Token Exchange

Keycloak's Secret Weapon for Platforms
Keycloak Dev Day 2025

Darmstadt, 06.03.2025

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About me

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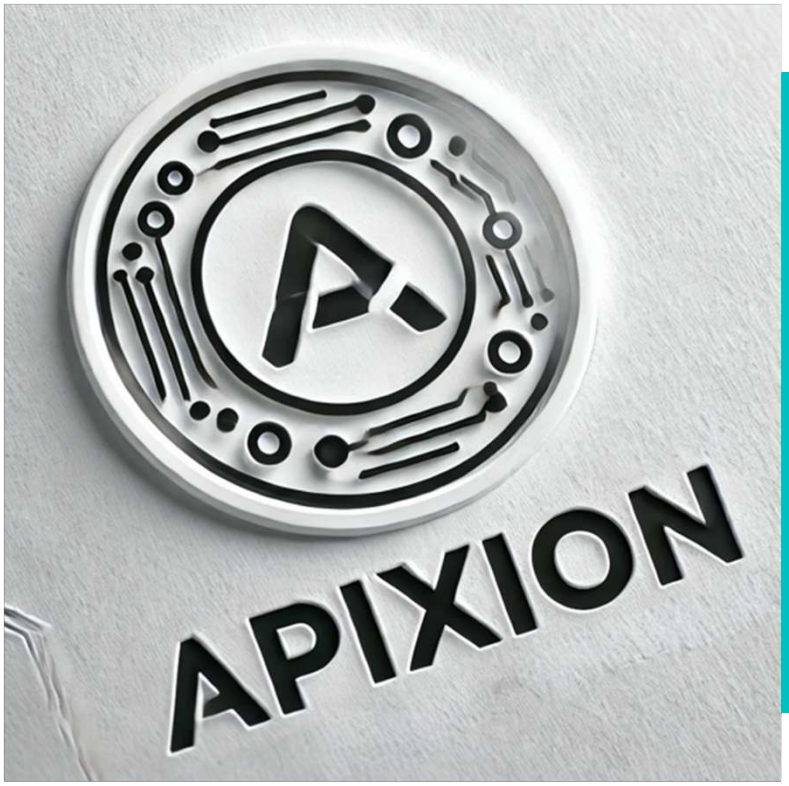
What is APIxion?



API Management
Providing Secure Access to internal and external APIs

Infrastructure as a Service
Enabling teams to provision and manage cloud-native resources.

CI/CD Automation
Streamlining deployment workflows for microservices and applications.

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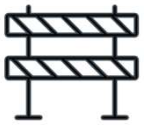
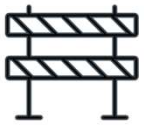
APIxion's Authentication Challenges



Microservices misused frontend user tokens

instead of having their own authentication

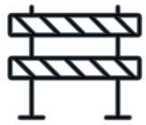
→ over-permissioned tokens



API keys were hardcoded into services

for external integrations

→ no clear delegation model



No clear access control

between internal services and across planes

→ increased the attack surface

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APIxion's Major Goals

Internal service-to-service authentication

without misusing user tokens

Secure external API access

without hardcoded credentials

Fine-grained permission control

with audience-restricted tokens

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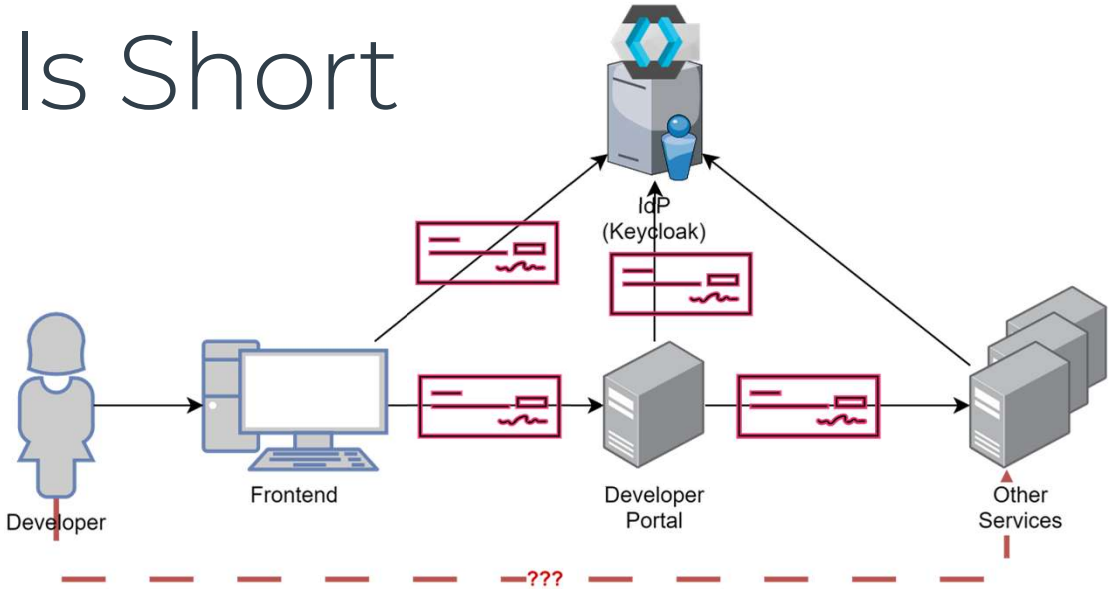
Where OAuth Falls Short (Delegation)



Forwarding the user's access token

This exposes scopes that backend services shouldn't have access to.

Using Client Credentials Grant (Service Account)

This issues a token for the backend service but doesn't retain the user's identity or permissions.

Stitching together both methods manually

This is cumbersome and error-prone, leading to security vulnerabilities and poor access control.

Poor-Man's Delegation & Why It Fails

🚨 This breaks security principles like least privilege and separation of concerns.


```
{
  "iss": "https://.../realms/apixion",
  "azp": "frontend",
  "sub": "developer-123@apixion",
  "aud": ["frontend","portal",
          "some-service"],
  "realm_access":{"roles":["user"]},
  "resource_access": {
    "frontend":{"roles":["user"]},
    "portal":{"roles":["admin"]},
    "some-service":{"roles":["viewer"]}
  }
}
```

01
Token Exchange

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Introducing Token Exchange RFC8693

User-to-Service Token Exchange

Securely exchange a user token for a backend service token.

