You snooze you lose:

RPC-Racer winning RPC endpoints against services

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About Me

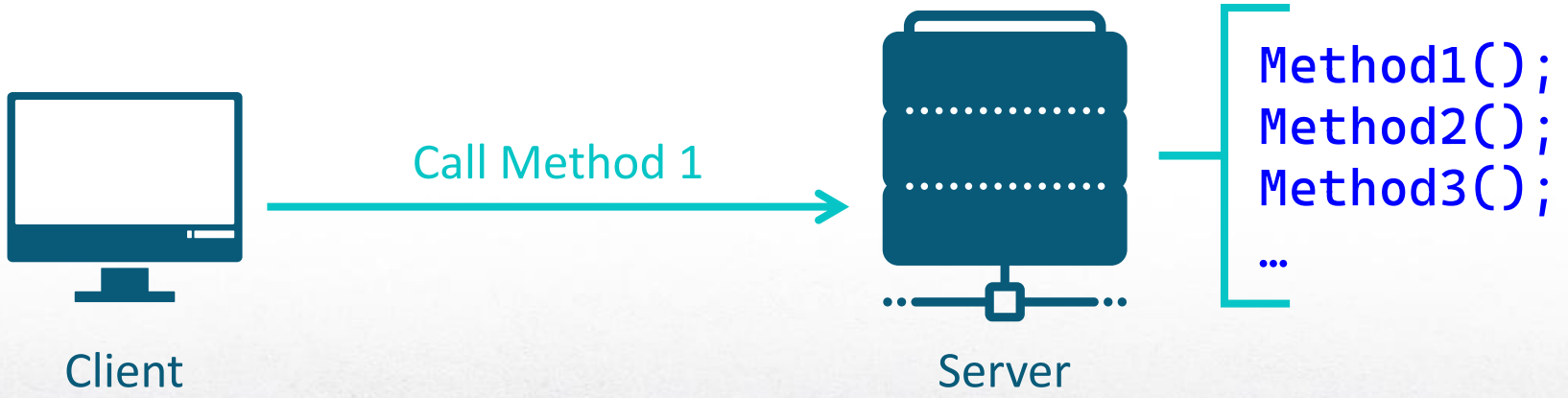
- Security Researcher @ SafeBreach
- Interested in reverse engineering, exploitation techniques and logical vulnerabilities
- Enjoys rock climbing and playing piano

Agenda

1. Intro – RPC fundamentals
2. Poisoning core RPC component
3. Performing recon for vulnerable servers
4. Manipulating built-in services
5. Leveraging machine account NTLM authentication
6. Conclusion

RPC Fundamentals

- Remote Procedure Call
- The server exposes functionalities
- The client asks the server to execute functions



RPC Fundamentals

RPC interfaces are defined by IDL files

```
[
uuid(8d864136-6900-4894-aece-66d455b552de),
version(1.0),
]
interface MyRpcInterface
{
long SendRpcMessage([in, string] const wchar_t* Message);
}
```

RPC Fundamentals

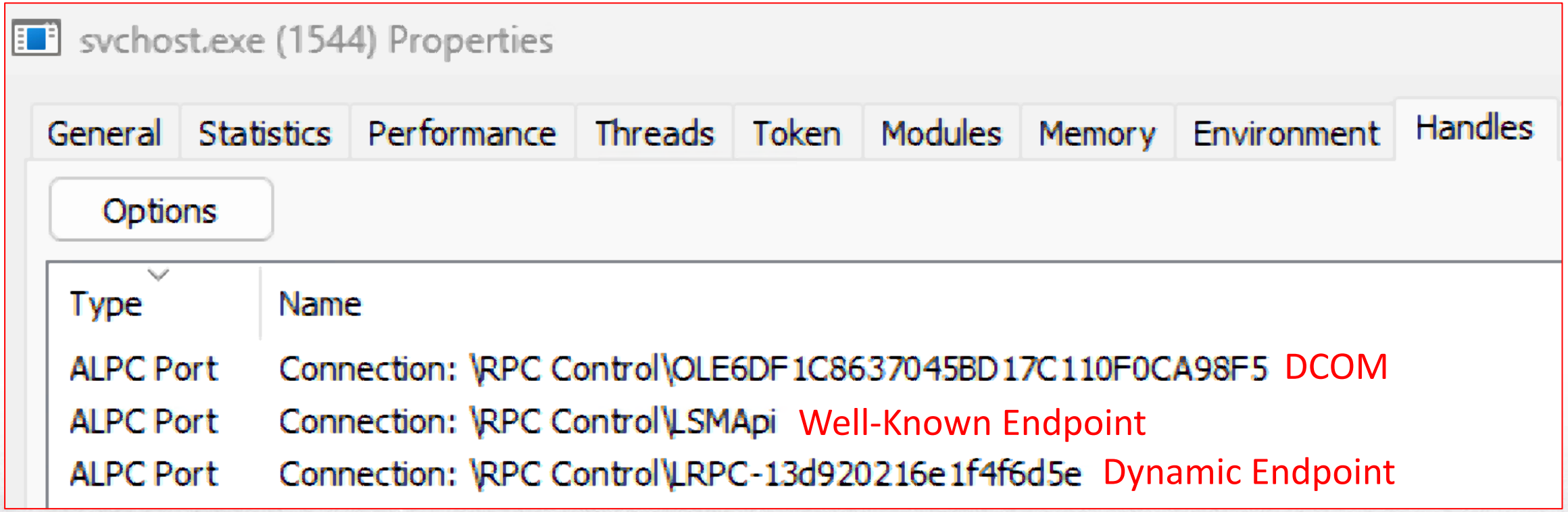
Binding Handles components

```
ncacn_ip_tcp:ronb-vm[8888]
ncalrpc:ronb-vm[MyRpcEndpoint]
ncacn_np:ronb-vm[\\pipe\\MyNamedPipe]
```

ProtSeq	NetworkAddr	Endpoint

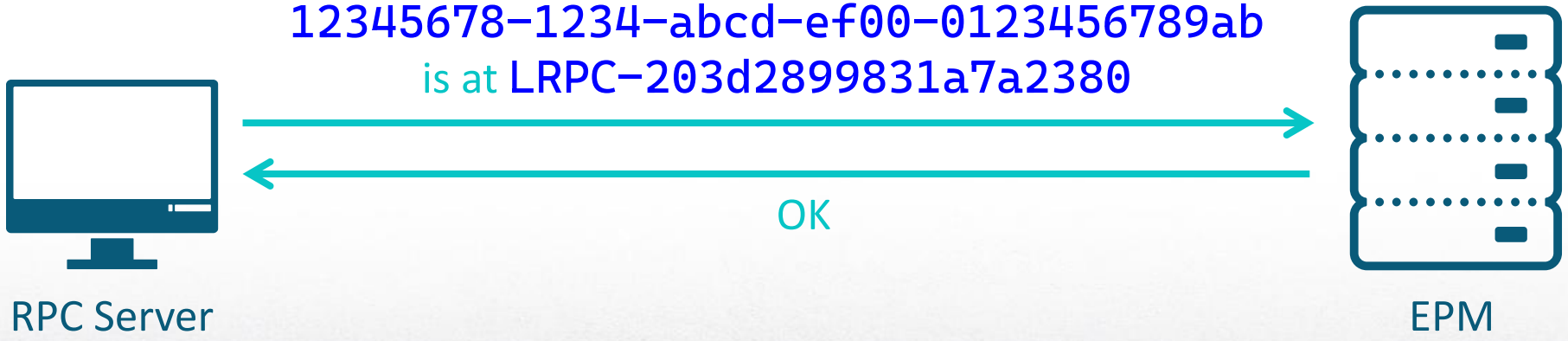
RPC Fundamentals

Well-known endpoints vs dynamic endpoints



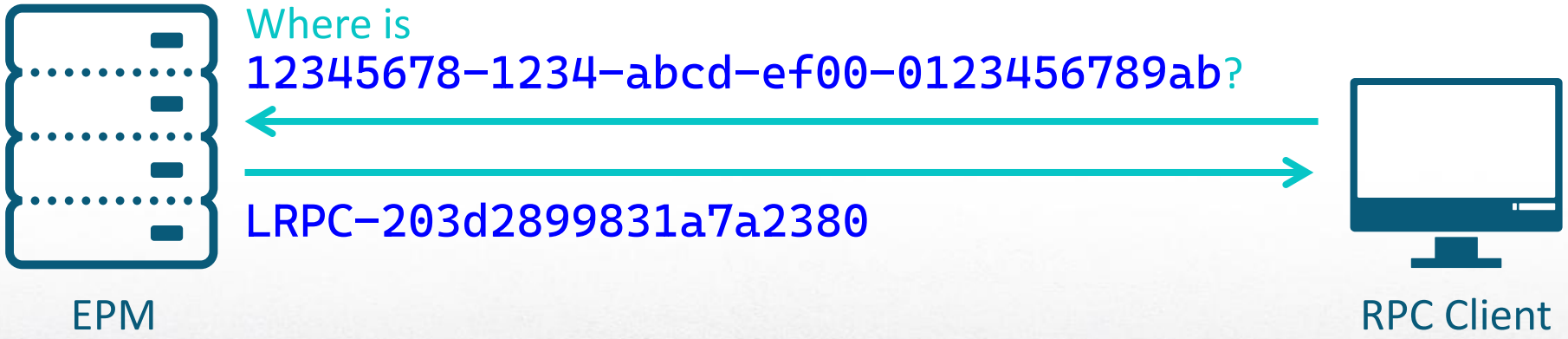
RPC Fundamentals

- The Endpoint Mapper (EPM)
- The server registers UUID to endpoint



RPC Fundamentals

- The Endpoint Mapper (EPM)
- The client queries UUID to endpoint



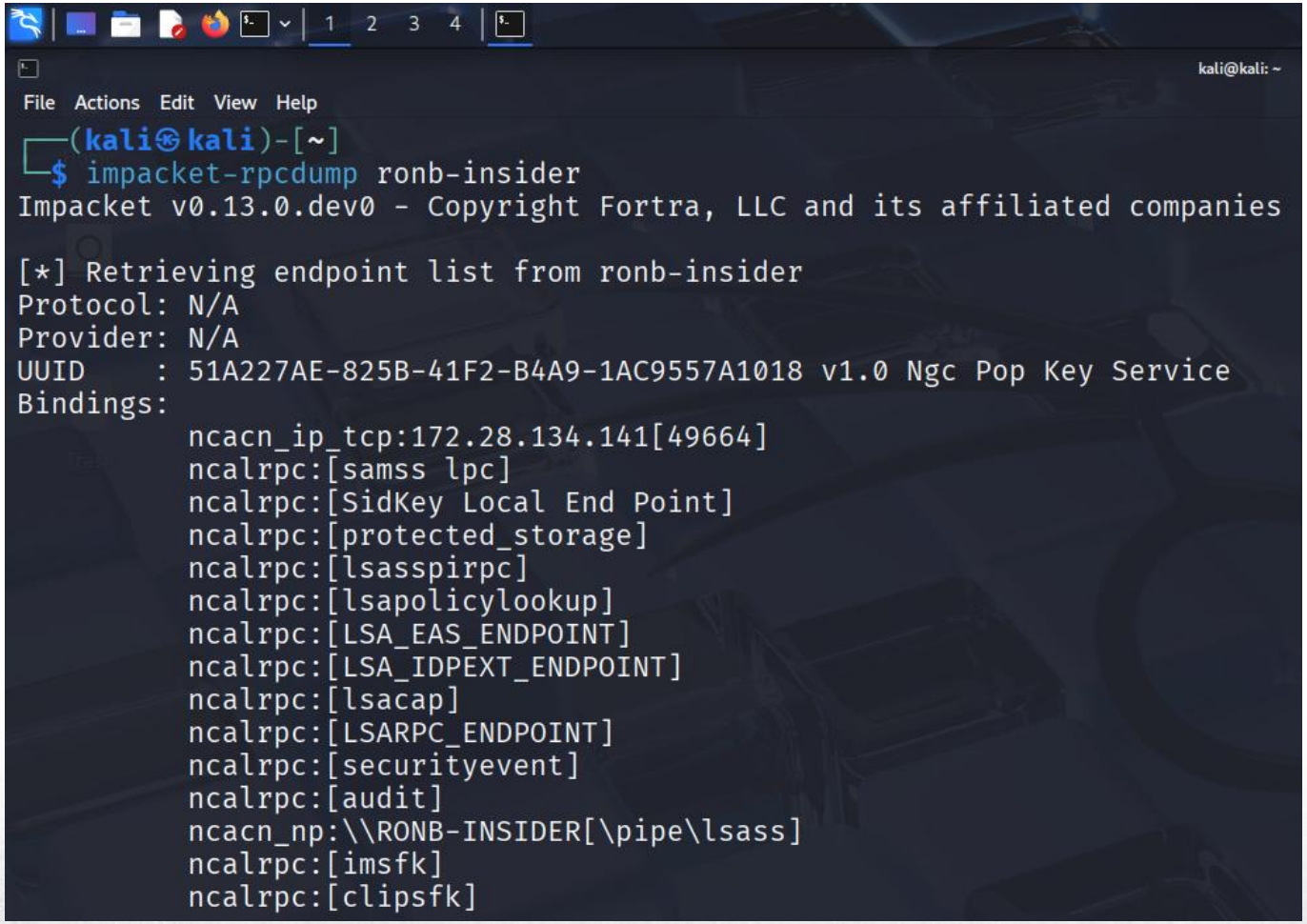
RPC Fundamentals

- The Endpoint Mapper (EPM)
- Implemented in C:\Windows\System32\RpcEpMap.dll
- Hosted by RpcSs

