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Enabling Decentralized Identifiers and Verifiable Credentials for Constrained IoT Devices

Vasilios A. Siris

Mobile Multimedia Laboratory
Athens University of Economics and Business, Greece
vsiris@aueb.gr

EU H2020 SOFIE: Secure Open Federation for Internet Everywhere

Contents

- Why constrained IoT (including intermittent or no connectivity) ?
- Authorization with constrained IoT devices
- What are Decentralized Identifiers (DIDs)?
- What are Verifiable Credentials (VCs)?
- Putting it all together: How and why use DIDs & VCs for authorization in constrained IoT environments?

Why constrained IoT environments?

- Because many IoT devices are constrained in terms of
  - processing and storage
  - network connectivity

Reducing usage also ***reduces power consumption*** & ***security threats***

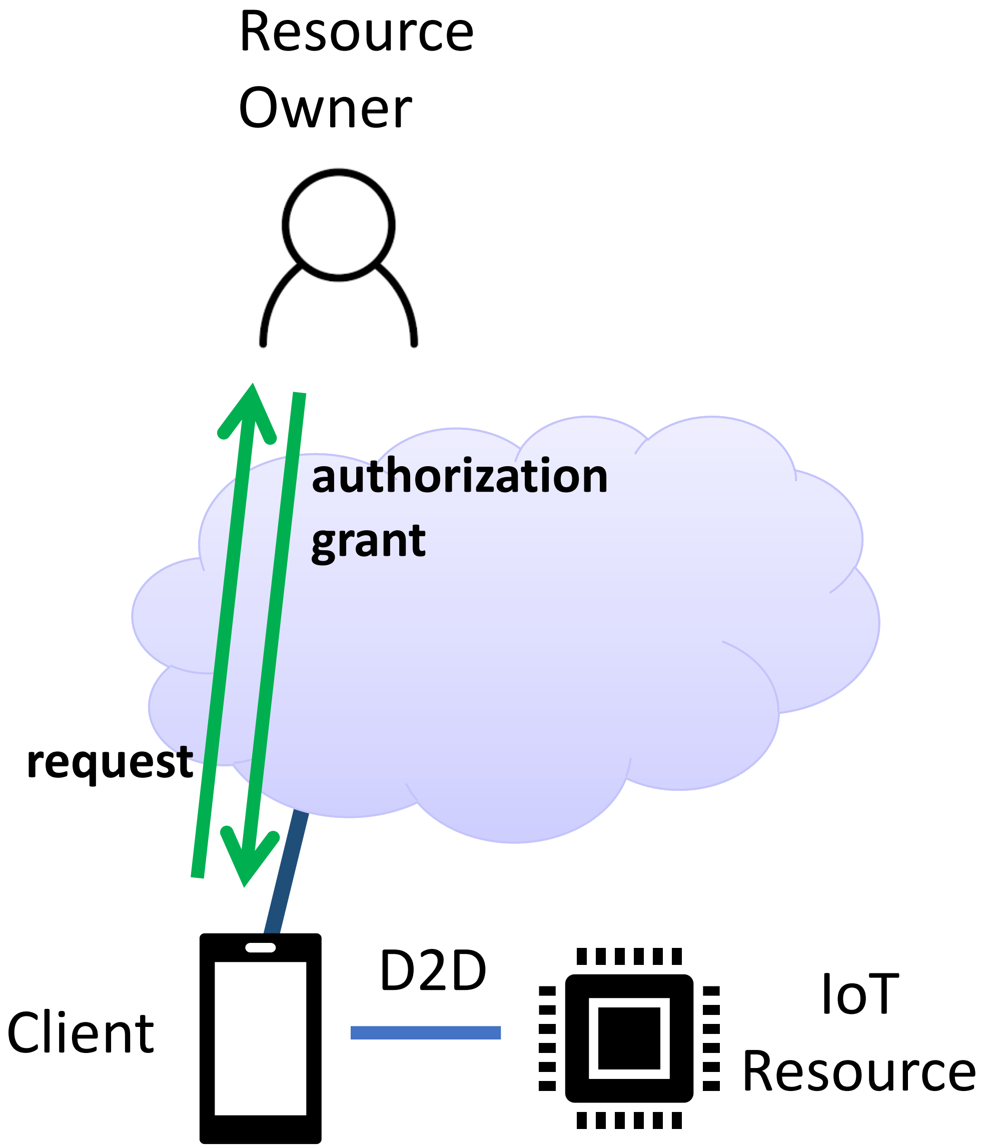
Scalability of IoT systems ***can be addressed*** by utilizing device-to-device & wireless multihop communication