Centralized API Token Management

Use a centrally managed API token to call external APIs.

Impersonation & Delegation

Act on behalf of another user or service, if permitted.

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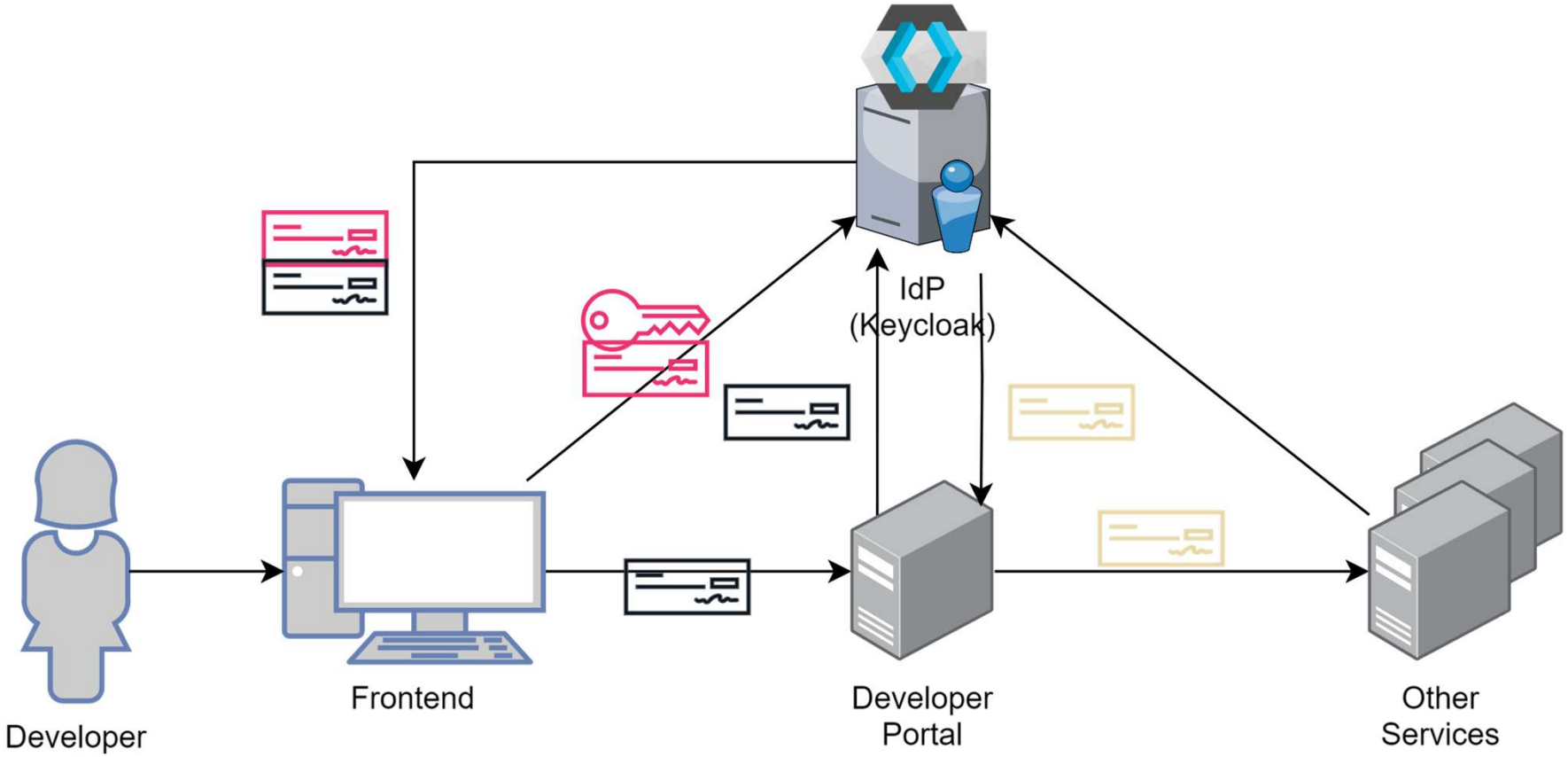
Token Exchange – How It Works



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02
Token Exchange in Keycloak

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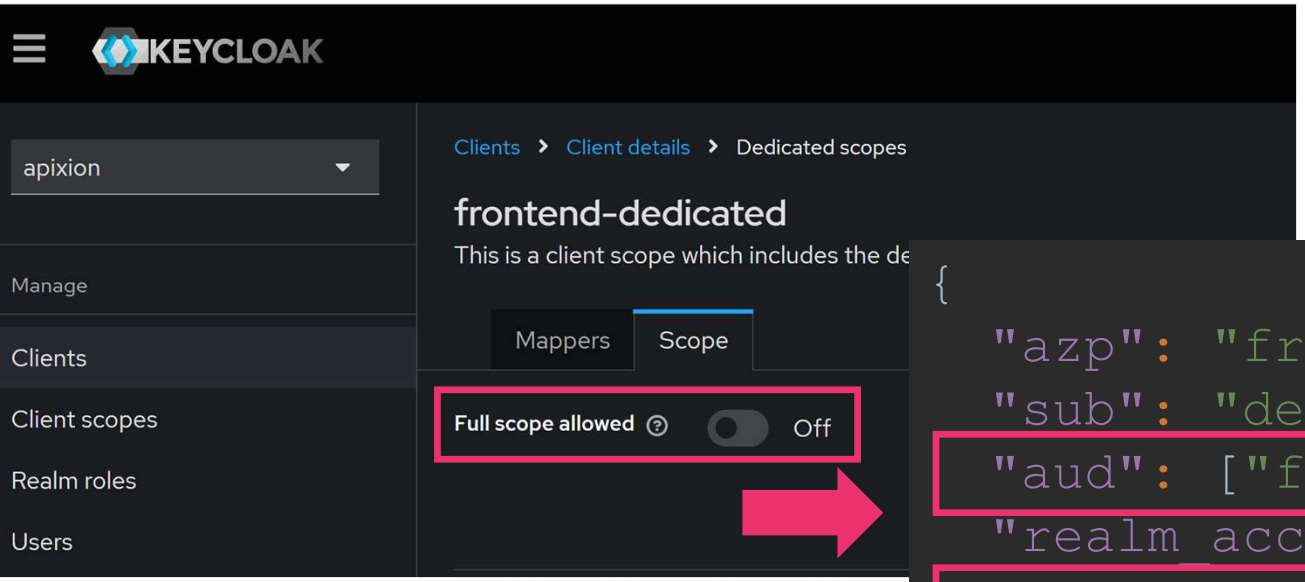
Restricting Full Scope for Clients




```
{
  "azp": "frontend",
  "sub": "developer-123@apixion",
  "aud": ["frontend"],
  "realm_access":{"roles":["user"]},
  "resource_access": {
    "frontend":{"roles":["user"]},
  },
  "iss": "https://.../realms/apixion"
}
```

