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Authorization (AuthZ) Engine Architecture for Distributed Systems

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What is AuthZ?

Authorization Answers Questions Like:

- What information or resource(s) does the **{ subject }** have access to?
- Is the **{ subject }** permitted to perform **{ operation }** on this **{ resource }**?

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Physical Realm AuthZ

- Mailboxes!
  - Key & lock is AuthN
  - Boxes and rear door as AuthZ
- A house with no AuthZ
- What about data systems?

Why do we care about AuthZ in data systems?

- In the physical realm, authorization is well understood
- Ensures: confidentiality, integrity, and availability of resources
- Protects resources
  - Reduce impact of bad actors
  - Can protect PHI data or EMRs
- Create chains of trust
- Exert control over systems

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Why Do I Care? Because **Data == Power**

Intelligence ⟺

Data ->

Knowledge ->

Patterns / Trends ->

Prediction ->

Control ->

Influence & Power

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Intellegence in Climate: Hot or Not?

"It's **cold** outside **today**, the climate isn't getting warmer"

"It's cold outside today, however, the trends in data point to a **warmer climate**"

Disconnected Data Points

Connected Data Points

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Intelligence In Warfare: Victory or Defeat?

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Intelligence In Therapeutics: Profit or Loss?

WHO WOULD WIN?

Psilocybin N=30
25mg / **every 3 weeks**
QIDS-SR-16 score: **-8.0** +/- 1.0

Escitalopram N=29
10mg / 20mg / **every day**
QIDS-SR-16 score: **-6.0** +/- 1.0

(2021) Trial of Psilocybin versus Escitalopram for Depression - .N Engl J Med 2021; 384:1402-1411
https://www.nejm.org/doi/full/10.1056/nejmoa2032994

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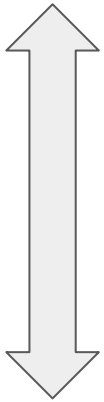
History of AuthZ Strategies

- **Club Bouncer:** Bruce
- **Unix:** File/directory permission bits
- **ACL:** Access Control List
- **RBAC:** Role-Based Access Control
- **ABAC (PBAC):** Attribute-Based Access Control
- **RAdAC:** Risk Adaptive-Based Access Control

Simple,
Less Expressive,
Less Sophisticated



Complex,
More Expressive,
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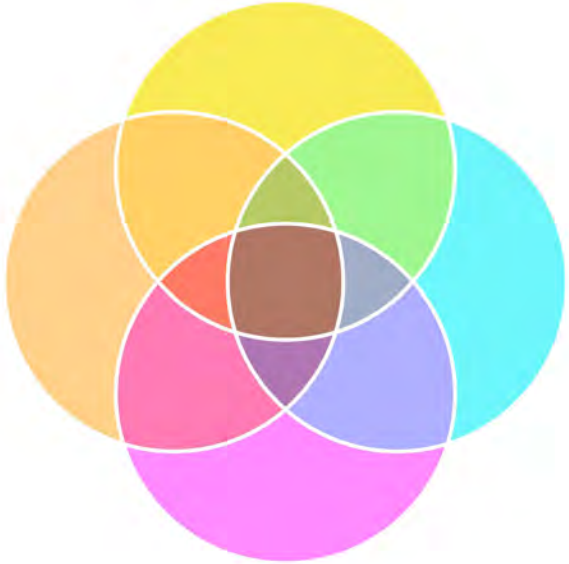
Other Access Control Mental Models

- **MAC** - Mandatory Access Control
  - Centrally managed
  - Permissions governed by identity + object tags (sensitivity)
  - e.g. Military and intelligence community governance
- **DAC** - Discretionary Access Control
  - Decentralizes security decisions to resource **owners**
  - Permissions governed by identity
  - e.g. Unix permissions, ACLs, etc…



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History of AuthZ Strategies: ACL

- ACL: Access Control List
- More granular and flexible

control— versus linux file mode bits

```
# file: home/sales/
# owner: john
# group: john
user::rw-
user:barryg:r--
group::r--
mask::r--
other::r--
default:user::rwx
default:user:john:rwx
default:group::r-x
default:mask::rwx
default:other::r-x
```

