Decentralized Identity and Zero Trust Enforcement for Industrial Robot Maintenance

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sirris

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Interreg Fr-Wa-Vl - Secuweb

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- Oct. 2024 - Sept. 2028
- Focus: next generation of the internet
- Technologies: 5G, AI, Blockchain, IoT, Quantum, Solid
- Domains: Food, E-Health, Industry 4.0, Mobility
- Technology Building Blocks, Demonstrators, Use Cases
- CITC, Eurasanté, Howest, Sirris, TUA West, UC Louvain, UGent, UPHF

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A common industrial challenge

On **Acme**'s factory floor, a **robotic arm** from **Robotics Inc.** is a key asset.

Access is tightly controlled within the industrial environment, with networked sensors and security zones protecting critical systems.

Internal Network 1

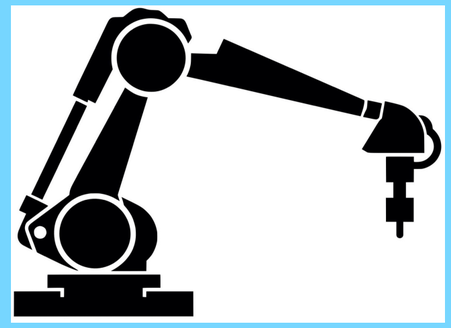
Solid Pod

UI

Command Interface

MQTT Broker

Internal Network 2



Robot

Internal Network 1

Identity store

Solid Pod

UI

Command Interface

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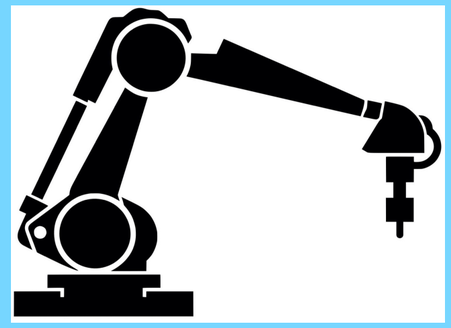
Internal Network 2



