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UCBlocker: Unwanted Call Blocking Using Anonymous Authentication

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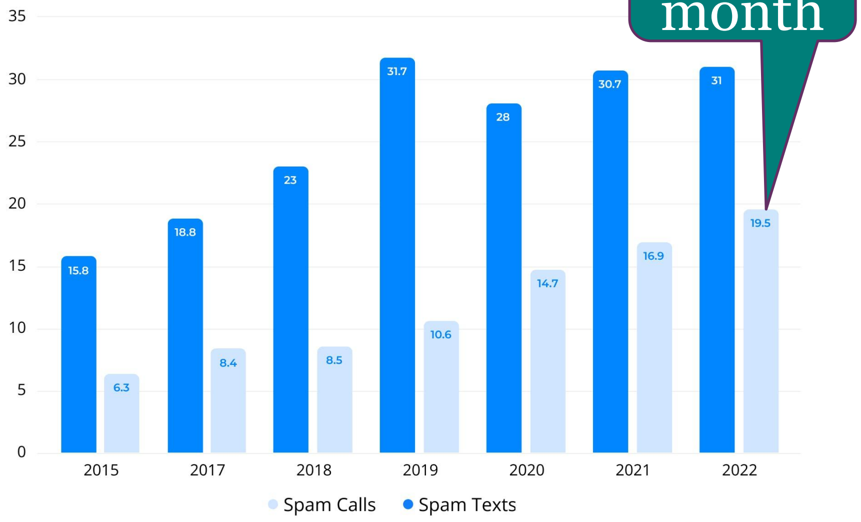
Spam and Scam Calls in the US

Monthly Spam Received

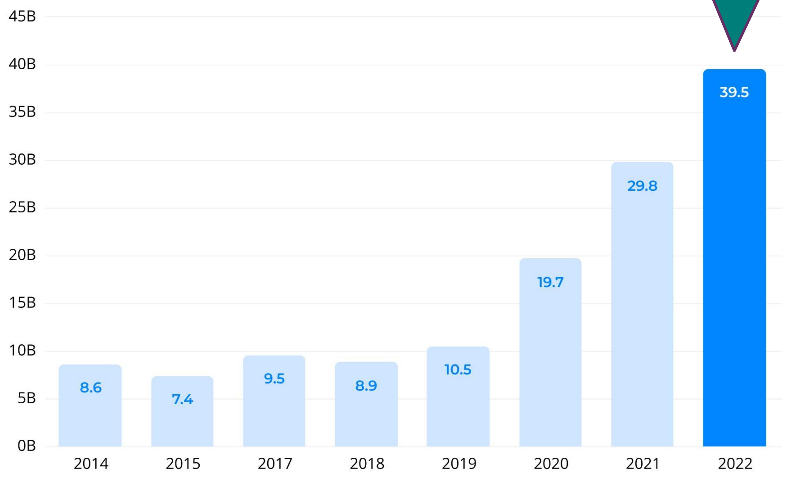
19.5/ month



Source: Truecaller Insights/Harris Poll

Total Money Lost to Scam Calls

$39.5 B



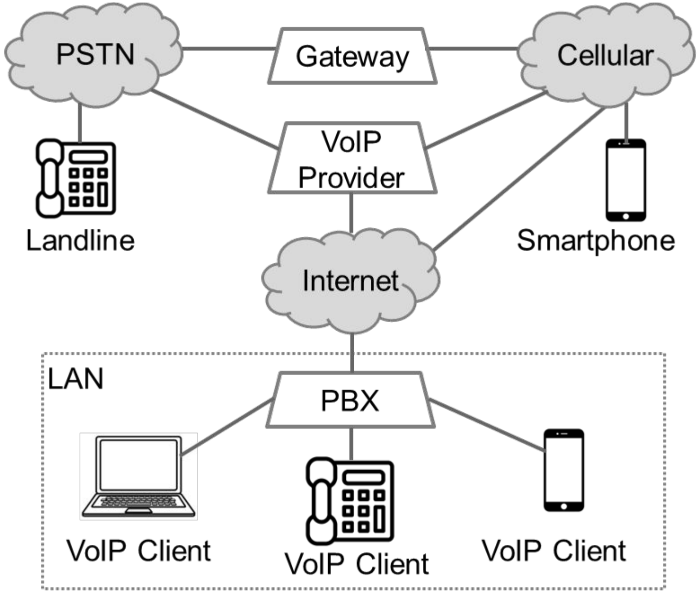
: Truecaller Insights/Harris Poll

Truecaller: https://www.truecaller.com/blog/insights/truecaller-insights-2022-us-spam-scam-report, 2022