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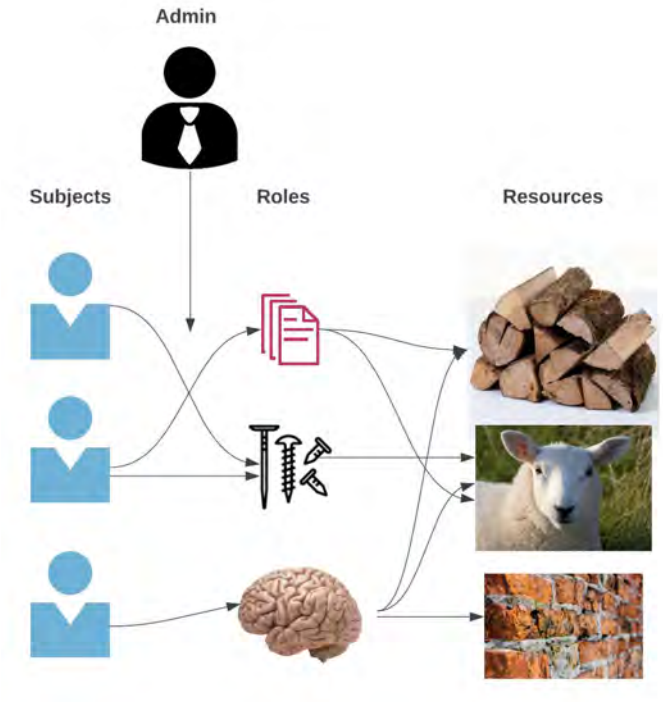
History of AuthZ Strategies: RBAC

RBAC:

Role-Based Access Control

Subjects ->
Roles ->
Resource Permissions



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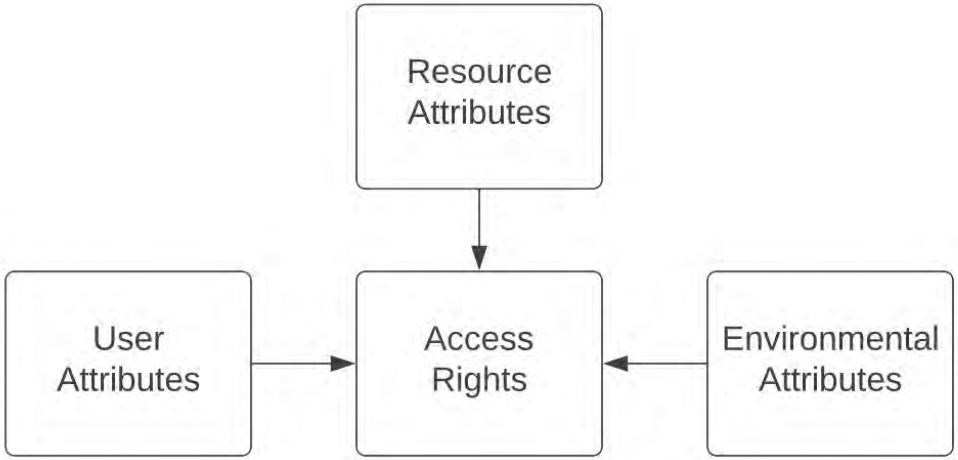
History of AuthZ Strategies: ABAC (PBAC)

ABAC (PBAC):
Attribute-Based Access Control



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History of AuthZ Strategies: RAdAC

RAdAC: Risk Adaptive-Based Access Control

- Examples:
  - To gain access to the conference, you must have a negative COVID test within the last 24 hours
  - You must not have visited a country with a breakout of virus x within the last 5 years
  - You must fly on an airline that meets our constantly changing requirements
- Difference from ABAC? Takes risk assessments to the extreme
  - Subject, resource, and environmental variables as knowledge graph, even utilizing external data sources
- Good place for application of AI/ML models that learn risks