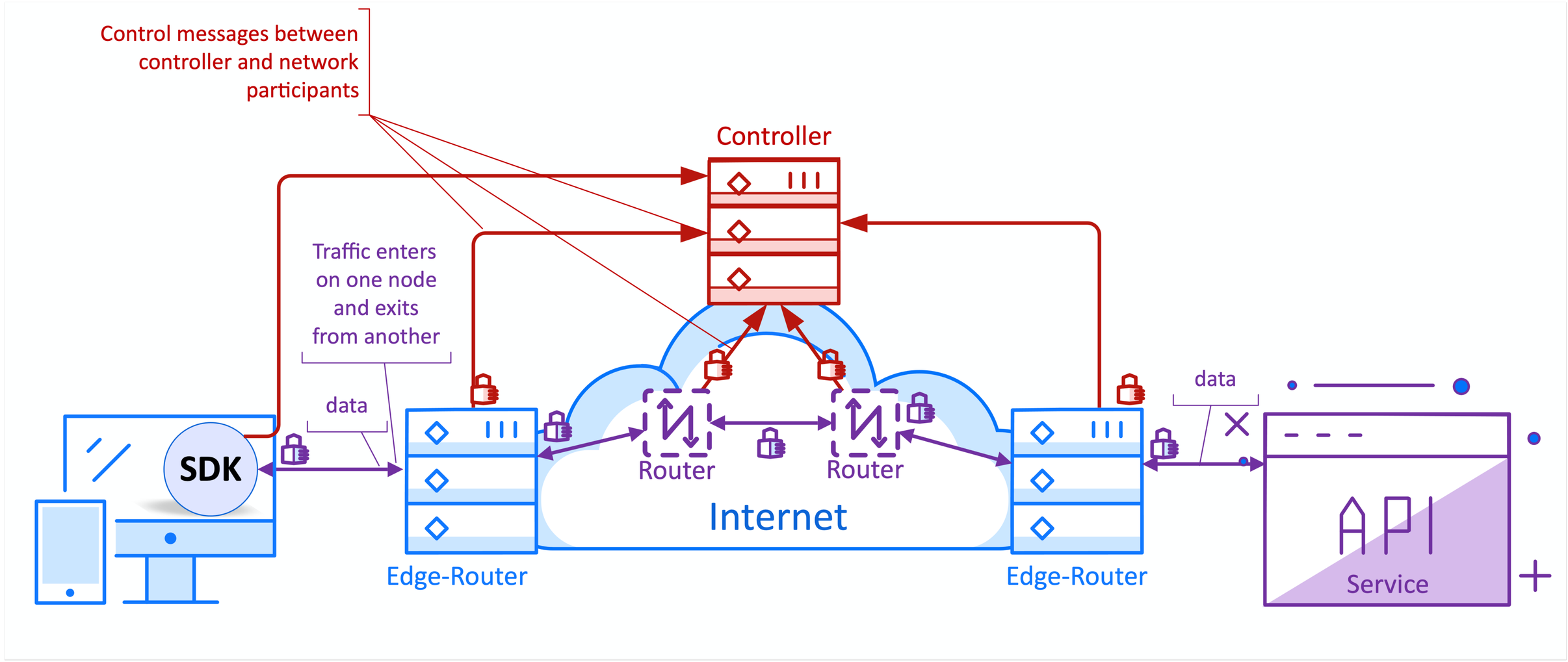
Robot

Zero Trust

Zero Trust is a security framework based on the principle:
“Never trust, always verify.”

It requires **strict identity verification** for **every user or device** trying to access resources, regardless of location.

This mitigates risks of insider threats, compromised credentials, and lateral movement within networks.


Control messages between controller and network participants
Controller
Traffic enters on one node and exits from another
data
data
SDK
Router
Router
Internet
Edge-Router
Edge-Router
API
Service