Protocol	Name
ncacn_ip_tcp	135
ncacn_np	\pipe\epmapper
ncalrpc	epmapper

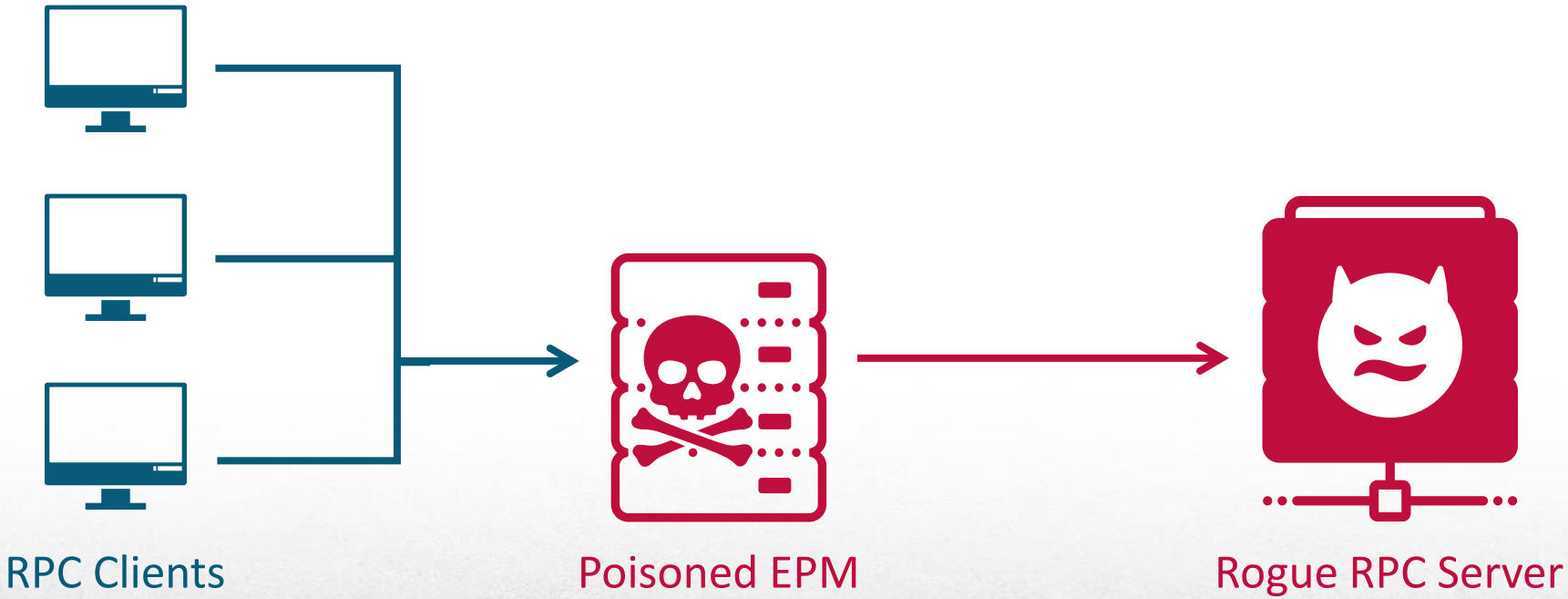
RPC Fundamentals

The Endpoint Mapper (EPM)



RPC Fundamentals

The Endpoint Mapper (EPM)



Previous RPC Exploits

Most exploitation tools target RPC Servers

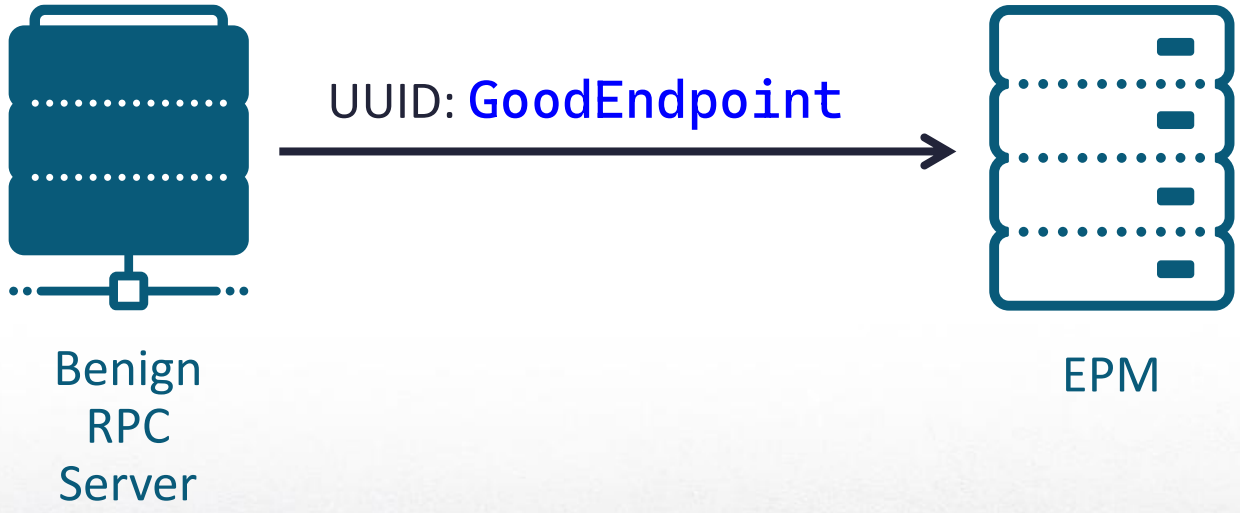
We'll target RPC clients

Research Goals

Poison the EPM → Masquerade as a legitimate RPC server → Manipulate RPC clients → Achieve local/domain privilege escalation

Register as built-in interface

Registration is made by calling `RpcEpRegister`

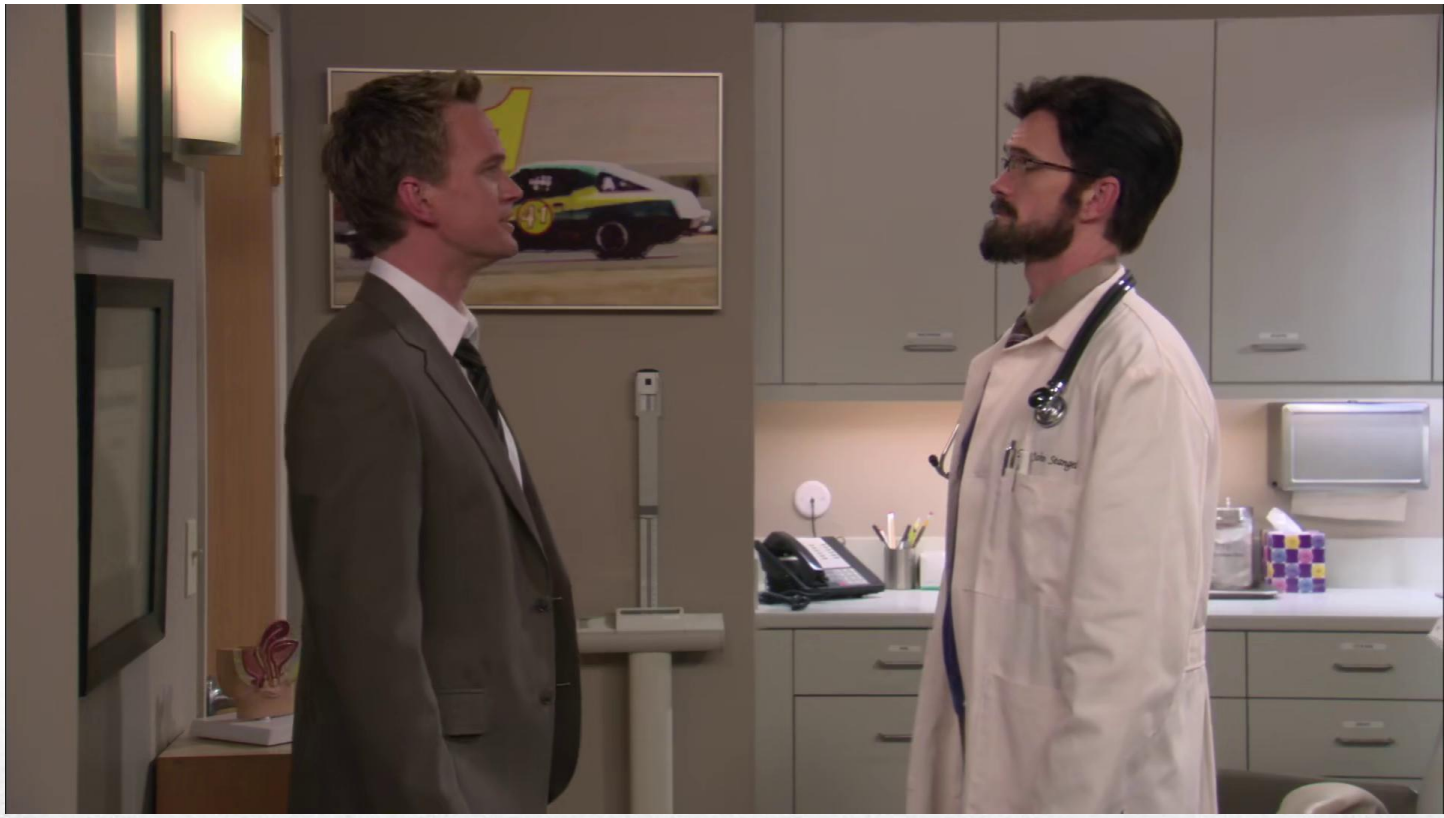


Register as built-in interface

The rogue server will mimic this behavior

Register as built-in interface

There is no verification on registering built-in interfaces



Register Before a legitimate server

If the service is not running, we can register first

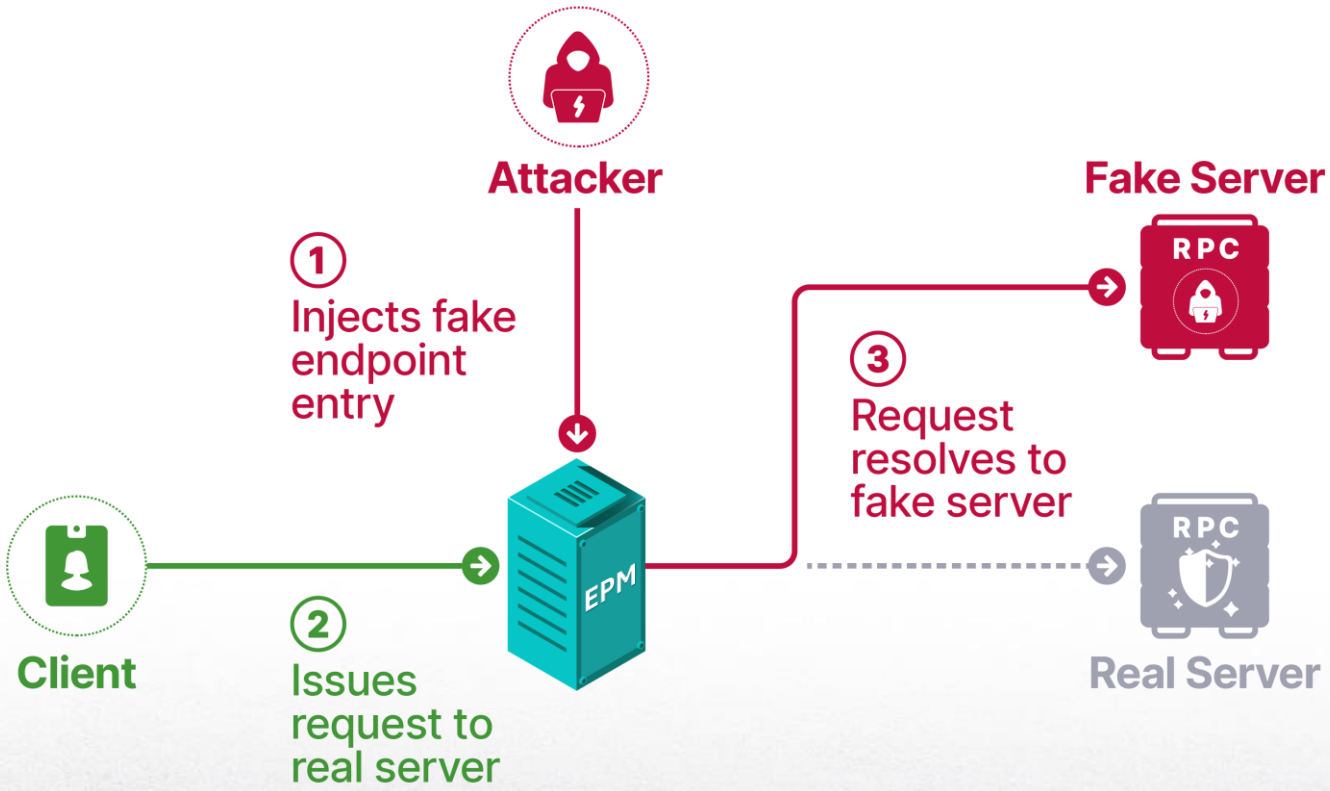
Registering first causes clients to connect to us