Device-to-device technologies ***exist*** and are ***becoming more mature***

New challenge: how to achieve ***trusted*** device-to-device communication

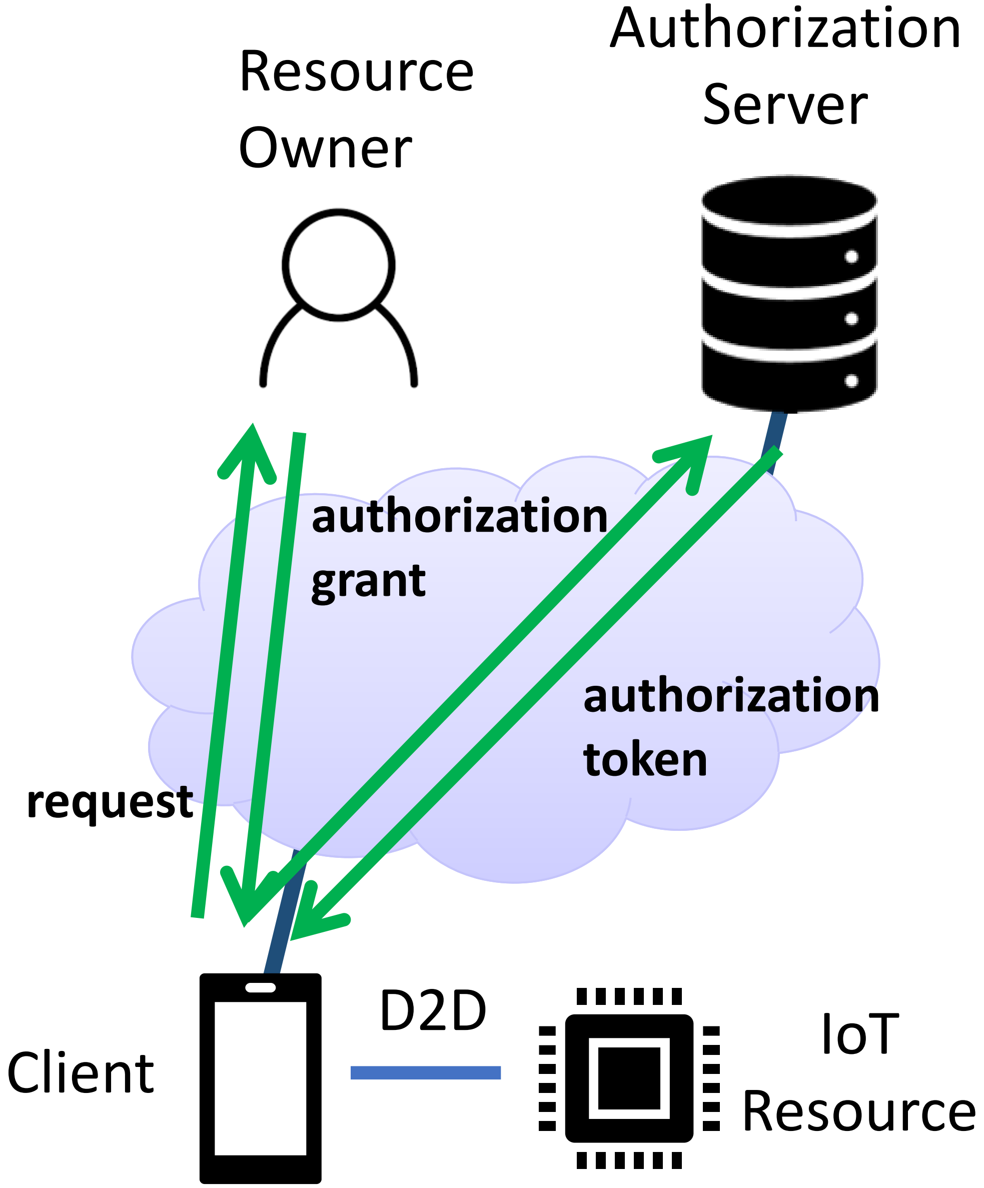
Authorization for IoT resources

- Client seeks to access an IoT Resource which may be disconnected from the Internet



SOFIE Authorization for IoT resources

- Client seeks to access an IoT Resource which may be disconnected from the Internet
- Authorization Server (AS) handles requests on behalf of IoT Resource
  - OAuth 2.0 authorization framework being developed by IETF's Authentication and Authorization for Constrained Environments (ACE) working group
  - Secure binding between AS-IoT Resource
  - Requires Resource Owner consent



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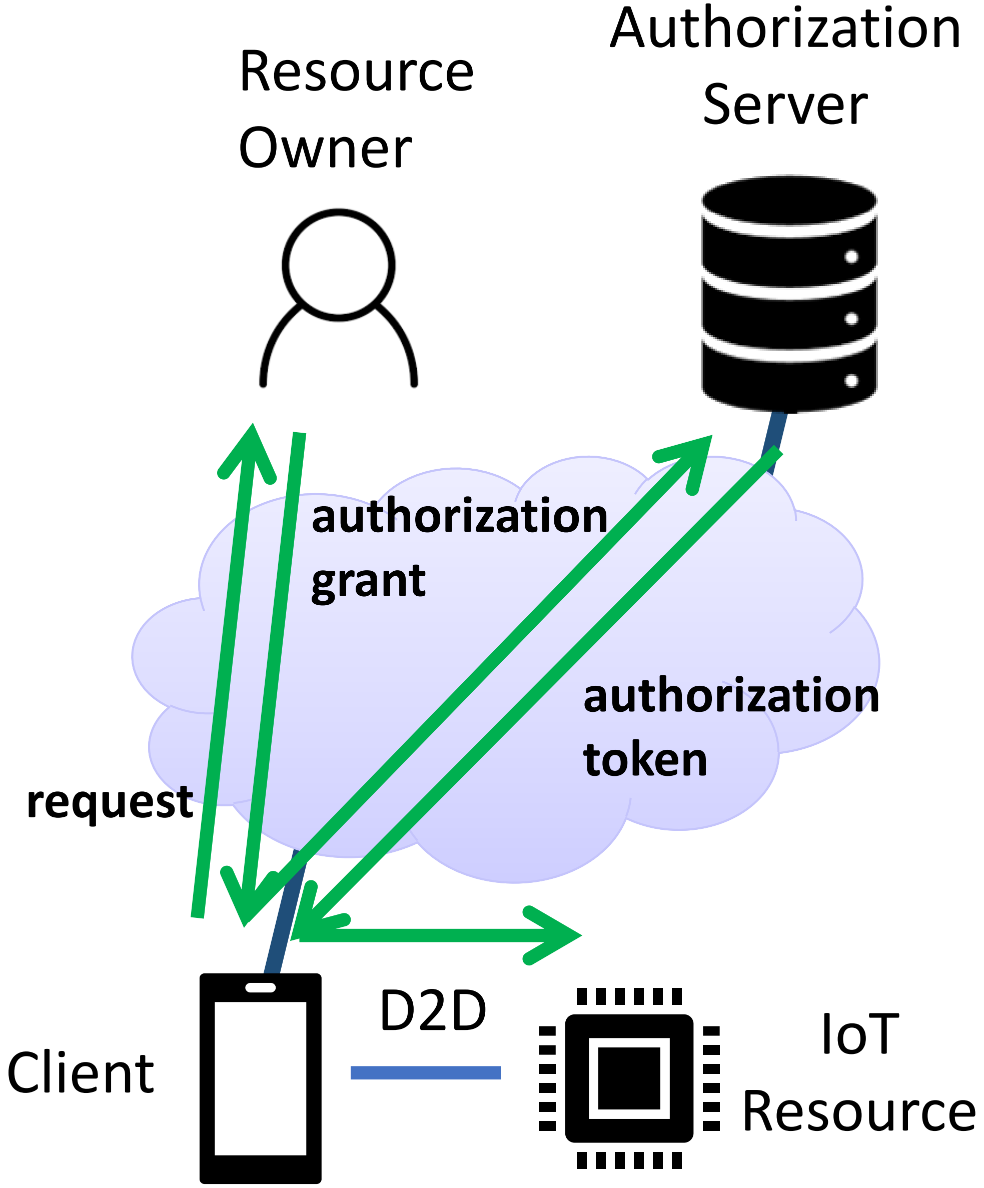
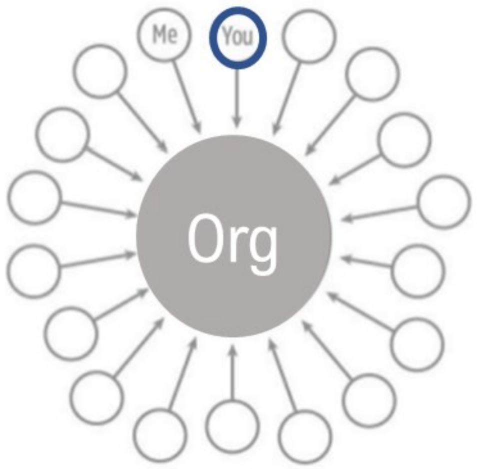
  - Requires Resource Owner consent
- Client accesses IoT Resource with authorization token