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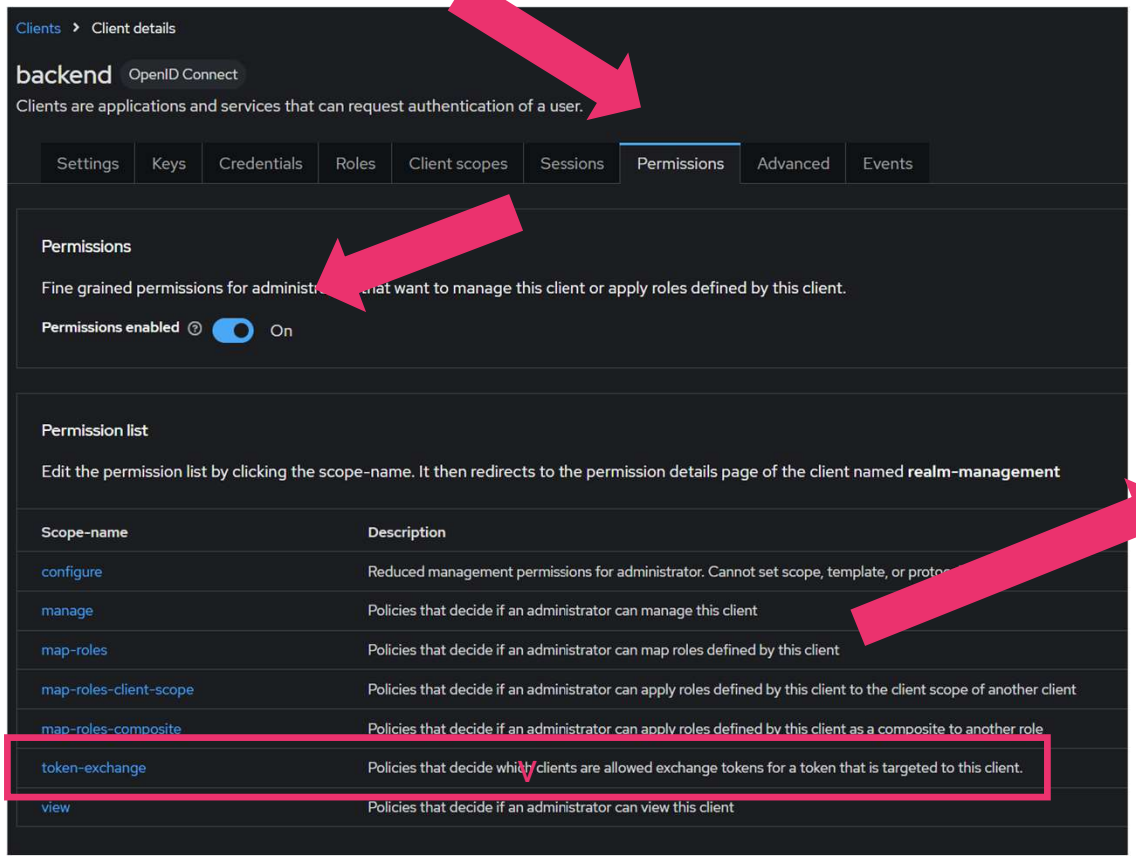
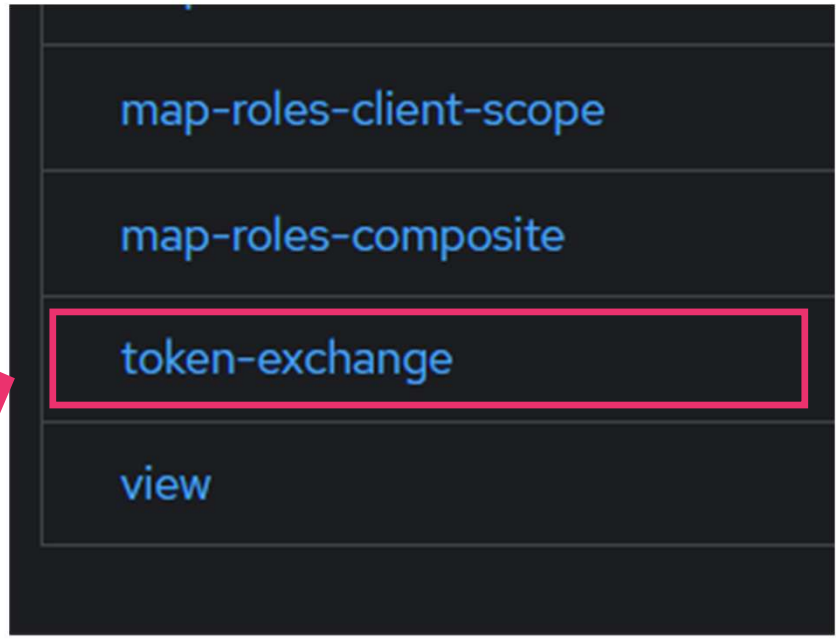
Configuring Token Exchange

```
services:
  keycloak:
    container_name: keycloak
    hostname: keycloak
    image: quay.io/keycloak/keycloak:26.1.3
    environment:
      KC_BOOTSTRAP_ADMIN_USERNAME: admin
      KC_BOOTSTRAP_ADMIN_PASSWORD: admin
      KC_FEATURES: token-exchange,fine-grained-authz
    command: ['start-dev']
    ports:
      - 8080:8080
```