EPM Poisoning

Novel manipulation technique

Destabilize the core of MSRPC

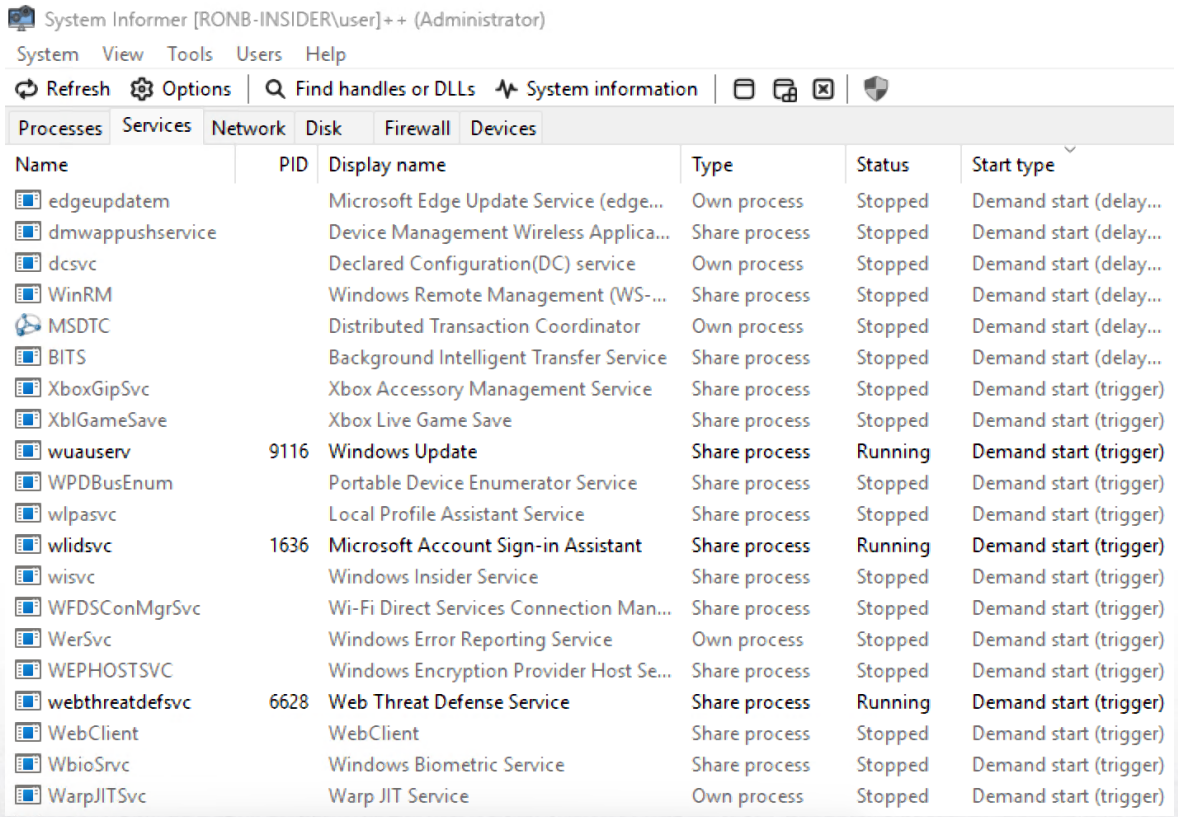
Doesn’t require admin privileges



Finding Delayed Services

Services with manual startup pose a security risk

Their RPC interface won't be registered on boot

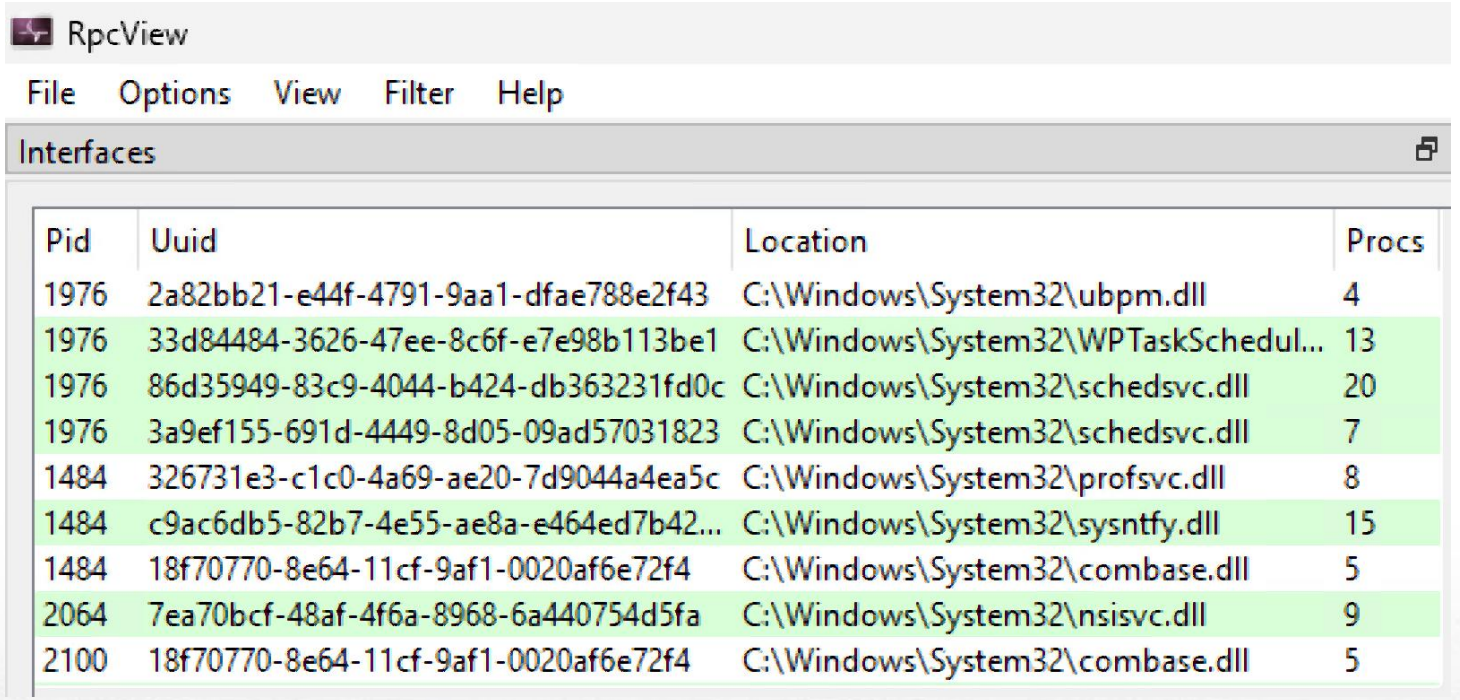


Name	PID	Display name	Type	Status	Start type
edgeupdatem		Microsoft Edge Update Service (edge...	Own process	Stopped	Demand start (delay...
dmwappushservice		Device Management Wireless Applica...	Share process	Stopped	Demand start (delay...
dcsvc		Declared Configuration(DC) service	Own process	Stopped	Demand start (delay...
WinRM		Windows Remote Management (WS-...	Share process	Stopped	Demand start (delay...
MSDTC		Distributed Transaction Coordinator	Own process	Stopped	Demand start (delay...
BITS		Background Intelligent Transfer Service	Share process	Stopped	Demand start (delay...
XboxGipSvc		Xbox Accessory Management Service	Share process	Stopped	Demand start (trigger)
XblGameSave		Xbox Live Game Save	Share process	Stopped	Demand start (trigger)
wuauserv	**9116**	**Windows Update**	**Share process**	**Running**	**Demand start (trigger)**
WPDBusEnum		Portable Device Enumerator Service	Share process	Stopped	Demand start (trigger)
wlpasvc		Local Profile Assistant Service	Share process	Stopped	Demand start (trigger)
wlidsvc	**1636**	**Microsoft Account Sign-in Assistant**	**Share process**	**Running**	**Demand start (trigger)**
wisvc		Windows Insider Service	Share process	Stopped	Demand start (trigger)
WFDSConMgrSvc		Wi-Fi Direct Services Connection Man...	Share process	Stopped	Demand start (trigger)
WerSvc		Windows Error Reporting Service	Own process	Stopped	Demand start (trigger)
WEPHOSTSVC		Windows Encryption Provider Host Se...	Share process	Stopped	Demand start (trigger)
webthreatdefsvc	**6628**	**Web Threat Defense Service**	**Share process**	**Running**	**Demand start (trigger)**
WebClient		WebClient	Share process	Stopped	Demand start (trigger)
WbioSrvc		Windows Biometric Service	Share process	Stopped	Demand start (trigger)
WarpJITSvc		Warp JIT Service	Own process	Stopped	Demand start (trigger)

Finding Delayed Services

The EPM can be queried programmatically

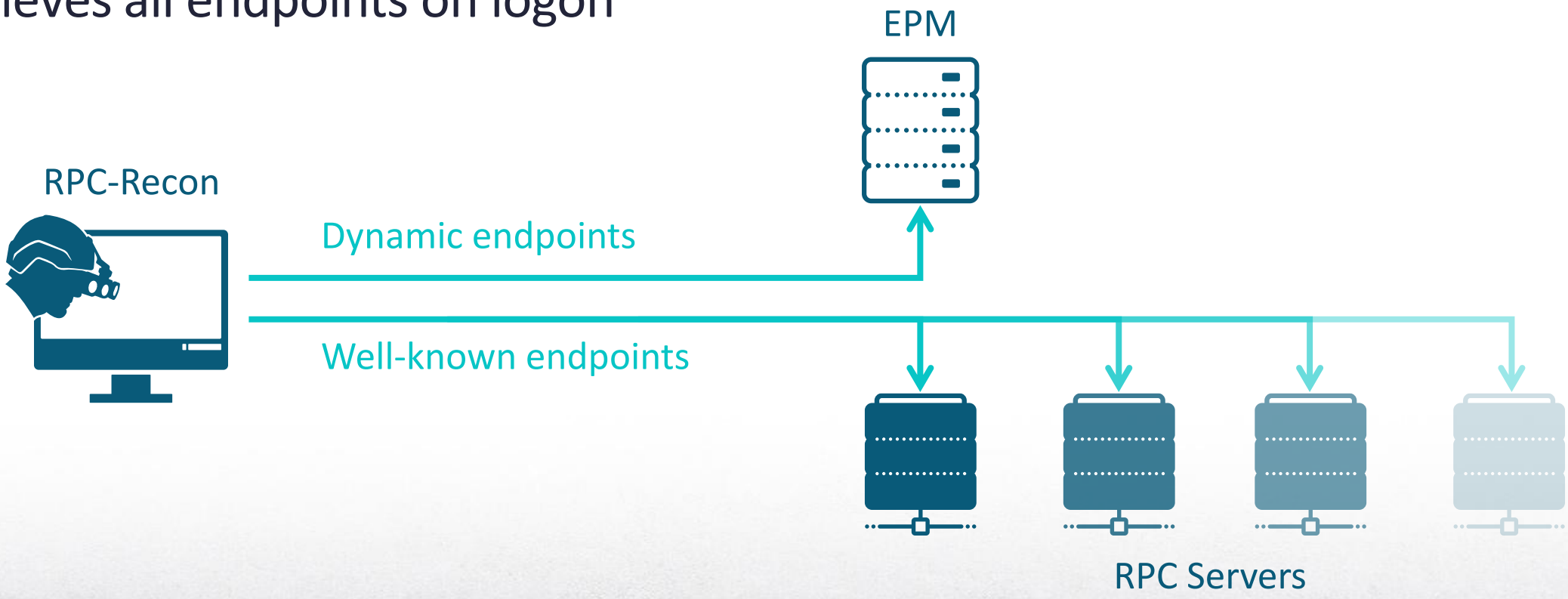
Well-known endpoints need to be extracted from memory



Pid	Uuid	Location	Procs
1976	2a82bb21-e44f-4791-9aa1-dfae788e2f43	C:\Windows\System32\ubpm.dll	4
1976	33d84484-3626-47ee-8c6f-e7e98b113be1	C:\Windows\System32\WPTaskSchedul...	13
1976	86d35949-83c9-4044-b424-db363231fd0c	C:\Windows\System32\schedsvc.dll	20
1976	3a9ef155-691d-4449-8d05-09ad57031823	C:\Windows\System32\schedsvc.dll	7
1484	326731e3-c1c0-4a69-ae20-7d9044a4ea5c	C:\Windows\System32\profsvc.dll	8
1484	c9ac6db5-82b7-4e55-ae8a-e464ed7b42...	C:\Windows\System32\sysntfy.dll	15
1484	18f70770-8e64-11cf-9af1-0020af6e72f4	C:\Windows\System32\combase.dll	5
2064	7ea70bcf-48af-4f6a-8968-6a440754d5fa	C:\Windows\System32\nsisvc.dll	9
2100	18f70770-8e64-11cf-9af1-0020af6e72f4	C:\Windows\System32\combase.dll	5

RPC-Recon

Retrieves all endpoints on logon



RPC-Recon

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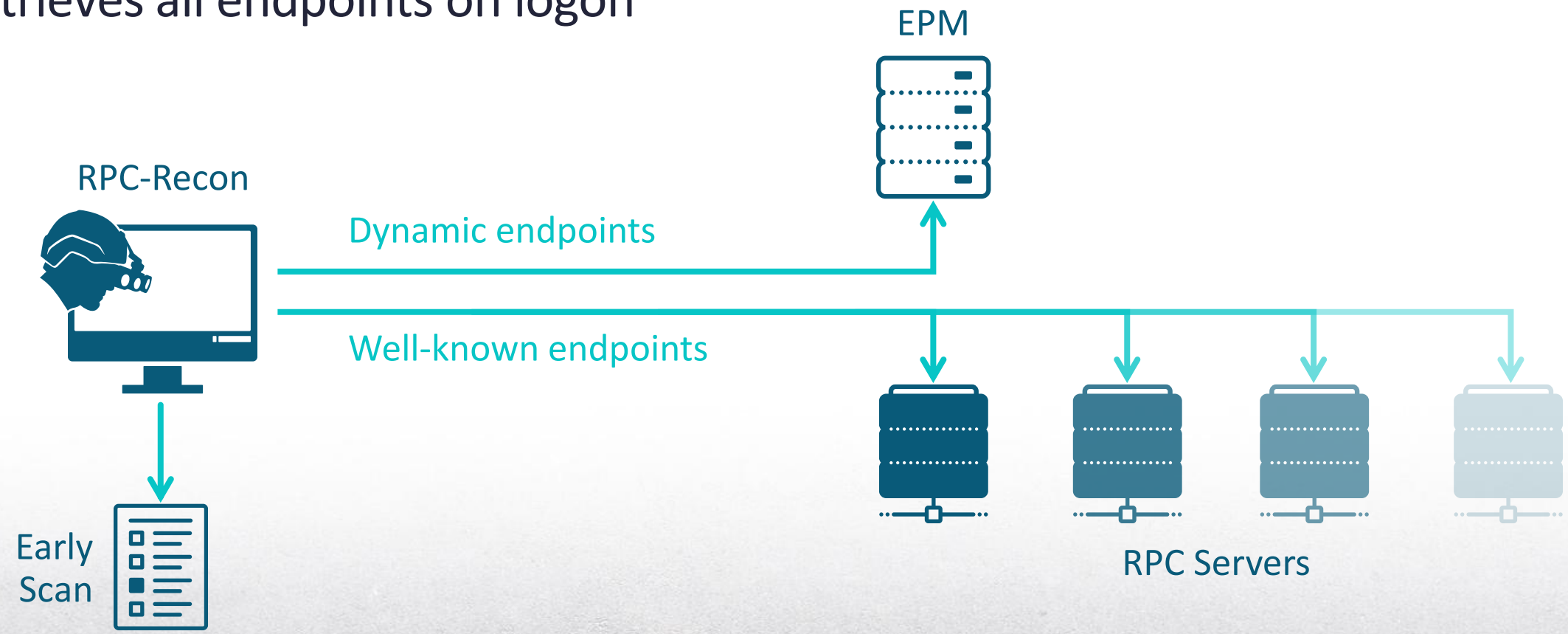
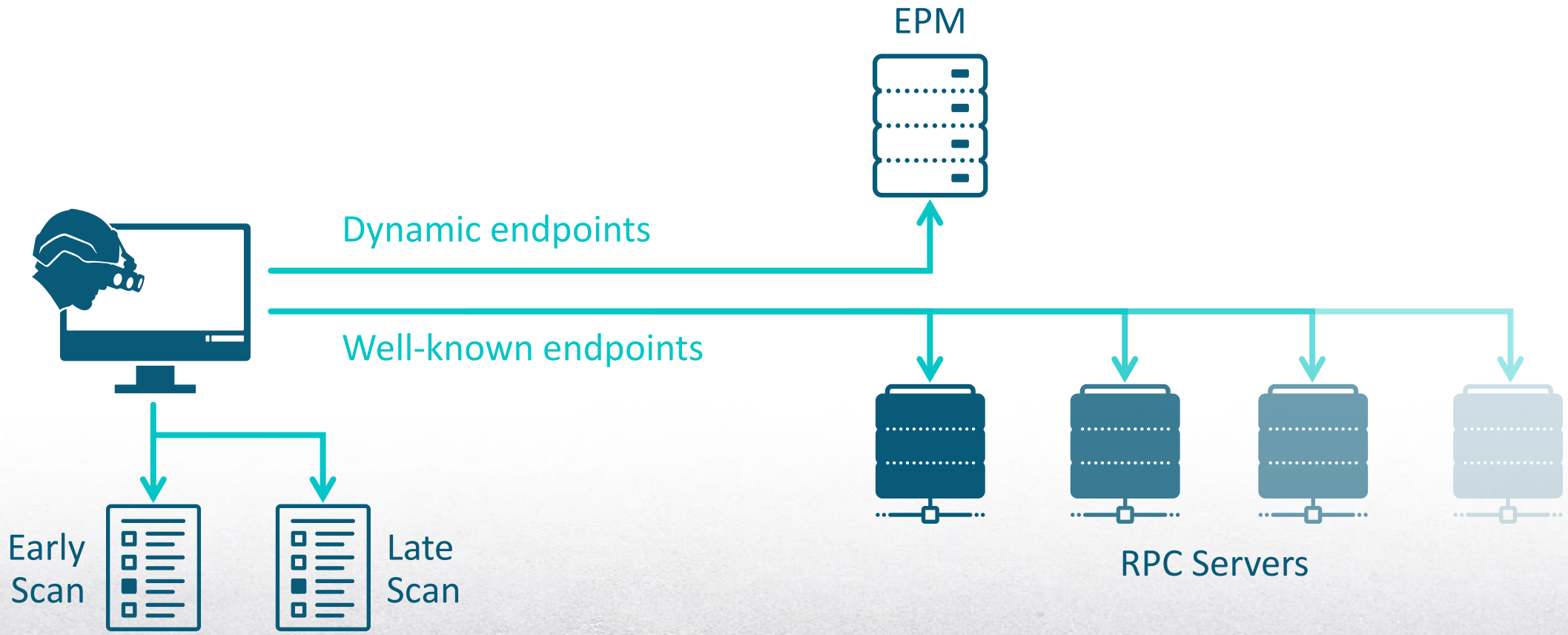