Enablers of the Spam/Scam Call Problem

- **VoIP** (Voice over Internet Protocol) + Autodialers
  - Massive calls at very low cost
  - Over the Internet, cross jurisdictions

- **Caller ID Spoofing**
  - Altering the Caller ID field (phone number and/or name) is easy
  - Spoofing legit government agencies/businesses



Existing Spam/Scam Call Defenses

- **End-to-end** Authentication
  - Via **voice channel**: **Authloop** [Security’16]
    - ~9 seconds due to low bandwidth (300 to 3400 Hz)
  - Via **data channel**: **AuthentiCall** [Security’17]
    - 1-1.4 seconds
    - Require a trusted server
- **Network-assisted** Solution - **STIR/SHAKEN** [FCC’20]
  - Caller ID authentication and verification over IP networks

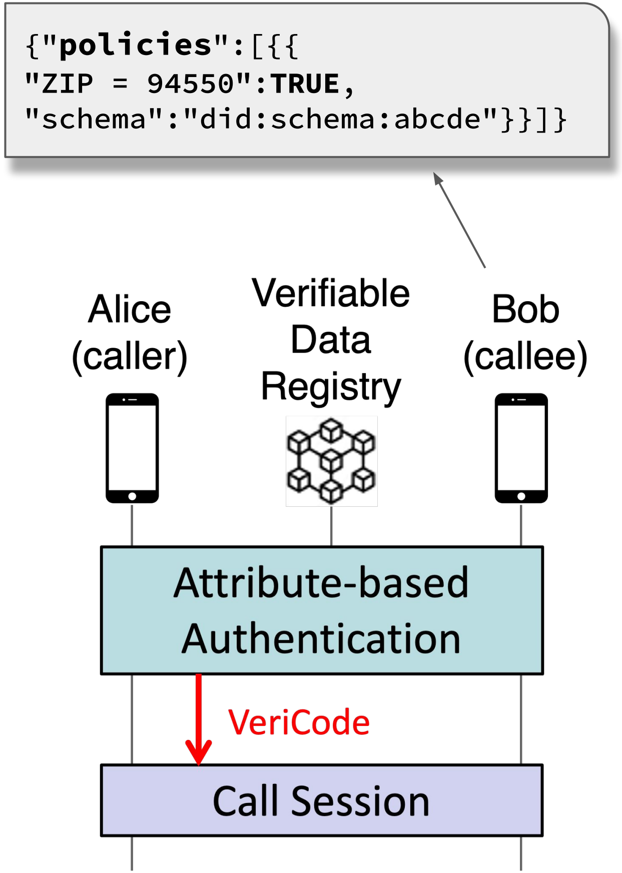
Only prevent caller ID spoofing, but still not all the unwanted calls that utilize legitimate caller IDs

Our Solution - UCBlocker (1/2)

- **User-defined Policy**

1) Callee can set up attribute-based **caller authentication policies**
2) Enables incoming calls from legitimate unknown numbers