Assigning Permissions





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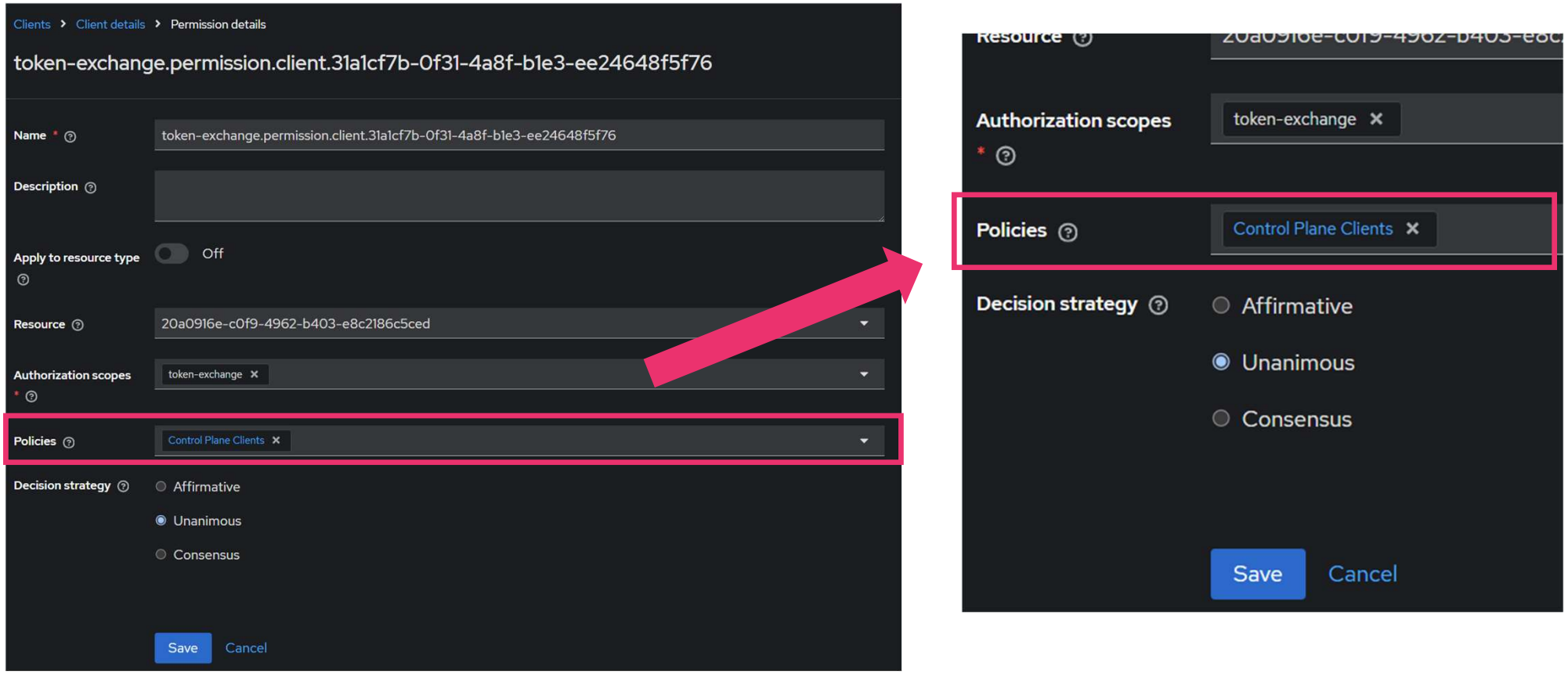
Assigning Permissions



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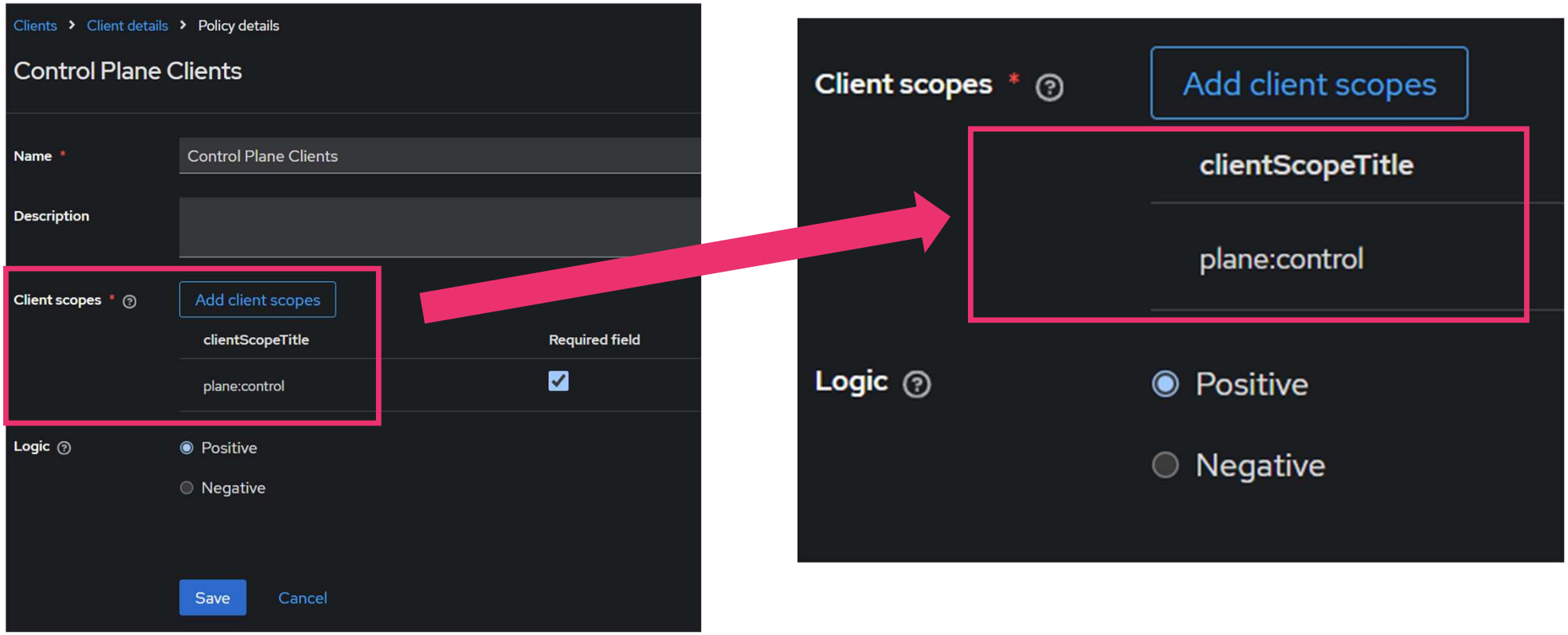
Assigning Permissions



