SPECTEROPS

Analyzing and Executing ADCS Attack Paths with BloodHound

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Agenda

- What is ADCS
- ADCS Components in BloodHound
- Demo Time!
- ADCS in BloodHound Enterprise

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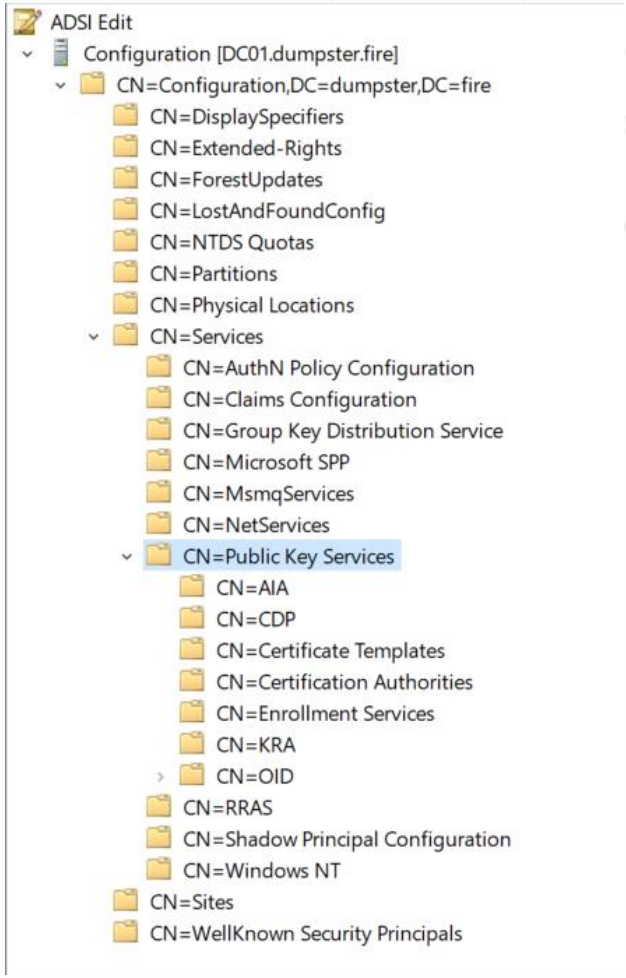
- BloodHound Enterprise Team @ SpecterOps

What is ADCS

Active Directory Certificate Services (ADCS)

What is ADCS

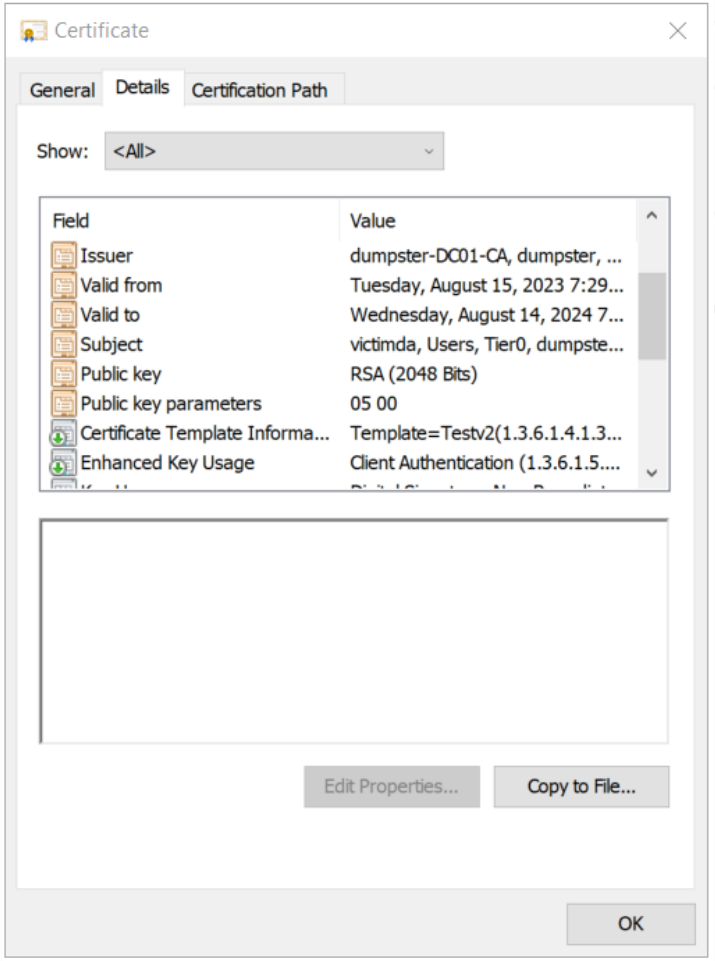
- Provides scalable Public Key Infrastructure (PKI)
- Used for issuing and managing digital certificates
- Located in the Public Key Services container



Digital certificate

What is ADCS

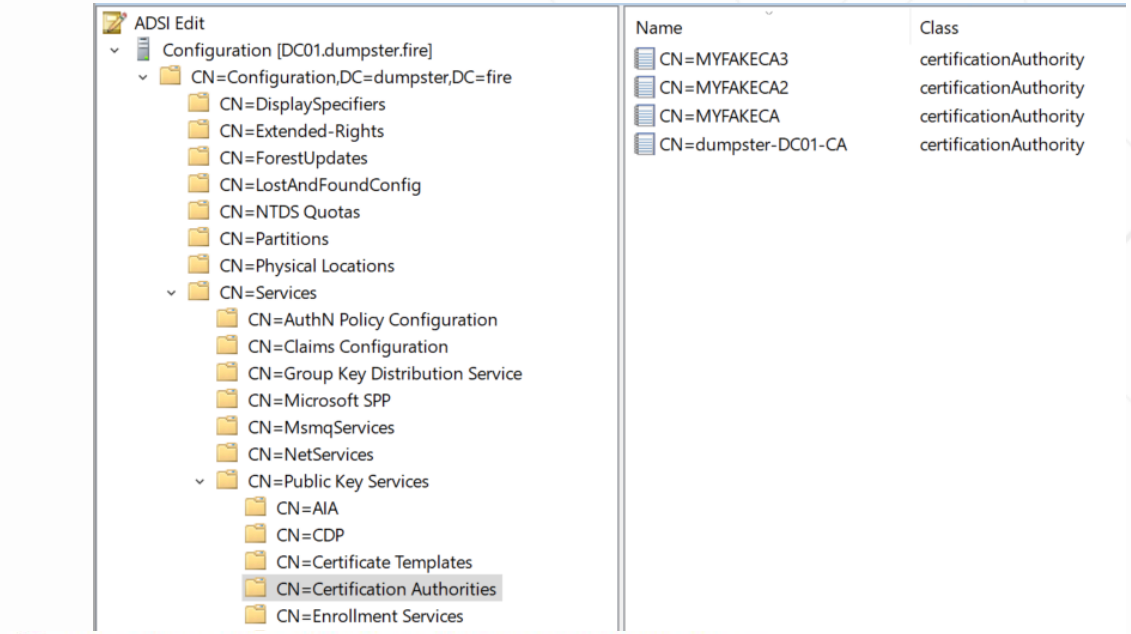
- Asymmetric cryptography (public and private key pair)
- Bound to a “Subject”
- Used for encryption, signing, and authentication
- Holds a certificate chain