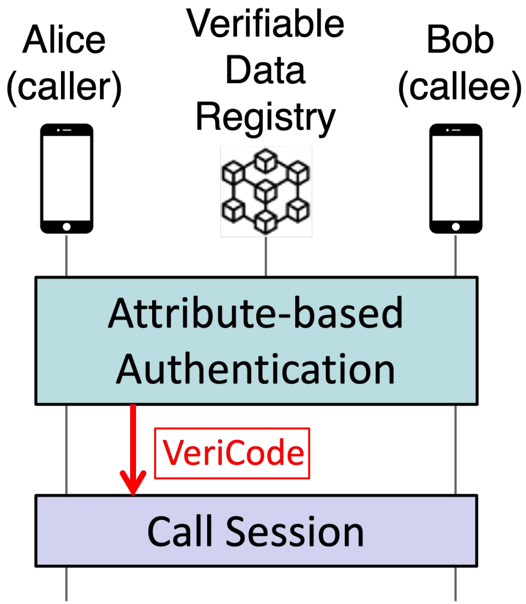
- Utilize **Attribute-based Anonymous Credentials (AC)**



```
{"policies":[{{
"ZIP = 94550":TRUE,
"schema":"did:schema:abcde"}}]}
```

Our Solution - UCBlocker (2/2)

- Decouples end-to-end caller authentication from call session initiation
  - Authentication - Out-of-Band
  - Call Session initiation over telephone networks
- One-time Verification Code
  - Binding authentication and call session
  - Sent for call-time verification



Anonymous Credentials (AC)

allows users to prove that they satisfies certain properties *without* disclosing unnecessary information

Cryptographic Primitives:

❑ Zero-Knowledge Proof (ZKP)

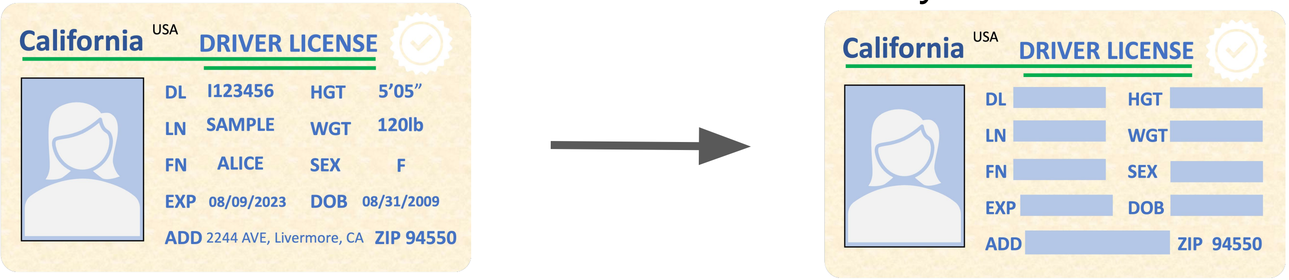
❑ ZKP-friendly signature schemes (e.g., BBS+)

❑ Commitment Schemes (e.g., Pedersen)

AC and Anonymous Presentation

- One AC can contain a set of attributes
- One **caller** can hold multiple ACs that issued by different **issuers**

Original Credential Anonymous Presentation


California USA DRIVER LICENSE
DL I123456 HGT 5'05"
LN SAMPLE WGT 120lb
FN ALICE SEX F
EXP 08/09/2023 DOB 08/31/2009
ADD 2244 AVE, Livermore, CA ZIP 94550
California USA DRIVER LICENSE
DL HGT
LN WGT
FN SEX
EXP DOB
ADD ZIP 94550