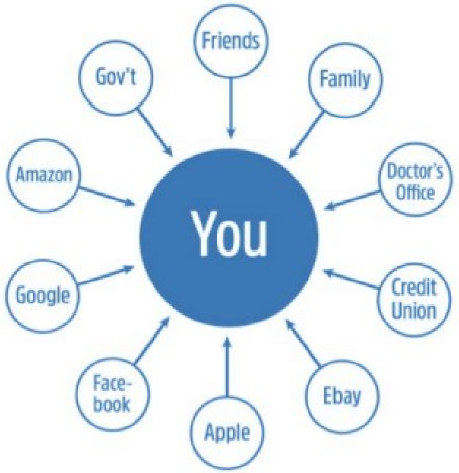


What are Decentralized Identifiers

- Self-sovereign identifiers for individuals, organizations, things



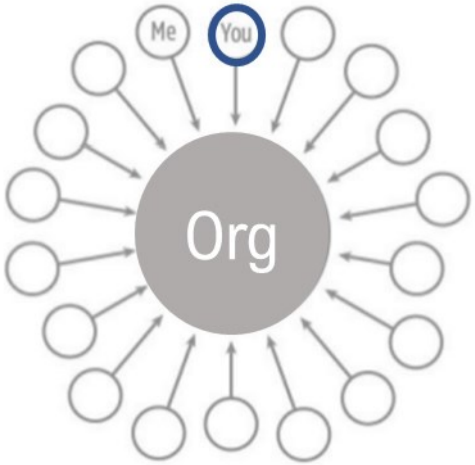
Organization in control of identity



User in control of identity

What are Decentralized Identifiers

- Self-sovereign identifiers for individuals, organizations, things
- Decentralized, persistent, resolvable, cryptographically verifiable



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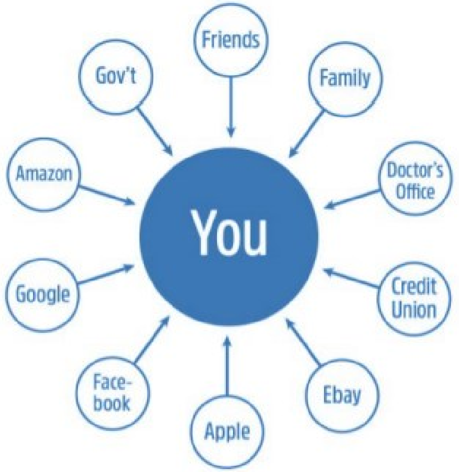


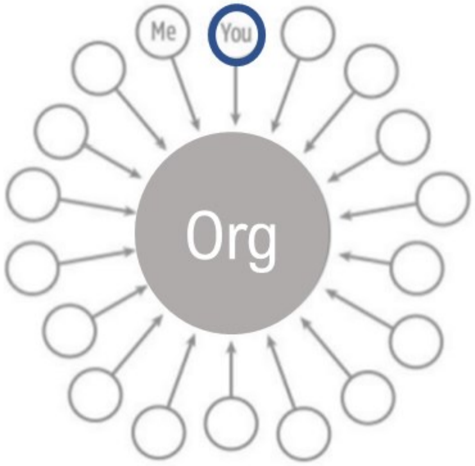
User in control of identity

What are Decentralized Identifiers

- Self-sovereign identifiers for individuals, organizations, things
- Decentralized, persistent, resolvable, cryptographically verifiable
- Registered in a blockchain, decentralized network, or off-ledger (ledger-agnostic)
- Currently being specified by W3C
- did:sov:3k9dg356wdcj5gf2k9bw8kfg7a

Method Method-specific identifier

Scheme



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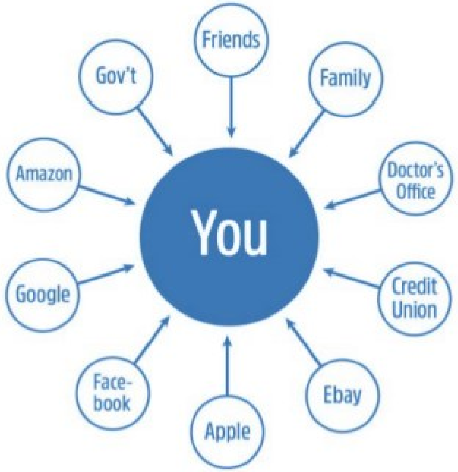

User in control of identity

DID methods

- Different DID methods did:sov, did:btcr, did:v1, did:uport, ...
- CRUD for DIDs: Create, Read (Resolve), Update, Delete (Revoke)
- Resolution: DID → DID Document
  - Set of public keys, set of service endpoints, timestamps, proofs