Internal Network 1

Identity store

Ziti Controller

Ziti Edge Router

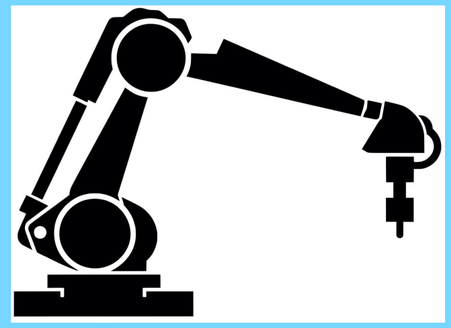
Solid Pod

UI

Command

MQTT Broker

Internal Network 2



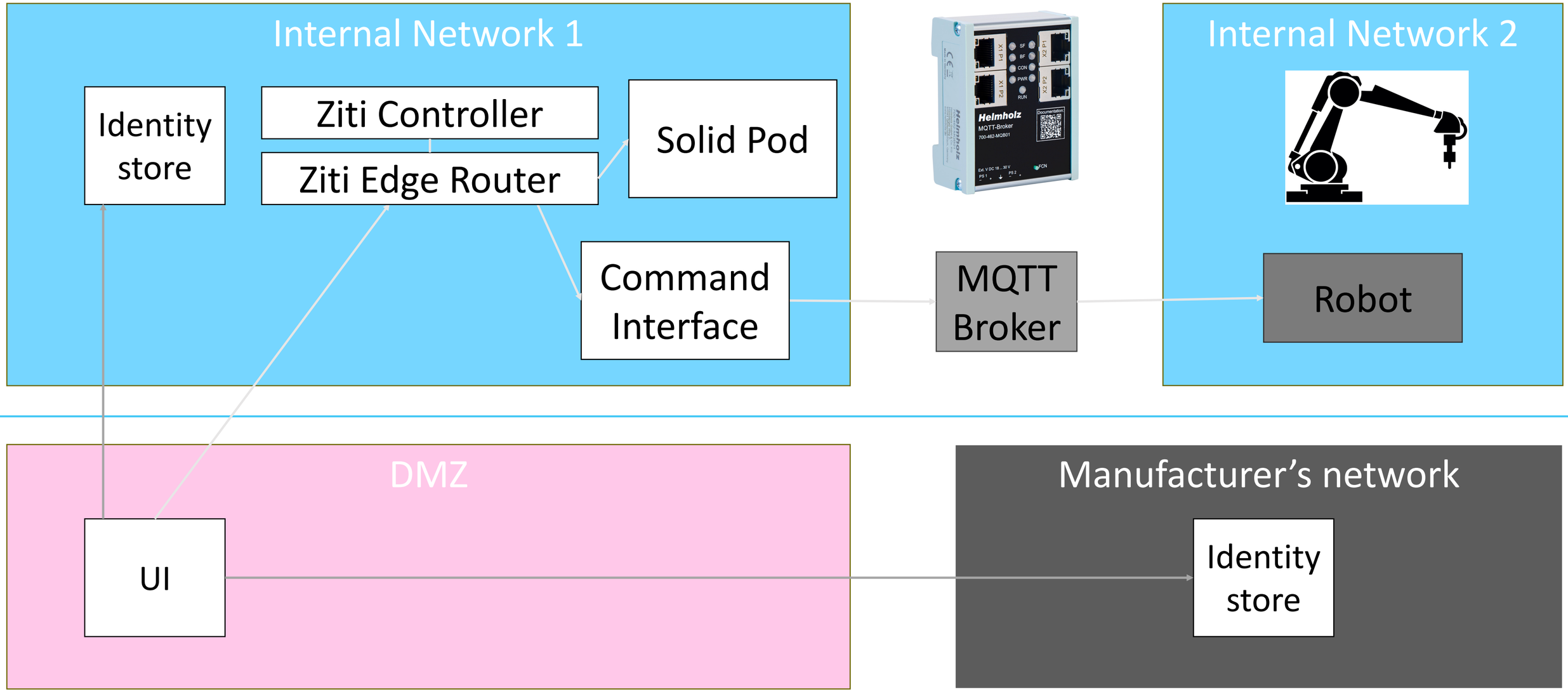
Robot

Meet Alice, an External Technician

Alice arrives claiming to be a technician from **Robotics Inc.** to service the robot.

But can we really **trust** her identity?

If Alice can impersonate a trusted technician, she could gain unauthorized access to critical systems.