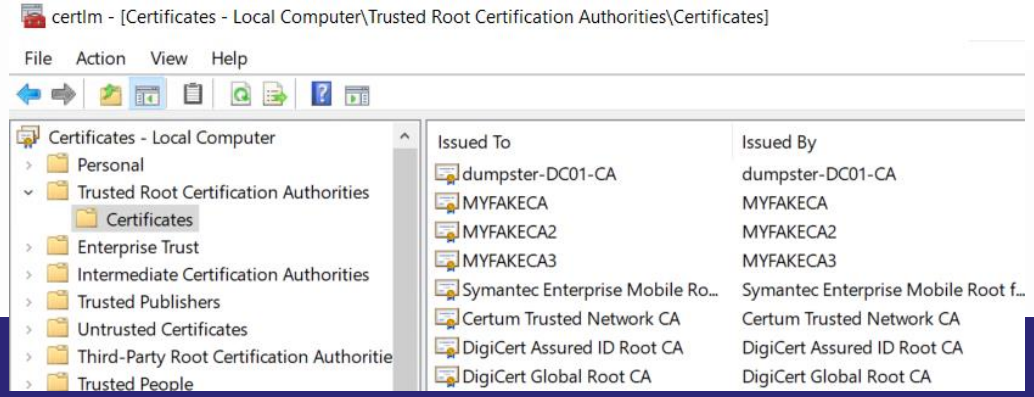


ADCS components – RootCA

What is ADCS

- Root Certificate Authority
- Self-signed certificate (no issuer)
- Trusted by all computers in the forest
- Issues Enterprise CA certificates

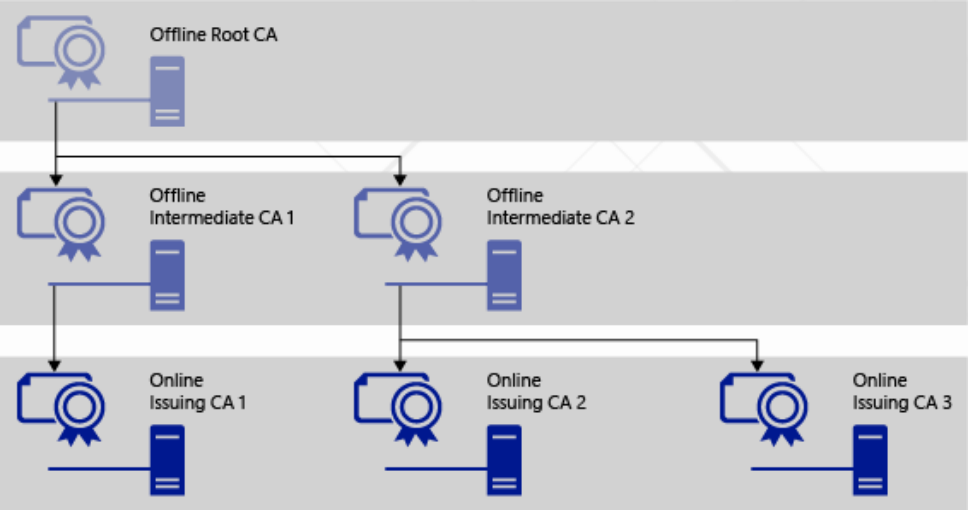


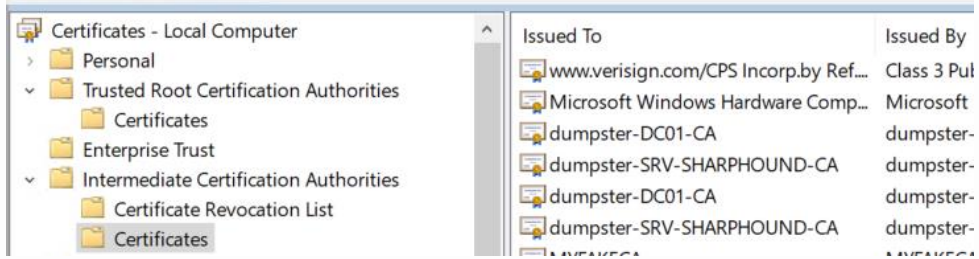


ADCS components – EnterpriseCA

What is ADCS

- Aka enrollment service
- Certificate chains up to a RootCA
- Intermediate CAs and Issuing CAs = EnterpriseCAs
- Located in the “Enrollment Services” container
- Trusted by all computers in the forest