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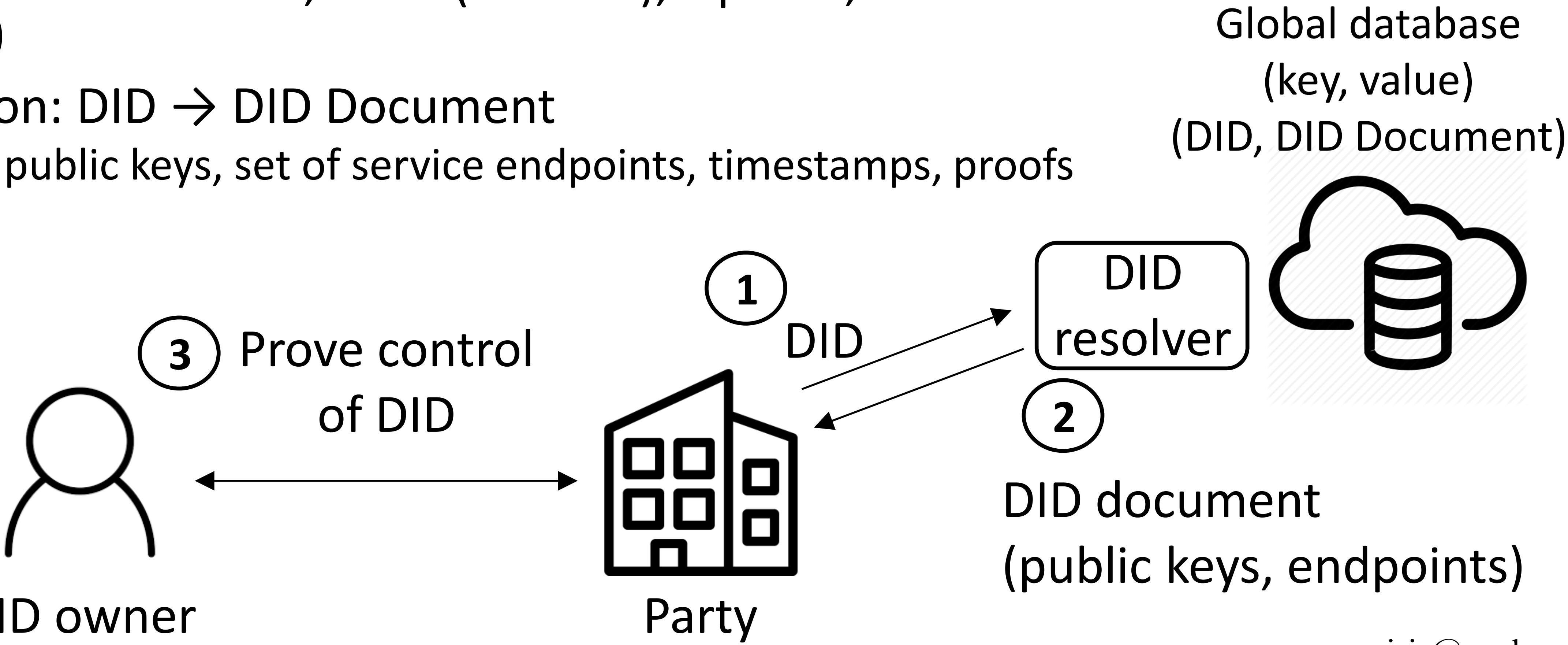
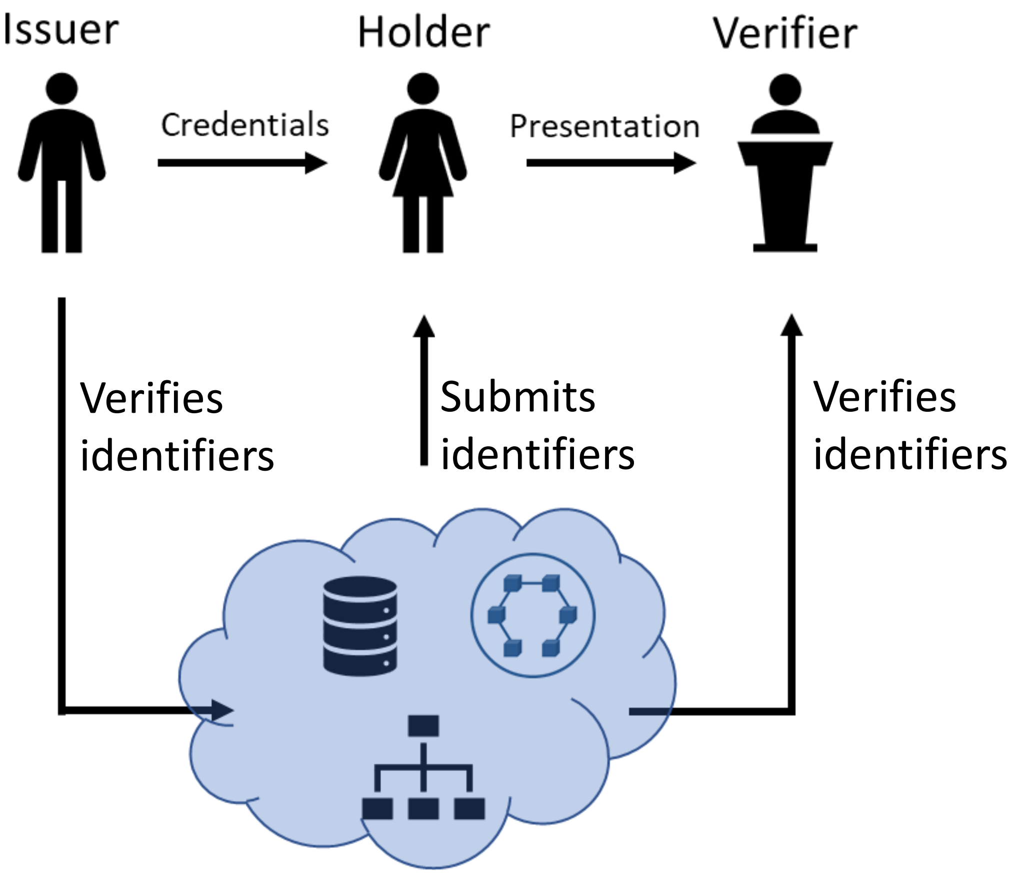


What are Verifiable Credentials (VCs)

- Credential: A set of one or more claims
- W3C recommendation
- Requires framework for verifying identities
- Users (Holders) positioned between credential Issuers and Verifiers
- Users receive and store VCs from Issuers through an agent that can be untrusted
- Users provide VCs to Verifiers through an agent that can be untrusted
- VCs are associated with users and not particular services
- Users control which VCs to use and when
  - DIDs allow users to own & control their identifiers
- Users may freely choose agents to help them manage and share their VCs