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Performing a Token Exchange

```
POST /realms/apixion/protocol/openid-connect/token
HTTP/1.1
Host: keycloak.example.com
Content-Type: application/x-www-form-urlencoded
Authorization: Basic BASE64(client_id:client_secret)

grant_type=urn:ietf:params:oauth:grant-type:token-exchange
&subject_token=eyJhbGciOiJIUzI1NiIsInR5cCI...
&subject_token_type=urn:ietf:params:oauth:token-type:access_token
&requested_token_type=urn:ietf:params:oauth:token-type:access_token
&audience=some-backend-service
```

Token Exchange Response and Token Validation

```
{
  "iss": "https://.../realms/apixion",
  "azp": "portal",
  "sub": "developer-123@apixion",
  "aud": ["some-backend-service"],
  "realm_access": { "roles": ["user"] },
  "resource_access": {
    "some-backend-service": { "roles": ["viewer"] },
  }
}
```

03

Types of Token Exchange

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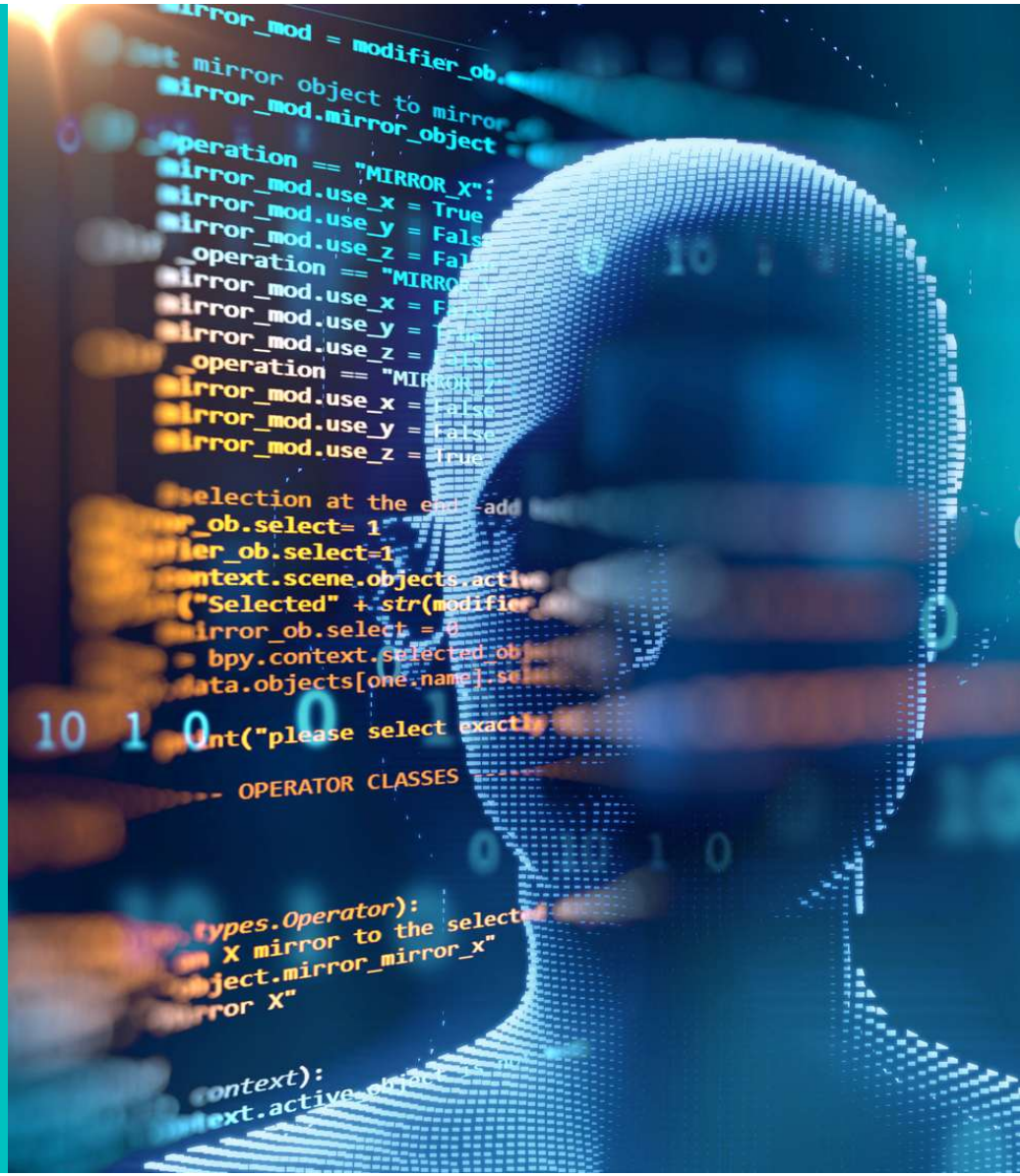
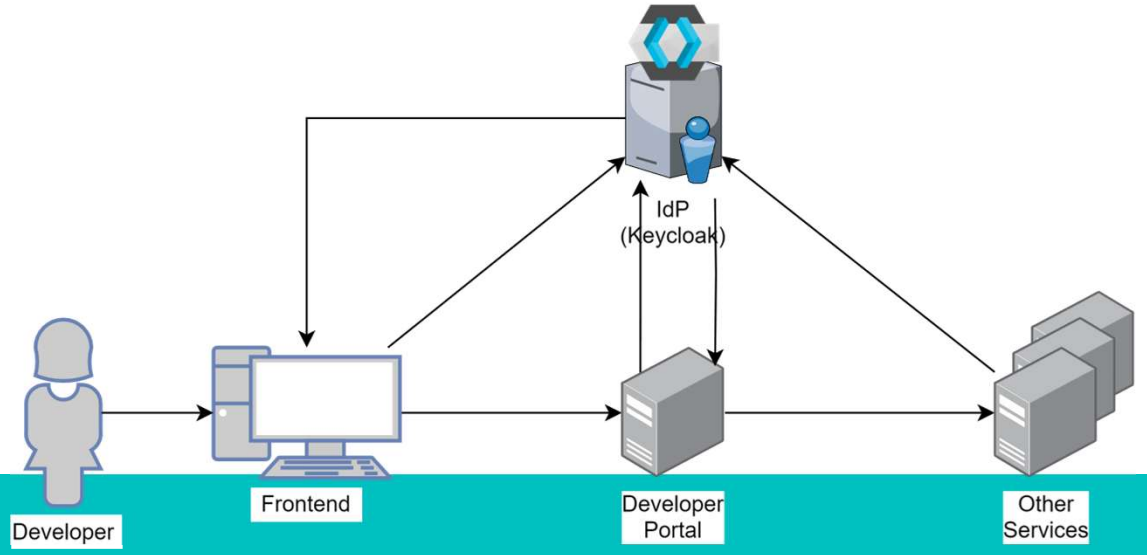