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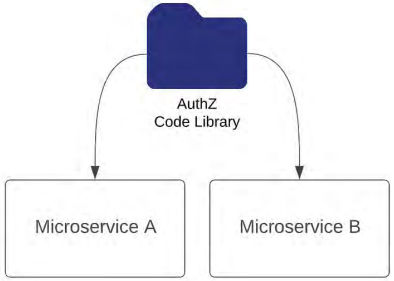
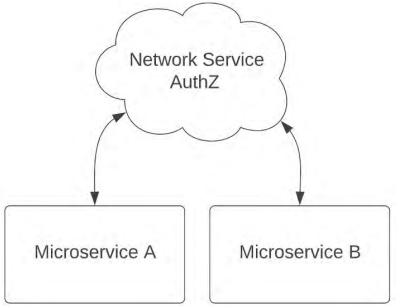
History of AuthZ Architecture

Ad Hoc -> **Shared Libraries** -> **Network Service**





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Architecture: Ad-Hoc

- Any AuthZ strategy
- Do whatever you want!
- Tightly coupled with application code and logic
- Service-specific
  - Not applicable to other services

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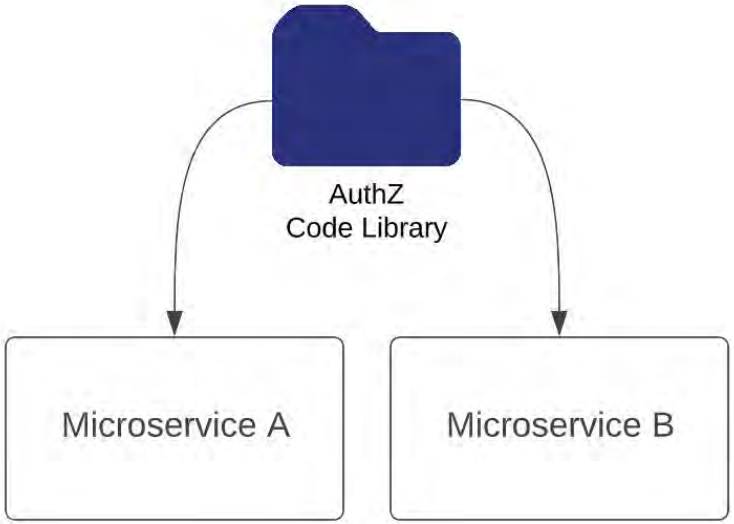
Architecture: Shared Library



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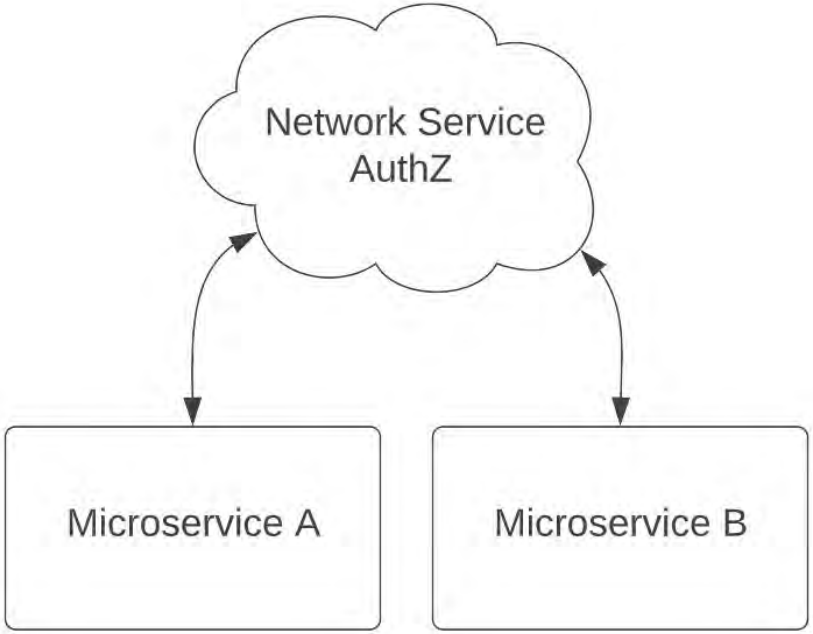
Architecture: Network Service



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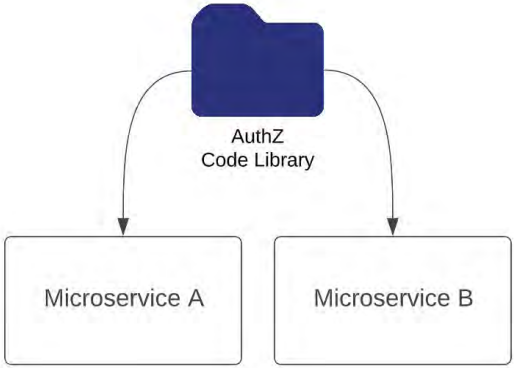
Architecture: Hybrid?