1 AC → **n** verifiable presentations (Indistinguishable)

✅ Caller Privacy

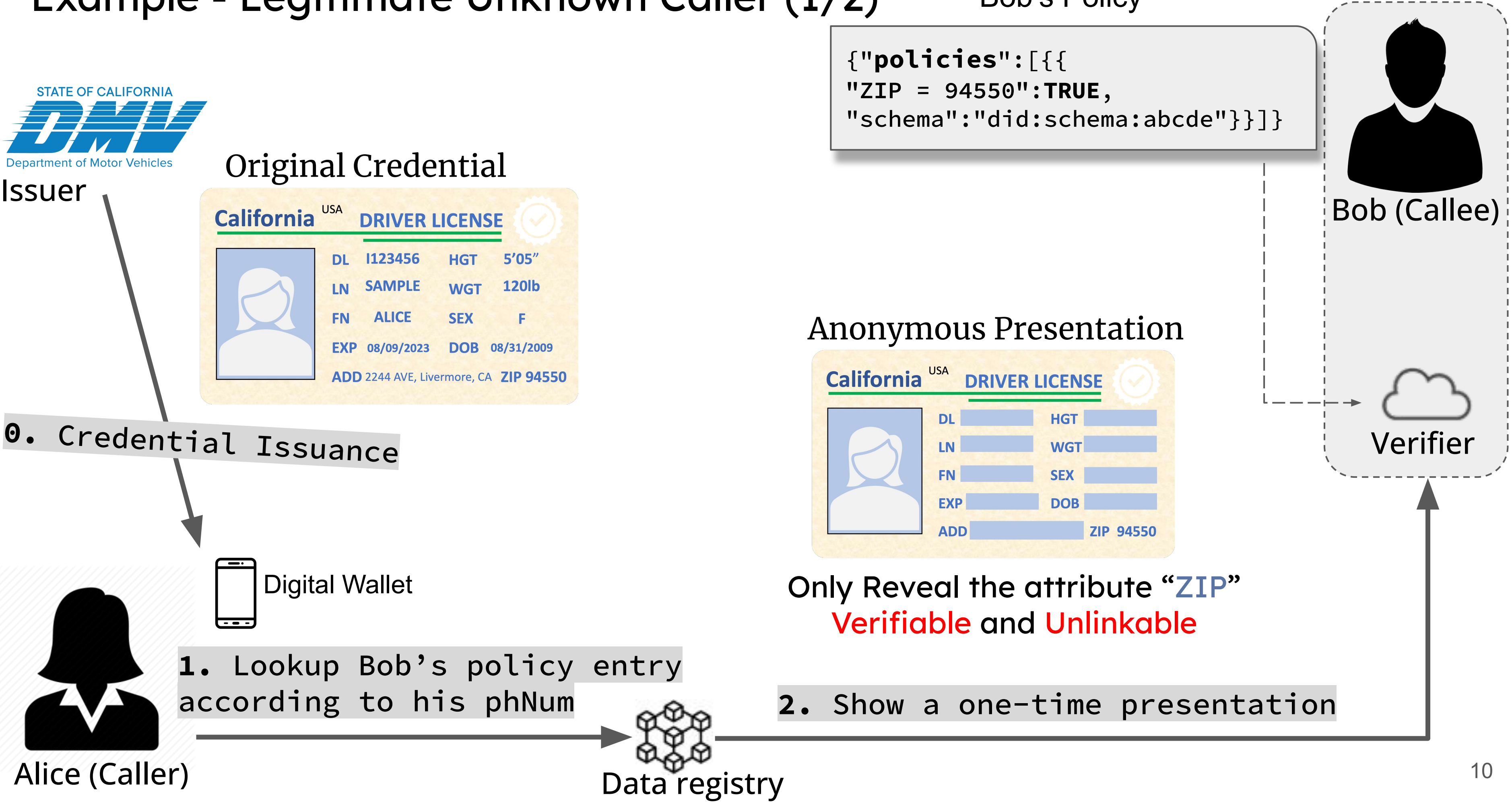
- Selective Disclosure - prove knowledge of hidden attributes
- Prove the integrity, authenticity of the AC

Who can issue the credentials?

Issuers can be different entities, e.g.,

1) Callee - Issue **Contact Credentials** to their friends through Internet (e.g, Facebook Messenger)
2) Trusted Authority - e.g., a Digital Driver License issued by DMV
3) MVNO (Mobile Virtual Network Operator, e.g., Google Fi) - a dedicated UCBlocker service provider/carrier

Example - Legitimate Unknown Caller (1/2)



Bob's Policy

```
{"policies":[{{
"ZIP = 94550":TRUE,
"schema":"did:schema:abcde"}}]}
```

Original Credential

California USA DRIVER LICENSE

DL I123456 HGT 5'05"
LN SAMPLE WGT 120lb
FN ALICE SEX F
EXP 08/09/2023 DOB 08/31/2009
ADD 2244 AVE, Livermore, CA ZIP 94550