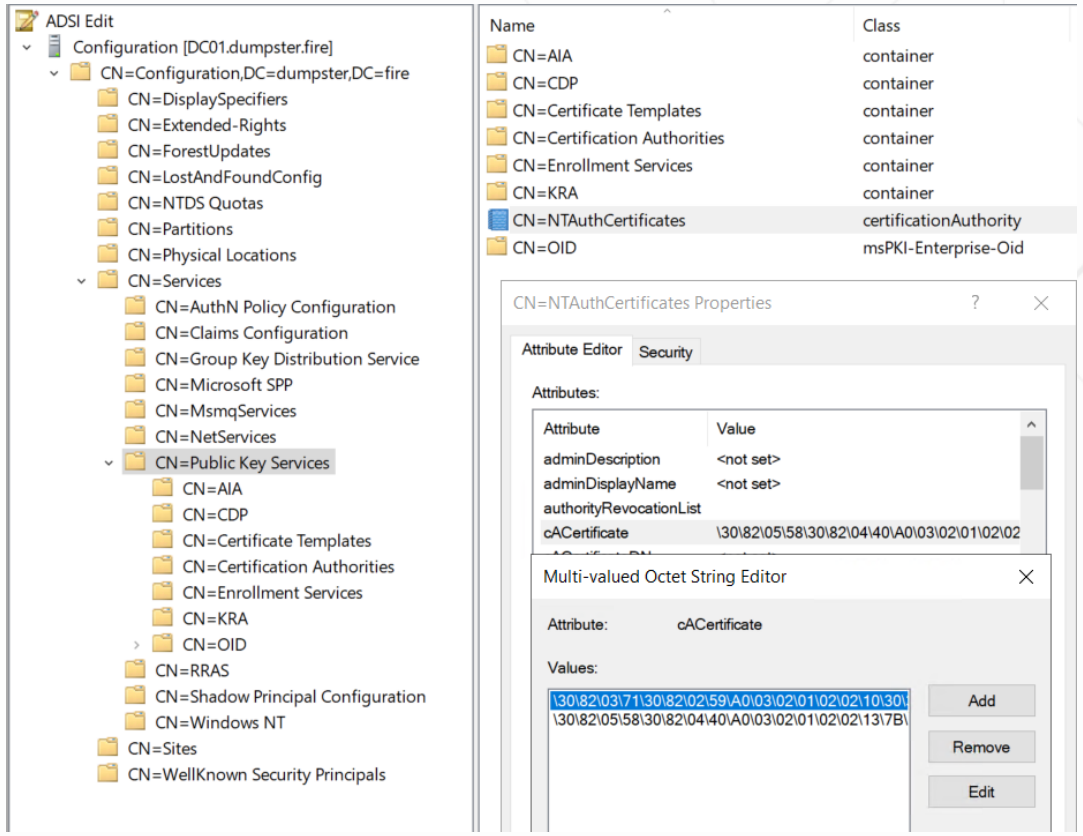




ADCS components – NTAuthStore

What is ADCS

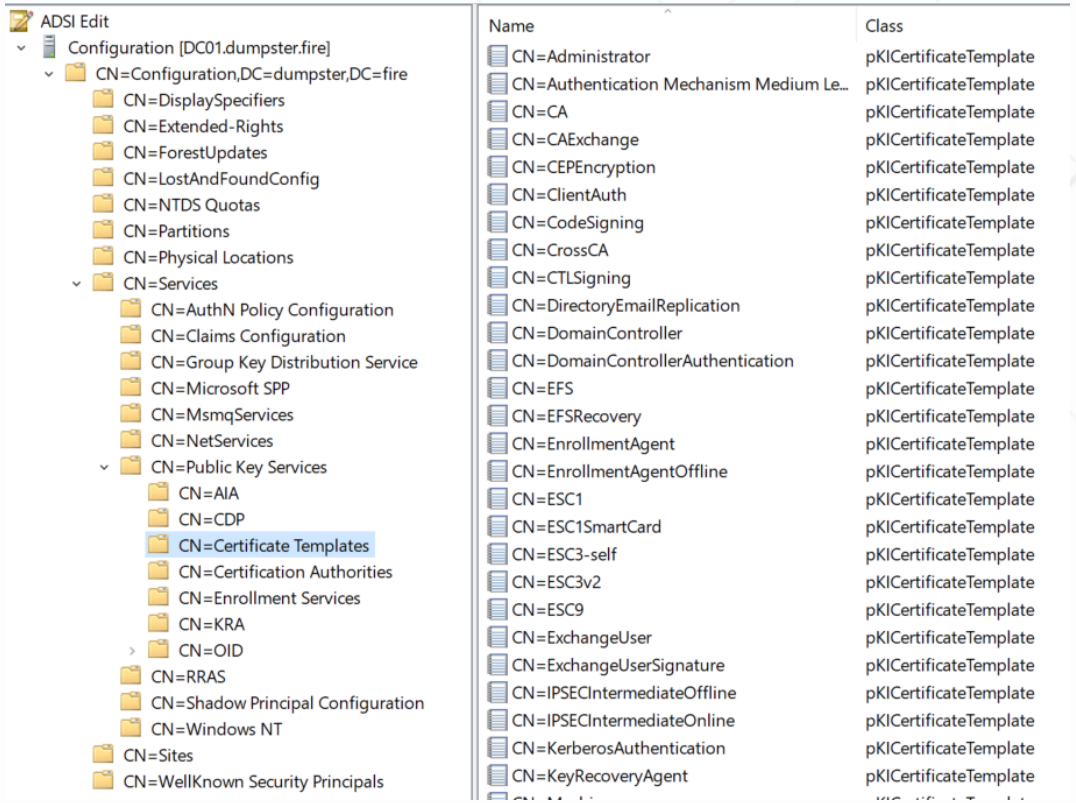
- EnterpriseCA must be trusted for *NT authentication*
- NTAuthCertificates object (aka *NTAuth store*)
- Replicated to the local NTAuth store on DCs



ADCS components – CertTemplate

What is ADCS

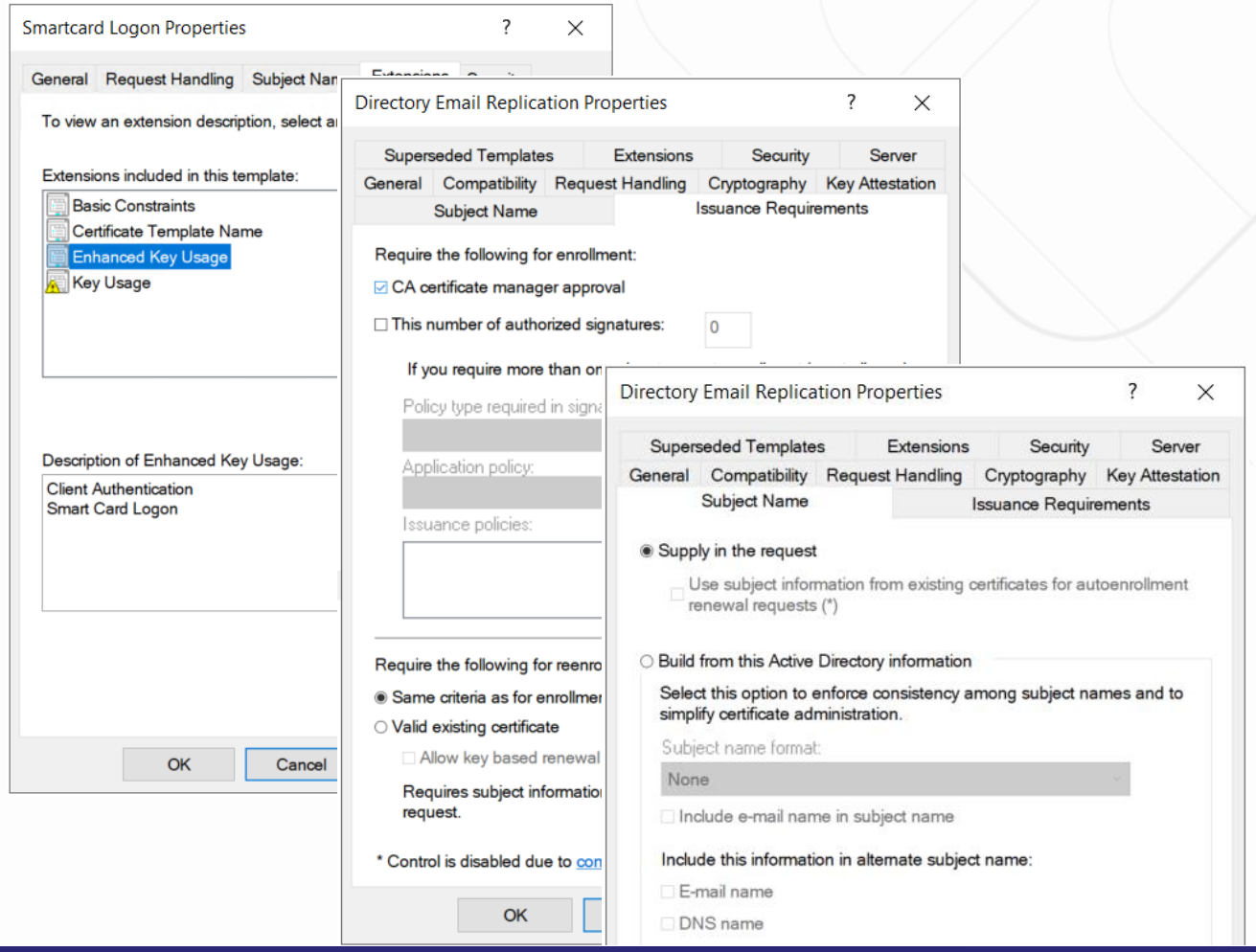
- Used for certificate enrollment requests
- Holds characteristics of a certificate
  - Certificate usage
  - Validity period
  - And more..
- Published by EnterpriseCAs