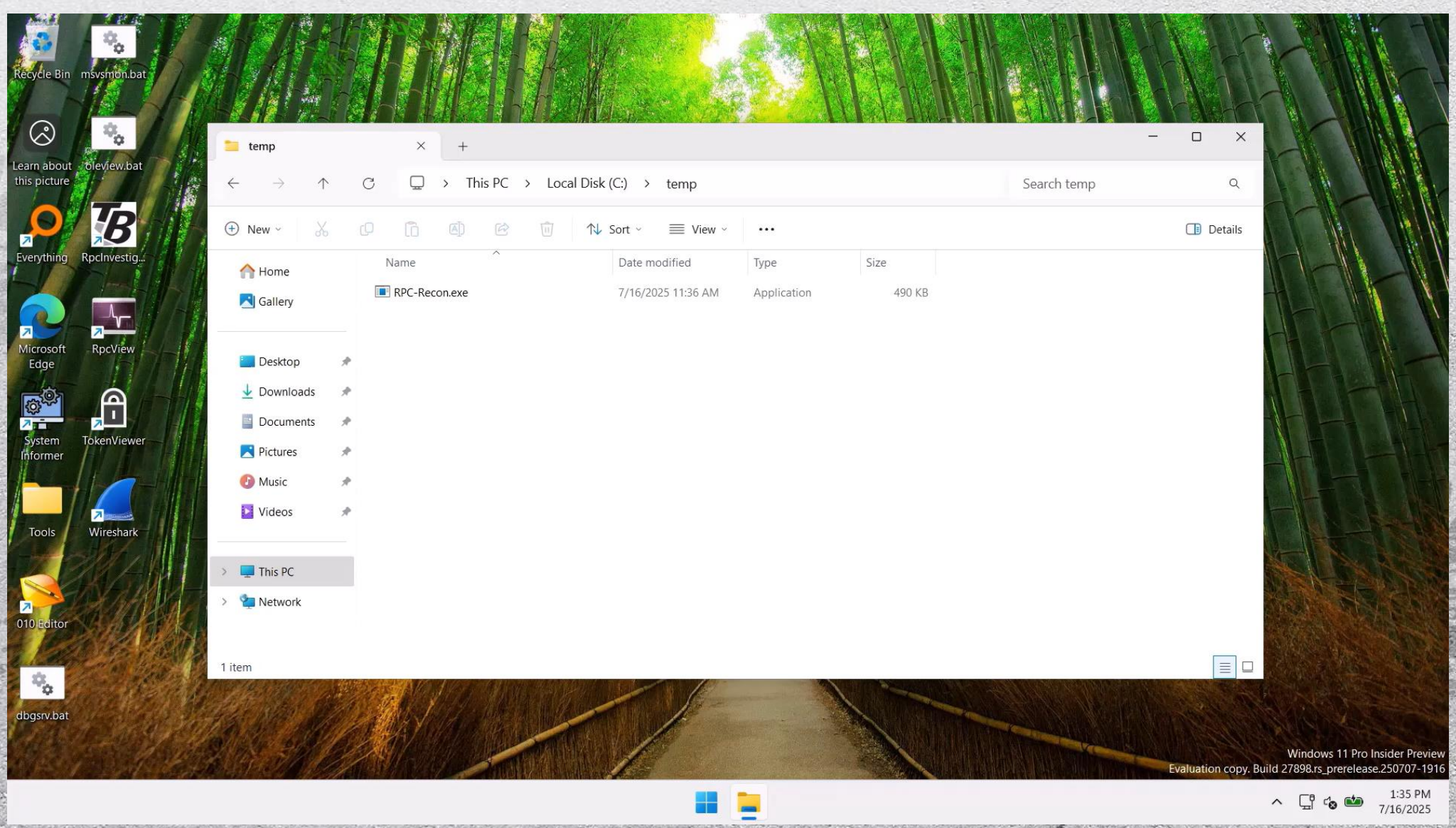
RPC-Recon


EPM
Dynamic endpoints
Well-known endpoints
Early Scan
Late Scan
RPC Servers

RPC-Recon

Comparing the lists reveals vulnerable interfaces

RPC-Recon Demo



Launching Rogue Server

Known interfaces were registered without admin privileges

The server received connections

The clients were services running as “NT AUTHORITY\SYSTEM”!

Leveraging The Connections

Can `RpcImpersonateClient` be used?

The level received is Identification

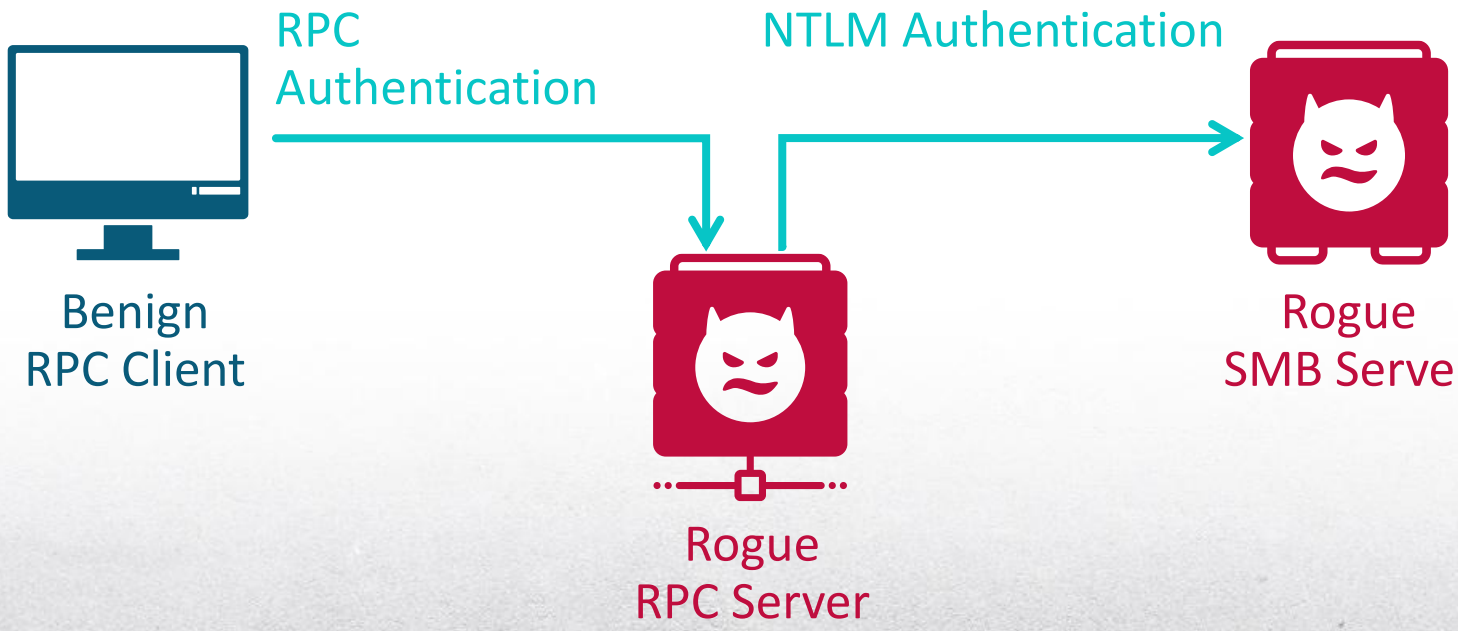
WinAPI will fail due to `ERROR_BAD_IMPERSONATION_LEVEL`

Leveraging The Connections

```
typedef enum _SECURITY_IMPERSONATION_LEVEL {
    SecurityAnonymous,
    SecurityIdentification,
    SecurityImpersonation,
    SecurityDelegation
} SECURITY_IMPERSONATION_LEVEL, * PSECURITY_IMPERSONATION_LEVEL;
```

Leveraging The Connections

- Maybe we can force an NTLM authentication?
- Accessing remote resources requires delegation




MoneyGram
COUGNAUD
TAGHeuer
TAG
MEDICAL CAR

Looking for Credentials

- Can we gain credentials by registering the right interface?
- We can imitate services used for authentication
- No connections received due to Security mechanisms

Service	Interface	Method
VaultSvc	bb8b98e8-84dd-45e7-9f34-c3fb6155eeed	VltAddItem
wlidsvc	cc105610-da03-467e-bc73-5b9e2937458d	WLIDSetAuthData, WLIDCreateIdentity
OneSyncSvc	923c9623-db7f-4b34-9e6d-e86580f8ca2a	AccountsMgmtRpcCreateAccount

RPC Security Mechanisms

The client can specify the expected privileges of the server

The RPC runtime will verify it before the connection

```
typedef struct _RPC_SECURITY_QOS_V4_W {
  unsigned long Version;
  unsigned long Capabilities;
  unsigned long IdentityTracking;
  unsigned long ImpersonationType;
  unsigned long AdditionalSecurityInfoType;
  union
      {
      RPC_HTTP_TRANSPORT_CREDENTIALS_W *HttpCredentials;
      } u;
  void *Sid;
  unsigned int EffectiveOnly;
} RPC_SECURITY_QOS_V4_W, *PRPC_SECURITY_QOS_V4_W;
```

RPC Security Mechanisms

```
*&sid.Revision = 0x101;
*&sid.IdentifierAuthority.Value[2] = 0x5000000;
sid.SubAuthority[0] = 0x12;
SecurityQOS.Version = 5;
SecurityQOS.Capabilities = 1;
memset(&SecurityQOS.IdentityTracking, 0, 24);
v3 = RpcStringBindingComposeW(0LL, L"ncalrpc", 0LL, 0LL, L"Security=impersonation dynamic false", StringBinding);
v4 = v3 <= 0;
if ( v3
  || (v3 = RpcBindingFromStringBindingW(StringBinding[0], &Binding), v4 = v3 <= 0, v3)
  || (v3 = RpcBindingSetAuthInfoExW(Binding, 0LL, 6u, 0xAu, 0LL, 0, &SecurityQOS), v4 = v3 <= 0, v3) )
```

wlidcli.dll (CWLIDBinding::Bind)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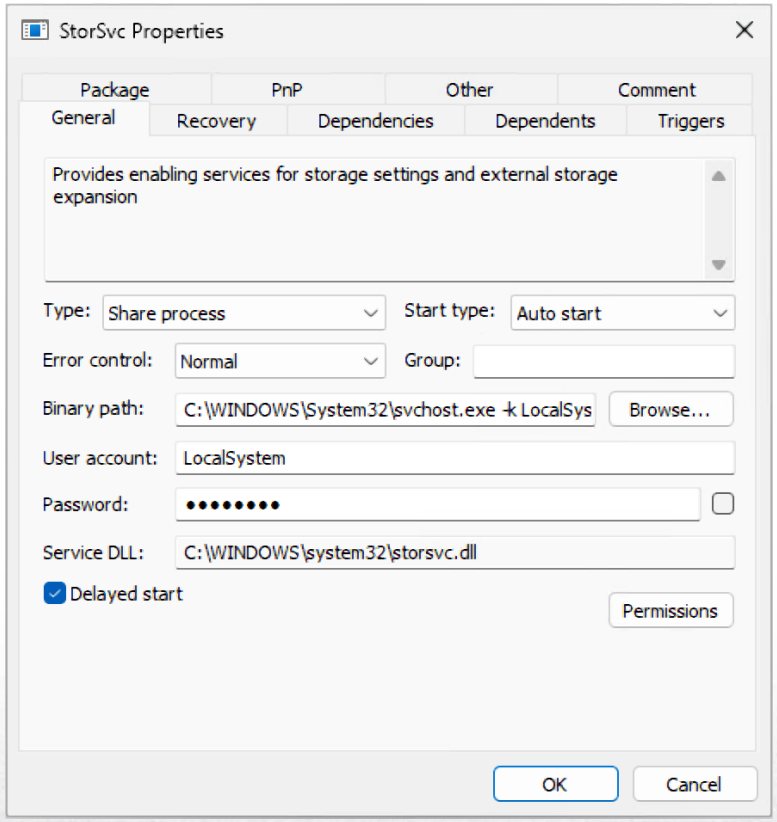
Steps Taken

Attack	Defense
Impersonating privileged clients	Impersonation policy
Masquerading as authentication service	Security quality of service

Manipulating File Access

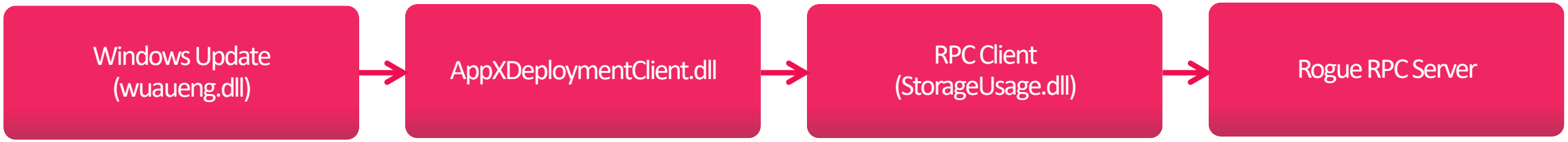
Can we achieve arbitrary write to protected directories?