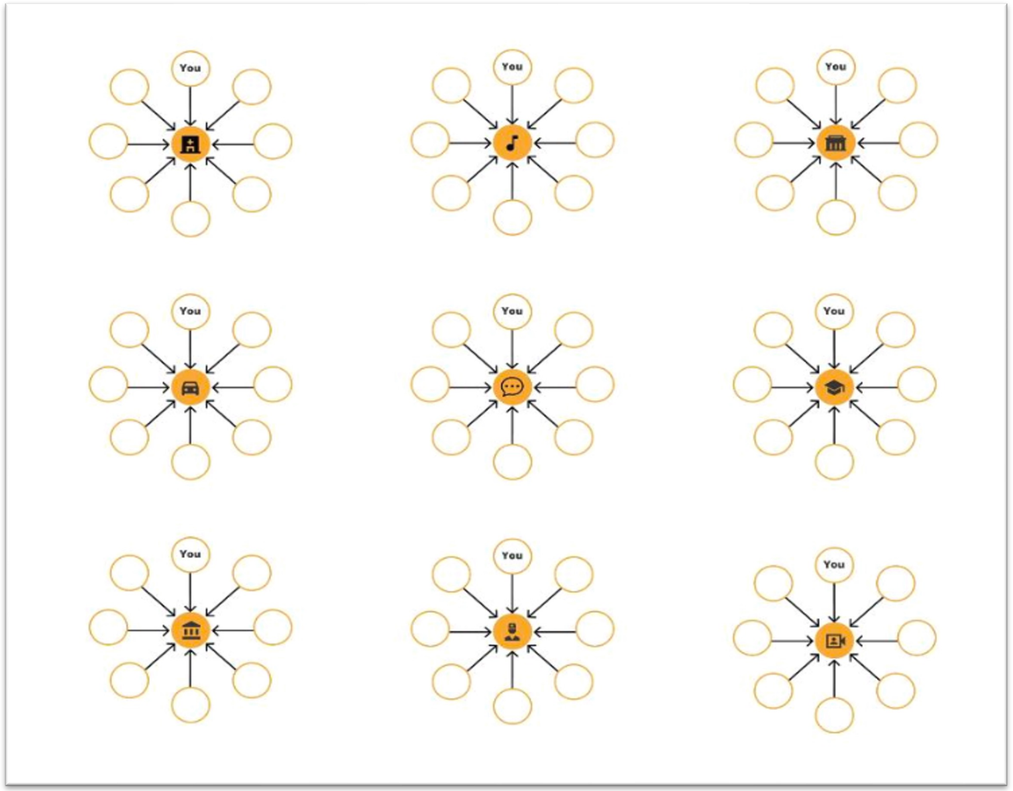

Internal Network 1
Identity store
Ziti Controller
Ziti Edge Router
Solid Pod
Command Interface
Helmholz
MQTT-Broker
700-462-MQB01
MQTT Broker
Internal Network 2
Robot
DMZ
UI
Manufacturer’s network
Identity store

This is troublesome

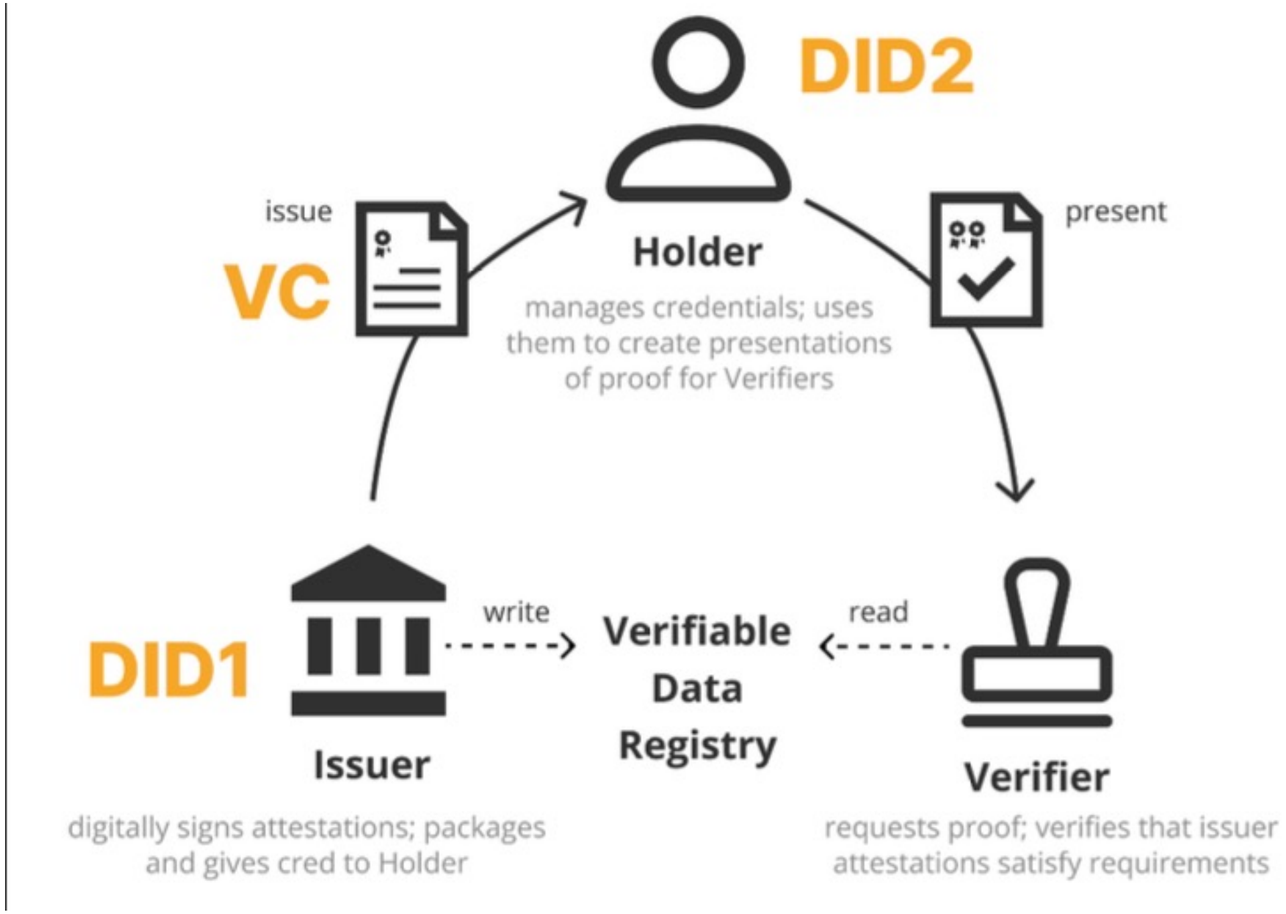
This doesn't scale well.