ADCS components – CertTemplate

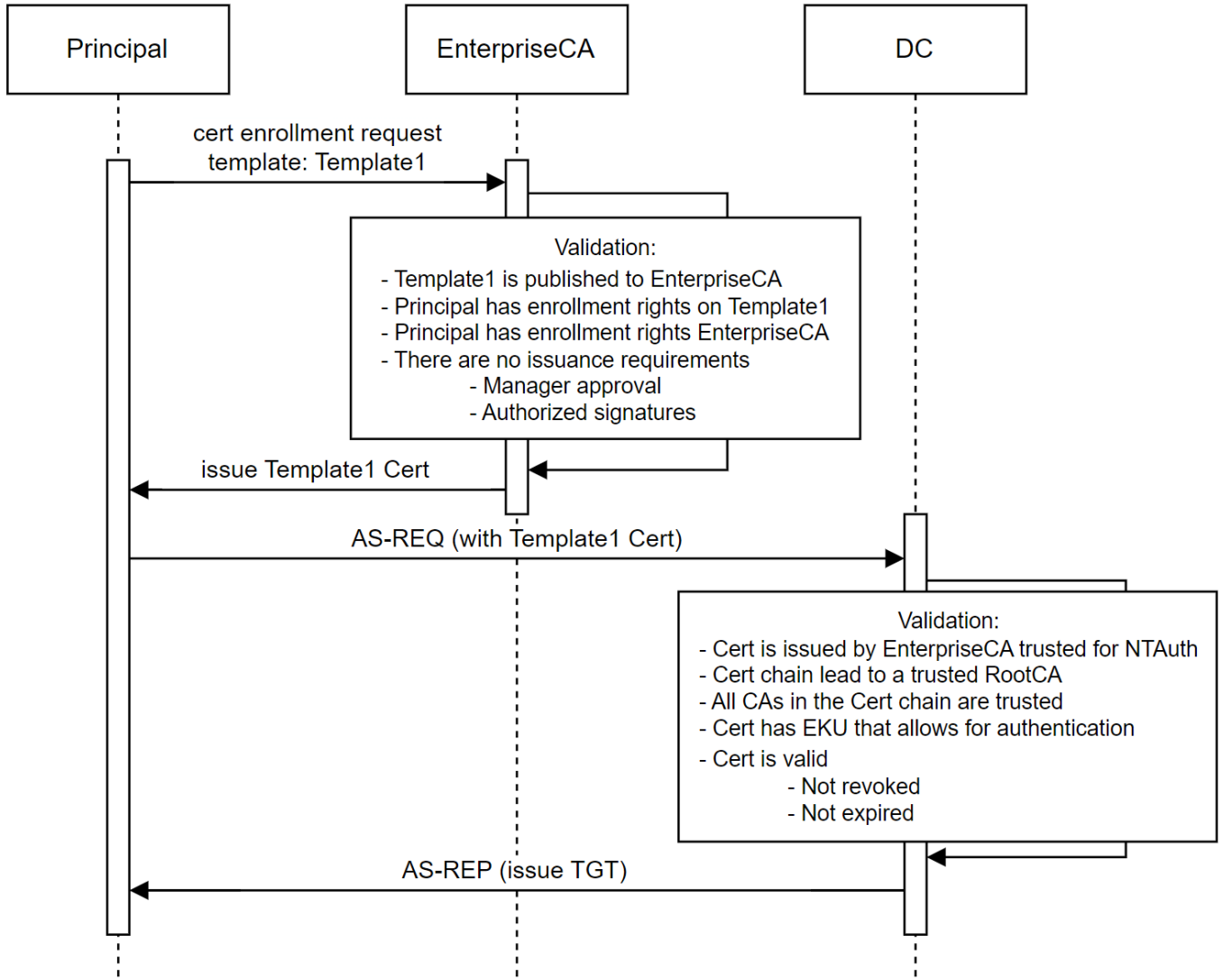
What is ADCS

- Enhanced Key Usage (EKU)
  - Client Authentication (1.3.6.1.5.5.7.3.2)
  - PKINIT Client Authentication (1.3.6.1.5.2.3.4)
  - Smart Card Logon (1.3.6.1.4.1.311.20.2.2)
  - Any Purpose (2.5.29.37.0)
  - SubCA (no EKUs)
- Issuance requirements
  - Manager approval
  - Authorized signatures
- ENROLLEE_SUPPLIES_SUBJECT flag
  - Enroll as anyone 🔥



Enrollment and authentication process (simplified)

