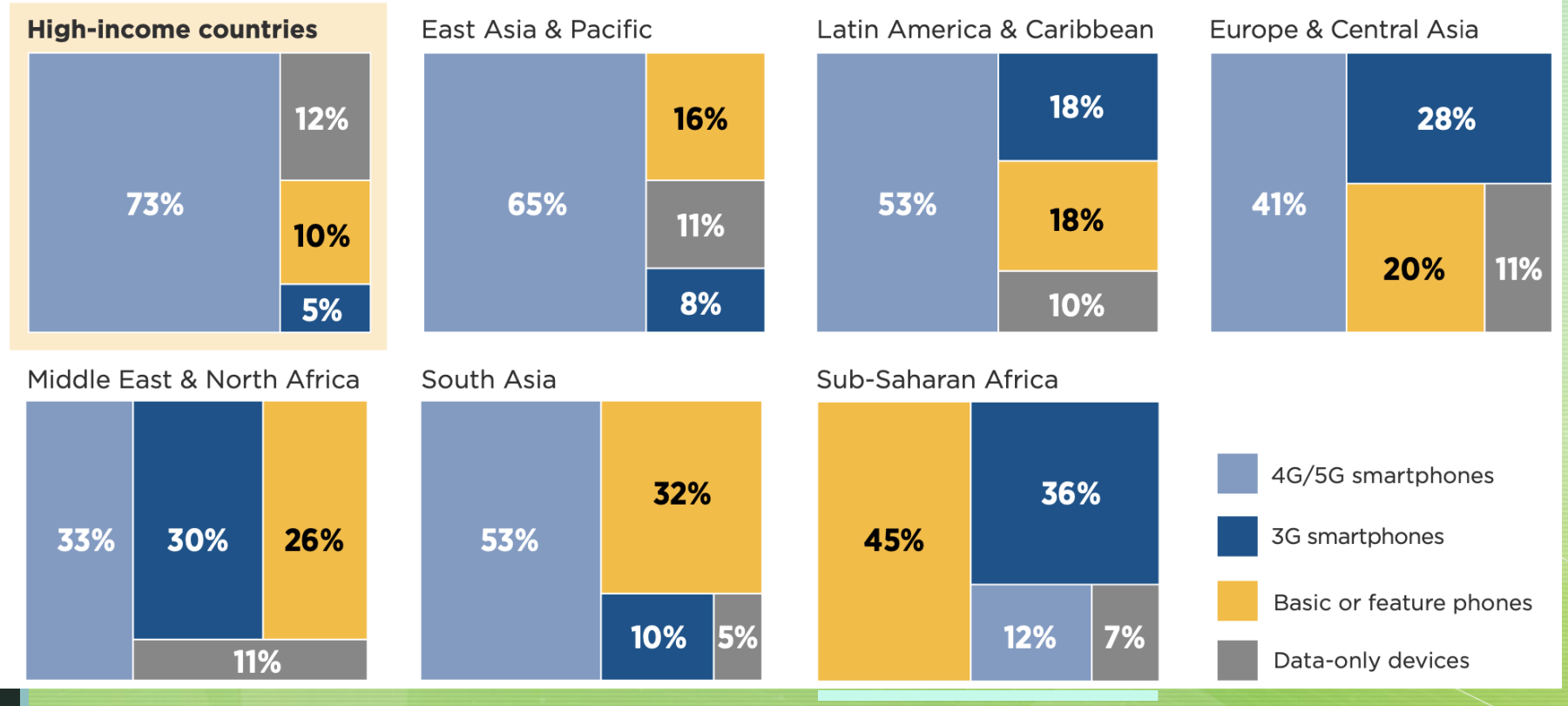
All these systems depend on…

and

or

The Alan Turing Institute

Mobile connections by device type for high-income countries and LMICs (by region), 2020