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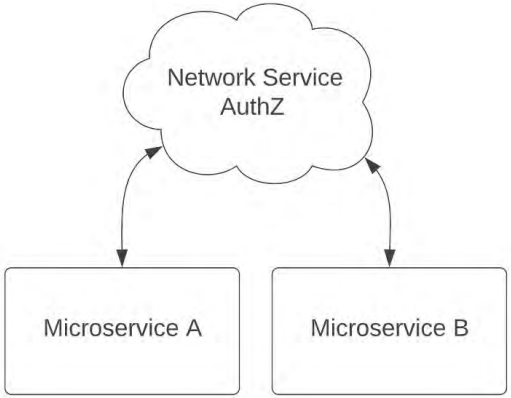

= ?

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Common Problems in AuthZ Systems

- Not able to express governance at a level of granularity required
- Not able to fully express required logic and rules for access
- Slow || Doesn't scale
- Not readily interoperable

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Distributed AuthZ Engine Proposal

John's Tenets & Principles of a Good One™

Just Remember:

M S C S C D

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Principles & Tenets of a Good, Distributed, AuthZ Engine

- **M**ultimodal: Orchestrate AuthZ governance for multiple services
- **S**calable
- **C**ryptographically trustable, correct, and consistent
- **S**upports advanced logic and capabilities
- **C**ommon syntax and vocabulary to define governance rules
- **D**ecoupled and modular, yet connected with mutually understood logic

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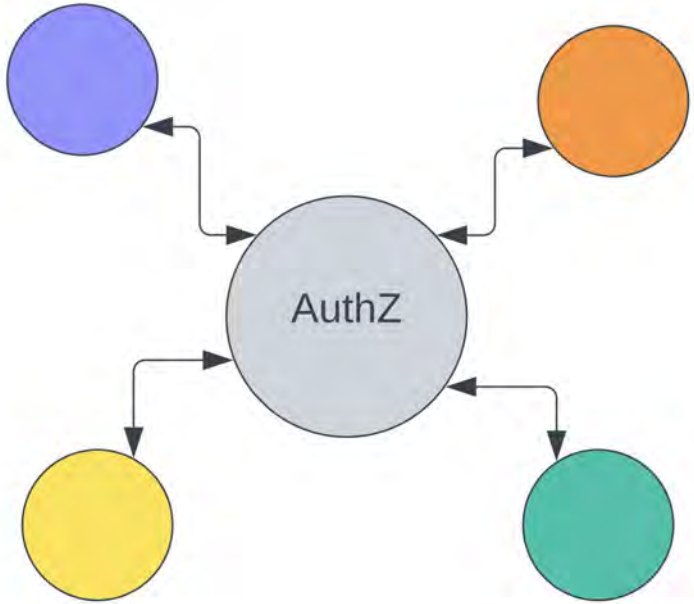
Multimodal: AuthZ Governance for Many Services

- Protects many types of resources from various services
- AuthZ engine runs as a decoupled network microservice
- Implementation should be generic and polymorphic
- Easily add or remove a service



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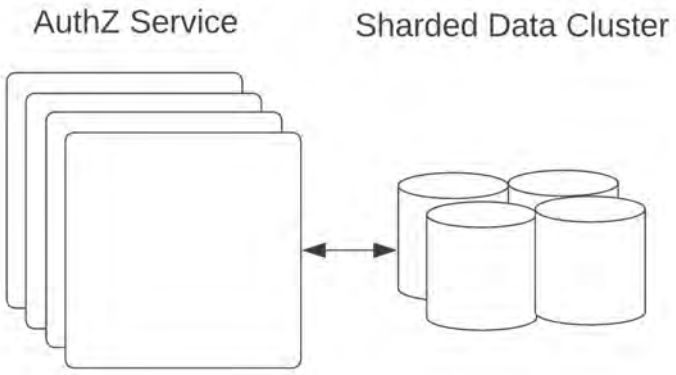
Scalable