What is ADCS



ADCS Components in BloodHound

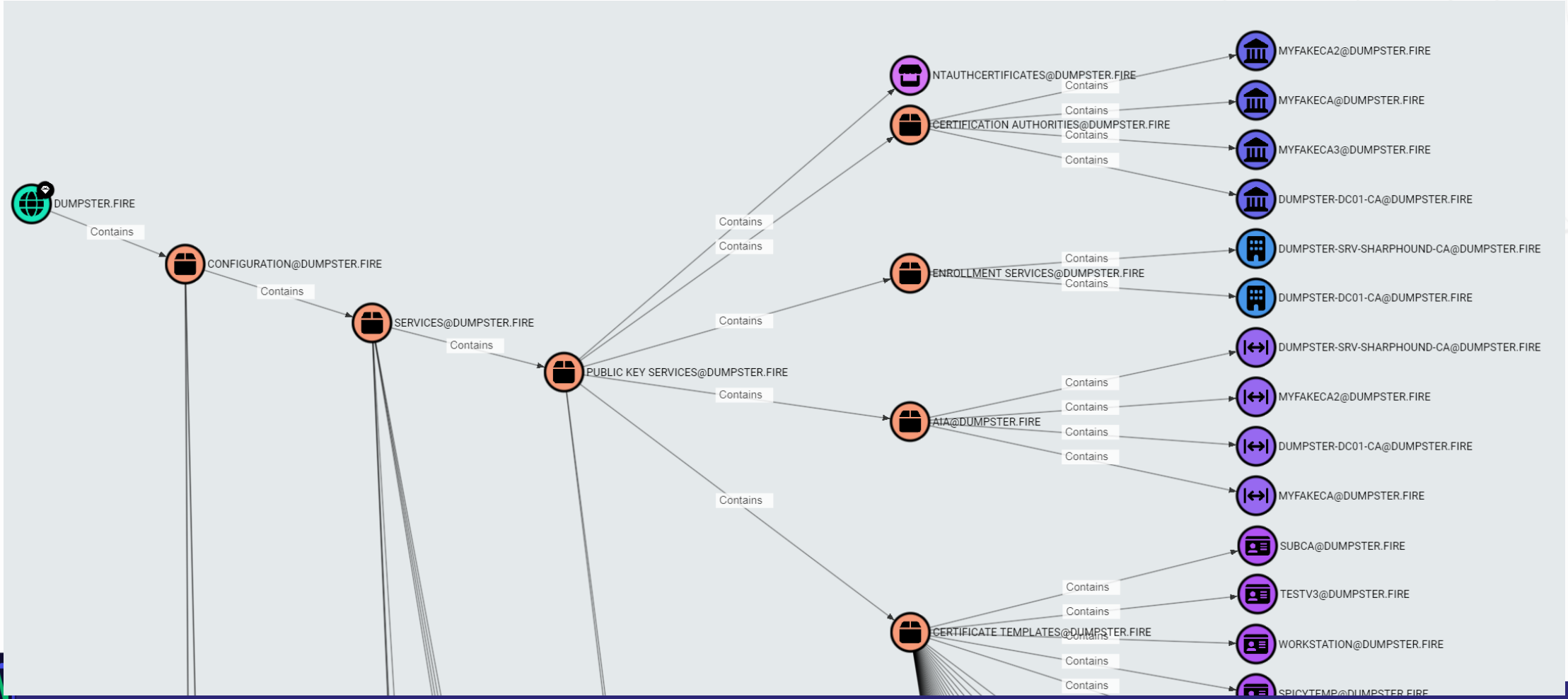
New node types

ADCS components in BloodHound

- AIACAs
- RootCAs
- EnterpriseCAs
- NTAuthStores
- CertTemplates

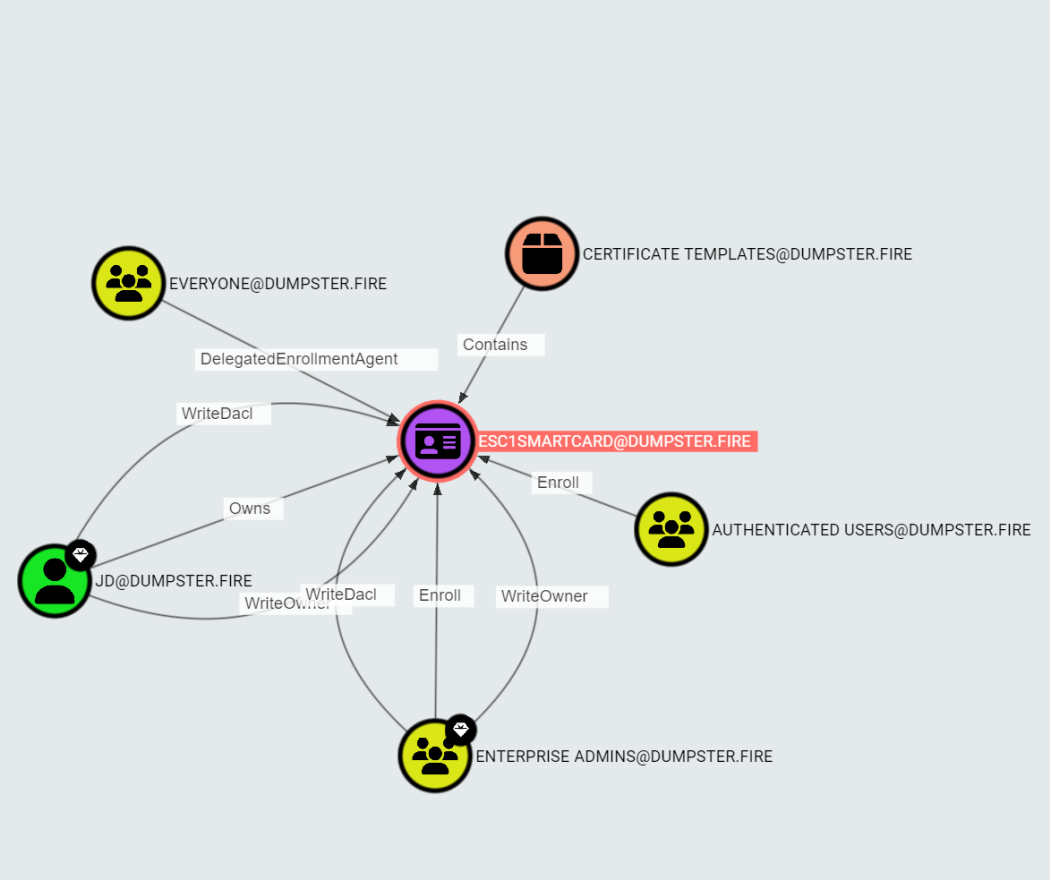
New node types

ADCS components in BloodHound



New node types

ADCS components in BloodHound



ESC1SMARTCARD@DUMPSTER.FIRE

Display Name:	ESC1SmartCard
Object ID:	8482B82C-4103-43BA-B530-409A2C763965
Authentication Enabled:	TRUE
Authorized Signatures Required:	0
Certificate Application Policies:	1.3.6.1.4.1.311.20.2.2
Certificate Name Flags:	ENROLLEE_SUPPLIES_SUBJECT, ENROLLEE_SUPPLIES_SUBJECT_ALT_NAME
Created:	2023-10-19 07:19 GMT+2 (GMT+0200)
Distinguished Name:	CN=ESC1SMARTCARD,CN=CERTIFICATE TEMPLATES,CN=PUBLIC KEY SERVICES,CN=SERVICES,CN=CONFIGURATION,DC=DUMPSTER,DC=FIRE
Domain FQDN:	DUMPSTER.FIRE
Domain SID:	S-1-5-21-2697957641-2271029196-387917394
Effective EKUs:	1.3.6.1.4.1.311.20.2.2
Enhanced Key Usage:	1.3.6.1.4.1.311.20.2.2
Enrollee Supplies Subject:	TRUE
Enrollment Flags:	PUBLISH_TO_DS
Last Collected by BloodHound:	2023-11-27 18:06 GMT+1 (GMT+0100)
No Security Extension:	FALSE
OID:	1.3.6.1.4.1.311.21.8.4571196.1884641.3293620.10686285.12068043.134.1116501.10660743
Renewal Period:	6 weeks
Requires Manager Approval:	FALSE
Schema Version:	2
Subject Alternative Name Require UPN:	FALSE
Validity Period:	1 year