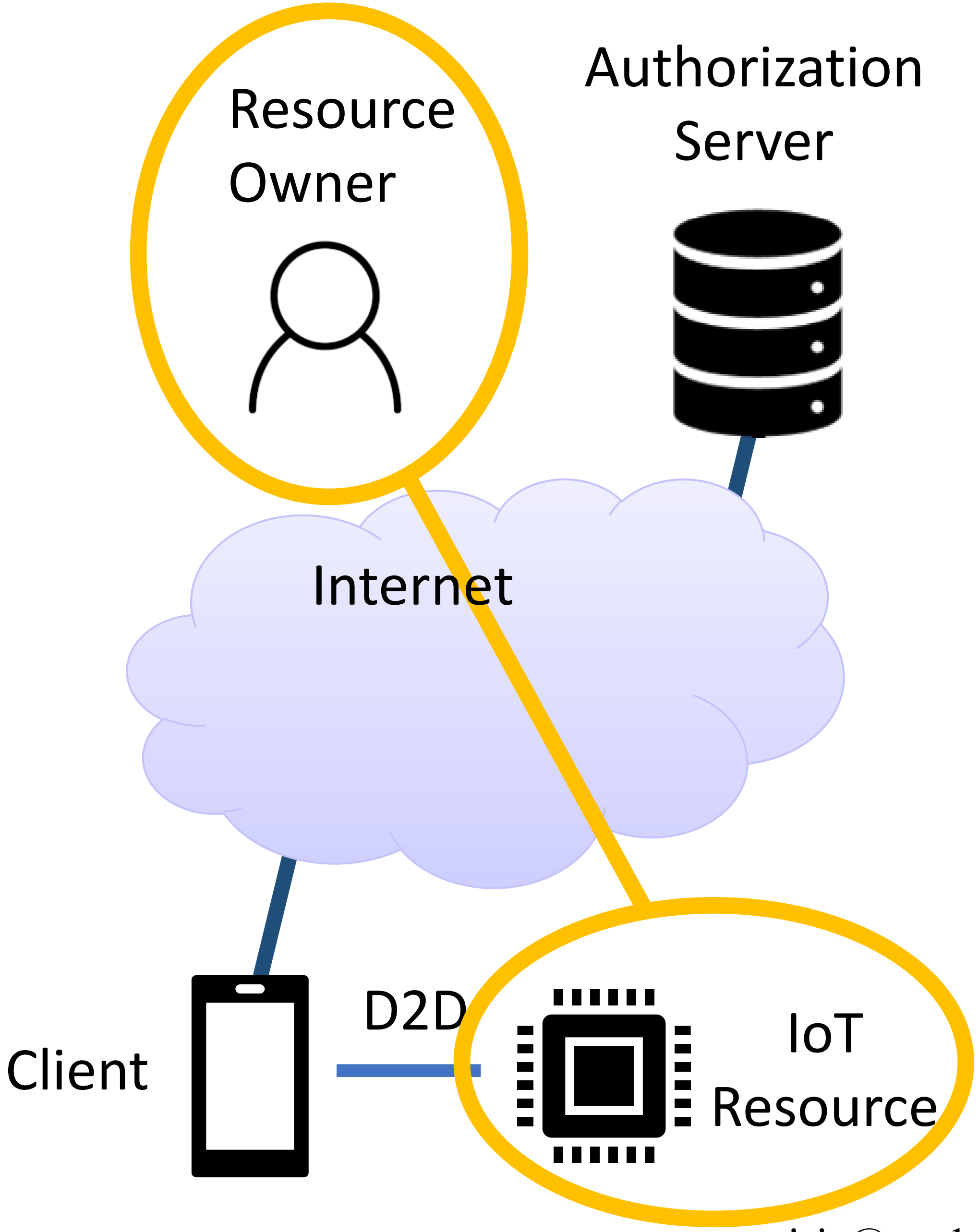


Verifiable data registry
(maintains identifiers and schemas)

vsiris@aueb.gr

Usage of DIDs

- DID for constrained IoT Resource
  - Used to bind IoT device to Resource Owner
  - Defines authentication method for Resource Owner (DID owner/controller)



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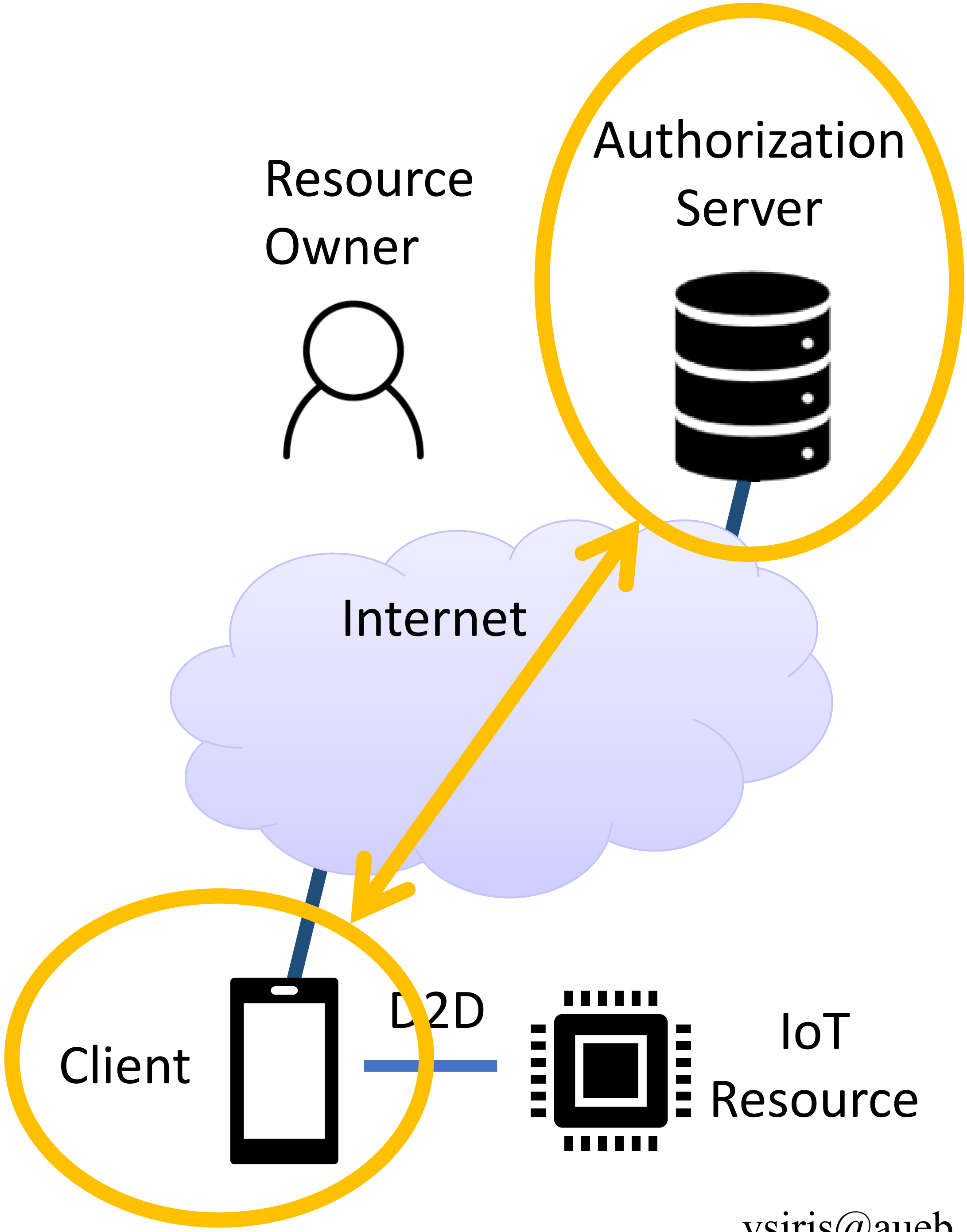
- DID for Client: used for authenticating Client