GSMA, 2021

The Alan Turing Institute

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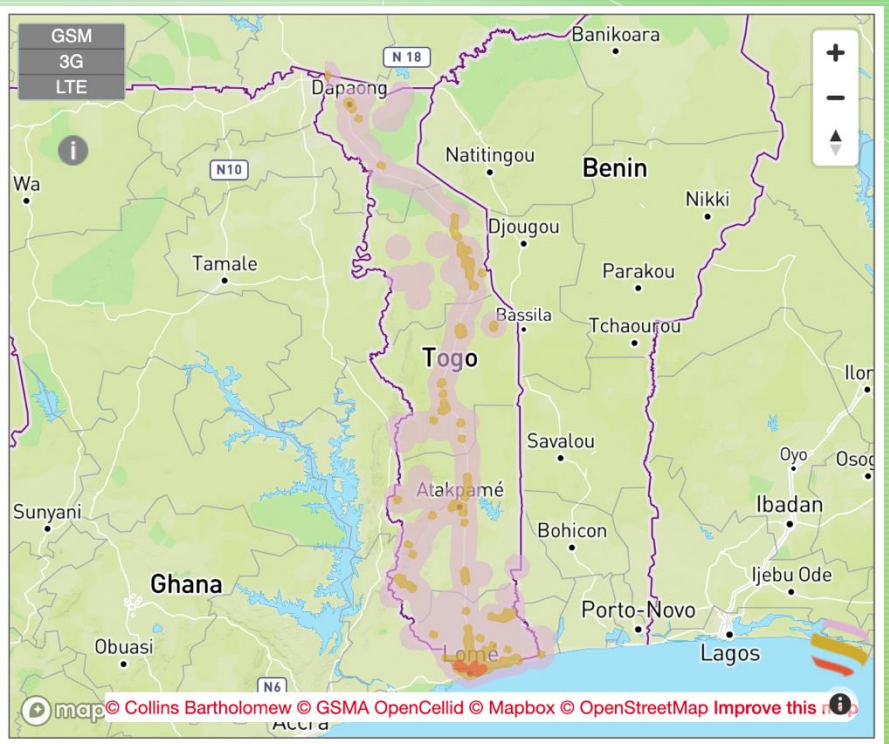