- Able to serve a high volume of requests and rules
- Implies denormalized data at some point
- Informs the architecture of the infrastructure



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Cryptographically Trustable, Correct, and Consistent

- Signed claims to reduce required communication
  - JWT
  - Why? No need for client to ask multiple times
- TLS to ensure authentication, integrity, and privacy

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Supports Advanced Capabilities

- ABAC or RAdAC level logic complexity
- Permissions for the data are determined by the data itself, connections to external data, or connections to the subject
  - and the relationships within resource data

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Common Syntax and Lexicon to Define Governance Rules

- Declarative, not imperative
  - YAML or JSON
  - Custom DSL - Ruby would be great for this
  - Better for developing GUIs and for use by non-coders
- Common logic and behavior well abstracted and reusable
  - Use them as to not reinvent the wheel or produce Wet markup or code

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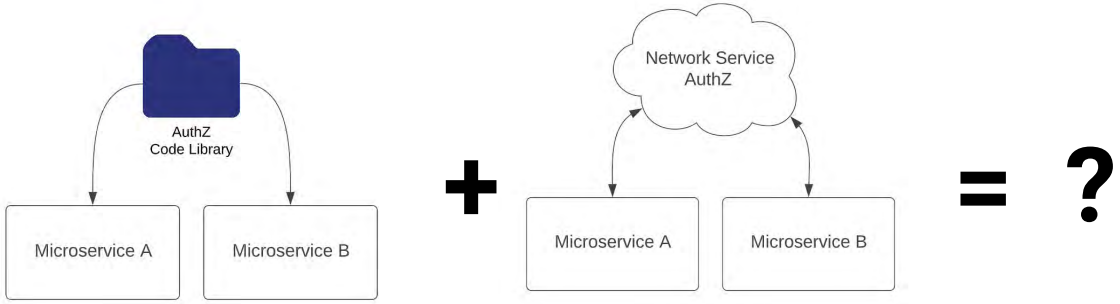
Decoupled and Modular, yet Connected with Mutually Understood Logic

- Boolean responses versus more nuanced responses and policy— The annoying subordinate problem
- Merging of shared library and network service architectures



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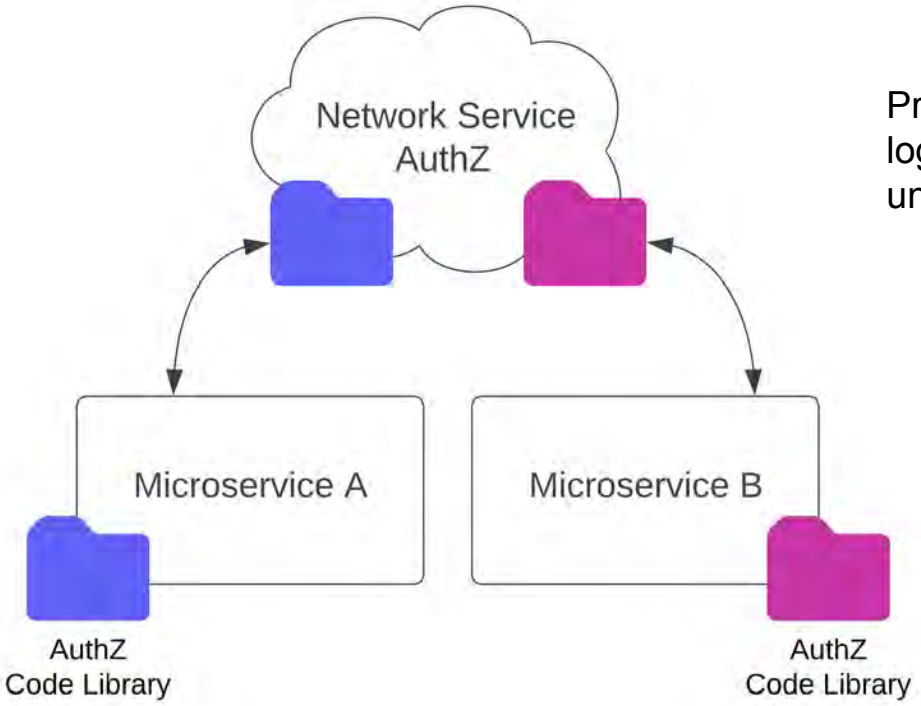
Hybrid: Network service w/ shared libraries