Anonymous Presentation

California USA DRIVER LICENSE

DL HGT
LN WGT
FN SEX
EXP DOB
ADD ZIP 94550

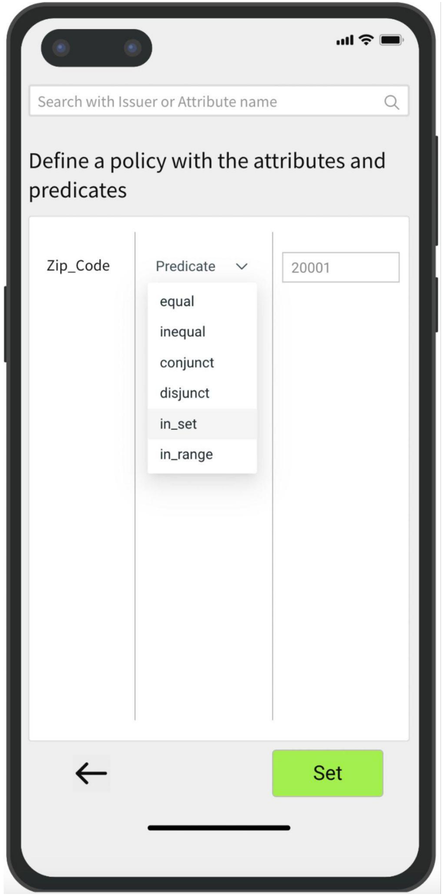
Only Reveal the attribute "ZIP"
Verifiable and Unlinkable

0. Credential Issuance

1. Lookup Bob's policy entry according to his phNum

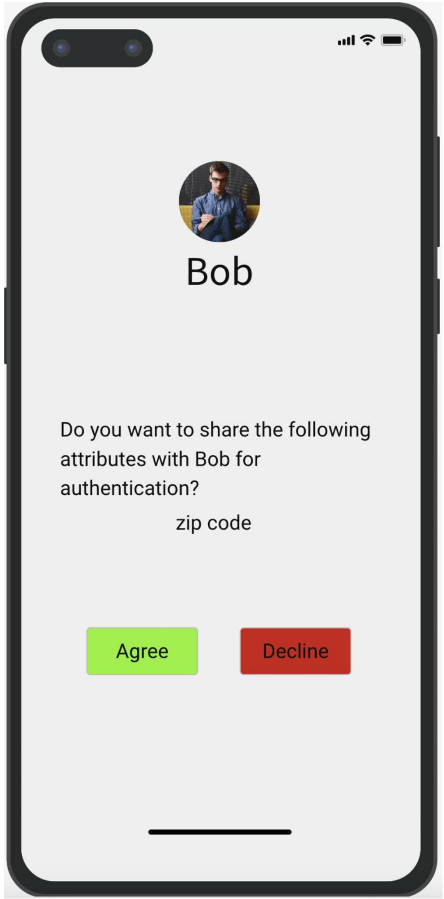
2. Show a one-time presentation

Example UI Interfaces - Policy Define and Attribute disclosure



Define a policy with the attributes and predicates

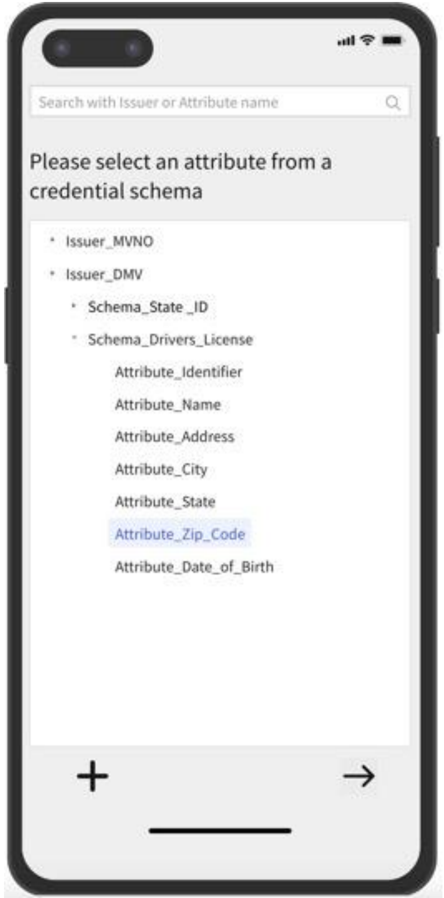
Bob’s Device



Do you want to share the following attributes with Bob for authentication?