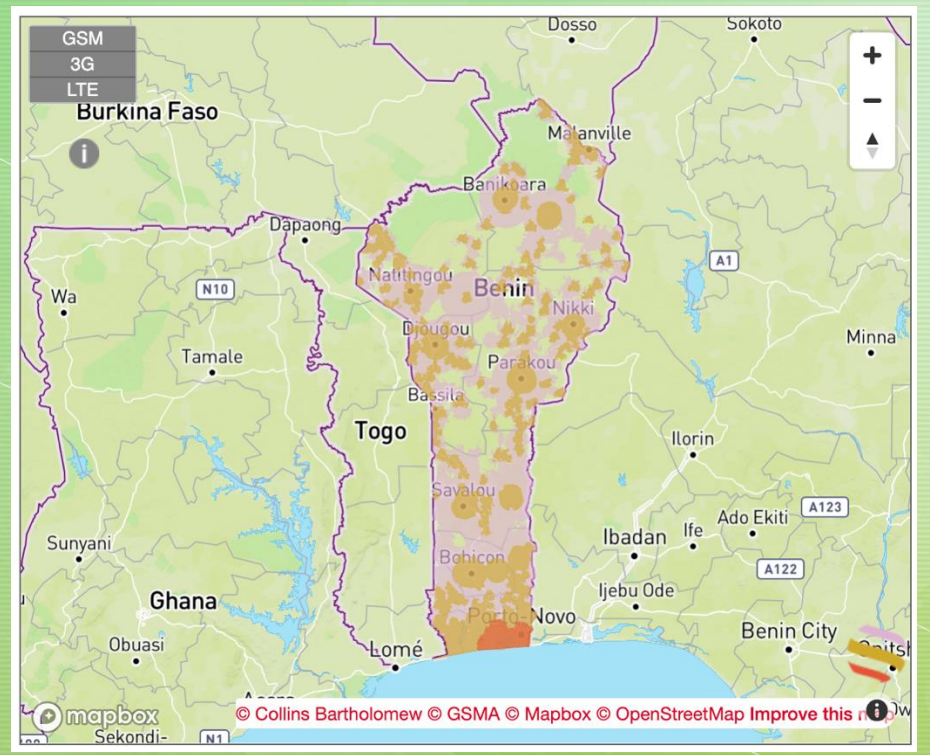

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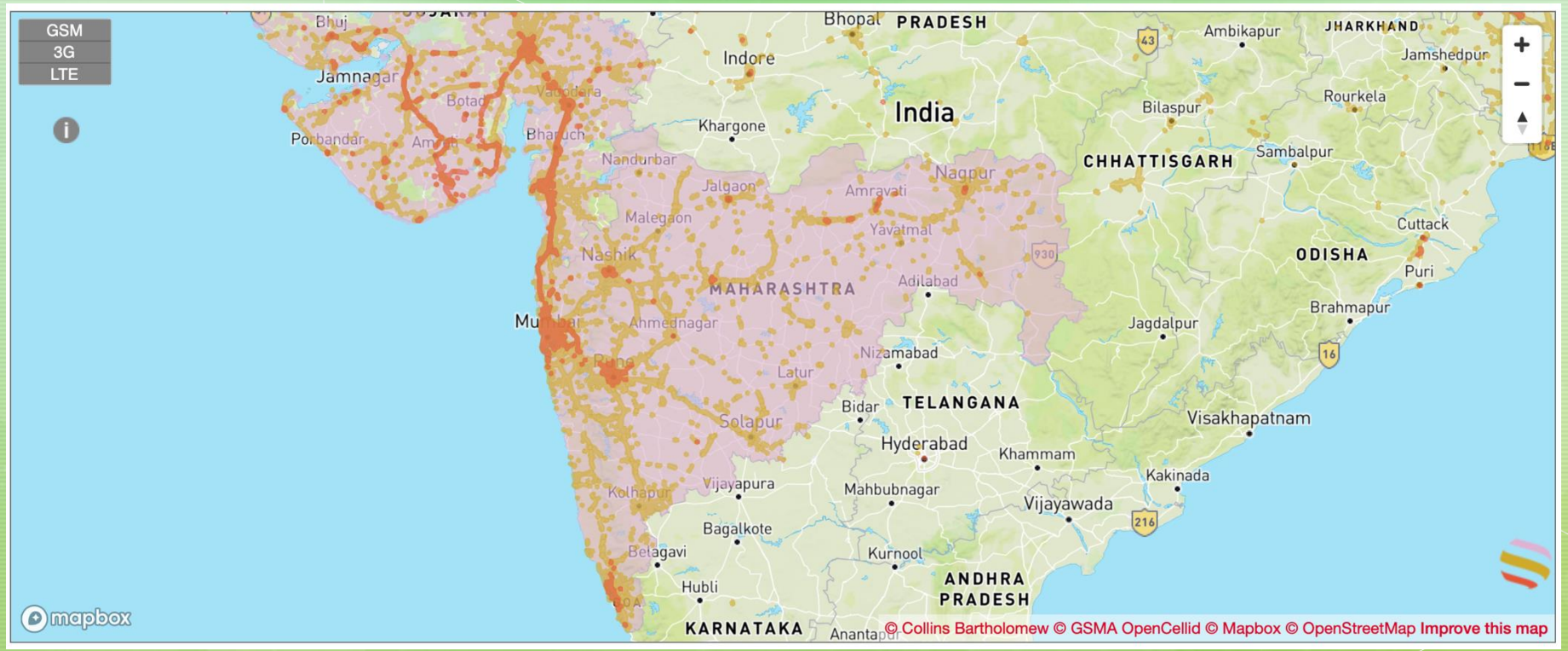
4G



The Alan Turing Institute

“When compared to other types of ID credentials, chip-based smart cards incur higher costs for design, printing and distribution”

– World Bank, 2018, Understanding the cost drivers of identification systems.