Protected resources and business logic permissions/policy shared and understood

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The Annoying Subordinate Problem

```
while ( true ) {
    prompt("Can I have a cookie?")
}
```

```
while ( true ) {
    prompt("Can I put this expense on my report?")
}
```

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The Annoying Subordinate Problem

Empower the requestor to make decisions using a well defined policy.
The requestor must be trusted to adhere to the policy.

prompt("Can I have a cookie?")

// yes, but it must be after you've eaten your dinner and it must be an oatmeal raisin cookie

prompt("Can I put this expense on my report?")

// Please stop asking me. You're using all of my time and energy to answer these questions. Please refer to the employee handbook for our policy on approved expenses

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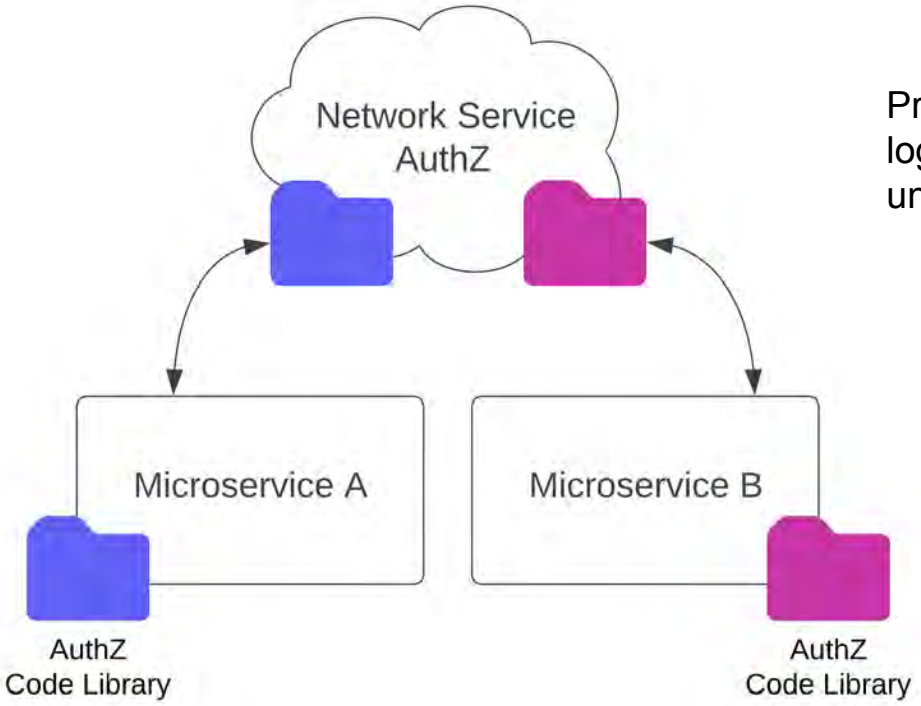
Hybrid: Network Service with Shared Libraries



Protected resources and business logic permissions/policy shared and understood

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Players in the Game

- Google Zanzibar
  - https://github.com/ory/keto
  - https://github.com/authzed/spicedb
  - https://github.com/authorizer-tech/access-controller
- Cloud provider IAM
- Gen3's Arborist
- BioTeam!

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Underlying Rule/Claim Transport Formats

XACML

JWT

PASETO

Open Information and Open Code

John believes the democratization of information and code:

Open

Accessible

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With Great Power, Comes Great Responsibility

- Responsibility is bidirectional: between the actors, and governance

- AuthZ shouldn't be used to restrict and oppress, should be used to protect

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Zero Sum Game

	Choice 1	Choice 2
Choice 1	–A, A	B, –B
Choice 2	C, –C	–D, D

Generic zero-sum game

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The End

Thanks For Listening!

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