Looking for file system services led to “Storage Service”



Manipulating File Access

Registering StorSvc interface resulted in several connections:



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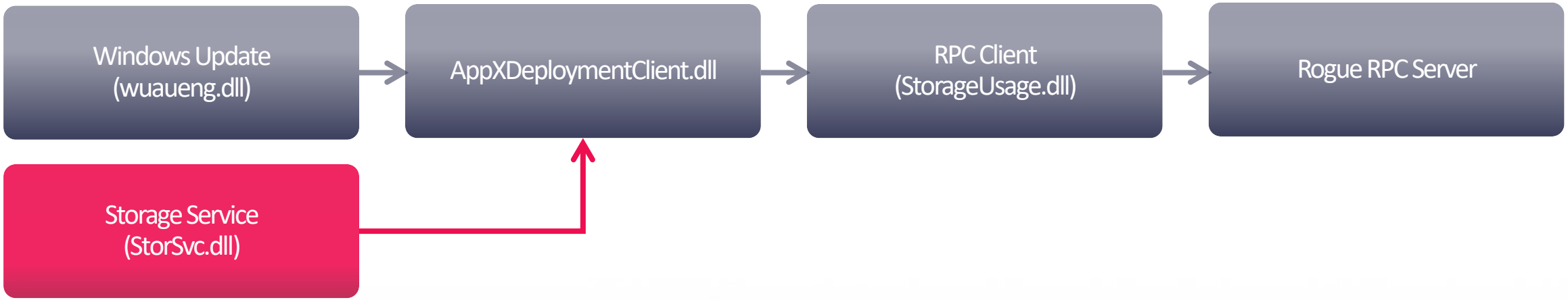

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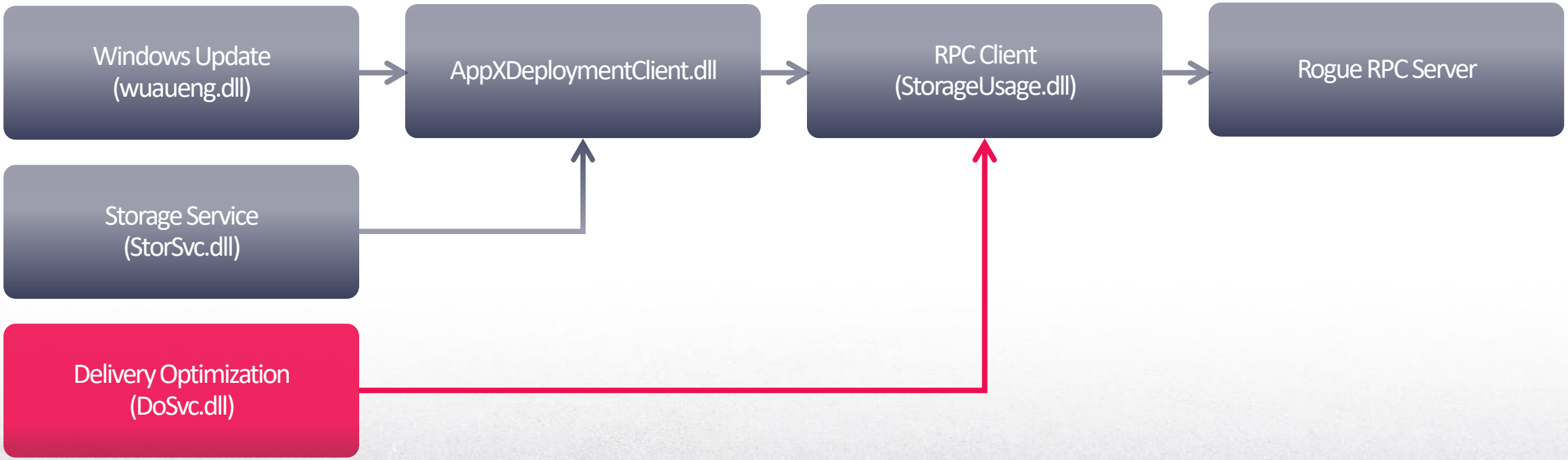


Manipulating File Access

The clients invoked 3 undocumented methods

```
long GetStorageInstanceCount([in] short arg1, [out] long* arg2);
long GetStorageSettings([in] short arg1, [in] long arg2, [in] short arg3, [out] long* arg4);
long GetStorageDeviceInfo([in] int arg1, [in] long arg2, [in, out] struct Struct_34_t* arg3);
```

Manipulating File Access

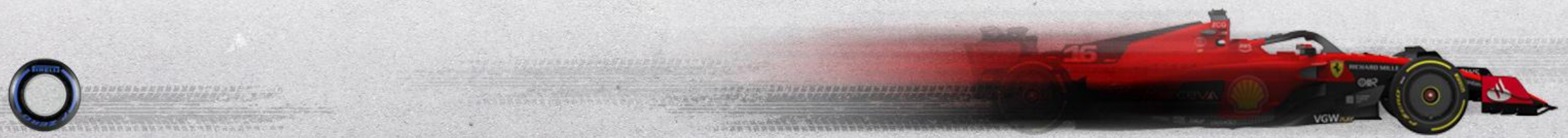
- Examining the client callstack led to `AppXDeploymentClient.dll`
- The public symbols contain definitions of the undocumented methods

Manipulating File Access

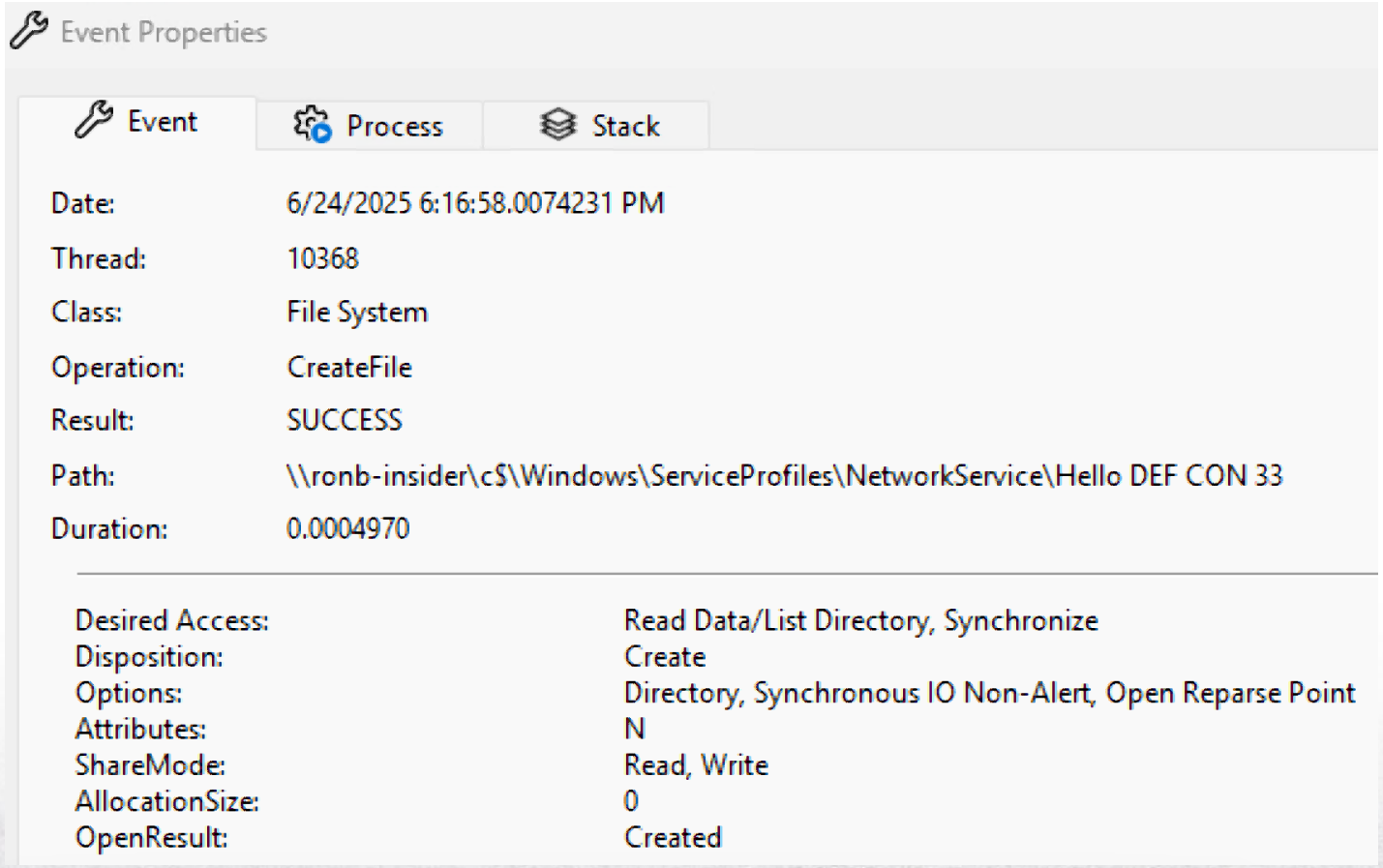
```
typedef struct _STORAGE_DEVICE_INFO
{
    unsigned int Size;
    wchar_t PathName[ 260 ];
    STORAGE_DEVICE_PROPERTIES DeviceProperties;
    STORAGE_PRESENCE_STATE PresenceState;
    STORAGE_DISMOUNT_REASON DismountReason;
    STORAGE_VOLUME_STATUS VolumeStatus;
    STORAGE_FREE_SPACE_STATE FreeSpaceState;
    STORAGE_TEMP_CLEANUP_STATE TempCleanupState;
    GUID StorageId;
    STORAGE_APP_PAIRING_STATUS AppPairingStatus;
    unsigned __int64 ReservedSize;
    wchar_t FriendlyName[ 260 ];
    unsigned int BusType;
    unsigned int FileSystemType;
    unsigned int PersistentVolumeState;
} STORAGE_DEVICE_INFO;
```

Manipulating File Access

- DoSvc calls `CreateDirectory` with the path returned
- This service is running as “NT AUTHORITY\NETWORK SERVICE”



Manipulating File Access

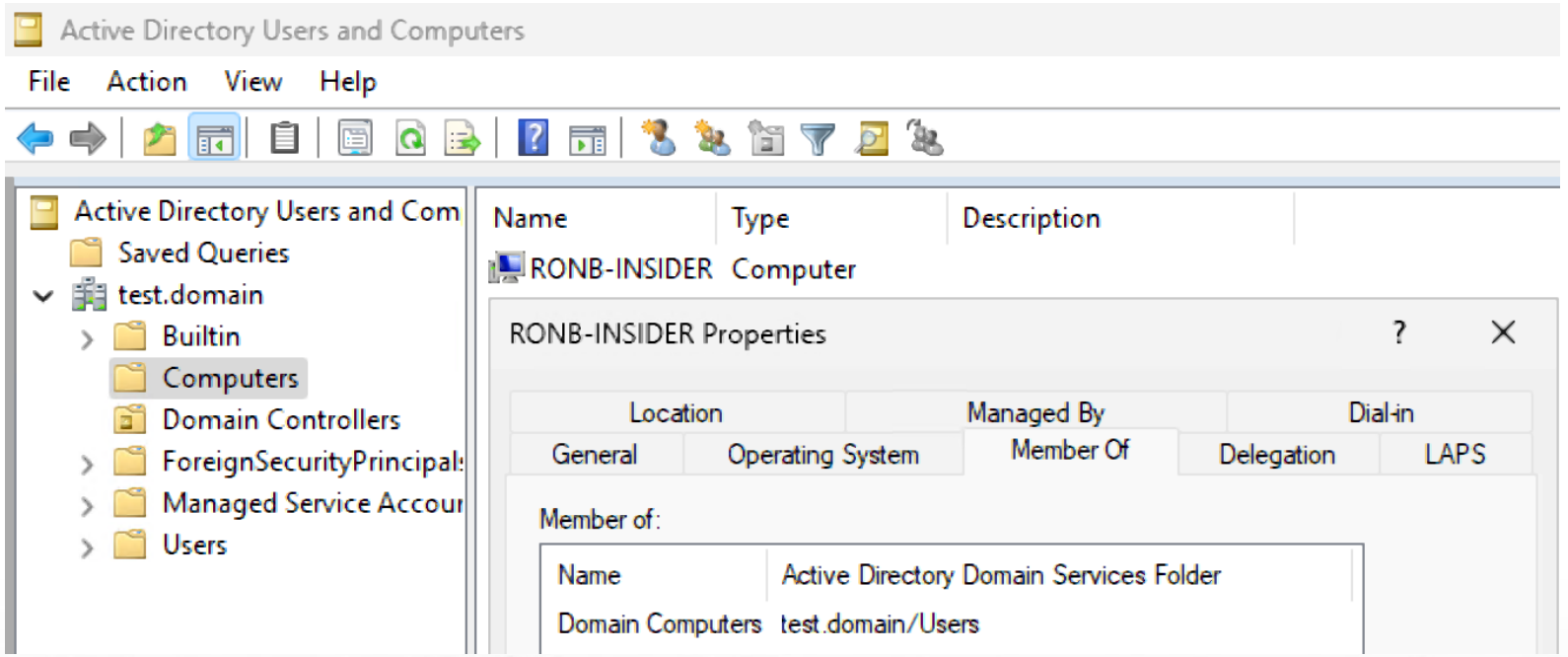


NT AUTHORITY\NETWORK SERVICE

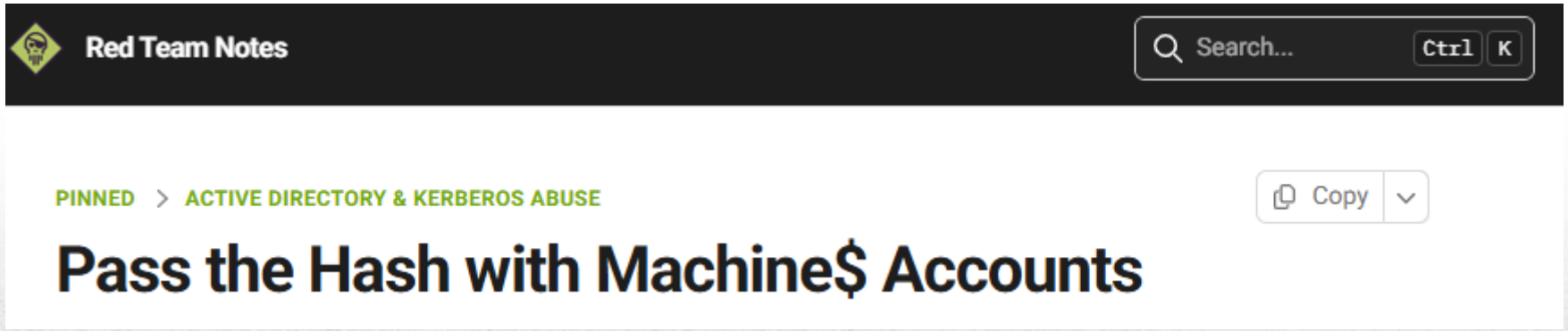
- Fewer capabilities than the local system account
- Authenticates remote resources with the machine account