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https://www.cl.cam.ac.uk/~rja14/DigiTally/

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System

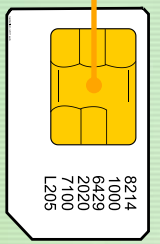
- Proprietary
- **Not developer friendly**

Outputs

- Screen (low res.)
- Sounds
- Vibrations
- Cellular

Inputs

- Text
- Microphone
- Cellular



https://www.cl.cam.ac.uk/~rja14/DigiTally/

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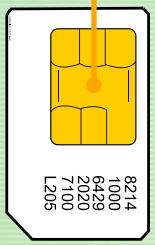
UICC (System 2)

- Somewhat developer friendly
- Secure Hardware
- Dedicated cryptographic co-processor
- Can be Java-based
- **Card Application ToolKit**



https://www.cl.cam.ac.uk/~rja14/DigiTally/

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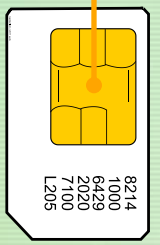
Card Application Toolkit

a.k.a. the STK!



SET UP MENU
GET INKEY
GET INPUT
DISPLAY TEXT
PLAY TONE
SEND SHORT MESSAGE
...

https://www.cl.cam.ac.uk/~rja14/DigiTally/

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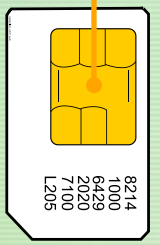
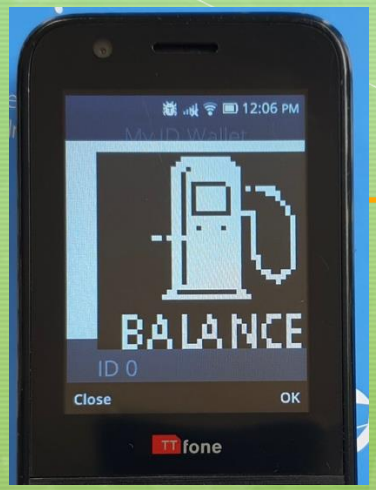
Card Application Toolkit

a.k.a. the STK!



SET UP MENU
GET INKEY
GET INPUT
DISPLAY TEXT
PLAY TONE
SEND SHORT MESSAGE
...

INCLUDE ICON



https://www.cl.cam.ac.uk/~rja14/DigiTally/

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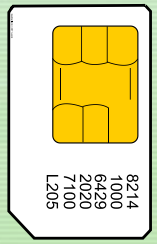
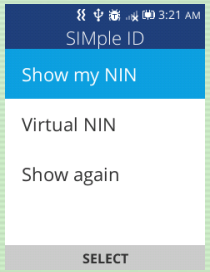
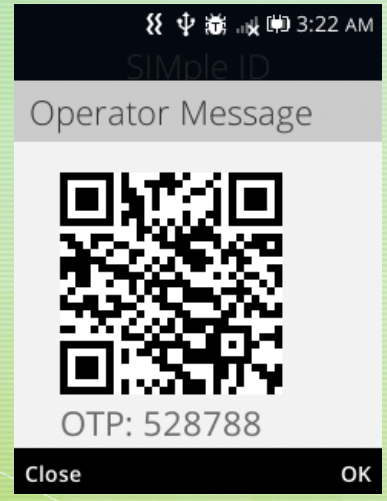


SIMple-OTP provides a standard OTP authentication and runs between the resident R, the UICC U, the requesting entity V and the issuer I. To begin, R has the PIN pin and U has the UID uid and OTP parameters (k_{OTP}, c). I has private signing key $k_{I\text{sig}}$, the CIDR containing unique residents' UID uid and OTP parameters (k_{OTP}, c) linked in the SIMple-Personalise phase.