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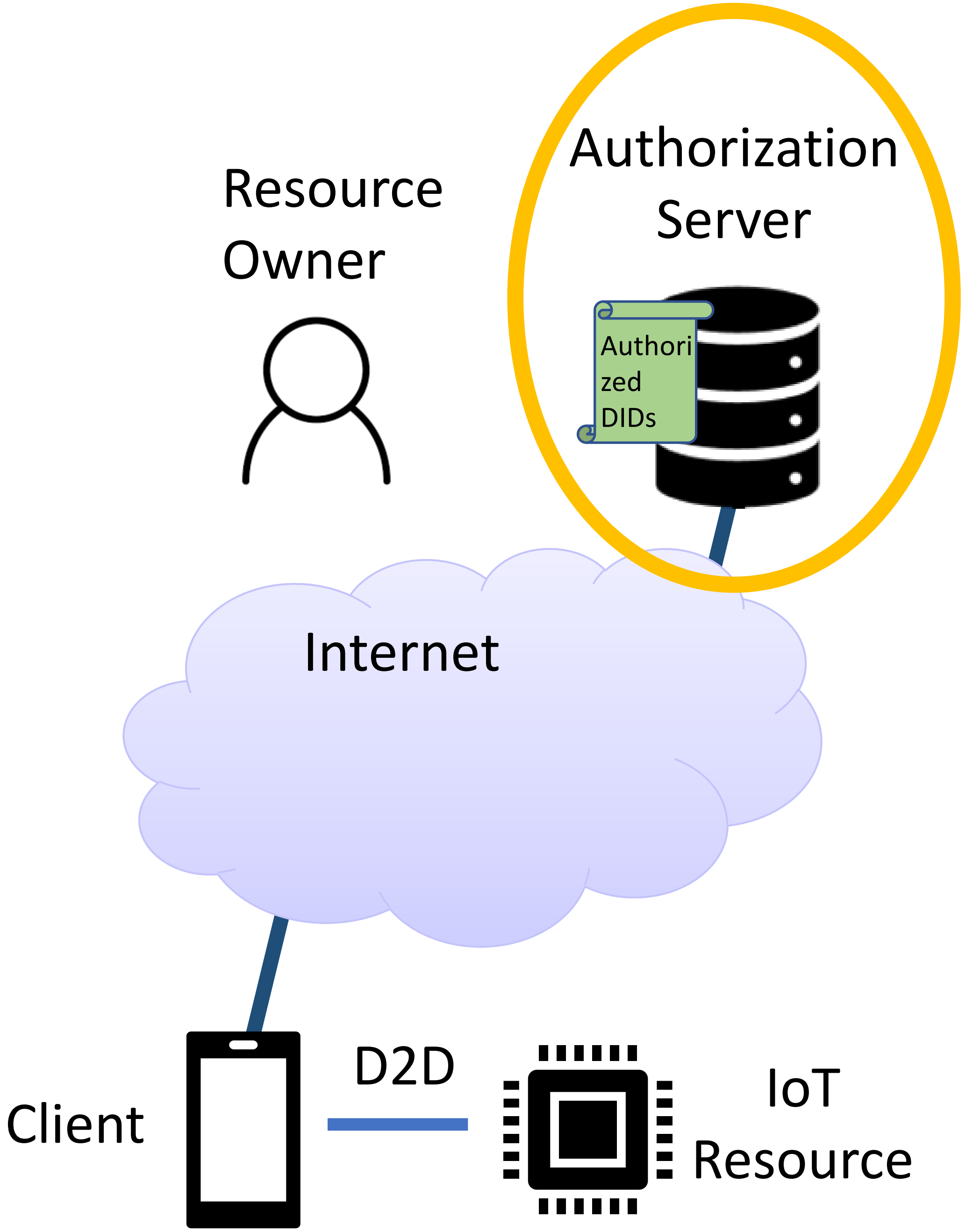
- DID of Client added to authorization list at AS
  - Resource Owner can be offline