Machine Account

- Represented as COMPUTERNAME$
- Used when the computer accesses remote resources

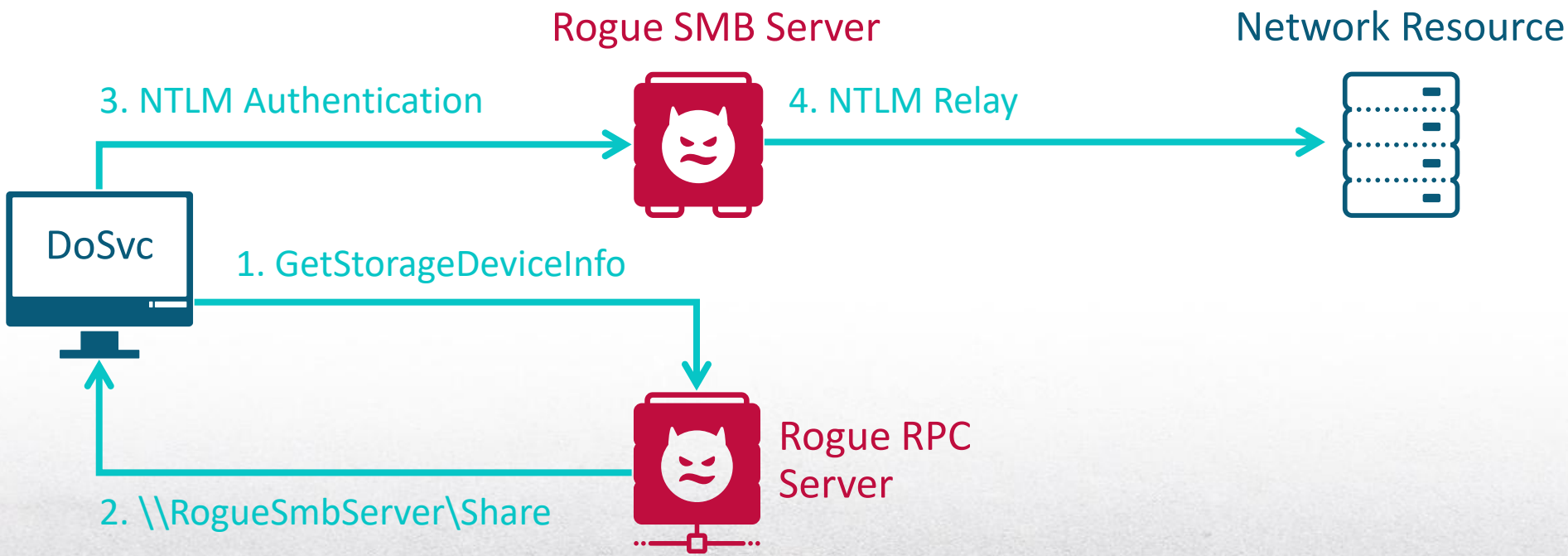


Machine Account



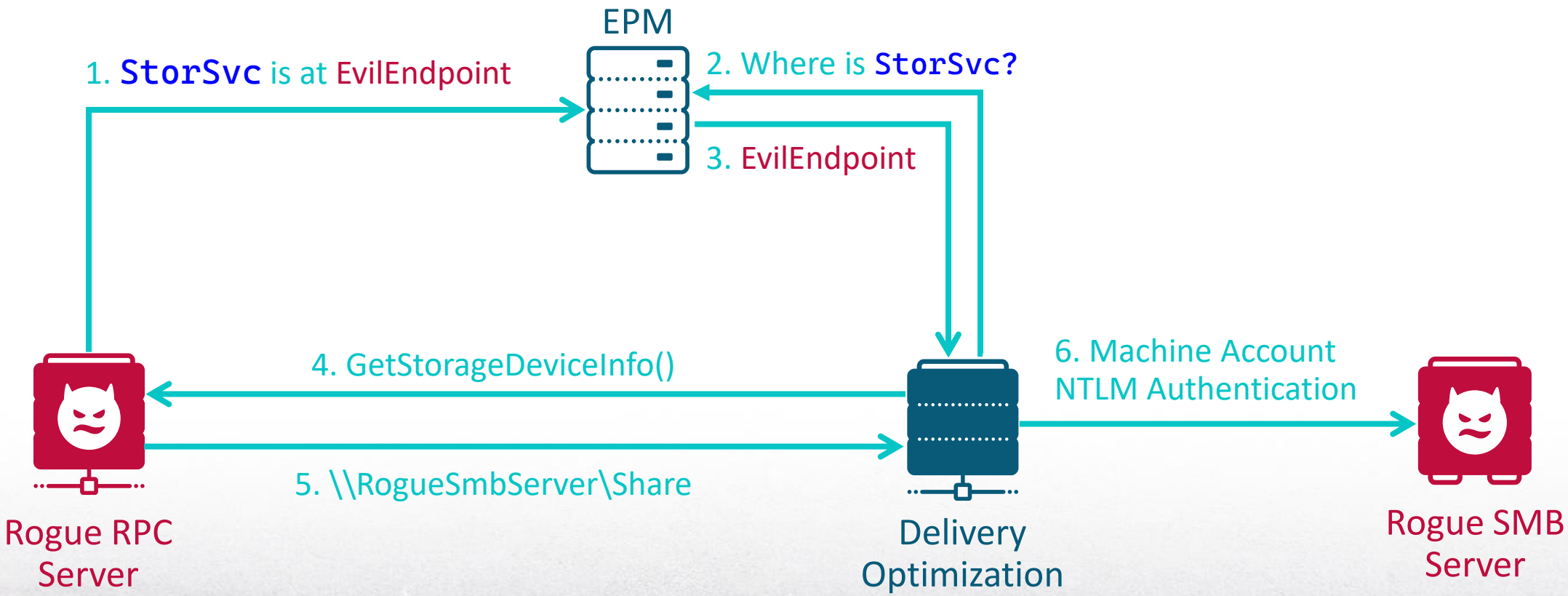
Forcing Machine Account Authentication

- Returning a network share forces an authentication
- It can be used for NTLM relay



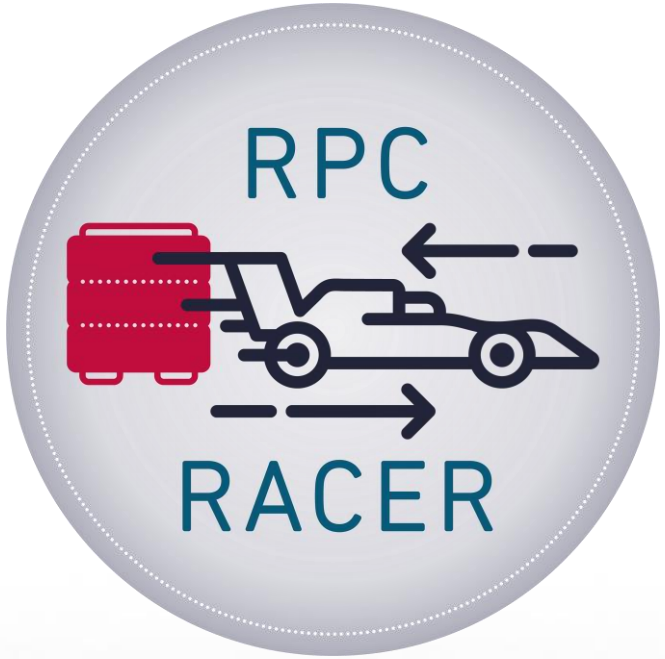
Success!

Attack Flow

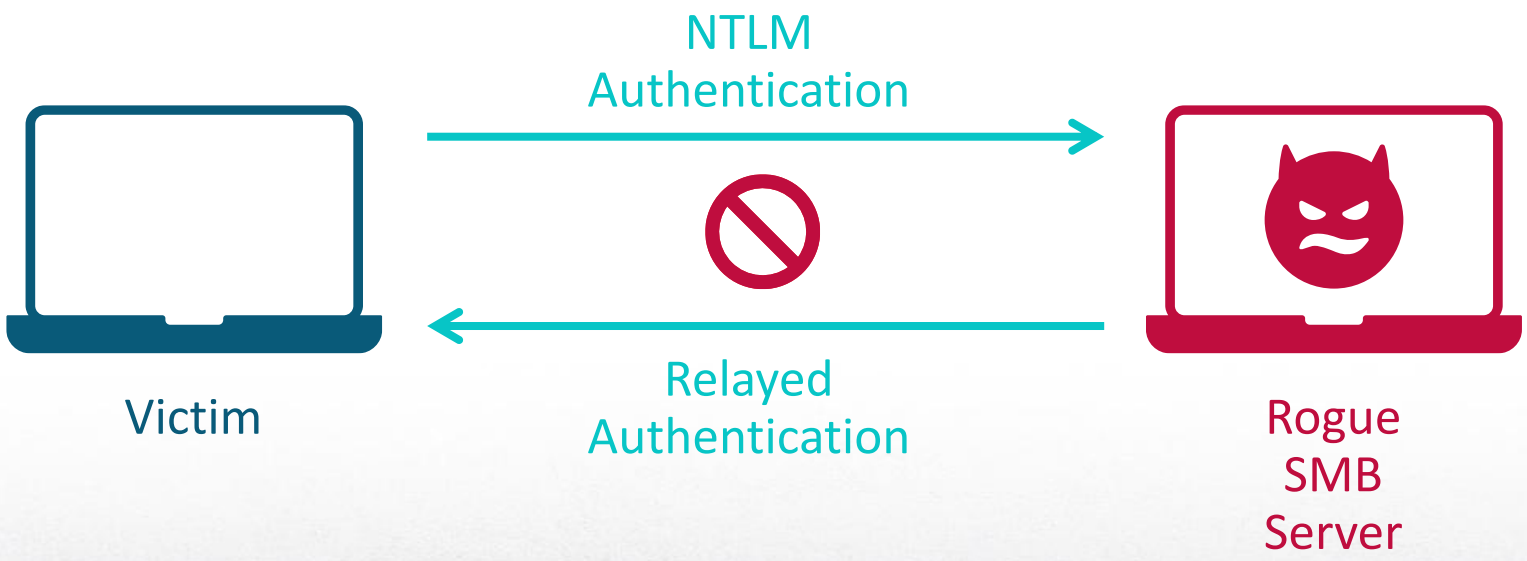

EPM
1. StorSvc is at EvilEndpoint
2. Where is StorSvc?
3. EvilEndpoint
4. GetStorageDeviceInfo()
5. \\RogueSmbServer\Share
6. Machine Account
NTLM Authentication
Rogue RPC
Server
Delivery
Optimization
Rogue SMB
Server

RPC-Racer

- New tool to launch rogue RPC interfaces
- Designed to be executed on logon
- Forces authentication of the machine account
- Patch for CVE-2025-49760 was released on July 8th, 2025



Where can we relay the machine account authentication?

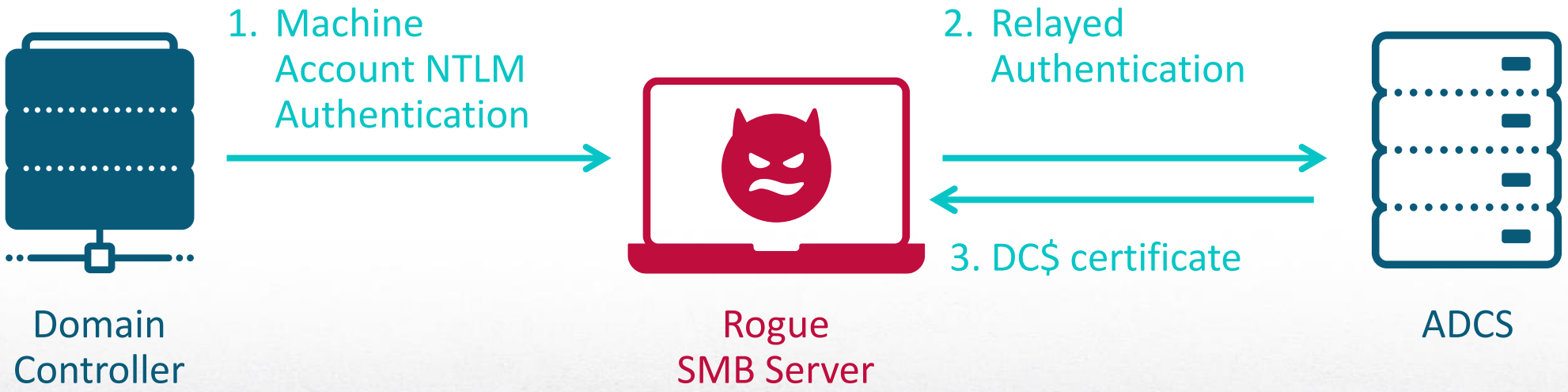


ESC8

- Targets Active Directory Certificate Service (ADCS)
- ADCS web server can enroll certificates
- Certificates can be used for authentication