- Requires **custom integrations** with each external supplier's system
- Depends on **uptime** of external system
- Depends on **security** of external system

What if we approached this differently?



Self Sovereign Identity



Verifiable Credential & Verifiable Presentation

Verifiable Credential (VC)

```
{
  "@context": ["https://www.w3.org/2018/credentials/v1", …. ],
  "type": ["VerifiableCredential", "ComcastCredential"],
  ……

  // (1) ID of Credential Issuer.
  // Resolved to machine-readable info about the issuer, e.g. Public Keys
  "issuer": "did:example:565049",
   …

  // (2) claims about the subject of the credential (holder)
  "credentialSubject": {
    // ID of credential subject (holder)
    // Resolved to machine-readable info about the holder, e.g. Public Keys
    "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",
    "name": "John",
    "contractNum": 123456,
    ……
  },

  // (3) digital proof that makes the credential tamper-evident
  "proof": {
    "type": "Ed25519Signature2020",
    "created": "2022-02-25T14:58:42Z",
    "verificationMethod": "did:example:565049#key-1",
    "proofPurpose": "assertionMethod",
    "proofValue": "z3FjecWufY46yg5LhxhueARiKBk9czhSePTFehP…"
  }
}
```

Verifiable Presentation (VP)

```
{
  "@context": ["https://www.w3.org/2018/credentials/v1", …. ],
  "type": "VerifiablePresentation",

  // (1) Verifiable Credential, see example ay the left.
  "verifiableCredential": [{
     "issuer": " did:example:565049",
     ….
     "credentialSubject": {
       "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",
        "name": "John",
        "contractNum": 123456,
        ……
     },
     "proof": { …. }
  }],


  // (2) digital signature by the credential holder
  // (proof of key possession)
  "proof": {
    "type": "Ed25519Signature2020",
    "created": "2022-03-25T16:37:21Z",
    "verificationMethod": "did:example:ebfeb1f712ebc6f1c276e12ec21#key-1",
    "proofPurpose": "assertionMethod",
    "proofValue": "f3FjecWufY46yg5Lhxhued244Jsdfs,PsdfglO2d…"
  }
}
```