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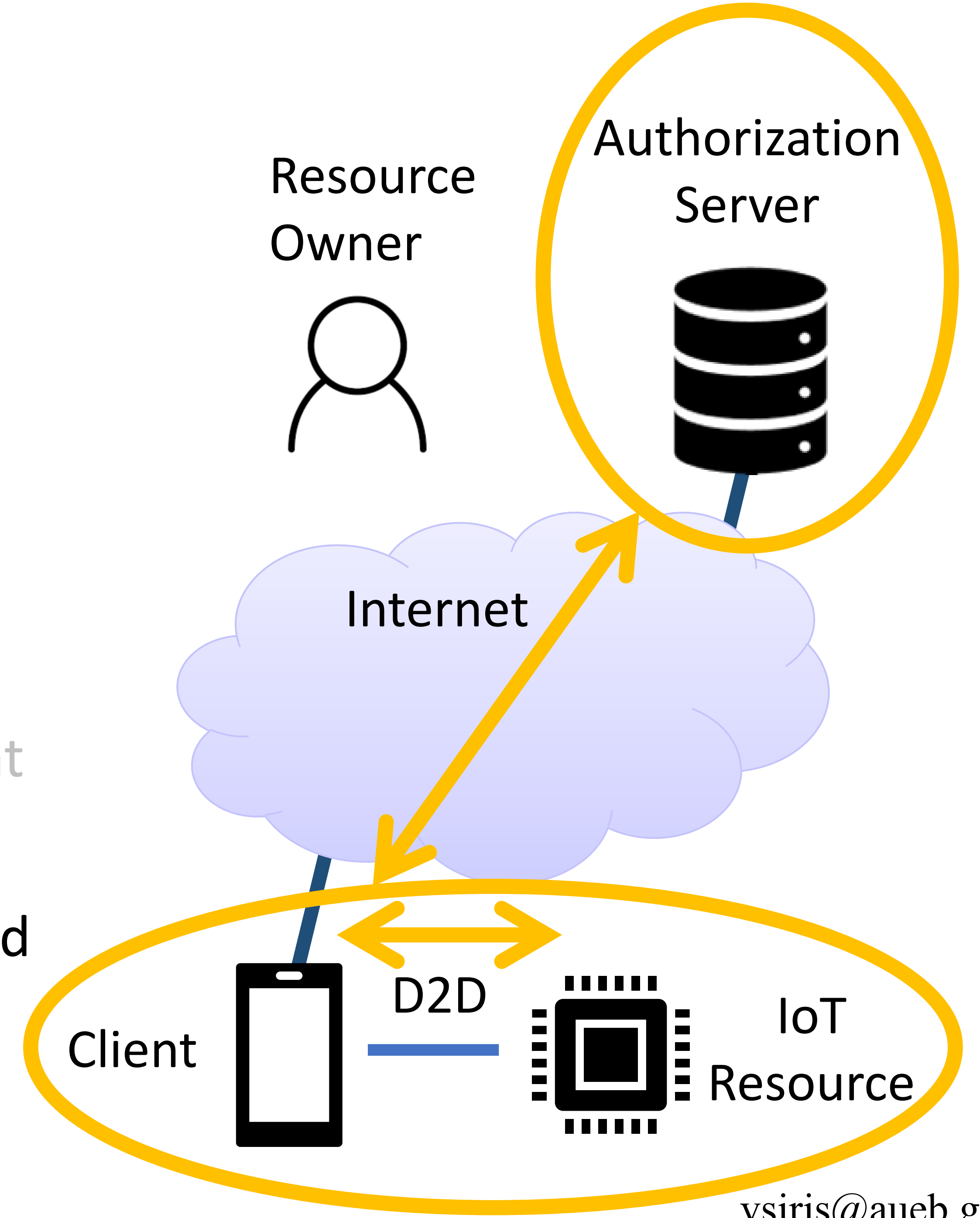
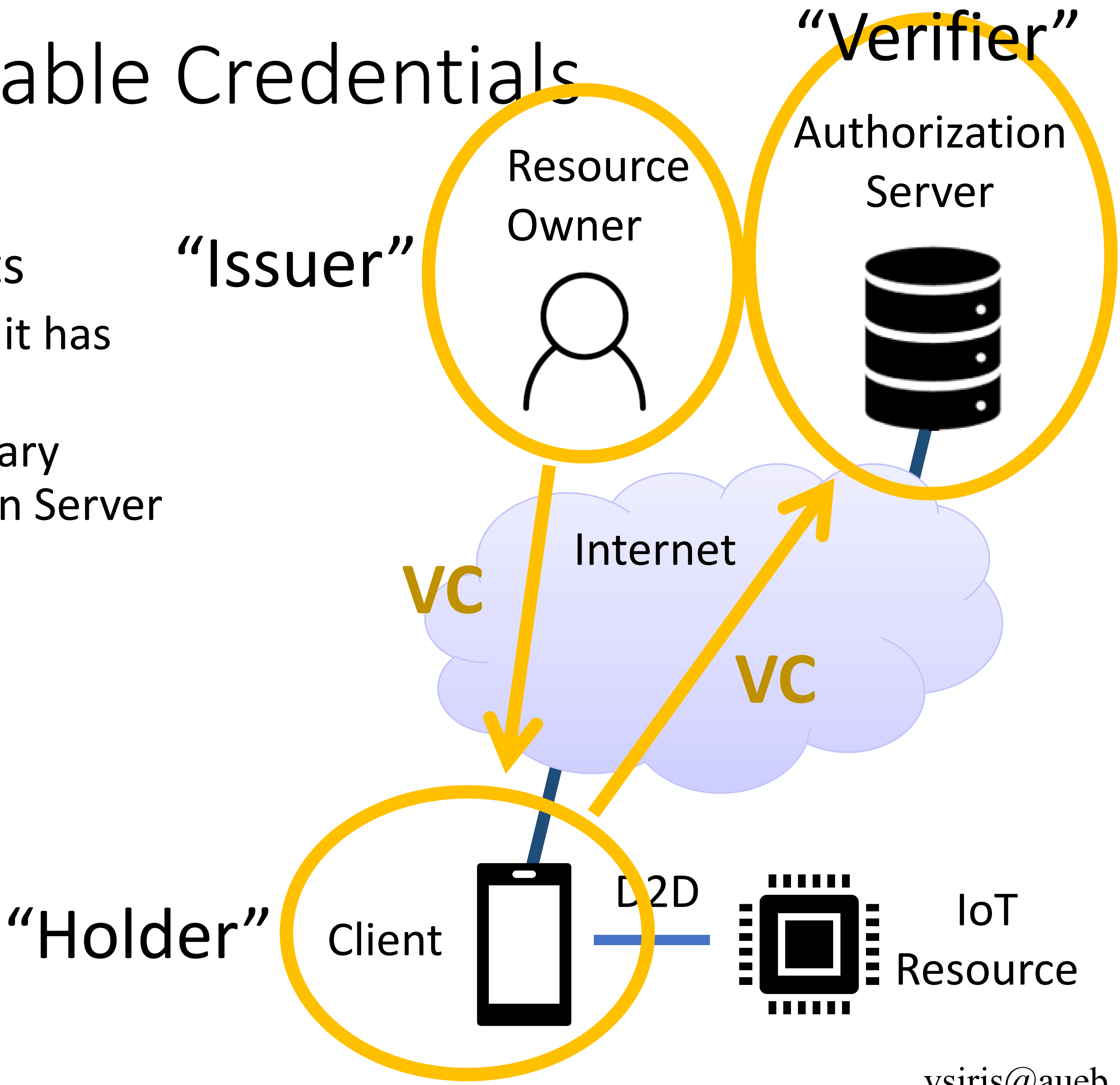
- Multiple DIDs for IoT Resource, Client, and AS
  - pairwise unique for each transaction
  - act as pseudonyms → improved privacy