New node types

ADCS components in BloodHound

CertTemplate – BloodHound

support.bloodhoundenterprise.io/hc/en-us/articles/22454652589083-CertTemplate

BloodHound Support

Search

Submit a request

Sign in

- AZGroup
- AZKeyVault
- AZLogicApp
- AZManagedCluster
- AZManagementGroup
- AZResourceGroup
- AZRole
- AZServicePrincipal
- AZSubscription
- AZTenant
- AZUser
- AZVM
- AZVMScaleSet
- AZWebApp
- CertTemplate
- Computer
- Domain

Entity Panel	Database	Directory	Description
Display Name	displayname	displayName	The display name of the object.
Object ID	objectid	objectGUID	The object's unique identifier in the directory.
ACL Inheritance Denied	isaclprotected	nTSecurityDescriptor	Whether inherited permissions (ACEs) from containers are blocked on this object.
Application Policies	applicationpolicies	msPKI-RA-Application-Policies	The required RA application policy EKU in the counter signatures of certificate requests.
Authentication Enabled	authenticationenabled	-	Whether the certificate can be used for authentication. See this blog post for more details on how it is calculated: https://posts.specterops.io/adcs-attack-paths-in-bloodhound-part-1-799f3d3b03cf
Authorized Signatures Required	authorizedsignatures	msPKI-RA-Signature	Specifies the number of enrollment registration authority signatures that are required in an enrollment request.
Certificate Application Policies	certificateapplicationpolicy	msPKI-Certificate-Application-Policy	List of EKUs that might go into issued certificates (see Effective EKUs).

New non-traversable edges

ADCS components in BloodHound

- RootCAFor
- EnterpriseCAFor
- NTAuthStoreFor
- PublishedTo
- ManageCertificates
- ManageCA
- DCFor
- CanAbuseUPNCertMapping
- CanAbuseWeakCertBinding
- Enroll
- HostsCAService
- WritePKIEnrollmentFlag
- WritePKINameFlag
- IssuedSignedBy
- EnrollOnBehalfOf
- DelegatedEnrollmentAgent
- TrustedForNTAuth

What is a non-traversable edge?

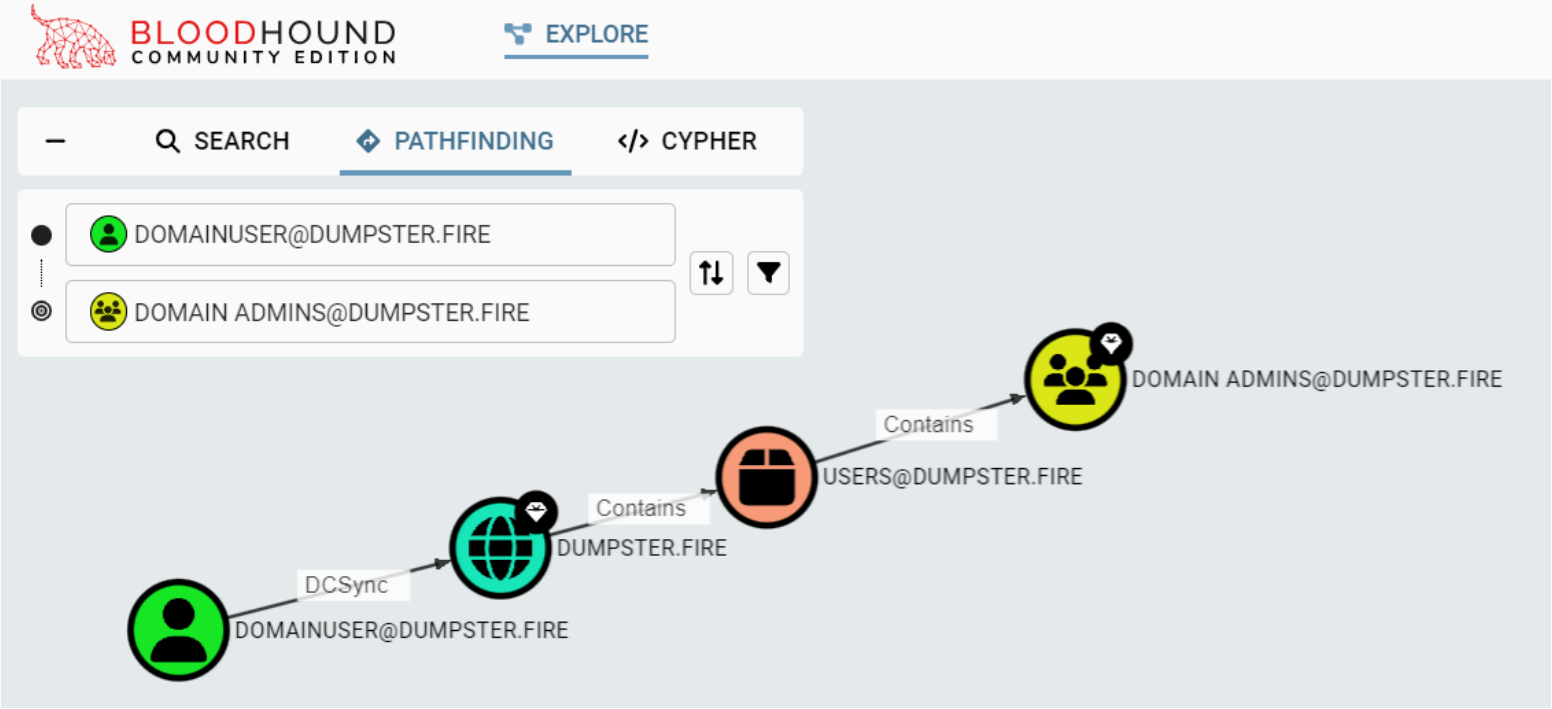
ADCS components in BloodHound

- Privileges and relationships that are not abusable on their own
- Excluded from path-finding
- Used to construct abusable (traversable) edges
- Example: GetChanges + GetChangesAll = DCSync

What is a non-traversable edge?

ADCS components in BloodHound

- Example: GetChanges + GetChangesAll = DCSync



What is a non-traversable edge?