zip code

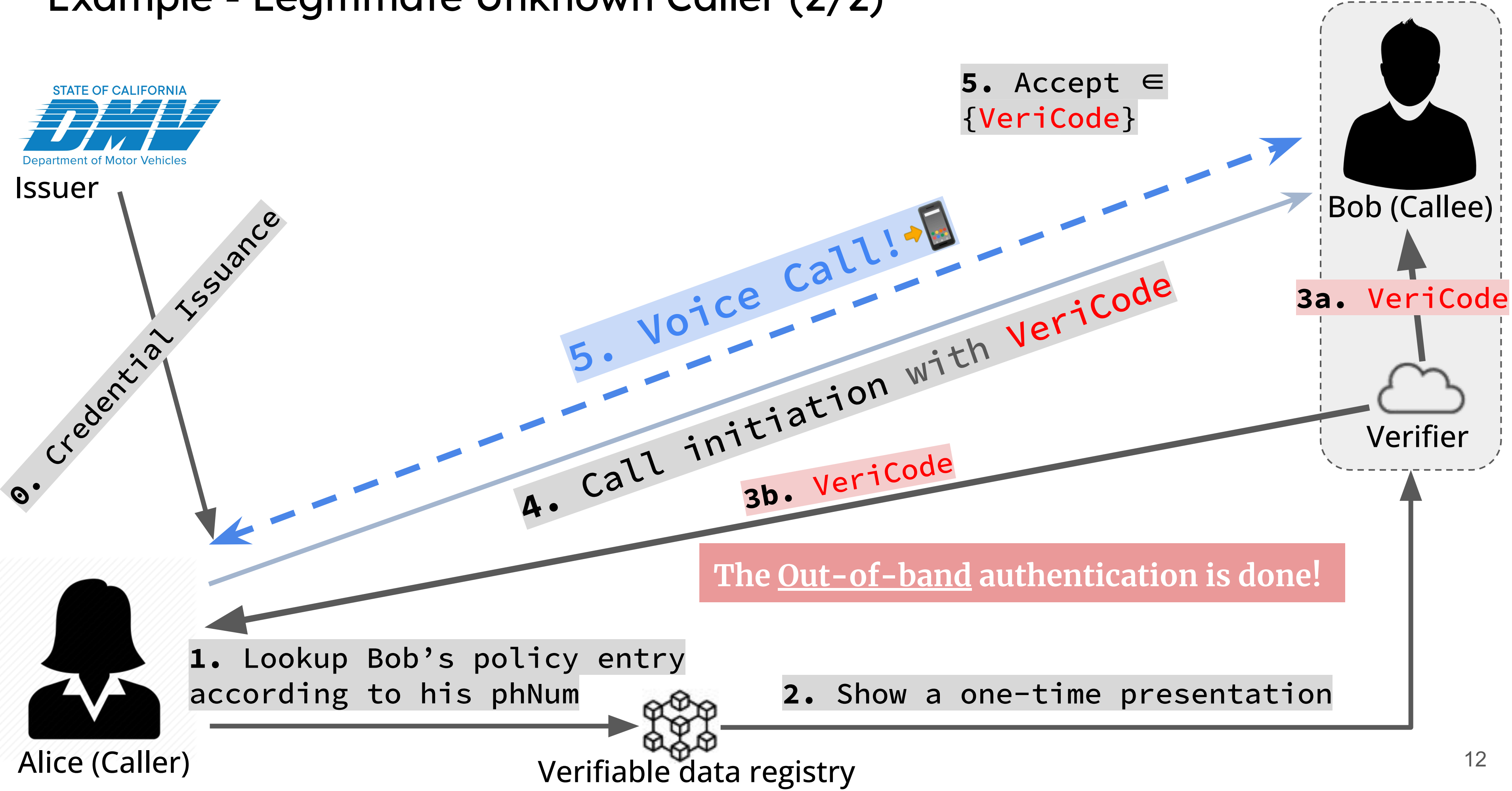
Alice’s Device



Please select an attribute from a credential schema

Alice’s Device

Example - Legitimate Unknown Caller (2/2)



0. Credential Issuance

1. Lookup Bob's policy entry according to his phNum

2. Show a one-time presentation

3a. VeriCode

3b. VeriCode

4. Call initiation with VeriCode

5. Voice Call!

5. Accept ∈ {VeriCode}

The Out-of-band authentication is done!