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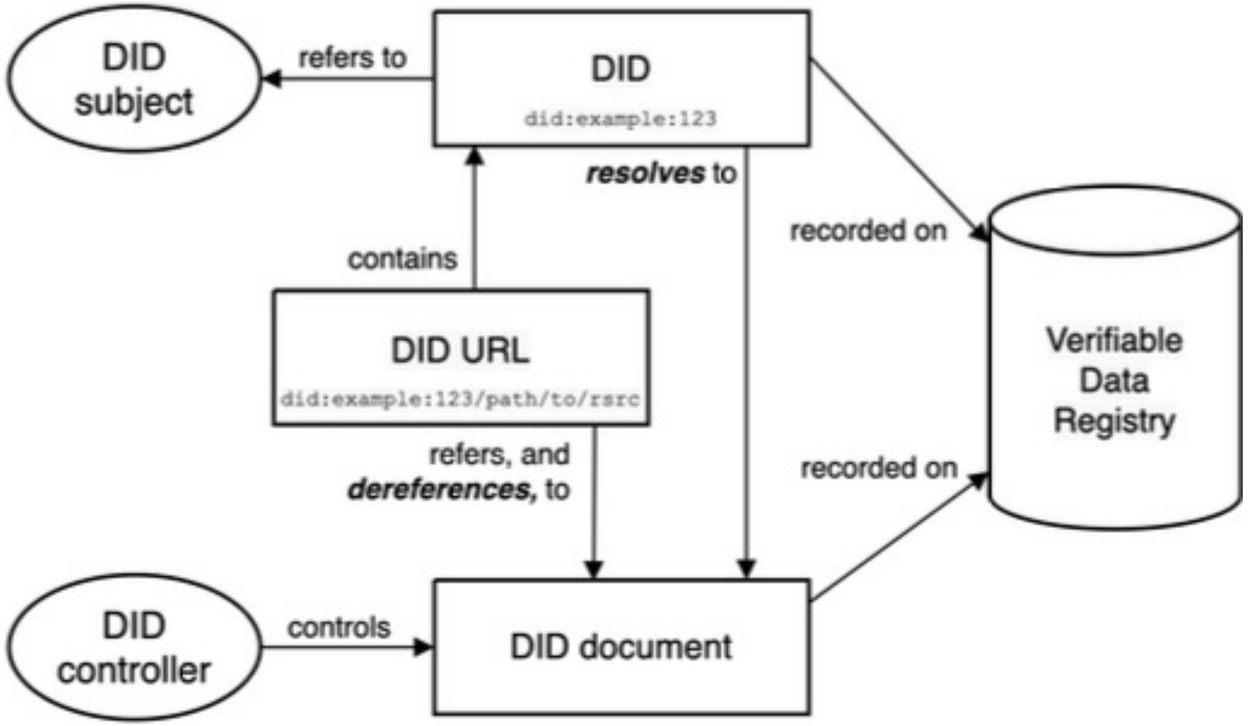
Decentralized Identity



Trusted Registry

Contains:

- DIDs (Decentralized identities)
- VC Schemas
- Accreditations

Internal Network 1

Identity store

Ziti Controller

Ziti Edge Router

Solid Pod

Command Interface

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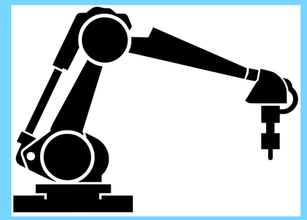
Internal Network 2