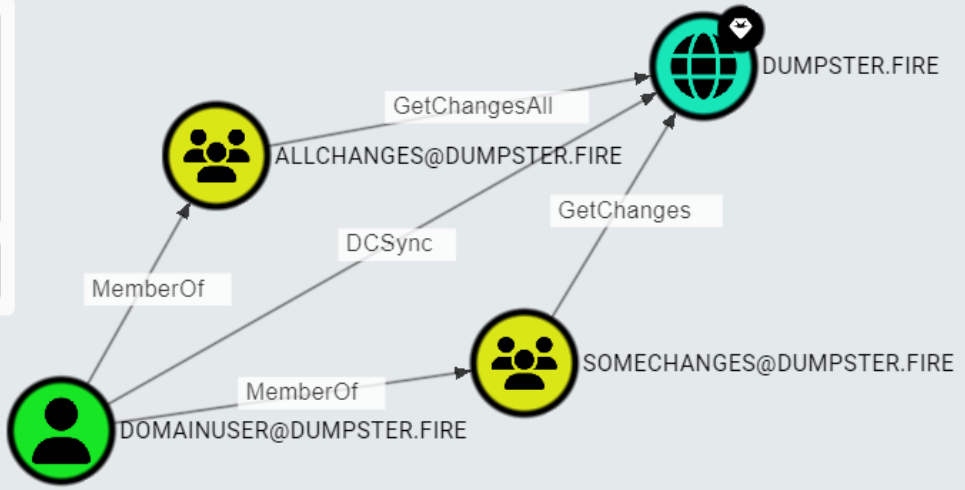
ADCS components in BloodHound

- Example: GetChanges + GetChangesAll = DCSync

SEARCH | PATHFINDING | CYPHER

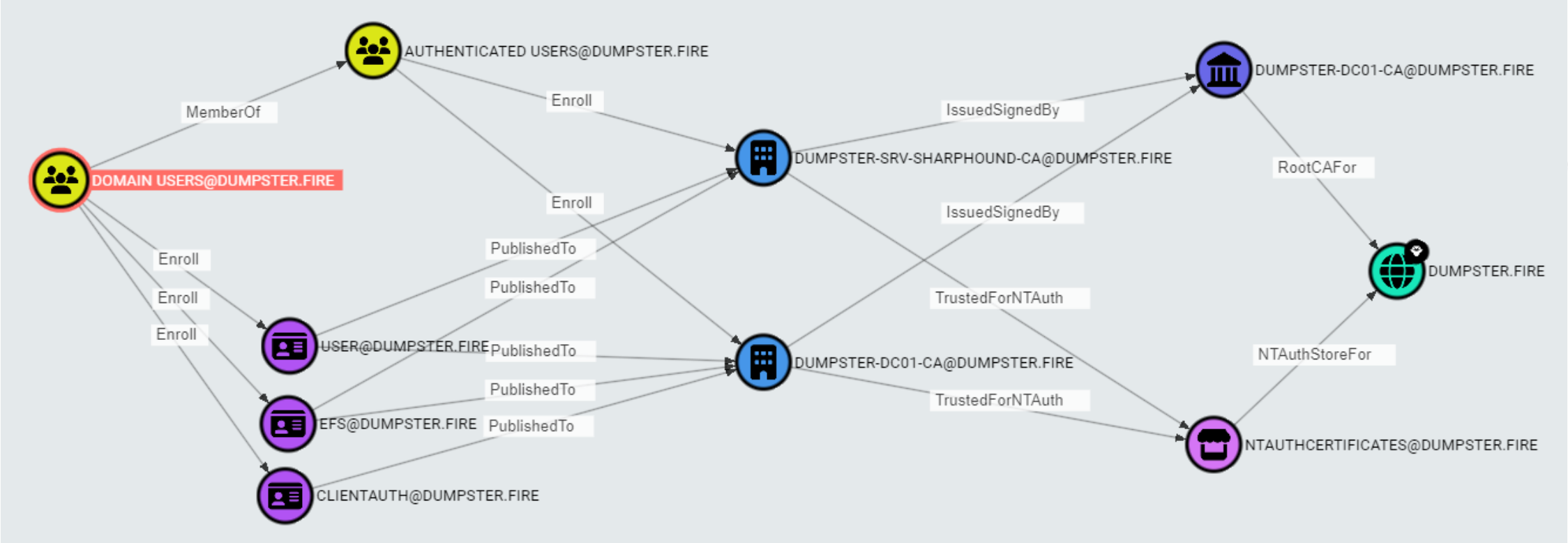
```
MATCH p=(u)-[:MemberOf*0..]->()-[:DCSync|GetChanges|GetChangesAll]->(:Domain)
WHERE u.name = "DOMAINUSER@DUMPSTER.FIRE"
RETURN p
```