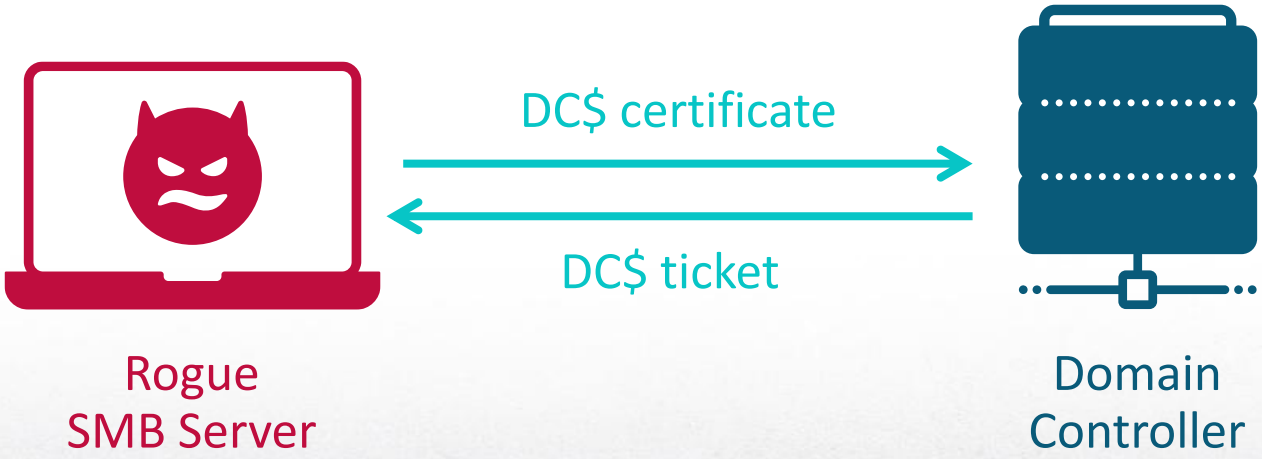
ESC8

Step 1: Requesting a certificate for DC$



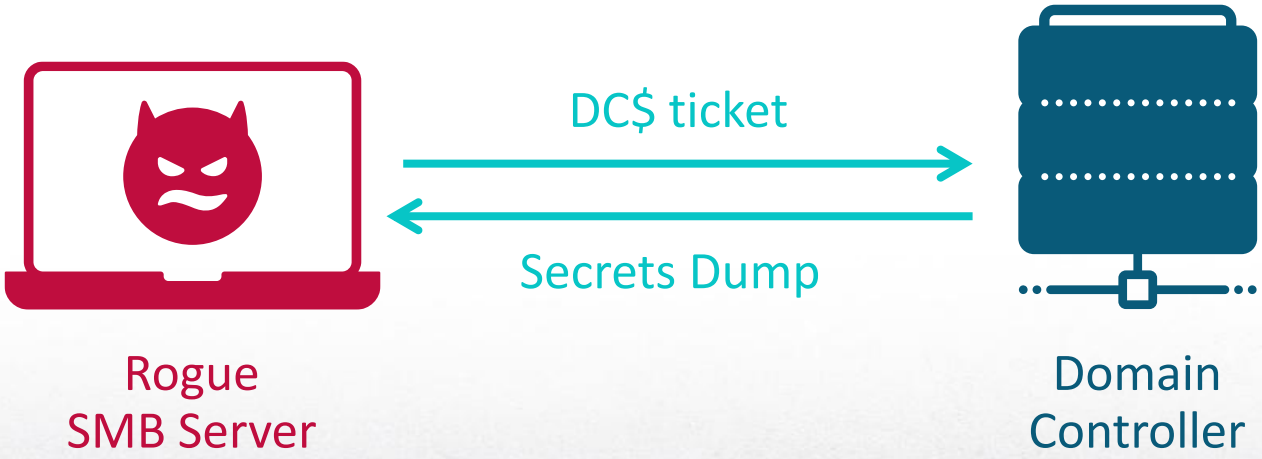
ESC8

Step 2: using the certificate to request TGT

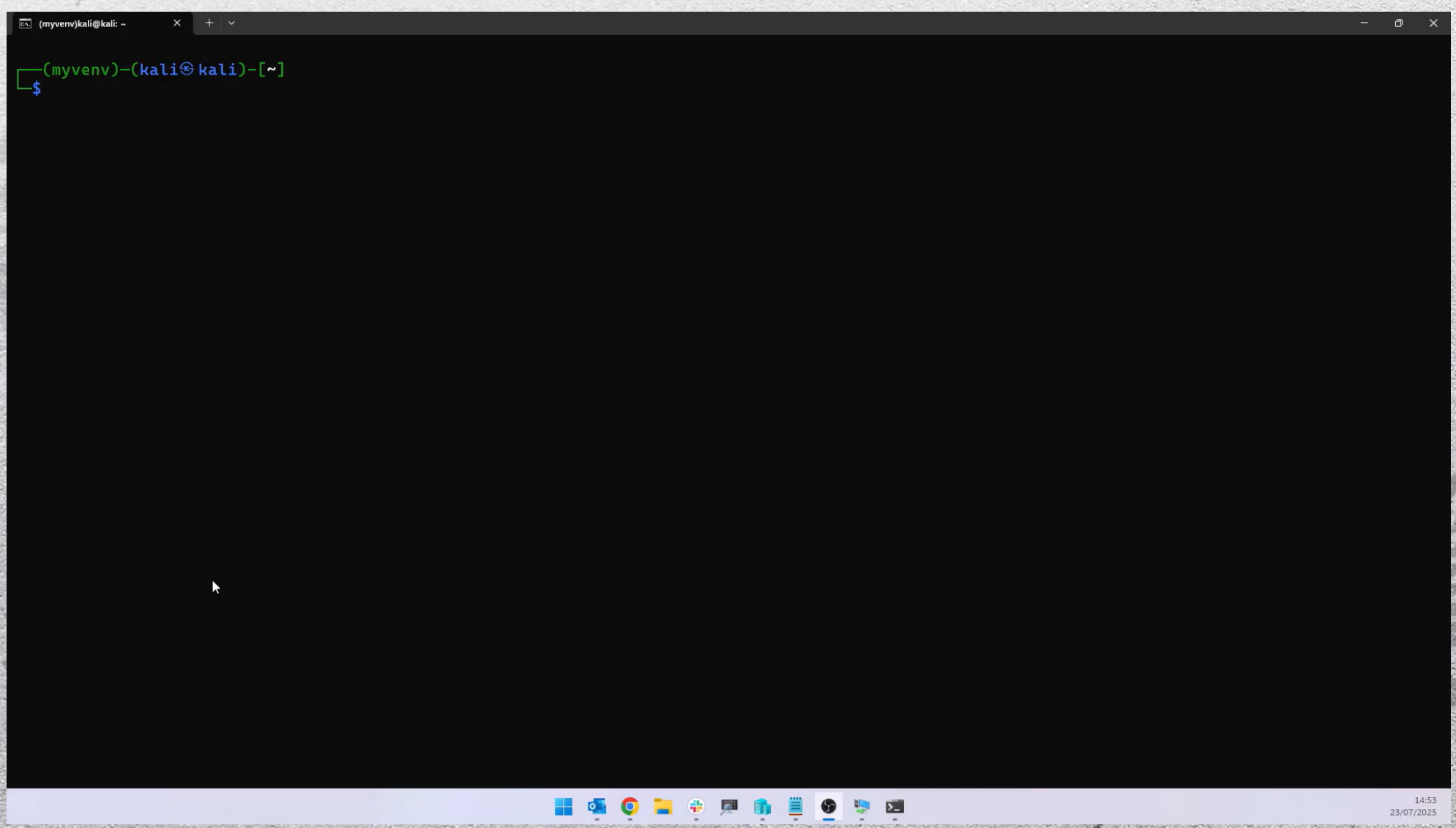


ESC8

Step 3: using the TGT to dump password hashes



RPC-Racer Demo



Implications

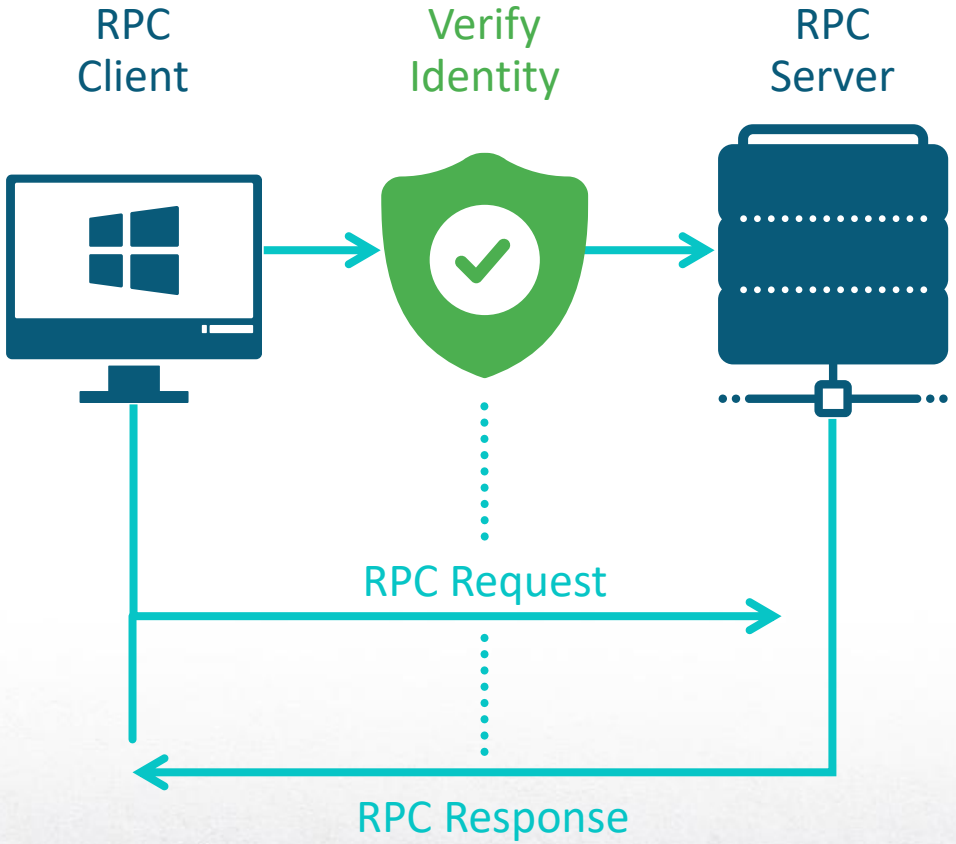
Man in the Middle

Denial of Service

Stealing Credentials

Takeaways

The destination address of every protocol should be verified by the source



Takeaways

Any stage where untrusted code can be executed should be considered unsafe

Services should be launched as early as possible

CVE-2025-49760

StorageUsage.dll was patched

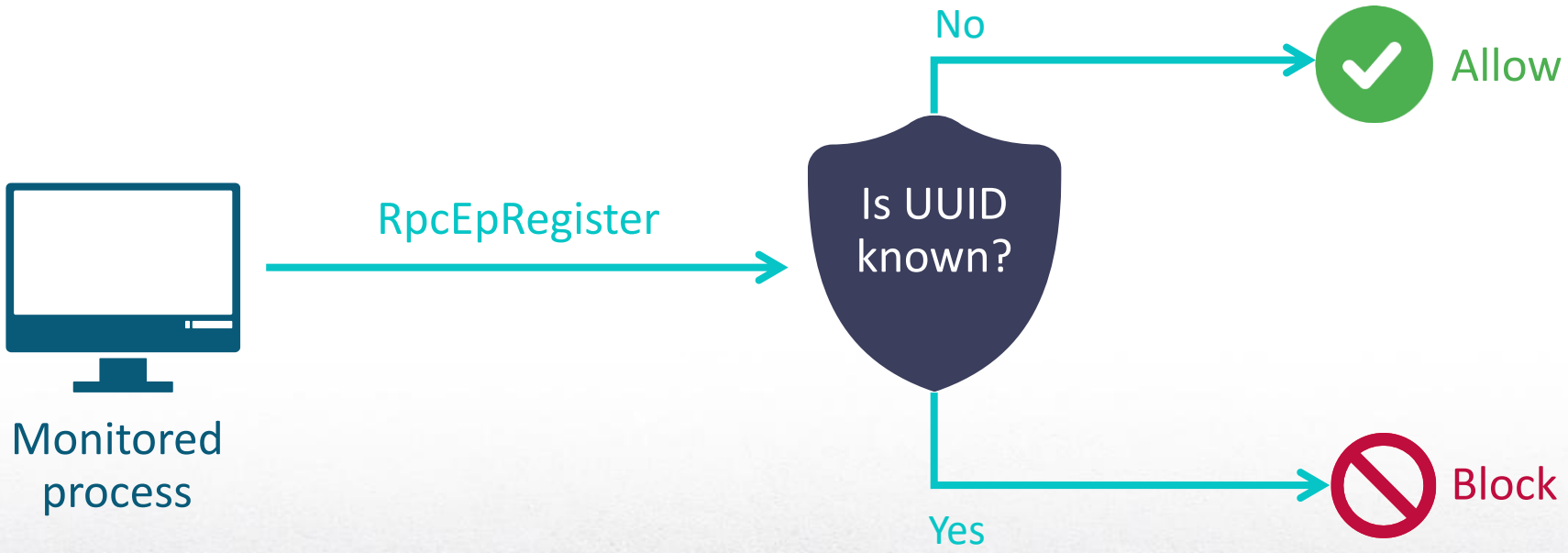
Security QOS applied to Binding handle

```
__int64 __fastcall StorageSvcInit(RPC_BINDING_HANDLE *Binding)
{
  // [COLLAPSED LOCAL DECLARATIONS. PRESS NUMPAD "+" TO EXPAND]

  *&pIdentifierAuthority.Value[4] = 0x500;
  String = 0LL;
  *pIdentifierAuthority.Value = 0;
  returnValue = 0;
  pSid = 0LL;
  memset(&SecurityQOS, 0, sizeof(SecurityQOS));
  wil::details::FeatureImpl<__WilFeatureTraits_Feature_3064785210>::__private_IsEnabled(&`wil::Fea
  if ( v3 )
  {
    if ( !AllocateAndInitializeSid(&pIdentifierAuthority, 1u, 0x12u, 0, 0, 0, 0, 0, 0, 0, &pSid) )
    {
      LastError = GetLastError();
      returnValue = LastError;
      if...
      goto LABEL_5;
    }
    tmpSecQOS.Version = 5;
    *(&tmpSecQOS.AdditionalSecurityInfoType + 1) = 0;
    tmpSecQOS.Sid = pSid;
    tmpSecQOS.Capabilities = 17;
    tmpSecQOS.u.HttpCredentials = 0LL;
  }
```