3 Methods of Transmitting Verification Code

1) Add an extra header field in SIP signaling message

- Similar to STIR/SHAKEN
- Requires substantial investment from all stakeholders

2) Using Voice Channel

- ~300 ms for a 128-bit verification code transmission (500 bps channel)

3) Repurposing Caller ID (of SIP)

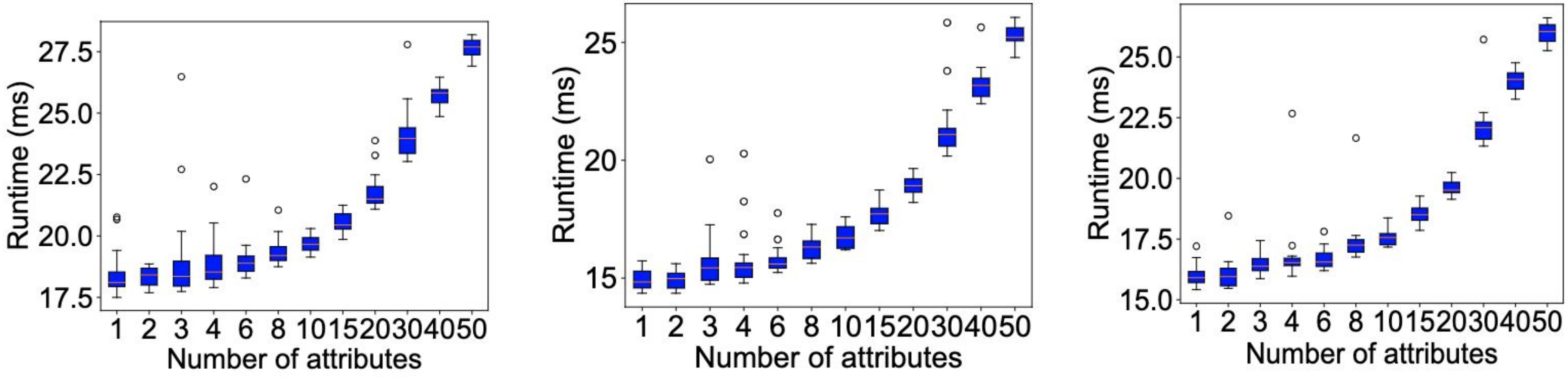
- Replace the caller ID with our `VeriCode`
- Can be easily set by a VoIP client or connected PBX in the header field
- 32-bit `VeriCode` - no extra cost

Evaluation - Implementation

- **VoIP PBX running on an AWS instance**
  - **PBX connects to the telephone networks using SIP trunk services**
- **UCBlocker Client**
  - **Issuer, User, Verifier**
  - **Anonymous credentials**
    - Relic toolkit
    - libpabc
    - BLS12-381 Elliptic Curve
    - Libsodium
- **Verifiable data registry**
  - **Public ledger -** Hyperledger Indy

Evaluation - Time Consumption

- ~1.5s end-to-end delay for a successful authentication
  - Lookup -> Proof construction -> Proof verification
  - VeriCode issuance



(a) Credential issuance

(b) Proof generation

(c) Verification

Summary

- **Flexibility**
  - Only calls that follow the callee’s policies can reach to the callee
- **Usability**
  - Legitimate calls from unknown numbers is supported
- **Privacy**
  - Caller does not need to disclose unnecessary information for authentication
- **Compatibility**
  - Minimal changes to the telephone networks
  - Eliminates the need for a call-time data channel
- **Efficiency**
  - No significant delays to original call session setup

Thank you for your attention!

Q&A