SAVE QUERY | HELP | SEARCH



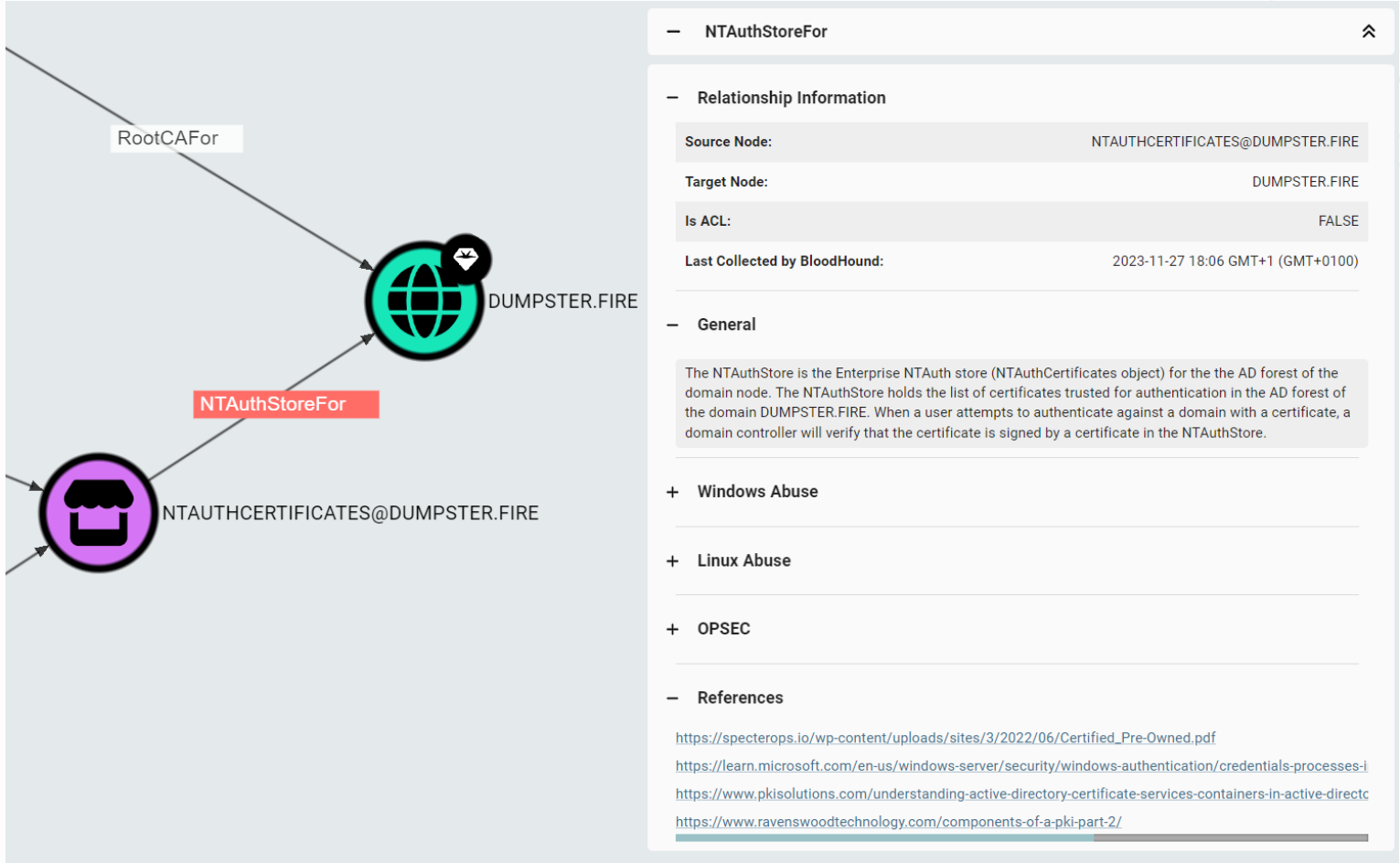
New non-traversable edges

ADCS components in BloodHound



New non-traversable edges

ADCS attack paths in BloodHound

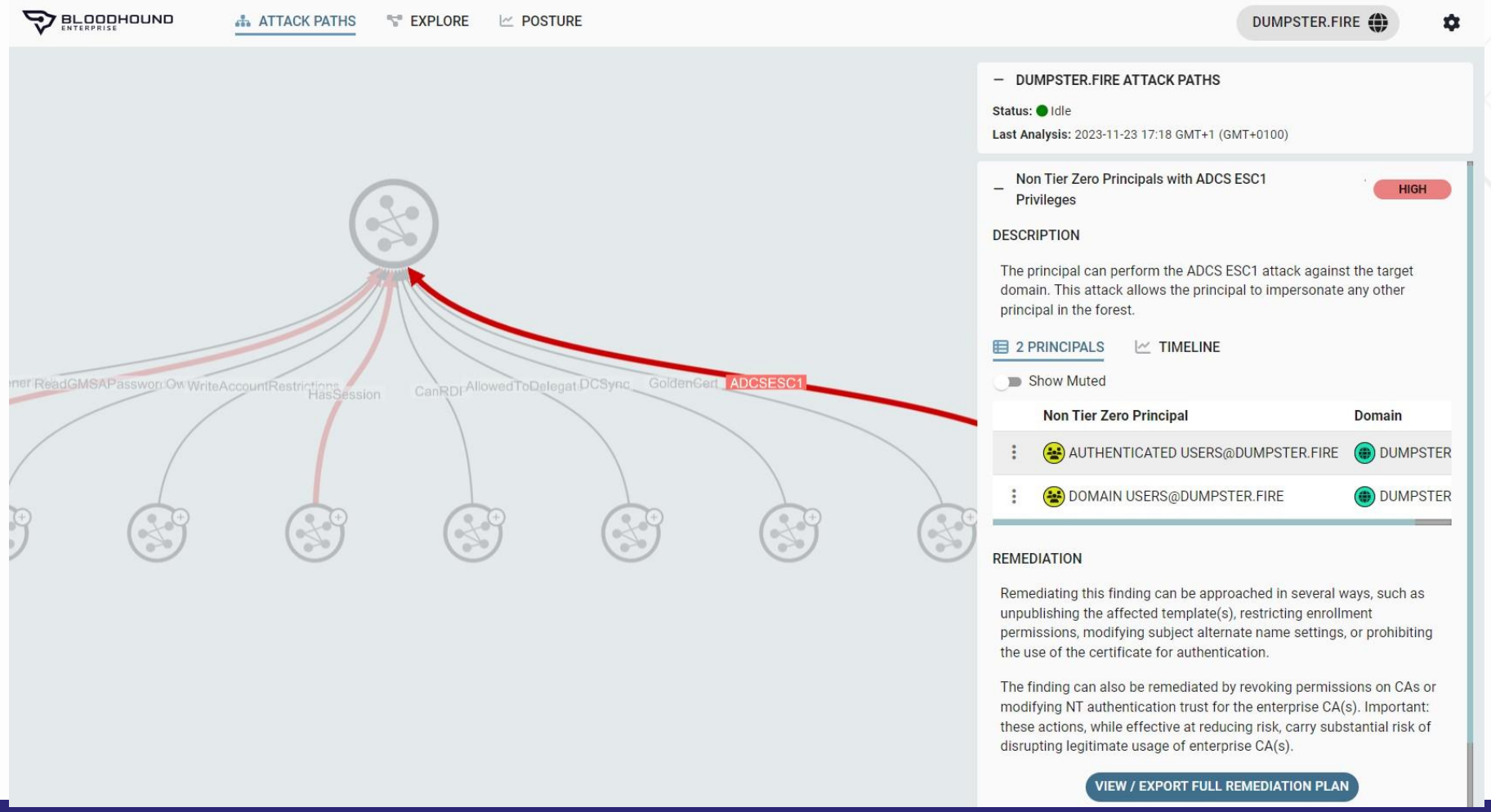


Demo Time!

ADCS in BloodHound Enterprise

New findings

ADCS attack paths in BloodHound



New remediations

ADCS attack paths in BloodHound

Non Tier Zero Principals with ADCS ESC1 Privileges

Recommended Remediation

We advise gaining a clear understanding of the intended use of the certificate templates to determine the most suitable remediation approach. This can be achieved through an evaluation of existing certificates and authentication logs, as outlined in the Certified Pre-Owned ADCS whitepaper sections:

- Monitor User/Machine Certificate Enrollments - DETECT1
- Monitor Certificate Authentication Events - DETECT2

Collaborate with the individual responsible for ADCS within the organization to address the following questions pertaining to the identified certificate templates. This process will help in considering the appropriate checks and remedial actions described below:

1. **Is the certificate template in use?**
   Check: Latest issued certificates and expiration dates.
   Remediation: *Unpublish (disable) certificate template*

2. **Which principals are enrolling in this template?**
   Check: Requester principals of issued certificates.
   Remediation: *Remove Enroll permission (restrict to Tier Zero)*

3. **Is the Subject Alternative Name (SAN) flag required?**
   Check: If the requester name and the SAN refer to the same principal in issued certificates.
   Remediation: *Remove SAN flag*

4. **Could the current setup be replaced with an enrollment agent setup?**
   Check: If it is feasible that a service account or group of employees in the IT department (potentially non-Tier Zero principals) performs the enrollment on behalf of the users that need the certificate.
   Remediation: *Implement enrollment agent*

5. **Does the certificate template need to allow for authentication?**
   Check: Login events using certificates created with the certificate template.
   Remediation: *Remove EKU that enables authentication*

6. **Could future certificate requests wait for a manual approval?**
   Check: If it is feasible that the certificate request has to wait for a Tier Zero principal to manually approve the request.
   Remediation: *Enable manager approval*

Unpublish (disable) certificate template

For every Enterprise CA in the finding:

SPECTEROPS

Thank you

Join us in the BloodHoundGang Slack: https://ghst.ly/BHSlack