Robot

DMZ

UI

SSI Network

Accreditations

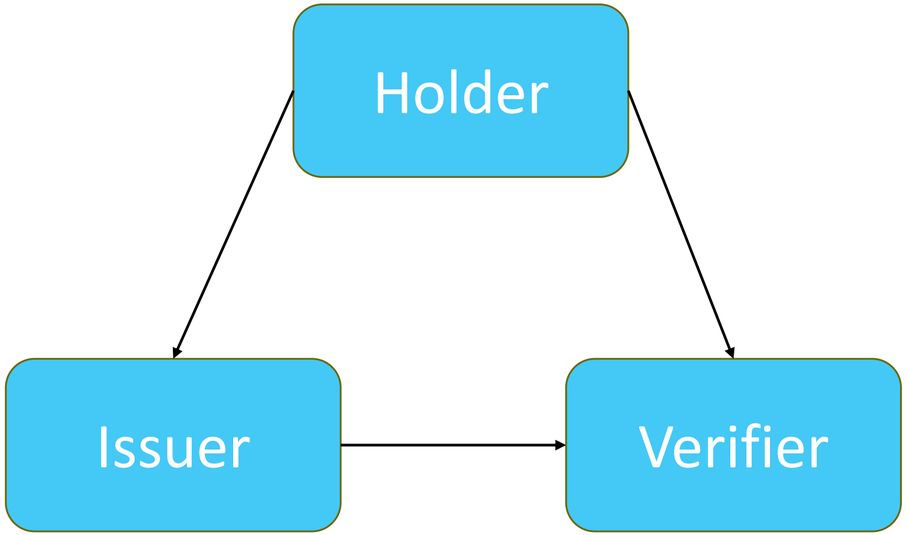
DID registry

Schema registry

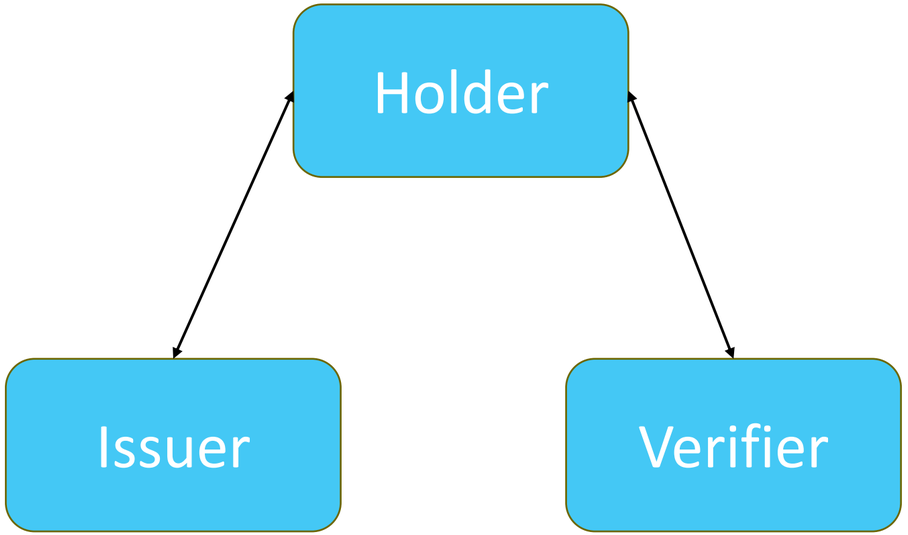
CRL

OIDC (OpenID Connect) vs. OIDC4VP

OIDC



OIDC4VP



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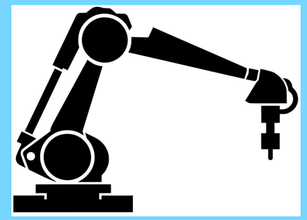