Internal-to-Internal Token Exchange



Step 1

The Frontend sends a request with a user token to Developer Portal.

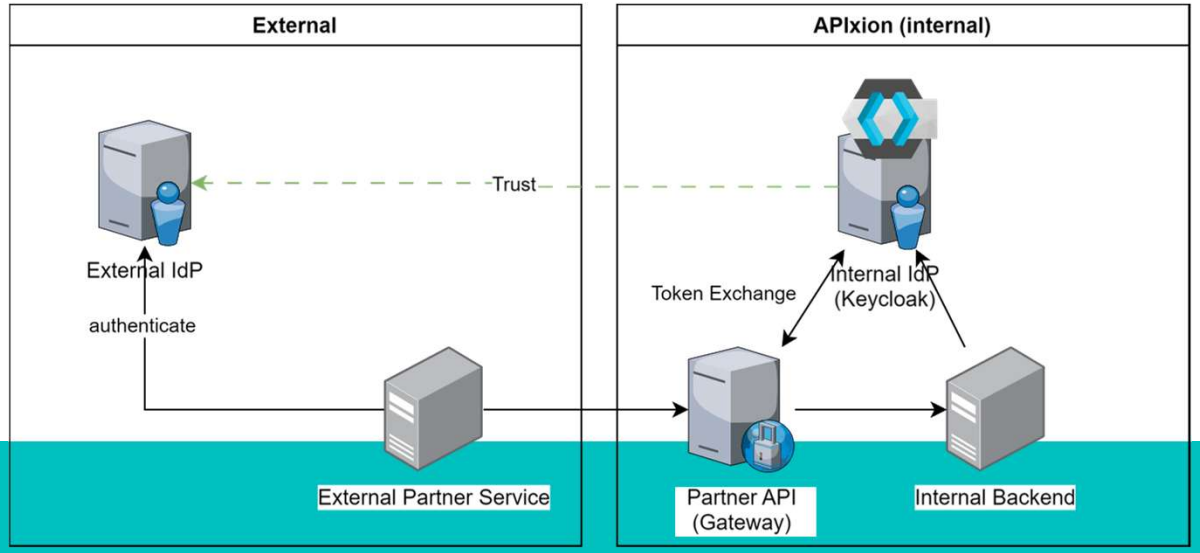
Step 2

Developer Portal exchanges the token for a new one meant for an Other Service.

Step 3

Developer Portal calls Other Service with the new token scoped for that service.

External-to-Internal Token Exchange



Step 1: Authentication

The external service authenticates with its **own IdP,** gets an external token, and calls an internal API Gateway.

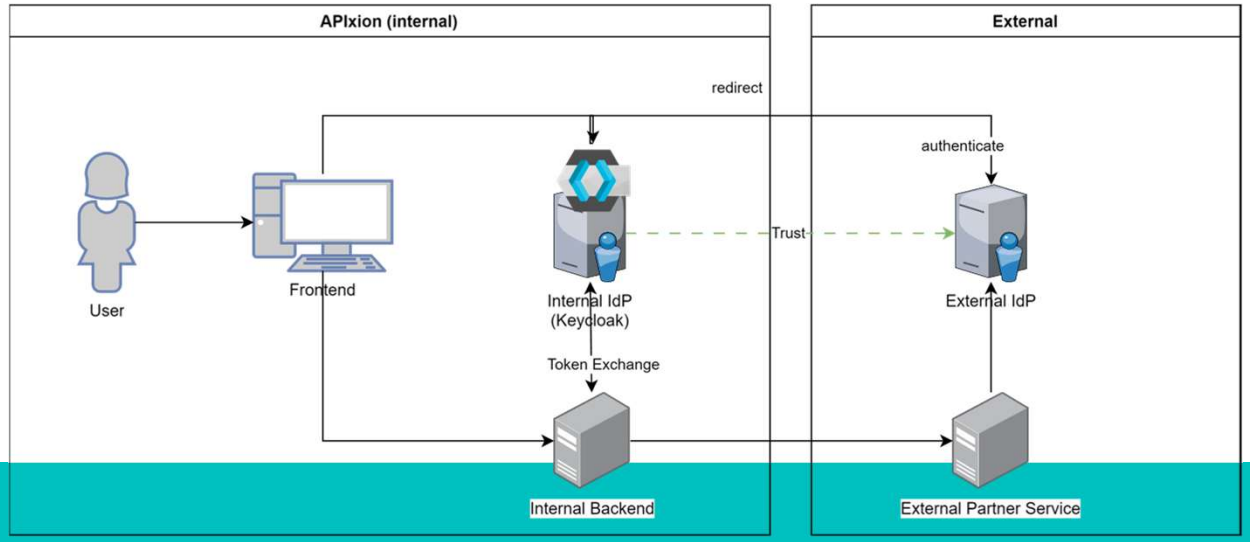
Step 2: Token Exchange

It exchanges the external token for a Keycloak token scoped for internal services.

Step 3: Service Request

It uses the new Keycloak-issued token to call the internal backend.

Internal-to-External Token Exchange



Step 1: Authentication

User authenticates to the internal and external IdP (identity provider federation)

Step 2: Forward Token

Internal backend receives a request from the frontend.

Step 3: Exchange Token

Backend exchanges it for a new token and calls the external API using the exchanged token.