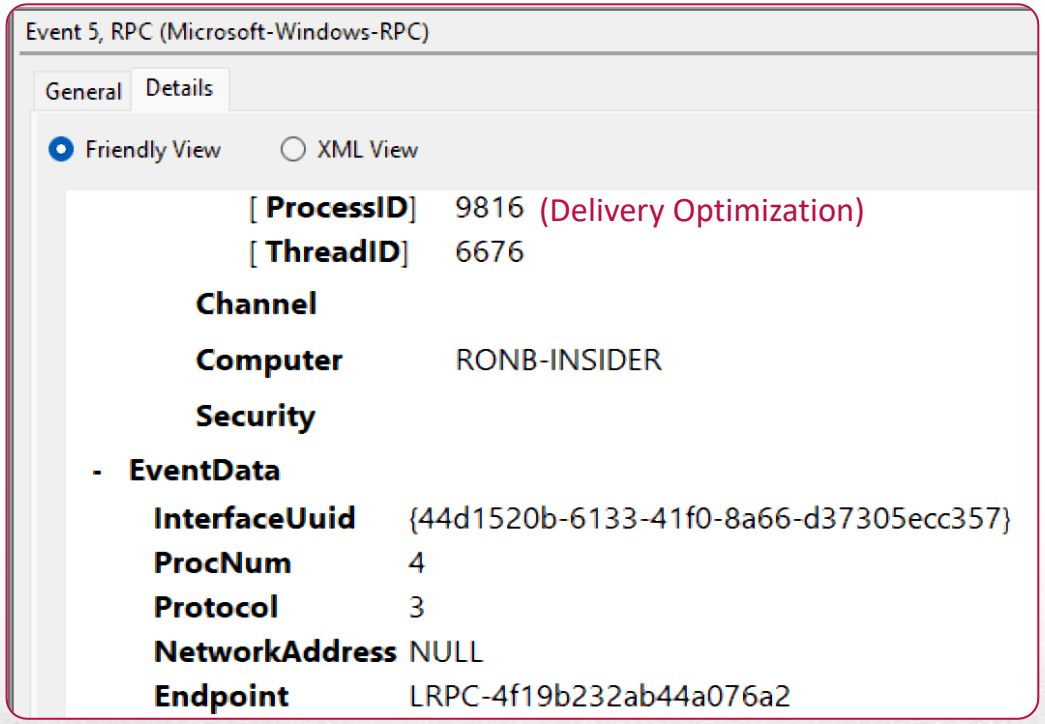
Detection

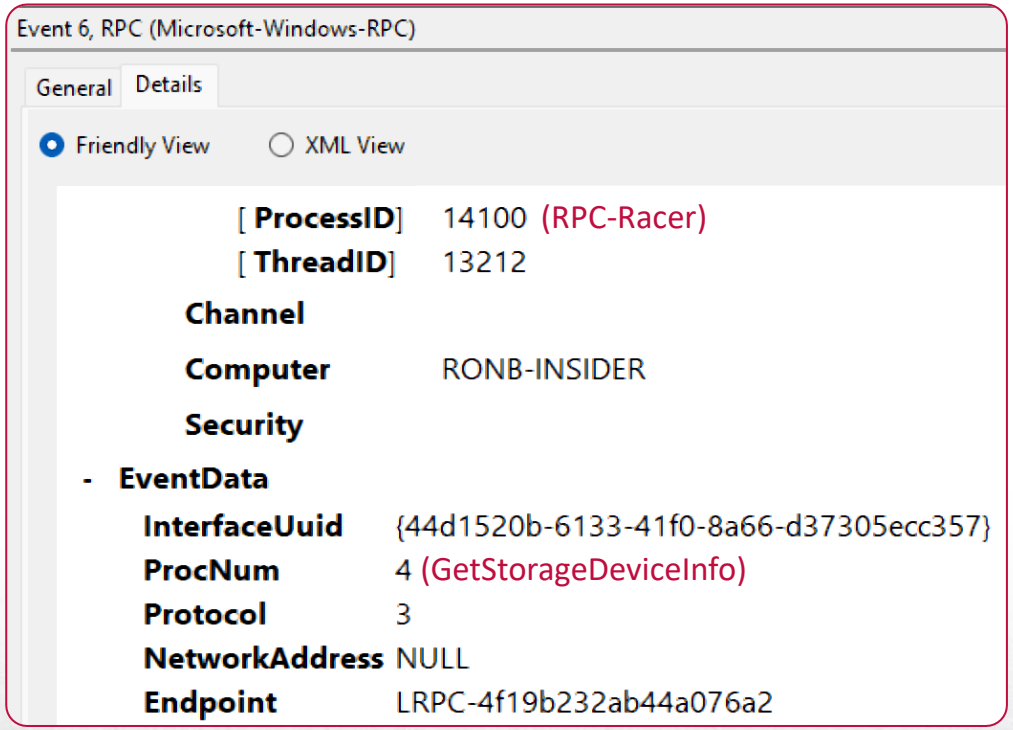
Validate registrations to the EPM



Detection

Monitor ETW





Further Research

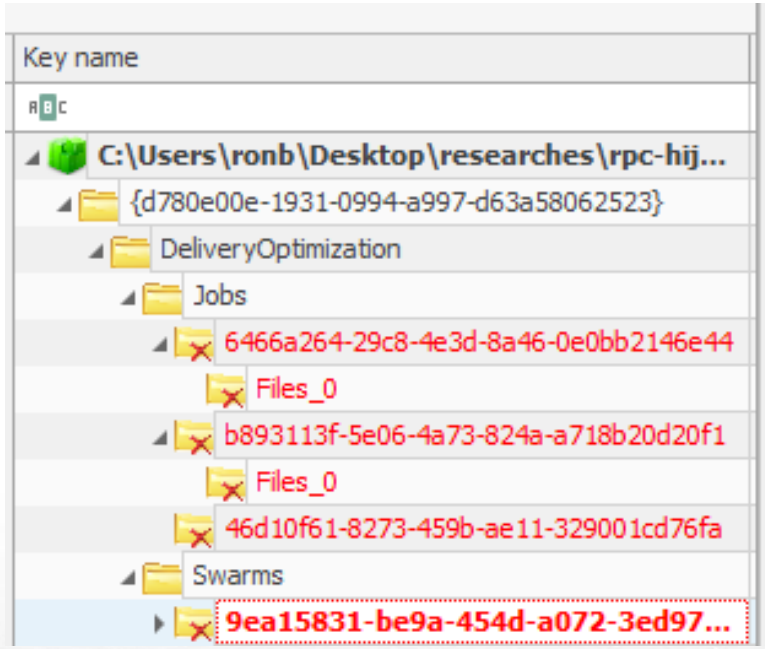
Force DoSvc to use poisoned config files

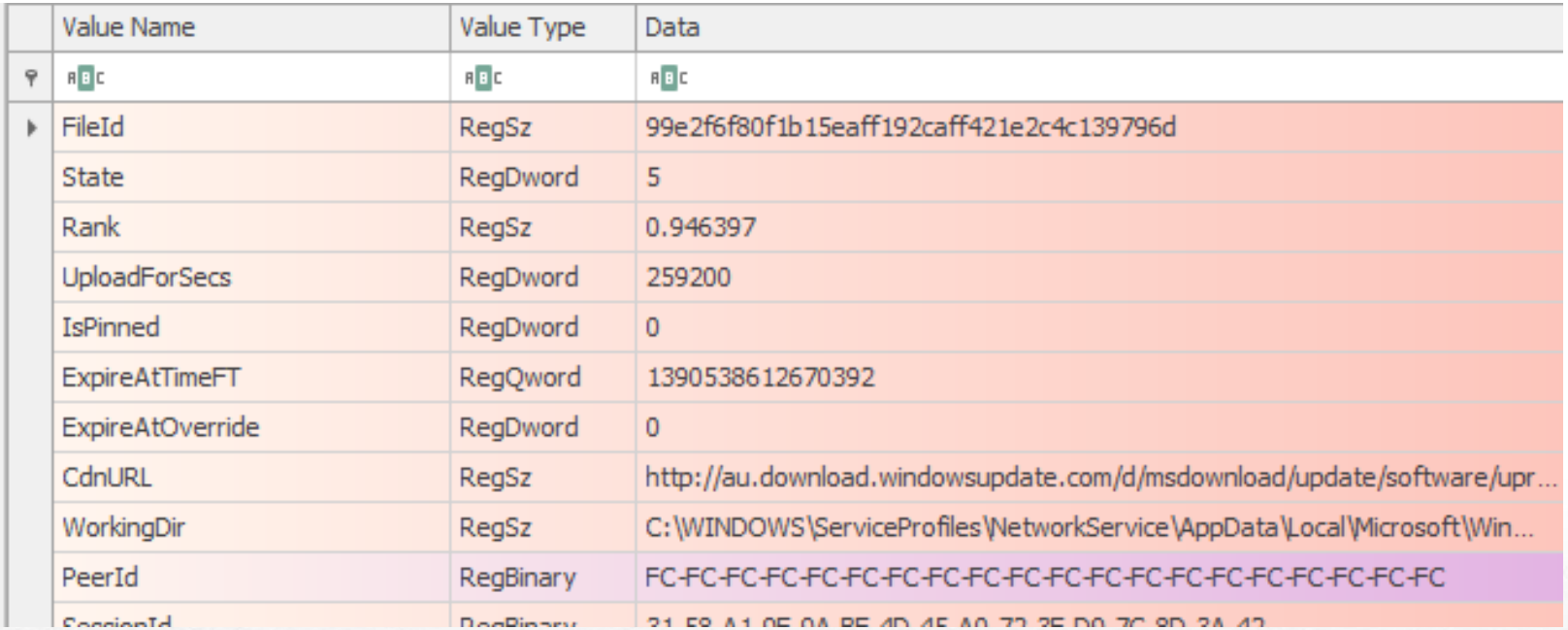

```
{
    "KeyValue_EndpointUri": "https://kv801.prod.do.dsp.mp.microsoft.com/",
    "KeyValue2_EndpointUri": "https://kv801.prod.do.dsp.mp.microsoft.com/",
    "Discovery_EndpointUri": "https://disc801.prod.do.dsp.mp.microsoft.com/",
    "Discovery2_EndpointUri": "https://disc801.prod.do.dsp.mp.microsoft.com/",
    "ContentPolicy_EndpointUri": "https://cp801.prod.do.dsp.mp.microsoft.com/",
    "ContentPolicy2_EndpointUri": "https://cp801.prod.do.dsp.mp.microsoft.com/",
    "KeyValue_EndpointFullUri": "https://kv801.prod.do.dsp.mp.microsoft.com/all",
    "KeyValue2_EndpointFullUri": "https://kv801.prod.do.dsp.mp.microsoft.com/all",
    "Discovery_EndpointFullUri": "https://disc801.prod.do.dsp.mp.microsoft.com/v2/content/{contentId}",
    "Discovery2_EndpointFullUri": "https://disc801.prod.do.dsp.mp.microsoft.com/content/{contentId}",
    "ContentPolicy_EndpointFullUri": "https://cp801.prod.do.dsp.mp.microsoft.com/v3/content",
    "ContentPolicy2_EndpointFullUri": "https://cp801.prod.do.dsp.mp.microsoft.com/content/{contentId}/contentpolicy",
    "Geo_EndpointFullUri": "https://geo.prod.do.dsp.mp.microsoft.com/geo",
    "GeoVersion_EndpointFullUri": "https://geover.prod.do.dsp.mp.microsoft.com/geoversion",
```


C:\Windows\ServiceProfiles\NetworkService\AppData\Local\Microsoft\Windows\DeliveryOptimization\State\keyValueLKG.dat

Further Research

Force DoSvc to use poisoned config files





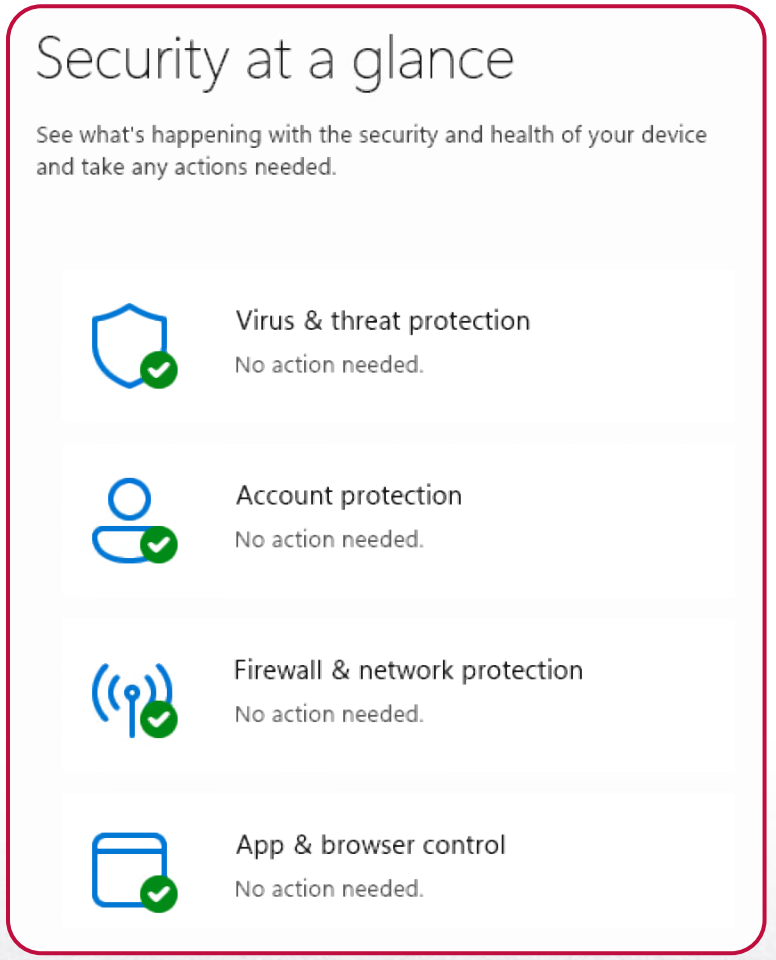
Value Name	Value Type	Data
FileId	RegSz	99e2f6f80f1b15eaff192caff421e2c4c139796d
State	RegDword	5
Rank	RegSz	0.946397
UploadForSecs	RegDword	259200
IsPinned	RegDword	0
ExpireAtTimeFT	RegQword	1390538612670392
ExpireAtOverride	RegDword	0
CdnURL	RegSz	http://au.download.windowsupdate.com/d/msdownload/update/software/upr...
WorkingDir	RegSz	C:\WINDOWS\ServiceProfiles\NetworkService\AppData\Local\Microsoft\Win...
PeerId	RegBinary	FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC-FC

C:\Windows\ServiceProfiles\NetworkService\AppData\Local\Microsoft\Windows\DeliveryOptimization\State\dosvcState.dat

Further Research

Find additional RPC servers with RPC-Recon

Security Center is vulnerable



Conclusion

- New attack discovered – EPM Poisoning
- RPC-Recon is released to map targets
- Methods to analyze clients were shown
- RPC-Racer is released to force NTLM authentication

Thank you

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github.com/SafeBreach-Labs/RPC-Racer