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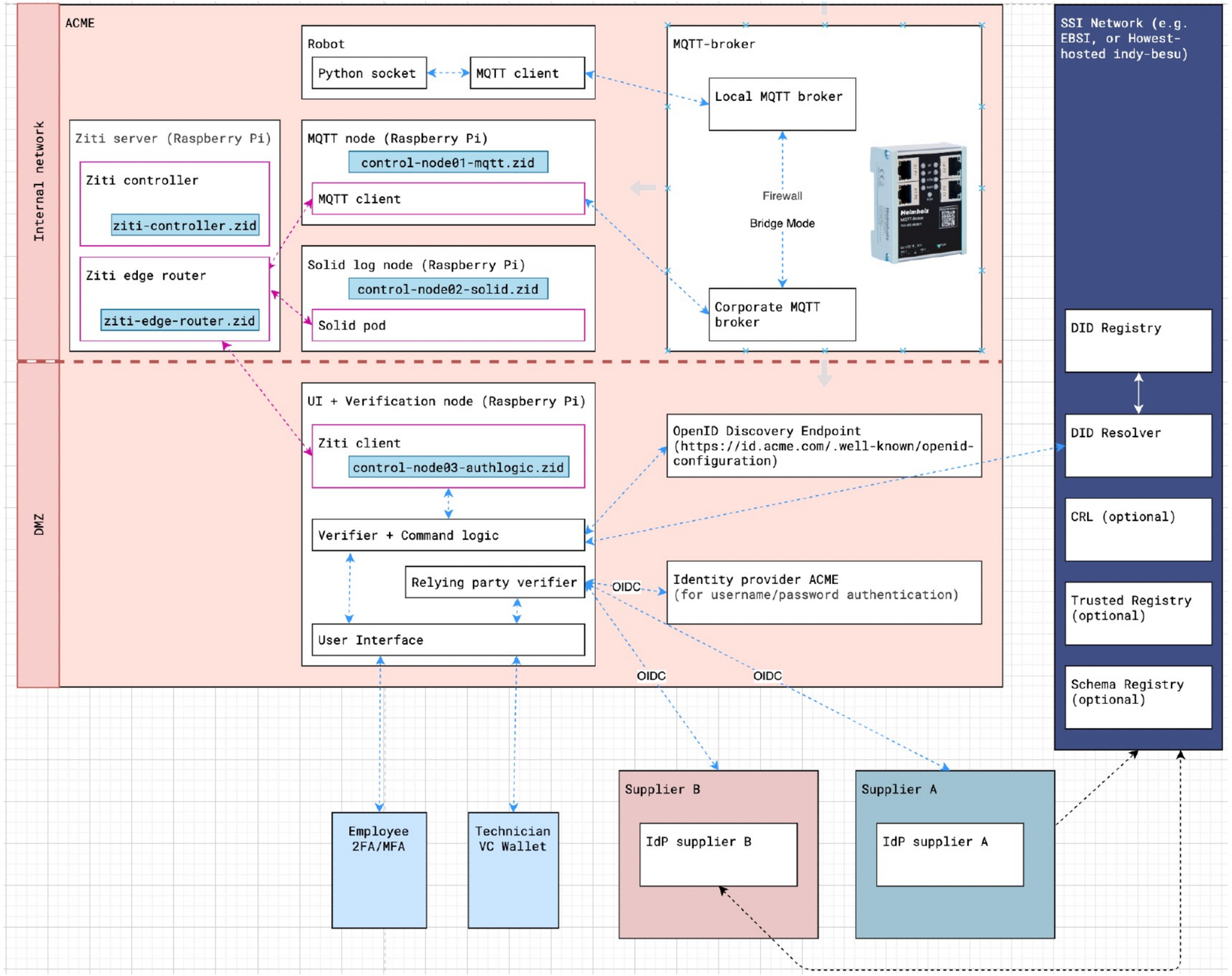
ACME
Internal network
DMZ
Robot
Python socket
MQTT client
MQTT-broker
Local MQTT broker
Firewall
Bridge Mode
Corporate MQTT broker
Ziti server (Raspberry Pi)
Ziti controller
ziti-controller.zid
Ziti edge router
ziti-edge-router.zid
MQTT node (Raspberry Pi)
control-node01-mqtt.zid
MQTT client
Solid log node (Raspberry Pi)
control-node02-solid.zid
Solid pod
UI + Verification node (Raspberry Pi)
Ziti client
control-node03-authlogic.zid
Verifier + Command logic
Relying party verifier
User Interface
OpenID Discovery Endpoint (https://id.acme.com/.well-known/openid-configuration)
Identity provider ACME (for username/password authentication)
OIDC
OIDC
OIDC
SSI Network (e.g. EBSI, or Howest-hosted indy-besu)
DID Registry
DID Resolver
CRL (optional)
Trusted Registry (optional)
Schema Registry (optional)
Employee 2FA/MFA
Technician VC Wallet
Supplier B
IdP supplier B
Supplier A
IdP supplier A

Security Benefits of Layered Approach

- Enforces strict **identity verification** on all users, internal or external
- Provides strong **auditability** and **revocation capabilities** for **external identities**
- Aligns with **Zero Trust** by never assuming implicit trust based on network location or user origin

Key Takeaways

- Industrial environments face unique challenges managing identities for both **internal** and **external users**.
- Traditional systems like **LDAP/OIDC** work well **internally** but fall short for external technicians.
- Combining **Self-Sovereign Identity** with trust registries enables scalable, secure **external** identity verification.
- Layered identity management strengthens security and supports Zero Trust principles.
- This approach integrates seamlessly with legacy protocols and infrastructure, enabling practical, future-ready solutions.

Thank you for your attention!