1. The resident R sends the PIN attempt pin' to the UICC U.
2. If $pin' \neq pin$ then authentication fails. Otherwise U computes the OTP $hotp = \text{HOTP}_{k_{\text{OTP}}}(c)$, increments the OTP counter c, and then sends the authentication message $m_{\text{auth}} = (uid \parallel hotp)$ to V.
3. V sends m_{auth} to the issuer I (e.g., using the SA-UA network).
4. I uses uid to look up the resident's eID record of the OTP parameters (k_{OTP}, c) and computes the OTP response $hotp' = \text{HOTP}_{k_{\text{OTP}}}(c)$. If the OTP is correct, i.e., $hotp' = hotp$, then I computes the response message $m_{\text{resp}} = \text{SIGN}_{k_{I\text{sig}}}(\text{“}yes\text{”})$ and increments c. Otherwise, I computes $m_{\text{resp}} = \text{SIGN}_{k_{I\text{sig}}}(\text{“}no\text{”})$. I sends m_{resp} to the requesting entity V.
5. V verifies the signature on m_{resp} and, if successful and the message is “yes” then authentication succeeds. Otherwise authentication fails.





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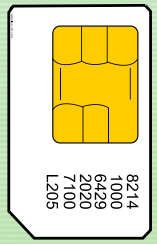

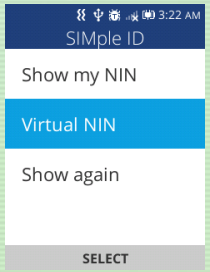

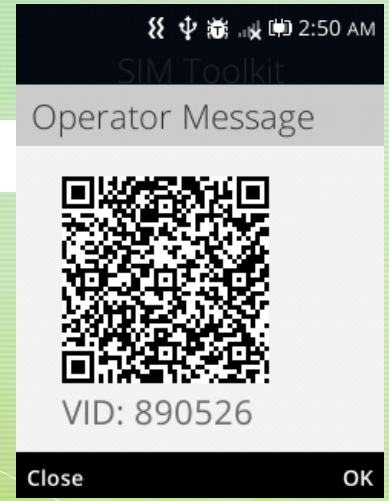

SIMple-VID provides authentication with improved privacy using public key encryption to hide the resident R's UID uid from the receiving entity V. This phase is run between R, the UICC U, V and the issuer I. To begin, R has the PIN pin and U has the UID uid and OTP parameters (k_{OTP}, c). I has private signing key $k_{I\text{sig}}$, private decryption key $k_{I\text{enc}}$, the CIDR containing unique residents' UID uid and OTP parameters (k_{OTP}, c) linked in the SIMple-Personalise phase.

1. The resident R sends the PIN attempt pin' to the UICC U.
2. If $pin' \neq pin$ then authentication fails. Otherwise U computes the OTP $hotp = \text{HOTP}_{k_{\text{OTP}}}(c)$, encrypts the authentication challenge $c_{\text{chal}} = \text{ENC}_{P_{I\text{enc}}}(uid \parallel hotp)$ using the public key of the issuer I and increments the OTP counter c. The UICC U sends c_{chal} to the receiving entity V (i.e., it is shown as a QR code).
3. V sends m_{auth} to the issuer I (e.g., using the SA-UA network).
4. I recovers uid and $hotp$ by decrypting c_{chal} using the private encryption key $k_{I\text{enc}}$. Next, I runs Step 4. from the SIMple-OTP phase.
5. V verifies the signature on m_{resp} and, if successful and the message is "yes" then authentication succeeds. Otherwise authentication fails.

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Deployment considerations

Existing SIM and device landscape

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Identity Authority Support

↓

Device OEM Support

↓

SIM manufacturer or MNO backing

↓

Usability and acceptance testing

SIMple-ID – Standards

Standards

- Protocol/DiD W3C
- Redacted DID needs too
- QR > ITU

Impact/Adoption

- MOSIP adopt?
- Note Airtel Africa interest
- Agnostic to smart phone too
- Virtual SIM version?

Example standard QR Codea

Next phases of project: Generalize to DPIs

Knowledge

- Fraud detection
- Equitable AI
- Privacy Enhancing Technologies
- Best practices for DPI
- Synthetic data generation

Development

- Partner consultations
- Models and use cases
- Prototype solutions
- Solution integration by partners

Implementation

- Cyber threat observatory
- Guidance to countries self-assessments of their identity systems

Success indicators

- Increased use of fraud management and AI fairness
- Increase in secure and private data sharing and interoperability
- Increased adoption of partner solutions
- Increase in DPI trustworthiness
- Increased capacity in addressing cyber security

Questions