04
Platforms

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Understanding Platform Planes

Control Plane: Manages orchestration, security policies, and infrastructure automation

Management Plane: Handles API gateways, service discovery, and centralized IAM.

Data Plane: Processes user traffic, application workloads, and storage operations.

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Examples of Platform Planes

Platform/Plane Type	 Control Plane	 Management Plane	 Data Plane
Cloud Providers	IAM, Policy Enforcement	API Gateway, Service Mesh	Compute & Storage
Service Meshes	Istio Pilot, Consul Control Servers	Authentication & Service Discovery (Keycloak, SPIRE)	Sidecar Proxies, API Traffic (Envoy, Linkerd proxy)
Enterprise SaaS	Tenant Management, Admin APIs	Identity Federation, API Security Policies	Tenant-Specific Applications & Data Stores

Planes, Trust Relationships, and Token Exchange

Trust Relationship	Example Use Case	Token Exchange Scenario
Control Plane → Management Plane	Multi-tenant SaaS platform managing identities across tenants.	A **Tenant Management Service** exchanges its control token for a **management token** to configure new identity providers in Keycloak.
Management Plane → Data Plane	API security enforcement for customer data.	An **API Gateway** exchanges its token for a **tenant-scoped token** before calling a customer's backend service.
Data Plane → Management Plane	Ensuring tenant microservices cannot escalate privileges.	A **tenant analytics dashboard** requests a **read-only token** to access metadata from APIxion's Service Registry.
Data Plane → Control Plane	Preventing tenant services from modifying platform configurations.	**Blocked by policy**—Tenant microservices are prevented from requesting control over platform-wide resources.

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Observability

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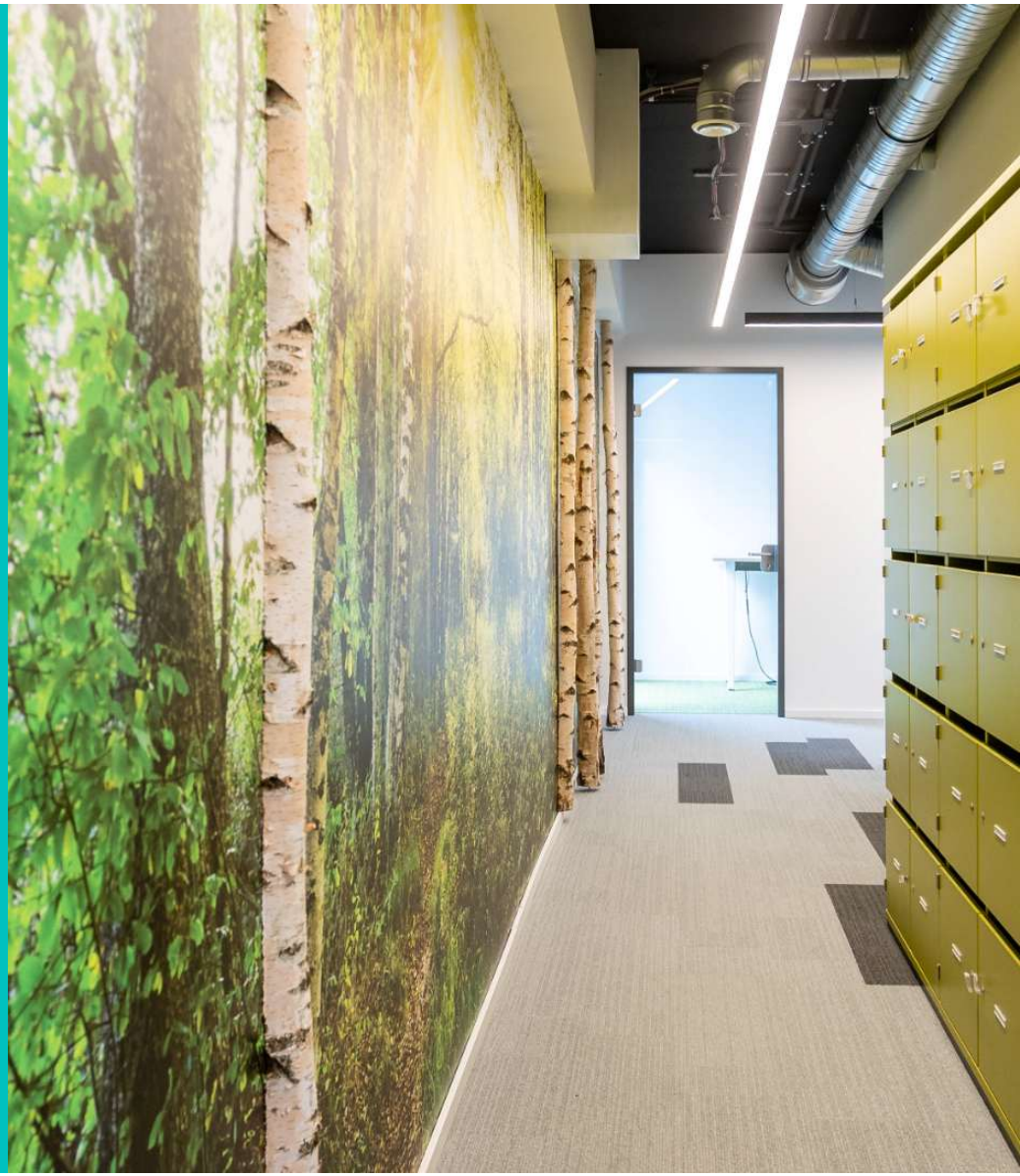
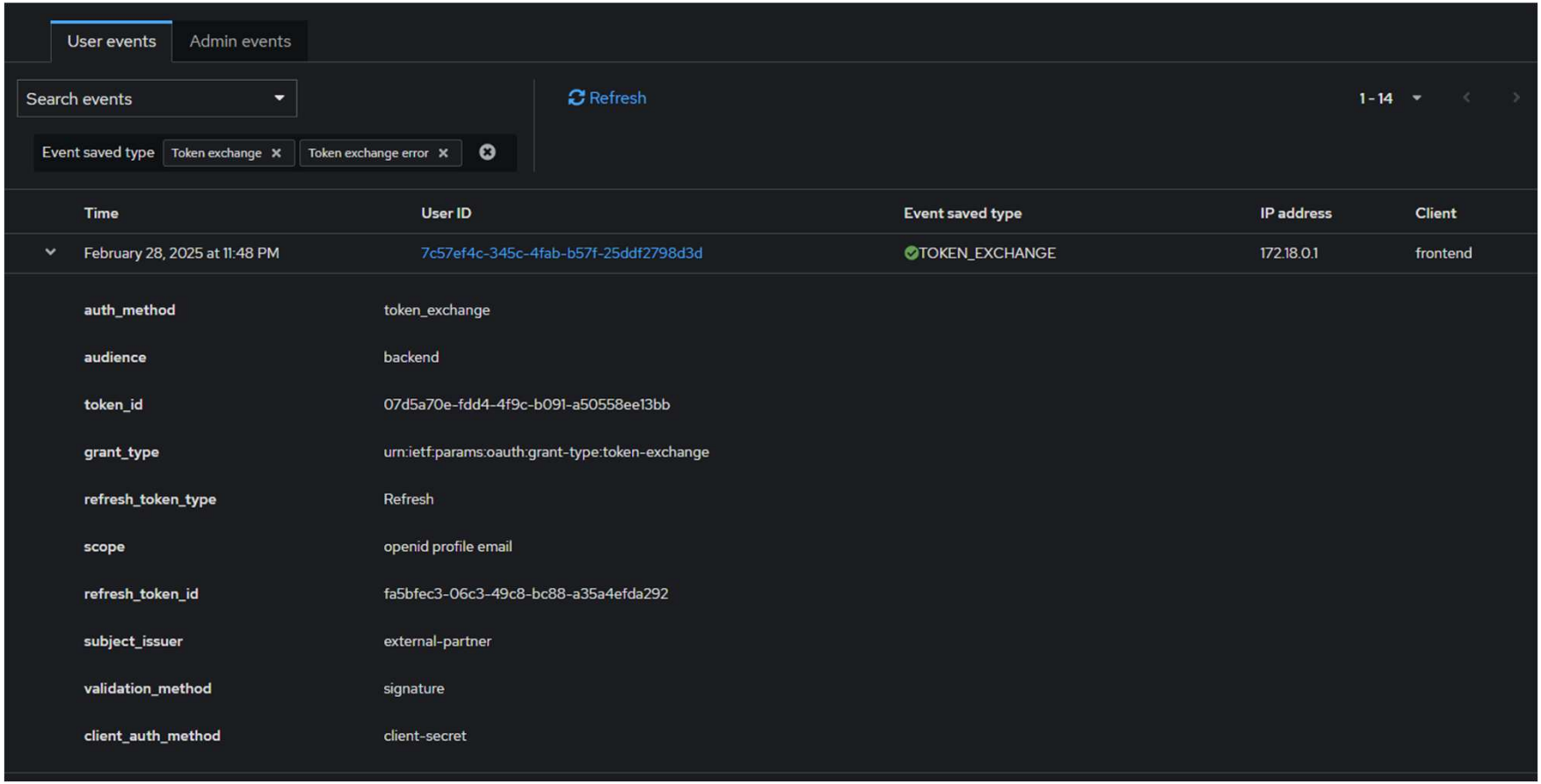