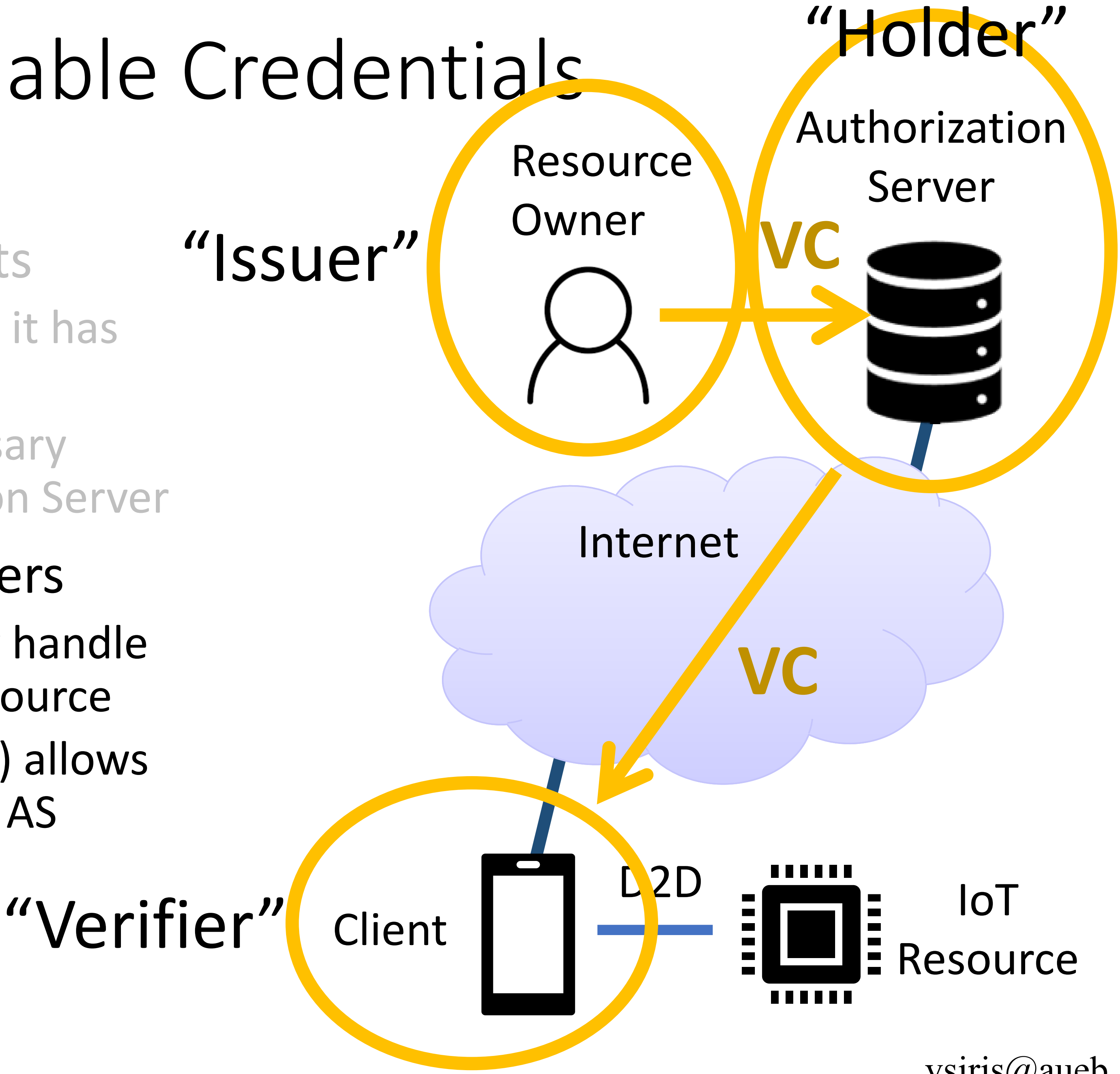
Usage of Verifiable Credentials

- VCs for authorization grants
  - Required by Client to verify it has authorization
  - Client discloses only necessary information to Authorization Server



Usage of Verifiable Credentials

- VCs for authorization grants
  - Required by Client to verify it has authorization
  - Client discloses only necessary information to Authorization Server
- VCs for Authorization Servers
  - Used by ASes to verify they handle authorization for an IoT resource
  - Revoking VC (or expired VC) allows Resource Owner to change AS



Takeaways

- Why **constrained IoT** (including intermittent or no connectivity) ?
  - constrained CPU/storage, power efficiency, security, scalability
- Authorization with constrained IoT devices
  - IETF OAuth 2.0; **both IoT Resources and Clients** can be **constrained devices**
- What are Decentralized Identifiers (DIDs)?
  - **Self-sovereign identifiers** (for individuals, organizations, things) that are decentralized, persistent, resolvable, cryptographically verifiable
  - In contrast: Public Key Infrastructure (PKI) is a **centralized trust infrastructure**
- What are Verifiable Credentials (VCs)?
  - A set of one or more **claims issued by an Issuer** to a **Holder** that can be **verified by a Verifier**

Takeaways (cont)

- Putting it all together: How and why use DIDs & VCs for authorization in constrained IoT environments?
  - **Bind IoT Resources to Resource Owners**
  - **Authenticate** Authorization Servers (ASes) and Clients
  - **Pairwise unique DIDs** (Clients, IoT Resources, ASes) for each transaction
  - **VCs for authorization grants** (Resource Owner to Client) and for **verifying ASes handling requests** (Resource Owner to AS)

- All above in a **decentralized manner** with **users in control of their identities, credentials,** and the **information disclosed**

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Thank You!

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https://mm.aueb.gr/blockchains/

SOFIE H2020 Project:
https://www.sofie-iot.eu/