Audit Logs



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Monitoring – Logging

```
2025-02-28 23:10:15,414 WARN  [org.keycloak.events] (executor-thread-3)
    type="TOKEN_EXCHANGE_ERROR",
    realmId="c6311f0b-e87a-423c-84e2-74f2a8618b40", realmName="apixion",
    clientId="frontend", userId="null", ipAddress="172.18.0.1",
    error="not_allowed", reason="client not allowed to exchange to audience",
    auth_method="token_exchange",
    audience="backend",
    grant_type="urn:ietf:params:oauth:grant-type:token-exchange",
    client_auth_method="client-secret"
2025-02-28 23:10:57,757 DEBUG [org.keycloak.events] (executor-thread-15)
    type="TOKEN_EXCHANGE„
    realmId="c6311f0b-e87a-423c-84e2-74f2a8618b40", realmName="apixion",
    clientId="frontend",
    userId="2bf85a60-3488-40e8-828b-2fbd25086834",
    sessionId="08e191c7-f3d4-4499-9c86-a2adf091ed03", ipAddress="172.18.0.1",
    auth_method="token_exchange",
    audience="backend",
    ...
```

Monitoring – Event Metrics

```
curl -s https://keycloak/metrics
| grep 'event="token_exchange"'

keycloak_user_events_total{
    client_id="portal",
    error="",
    event="token_exchange",
    idp="",
    realm="apixion"} 15422.0
keycloak_user_events_total{
    client_id="portal",
    error="not_allowed",
    event="token_exchange",
    idp="",
    realm="apixion"} 38.0
```

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06
Takeaways

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How APIxion Uses Token Exchange

Frontend User Authentication → Internal API Access

The frontend receives a **user token** but exchanges it for a **backend-scoped token** before making API calls

Internal Service-to-Service Authentication

Services use **Token Exchange to request scoped tokens** instead of forwarding user credentials.

External API Integrations

When an internal API needs to call an **external service**, it exchanges its Keycloak-issued token for an **API-specific access token**

Platform Segmentation

APIxion **segregates trust between its Control, Management, and Data Planes**, ensuring **least privilege** at every level

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Best Practices on Platform-Level

Enforce Fine-Grained Permissions

Always configure **strict Token Exchange policies** per client. Do not allow unrestricted token exchange.

Disable Full Scope for Clients

Ensure clients/services only get the **minimal scopes** they need, preventing token misuse.

Use Audience Restrictions

Tokens should always have **specific target audiences** to prevent cross-service misuse.

Establish Clear Trust Boundaries

If your platform has **Planes**, define **explicit trust relationships** and enforce separation of concerns.

Monitor and Audit Token Usage

Regularly inspect logs and metrics for **unexpected token exchange requests** to detect misconfigurations or security threats

Limit Token Exchange Availability

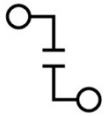
Not all clients should be able to exchange tokens—restrict it to **approved services only** via Keycloak permissions

Final Thoughts

Why Token Exchange is Key to Secure Platforms

Token Exchange is critical for modern platforms

It prevents Poor-Man's Delegation



It enforces trust and separation in a platform

It strengthens microservices, API security, and external integrations

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Q&A – Let’s Discuss

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